

# **THE WORLD OF SCIENCE WITHOUT BORDERS**

**PROCEEDINGS  
10<sup>th</sup> INTERNATIONAL SCIENTIFIC AND PRACTICAL  
CONFERENCE FOR YOUNG RESEARCHERS**

**April 21, 2023  
Tambov**

# **МИР НАУКИ БЕЗ ГРАНИЦ**

**МАТЕРИАЛЫ  
10-й МЕЖДУНАРОДНОЙ НАУЧНО-ПРАКТИЧЕСКОЙ  
КОНФЕРЕНЦИИ МОЛОДЫХ УЧЕНЫХ**

**21 апреля 2023 года  
Тамбов**



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## FOREWORD

This volume of Proceedings gathers the papers presented at the 10th International conference of young researchers “**The World of Science without Borders**” held at Tambov State Technical University on April 21, 2023. The annual conference was initiated in 2011 as a regular event to allow the participation of graduate and postgraduate students. This type of conference looks particularly appropriate and useful because it addresses research problems from different areas.

The mission of the conference is to remove the barriers on the way of disseminating innovative projects among young scientists. The language of publications is mainly English, serving the purpose of removing all hurdles in the academic communication and firmly positioning Russian science on the global arena.

More than 150 papers have been included in this volume featuring the scope of research interests of students at Tambov State Technical University and partner institutions including young foreign scholars. This selection will be of interest for everybody who is keen on keeping in touch with the science of the young in Russia. The latest research findings can provide a further burst in the development of novel ideas.

*Natalia Gunina, PhD in Linguistics,*

*Head of Department of Foreign Languages and Professional Communication, TSTU*

УДК 690.91  
ББК 31.65

## Technology of Using Biological Waste to Produce Biogas

**J. D. Guseva\*, I. A. Saprykin**

Tambov State Technical University, Tambov, Russia

\*e-mail: JUL.G1305@yandex.ru

### Abstract

The constantly rising prices of fossil fuels make the task of finding alternative, constantly renewable sources of energy very urgent. The use of methods of biological conversion of organic waste in order to obtain gaseous or liquid fuel is currently very promising. Animal waste used as biomaterial becomes a cheap organic fertilizer after processing in a biogas plant reactor. The fertilizer obtained in the course of processing is purified from viral bacteria and can be used on agricultural fields.

**Keywords:** biofuels; biogas; green energy; renewable energy sources.

### Introduction

Biofuel or biogas is the final gaseous product obtained in the process of anaerobic (without air access) fermentation of biological masses. The raw material for biogas production is biomass. The term biomass (BM) is usually understood as carbon-containing organic matter of plant and animal origin (wood, straw, manure, etc.).

### Biogas technologies

In practice, the following methods of processing biomass for the purpose of obtaining energy are used:

- direct combustion for direct heat generation;
- pyrolysis (dry distillation) aimed at obtaining the maximum volume of gaseous fuel (mainly hydrogen and CO). Generator gas has a calorific value in the range of 4-8 MJ/m<sup>3</sup>;
- alcohol fermentation in order to obtain ethyl alcohol (ethanol) from biomass;
- anaerobic digestion, which is the most promising means of obtaining fuel from organic matter. As a result of the action of anaerobic bacteria, biogas is obtained from biomass, consisting mainly of methane (50-80%) and carbon dioxide (20-50%) with traces of hydrogen sulfide, ammonia and other substances.

Anaerobic digestion of biomass in order to produce methane is the most widely used. Through the use of biogas in agriculture, for example, in India, 20% of energy needs are covered, in China - 30%. Biomass can provide 6-10% of the total energy demand of industrialized countries.

The following modes of anaerobic methane digestion are known:

- psychophilic (fermentation process temperature from +15 to +17 °C);
- mesophilic (from +33 to +35 °C);
- thermophilic (from +53 to +55 °C).

Methane digestion is a process of decomposition of organic substances to end products, mainly methane and carbon dioxide, as a result of the vital activity of a complex complex



of microorganisms under anaerobic conditions.

When organic waste is digested, biogas is produced. It is a mixture of gases that contains 50-80% methane, 50-20% carbon dioxide, less than 1% hydrogen sulfide and traces of ammonia.

The content of methane in biogas fluctuates, which significantly affects the calorific value of this fuel. When burning 1 m<sup>3</sup> of biogas with a 50% content of methane, 17.8 MJ of energy is obtained, with a 70% content - 25.0 MJ. When burning 1 m<sup>3</sup> of natural gas, 34 MJ are obtained, and 1 kg of liquid fuel - 42 MJ [1].

In a biogas plant thanks to heating by built-in heat sources, reliable thermal insulation, continuous supply of fresh raw materials

a constant temperature is maintained. When the substrate is mixed, the process of formation and removal of biogas occurs more intensively.

Biogas is obtained using a biogas plant (figure), the main elements of the scheme of which are: a digestion chamber (reactor, methane tank); devices for maintaining a constant temperature in the reactor; a device for mixing the substrate in the reactor; biogas accumulation and storage devices (gas tank)

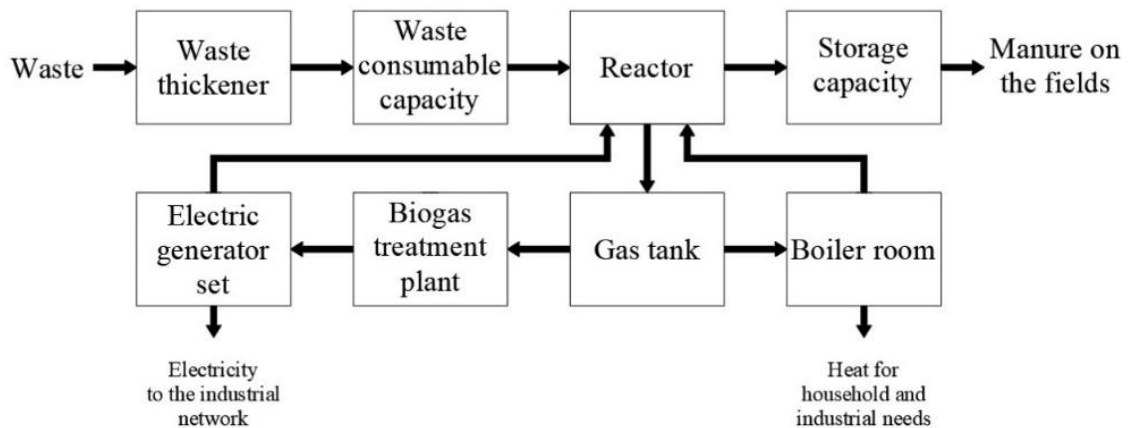


Figure 1 - Block diagram of a biogas plant.

On average, 1 ton of manure with a moisture content of 85% releases 45-65 m<sup>3</sup>, and burning 1 m<sup>3</sup> of biogas produces 2 kWh. This is enough to provide electricity for technological processes in the livestock complex, such as feeding, milking, manure cleaning and space heating. The yield of biogas depends on such factors as the technological time of the fermentation cycle, the loading of the working space, the intensity of mixing, etc. The amount of biogas produced varies depending on the technology used during operation.

To ensure energy production from livestock waste, a biopower plant is installed on the territory of the livestock complex.

The required volume of the bioPP reactor is calculated by the formula:

$$V = mtk,$$

where  $m$  is the amount of manure excreted by the herd per day,  $t$ ;

$t$  is the time required for the beginning of the vital activity of bacteria from the moment the raw material is loaded into the reactor, days.

$k$  is the coefficient that takes into account the formation of the upper biomass cap in the reactor.

Capital costs for the construction of a biopower plant, operating costs for its maintenance (number and salary of personnel, expenses for repairs, spare parts and materials, maintenance of a motor vehicle fleet) and costs for providing raw materials (loading and transporting it to a biopower plant, preparation for burning) are determined in accordance with the required capacity of the biopower plant and the average construction and production standards.

When evaluating economic efficiency, it should be taken into account that a biogas plant provides both manure disinfection and fertilizer production. It also refers to the system of measures for the protection of the environment. In this case, biogas plants will always have a positive economic effect.

### **Conclusion**

The analysis shows that the use of bioPS in single livestock and poultry farms is economically justified with a fairly large, but not super-large number of livestock: about 500 cattle, 100-1500 small cattle, over 50 thousand birds. At the same time, the minimum cost of electricity from a bioelectric power plant based on livestock waste will be 2.74-3.23 rubles per kWh.

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## **Технология использования биологических отходов для получения биогаза**

**Ю. Д. Гусева\*, И. А. Сапрыкин**

ФГБОУ ВО «Тамбовский государственный технический университет», Тамбов, Россия

\**e-mail: JUL.G1305@yandex.ru*

**Аннотация.** Постоянно растущие цены на ископаемое органическое топливо делают весьма актуальными задачи изыскания альтернативных, постоянно возобновляемых источников энергии. Использование методов биологической конверсии органических отходов с целью получения газообразного или жидкого топлива в настоящее время является весьма перспективным. Отходы животноводства, используемые в качестве биоматериала, после переработки в реакторе биогазовой установки становятся дешевым органическим удобрением. Полученное в ходе переработки удобрение является очищенным от вирусных бактерий и может использоваться на сельскохозяйственных полях.

**Ключевые слова:** биотопливо; биогаз; возобновляемые источники энергии; зеленая энергетика.

## Solar Heating System as an Effective and Inexpensive Way to Heat

**A. A. Kolesnikov, A. S. Nazarov, V. V. Ryzhov**

Tambov State Technical University, Tambov, Russia

*\*e-mail: palkanov.palkan@mail.ru*

### **Abstract**

Solar heating system is a solar system that can be used for warming of water and maintaining of heating. Owing to the fact that solar energy is available for free there is a saving of fossil fuels. Furthermore, the investment in the solar heating system repays in a few years. The relevance lies in obtaining a free source of energy.

**Keywords:** Solar thermal system, collector, condensing boiler, hot water tank.

Collecting panels must to harvest solar rays so that there is a possibility of using solar energy. Evacuated tube and flat plate collectors were designed for this purpose. They absorb the solar rays and transform them into usable warmth. In addition to collectors, solar heating system consists of absorber, solar circuit and solar liquid that is used as heat exchanger.

When the rays hit the panels, their energy is converted into heat in the absorber. First, it comes into a buffer storage tank or into a storage tank of drinking water, and from there it is distributed along the circuit in the household - either as a support for the heating circuit, or for heating service water. Then, as needed, the warm water from the storage tank reaches the taps, such as a mixer tap or shower.

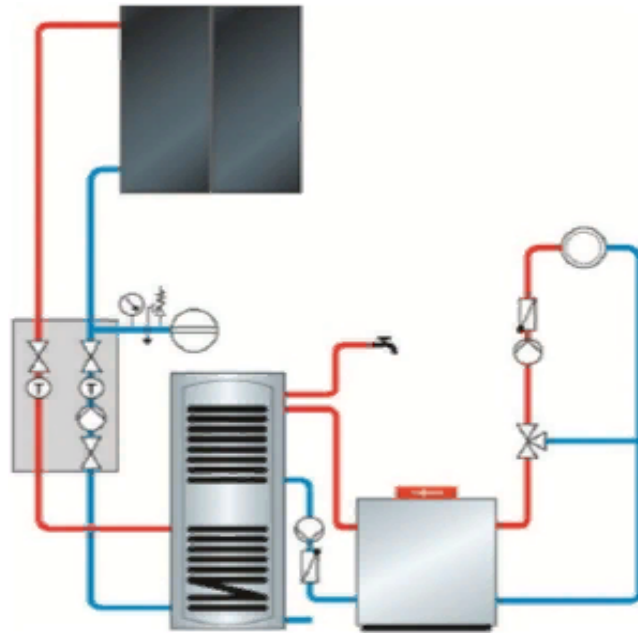
Solar systems are ideal for heating drinking water and maintaining the temperature of the coolant in the heating system. The system works most effectively at an angle of attack by sunlight from 30 to 55 degrees and a southern orientation.

Solar thermal systems have a service life of at least 20 years. Their main advantage is that they can be quickly and easily connected to an existing heating system.

During the year, the solar thermal system can cover up to 50 percent of the need for hot water. With a heating maintenance system, costs can be reduced by 30 percent.

There are several basic versions of solar heating systems.

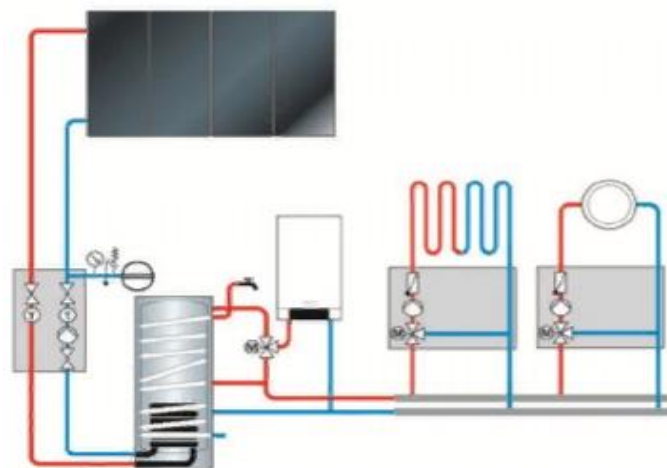
The first solar system with a divalent tank for heating hot water is shown in Fig.1.



*Figure 1 - Solar system with a bivalent hot water tank*

If there is enough solar radiation, then the tank in the solar system heats up. The core of this solution is a bivalent hot water tank. The water in the capacitive water heater is heated through the lower heat exchanger. If the temperature decreases due to water intake during the shower, the boiler will turn on and water heating will start along the second heating circuit.

The second solar system for heating drinking water and heating is shown in Fig. 2.



*Figure 2 – Solar system for water and heating*

In addition to heating water, the solar system can also be used for additional heating of water for heating, for this it uses a circuit through a heat exchanger, which is continuously heated by the heat of solar panels.



*Figure 3 - The location of the elements of the solar heating system  
1 - condensing boiler; 2 - combined tank for water and maintaining of heating  
system; 3 - flat plate solar collectors*

Thus, energy-saving construction methods and economical heating systems such as condensing boiler units and solar collectors can significantly reduce energy consumption and thereby save resources and contribute to the protection of the Earth's atmosphere.

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### **Солнечная система отопления - эффективный и недорогой способ обогрева**

**А. А. Колесников, А. С. Назаров, В. В. Рыжов**

ФГБОУ ВО «Тамбовский государственный технический университет», Тамбов, Россия  
*e-mail: palkanov.palkan@mail.ru*

**Аннотация.** Солнечная система отопления – это солнечная система, которую можно использовать для нагрева воды и поддержания отопления. Благодаря тому, что солнечная энергия доступна бесплатно, происходит экономия ископаемого топлива. Кроме того, инвестиции в систему солнечного отопления окупаются за несколько лет. Актуальность заключается в получении бесплатного источника энергии.

**Ключевые слова:** солнечная тепловая система, коллектор, конденсационный котел, бак для горячей воды.

## Osmotic Generation as an Alternative Energy Production

**A. Y. Kudinov, R. V. Gorshkov, V. O. Mikhailov**

Tambov State Technical University, Tambov, Russia

*e-mail: kudinov2.000@list.ru*

### **Abstract**

The article is devoted to one of the promising technologies in the field of alternative energy - osmotic plant. This paper gives a definition of this technology, as well as examples of its application in the energy sector.

**Keywords:** energy, alternative energy, technology, osmotic generation.

Osmotic energy generation is a renewable energy source that does not cause atmospheric pollution, but creates only moderate emissions into the sea. Worldwide, the energy potential of osmotic generation is estimated to be about 1,650 TWh, which is about 12 times the annual energy production in Norway.

The principle of osmotic energy generation is the release of so-called "mixing energy" when fresh water is mixed with salt water. The osmotic generating station uses a semi-permeable membrane to extract this energy.

When fresh water is mixed with salt water, energy is released. To use this energy, seawater and freshwater must meet on either side of the membrane, and the pressure on the seawater side must be higher. The fresh water will then flow through the membrane to the seawater side, which will cause the pressure on that side of the membrane to increase. The increased water pressure is used to drive the turbine and generate electrical energy.

The challenge is to get the membrane to let the water through, keeping the salt out. In other words, a good membrane will have "inconsistent" properties. In our case, as mentioned above, this is to create a "transition state" in which water passes through the membrane, but salt is trapped. In other words, the membrane must be able to pass salt and water simultaneously.

Other objectives are to create a membrane that is both efficient and durable enough to withstand operation over a long period of time, as well as having good resistance to external factors such as water, steam and ozone.

Currently, the most common materials for making membranes are polymers. However, even polymers cannot fully meet these requirements.

To solve this problem, many attempts have been made to create new materials. For example, in order to create ozone-resistant membranes, it was proposed to use silica-based materials in their composition. This is not an easy task: an osmotic power plant corresponding to a medium-sized hydroelectric power plant would require membranes that are many times larger than the largest desalination plants built to date.

To achieve the required energy efficiency, up to five million square meters of membranes would be required to operate a 25 MW osmotic generating plant. This can

be achieved by packaging the membranes in special modules, with each cubic meter of module containing up to 1,000 square meters of membrane. This makes it possible to build compact generating plants that make efficient use of space.

The membranes are about a tenth of a millimeter thick and consist mainly of two layers. One layer has separating properties that allow water to pass through it, while salt does not. The other layer acts as a support structure for the separating membrane. It is not just the membrane that affects energy production in an osmotic power plant: Among other things, the organic material in the water used in the plant can also cause problems.

Water in rivers and lakes contains both dissolved substances and solids that can cause membrane contamination. One of the main activities of this project will be to conduct tests both in the field and under controlled conditions in the laboratory. This will provide insight into the effects of such contamination on membrane performance over a period of time.

The idea of osmotic energy production originated around 1950, and some twenty years later a number of theories were published concerning the potential of this method for energy production. This attracted the interest of two research scientists, Torleif Holt and Thor Thorsen, who began studying the concept in the early 1980s and have been working on a viable method of renewable energy production based on osmosis ever since.

The first research project began in 1997. Since then, continuous activities in the field of osmotic energy production have continued, and SINTEF now has world-leading expertise in this field.

The method of generating osmotic energy was also developed by Sidney Loeb and called pressure-retarded osmosis. Pressure-retarded osmosis (PRO) represents the energy of mixing a concentrated salt solution with a dilute solution. In practice, osmotic energy can be obtained using PRO when the concentrated and dilute solutions are separated by a selective semi-permeable membrane that allows water movement but rejects most ionic species. The concentrated solution (pumping solution) is pressurized and pumped into the PRO membrane, which separates the pumping solution from the dilute solution (feed solution). The difference in osmotic pressure between the pumping and feed solutions causes fresh water to move across the membrane and dilute the pumping solution. The pressurised pumping solution then travels to a special water turbine system for power generation. Experimentally, the PRO process is a viable technology, but most of the work has been done on a laboratory scale and only a few pilot installations have been made. Experimental work has also revealed the influence of the intrinsic properties of the membranes on the performance of the PRO process. The concentration of the feed solution and the dilution of the pumping solution often referred to as the intrinsic and extrinsic concentration polarities have been experimentally measured and found to have an adverse effect on the process performance.

Altaee et al. recently proposed a two-stage PRO (DSPRO) process in an effort to reduce the effect of concentration polarization and improve osmotic plant

performance. In practice, the concentration of feedstock in osmotically controlled membrane processes tends to reduce the osmotic pressure gradient and water flux. Unlike pressure-controlled membrane processes, which suffer from concentration polarization on the inlet side, osmotically controlled membrane processes suffer from concentration polarization on both sides of the membrane. In the DSPRO process, the concentrated pumping solution from the first stage of the PRO process is replaced by fresh pumping solution to exchange fresh water with the already pressurized pumping solution from the first stage. Theoretical studies have shown that the DSPRO process is able to increase the energy yield of the PRO process by more than 18%. Leaving aside the problems of membrane fouling, studies have shown that the DSPRO process is more efficient for a high concentration feed solution such as seawater or brine from RO. DSPRO does not require an extra high-pressure pump for the feed solution because the pressurized feed solution from the first stage of the PRO process is recycled to the second stage.

Thus, the development of alternative energy leads to more and more new technologies and ideas, one of which was the development of osmotic energy generation. Osmotic energy generation can become a direction that can bring new ideas for the development of alternative energy.

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## **Осмотическая генерация как альтернативная добыча электроэнергии**

**А. Ю. Кудинов, Р. В. Горшков, В. О. Михайлов**

ФГБОУ ВО «Тамбовский государственный технический университет», Тамбов, Россия  
*e-mail: kudinov2.000@list.ru*

**Аннотация.** Статья посвящена одной из перспективных технологий в сфере альтернативной энергетики – осмотической станции. В данной работе дано определение этой технологии, а также приведены примеры её применения в энергетике.

**Ключевые слова:** энергетика, альтернативная энергетика, технологии, осмотическая генерация.



## **Einige Ergebnisse von Vorstudien zur Schaffung eines Industriereaktors für die oxidative Torrefizierung von Bioabfall**

**O. Yu. Milowanow, R. L. Isemin, A. W. Mikchalew,  
D. W. Klimow, S. N. Kuzmin, N. S. Muratova, A. E. Sakowych**  
Staatliche Technische Universität Tambow, Tambow, Russland  
*\*email penergy@list.ru*

### **Zusammenfassung**

Es wird vorgeschlagen, den Torrefizierungsprozess von Bioabfallarten, wie einer Mischung aus Hühnermist und Holzsägemehl, Holzsägemehl und Sonnenblumenschalen, in einer Wirbelschicht durchzuführen, die durch den zerkleinerten Bioabfall gebildet wird, der aus den austretenden Rauchgasen geblasen wird. Die vorläufigen Untersuchungen des oxidativen Torrefizierungsverfahrens zeigten, dass die Verweildauer von Biomassepartikeln in einem solchen Reaktor 5 Minuten nicht überschreiten darf. Um die angegebene Verweildauer der Biomassepartikel im Oxidations-Torrefizierungs-Reaktor zu gewährleisten, wird vorgeschlagen, in einer Wirbelschicht mehrere senkrechte Trennwände in einem Abstand von 50 mm zueinander anzubringen. Diese Trennwände sorgen für eine schleifenartige Bewegung des Bioabfallmaterials von der Beladestelle in den Reaktor bis zur Entladestelle. Wie Untersuchungen an einer Kälteapparatur zeigten, können diese Trennwände für die notwendige Verweildauer im Reaktor und einen festgelegten Grad der Bioabfallbehandlung sorgen. Für einen Reaktor mit einem Durchmesser von 1m sorgt das Vorhandensein eines solchen Pakets von Trennwänden für eine Verweildauer von Biomassepartikeln in einer Wirbelschicht von 5 Minuten mit einer Reaktorproduktivität von 300 kg/h in der anfänglichen Biomasse oder 150 kg/h in die resultierende Pflanzenkohle.

**Schlüsselwörter:** Bioabfall-Torrefizierung, oxidative Torrefizierung, Wirbelschicht.

Biomasse ist ein CO<sub>2</sub>-neutraler und weit verbreiteter Brennstoff. Ihre breite Anwendung ist jedoch dadurch begrenzt, dass die anfängliche Biomasse einen niedrigeren Heizwert, eine höhere Feuchtigkeit und eine geringere Schüttdichte als fossile Brennstoffe hat. Die Torrefizierung ist eine Methode der Behandlung bei niedriger Temperatur (200 - 300 ° C) in einer sauerstofffreien Umgebung, die die Feuchtigkeit der Biomasse reduzieren, die hydrophoben Eigenschaften der Biomasse erhöhen und den Heizwert von Biomasse erhöhen kann, machen die Biomasse für die weitere thermische Verarbeitung durch Pyrolyse, Vergasung und Verbrennung besser geeignet (Chen et al., 2015).

Gleichzeitig ist die Torrefizierung ein energieaufwändiger Prozess, und die Verwendung eines Inertgases (Stickstoff) macht diesen Prozess noch teurer.

Es ist wirtschaftlicher, nicht Inertgas, sondern Rauchgas aus einem Kessel oder Ofen zu verwenden (Mei et al., 2015, Uemura Y et al., 2017). Die Sauerstoffkonzentration im Rauchgas kann zwischen 6 und 14 Vol.-% liegen. (Uemura Y. et al., 2017). Bei der oxidativen Torrefizierung von Biomasse werden neben Reaktionen, die mit der Entfernung eines Teils der flüchtigen Substanzen und Sauerstoff verbunden sind, auch exotherme Reaktionen beobachtet. Diese Reaktionen

tragen zur Reduzierung des Energieverbrauchs für den Torrefizierungsprozess bei. Bei der oxidativen Torrefizierung wird auch die für die Torrefizierung benötigte Zeit reduziert. Um den gleichen Massenverlust wie bei der nicht-oxidativen Torrefizierung zu erzielen, sind bei der oxidativen Torrefizierung niedrigere Temperaturen erforderlich (Chen W.-H., et al., 2014).

Leider wird die oxidative Torrefizierung nur in Laboraufbauten, einschließlich Wirbelschichtreaktoren, durchgeführt (Wang Z., et al., 2018). In dieser Forschung untersuchten wir den Prozess der oxidativen Torrefizierung von Sägemehl in Wirbelbett aus Glaskugeln mit einem Durchmesser von 1,0 mm bei einer Temperatur von 240 - 300 °C und einer Sauerstoffkonzentration im Gasgemisch, das dem Reaktor zugeführt wurde, von 0 bis 9 Vol. %. Die Versuche haben gezeigt, dass es bei oxidativer Torrefizierung möglich ist, den Brennwert von Sägemehl auf 22 MJ/kg zu erhöhen (in Abwesenheit von Sauerstoff überschritt der höhere Brennwert 20 MJ/kg nicht), den Hemicellulosegehalt auf 8,1 % zu reduzieren gegenüber 14,5 % in Abwesenheit von Sauerstoff, und den Gehalt an flüchtigen Substanzen auf 56 % gegenüber 70,38 % zu reduzieren, den Gehalt an festem Kohlenstoff auf 43 % gegenüber 29 % zu erhöhen. Die oxidative Torrefizierung liefert also Biobrennstoffe, die für die gemeinsame Verbrennung mit Kohle besser geeignet sind als die nicht-oxidative Torrefizierung.

Andererseits ist es in einer Wirbelschicht schwierig, eine gleichmäßige Verarbeitung von Rohstoffen sicherzustellen. In Papier (Wang Z., et al., 2018) wurde Sägemehl kontinuierlich in einen Torrefizierungsreaktor eingeführt. Bei der Verarbeitung des Sägemehls verlor das Sägemehl an Gewicht, wurde durch einen Gasstrom aus der Wirbelschicht entfernt und in einem Zyklon vom Gasstrom getrennt. Es stellte sich heraus, dass nach 50 Minuten Dauerbetrieb des Versuchsaufbaus nicht alle Sägespäne das Wirbelbett aus Glaskugeln verlassen konnten, was zu einer Erhöhung der Betthöhe um 10–30 % führte. Sägemehl, das nach kontinuierlicher oxidativer Torrefizierung für 50 Minuten bei einer Temperatur von 300 °C aus einem Wirbelbett entnommen wurde, enthielt 56 % flüchtige Stoffe und 43 % festen Kohlenstoff, und aus einem Zyklon ausgewählt, enthielt es 78 % flüchtige Stoffe und 22 % festen Kohlenstoff. So betrug der Heterogenitätsgrad der Biomasseverarbeitung in den Experimenten (Wang Z., et al., 2018) 39 - 95 %.

Gemäß einem Vertrag mit dem russischen Ministerium für Wissenschaft und Hochschulbildung haben wir eine Reihe von Geräten zur Erzeugung von thermischer und elektrischer Energie aus Bioabfällen (einer Mischung aus Hühnermist und Sägemehl, Sonnenblumenschalen, Holzabfällen und anderen) entwickelt. Der Komplex umfasst einen 2-MW-Kessel, der mit einem Wirbelschichtofen ausgestattet ist, in dem Bioabfälle verbrannt werden. Im Kessel wird ein Hochtemperaturkühlmittel auf 160 °C erhitzt, das einem Turbogenerator des Herstellers ZUCCATO ENERGIA S.r.l., (Italien) mit dem organischen Rankine-Zyklus zugeführt wird. Der Turbogenerator erzeugt 250 kW elektrische Energie. Die Rauchgase hinter dem Kessel enthalten 6 % Sauerstoff und haben eine Temperatur von 350 °C. Es wird vorgeschlagen, diese Gase zur oxidativen Torrefizierung von Bioabfällen zu

verwenden. Basierend auf unseren eigenen Forschungserfahrungen im Bereich der Torrefizierung verschiedener Bioabfälle (Isemin R., et al., 2018), auch in einer Wirbelschicht (Isemin R., 2019), und unter Rückgriff auf die Erfahrungen bei der Auslegung von Anlagen zur Wärmebehandlung von Biomasse in einem Wirbelbett (Isemin R., et al., 2016) haben wir uns für ein oxidatives Torrefizierungsverfahren im Wirbelbett für die Bioabfallverarbeitung entschieden.

### **Danksagungen**

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## **Некоторые результаты предварительных исследований по созданию промышленного реактора для окислительной торрефикации биоотходов**

**О. Ю. Милованов, Р. Л. Исёмин, А. В. Михалёв, Д. В. Климов,  
С. Н. Кузьмин, Н. С. Муратова, А. Е. Саковых**

ФГБОУ ВО «Тамбовский государственный технический университет», Тамбов, Россия  
*e-mail penergy@list.ru*

**Аннотация.** Процесс торрефикации видов биоотходов, таких как смесь куриного помета и древесных опилок, древесных опилок и лузги подсолнечника, предлагается проводить в псевдооживленном слое, который образован измельченными биоотходами, выдуваемыми из дымовых газов, выходящих из котла. Предварительные исследования процесса окислительной торрефикации показали, что время пребывания частиц биомассы в таком реакторе не может превышать 5 минут. Для обеспечения указанного времени нахождения частиц биомассы в реакторе окислительной торрефикации предлагается разместить количество вертикальных перегородок, установленных на расстоянии 50 мм друг от друга в псевдооживленном слое. Эти перегородки обеспечивают петлеобразное перемещение биоотходного материала от места загрузки в реактор к месту выгрузки. Как показали исследования на холодном аппарате, эти перегородки могут обеспечить необходимое время пребывания в реакторе и заданную степень обработки биологических отходов. Для реактора диаметром 1 м наличие такого пакета перегородок обеспечивает время нахождения частиц биомассы в псевдооживленном слое в течение 5 минут с реактором производительность 300 кг/ч в исходной биомассе или 150 кг/ч в полученном биоугле.

**Ключевые слова:** торрефикация биоотходов, окислительная торрефикация, псевдооживленный слой.

## Development Potential of “Smart Grid” Concept in Russia

E. A. Semyaninova<sup>\*1</sup>, I. E. Rodionova<sup>2</sup>

<sup>1</sup>Tambov State Technical University, Tambov, Russia

<sup>2</sup>Saint-Petersburg National Research University of Information Technologies, Mechanics and Optics, Saint-Petersburg, Russia

*\*e-mail: semyaninova2000@mail.ru*

### Abstract

The purpose of this study is to discuss the development process of energy digitalization based on the concept of «smart grid». Technology application and its most relevant directions have been studied; key development goals have been identified. The benefits of integrated interfaces to energy businesses' operations are discussed, and the prospects for implementing the concept in Russia are evaluated.

**Keywords:** integrated interfaces, power efficiency, smart grid, smart city

### Introduction

The digital economy of the future is fundamentally dependent on digital energy. According to experts, digitization would enable enterprises within the Russian electric power complex to increase short-term revenue growth by 3-4% and lay the groundwork for future long-term, sustainable growth. The advancement and application of the concept of «smart» power supply networks is one of the current worldwide trends, and it is also one of the top priorities for the growth of the Russian energy sector.

### Current state of smart grids in Russia

Smart grids are modernized power networks that can automatically increase the efficiency, reliability, economic benefit, and sustainability of electricity production and distribution by collecting information about energy production and consumption using information and communication networks and technologies.

A smart city is a complex system of information and communication technologies that should ensure the energy efficiency of urban facilities.

One of the most important elements of a smart city is its energy infrastructure, which significantly enhances the city's sustainable development objectives and gives its citizens a cleaner environment.

Maintenance of a smart city requires reliable power supply and integration of smart grid components, which are operated by utility businesses to enable sustainable transformation in the urban environment.

The main elements are the integration of distributed generation, energy storage systems, electric vehicles and smart lighting systems. The cross-cutting nature of smart grids and smart city components will be involved in shaping the future of urban life.

The use of «smart grids» contributes to improving the quality and continuity of electricity, optimizing operating costs and improving the financial performance of the

service organization. Due to this concept, consumers will be able to use high-quality electricity, and organizations will be able to increase the convenience in their work.

Three current trends in implementation of smart grids can be identified:

- measuring instruments and devices (e.g., smart meters and smart sensors);
- an integrated development environment and decision support methods, power demand control, distributed automatic systems for monitoring the current production control and new methods for planning and designing both the development and operation of the power system and its elements;
- integrated means of communication.

Moreover, it is possible to single out the key goals for the development of the smart grids concept for energy companies:

- reduction of energy resources losses;
- the possibility of equalizing the electrical load at different times of the day;
- increase in the efficiency of energy companies' asset management;
- improvement of the quality of introduction of renewable and distributed generation facilities into the energy system;
- improvement of the reliability of the power system in case of emergencies.

In order to accomplish the above goals, numerous methods and interfaces assist in enhancing the performance of energy organizations.

Network operators use integrated interfaces for working with big data, predicting possible emergencies and their analysis, including assessment of actions in case of their occurrence. Operators can improve their skills and improve their work efficiency on software simulators using improved interfaces and decision support (IIDS) methods.

In Russia, work on the introduction of electricity metering devices and smart lighting, as well as ASCEM and SCADA programs, to the mass use is relevant.

ASCEM (automated system for commercial electricity metering) – provides for the collection, processing and storage of energy consumption generation values received from metering equipment.

SCADA (supervisory control and data acquisition) – a program that gives real-time operator control over technical processes by gathering, processing, displaying, and archiving information about the monitoring (control) object.

Such programs frequently lack visualization to capture the scale of the work. This is one of the main shortcomings of existing interfaces and makes it challenging to comprehend what must be done precisely to assess the data, adopt a solution, and implement it.

### **Conclusion**

Despite the fact that the digitalization of the energy industry is in full swing, foreign experience in implementing smart grids cannot be fully applicable in Russia. This is explained by the following factors:

- the existence of a significant «technological gap» estimated to be at least 10-15 years long and the level of machine wear in Russia being nearly twice as high as rates from abroad;

– a small degree of decentralized management of electric power facilities. At the present moment, consumers are only considering the possibility of withdrawing from the unified energy system formed in the country.

Therefore, in order to obtain and use the maximum value of smart grid technology, the functions provided by the programs and interfaces discussed in the article are not sufficient. There is a need to refine them in order to obtain a more complete picture of the work of the staff, which is of further research interest.

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## Потенциал развития концепции «умные сети» в России

Е. А. Семьянинова<sup>\*1</sup>, И. Э. Родионова<sup>2</sup>

ФГБОУ ВО «Тамбовский государственный технический университет», Тамбов, Россия

<sup>2</sup>Национальный исследовательский университет ИТМО, Санкт-Петербург, Россия

<sup>\*</sup>*e-mail: semyaninova2000@mail.ru*

**Аннотация.** В статье рассматривается процесс развития цифровизации энергетики, основанной на концепции «умные сети». Исследовано применение данной технологии, наиболее актуальные направления и определены ключевые цели развития. Описаны интегрированные интерфейсы, способствующие улучшению работы энергетических компаний, а также оценены перспективы внедрения концепции в России в настоящее время.

**Ключевые слова:** интегрированные интерфейсы, умные сети, умный город, энергоэффективность

# Production and Use of Green Hydrogen Based on Renewable Energies

Meriem Slimanou\*, V. F. Kalinin

Tambov State Technical University, Tambov, Russia  
*e-mail: slimanou.meriem@gmail.com*

## Abstract

The article describes how to produce and store green hydrogen from renewable sources. The intermittency of production and the desynchronization between production and consumption are resolved by a hydrogen storage unit which ensures continuity of supply for demand. The method of hydrogen production based on renewable sources called water electrolysis is defined.

**Keywords:** micro-grid, renewable energies, electrolyze, hydrogen storage.

## Introduction

Given the energetic asymptotic trajectories of fossil origins which are inevitably on the decline, or even to the disappearance as well as societal constraints highly damaging that will result from it, then micro-grids integrating renewable energy sources are a major challenge for the future energy situation. The main disadvantage of renewable energy sources lies in their strong intermittent character. Indeed, the production of energy electrical of these sources is very dependent on the variability of the weather conditions and the rotations of our planet.

To overcome this deficit, it is customary to use storage devices that are mostly aimed at two ends, the short and the long term. In general, short-term energy storage is provided by a classically battery-type system. Although this solution may be of interest for this situation, it nevertheless remains that batteries do not necessarily appear to us as always optimal solutions, neither in terms of ecology (highly polluting metallurgy, toxic materials, and corrosive substances) nor in terms of durability [1, 2]. Hydrogen solves the problem of long-term storage. The latter consists of an electrolyser, a fuel cell and a storage tank.

The importance of this article is to explain the principle of the electrolyser which makes it possible to produce green hydrogen.

## Hydrogen production

Wind and solar PV power productions are variable and difficult to predict. Introduction of electrolytic hydrogen into an intermittent renewable power generating system can increase the flexibility of the system. Hydrogen is then often regarded as an energy storage or energy carrier. The produced hydrogen could be stored locally, fed into the natural gas infrastructure, and be used in transport, heating, re-electrification in power plants, or as feedstock for the chemical and petrochemical industries [3].

Green hydrogen is generated by electrolyzing water. This procedure consists in carrying out the decomposition of the water element ( $H_2O$ ) into dihydrogen ( $H_2$ ) and

dioxygen (O<sub>2</sub>) thanks to an electric current. To do this, we use a device called an electrolyzer and electricity of renewable origin generated for example by photovoltaic panels. The hydrogen produced in this way is considered completely clean and therefore green.

A DC electrical power source is connected to two electrodes, or two plates (typically made from an inert metal such as platinum or iridium) that are placed in the water. Hydrogen appears at the cathode (where electrons enter the water), and oxygen at the anode [4], Assuming ideal faradaic efficiency, the amount of hydrogen generated is twice the amount of oxygen, and both are proportional to the total electrical charge conducted by the solution. [5]

In pure water at the negatively charged cathode, a reduction reaction takes place, with electrons (e<sup>-</sup>) from the cathode given to hydrogen cations to form hydrogen gas. The half reactions, balanced with acid, are:

Cathode (reduction):



Anode (oxidation):

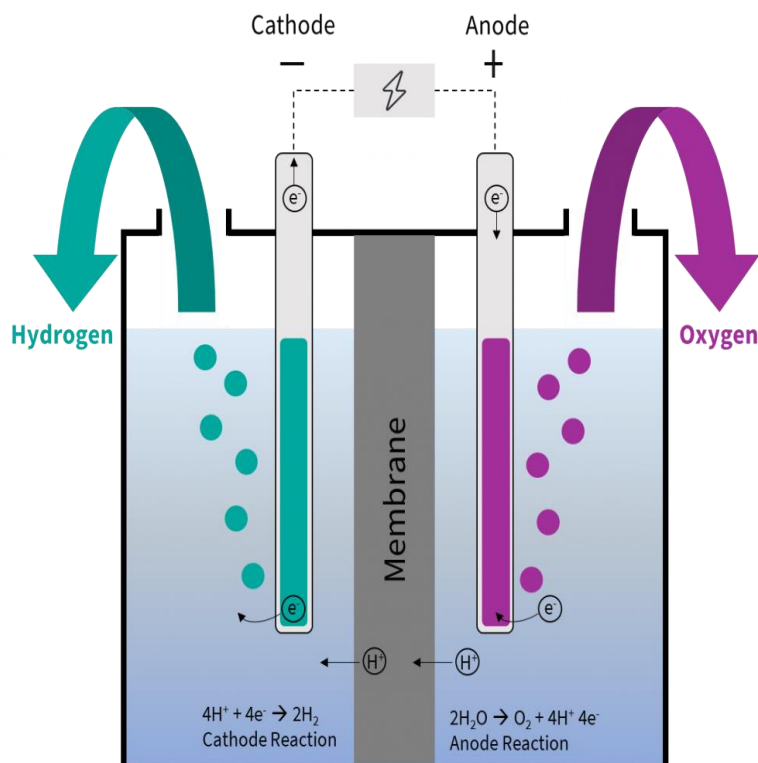
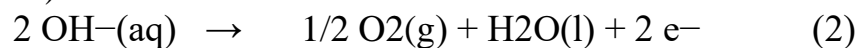


Figure 1- Proton Exchange Membrane (PEM) electrolysis. [6]

## Conclusion

Hydrogen is considered a versatile solution to meet several challenges related to the energy transition. It acts both as an energy carrier as a substitute for hydrocarbons



and as an energy storage medium. Its chemical and molecular natures allow it to be stored or transported.

In this article we have seen how to produce dihydrogen from electrolysis which is used in various industrial processes.

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## **Производство и использование зеленого водорода на основе возобновляемой энергии**

**М. Слиманоу\*, В. Ф. Калинин**

ФГБОУ ВО «Тамбовский государственный технический университет», Тамбов, Россия  
*e-mail: [slimanou.meriem@gmail.com](mailto:slimanou.meriem@gmail.com)*

**Аннотация.** В статье описывается, как производить и хранить зеленый водород из возобновляемых источников. Прерывистость производства и десинхронизация между производством и потреблением решаются с помощью хранилища водорода, которое обеспечивает непрерывность поставок для спроса. Определен метод производства водорода на основе возобновляемых источников, называемый электролизом воды.

**Ключевые слова:** возобновляемые источники энергии, микросеть, хранение водорода электролизер.

**Application of Accelerated Synthesis Technology  
of Electrodynamic Models in the Development of Two-Mirror of Offset  
Antenna Complexes of Mobile Radio Communication Ka and Ku  
Ranges**

**P. P. Borovikov**

Tambov State Technical University, Tambov, Russia

(*e-mail: protote01@mail.ru*)

**Abstract**

The article presents the advantages of using accelerated synthesis technology in the design of electrodynamic structures on the example of developing a model of a two-mirror offset Ka-band antenna of the Cassegrain system.

**Keywords:** synthesis, two-mirror antenna

At present, satellite communication systems are developing at a fairly high pace, in particular those that use the technology of small base stations.[1] Their work carried out in a variety of frequency ranges: C, Ku, K, Ka, etc.

The main difficulties that arise in the construction of such systems are as follows: the inability to quickly install and tune the terminal to the required orbital position, not always sufficient gain of the transmitting antenna of a small satellite station, as well as weight and size indicators.[2] These restrictions do not allow adequate implement data transfer with the features that are laid down in these standards. Therefore, it is proposed to use efficient antennas that have a high gain. These include reflective antennas. At the moment there are several types of them: offset, direct focus, with a mirror of complex configuration, as well as antenna systems, built according to technology with two mirrors, called two-mirror, which in turn have several varieties. The use of direct-focus one- or two-mirror antennas is not can always be justified, since they can be quite cumbersome, and represent difficulty in adjusting to an orbital position, since they have a rather narrow diagram orientation, which will not allow you to connect to the mobile satellite communication complex in the shortest possible time.

To solve this problem, it is proposed to use offset two-mirror antennas. Their exclusivity lies in the fact that they are quite simple in their installation and configuration, with sufficiently small weight and size characteristics, such an antenna, due to the effective use of the aperture area, has a large gain, which is important factor for mobile satellite communication stations. In addition, it is equally effective in northern, southern and equatorial latitudes. When developing such an antenna structure, a large number of difficulties arise in the form of cumbersome calculations and various calculation procedures. This article proposes the use of technology for accelerated synthesis of electrodynamic structures, which consists in building the

necessary phenomenological model in one of the specialized software packages for electrodynamic modeling. As a result of the synthesis and analysis of this model, we obtain the necessary antenna structure that satisfies key development requirements. This technology is applicable to the development of all types of antennas.

An example of such a development is the synthesis of a two-mirror offset antenna Ka band Cassegrain systems in the AntennaMagus software product. This software can offer the developer a database of various antennas where the information is structured and standardized to meet the need for rapid assessment of many elements of the antenna complex and to simplify the comparison of certain structures. Also, unlike most literature, Antenna Magus focuses on the unique properties of each antenna, making it easy to compare antennas to each other and match them to your requirements.

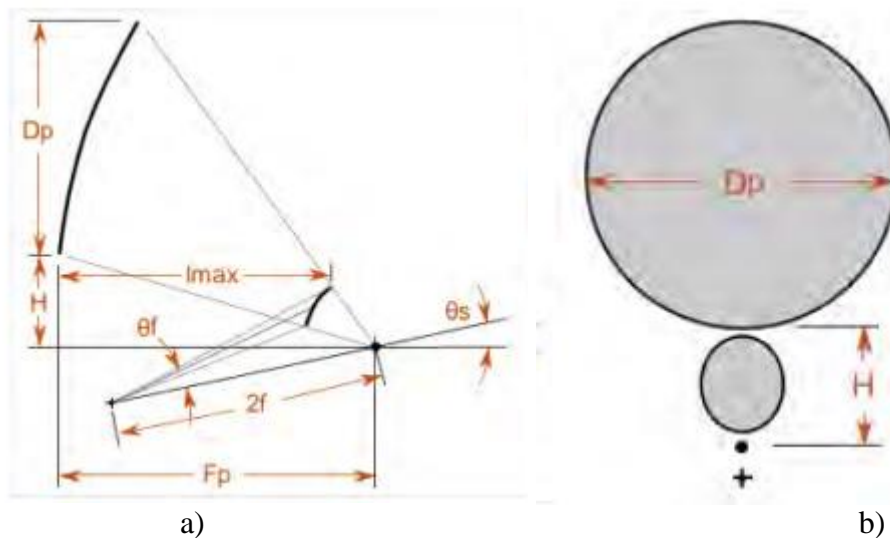


Figure 1 - Types of a two-mirror offset antenna according to the Cassegrain system in a software environment Antenna Magus

a) side view; b) front view;  $D_p = 224.4 \text{ mm}$  is the diameter of the main mirror;

$F_p = 175.1 \text{ mm}$  - focal length main mirror;  $H = 17.05 \text{ mm}$  – offset height of the auxiliary mirror;  $\theta_j = 28.87^\circ$  – emitter tilt angle;  $l_{max} = 140.1$  - maximum length to the auxiliary mirror.

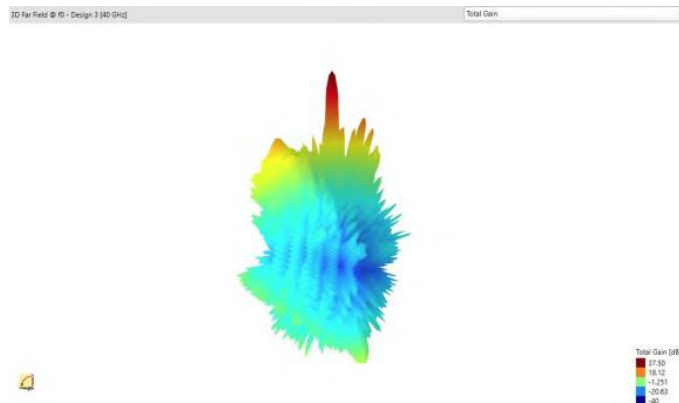


Figure 2 - 3D radiation pattern of a two-mirror offset antenna Ka band Cassegrain system

Using this approach, it is possible to synthesize various emitters, in particular, as it was shown on the example of the synthesis of a two-mirror offset antenna, as well as various electrodynamic structures, including transmission lines, antenna arrays, etc.

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### **Применение технологии ускоренного синтеза электродинамических моделей при разработке двухзеркальных офсетных антенных комплексов мобильной радиосвязи Ka и Ku диапазонов**

**П. П. Боровиков**

ФГБОУ ВО «Тамбовский государственный технический университет», Тамбов, Россия  
(*e-mail: protote01@mail.ru*)

**Аннотация.** В статье приведены преимущества использования технологии ускоренного синтеза при проектировании электродинамических структурна примере разработки модели двухзеркальной офсетной антенны Ka диапазона системы Кассегрена.

**Ключевые слова:** синтез, двухзеркальная антенна.

## Design of Secondary Power Supplies with Increased Efficiency Based on Gallium Nitride Semiconductors

I. N. Kochetov\*, V. P. Semichastnov, D. V. Pomeschchikov

Tambov State Technical University, Tambov, Russia

\*e-mail: igor.kochetov.97@mail.ru

### Abstract

The purpose of this study is to consider the features of constructing converters based on GaN transistors and avoiding errors in their design.

**Keywords:** GaN FET driver, GaN transistor, power supplies and converters.

With the development of technologies in the telecommunications industry, new equipment is being developed and introduced that requires a different supply voltage than that used by the main equipment.

In this regard, there is a demand to develop new high-performance secondary power sources. The solution to this issue is the use in them of semiconductor structures based on gallium nitride (Fig. 1).

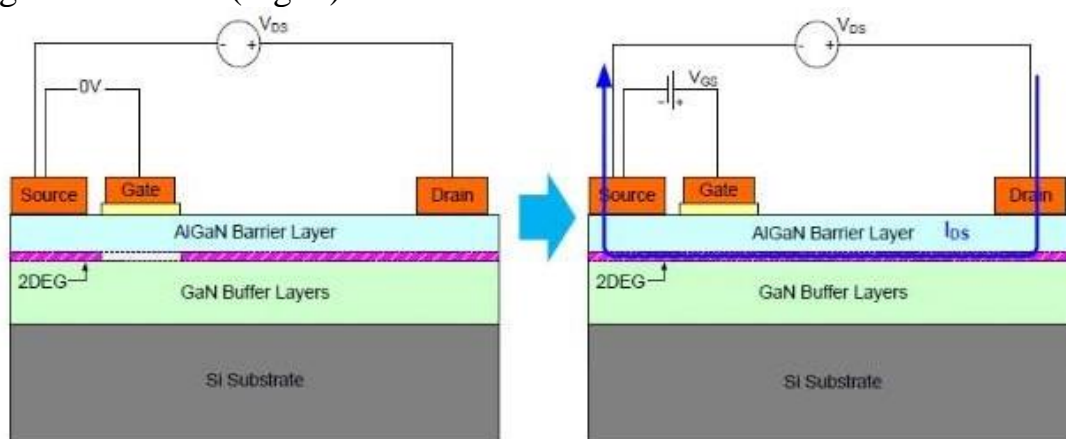


Figure 1 - GaN transistor structure

The use of GaN transistors in modern power supplies and converters is quite a promising direction in the development of electronics. It is due to factors such as approaching the limit of improvement of silicon-based transistors, which implies a slight increase in characteristics with improved manufacturing technology, and better performance values for gallium nitride structures [1]. Thus, semiconductors based on gallium nitride have a large band gap, which ensures higher stability of parameters during temperature changes, the open state resistivity is much lower, and the electric field strength is much higher. It is also worth noting the high switching speed and very short recovery time of gallium nitride switches [2]. The above parameters allow to reduce the dimensions of semiconductor products, allowing to achieve high efficiency.

However, in the design of power devices based on GaN structures, there are a number of features that require attention. One of them is the gate parameters of the transistor.

The gate of a GaN transistor has a low threshold voltage and also has a lower gate capacitance than a MOSFET. This is both an advantage and a drawback. On the one hand, less energy is needed to recharge the gate capacitance, but low voltage and capacitance values make it vulnerable to voltage surges during transients (Fig. 2). The solution in this case is to reduce the stray inductance in the gate circuits. This can be achieved by shortening them along with an increase in the cross section.

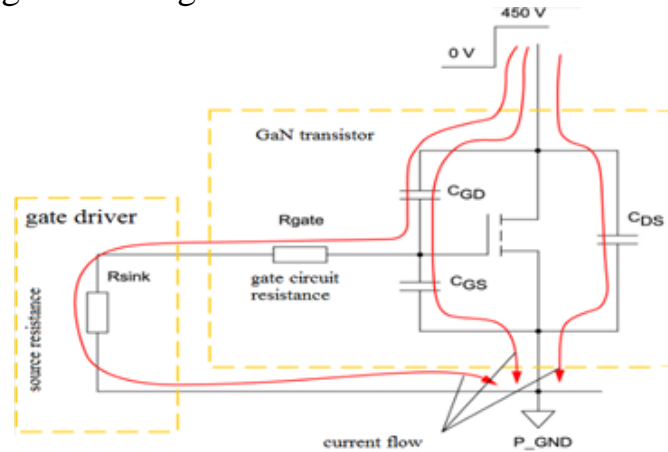


Figure 2 - Flow paths of currents during transient processes

Another important factor is the slew rate of the GaN transistor drain voltage. It is high enough to reduce losses during "hard" switching, but electromagnetic interference is amplified, which can affect control circuits and disable the device. To avoid this, you should choose the appropriate gate driver and gate power supply [3].

Another feature is the temperature conditions of the transistor and the peculiarity of the arrangement of the elements of the device. For best performance, minimum gate lengths are required, which means the gate driver is in close proximity to the high temperature transistor. Therefore, it is recommended to select drivers and power supplies that are reliable at high temperatures.

To organize the operation of transistors based on gallium nitride, special drivers are required (Fig. 3). They form control currents and voltages. Their use allows to solve some problems that arise in the design process. Manufacturers of modern microelectronics manufacture these drivers together with their power supplies in a single package, which allows to significantly minimize the size of the converter. And the use in conjunction with GaN transistors allows you to achieve high efficiency rates.

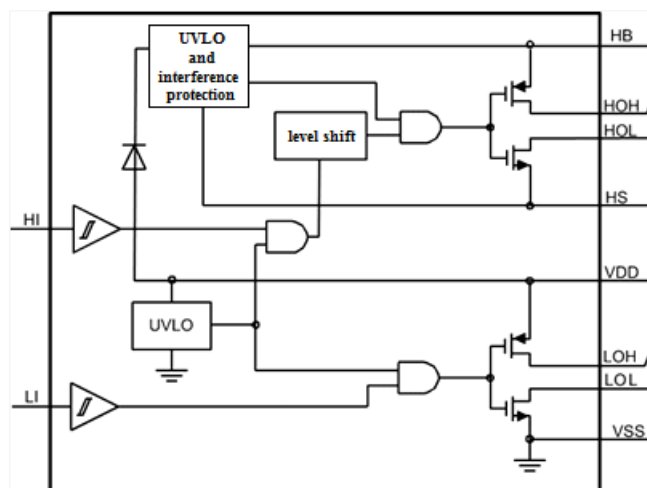


Figure 3 - Block diagram of the driver

Thus, the use of gallium nitride transistors in the development of power supplies and converters has its own characteristics, however, with proper design; these devices will significantly outperform devices based on silicon transistors. Such devices will be in demand for new modern telecommunications equipment.

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## Проектирование вторичных источников питания с повышенным КПД на основе нитрид галлиевых полупроводников

И. Н. Кочетов\*, В. П. Семичастнов, Д. В. Помещиков

ФГБОУ ВО «Тамбовский государственный технический университет», Тамбов, Россия

\*e-mail: igor.kochetov.97@mail.ru

**Аннотация.** Целью этого исследования является рассмотрение особенностей построения преобразователей на GaN транзисторах и избежание ошибок при их проектировании.

**Ключевые слова:** драйвер GaN транзистора, источники питания и преобразователи, нитрид галлиевый транзистор.

## Overview of Modern Navigation Methods of Unmanned Vehicles

**I.V. Kuleshov, V. O. Chereshev, S.P. Moskvitin**

Tambov State Technical University, Tambov, Russia

*e-mail: kuleshov.ilja2017@yandex.ru*

### **Abstract**

The paper contains an overview of navigation systems of mobile objects and brief information about the principles of their functioning.

**Keywords:** unmanned vehicles, navigation systems.

### **Introduction**

To solve the problems of navigation of moving objects, navigation complexes are used, which are designed to determine the current coordinates and motion parameters. The navigation complex is a complex information and navigation system, which is based on a satellite radio navigation system (SRNS) and an inertial navigation system (INS), as well as video navigation systems are additionally used. In the presented work, the main methods of navigation are considered.

In the navigation systems of most modern unmanned vehicles, receivers of global satellite navigation systems (GPS) are used to determine the coordinates of the location, for greater autonomy, blocks of inertial spatial orientation sensors are additionally used. In order to perform the assigned tasks, unmanned vehicles operating in the composition with inertial systems need a signal from the GSSN.

The accuracy and speed of determining the coordinates of the location is especially important for unmanned aerial vehicles (UAVs), when using low-precision inertial systems, the long absence of a GPS signal leads to an increase in the number of errors and the occurrence of an emergency situation that can lead to the loss of the UAV. It is for this reason that the suppression of the GSSN is considered as the main method of combating UAVs. The autonomous navigation unit for use in UAVs must have high accuracy and low weight, however, the use of high-precision inertial navigation systems is not completely able to solve the problem due to the high cost and high weight of even medium-quality inertial navigation systems.

To increase noise immunity, systems are being developed that work on the principle of optical scanning of the terrain, the essence of video navigation is the review and high-speed processing of the received images of the terrain, the presented method is similar to the method of human orientation on the terrain. Similar navigation systems are being developed by foreign and domestic companies. In Russia, the leading company for the development of systems that do not depend on the GSSN signal is engaged in the Kalashnikov group of companies belonging to the Rostec state Corporation. The navigation systems created by the company consist of a wide-angle camera and a productive, small-sized computer that processes incoming information.

The method of determining the coordinates of the UAV by direction-finding



measurements on the observed object with known coordinates. Due to the lack of direct measurements of the range to the target, the problem arises of determining its coordinates only on the basis of angular measurements. The next step is to link the coordinates of the target to the terrain map, for which it is necessary to accurately determine the position of the UAV itself and, in general, implement the method of simultaneous localization and mapping [2, 3].

Binding to the coordinates of ground landmarks is necessary for the UAV to determine the exact coordinates of its own location. The characteristic features of the local terrain with previously known coordinates or a network of radio towers that are able to locate the location of the UAV and transmit location data to it at a predetermined frequency can act as terrestrial landmarks.

Onboard navigation systems achieve the highest accuracy when using all methods in combination with an inertial navigation system

### **Conclusion**

Based on the result of the information search, it was determined that most navigation systems use the GPS signal in their work. It is for this reason that the suppression of the GSSN is considered as the main method of combating UAVs. After analyzing the information, it can be concluded that in order to prevent the loss of the drone, it is necessary to improve its on-board equipment, which will function even without a stable GSSN signal

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## **Обзор современных методов навигации беспилотных транспортных средств**

**И.В. Кулешов, В. О. Черешнев, С.П. Москвитин**

ФГБОУ ВО «Тамбовский государственный технический университет», Тамбов, Россия  
*e-mail: kuleschov.ilja2017@yandex.ru*

**Аннотация.** Для решения задач навигации подвижных объектов используются навигационные комплексы, которые предназначены для определения текущих координат и параметров движения. Навигационный комплекс представляет собой сложную информационно-навигационную систему, основу которой составляют спутниковая радионавигационная система (СРНС) и инерциальная навигационная система (ИНС), так же дополнительно применяются системы видеонавигации. В представленной работе рассмотрены основные методы навигации.

**Ключевые слова:** беспилотные транспортные средства, навигационные системы.

## Netze der fünften Generation

**A. A. Melnikow**

Staatliche Technische Universität Tambow, Tambow, Russland  
*e-mail: melnikov.antoxa@yandex.ru*

### **Zusammenfassung**

Dieser Artikel soll einen Überblick über die neuesten Entwicklungen im Bereich der zellularen Netze geben. In den letzten Jahren hat die fortschreitende Entwicklung der Technologie hin zu mehr Leistung und einer größeren Anzahl von Funktionen es ermöglicht, Probleme zu lösen, die mit früheren Generationen von Netzen nicht zu bewältigen waren.

**Schlüsselwörter:** Basisstationen, Mobilkommunikation, Netz der fünften Generation.

Die Technologie entwickelt sich in Bezug auf Leistung und Fähigkeiten ständig weiter. Zusätzlich zu den bestehenden Funkzugangstechnologien werden neue Technologien entwickelt, um die Herausforderungen der Netze der dritten (3G) und vierten (4G) Generation zu bewältigen. Durch die Entwicklung und Verbesserung von Technologien wird die Qualität der Nutzererfahrung verbessert und die Palette der angebotenen Dienste erweitert.

Die Leistung ist die wichtigste Anforderung für die Nutzer von Netzen der fünften Generation (mobiles Breitband). Die Zahl der angeschlossenen Geräte wächst exponentiell.

Verbindungen, die ohne effiziente und produktive Lösungen nicht möglich sind, können mit Mobilfunknetzen der fünften Generation (5G) realisiert werden. Bei ihrer Umsetzung gibt es jedoch eine Reihe von Herausforderungen. Der Mobilfunkverkehr hat in den letzten Jahren unaufhaltsam zugenommen und wird dies auch in Zukunft tun.

Neue Anforderungen an Mobilfunknetze können sich aus der Zunahme der Zahl der an das Netz angeschlossenen Geräte ergeben. Eine weitere Herausforderung für 5G-Netze besteht darin, minimale Latenzzeiten und eine hohe Zuverlässigkeit des Netzes zu gewährleisten und große Datenmengen zu übertragen, um den Anforderungen der verschiedenen Nutzer gerecht zu werden. Die Preispolitik muss auch den verschiedenen Bevölkerungsgruppen je nach ihren Bedürfnissen gerecht werden.

Um all diese Probleme zu lösen, sind neue Normen für mobile Breitbandzugangsnetze erforderlich. Der Schwerpunkt des 5G-Konzepts liegt auf der Verbesserung des Nutzererlebnisses durch die Einführung neuer Technologien und nicht auf dem technischen Aspekt.

Das Rückgrat der Mobilfunknetze der fünften Generation bilden die bestehenden Technologien wie HSPA und LTE. Auf diese Weise werden Datenübertragungsgeschwindigkeiten von Hunderten von Mbit/s für jeden Nutzer

verfügbar sein. Die Einführung intelligenter Antennenmanagementtechnologien und die Entwicklung neuer Signalcodierungsbereiche werden den Zugang zu mobilen Diensten mit hohen Geschwindigkeiten ermöglichen.

Es sind neue Optionen für den Netzaufbau erfunden. Immer mehr Betreiber haben ihre Aufmerksamkeit auf Strategien für den Einsatz kleiner Zellen gerichtet. Auch bei der Kommunikationskomponente hat es eine Veränderung gegeben. Die Maschine-zu-Maschine-Kommunikation hat an Einfluss gewonnen.

Es sind Technologien für den Aufbau extrem dichter Netze eingeführt. Ihre Bandbreite ist in den oberen Bändern aufgrund neuer Funkzugangstechnologien viel größer. Alle sind für die Verarbeitung großer Datenmengen bei hohen Übertragungsgeschwindigkeiten ausgelegt.

Die Komponenten von Netzen mit hoher Dichte sind Stationen mit geringer Leistung. Ihre Installationsdichte ist wesentlich höher als die der bisher verwendeten Basisstationen. In Innenräumen gibt es in jedem Zimmer Basisstationen. Außerhalb des Geländes entspricht der Abstand zwischen den Stationen dem Stationsabstand.

Ultradichte Netze haben eine Bandbreite von mehreren hundert MHz und können auf mehrere GHz erweitert werden, um Gigabit-Datenraten nahtlos zu unterstützen. Der Betriebsbereich der ultradichten Netze reicht von 10 GHz bis 100 GHz. Diese Frequenzen eignen sich gut für Übertragungen mit kurzer Reichweite und hoher Kapazität, wie sie für Netze mit hoher Dichte erforderlich sind, auch wenn die Nutzung solcher Frequenzen in solchen Dimensionen mit vielen Fragen verbunden ist. Um Hochgeschwindigkeitsdatennetze zu unterstützen, muss eine große Bandbreite zur Verfügung stehen. Diese Aufgabe wird durch Hochfrequenzbänder erleichtert.

Basisstationserweiterung und Multi-Hop-Technologien sind Teil von Ultra-Density-Netzen. Ultradichte Netze müssen trotz eines anderen Betriebsbereichs gut mit früheren Generationen von Mobilfunknetzen integriert werden. Der Nutzer sollte keine Verzögerungen oder Einbrüche bei den Datenübertragungsraten feststellen, wenn er den Versorgungsbereich von Netzen mit extrem hoher Dichte verlässt.

Die Standards für 4G-Mobilfunknetze erfüllen nicht alle Nutzer- und Anwendungsanforderungen, obwohl die bestehenden LTE-Technologien im Rahmen der 3GPP-Normen verbessert werden. Aus diesem Grund müssen neue Technologien eingeführt werden, um beispielsweise Geräte mit begrenztem Stromverbrauch zu unterstützen. Die Technologien dieses Plans sind Bestandteil der Mobilfunktechnologien der nächsten Generation. Dies ermöglicht den Nutzern einen ständigen Zugang zu Informationen und zum Internet.

Das Device-to-Device (D2D)-Protokoll kann sinnvollerweise anstelle der Netzinfrastruktur verwendet werden, wenn die Entfernung zwischen den Nutzern ausreichend kurz ist oder wenn Informationen zwischen dem Nutzer und der Umgebung ausgetauscht werden. Da das Netz von D2D innerhalb des lizenzierten Bereichs verwaltet werden darf, kann dieses Protokoll eine Zuverlässigkeit bieten, die mit der von Mobilfunkbetreibern vergleichbar ist. Die ersten Schritte zur Einführung von D2D in die Netzkommunikationstechnologie erfolgten im Rahmen der Mobilfunkstandards der vierten Generation (LTE). Da dieses Protokoll in der Lage ist,

die lokale Kommunikation auch im Falle eines Kommunikationsausfalls aufrechtzuerhalten, wird es in NSPS-Anwendungen eingesetzt.

Bisher konnten Funknetzstandards die Zuverlässigkeitsanforderungen von Nutzern in der industriellen Kommunikation, z. B. im Gesundheitswesen oder in der Verkehrssicherheit, nicht erfüllen. Manchmal sind die Anforderungen an die Signalverzögerung höher als das, was frühere Kommunikationsnetze bieten konnten, d.h. nicht mehr als ein paar Millisekunden.

Die wichtigsten Kriterien, die die Zuverlässigkeit der Kommunikation beeinflussen, sind die Architektur, die Konfiguration und die erforderlichen Netzressourcen zur Bewältigung von Spitzenlasten.

Bei der infrastrukturellen Neugestaltung der Geräte war es möglich, zuerst die besonders wichtigen Verkehrspakete zu verarbeiten und dann den Rest. Die größte Herausforderung bestand darin, die vorherigen Generationen von Mobilfunknetzen neu zu gestalten, da deren Schwerpunkt auf Bandbreite, Abdeckung und Datenraten lag. Um die Netze zu optimieren und eine minimale Verzögerung zu gewährleisten, ist das Gleichgewicht zwischen Kodierung, Funkressourcenmanagement, Kontrollkanalgestaltung und adaptiver Modulation verändert.

Es ist eine neue Technologie integriert, um kurze Übertragungszeiten zu gewährleisten, die dort, wo sie benötigt werden, zu minimalen Verzögerungen führen.

Die Energieeffizienz spielt eine zentrale Rolle bei der Konzeption aller Netzlösungen der fünften Generation. Die Senkung des Stromverbrauchs in 5G-Netzen hat dazu beigetragen, den Zellradius in dichten Netzen zu verringern, intelligente Steuersysteme für Basisstationsmodi einzuführen und den Signalisierungsverkehr bei der Synchronisierung und Netzerkennung zu reduzieren.

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## **Сети пятого поколения**

**А. А. Мельников**

ФГБОУ ВО «Тамбовский государственный технический университет», Тамбов, Россия  
*e-mail: melnikov.antoxa@yandex.ru*

**Аннотация.** Цель статьи – дать обзор последних достижений в области сетей сотовой связи. В целом, в последние годы, продолжающееся развитие технологий по пути увеличения производительности и числа возможностей позволяет решать задачи, неподвластные сетям прошлых поколений.

**Ключевые слова:** базовые станции, мобильная связь, сеть пятого поколения.

## Operating Algorithm of the Intelligent System for Monitoring Humidity of the Drying Plant by VetterTec CmbH

**D. Y. Potlov, Q. S. Sayfullozoda, E. M. Nikolyukina**  
Tambov State Technical University, Tambov, Russia  
*\*e-mail: Vilitr31@gmail.com*

### Abstract

The algorithm of operation of the VetterTec CmbH intelligent system for monitoring the humidity of the drying plant, which allows you to quickly determine the moisture content of the material at the exit of the drying plant, is presented.

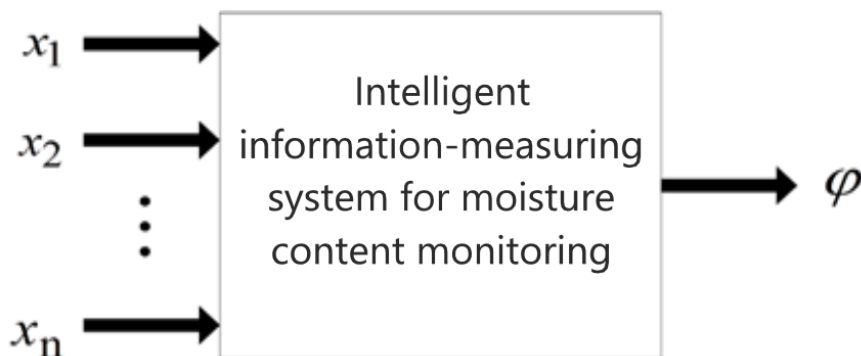
**Keywords:** algorithm; intelligent humidity monitoring system; moisture assessment.

### Introduction

To develop control actions and timely correction of the drying process in order to achieve the required level of material quality at the outlet of the dryer, constant monitoring of the moisture content of the material at the outlet of the dryer is required

### Description of the method

The moisture content of the material is monitored using an intelligent moisture monitoring system. The operation of the system is based on an analytical model of the species, which allows you to quickly determine the moisture content of the material at the outlet of the dryer. The block diagram of the moisture assessment model is shown in fig. 1.



*Figure 1 - Structural diagram of the moisture assessment model*

The input of the system receives data obtained by polling sensors installed in the dryer. The output data of the monitoring system are the values of the moisture content of the dried stillage at the outlet of the drying plant, calculated from analytical models. This information is transmitted for display and use by the EMS. At the same time, the monitoring system is integrated into the SUPP, where the calculated moisture content values are displayed continuously on the monitor screen in graphical form. The permissible ranges of moisture content of the material at the outlet of the dryer for this type of process are also reflected.

The monitoring system operation algorithm consists of the following operations:

Step 1. Interrogation of the sensors of the dryer through the SUPP.

Step 2. Checking the condition for the measured values to enter the range of values used in training the neural network. If the condition is not met, the data is written to the memory (accumulation of statistics) and a message is sent to the user working with the EMS. Moisture assessment is not performed in this case.

Step 3. Normalization of the measured values.

Step 4. Calculation of the moisture content of stillage using analytical models based on neural networks.

Step 5. Denormalize the moisture content of the stillage.

Step 6. Displaying the vinasse moisture estimate for the EMS user.

Step 7. Saving the calculated value to the database (accumulation of statistics).

### **Conclusion**

The monitoring system is implemented as a separate software module integrated into the SUPP, allows you to quickly determine the moisture content of the dried stillage at the outlet of the dryer

### **Acknowledgement**

The work was carried out under the supervision of Ph.D. Associate Professor, O. A. Belousov.

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## **Алгоритм работы интеллектуальной системы мониторинга влажности сушильной установки фирмы VetterTec СmbН**

**Д. Ю. Потлов, К. С. Сайфуллозода, Е. М. Николюкина**

ФГБОУ ВО «Тамбовский государственный технический университет», Тамбов, Россия.  
*e-mail: Vilitr31@gmail.com*

**Аннотация.** Приведен алгоритм работы интеллектуальной системы мониторинга влажности сушильной установки фирмы VetterTec СmbН, позволяющий оперативно определять влагосодержание материала на выходе сушильной установки.

**Ключевые слова:** алгоритм; интеллектуальной системы мониторинга влажности; оценка влажности.

## Features of the Construction of Reconfigurable Surfaces of Radio Vision Systems

V. P. Semichastnov, I. N. Kochetov, D. V. Pomeshchikov

Tambov State Technical University, Tambov, Russia  
*e-mail: Semichastnov.98@mail.ru*

### Abstract

The article is devoted to the reconfigurable surface of radio vision systems. The article describes the advantages of using an intelligent surface.

**Keywords:** intelligent surfaces.

Currently, unmanned agricultural machinery is being widely developed. In order for this technique to work properly or move in space, positioning or vision needs to be more precise. This can be achieved through the use of advanced radar complexes and reconfigurable surfaces that will properly complete the directional pattern that came from the radar station.

Radio vision is the acquisition of an image of any visible object using a radio wave, for these purposes, centimeter and millimeter ranges are used, which are opaque to optical waves or objects located in optically opaque media. It is based on the use of the ability of some bodies under the influence of radio radiation to change their state or shape in accordance with the change in the intensity of radio emission, the phase of radio waves, the nature of their polarization, the delay time. Radio waves emitted or reflected by the objects being monitored transmit information about their external appearance and position in space, the so-called medium. One of the main tasks of radio vision is the visualization of the received information. This is assisted by special devices - radio imagers. Radio science is currently also widely used in other fields: medicine, aviation, shipbuilding, meteorology, and so on.

A reconfigurable intelligent surface can be used as a reflection of radio waves.

A reconfigurable intelligent surface is a structure with a preset program that can be used to control the propagation of electromagnetic waves by changing the electrical and magnetic properties of the intelligent surface. It is possible to control the properties of radio channels by placing these surfaces in a certain environment. In the intellectual surface, depending on the current situation, the polarization will change, that is, it will pre-polarize the wave that will come from the radar. In addition to controlling electromagnetic waves, a reconfigurable intelligent surface can be used to detect radio communications by integrating detection capabilities into it. By placing intelligent surfaces in an environment where wireless systems operate, it is possible, at least partially, to control the properties of radio channels. This gives new opportunities to improve the performance of wireless systems.

Radio channel management changes the traditional model of wireless systems design, where the radio channel is considered as an uncontrolled entity that distorts the

transmitted signals. The transmitter and receiver align the effects of the channel. The assumed scenarios depend on cases when one intelligent panel is placed on the surface of the field, towards signals coming from a given direction, for example, from a base station, to an environment where almost all reconfigurable intelligent surfaces are based on a meta-surface. Metasurfaces are electrical thin and dense two-dimensional arrays of structural elements having the desired properties provided by their constituent elements. Elements are called meta-cells, elementary cells, or meta-atoms. The size of the meta cells is much smaller than the wavelength of the signal. In addition to controlling the propagation of electromagnetic waves, metasurfaces can be used to implement complex operations: data modulation and mathematical operations.

The introduction of intelligent surfaces can improve the reliability and energy efficiency of wireless systems. They can provide accurate localization of people and objects in environments where, for example, satellite positioning systems do not work properly. It is expected that when designing radio equipment, intelligent surfaces implemented using metasurfaces will allow the implementation of low-cost and energy-efficient transceivers, which require only a limited, ideally one active radio frequency circuit.

With the introduction of a reconfigurable intellectual surface, vast expanses of agricultural land can be brought under control. In addition to helping agriculture, this technology will help to control production costs, respond to the condition of cultivated crops in a timely manner and increase yields.

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## Особенности построения реконфигурируемых поверхностей систем радиовидения

**В. П. Семичастнов, И. Н. Кочетов, Д. В. Помещиков**

ФГБОУ ВО «Тамбовский государственный технический университет», Тамбов, Россия  
*e-mail: semichastnov.98@mail.ru*

**Аннотация.** Статья посвящена реконфигурируемой поверхности систем радиовидения. В статье описываются преимущества использования интеллектуальной поверхности.

**Ключевые слова:** интеллектуальная поверхность.



## **Selektivität von Signalempfangs- und Verarbeitungsgeräten. Methoden zur Erhöhung der Selektivität des Radios**

**A. V. Starikov**

Tambov State Technical University, Tambov, Russia

*\*e-mail: andrey2014starikov@yandex.ru*

**Zusammenfassung:** Ziel dieser Studie ist es, Methoden zur Verbesserung der Selektivität des Funkempfängers zu identifizieren und die Art der Selektivität des Empfangs und der Signalverarbeitung zu untersuchen.

**Schlüsselwörter:** Selektivität, Radioempfangsgerät, Signal.

Die Selektivität des Empfängers charakterisiert die Immunität des Empfängers gegenüber Funksignalen in benachbarten Funkfrequenzen. Mit anderen Worten charakterisiert Selektivität die Fähigkeit des Empfängers, ein nützliches Signal von Störungen zu trennen.

Die Wirkung von Störungen wird durch die Verwendung unterschiedlicher Art und Anzahl der selektiven Stromkreise des Funkempfängers erheblich reduziert. Alle Verfahren zur Gewährleistung einer bestimmten Selektivität basieren darauf, dass das Radioempfangsgerät das Signal aufgrund einiger Merkmale, die nur für ein nützliches Signal typisch sind, von der Interferenz unterscheidet.

Zu den wichtigsten Arten der Selektivität gehören:

- Frequenzselektivität;
- räumliche Selektivität;
- polarisierende Selektivität;
- Amplitudenselektivität;
- vorübergehende Selektivität;
- selektivität nach Signalform.

Frequenzselektivität. Bei der Bewertung der Frequenzselektivität werden zwei Arten von Selektivität berücksichtigt: die Selektivität über einen benachbarten Kanal und die Selektivität über zusätzliche Empfangskanäle. Zusätzliche Empfangskanäle sind für Radiogeräte inhärent (Sieh ausführlicher: [1])

Die quantitative Frequenzselektivität des Empfängers wird durch das Verhältnis seiner Resonanzverstärkung zu der Verstärkung bei der Frequenz des störenden Kanals, d.h. bei der Frequenz eines benachbarten oder parasitären Empfangskanals, bewertet.

Die räumliche Selektivität erfolgt über gerichtete Empfangsantennen und ermöglicht eine deutliche Abschwächung der externen Störungen am Eingang des Empfängers. Dies ist wirksam, wenn sich die Richtung zu Signalquellen und Störungen deutlich voneinander unterscheiden. Am weitesten verbreitet ist diese Art der Selektivität im Bereich von extrem hohen Frequenzen, in denen scharf gerichtete

Empfangsantennen leicht möglich sind.

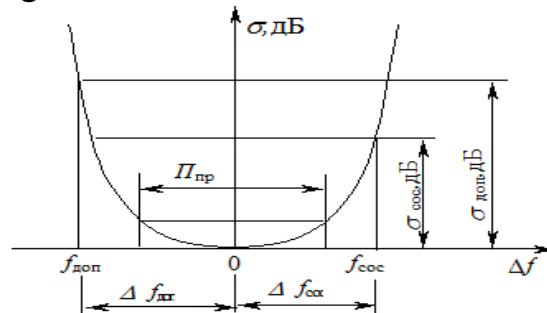


Abbildung 1 - Die Abhängigkeit der Selektivitätskurve des Funkempfängers von der Frequenz

Die Polarisationsselektivität basiert auf dem Unterschied in der Polarisation elektromagnetischer Signalschwingungen und Störungen. Es wird darauf hingewiesen, dass die elektromagnetische Strahlung von einigen industriellen Störquellen eine vertikale Polarisation aufweist. Die Verwendung der horizontalen Signalpolarisation und die Verwendung geeigneter Antennen können die Auswirkungen von Störungen reduzieren. Es ist jedoch nicht möglich, die Auswirkungen von Störungen signifikant zu verringern, daher hat diese Art der Selektivität keine praktische Anwendung gefunden.

Die Amplitudenselektivität wird am häufigsten in Radioempfangsgeräten verwendet, die für den Empfang von impulsmodulierten Signalen ausgelegt sind. Das Wesen der Schaltungsimplementierung besteht darin, dass der Amplitudenauswahlschalter nur solche Signale an den Ausgang des Funkempfängers sendet, deren Intensität innerhalb einer möglichen Änderung des Nutzsignalpegels liegt. Störungen, die den Wert des Nutzsignals überschreiten, können jedoch nur dann effektiv unterdrückt werden, wenn sie impulsiv sind und sich relativ selten mit dem Nutzsignal überlappen.

Die zeitliche Selektivität kann realisiert werden, wenn der Moment, an dem das Signal am Eingang des Empfängers erscheint, genau bekannt ist. Diese Art der Selektivität wird häufig in gepulsten Radarempfängern mit Strobe verwendet. Im Strobe-Modus wird der Empfänger nur für kurze Zeiträume geöffnet, die der erwarteten Ankunft der reflektierten Impulssignale entsprechen. Den Rest der Zeit ist der Empfänger geschlossen, was erheblich ist. [2].

Methoden zur Erhöhung der Selektivität des Radios.

Die Selektivität über den benachbarten Kanal wird hauptsächlich durch den PCH-Trakt gewährleistet. Starke Störungen im benachbarten Kanal führen jedoch zu einer geringeren Empfindlichkeit und Intermodulation (Cross-Modulation), da die HF-Eingangsschaltungen des Funkempfängers und der Mischer nicht ausreichend gegen Störungen geschützt sind. Um dieses Problem zu beheben, werden Bandfilter am Eingang des Radios verwendet oder die Empfindlichkeit des Eingangsstromkreises wird absichtlich verringert (ein Dämpfungsglied wird verwendet).

Die Selektivität des Empfängers hängt von der Anzahl der Kaskaden im Hochfrequenzverstärker und der Qualität der Resonanzfilter in jeder Kaskade ab. Die

Erhöhung der Selektivität des Empfängers ist auf eine Erhöhung der Anzahl von Verstärkungsschleifen und -Kaskaden im Empfänger zurückzuführen, was die Kosten erhöht und die Einstellung erschwert. Daher hat seine Selektivität je nach Zweck des Empfängers einen bestimmten Wert, der bei der Gestaltung des Radios festgelegt wird.

Eine Schaltung mit zwei Frequenzumsetzungen bietet eine wesentlich höhere tatsächliche Selektivität als bei 1 PH. Bei den besten Modellen von importierten Radiostationen, die nach einem Heterodyn-Schema mit zwei Transformationen gebaut wurden, erreicht die Selektivität 60-75dB. Die Selektivität von Direktverstärkungsempfängern, die auf einem RDA-Chip ausgelegt sind, beträgt durchschnittlich 40 dB. [3].

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## **Избирательность устройств приема и обработки сигналов. Методы повышения избирательности радиоприемника**

**А. В. Стариков**

ФГБОУ ВО «Тамбовский государственный технический университет», Тамбов, Россия  
*\*e-mail: andrey2014starikov@yandex.ru*

**Аннотация.** Целью данного исследования является определение методов повышения избирательности радиоприемника, а также рассмотрение видов избирательности приема и обработки сигналов.

**Ключевые слова:** избирательность, радиоприёмное устройство, сигнал.

## The Optimal Method of Ensuring Communication Channel Stealth

**S. A. Svinsov, K. S. Sayfullozoda, E. M. Nikolyukina**

Tambov State Technical University, Tambov, Russia

*\*e-mail: Sqiyom@bk.ru*

### **Abstract**

The analysis of methods for ensuring the secrecy of the communication channel by the base is presented.

**Keywords:** receiver; signal strength; channel secrecy.

### **Introduction**

Energy secrecy (or the probability of not detecting the operation of the channel) ensures the ability of the channel to keep the fact of information transmission secret.

### **Description of the method**

The secrecy of the channels was evaluated under certain assumptions. In particular: a power receiver is used as a reconnaissance one, a search for a signal in space was carried out by the orientation of the antenna pattern.

The signal power at the input of the reconnaissance receiver will be determined both by the characteristics of the channel and by the mutual placement of the channel facilities (transmitter and receiver) and the reconnaissance receiver.

To increase the energy secrecy of the channel (reduce the signal-to-noise ratio at the output of the linear part of the reconnaissance), it is necessary, firstly, to use a transmission with the lowest possible quality indicator, and secondly, to use highly directional antennas in the channel (omnidirectional in the horizontal plane) with a minimum possible level of side lobes, thirdly, use a receiver with a low noise level, fourthly, the maximum signal energy loss during its propagation from the transmitter to the receiver should be significantly less than the losses during its propagation to the reconnaissance receiver, which is possible when the reconnaissance receiver is removed from channel position zone; fifth, use the carrier signal with the largest base value, i.e. use complex signals.

The fulfillment of all these conditions is the most difficult scientific and technical task, the solution of which is determined by the level of development of many areas of radio electronics and the improvement of organizational measures

### **Conclusion**

After analyzing the methods of ensuring the secrecy of the communication channel by the base, we came to the conclusion that it is necessary to follow the path of expanding the signal base and reducing the acceptable quality indicator of the signal-to-noise ratio

### **Acknowledgement**

The work was carried out under the supervision of Ph.D. Associate Professor,

O.A. Belousov.

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## Оптимальный метод обеспечения скрытности канала связи

С. А. Свинцов, К. С. Сайфуллозода, Е. М. Николюкина

ФГБОУ ВО «Тамбовский государственный технический университет», Тамбов, Россия  
*e-mail: Sqiyom@bk.ru*

**Аннотация.** Приведен анализ методов обеспечения секретности канала связи базой.

**Ключевые слова:** приёмник; мощность сигнала; скрытность канала.

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## Features of Constructing Headlights for Holographic Radar

A. A. Trishakov, R. D. Karikh, N. V. Zahodyakin

Tambov State Technical University, Tambov, Russia

*e-mail: KarikhRD@yandex.ru*

### Abstract

The article is devoted to phased antenna arrays for holographic radar. The article describes the advantages of using headlights.

**Keywords:** phased array antenna.

It was at the moment of great progress and the creation of new types of aircraft, which led to an increase in target speeds and a decrease in their effective scattering surface, that the improvement of radar stations (radars) was required. During this period, the widespread use of phased array antennas (headlights) in radar for various purposes was started. [1]

The modern radio engineering situation requires the development of multi-functional radio-electronic complexes (RECs), easily adaptable to the specific conditions of the surrounding interference situation, and significant improvement of the characteristics of all types of RECs and radio systems that are part of the complex. [2]

One of the most vital REC systems is the antenna module, which largely determines the characteristics of the complex as a whole. For the construction of such modules, AFAR for various purposes were introduced into the REC, which make it possible to effectively solve many tasks on a real time scale. [3] The experience of the first developments of ground-based AFAR allowed us to develop the theory and technique of their design, but at the same time showed that AFAR cannot be developed by traditional methods, when individual elements (antenna, transmitters, etc.) are first created, and then a system is formed from them. [4]

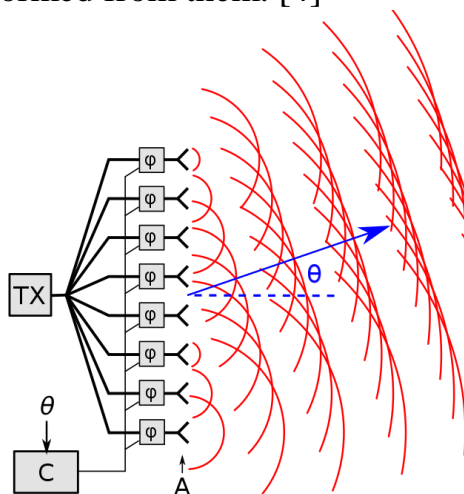


Figure 1- Phased array antenna

As part of the AFAR, all these elements are interconnected, intensively affect each other's parameters and, as a result, determine the electro-dynamic characteristics of the grid, and therefore the AFAR is considered as a single complex, and its design is a systemic task.

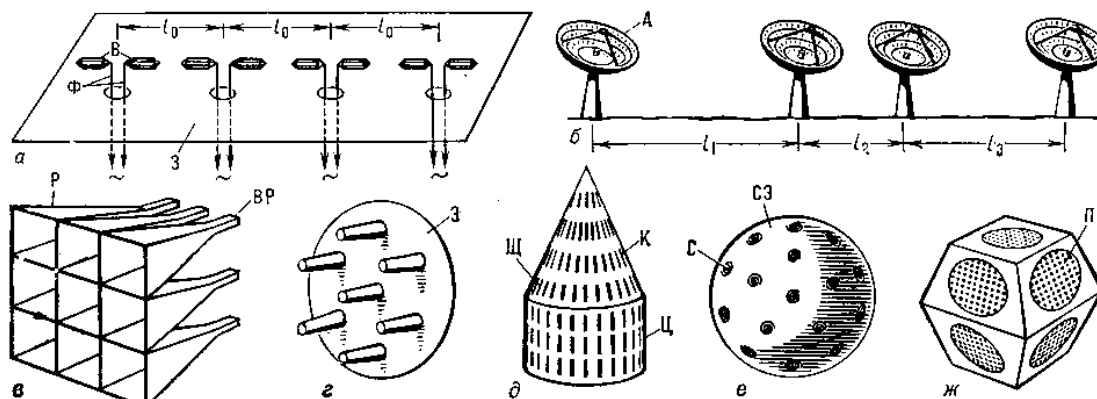


Figure 2 - Block diagrams of some phased array antennas

Thus, the use of AFAR is an opportunity to create fundamentally new integrated RECs on their basis, providing multi-functional operation with flexible control of spatial characteristics and high energy potential, adaptation to rapidly changing conditions and complex interference environment.

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### Особенности построения фар для голографического радиолокатора

А. А. Тришаков, Р. Д. Карих, Н. В. Заходякин

ФГБОУ ВО «Тамбовский государственный технический университет», Тамбов, Россия

e-mail: KarikhRD@yandex.ru

**Аннотация.** Статья посвящена фазированным антенным решеткам для голографической радиолокации. В статье описываются преимущества использования фар.

**Ключевые слова:** Фазированная антенная решетка.

## Features of AI Technologies in Construction of GIS-based on Radiographic Images for Digital Precision Farming Systems

A. A. Trishakov\*, R. D. Karikh, N. V. Zahodyakin

*Tambov State Technical University, Tambov, Russia*

*\*e-mail: trishakov2016@yandex.ru*

### Abstract

The article is devoted to the use of artificial intelligence in the construction of GIS based on radiographic images for digital systems of precise positioning, which will help to increase the efficiency of agro-industrial enterprises.

**Keywords:** artificial intelligence

Currently, precision farming technologies are being used quite actively. Agricultural unpiloted machinery moves according to coordinates, which are carried out by GPS, GSM and GLONAS global positioning systems.

These navigation systems have a disadvantage, namely, low accuracy ( $\pm 5$  m), which causes certain difficulties in the implementation of precision farming systems [1].

To solve this problem, it is necessary to use more correct positioning methods. One of them is the construction of radiographic images of the object, which is achieved through the use of radar [2] (fig. 1).



*Figure 1 - Precise positioning system*

Radiographic images in most cases are used by irradiating a certain object in different planes. After receiving the initial information, it is turned into a holographic one [3].

Integration of artificial intelligence technologies in algorithms for processing holographic images and algorithms for the formation of multipath radiation patterns will allow:

- to have a trained neural network in these fields, which, during subsequent processing, will make it possible to have a positioned system without the need to



launch a radar.

To get a more accurate hologram, high-resolution radar systems are needed, the latter is achieved by:

- formation of multiple DN and creation of a holographic image based on information about the displaying surface (fig. 2);
- frequency range: the higher it is, the greater the accuracy [4].



*Figure 2 - Algorithm of the precise positioning system*

Approximate technical characteristics of such a system will be:

Height: 568 mm;

Diameter: 626 mm;

Navigation technologies: Radar technologies;

Number of simultaneously formed beams:  $\leq 92$ ;

Resolution: 500 mm;

Accuracy: 298 mm;

Reliability: 28900 hours' time to failure;

Power Supply: 12-24 V;

Belongs to the operation group: B4;

Operating conditions: UHL.

Thus, the use of artificial intelligence in the construction of geoinformation systems will allow to form a three-dimensional picture of the cultivated areas, as well as to increase the accuracy of positioning agricultural machinery in real time.

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# **Особенности применения технологий искусственного интеллекта при построении ГИС на основе радиологических изображений для цифровых систем точного земледелия**

**А. А. Тришаков\*, Р. Д. Карих, Н. В. Заходякин**

ФГБОУ ВО «Тамбовский государственный технический университет», Тамбов, Россия

*\*e-mail: trishakov2016@yandex.ru*

**Аннотация.** Статья посвящена применению искусственного интеллекта при построении ГИС на основе радиологических изображений для цифровых систем точного позиционирования, которые помогут повысить эффективность работы агропромышленных предприятий.

**Ключевые слова:** искусственный интеллект

## Modernized Ultrasound Apparatus with the Development of a Spatial Bandpass Filter

V. V. Yumasheva

Tambov State Technical University, Tambov, Russia  
*e-mail: yumasheva2014@mail.ru*

### Abstract

The article analyzes in detail the development of a spatial bandpass filter, considers the existing devices for ultrasound therapy, their block diagrams, and identifies their disadvantages and advantages. The paper presents the development of a spatial bandpass tunable filter based on charge-coupled matrix devices, which operates in real time and is characterized by efficiency, small weight and size, and low cost.

**Keywords:** Bandpass filter, simulation, ultrasonic device, electrical signals, processing

Ultrasound is high-frequency vibrations that lie in the range above the frequency band perceived by the human ear (more than 20,000 Hz).

Ultrasound research methods occupy the leading places in modern clinical medicine. This is facilitated by a number of factors and, above all, the reliability of the results obtained, the availability and relative simplicity of the procedure. In the early 80s, the first medical ultrasound diagnostic devices appeared in our country, allowing not only to take pictures on special photographic paper, but also to create a database of pictures. Only a few years ago, thanks to technological progress, such systems were further developed. Powerful new platforms emerged, monitors with high resolutions and minimal curvature of the screen surface became the standard for high-bandwidth networks.

A significant leap in the issue of improving research methods was achieved thanks to the development and introduction into practice of fundamentally new methods for obtaining medical images, including the ultrasound method.

One of the most reliable ways of objective diagnosis is visual observation of the affected organs of the patient. Therefore, electronic visual surveillance devices are becoming increasingly widespread, both in our country and abroad. These include ultrasound equipment, MRI equipment and radiographic equipment. Ultrasound research methods occupy one of the leading places in modern clinical medicine. Ultrasound is widely used to diagnose diseases of various organs and systems: cardiovascular, digestive, genitourinary, superficially located organs and tissues.[3]

But ultrasound equipment gives an image that often suffers from information redundancy and has interference components of various frequencies, which often hinders or complicates the objective diagnosis. Hence, it becomes necessary to process the image in order to eliminate unnecessary information and noise components, to highlight the spatial structures of the image that are most interesting to the doctor.

The present paper is aimed at constructing a spatial bandpass filter that will improve ultrasound images in terms of suppressing noise interference and highlighting the necessary details that carry information. As a result, this will allow more reliably perceiving the information content of the image and carrying out more accurate diagnostics.

The problem of band-pass spatial filtering can be solved by digital methods. However, the same problem can be solved in real time at much lower hardware and energy costs on a modern element base, namely on charge-coupled matrix devices(MPCD)[1].

The prototype filter was taken as the basis for constructing the filter, i.e. spatial low-pass filter based on MPCD. Bandpass filtering is implemented by introducing an image frame into the MPCD with its further defocusing due to the application of the controlled charge averaging mode.

The structural diagram of the bandpass filter contains two MPCDs, in which a different degree of defocusing of the same-named frames of the ultrasound image is realized with their further subtraction. Due to this, two-dimensional band-pass filtering in space is realized.

The MPCD-based spatial bandpass filter is built directly into the ultrasound equipment as a separate subunit, and in the equipment structure it should be located directly in front of the monitor after the imaging unit.[2]

When considering the analysis of two visual images, medium-sized structures were presented, which was not in the original image. Filtration gave a real positive result.

Based on the modeling of image filtering, it can be argued that the shown image processing procedure is really useful and should be applied in practice, since it allows you to select areas from the original image that are not visually manifested initially.

As a result, ultrasound images were analyzed, the need for their processing was substantiated, an analysis of existing filtering methods was carried out, based on these data, a multifunctional spatial band-pass filter was formed on a matrix CCD, which eliminates unnecessary information and noise components, highlights medium-sized structures. The filter is capable of processing images in various modes. The technical implementation of the filter has shown its economic and technical advantage in practice.

Thus, based on the analysis of the conditions from the literature, the use of ultrasound physiotherapy, monitoring the indications of ultrasound therapy, their scheme, the analysis of specific ultrasound images and on the basis of its definition, it is aimed at image processing with the aim of more detailed and specific diagnosis. The main methods of image processing are analyzed. Possible options for constructing outdoor image filters based on charge-coupled matrix devices.

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## **Модернизированный аппарат ультразвуковых исследований с разработкой пространственного полосового фильтра**

**В.В. Юмашева**

ФГБОУ ВО «Тамбовский государственный технический университет», Тамбов, Россия  
*e-mail: yumasheva2014@mail.ru*

**Аннотация.** В статье подробно анализируется разработка пространственного полосового фильтра, рассматриваются существующие устройства для ультразвуковой терапии, их структурные схемы, выявляются недостатки и преимущества. В статье представлена разработка пространственного полосового перестраиваемого фильтра на основе матричных устройств с зарядовой связью, который работает в режиме реального времени и характеризуется эффективностью, малым весом и размерами, а также низкой стоимостью.

**Ключевые слова:** полосовой фильтр, моделирование, ультразвуковое устройство, электрические сигналы, обработка

## Features of Constructing a Multipath Antenna Array for Microwave Radar

**N. V. Zahodyakin, A. A. Trishakov, R. D. Karikh**

Tambov State Technical University, Tambov, Russia

*e-mail: zaxodyakin00@mail.ru*

### Abstract

This article discusses the features of using microwave radar to form multipath radiation patterns with a certain shape.

**Keywords:** multipath antenna.

For the effective functioning of microwave radars, it is necessary that multipath radiation patterns with a certain shape (cosecance, etc.) are formed. To solve this problem, a sufficiently efficient antenna system should be used, such an antenna system can be multipath antenna arrays constructed according to different geometries (flat, cylindrical, etc.)

A multipath antenna (MLA) is an antenna having a multi-lobed radiation pattern (Fig. 1). Usually it has several independent inputs / outputs, each of which corresponds to its own radiation pattern – its own beam. A multipath antenna array (IDA) is a complex antenna containing a set of radiating elements arranged in such a way as to obtain the necessary radiation pattern [1].

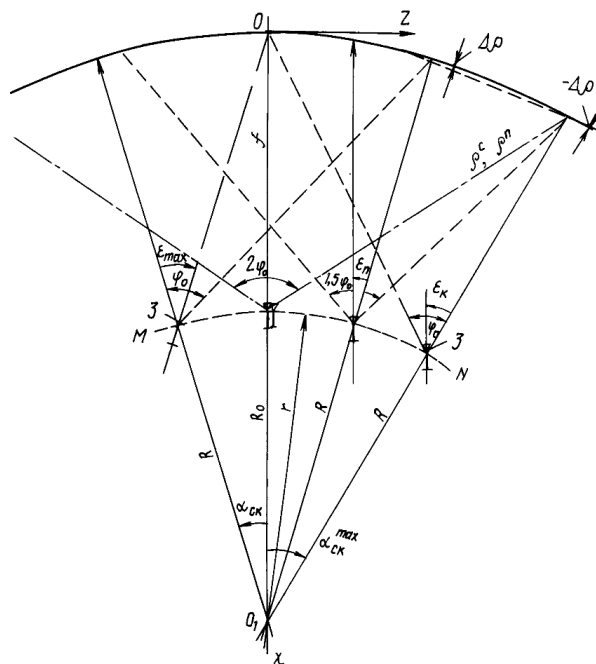
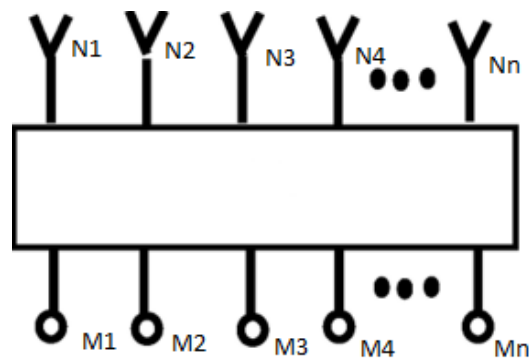


Figure 1 - Multipath antenna

Currently, MAR is widely used in microwave radars, allowing you to quickly detect objects in space and simultaneously accompany a large number of them. This is achieved by illuminating objects in the service area with a wide transmitting beam and covering it with many highly directional receiving beams.

The principle of operation of a multipath antenna array can be explained as follows: there is an antenna array consisting of  $N$  emitters (Fig. 1). [2] The signal from the generator is fed to any of the  $M$  inputs and distributed between the emitters using a passive multipole. It is a circuit that provides a linear phase change along the antenna array, and the magnitude of the phase shift  $\gamma$  between neighboring emitters, and therefore the orientation of the main lobe is determined by the number of the input to which the signal is received [3].



*Figure 2 - Passive multipole*

Despite the fact that the MAR in microwave radars have such advantages as:

- the ability to form a directional pattern of complex shape
- the possibility of using electrical scanning (moving the beam in space without physically changing the position of the antenna)
- adaptation to interference conditions and compensation of equipment failures
- possibility of multi-beam operation

The main disadvantages are:

- the great complexity of the element base and the requirements for it
- difficulties in design calculation [4].

Multipath antenna arrays are widely used in radio systems and largely determine the possibilities of cost-effective servicing of a large number of subscribers in broadband communication systems, as well as detecting and tracking a large number of objects using radar.

The use of multipath antenna arrays as part of the radar complex will allow you to more effectively identify targets, while maintaining not one, but several targets, due to the formation of multipath radiation patterns.

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## Особенности построения многолучевой антенной решетки для микроволнового радиолокатора

Н. В. Заходякин, А. А. Тришаков, Р. Д. Карих

ФГБОУ ВО «Тамбовский государственный технический университет», Тамбов, Россия  
*e-mail: zakhodyakin00@mail.ru*

**Аннотация.** В данной статье рассматриваются особенности использования микроволнового радара для формирования многолучевых диаграмм направленности определенной формы.

**Ключевые слова:** многолучевая антенна



## **Emulation Block of Sensitive Elements of Strapdown Inertial Systems**

**M.V. Zverev**

Tambov State Technical University, Tambov, Russia

*e-mail: 070898q@mail.ru*

### **Abstract**

The purpose of this study is to develop an algorithm for calibrating strapdown inertial navigation systems. For this, software was developed that emulates the behavior of a part of the system, using which it is possible to obtain the required parameters of the sensitive elements of the system, which will be used in debugging the calibration algorithm.

**Keywords:** calibration, strapdown inertial navigation systems

### **Introduction**

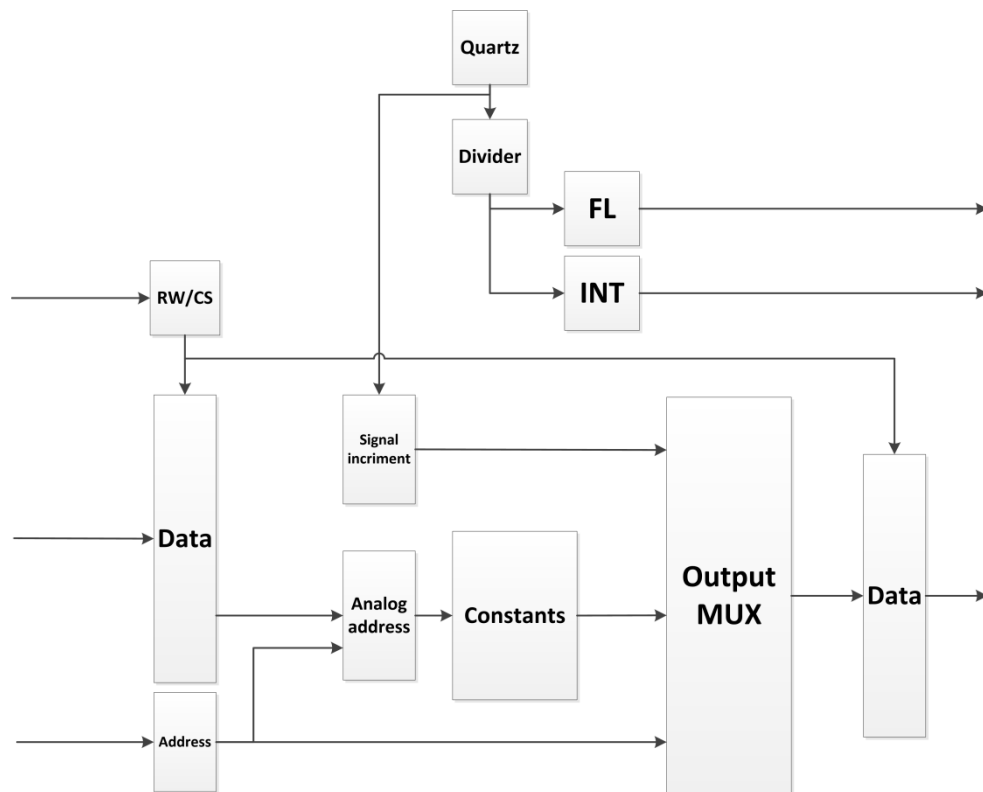
During of study “Development of software and hardware for calibration of strapdown inertial navigation systems” there was developed the software for Data Acquisition Board (DAB) of strapdown inertial navigation systems. We can see the importance of correct calibration algorithms in this article [1]. MEMS sensors have low accuracy, but with the right system calibration we get impressive results.

For checking correctness of understanding compensation calibration algorithms on compensation of different kinds of parasitical effects/impact (e.g. temperature drifts etc.) the software was made. DAB receives signal from Block of Sensitive Elements (BSE) providing analog to digital conversion for system. The developed software is capable of generating similar to BSE signals for the system which requires for perfect (in this particular case - constant) characteristics, due to help of Field-Programmable gate array with hardware description language VERILOG. Expecting results are achieved by recreating data transfer protocol of real existing system. Newly created protocol is sending data (e.g constants and emulated signals) by system’s data bus.

The paper presents an algorithm that describes the behavior of an integrated circuit in the VERILOG language:

- Implemented frequency dividers that generate clock signals of the INT and FL exchange protocol based on the module's clock generator;
- Memory elements containing all constant values are made in the form of registers;
- Buses address, data and protocol control signals, through which data is exchanged;
- Multiplexers, based on the address, issuing the required values on the data bus; - Counters simulating the operation of gyroscopes and their BChE vibration supports.

In figure 1, we can see a visual representation of the blocks of the developed software.



*Figure1 -Program's block diagram*

Quartz is generating 20MHz clock frequency for creating FL and INT signals via the divider. This 20 MHz are used in the block “signal increment” for making partial signals of BSE. The block RW/CS determines by data bus and manages data exchange. The block “data” and “address” represents description of data bus and address bus respectively. Block “signal increment” represents a generator of values for laser gyros and accelerometer. The block receives quartz clock frequency through inner dividers and then creates a certain values of Angular Velocity Sensor (AVS) and increment laser gyros. Laser gyro’s incrementing values, which are constantly increasing with a specific speed, AVS is a distortion of laser gyro values.

Signal increment block including two counters, the first of them is a counter which emulates a laser gyro increments values with a fixed speed and the second is emulating AVS describes an integrative distortion of laser gyros. After calculating values of laser gyro then the derivative of AVS is taken and added to calculation. Next they are redirected in the block MUX. The block analog address takes data and address from corresponding blocks and converts them to internal address of constants. Block “constant” receives value of previous block then send appropriate constant to MUX. The block MUX receives value from the block address and choosing value to output to data bus.

FPGA controllers have limitations in the complexity of mathematical calculations. A microcontroller will be added to the design documentation to build complex laws of the behavior of the BSE. The microcontroller will solve the problem of emulating various kinds of system behavior. With the help of the developed data transfer protocol, the pre-generated behavior of the system will be transmitted through the

DAB to other modules.

Based on the microcontroller, the calculation of sensor values will be organized. The microcontroller will greatly facilitate the introduction of changes in the behavior of the system, and will also allow to control this behavior using a personal computer. With this improvement, it is possible to explore the mathematical model of the system. The development of adequate mathematical models of sensors, manufacturing technology and compensation of systematic errors can significantly improve the accuracy and stability of metrological characteristics of sensors [2].

### **Conclusion**

Developed software allows create the perfect emulated BSE of strapdown internal navigation systems which will be used for calibration algorithm of respective system and thus for its checking and correction of calculations.

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## **Эмуляция блока чувствительных элементов бесплатформенной инерциальной навигационной системы**

**М.В. Зверев**

ФГБОУ ВО «Тамбовский государственный технический университет», Тамбов, Россия  
*e-mail: 070898q@gmail.com*

**Аннотация:** Целью данного исследования является разработка алгоритма калибровки бесплатформенных инерциальных навигационных систем. Для этого было разработано программное обеспечение эмулирующее поведение части системы, используя которое возможно получить требуемые параметры чувствительных элементов системы что будет использовано в отладке алгоритма калибровки.

**Ключевые слова:** бесплатформенные инерциальные навигационные системы, калибровка

УДК 574  
ББК 24.434

## Monitoring of Ammonium Nitrogen in Water Bodies of the Tambov Region

**A. A. Antipova, O. V. Shanina, K. S. Shabalkina**

Tambov State Technical University, Tambov, Russia

*e-mail: Ainolgon@yandex.ru*

### Abstract

Wastewater treatment is an integral part of the work cycle of an industrial enterprise, since poor-quality treatment carries an irreversible danger to the environment. It is very important to extract maximum harmful substances from wastewater, such as ammonium nitrogen. The purpose of this work is to review the results of monitoring of the Tsna river for excess of ammonium nitrogen content in it by photometric method. Also, the obtained results were analyzed and compared with the norms of the LOC.

**Keywords:** Ammonium nitrogen, monitoring, photometric method, Tambov region, Tsna river.

### Introduction

At the enterprise, wastewater treatment from ammonium nitrogen is an important stage, because the composition of such waters differs in the content of labor-oxidizable organic and inorganic compounds, which in turn are toxic to microorganisms living in the reservoir.

For the analysis, water samples were taken from the Tsna River, since it has a significant length on the territory of the Tambov region and, in particular, it is located in the immediate vicinity of the city of Tambov. This is an area where there is a noticeable anthropogenic impact on water bodies.

### Methodology of analysis

To measure the mass concentration of ammonium nitrogen, a photometric method was chosen, which is based on the formation of a bright blue dye during the interaction of ammonia and ammonium ions in an alkaline medium with chlorine and phenol in the presence of sodium nitroprusside, followed by photometric measurement of optical density at a maximum in the absorption spectrum, which is observed at 630 nm [1].

The results of measurements of ammonium nitrogen by photometric method in the form of indophenol blue are shown in Tables 1 and 2. Photometric determination was performed in the form of indophenol blue in the range from 0.010 to 10.00 mg/dm<sup>3</sup>. Measuring instrument: KFK-3-01 "ZOMS", wavelength: 630 nm. The measurement dates were 22.01. 2022 and 06.07. 2022. The measurements were carried out according to RD 52.24.383-2018.

## Results of the measurements

*Table 1 – Results of measurements of ammonium nitrogen by photometric method (measurement date 22.01.2022)*

Date of construction of the calibration chart	Sample number	The certified value of the component in the sample for calibration, C, mg/dm <sup>3</sup>	Cuvette, 1 cm		Cuvette, 5 cm	
			Opt. Dense. d <sub>x</sub>	Opt. Dense. Δd	Opt. Dense. d <sub>x</sub>	Opt. Dense. Δd
22.01.2022	Single	0			0.065	
	1	0.020				0.115
	2	0.040				0.254
	3	0.060				0.367
	4	0.080				0.505
	5	0.099	0.006	0.105		0.630
	6	0.199		0.207		
	7	0.398		0.420		
	8	0.596		0.617		
	9	0.795		0.805		
	10	0.994		0.965		

*Table 2 - Results of measurements of ammonium nitrogen by photometric method (measurement date 06.07.2022)*

Point No.	Sampling location (r. Tsna)	NH <sub>4</sub> concentration, mg/dm <sup>3</sup>
1	3.0 km above Kotovsk, within the village of Kuzmina Gat, 26 km above the city of Tambov, 1 km of the confluence of the river Lesnoy Tambov	d <sub>np</sub> =0.128 c=0.12
2	10.0 km below the city of Kotovsk, 2.2 km above the city of Tambov, at the railway bridge	d <sub>np</sub> =0.200 c=0.20
3	1.5 km below the city of Tambov, 3.0 km below the confluence of the Nameless stream	d <sub>np</sub> =1.961 c=1.91
4	12.5 km below the city of Tambov, 2.0 below the village of Tatanovo, 4.5 km below the confluence of the Liplai stream, 0.9 km below the confluence of the Urlai river	d <sub>np</sub> =1.091 c=1.06

For water bodies of fishery significance, the threshold limit value (LOC) of ammonium ions is 0.4 mg/ dm<sup>3</sup>, ammonia is 0.04 mg/ dm<sup>3</sup>; for objects of economic and drinking and cultural purposes, the LOC is 1.5 mg/dm<sup>3</sup>. The LOC values are given in terms of ammonium nitrogen [2].

## Conclusions

The standards for the maximum permissible concentrations of ammonium nitrogen in the waters of water bodies of fishery significance, which include the collection sites indicated in Table 2, is equal to 0.5 mg/dm<sup>3</sup>. Thus, the results of the study showed an excess of ammonium nitrogen concentrations at two points: No. 3 and No. 4, which are located below the city of Tambov.

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## Мониторинг аммонийного азота в водных объектах Тамбовской области

А. А. Антипова, О. В. Шанина, К. С. Шабалкина

ФГБОУ ВО «Тамбовский государственный технический университет», Тамбов, Россия  
*e-mail: Ainolgon@yandex.ru*

**Аннотация.** Очистка сточных вод является неотъемлемой частью цикла работы промышленного предприятия, так как не качественная очистка несет в себе необратимую опасность для окружающей среды. Очень важно извлекать из сточных вод максимум вредоносных для природы веществ, к примеру, таких как аммонийный азот. Целью данной работы является рассмотрения результатов мониторинга реки Цна на предмет превышения содержания в ней аммонийного азота фотометрическим методом. А также проанализировать полученные результаты и провести их сравнение с нормами ПДК.

**Ключевые слова:** Аммонийный азот, мониторинг, фотометрический метод, Тамбовская область, р. Цна.

## To the Development of the Flushing Oil Composition for Diesel Engines of Tractors

A. V. Koshelev<sup>1</sup>, V. V. Ostrikov<sup>1</sup>, M. N. Makeeva<sup>2</sup>

<sup>1</sup>All-Russian Research Institute for Use of Machinery and Petroleum Products in Agriculture

<sup>2</sup>Tambov State Technical University, Tambov, Russia

*e-mail:alex-koschelev94@yandex.ru*

### Abstract

At the time of replacement engine oil most often does not meet the operation requirements. A significant amount of coke-tar deposits accumulate in the lubrication system, in the oil valves, in the engine crankcase and on the parts of the CPG. This outcome reduces the efficiency of the oil circulation process, heat removal and lubrication of parts that decrease compression in the cylinders and increase fuel consumption. To minimize the effect of lubrication system contamination on the engine performance, it is provided such maintenance operation as engine flushing the with special flushing oils. The experience of using the operation of flushing the lubrication system before replacing used engine oil with fresh one shows the viability and necessity of this operation. In agricultural production, the lubrication system flushing is practically not used due to the relatively high price of flushing oils and due to insufficient detergency to remove contaminants from tractor engines. Thus, the development of a flushing oil composition based on used engine oil is an urgent task.

**Keywords:** lubrication system, contamination, flushing.

### Introduction

As is known, industrial oils I-12A and I-30A that practically do not contain additives are most often used as the basis of flushing oils. Their high price is one of the refusal factors to use flushing oils during maintenance and replacement of motor oils [1].

Waste motor oils available in any agricultural enterprise also contain industrial base oils. However, used motor oils also contain a significant amount of dissolved resins, impurities, and oxidation products. By removing all types of contaminants from used motor oils, it is possible to consider and use them as the basis for flushing oils [2].

One of the most important and difficult tasks in the implementation of the process of waste oils cleaning from contaminants is the process complexity and the high price of equipment. In conditions of agricultural production, limited in its financial capabilities, it is necessary to conduct research and develop simplified methods and technologies for cleaning of used motor oils. At the same time, it is important to maintain high quality in terms of the removal degree of soluble resins and clarification. [3,4]. It is also important to preserve the residual content of additives present in the composition of the used oil during the refining process.

### Research results and discussion

Based on the task of the study, a simplified method and technological process for

cleaning waste motor oils from contaminants is being developed.

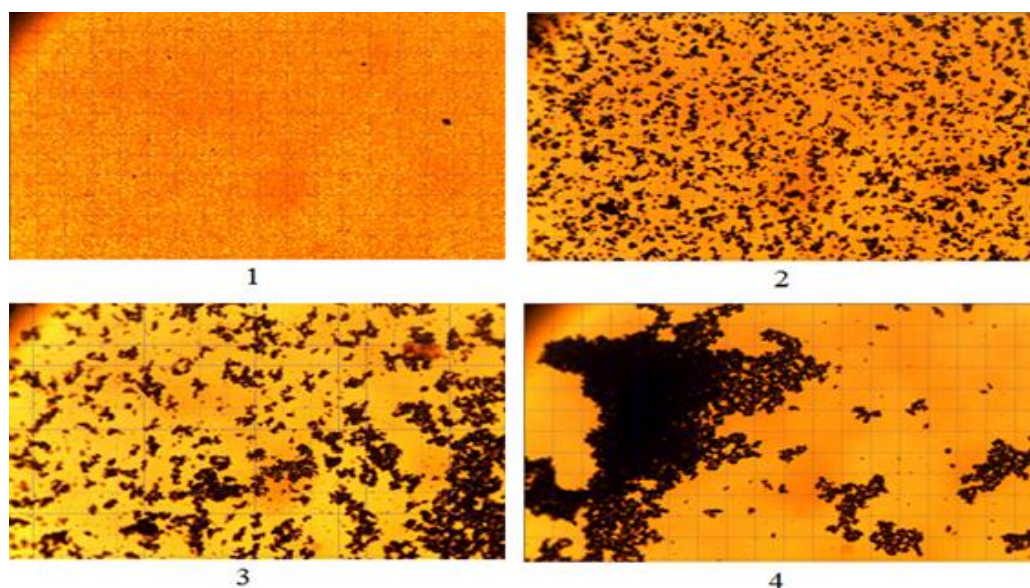
Research was conducted on used engine oil M-10DM, drained from the engine crankcase of an MTZ-82.1 tractor, which worked in the conditions of agricultural production at the SKhPK PZ "Prigorodny" of the Tambov district of the Tambov region. Table 1 presents the results of the physicochemical analysis of engine oil.

*Table 1 - Results of physical and chemical analysis of used engine oil M-10DM*

Indicators	Value
Kinematic viscosity at 100 °C, mm <sup>2</sup> /s	10.6
Base number, mg KOH/g	3.4
Acid number, mg KOH/g	2.1
Insoluble sediment content, %	1.3
Flash point, °C	218
Color, score, unit CNT	9

The used engine oil under consideration contains a significant amount of dissolved contaminants. At the same time, the residual content of additives, determined by the base number of the oil, indicates sufficiently high performance properties, which makes it more preferable for application as the flushing oil basis.

To the used motor oil isopropanol is added in a percentage of 1-3% of the mass and monoethanolamine 1-3% of the mass. The oil was preheated to a temperature of 80°C. The mixture of oil with reagents was heated with constant stirring to a temperature of 120°C. The assessment of the coagulation (enlargement) process of contaminants was carried out with a microscope. Figure 1 shows microphotographs of engine oil depending on the concentration of the introduced reagents.



*Figure 1 - Microphotographs of oil samples at 400 times magnification (Melamed microscope):*

*1 - original used engine oil; 2 - with the addition of 1% isopropanol and*



monoethanolamine; 3 - with the addition of 2% isopropanol and monoethanolamine; 4 - with the addition of 3% isopropanol and monoethanolamine

It was established that the addition of 1% mass of reagents to the oil provides a slight increase in the dispersed composition of contaminants. With an increase in the concentration of reagents up to 2%, the particles of contaminants increase to a size of 20 ... 30 microns, which ensures a fairly rapid deposition of particles in a force field. A subsequent increase in concentration to 3% does not significantly change the picture of the coagulation process.

Due to the fact that the addition of monoethanolamine and isopropanol affects some properties of the oil and may have a negative effect on the composition of the flushing oil, an analysis of the change in base, acid number, flash point and viscosity was carried out. Figure 2 shows the dependence of the change in the properties of used oil on the concentration of introduced reagents.

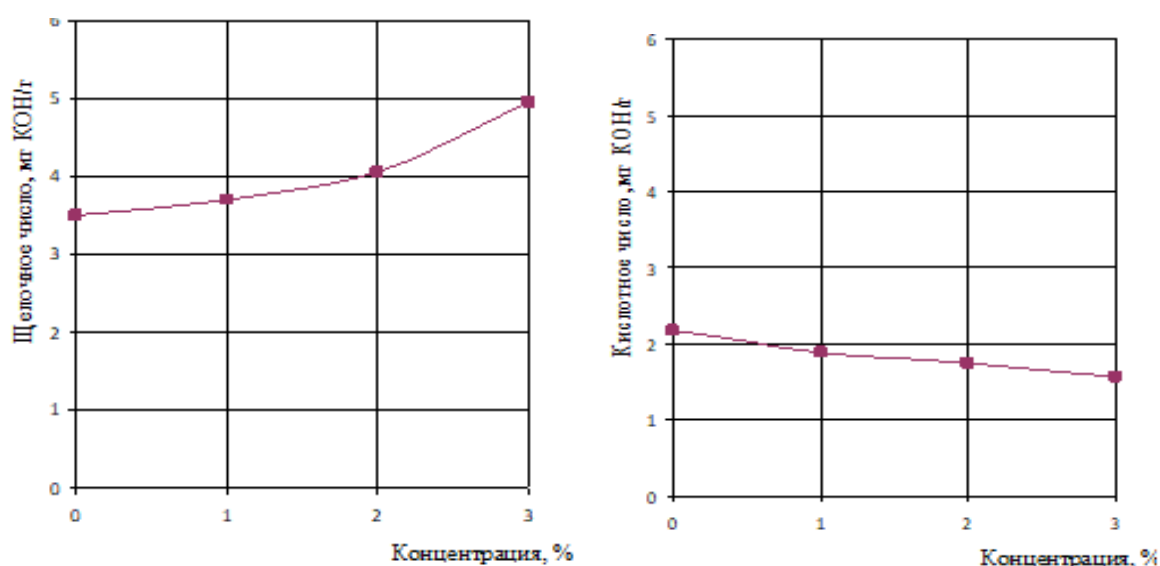


Figure 2 - Dependence of the change in the oil base and acid number on the reagents' concentration in the used engine oil.

As a result of the analysis, it was determined that the reagents' introduction contributes to an increase in the base number and a slight decrease in the acid number of the oil. In this case, an increase in the base number should be regarded as a fact that positively affects the washing properties of the resulting base for its use as flushing oil.

### Conclusions

The decrease in viscosity is regarded as a positive fact, since almost all flushing oils have a viscosity of 6-8 mm<sup>2</sup>/s. Lower viscosity increases the pumpability of the oil and increases the rate of oil flow in the lubrication system. The temperature of used engine oil drops from 218 °C to 207 °C, which does not adversely affect its performance properties.

Analyzing the effect of reagents on the composition and properties of used motor oil for its use as the basis of flushing oil, it should be noted that the oil cleaning

process, an increase in heating temperature, cleaning time, indicators such as viscosity and flash point may change, since isopropanol has the property to evaporate at a temperature above 100 °C.

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## К разработке состава промывочного масла для дизельных двигателей тракторов

А.В. Кошелев<sup>1</sup>, В.В. Остриков<sup>1</sup>, М.Н. Макеева<sup>2</sup>

Всероссийский научно-исследовательский институт использования техники и нефтепродуктов в сельском хозяйстве;

<sup>2</sup>ФГБОУ ВО «Тамбовский государственный технический университет», Тамбов, Россия  
*e-mail:alex-koschelev94@yandex.ru*

**Аннотация.** Моторное масло к моменту замены чаще всего не отвечает требованиям эксплуатации. В системе смазки, в масляных клапанах, в картере двигателя, на деталях ЦПГ накапливается значительное количество коксо-смолистых отложений, снижающий эффективность процесса циркуляции масла, отвод тепла и смазывание деталей, понижающих компрессию в цилиндрах, увеличивающих расход топлива. Для снижения влияния загрязнений системы смазки на эксплуатационные характеристики двигателя предусмотрена его промывка при проведении операции технического обслуживания специальными промывочными маслами. Опыт использования операции промывки системы смазки перед заменой отработанного моторного масла на свежее показывает на состоятельность и необходимость проведения данной операции. В сельскохозяйственном производстве промывка системы смазки практически не используется в силу относительно высокой цены на промывочные масла и из-за недостаточной моющей способности для удаления загрязнений из двигателей тракторов. Разработка состава промывочного масла на основе отработанного моторного масла является актуальной задачей.

**Ключевые слова:** система смазки, загрязнения, промывка.

## **Besonderheit der Aktualisierung des Konzepts der Grünen Wirtschaft in Russland**

**K. W. Michejewa**

Staatliche Technische Universität Tambow, Tambow, Russland  
*e-mail: lady\_krista2000@mail.ru*

**Zusammenfassung:** Dieser Artikel befasst sich mit den Besonderheiten des Übergangs Russlands zu einer grünen Wirtschaft, die mit traditioneller Kohlenwasserstoffenergie verbunden ist. Es nimmt weltweit, insbesondere in Russland, eine führende Position im Wirtschaftsbereich ein.

Das Problem der rationellen Naturbewirtschaftung und des Respekts vor der Umwelt ist von großer Bedeutung im menschlichen Leben, sowohl in der Gegenwart als auch in der Zukunft. Nicht alle Industrie- und Entwicklungsländer können es sich aus wirtschaftlichen Gründen leisten, das notwendige Maßnahmenpaket zur Einführung umweltfreundlicher Technologien für das Umweltmanagement zu schaffen. In Russland, das den Weg eines rohstoffexportierenden Modells der wirtschaftlichen Entwicklung verfolgt, braucht es Transformation und Modernisierung der Wirtschaft, innovatives Wachstum und eine energieeffiziente Politik. In diesem Zusammenhang ist es ratsam, die Hauptmerkmale der Entwicklung des Konzepts einer grünen Wirtschaft in Russland zu untersuchen, Probleme zu identifizieren und geeignete Maßnahmen zur Beseitigung von Problemen zu ergreifen.

**Schlüsselwörter:** grüne Wirtschaft, grüne Technologien, Russland, UNEP, erneuerbare Energiequellen.

Der Beginn des 21. Jahrhunderts war laut den Autoren der Studie von der Stärkung der Positionen des Konzepts der Green Economy geprägt. Es gibt mehrere globale Probleme auf der Welt, wie z. B. ein instabiles Klima, Mangel an Süßwasser, Umweltverschmutzung, Verringerung der biologischen Vielfalt der Lebensformen usw. All diese Probleme sind für die gesamte Menschheit sehr gefährlich. Der Übergang einer Reihe westlicher Länder zur Nutzung und Implementierung grüner Technologien weist den Weg für die schnell wachsenden BRICS-Volkswirtschaften. Unser Land, das über ein riesiges territoriales und natürliches Potenzial verfügt, braucht eine innovative Entwicklung, die natürlich die Modernisierung des Wirtschaftsbereichs einschließt. In Russland wurde die Entwicklung einer grünen Wirtschaft möglich dank der Entstehung solcher konzeptioneller Strategien wie dem UNEP-Bericht «Towards a Green Economy: Pathways to Sustainable Development and Elimination of Poverty»; die Abschlusserklärung des Rio + 20-Gipfels zur Zukunft der Ökologie der Russischen Föderation für den Zeitraum bis 2030; Bundesgesetz „Über Änderungen des Bundesgesetzes «Umweltschutz» und «bestimmter Rechtsakte der Russischen Föderation usw» [1].

Die Position der Blockstaaten, einschließlich der Russischen Föderation, zum Konzept einer Green Economy ist folgende: «Nationalen Behörden muss die Möglichkeit gegeben werden, Flexibilität und politischen Spielraum zu zeigen, damit sie aus einer Vielzahl von Alternativen unabhängig wählen und die Wege bestimmen können die zu einer nachhaltigen Entwicklung führen, basierend auf dem bereits

erreichten Entwicklungsstadium eines bestimmten Landes, nationalen Strategien, Merkmalen und Prioritäten. Wir werden die Einführung von Handels - und Investitionshemmnissen jeglicher Art unter dem Vorwand der Schaffung einer grünen Wirtschaft nicht akzeptieren». In diesem Fall ist dies auf Befürchtungen zurückzuführen, dass der Übergang weniger entwickelter Länder zu einem solchen Konzept im Rahmen der bestehenden Strategie ihre wirtschaftliche Entwicklung einschränken wird. BRICS-Teilnehmer sollten ihr Konzept präzisieren und notwendige Änderungen vornehmen.

Diese Schlussfolgerung zeigt, dass der Übergang zu einer grünen Wirtschaft in Russland eine lange Transformationsphase erfordern wird, die Integration von Umwelttechnologien in die moderne Infrastruktur, die Abkehr von der traditionellen braunen Wirtschaft wird zur Bildung eines neuen Wirtschaftsmodells des Landes führen. Ansätze zur nachhaltigen Entwicklung nach dem neuen Konzept erfordern aktive staatliche Eingriffe in die Wirtschaft, die Schaffung eines staatlichen Regulierungsregimes für die Entwicklung umweltfreundlicher Industrien und Infrastrukturen.

Beim Übergang zu einer grünen Wirtschaft müssen die angesammelten wirtschaftlichen und sozialen Probleme im Zusammenhang mit dem wirtschaftlichen Abschwung der 1990er Jahre und den laufenden Reformen in Bezug auf Ölunternehmen, Kohlekraftwerke und Stahlunternehmen angegangen werden. In den folgenden Jahren verdreifachte sich der Energiesektor, und die russische Wirtschaft ist nun zunehmend abhängig von den Rohstoffsektoren, wie die aktuelle Krise zeigt. Beim Übergang zu einer grünen Wirtschaft müssen die angesammelten wirtschaftlichen und sozialen Probleme im Zusammenhang mit dem wirtschaftlichen Abschwung der 1990er Jahre und den laufenden Reformen in Bezug auf Ölunternehmen, Kohlekraftwerke und Stahlunternehmen angegangen werden. In den folgenden Jahren verdreifachte sich der Energiesektor, und die russische Wirtschaft ist nun zunehmend abhängig von den Rohstoffsektoren, wie die aktuelle Krise zeigt.

Russland verfügt nicht über Mechanismen zur Unterstützung des grünen Clusters in der Wirtschaft, und es gibt praktisch keine Erfahrung mit öffentlich-privaten Partnerschaften in dieser Branche. Augenzeugen sagen, dass der Staat derzeit die Initiatoren der Einführung grüner Technologien nicht wirklich unterstützen kann. Obwohl auf Bundesebene viele verschiedene Verordnungen und Gesetze erlassen wurden [2].

Die Hauptrichtungen der Entwicklung und Umsetzung grüner Technologien in Russland können als Aufgaben der staatlichen Umweltpolitik bezeichnet werden. Die ökologische Doktrin Russlands wurde festgelegt und durch die Anordnung der Regierung der Russischen Föderation vom 31. August 2002 Nr. 1225-r gebilligt. Laut diesem Dokument sind die wichtigsten Vektoren der staatlichen Politik im Bereich der Ökologie die folgenden:

- 1) Gewährleistung einer nachhaltigen Naturbewirtschaftung;
- 2) Verringerung der Umweltverschmutzung und Ressourceneinsparung;
- 3) Erhaltung und Wiederherstellung der natürlichen Umwelt.

Um die mit diesen Bereichen verbundenen Probleme zu lösen, wurde ein Maßnahmenpaket entwickelt. Sie sind die wichtigsten Methoden zur Einführung grüner Technologien, die den wichtigsten Bereich der innovativen Entwicklung des Landes darstellen.

UNEP hebt 10 Hauptsektoren einer grünen Wirtschaft hervor: Landwirtschaft, Gebäudeheizung und- beleuchtung, Energieversorgung, Fischerei, Forstwirtschaft, Industrie, Verkehr, Abfall, Wasser, Energie.

Die Transformation des Energiesektors, der stark zur Umweltverschmutzung beiträgt, ist für unser Land sehr wichtig, aber die Schwierigkeit liegt in der führenden Rolle dieser Branche in der Volkswirtschaft. Russland hat eine Energiestrategie für den Zeitraum bis 2030 entwickelt, die zur Grundlage für die Verbesserung der Energieeffizienz des Landes und gleichzeitig eine «dauerhafte Begrenzung der Belastung des Energiekomplexes und der Energie auf Umwelt und Klima durch Verringerung der Schadstoffemissionen, deren Ausstoß verschmutztes Abwasser und Treibhausgasemissionen, Reduzierung von Produktionsabfällen und Energieverbrauch gewährleistet, werden kann».

Wichtige strategische Aufgaben der staatlichen Energiepolitik sind die möglichst rationelle Nutzung der Energieträger und der Einsatz energiesparender Technologien. Russland hat großes Potenzial im Bereich der Einführung energiesparender Technologien auf Basis erneuerbarer Energiequellen. Der Anteil grüner Energie in der Russischen Föderation beträgt weniger als 1% der gesamten Stromerzeugung. Zu den gebräuchlichsten Energiearten aus erneuerbaren Quellen gehören Biokraftstoffe, Windkraft und Solarenergie [3].

Die geringen Entwicklungsraten energiesparender Technologien auf Basis der Nutzung von Energie aus alternativen Quellen werden durch folgende Faktoren bestimmt:

- 1) Rentabilität von Projekten, die erneuerbare Energiequellen verwenden, im Vergleich zu Projekten, die auf Kohlenstoffbrennstoffen basieren;
- 2) Mangel an staatlicher Unterstützung durch Immobilien und spezifische Vorschriften, die die Nutzung erneuerbarer Energiequellen in der Elektrizitätsindustrie fördern;
- 3) Es gibt keine notwendige Infrastruktur für die erfolgreiche Entwicklung des Elektrizitätssektors auf der Grundlage erneuerbarer Energiequellen.

Gemäß dem Dekret der Regierung der Russischen Föderation „Über die Hauptrichtungen der staatlichen Politik im Bereich der Steigerung der Energieeffizienz der Elektrizitätswirtschaft auf der Grundlage der Nutzung erneuerbarer Energiequellen «wurde die Aufgabe abgeschlossen. Bis 2020 beträgt der Zielwert für das Volumen der Produktion und des Verbrauchs elektrischer Energie unter Verwendung alternativer Energiequellen 4,5 % des gesamten in Russland erzeugten Energievolumens. Zu diesem Zweck erscheint es sinnvoller, vielversprechende Energiesparprogramme im Bauwesen, im öffentlichen Sektor, im Wohnungsbau und bei kommunalen Dienstleistungen einzuführen; verschiedene Maßnahmen der öffentlichen Verwaltung anzuwenden (Steuern, Sozialleistungen, Tarifpolitik usw.), an große

Industrieunternehmen, um die Ressourceneffizienz zu verbessern und Umweltschäden zu vermeiden; schrittweiser Ersatz veralteter Energietechnologien und -anlagen durch neue energieeffiziente Anlagen; ein nach Produktionstechnologie differenziertes Tarifsysteem für Strom anzuwenden.

Eine allmähliche Änderung der Rohstoffnatur der Wirtschaft wird dazu beitragen, eine ausgewogene wirtschaftliche Entwicklung des Landes zu erreichen, die wirtschaftliche Stabilität aufrechtzuerhalten, das Wohlergehen der Menschen und die Lebensqualität, die Quantität des Lebens zu verbessern. In den Arbeiten russischer Experten gibt es einige Empfehlungen, die einen echten Impuls für den Übergang zu einer «grünen» Wirtschaft enthalten [3].

Die Modernisierung der Wirtschaft und die Einführung umweltfreundlicher Technologien erfordern jedoch das aktive Eingreifen des Staates, die Beteiligung am Prozess der Unternehmensstrukturierung und das Interesse der Bevölkerung. Darüber hinaus bedarf es zur Erreichung der Energieeffizienz einer zusätzlichen landesrechtlichen und wirtschaftlichen Regelung von Steuern, Subventionen, Investitionen, Bußgeldern etc. Das aktuelle, auf maximalen Konsum ausgerichtete Marktumfeld ist jedoch mit der radikalen Einführung „grüner“ Innovationen nicht vereinbar. Zudem birgt die Einführung erneuerbarer Energiequellen Risiken für den Arbeitsmarkt. Daher kann die Suche nach einem Ausgleich zwischen den Interessen der Wirtschaft und des Naturschutzes bei der Umsetzung des Konzepts der «grünen Wirtschaft» in Russland lange dauern.

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### **Особенность актуализации концепции зеленой экономики в России**

**К. В. Михеева**

ФГБОУ ВО «Тамбовский государственный технический университет», Тамбов, Россия  
*e-mail: lady\_krista2000@mail.ru*

**Аннотация.** В данной статье рассматривается специфика перехода России к концепции зеленой экономики, связанная с традиционной углеводородной энергетикой. Она занимает ведущее положение в экономической сфере во всем мире, а именно в России. Проблема рационального природопользования, бережное отношение к окружающей среде имеет весомое значение в жизни человека, как в настоящем и будущем времени. Не все развитые и развивающиеся страны могут себе позволить создать необходимый набор мер для внедрения экологических чистых технологий для рационального природопользования, по экономическим соображениям. В России, которая идет по пути экспортно-сырьевой модели экономического развития, нуждается в трансформации и модернизации экономики, инновационном росте и энергоэффективной политике. В связи с этим целесообразно изучить основные характеристики развития концепции зеленой экономики в России, а также выявить проблемы и предпринять соответствующие действия для устранения проблем.

**Ключевые слова:** зеленая экономика, зеленые технологии, Россия, ЮНЕП, возобновляемые источники энергии.

## Modern Methods of Processing Sewage Sludge

**A. V. Nekhorosheva, Y. S. Medvedeva**

Tambov State Technical University, Tambov, Russia

*e-mail: nehoroshewa126@gmail.com*

### Abstract

At the moment, domestic wastewater is a huge problem both from the point of view of ecology and the environment, and from the economic side. Organic substances, which enter the hydrosphere from household wastewater, are decomposed by colonies of oxygen-consuming bacteria. With the necessary air access, aerobic bacteria process wastewater into environmentally friendly substances. With limited access of oxygen to the drains, the vital activity of aerobic bacteria decreases, as a result of which anaerobic bacteria develop, thus provoking the process of rotting. The aim of the work is to analyze the available methods of processing sewage sludge. The most effective of these are processing into raw materials that can be reused, for example, in construction and in the agricultural complex.

**Keywords:** asphalt concrete, construction, organic fertilizers, precipitation processing, sewage sludge.

### Introduction

Sewage sludge from urban wastewater treatment plants is one of the main wastes of household activities of the population.

The annual volumes of accumulated sewage sludge in Russia amount to 30-35 million tons based on the natural humidity of 75%. In terms of dry matter, this amounts to 9-10 million tons.

Due to the fact that the volume of sewage sludge is constantly increasing, an urgent problem is their disposal.

In the process of searching for alternative ways to dispose of sewage sludge by conducting theoretical and experimental studies and pilot testing, it was proved that the solution of the environmental problem - the elimination of accumulated waste volumes — is possible through their active involvement in economic turnover.

Currently, sewage sludge can be used in the following industries:

- road construction (production of organo-mineral powder instead of mineral powder for asphalt concrete);
- construction (production of expanded clay type insulation and ceramic effective bricks);
- agricultural sector (production of high-humus organic fertilizer).

### Road construction

For the manufacture of asphalt concrete mixtures from the industrial waste of the Water Utility and their use in the road surface, the smallest possible complex in terms of capacity is proposed — a mobile asphalt concrete plant (mini-ACP). The advantages of such a complex are low price, low operating and depreciation costs. The small dimensions of the installation make it possible to ensure not only its convenient storage, but also an energy-efficient instant start-up and release of finished asphalt

concrete. At the same time, the production of asphalt concrete is carried out at the laying site, bypassing the transportation stage, using a high-temperature mixture, which ensures a high degree of compaction of the material and excellent quality of the asphalt concrete coating [1].

### **Construction**

It is also proposed to use sewage sludge in cement production. The technology consists in the production of powder from sewage sludge (the so-called DSWP, domestic waste sludge powder). To do this, "cakes" are formed from the sediment, which are then dried and burned to remove moisture. Then these "cakes" are crushed and sieved. Using different proportions of DWSP (3, 5, 7, 10 and 15 percent) mixed with cement, the researchers were able to obtain various types of concrete, both of the usual strength class (B30) and higher strength class (B40 and B50) [2].

### **Agricultural sector**

In recent years, a lot of research has been conducted to obtain compost from sewage sludge and the organic part of municipal solid waste (MSW). The resulting compost fertilizer has a positive effect on the structure of the soil, improves its physico-chemical, biological and anti-erosion properties. Compost is successfully used to enrich depleted lands, recultivate soils, increase moisture capacity, improve biological activity and resistance of plants to diseases [3].

In the joint composting of liquid or compacted sewage sludge and MSW, valuable qualities of precipitation (organic substances, protein compounds, amino acids) are more fully used, which enrich MSW and improve the quality of the mixture as fertilizers. With such composting, not only thermal drying of precipitation is excluded, but also mechanical dewatering of them, which simplifies the precipitation treatment process and reduces its cost.

Silt water released by methane tanks or obtained after mechanical dewatering of fermented sediments contains a large amount of ammonium salts. This water is sent for purification, meanwhile it is characterized by high alkalinity and ammonium nitrogen can be isolated from it, which can then be used as fertilizer. According to research data, 1 liter of silt water after methane tanks contains up to 600-800 mg of ammonium salts nitrogen [3].

The process flowchart can be depicted as follows: sludge water, from the methane tanks and the mechanical dewatering plant, is sent to a shell-and-tube heat exchanger (HE), for heating up to 70 - 75 ° C. The heated sludge water is sent to the bubbler (B) for further air purging. After 5 hours of purging, 62.2% of ammonia can be obtained from its content in silt water. Then the ammonia-saturated air is fed into the adsorber (A). The adsorbent is a dehydrated precipitate with a humidity of 40-60%. The diagram is shown in Figure 1 and the flows in Table 1. The dehydrated sediment is saturated with ammonia, thereby increasing its fertilizing qualities. At the end of the process, we get a ready-made nitrogen-saturated fertilizer that can be used in all branches of the agricultural industry.



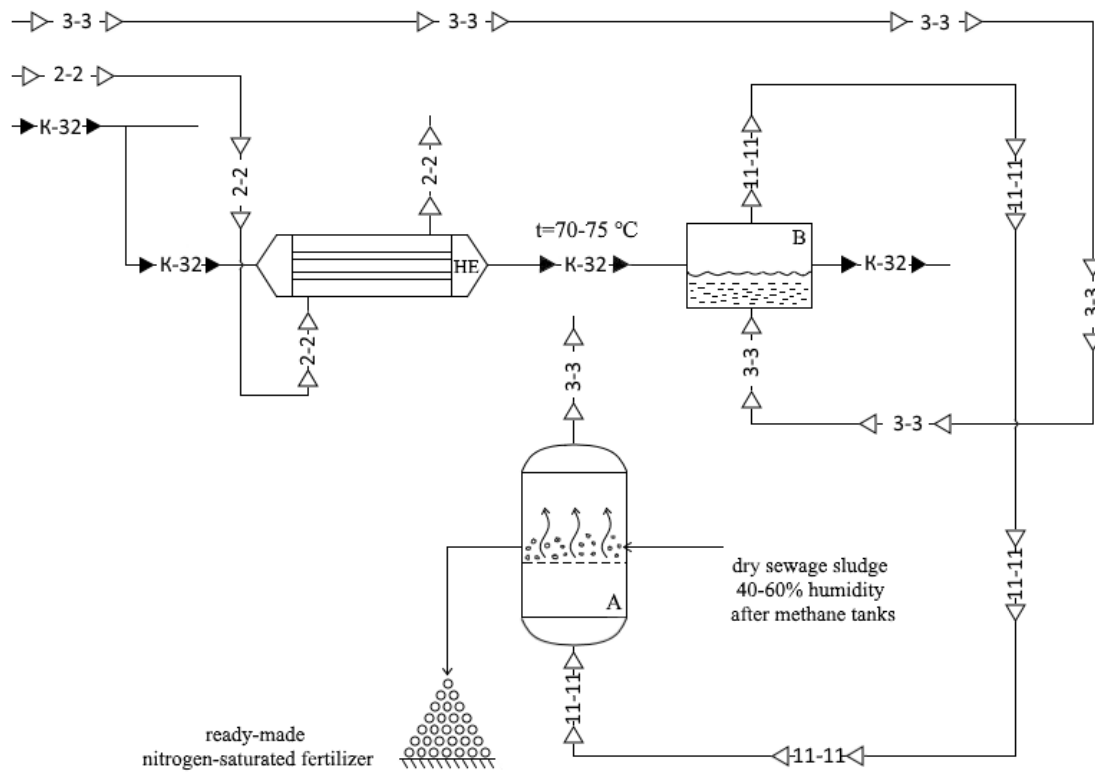


Figure 1 – Sewage sludge treatment block diagram

Table 1 – Flow table

Conditional designation		Name of the medium in the pipeline
Number	Graphic	
2-2		Steam
3-3		Air
11-11		Ammonia
K-32		Silt water

It is impossible to conduct progressive agriculture without nitrogen fertilizers. Farmers use them to grow both vegetables and cereals, industrial crops. Nitrogen fertilizers are applied in the form of granules, powder or liquid solution. The latter can be introduced into the soil – to nourish the root system, or on the leaves – foliar top dressing. The optimal time, type and method of application of ammonia fertilizer is determined based on the technology of cultivation of agriculture.

### Conclusion

Having considered the above methods, we can say that the processing of sewage

sludge into fertilizers is more efficient. This method more fully uses the valuable qualities of sludge (organic substances, protein compounds, amino acids), which enrich MSW and improve the quality of the mixture as fertilizers. Fertilizers obtained by this method can be used at all stages of agrocenosis. Also, the simplified precipitation treatment process reduces its cost.

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## Современные способы переработки осадка сточных вод

А. В. Нехорошева, Ю. С. Медведева

ФГБОУ ВО «Тамбовский государственный технический университет», Тамбов, Россия  
*e-mail: nehoroshewa126@gmail.com*

**Аннотация.** На настоящий момент бытовые стоки – это колоссальная проблема как с точки зрения экологии и окружающей среды, так и с экономической стороны. Из хозяйственных бытовых стоков в гидросферу поступают органические вещества, которые разлагаются колониями потребляющих кислород бактерий. При необходимом доступе воздуха аэробные бактерии перерабатывают стоки в экологически безвредные вещества. При ограниченном доступе кислорода воздуха к стокам снижается жизнедеятельность аэробных бактерий, вследствие чего развиваются анаэробные бактерии, провоцирующие процесс гниения. Целью работы является проанализировать доступные методы переработки осадка сточных вод, наиболее эффективными из которых являются переработка в сырье, которое можно использовать повторно, например, в строительстве, в аграрном комплексе.

**Ключевые слова:** асфальтобетон, органические удобрения, осадок сточных вод, переработка осадков, строительство.

## Optimization of Pedestrian Crossing Placement

**U. A. Potapova**

Tambov State Technical University, Tambov, Russia

\*e-mail: *petrik.ulya@yandex.ru*

### Abstract

Optimization of pedestrian crossings placement in settlements to reduce the amount of emissions of harmful substances by motor transport is considered. Proposals are made to amend the regulations documents regulating the placement of pedestrian crossings.

**Keywords:** motor transport, pedestrian crossing, air pollution by motor transport.

In the modern world, there are more and more problems associated with environmental pollution by motor vehicles, namely their exhaust gases, as well as dust emissions from worn tires and their friction with asphalt, which significantly affects changes in the natural environment [1].

As it is known, before a pedestrian crossing, a car should always slow down regardless of whether a pedestrian is on it [2], and after that the car picks up speed again. Constant braking and acceleration of the car, as well as its complete stop before a pedestrian crossing, are the most obvious causes of environmental pollution, since when braking, acceleration, tires are erased on asphalt, leaving invisible dust in the air that we breathe. And when the engine is idling, the highest concentration of pollutants is released Table 1[3].

*Table 1. Concentration of harmful emissions*

Toxic substances	Concentration of harmful emissions, %			
	Idle	Braking	Acceleration	Constant speed
CO	6.9	3.9	2.9	2.7
NO	1.05	1.06	1.07	1.09

To optimize the placement of pedestrian crossings, Chicherina Street in Tambov was proposed for consideration. There are 7 pedestrian crossings on the site under consideration, the length of Chicherina Street is 1km 100m, the greatest distance from one pedestrian crossing to another is 250m, the average distance of these crossings from each other is 157m, which leads to constant braking, acceleration of the car, which, with these manipulations, emit pollutants into the atmosphere. Reduction of pedestrian crossings to 5, do not violate the requirements of GOST R 32944-2014 p. 4.5.2.1 "Pedestrian crossings over highways in populated areas are located 200-300 m apart. In settlements up to 0.5 km, no more than two pedestrian crossings are arranged at intervals of 150-200m. The maximum distance between pedestrian crossings will increase by 10m, and will be 260m, but the average distance between pedestrian crossings will increase and will be 220m. These changes do not contradict GOST,

thereby they will not reduce road safety, but at the same time they will improve the environmental component of the city, because the intensity of traffic flows on this street is high [4].

The topic of optimization (reduction) of pedestrian crossings is very relevant for the whole of Russia, the example on Chicherina Street in Tambov is a clear confirmation of this.

These changes will help to reduce the number of pedestrian crossings, which will lead to a reduction in harmful emissions of vehicles due to the need for frequent braking, acceleration and stopping in front of them. Harmful emissions are considered: exhaust gases, dust from wiping tires on the asphalt surface, evaporation from power systems, etc.

In addition, the issue of tougher penalties for these violations should be considered, such as "violation of the requirements of an environmental sign prohibiting the movement of trucks", "left turn or U-turn in violation of the requirements of environmental signs", "violation of the requirements of other environmental signs". The introduction of punishments should be transferred to the jurisdiction of the regions of the Russian Federation.

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## Оптимизация размещения пешеходных переходов

У.А. Потапова

ФГБОУ ВО «Тамбовский государственный технический университет», г.Тамбов, Россия  
*\*e-mail: petrik.ulya@yandex.ru*

**Аннотация.** Рассматривается оптимизация размещения пешеходных переходов в населенных пунктах для снижения количества выбросов вредных веществ автотранспортом; приводятся предложения по внесению изменений в нормативные документы, регламентирующие размещение пешеходных переходов.

**Ключевые слова:** автомобильный транспорт, пешеходный переход, загрязнение атмосферы автотранспортом.

## **Preparation for the Management Decision on the Implementation of the Project to Improve Activities in the Testing Laboratory**

**K. A. Selezneva, D. V. Olifirenko, S. V. Ponomarev**

Tambov State Technical University, Tambov, Russia

*e-mail: miti@tstu.ru*

### **Abstract**

The basics of using the expert method in preparing the adoption of a management decision on the implementation of projects to improve activities in the testing laboratory, based on determining the rank of the indicator "Indicator of the possibility of improvement" ITS. An example of the application of the proposed method in the preparation for making a management decision on the use of two existing projects to improve activities in the laboratory is given.

**Keywords:** expert method, improvement possibility indicator, probability of project implementation, significance of positive consequences of project implementation, managerial decision, preparation.

The article considers an example of applying the results of the work of a team of experts on the preparation of a management decision on the implementation of a project to improve activities in a testing laboratory, based on the use of the "Improvement Opportunity Indicator", determined by an expert method by the values of two indicators "Probability of implementing an improvement project" and "Significance of the positive consequences of project implementation".

#### 1. The main problem of the article.

Since September 1, 2019, GOST ISO / IEC 17025 - 2019 requires (to confirm the status of accreditation) annual submission of information on taking into account existing risks and identified opportunities when demonstrating successful improvement of activities, and the testing laboratory has no practical experience in implementing such activities. As part of solving this problem, the article proposes a methodology for preparing the adoption of a managerial decision on the implementation of a project to improve activities, taking into account the existing opportunities for improving the functioning of the testing laboratory.

#### 2. The use of two indicators in the comparative evaluation of performance improvement projects.

When evaluating the "Improvement Opportunity Indicator" indicator, we use a combination of two indicators:

- 1) "Probability of project implementation",
- 2) "The significance of the consequences of the project implementation".

The outlined approach provides for the following procedure:

- 1) the tutor of the laboratory creates a team of experts and instructs them to make a comparative assessment of the available options for improvement projects in the laboratory;

- 2) a team of experts performs a scoring of the first indicator "Probability of project

implementation" using a five-point qualimetric scale

3) a team of experts performs a scoring of the second indicator "The significance of the positive consequences of the project implementation" using a five-point qualimetric scale

4) the rank of the desired assessment of the "Improvement Opportunity Indicator" indicator for each improvement project under consideration is determined using a two-dimensional matrix, a cell located at the intersection of a row and a column is found, and the rank value is read in this cell of table 1.

*Table 1- Improvement opportunity indicator*

Probability of project implementation/The significance of the consequences of the project implementation	Costs pay off					
	>7 years	5-7 years	3-4 years	1-2 years	<1 year	
	1	2	3	4	5	
90-100%	5	II	III	IV	V	VI
65-90%	4	II	II	III	IV	V
35-65%	3	I	II	II	III	IV
10-35%	2	I	I	II	II	III
0-10%	1	I	I	I	II	III

Matrix for determining the rank of the indicator "Indicator of the possibility of improvement" based on the results of the assessment of indicators, the probability of project implementation and the significance of the consequences score of the project implementation

3. An example of applying the approach in the preparation of a management decision.

Two projects were considered for the implementation of improved algorithms for processing experimental data when measuring the thermophysical properties of solid materials, namely in the laboratory of the Department of Mechatronics and Technological Measurements of the Tambov State Technical University, in 2020:

Project No. 1, it is included the use of an algorithm for processing experimental data (obtained by the method of a flat pulsed heat source)

Project No. 2, it is involved the use of an algorithm for processing experimental data (obtained by the method of a linear pulsed heat source)

A team of experts-specialists, which included 6 people, carried out work to obtain:

1) first, scoring the indicators "Probability of implementation of the improvement" project by "Probability of project implementation" and "Significance of the positive consequences" of "Significance of the consequences" of the project implementation of the implementation of the improvement project" for the two projects under consideration;

2) then the rank values of each of these two improvement projects in the thermophysical laboratory. The results of this team work are presented in Table 2.

*Table 2- Improvement projects in the thermophysical laboratory*

Expert number	Project No.1			Project No.2		
	Score		Rank	Score		Rank
	Probability of project implementation	The significance of the consequences of the project implementation	Indicator of the possibility of improvement	Probability of project implementation	The significance of the consequences of the project implementation	Indicator of the possibility of improvement
1	4	4	IV	4	5	V
2	5	4	V	5	4	V
3	5	4	V	5	5	VI
4	5	5	VI	5	5	VI
5	5	4	V	5	5	VI
6	5	4	V	5	5	VI
Final value	4,8 ≈ 5	4,16 ≈ 4	V	4,8 ≈ 5	4,8 ≈ 5	VI

The results of the work of the team of experts on the evaluation of the rank of two projects for the improvement of activities in the thermophysical laboratory

The report on the results of the work performed was submitted for consideration to the head of the thermophysical scientific school of the Tambov State Technical University, who is the owner of the process in question in the thermophysical laboratory of the mechatronics and process measurements department.

The owner of the process decided to include the proposal under consideration in the composition of the quality objectives and the action plan to achieve the goals in 2021.

Currently, work is being successfully carried out to introduce project No. 2 into the practical activities of the thermophysical laboratory of the mechatronics and process measurements department of the Tambov State Technical University.

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## **Подготовка принятия управленческого решения о внедрении проекта совершенствования деятельности в испытательной лаборатории**

**К. А. Селезнева, Д. В. Олифиренко, С. В. Пономарев**

ФГБОУ ВО «Тамбовский государственный технический университет», Тамбов, Россия;  
*e-mail: miti@tstu.ru*

**Аннотация.** Рассмотрены основы использования экспертного метода при подготовке принятия управленческого решения о внедрении проектов совершенствования деятельности в испытательной лаборатории, базирующегося на определении ранга показателя «Индикатор возможности улучшения» ИВУ. Приведён пример применения предложенного метода при подготовке принятия управленческого решения об использовании имеющихся двух проектов совершенствования деятельности в лаборатории.

**Ключевые слова:** экспертный метод, индикатор возможности улучшения, вероятность реализации проекта, значимость положительных последствий внедрения проекта, управленческое решение, подготовка.



## Microalgae Application Potential in Industry

**E. I. Shishkov, I. A. Protopopov**

Tambov State Technical University Tambov, Russia

*e-mail: shiskoveugene@mail.ru*

### Abstract

Microalgae have great potential for the production of various products. Microalgae are an economical resource for the production of fuel, bioactive products and feed additives. In this paper, the possibility of using microalgae in industry is considered

**Key words:** animal husbandry, biofuel, microalgae, pharmaceuticals, pigment.

### Introduction

In comparison with the cultivation of other food and energy crops, the cultivation of microalgae does not require land use and does not contribute to environmental pollution. But despite these advantages, the commercialization of microalgae cultivation technologies is still at an early stage due to problems preventing the use of microalgae on an industrial scale. Complex processing of microalgae can reduce economic costs and increase the sustainability of production. Therefore, it is necessary to study the potential of using microalgae biomass. The purpose of this study is to review potential industrial applications of microalgae and their components.

### Areas of microalgae application

**Biofuels** are a clean alternative fuel source that can replace fossil fuels. Recently, algae have been attracted as a potential raw material for biofuels, which is due to the advantages of their use: high rate of biomass accumulation, high lipid content, resistance to extreme environmental conditions. The total lipid content of some types of microalgae can reach 30...60% of the dry weight [1]. Among the species of microalgae for biofuel production, the following are distinguished: *Chlorella vulgaris*, *Kirchneriella lunaris*, *Lyngbya kuetzingii*, *Selenastrum capricornutum*, *Scenedesmus obliquus*. These species have high lipid productivity, synthesize mainly unsaturated fatty acids, the biodiesel obtained from them has a high cetane number and a relatively low turbidity temperature.

### Biogas

The production of biogas from microalgae occurs by anaerobic digestion of microalgae biomass by bacteria. Microalgae are considered an advantageous substrate for anaerobic digestion due to the high productivity of biomass and low ash content. When choosing algae species, preference is given to strains with thin cell walls, which makes them more easily degradable. In addition to easy decomposition, other characteristics, such as performance or sensitivity to contamination, must be taken into account. Among the promising species for biogas production are: *Arthrospira platensis*, *Chlamydomonas reinhardtii*, *Chlorella kessleri*, *Dunaliella salina*, *Euglena gracilis*, *Spirulina maxima*.

## **Cosmetics**

Microalgae extract, as a rule, *Chlorella vulgaris specie*, *Chlorogloeopsis spp.*, *Isochrysis*, *Nannochloropsis* has the ability to protect against solar radiation (light absorption) due to the presence of chlorophyll-a, sporopollenin and mycosporin-like amino acids in its composition, in this regard they are used as a component of sunscreens. Some proteins and hydrolysates of algae of the genus *Porphyra*, *Spirulina sp.* and *Chlorella sp.* they have an affinity with skin and hair proteins, providing moisture retention and suitable viscosity. In this regard, cosmetics containing algae proteins can be used in skin and hair care products, shampoos, hair dyes. Extracts of *Chlorococcum sp.* and *Chlorella vulgaris* can be used in anti-aging products, as they are able to stimulate the production of collagen and promote tissue regeneration. *Nannochloropsis oculata* extract containing zeaxanthin is able to inhibit the enzyme tyrosinase, thus preventing hyperpigmentation of the skin and stimulating discoloration of pigment spots. Currently, there are several brands for the production of cosmetics based on microalgae. For example, the French company ProTec Ingredients, which produces a cream from the extract of *C. vulgaris* Dermo Chlorella. The cream has a firming and restructuring effect on the contour of the eyes, and also stimulates the synthesis of collagen.

## **Pigments**

Microalgae pigments: chlorophyll, carotenoids, phycobiliproteins, astaxanthin and xanthophyll are often used in industries such as food, nutraceutical, pharmaceutical, aquaculture and cosmetics; as well as in research laboratories [2]. The following types of microalgae are used as pigment producers: betacarotene – *Scenedesmus almeriensis*, *Dunaliella abardawil*, *Dunaliella salina*, lycopene – *Chlorella marina*, lutein – *Chlorella protothecoides*, *Dunaliella salina*, astaxanthin – *Chlamydomonas*, *Chlorella*, *Haematococcus*, Chlorophyll – *Chlorella sp.*, *Chlorella minutissima*, *Nannochloropsis oculata*.

## **Wastewater treatment**

Microalgae can purify urban, industrial, agro-industrial and livestock wastewater [3]. When using microalgae, there is a significant decrease in the chemical oxygen demand. *Chlorella*, *Scenedesmus*, *Oscillatoria*, *Micractinium* are used as biological agents in wastewater treatment. Microalgae are also able to effectively absorb heavy metals from wastewater, for example, *Chlorella vulgaris* absorbs  $Pb^{2+}$ .

## **Application in agriculture**

Microalgae can be useful in the mineralization of soil nutrients, as plant growth stimulants, reclamation of wastelands, plant protection. It is shown that the biomass of microalgae contains micro- and macroelements: nitrogen, phosphorus and potassium and can be used as an organic fertilizer. Microalgae of the *Chlorophyceae*, *Trebouxiophyceae*, *Ulvophyceae* and *Charophyceae families* can be used as biostimulants due to the content of the following substances in their composition: betaines, amino acids, vitamins and polyamines that stimulate plant growth. Biostimulants and biofertilizers based on microalgae are considered environmentally friendly and cost-effective [4].

### **Animal husbandry**

In animal husbandry, microalgae are used for foraging. The added biomass of microalgae has a positive effect on the physiology of animals, improving their immune response, resistance to diseases and intestinal function, promotes weight gain. In particular, the use of *Chlorella vulgaris* when feeding dairy cattle leads to a change in the profile of fatty acids in milk; the addition of microalgae to feed intended for lambs and horses increases the content of fatty acids in the resulting meat, the inclusion of *Arthrospira platensis* in poultry feed contributes to better weight gain.

### **Pharmaceuticals**

Microalgae are a rich source of biologically active primary and secondary metabolites. These metabolites are of interest to the pharmaceutical industry. It has been proven that algae extracts have antibacterial activity in vitro against both gram-positive and gram-negative bacteria. It is also reported that microalgae extract has antifungal activity.

### **Conclusion**

Large-scale cultivation of microalgae can be useful for the commercialization of biofuels and high-value-added products. Microalgae can also be used to reduce CO<sub>2</sub> emissions. Thus, microalgae are a safe raw material that offers a whole arsenal of valuable commercial products in various industries.

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## **Потенциал применения микроводорослей в промышленности**

**Е. И. Шишков, И. А. Протопопов**

ФГБОУ ВО «Тамбовский государственный технический университет», Тамбов, Россия  
*e-mail: shiskoveugene@mail.ru*

**Аннотация.** Микроводоросли обладают большим потенциалом для производства различных продуктов. Микроводоросли являются экономичным ресурсом для производства топлива, биоактивных продуктов и кормовых добавок. В данной работе рассматривается возможность использования микроводорослей в промышленности.

**Ключевые слова:** биотопливо, животноводство, микроводоросли, пигменты, фармацевтика.

## Determining the Optimum Speed when Moving a Personal Breathing Apparatus

**D.Yu. Tulupov**

Tambov State Technical University, Tambov, Russia  
*e-mail: tulupovden@yandex.ru*

### **Abstract**

The purpose of this study is to determine the optimal speed of movement when using a personal breathing apparatus (PBA). The relevance of the study lies in the fact that the correct choice of the speed of movement can significantly increase the time of the protective action of the PBA. The results of experiments involving two testers walking on a treadmill at different speeds are presented. Dependences of changes in pulmonary ventilation and heart rate on the speed of movement are shown. It is shown that the optimal speed of movement on straight sections in the PBA is the speed from 3 to 5 km/h with its increase.

**Keywords:** individual training; personal breathing apparatus (PBA); physiological parameters; self-contained breathing apparatus

A self-contained breathing apparatus is a portable source of breathing gas suitable for human breathing, and is used either when there is a lack of oxygen in the surrounding atmosphere, or when it contains a high content of toxic substances that cannot be filtered out by other means of personal respiratory protection. Exhaled carbon dioxide is absorbed by the chemical composition, then the mixture is enriched with oxygen and fed to the breath. Such devices are widely used in coal mines, where there is a high risk of fire or explosion, which entails a large release of carbon monoxide or white gas. In the event of an emergency in the mine, these devices help to get to less dangerous places.

Personal breathing apparatus (PBA) has a limited time of protective action, during which it can provide a person with a gas respiratory mixture. The nominal (with pulmonary ventilation 35 dm<sup>3</sup>/min.) protective action time (PTA) is indicated in the characteristics of a particular device and ranges from 15 to 90 minutes on average. A large number of factors, both human and hardware, influence the actual PVR of the breathing apparatus. Human factors include factors that affect the amount of oxygen consumed by a person, and hardware factors - factors that affect the quantity and quality of the respiratory gas mixture generated by the PBA.

The speed of movement directly affects the time of the protective action of the PBA. The higher the speed is, the higher the physical load and, accordingly, the oxygen consumption of the body is. On the other hand, a higher movement speed allows you to get out of the danger zone faster. Therefore, in order to determine the optimal movement speed in the PBA, the task was to study and evaluate the influence of the movement speed on the main physiological parameters of a person that directly affect the PBA, namely pulmonary ventilation and heart rate (HR).

## Materials and methods

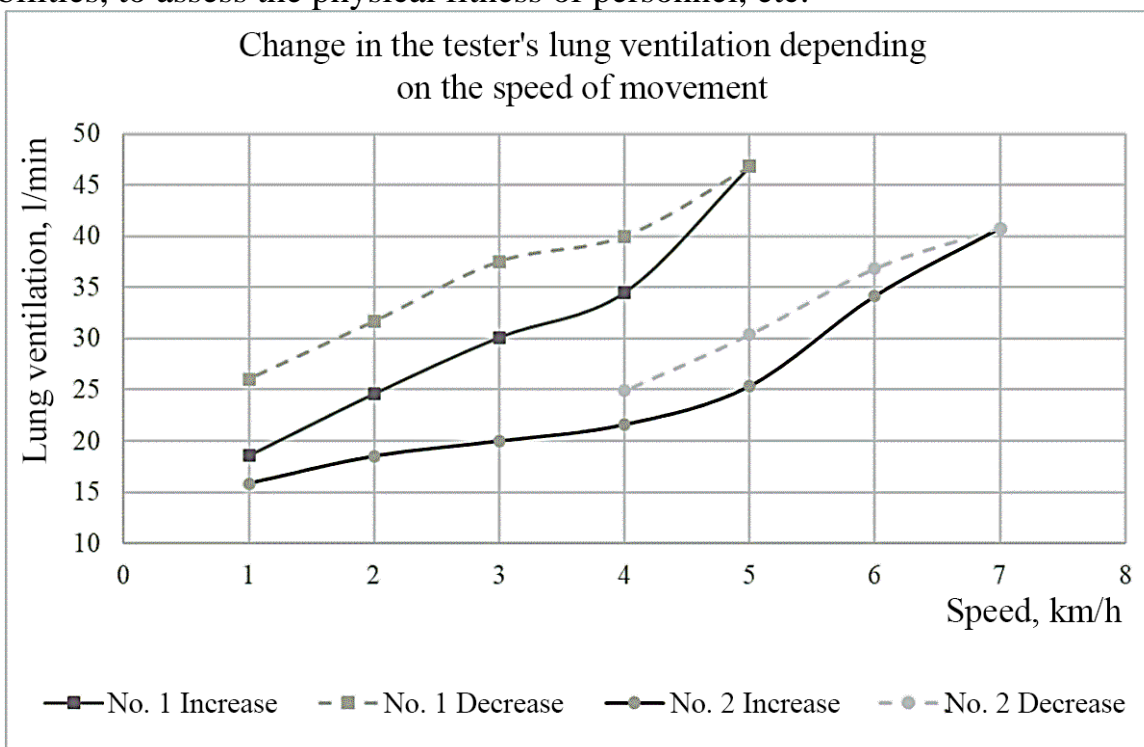
For the experiment, 2 test volunteers were selected with an average age of 37 years, in good health, with an average level of physical fitness. For the registration of physiological parameters, a simulator-recorder of the LLC Ambitex company was used, which simulates the breathing conditions of a real PBA. The measurement results were entered into a database located on the operator's personal computer using a Wi-Fi channel. The choice of the device is due to ease of use, availability and fixation of the necessary data with high accuracy. The data obtained allow the use of mathematical models to calculate oxygen consumption, human energy costs, endurance coefficients and other physiological parameters required to assess a person's physical fitness and the dynamics of its change over time.

Test No. 1 walked on the treadmill at a speed of 1 to 5 km/h, increasing the speed by 1 km/h every 10 minutes. Test subject No. 2 also walked on the treadmill, but at a speed of 1 to 7 km/h, increasing the speed by 1 km/h every 5 minutes. A high speed of movement was not considered, since usually as a result of accidents there are difficulties associated with smoke in the environment, as a result of which running becomes impossible due to low visibility.

## Results and discussion

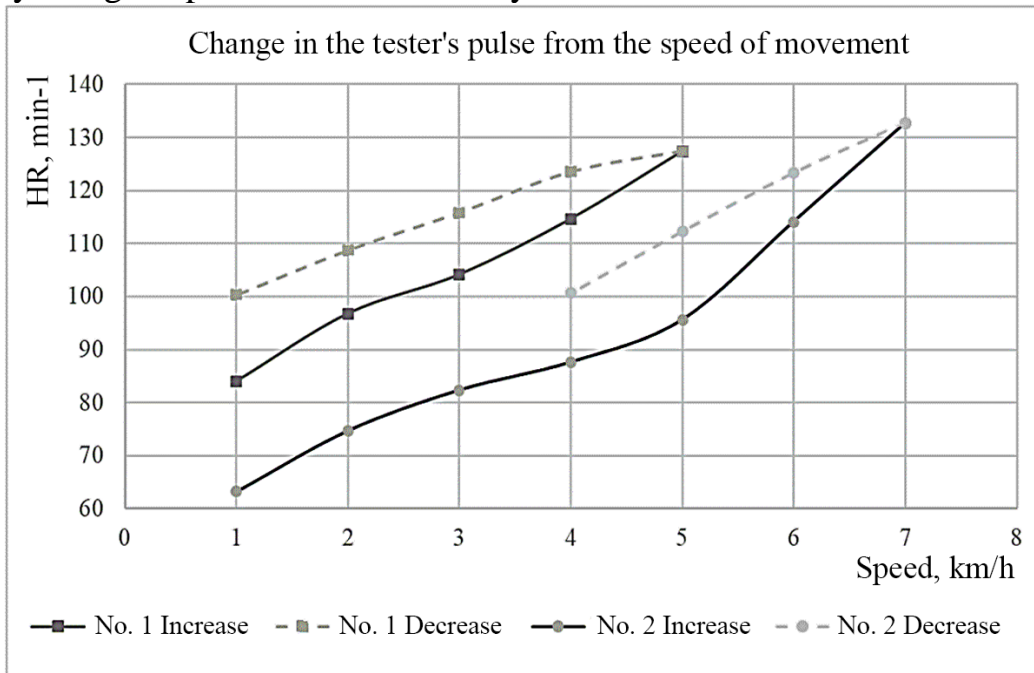
During the experiment, a graph of the dependence of pulmonary ventilation on the speed of movement was obtained (Fig. 1), as well as a graph of the dependence of heart rate on the speed of movement (Fig. 2).

It is easy to see that the parameters of testers No. 1 and No. 2 differ significantly under the same loads, which makes it possible to use the information received to solve various applied problems, for example, for personnel selection, for drawing up individual training plans, for selecting groups of people with loved ones, physical capabilities, to assess the physical fitness of personnel, etc.



*Figure 1 - Dependence of pulmonary ventilation of testers No. 1 and No. 2 at different speeds on the treadmill*

On the graphs, one can observe the same type of «dips» at speeds from 3 to 5 km/h with an increase in the speed of movement. They characterize the optimal ratio of energy consumption and speed of movement in the PBA. With a smooth decrease in the speed of movement, the curves are more linear and do not show a significant effect on the physiological parameters of the body.



*Figure 2 - The dependence of the heart rate of testers No. 1 and No. 2 at different speeds on the treadmill*

A certain range is relevant for straight sections of the route. In the case of ascents and descents, the speed of movement is directly proportional to the load being tested.

### **Conclusions**

The conducted experiment shows that the optimal speed of movement on straight sections in the PBA is the speed from 3 to 5 km/h with its increase. It is this speed that makes it possible to use the PBA resource as efficiently as possible, thereby increasing the time of the protective action, as a result of which the rescued person can travel a greater distance and will have greater chances of survival.

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## **Определение оптимальной скорости при движении в индивидуальном дыхательном аппарате**

**Д. Ю. Тулунов**

ФГБОУ ВО «Тамбовский государственный технический университет», Тамбов, Россия  
*e-mail: tulupovden@yandex.ru*

**Аннотация:** Целью данного исследования является определение оптимальной скорости движения при использовании индивидуального дыхательного аппарата (ИДА). Актуальность исследования состоит в том, что правильный выбор скорости движения, может существенно увеличить время защитного действия ИДА. Приведены результаты экспериментов с участием двух испытуемых, осуществляющих ходьбу по беговой дорожке с разными скоростями. Показаны зависимости изменения лёгочной вентиляции и частоты сердечных сокращений от скорости движения. Показано, что оптимальной скоростью движения на прямых участках в ИДА является скорость от 3 до 5 км/ч при её увеличении.

**Ключевые слова:** индивидуальное обучение, индивидуальный дыхательный аппарат (ИДА), физиологические параметры, автономный дыхательный аппарат.

## Environmental Safety in Passenger Transport

**A. A. Vladimirova, D. N. Baskakov**

Tambov State Technical University, Tambov, Russia

*e-mail:basckakov.danil@yandex.ru*

### Abstract

The article studies the types of fuels, their advantages and disadvantages. A brief essence of environmental problems in the operation of passenger transport, and ways of their solving are given. Studying the basics of ecology for students of transport and environmental specialties is considered to be essential.

**Keywords:** ecology, environmental problems, operation of transport, passenger transport.

Transport and ecology are an inextricable link that brings harmful effects to the environment, both during operation and during disposal. Passenger transport is driven by an internal combustion engine, which is capable of running on diesel, gasoline and gas engine fuel [2]. Currently, electric motors are gaining popularity, which have a positive effect on environmental dynamics, compared with other types of fuel. But a vehicle with an electric motor is not capable of driving long distances, and it is also worth noting the dependence on the weather, the limited service life and the need for energy replenishment, which can take sufficient time to fully charge.

Gasoline and diesel fuels emit toxic substances to a greater extent than other types of sources of pollution from passenger transport. Therefore, if this problem remains unsolved, it might cause global warming, changing the composition of the soil and weakening the state of human health [1].

During operation, in order to maintain the technical condition, daily pre-trip and post-trip technical inspections are carried out, with regard to buses of different capacities that go on a daily flight. First of all, those elements that affect technical safety should be in good condition: the braking system, steering mechanism, etc. From the environmental safety side, inspections and inspections are not carried out: how many emissions are made over a period of time, what substances come from the operation of the entire motor interconnected transport system. To study the amount of emissions, their percentage ratio, it is necessary to use the equipment intended for this purpose: a smoke meter. A smoke meter is a device for measuring the density of smoke, the concentration of particles in the air, and measuring the composition of smoke.

An important factor of environmental friendliness is the lifespan of passenger transport. In total, the omission of post-flight and pre-flight technical inspections, as well as a high coefficient of deterioration, leads to environmental disaster. There are many reasons why the necessary procedures for safe operation and daily, high-quality maintenance of transport are skipped: the human factor, the low level of wages, both drivers of passenger public transport and mechanics who have to carry out technical inspections, and it is also worth emphasizing - the low level of sources of income for



the maintenance of transport. The price for travel in Tambov from December 1, 2022 rises to 25 rubles [3], despite the fact that the quality and type of transport does not change.

A passenger taxi does not fully possess all the declared characteristics: affordable, fast and safe. Drivers in pursuit of orders are ready to violate the Rules of the road [4], starting with the very first and important rule: fasten your seat belt. Bus drivers also do not adhere to the same rules: they conduct telephone conversations without a proper Bluetooth device; they are ahead of buses in order to boarder a large number of passengers to a full interior space, which creates uncomfortable conditions for passengers.

During the advance, there is an increase in speed, engine speed and, accordingly, the release of pollutants. With such acts of drivers, there is also an additional problem: the arrival of the bus does not occur in the designated entry pocket. Public transport occupies a lane for traffic, which harm so the road users and creates an emergency situation.

Summing up the above, I would like to note that environmental safety is a concept that is associated with all life cycles of vehicles [1]: during operation, it is necessary to adhere to the requirements and norms that currently exist, including Traffic Rules. In case of non-compliance with the rules, the resulting traffic accident, such as collisions, rollovers [5] and other types of road accidents, where the leakage of technical fluids may result, as well as the ignition of the vehicle, which leads to the release of pollutants into the atmosphere. Therefore, it is necessary to conduct preventive conversations with drivers and administratively punish them in case of more than one violation. Among other things, at the legislative level, it is necessary to introduce activities to control environmental indicators from motor vehicles: enter work data during each interval of a certain period of time or relative to the motorcycle hours passed.

As passenger transport develops, it is necessary to pay attention to alternative fuel sources: gas-engine fuel or electric [1]. But according to the criteria, it is economical, practical – gas engine fuel. There is one gas-powered filling station in Tambov, despite the fact that only part of the buses are relatively new, equipped for this type of fuel. The demand for gas equipment is widespread not only on public transport, but also on a light car. In the near future, it is planned to build a second station, where gas refueling will be allowed [6]. Thus, positive changes are expected, which may attract motorists to use gas fuel and re-equip their vehicles, since the demand for a single gas station was hyped.

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## **Экологическая безопасность на пассажирском транспорте**

**А. А. Владимирова, Д. Н. Баскаков**

ФГБОУ ВО «Тамбовский государственный технический университет», г. Тамбов, Россия  
*e-mail: basckakov.danil@yandex.ru*

**Аннотация.** Рассматриваются виды топлива, их преимущества и недостатки, дается краткая сущность экологических проблем при эксплуатации пассажирского транспорта, способы их решения. Предназначено для студентов транспортно-экологических специальностей, изучающих основы экологии.

**Ключевые слова:** экология, пассажирский транспорт, эксплуатация транспорта, экологические проблемы.

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## Mixing in the Preparation of Complete Feed

**A.Yu. Konev, N.V. Kholshch**

Tambov State Technical University, Tambov, Russia  
*e-mail: Konev.a1998@mail.ru*

### Abstract

The article describes the schemes for the production of compound feed, the existing designs for mixing dry loose feed mixtures, the dependence ratio of the preparation quality of feed mixtures, through the use of modern technological equipment produced on the basis of scientific research.

**Keywords:** feed mixer, loose feed, mixer classification,

### Introduction

The country's food security is the most important component of its independence. Given the current situation, this issue is very acute in our country. One of the ways out of this situation is to search for affordable alternatives to the equipment that is currently being produced, with the intensification of the development and implementation of domestic equipment meeting modern requirements to agro-industrial technologies for feeding farm animals. In order to obtain high productivity of farm animals, it is necessary to provide them with all necessary nutrients. This can be achieved only with the use of complete feed mixtures.

### Mixing of complete feeds

One of the components of the production of livestock products is the feeding of farm animals. This operation is time-consuming and costly, in addition to the feed itself, it is necessary to prepare it for feeding and distribution. These operations also require a significant amount of technological equipment. To obtain high productivity of farm animals, it is necessary to provide all the necessary nutrients. This can be achieved only by using complete feed mixtures. It is known that feeding with high-quality complete mixtures can increase productivity by 25...30%, while reducing the cost of production [4].

A significant share in the composition of complete feed mixtures is occupied by compound feeds. So in the diet of poultry they should be 95... 100%, pigs – 85... 90%, cattle – 24... 30% [1]. The production of compound feeds is carried out at feed mills and in the conditions of farms. In the latter case, the cost of compound feed will be less due to its cheaper feed components, as well as the absence of transport costs for the delivery of a large volume of compound feed and trade margins. Complete feed mixtures can consist of a large number of components (more often from 10 to 50) and the uniformity of distribution of these components in a portion of the mixture will have

a great impact on the effectiveness of their use [2, 3]. There are rather strict zootechnical requirements for the uniformity of the distribution of components in the feed: for pigs — 85%; for poultry — 90%; for cattle — 80% (with the introduction of carbamide — 90%); for compound feeds of own production — 90...95% [2]. Feed mixers are used to ensure a given uniformity of the mixture, as well as better feed palatability. Without the use of this type of equipment, it is impossible to prepare a high-quality complete mixture.

There are several technological schemes for the production of compound feed in the conditions of the economy [3]:

- series-parallel preparation of all components and one-time dosing (classical scheme);
- formation of preliminary mixtures of grain, protein and mineral raw materials with repeated dosing;
- formation of preliminary mixtures of grain, protein and mineral raw materials without repeated dosing;
- the direct-flow method.

Each of these technological schemes provides for a mixing operation, and in some this operation is performed several times at different stages. Scientific research has established that the most preferable scheme is the formation of preliminary mixtures of grain, protein and mineral raw materials with repeated dosing [3]. This technology provides for the presence of several mixers. Ultimately, the quality of the mixture and the effectiveness of the feed use depend on their work.

There are also a number of machines for the preparation of compound feeds in the conditions of the farm, working according to a simplified technological scheme: AK-1000, AK-2000, AK-3000, "Prok", "Treasure", "SKIOLD", KU-2, UK-2, feed plants "KOMBINAT", "RIELA", "MILL-MIXER", "SKIOLD PICCOLO", mini-feed mills DOZA, container-type feed mills produced by firms "OTTEVANGER MILLING ENGINEERS", "WYNVEEN INTER-NATIONAL B. V.", semi-trailer feed mills RM 35 and "Mix all", self-propelled plants for the preparation of compound feeds of firms "Polymya" and "Awila" [4]. The use of such aggregates ensures the production of compound feed in the farm from available components according to generally accepted recipes or according to recipes compiled by specialists of the farm. Their relatively small cost and fairly fast payback cause their widespread distribution. Mixers of various designs are also used in these units [4].

## **Conclusion**

Based on the analysis, improving the quality of preparation of feed mixtures is possible, first of all, through the use of modern technological equipment produced on the basis of scientific research. Currently, there is a large assortment of feed mixers on the market, but not all of them have the appropriate performance indicators: low homogeneity of the mixture, complexity of construction, high specific energy intensity of the mixture preparation process, long mixing time, the complexity of reconfiguration for various types of components. Given the shortage of imported

mixing equipment, the issue of developing new feed mixers, as well as improving existing ones, becomes even more urgent. This can be achieved by scientific substantiation of mixer designs taking into account the requirements of existing enterprises and with subsequent complex tests in real conditions of farms.

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## **Смешивание при приготовлении полнорационных кормов**

**А.Ю. Конев, Н.В. Хольшев**

ФГБОУ ВО «Тамбовский государственный технический университет», Тамбов, Россия  
*e-mail: Konev.a1998@mail.ru*

**Аннотация.** В статье описывается схемы производства комбикормов, существующие конструкции для смешивания сухих рассыпных кормосмесей, отношение зависимости качества приготовления кормосмесей, за счет использования современного технологического оборудования, произведенного на основе научных исследований.

**Ключевые слова:** смеситель кормов, классификация смесителя, рассыпной комбикорм.

## Classification of Dry Feed Mixers

**E.B. Lozhkina<sup>\*2</sup>, S.M. Vedishchev<sup>1</sup>, V.S. Lozhkin<sup>2</sup>**

<sup>1</sup> Tambov State Technical University, Tambov, Russia

<sup>2</sup> All-Russian Research Institute for Use of Machinery and Petroleum Products in Agriculture  
*e-mail: vniiti@mail.ru*

### **Abstract**

This article describes the classification of mixers, the principle of operation, the main characteristics, and provides an analysis of the most typical designs of such machines. The classification features include only those structural elements that affect the quality indicators of the mixing process and specific energy costs.

**Keywords:** feed mixer, mixer classification, loose compound feed.

### **Introduction**

Feed mixers for animals have found application in Russia and abroad. Their abundance is associated with different zootechnical requirements that are imposed on the mixing process for different species and age groups of animals, a variety of zonal features of feeds depends greatly on the animal age. In this regard, we were looking for a rational design of the machine according to its quality indicators that most fully meets the zootechnical, design and economic requirements.

### **Classification of various mixers**

The most important and most urgent task facing agricultural producers, agricultural science and production areas related to the agro-industrial complex is to ensure the maximum realization of the genetic potential of animals. For the production of livestock products, the issue of preparing well-digested feed is always relevant.

Feed mixers of various designs and operating principles, both mass-produced and individual samples made by graduate students and applicants, design bureaus, as well as specialists and innovators on farms, on feed production enterprises, on technological lines of feed preparation on livestock farms and complexes of our country and abroad. The variety of these devices is explained by the prospect of their use and the search for the optimal design of the machine, which, in terms of the quality of the finished product, most fully meets the zootechnical requirements. Feed mixers used in agriculture are very diverse in their design. It is obviously explained by different technical requirements for the mixing process for different species and age groups of animals, various zonal features of the feed, depending on its physical characteristics and purpose. As well as the constant search for the most effective mixer design for all zootechnical requirements. Before determining the direction of development of existing feed mixers, we will consider the classification and give an analysis of the most typical designs of such machines. In the category of classifications, we will include only those constructions that affect the quality indicators of the mixing process

and specific energy costs [1].

There are two most common types of mixers for the production of dry compound feeds: mixers of continuous and mixers of periodic action. Due to the constant replenishment of the initial components in continuous mixers, the process of moving from the loading site to the unloading site occurs. To use such mixers, you need to precisely control the amount of ingredients to obtain a high-quality product. Finding the regularities of the mixing process in such mixers causes difficulties, since equipment errors can be detected during the study [2].

According to the rotation speed of the mixer's working bodies, they can be divided into slow-speed and high-speed. Mixers designed for fast food preparation may not be used in all types of feed. Cooking in them is somewhat longer than in slow-moving ones. But more specific energy consumption per unit of feed. In addition, at a high speed of rotation of the working bodies, additional crushing of feed components occurs. This is unacceptable by zootechnical requirements [3].

Mixers with a rotating body or drum mixers are used for mixing food. Advantages of drum mixers: simplicity of the device; the ability to mix components without abrasion of the mold; mixing of abrasive components. Disadvantages and drawbacks: poor mixing quality; long mixing cycle; high energy costs per unit of finished product.

Two-shaft screw belt mixers are used as a mixer for rational mixing of feed materials. For this reason, an increase in the number of working bodies leads to a design scheme complication and a labor intensity increase.

As a result of the horizontal arrangement of the augers, the risk of damage to the mixing chamber by foreign bodies increases.

Horizontal working bodies are used for the preparation of mixers. They provide high quality and low specific energy consumption.

The invention for forced-action mixers includes mixing working bodies that affect the mass of the initial components and redistribute them [4].

Positive aspects of Forced Action Mixers include: high power; the ability to prepare mixtures of various physical characteristics and high mixing quality. Negative aspects are: high cost, difficulties in operation, high wear of working bodies [4].

The movement of materials inside the mixer hopper can be divided into two types: introduction, redistribution and circulation. Various installations for mixing components ensure good quality and high quantity of products. However, when using finely dispersed components of compound feeds, there is a threat of fire or explosion.

Redistributive mixers work on the principle of redirection. As a result, the materials inside the hopper move chaotically. In such devices, the duration of mixing depends on the rate of formation of shear surfaces in the mixers. This type of mixers has high performance factor. The advantage is the simplicity of the design, a small amount of energy and a sufficiently high uniformity of the mixture. Disadvantages of this type of mixer are: due to a large number of interspersions of mixed materials inside the hopper, may occur the segregation of individual components.

When used as a filler of dry feed mixtures, vibratory mixers are used to produce dry feed mixtures.



For mixing in circulation mixers, a powerful mixing process is used, which makes it possible to repeatedly move the material inside the hopper. This process, in essence, can be characterized as convective mixing, when the particles of the components move in groups and constantly create new interface surfaces. Thanks to this fact, they can provide any necessary feed quality.

## Conclusion

Taking into account the above information, the following mixer design can be taken as a sample for research and further development: by type of feed – dry; by the design of the hopper - round; by the number of mixing shafts – inclined; by the method of mixing — forced action; by the type of movement of the mixed components – circulating; by the type of working body – screw with an active return channel.

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## Классификация смесителей сухих комбикормов

**Е.Б. Ложкина<sup>2\*</sup>, С.М. Ведищев<sup>1</sup>, В.С. Ложкин<sup>2</sup>**

<sup>1</sup> ФГБОУ ВО «Тамбовский государственный технический университет»;

<sup>2</sup> ФГБНУ «Всероссийский научно-исследовательский институт использования техники и нефтепродуктов в сельском хозяйстве»б Тамбов, Россия

*e-mail: lozhkina.ekaterina2016@gmail.com*

**Аннотация.** В данной статье описывается классификация смесителей принцип их работы и основные характеристики, приведен анализ наиболее типичных конструкций таких машин. В классификационные признаки включаются лишь те элементы конструкций, которые оказывают влияние на показатели качества процесса смешивания и удельные затраты энергии.

**Ключевые слова:** смеситель кормов, классификация смесителя, рассыпной комбикорм.



## Overview of Seeding Units in the Precision Farming System

**A. V. Prokhorov, V. N. Zenkin\*, S. P. Strygin**

Tambov State Technical University, Tambov, Russia

*e-mail: zenkinvn@yandex.ru*

### Abstract

The purpose of this study is to analyze seeding units considering their application in the precision farming system. The study considers the types of seeding units and the features of their operation. The relevance of the study is that the quality of the seeder is directly related to the yield of agricultural crops. As a result, it is necessary to develop a set of measures to improve the accuracy of sowing by upgrading old seeding systems and developing new ones.

**Keywords:** precision farming, seeder, seeding unit, sowing.

### Introduction

Recently, in all spheres of human activity, in particular in agricultural production, interrelated problems of energy conservation and environmental protection have become more acute. The precision farming system is a promising direction for the development of mechanization of crop production, ensuring a reduction in energy consumption and improving the environmental friendliness of the industry.

A distinctive feature of precision farming is the economical use of fertilizers, pesticides in accordance with the needs of plants located in the specific conditions of a particular area of the field and, due to this, decreasing the anthropogenic load on the soil and improving the environmental friendliness of the final product. The maximum effect of the use of precision farming is achieved when plants are placed on the field according to the coordinate principle – in a certain order, at predetermined points of the field with specified coordinates, which minimizes the cost of performing plant care operations. For the full implementation of precision farming, means of coordination of all the working bodies used in relation to the field and plants are necessary.

In precision farming systems based on existing machines, satellite navigation tools are used for this purpose, supplemented by local positioning systems and plant recognition systems. After the introduction of advanced farming with a coordinate system, which is inherently accurate, it will be possible to regulate the working bodies without the use of satellite navigation systems. To implement the sowing of seeds according to the coordinate principle in precision farming, seeders are needed, the peculiarity of which is the sowing according to the signals of the local navigation system or other means of determining the machine. [1]

### Results and Discussion

The sowing system of the seeder is a whole composed of many elements that are in relationships and connections with each other, forming a certain unity and focus on the main task – the qualitative placement of seeds over the field area [2].

Seeding units of the seeders for sowing various seed materials are classified into:

mechanical, pneumatic, pneumo-mechanical, hydraulic [3], Figure 1.

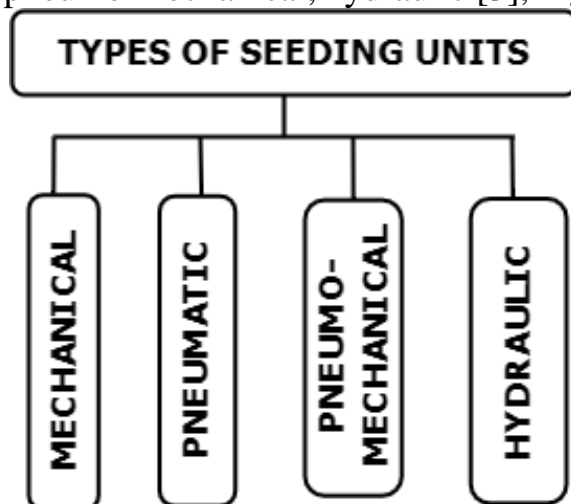


Figure1 -. Classification of seeding units

Mechanical units are distinguished by the method of seed selection from the total mass: single and group selection; according to design features, they are divided into tape, disk, drum, sleeve, screw and spoon. Seeding elements in tape, sleeve and drum machines move continuously, and in disk devices – both continuously and periodically. The disadvantage of this type of seeding units is the poor quality of seeding.

In pneumatic units, vacuum or overpressure is used to select seeds from the hopper. Vacuum devices are disk and drum. Suction holes or nipples in disk devices are located on the side surface of the disk, in drum units – on a cylindrical surface. To ensure single-seeded selection, seeding units are equipped with means of removing excess seeds. The main disadvantage of the device in question is the high requirement for the quality of vacuum wires.

In pneumo-mechanical sowing units, the air flow is usually used to remove excess seeds from the cells of the sowing disc. The disadvantage is the complexity of the design of this type of apparatus.

Hydraulic seeding units belong to a new promising class. These seeding units make it possible to solve a number of issues that cannot be implemented by other seeding units: ensure the sowing of germinated seeds, minimize injury to seeds, carry out simultaneous application of protective and make-up fluids, increase field germination of seeds, reduce seeding rates, accelerate the appearance. Despite the advantages of hydraulic seeding, the main disadvantage of the device under consideration is the low speed associated with the cyclicity and separation in time of two processes – seed capture and sowing.

The drive of the seeding units is carried out mechanically through a gearbox and chain gears, which leads to slipping of the drive wheels, reduces the efficiency of the unit and worsens the quality of seeding. Currently, work is actively underway to modernize the seeders with the replacement of a mechanical drive with an electric one.

[4]

Analyzing the currently existing seeding systems for various agricultural materials presented in the classification, one can see their development paths and trends for further improvement.

### **Conclusion**

Seeding accuracy is one of the most important criteria for the quality of seeding units and in conventional technologies should provide optimal sowing density.

Among the considered types of sowing units, the pneumatic one is the optimal, since it has the greatest reliability and provides high-quality sowing of seeds.

We can conclude that in order to increase yields using precision farming systems, it is necessary to modernize pneumatic seeding systems and develop new ones to ensure more accurate placement of seeds in the field.

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## **Обзор высевающих аппаратов в системе точного земледелия**

**А. В. Прохоров, В. Н. Зенкин\*, С. П. Стрыгин**

ФГБОУ ВО «Тамбовский государственный технический университет», Тамбов, Россия  
*e-mail: zenkinvn@yandex.ru*

**Аннотация:** Целью данного исследования является анализ высевающих аппаратов с учётом их применения в системе точного земледелия. В исследовании рассмотрены типы высевающих аппаратов и особенности их работы. Актуальность исследования заключается в том, что качество работы сеялки напрямую связано с урожайностью сельскохозяйственных культур. В результате этого необходимо разработать комплекс мер по улучшению точности высева путём модернизации старых высевающих систем и разработки новых.

**Ключевые слова:** высевающий аппарат, посев, сеялка, точное земледелие.

## Advanced Technologies for Drying Vegetable Raw Materials

**G. V. Rybin, S. V. Prokhorov, N. A. Shuvaev\***

Tambov State Technical University, Tambov, Russia

*e-mail: shuvaevn@list.ru*

### Abstract

The market of functional nutrition, that is, products that have a high content of nutrients and trace elements, is actively developing in our country. Therefore, it is important to develop technology and equipment for such goods production. One of the most common ways to enrich a product with useful properties is to add plant material (fruits, berries, herbs) to its composition. However, in most cases, it is not advisable to use fresh raw materials. When processing plant material for functional nutrition, the most important task is to preserve the maximum amount of biologically active substances. Drying is one of the main stages of processing. Two-stage convective vacuum impulse drying is the most suitable in terms of achieving maximum energy efficiency with minimal loss of biologically active substances.

**Key words:** drying, functional nutrition, vacuum, vegetable raw materials.

Currently, the market for healthy nutrition and functional products is actively developing. One of the key ways to enrich the product with useful substances and trace elements is to add one or another vegetable raw material to the composition [1]. And the addition of vegetable raw materials growing in the production area can significantly reduce the cost of goods.

Raw materials can be difficult and impractical to add to the finished product, since it is poorly distributed in volume, can reduce the shelf life and, in general, makes the manufacturing process less technological. Therefore, in most cases, in the manufacturing of herbal supplements, primary processing processes are used, such as drying, extraction and grinding. The most important task in the processing of plant material is to preserve the maximum amount of biologically active substances and functional components contained in the raw material.

Drying is the most common process for processing vegetable raw materials, since after it the material can already be used for the manufacture of products. Without drying, in most cases, grinding is impossible. Also, drying significantly speeds up the extraction process.

The selection of the drying method is carried out depending on the properties of the raw materials (structure, degree of grinding), on the properties of the final product and the economy of production.

Drying is classified according to various criteria.

By the method of exposure to the drying agent, they are divided into natural and artificial. The first type involves drying in a thin layer of material in open humidity. This method is advisable to use in regions with appropriate climatic conditions. Such drying is characterized by low energy consumption, but also low productivity. This

process is often little mechanized. Possible contamination of the product and also the final humidity will depend on the humidity of the surrounding air and will be different, which is inconvenient.

By the mode of operation, they are divided into devices of periodic and continuous action.

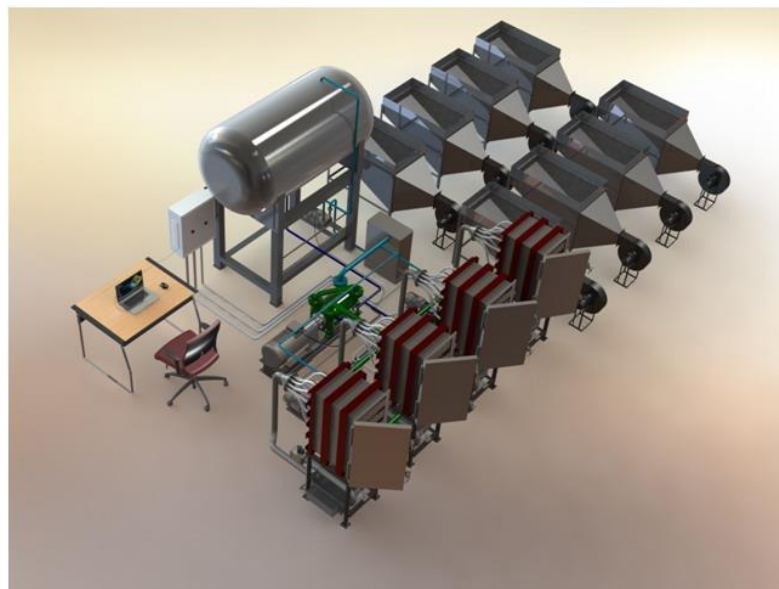
By to the method of supplying heat to raw materials, there are convective (heat is transferred by convection), conductive (heat is transferred by contact with a heated surface), thermoradiation (heat is transferred by thermal radiation), HDTV (heating occurs by high-frequency currents), combined (heat is transferred by a combination of various methods).

Thermoradiation and high-frequency heating destroy a large number of biologically active substances, so these methods are not suitable for the production of functional products.

The conductive method has a high heat transfer coefficient. However, it is necessary to constantly mix the material, which reduces the quality of the product.

The convective method uses the transfer of heat to the material by means of heated air. With such drying, you can get a quality product on relatively simple equipment. However, it is characterized by a high duration and large heat losses. Convective drying is very effective in removing surface moisture from the material, however, after its removal, the process slows down significantly.

A two-stage convective vacuum-impulse drying (Fig.1) allows solving most of the problems mentioned above [2].



*Figure 1 - Two-stage convective vacuum impulse drying*

The first stage of such an apparatus is convective, which quickly and without loss of quality removes surface moisture. The second stage is a vacuum cabinet. The material that has passed the first stage is placed in a vacuum cabinet, after which there is periodic heating with hot air, and then evacuation. Under vacuum, the liquid in the pores of the material boils, what significantly accelerates the drying process without

loss of quality.

To organize the vacuum in such an apparatus, the most suitable is a liquid ring vacuum pulse pump. In addition to such advantages as low noise and vibration levels, simplicity and reliability of the design, such a pump is capable of pumping air containing vapors, dropping liquid, and solid inclusions. This eliminates air filtration equipment from the production line and reduces installation costs [3].

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## Перспективные технологии сушки растительного сырья

Г. В. Рыбин, С. В. Прохоров, Н. А. Шуваев\*

ФГБОУ ВО «Тамбовский государственный технический университет», Тамбов, Россия.  
*e-mail: shuvaevn@list.ru*

**Аннотация.** Рынок функционального питания, то есть продуктов, которые обладают высоким содержанием полезных веществ и микроэлементов, активно развивается в нашей стране. Поэтому важным является разработка технологии и оборудования для производства таких товаров. Одним из наиболее распространённых способов обогащения продукта полезными свойствами является добавление в его состав растительного материала (плодов, ягод, трав). При этом в большинстве случаев использовать свежее сырьё нецелесообразно. При переработке растительного материала для функционального питания важнейшей задачей является сохранение максимального количества биологически активных веществ. Сушка является одной из основных стадий переработки. Двухступенчатая конвективно вакуум-импульсная сушка является наиболее подходящей с точки зрения достижения максимальной энергоэффективности при минимальной потере биологически активных веществ.

**Ключевые слова:** растительное сырьё, функциональное питание, сушка, вакуум.

## Optimierung der Spritzgießausrüstung

**A. V. Anufriev, A. A. Ykhin**

Staatliche Technische Universität Tambow, Tambow, Russland  
e-mail: andryushka.anufriev.00@mail.ru, ukhin.leha@bk.ru

### Zusammenfassung

Ziel dieser Studie ist die Optimierung von Spritzgussanlagen. Die Studie wird alle Bereiche der Spritzgussausrüstung abdecken.

**Schlüsselwörter:** Spritzguss, Spritzgussmaschine, Polymere

Spritzgießen ist das am weitesten verbreitete Verfahren zur Herstellung von Produkten aus Polymermaterialien. Der stationäre Spritzgussbetrieb ist ein Batch-Prozess zur Verarbeitung von Polymeren. Im beheizten Materialzylinder der Plastifiziereinheit wird der Kunststoff plastifiziert und anschließend mittels einer als Kolben wirkenden Schnecke in den sich bildenden Hohlraum des Werkzeugs eingespritzt. Beim Halten unter Druck im Formhohlraum erstarrt die Schmelze und wird nach dem Abkühlen als fertiges Produkt entnommen.



Abb. 1. Gesamtansicht und Diagramm der Hauptkomponenten der Spritzgießmaschine

Gesamtansicht und Diagramm der Hauptkomponenten der Spritzgießmaschine sind in Abbildung 1 dargestellt.

Die Spritzgießmaschine besteht aus drei wichtigsten Komponenten:

- Schließereinheit
- Plastifiziereinheit;
- Maschinengestell mit Antriebssystem und Steuerung.

Plastifiziereinheit enthält einen Fülltrichter (beheizt für einige Polymere oder mit einer Verdichtungs Vorrichtung) mit einem Sichtfenster; Materialzylinder (dickwandiges Stahlrohr mit Band- oder Ringheizungen). Die Aufgaben der Plastifiziereinheit sind wie folgt: Beladen, Zuführen, Plastifizieren, Dosieren und

Einspritzen (Einspritzen) des Thermoplasten. Kunststoff in Form von Pulver oder Granulat gelangt durch den Aufgabetrichter in den Materialzylinder. Ferner wird aufgrund der Drehbewegung der Schnecke das Formmaterial dem Mundstück zugeführt. Während der Rotationsbewegung der Schnecke und der Einwirkung von Temperatur des Zylinders und Druck auf das Material kommt es im Materialzylinder zu einer Plastifizierung des Thermoplasten in einen zähflüssigen Zustand. Die Schnecke fördert, plastifiziert und homogenisiert das Material (bestehend aus Schneid-, Lade-, Verdichtungs- und Dosierzonen). Die Temperatur des Materialzylinders beim Plastifizieren wird durch elektrische Widerstandsheizungen erzeugt, deren Leistung dem Pass der Spritzgießmaschine entsprechen muss. Die Beheizung des Materialzylinders ist in Zonen unterteilt, deren Temperatur zum Mundstück hin langsam ansteigt. Die Aufgaben der Verschlusseinheit sind: Kontaktierung des Mundstücks, Öffnen und Schließen der Form, Erzeugen der zum Zuhalten der Form erforderlichen Kraft und Entnahme des Produkts aus der Form. Es gibt mechanische (Kniehebel) und hydraulische Spannsysteme. Das Mundstück ist das Bindeglied zwischen Zylinderfront und Form. Die Befestigung des Mundstücks am Materialzylinder erfolgt über Schraubvorrichtungen oder einen Schnellverschluss. Mundstückdesigns hängen von den Eigenschaften des zu verarbeitenden Materials ab. Es gibt Mundstücke mit freiem Auslauf und Mundstücke mit Ventil. Bei einem Mundstück mit gesteuertem Nadelventil verschließt die Nadel unter der Wirkung einer Feder die Öffnung des Mundstücks. Ein Mundstück mit Absperrschieber ermöglicht es Ihnen, den Gießkopf der Hülse mit Hilfe eines Anschnitts zu fixieren.

Beim Spritzgießen von Produkten aus thermoplastischen Kunststoffen können technologische Produktionsabfälle in Form von Angüssen, fehlerhaften Produkten, Zerspanungsprodukten und Abfällen aus Rüst- und Reinigungsgeräten entstehen. Bei der Herstellung von Kleinteilen empfiehlt es sich, Sekundärrohstoffe am Gießereiarbeitsplatz zu verarbeiten. An modernen Spritzgießstandorten werden kleine Brecher in der Nähe jeder Spritzgießmaschine von der Seite der Schließeinheit installiert.

Auf dem Bett werden die einzelnen Konstruktionselemente der Spritzgießmaschine platziert und zuverlässig befestigt. Der Prozess wird durch Zeitschaltuhren oder elektronische Zeitsensoren gesteuert.

Vollelektrifizierte Spritzgießmaschinen erfüllen Umweltstandards (kein Öl, niedriger Energieverbrauch, Geräuschpegel, Vollautomatisierung, hohe Dynamik).

Hydraulische Maschinen umfassen geschlossene und halbgeschlossene Hydrauliksysteme (hohe Energiekonzentration, Leistung, Lebensdauer, geringere Kosten).

Verschiedene Ausführungen von Spritzgießmaschinen:

a) eine Spritzgießmaschine mit vertikaler Schließeinheit und horizontaler Trennebene;

b) eine Spritzgießmaschine mit einer wiederholten Plastifiziereinheit hat eine horizontale Schließeinheit, die senkrecht zur Trennebene angeordnet ist;

c) eine Spritzgießmaschine mit vertikal angeordneter Plastifiziereinheit und



Schließeinheit.

Das Spritzgussverfahren ist eines der wichtigsten Verfahren zum Formen von Gummiwaren. Die bis heute gesammelten langjährigen Erfahrungen legen nahe, dass die tatsächliche Effizienz des Prozesses und die Realisierung seiner Vorteile wirklich durch die Optimierung des gesamten Prozesses, die Auswahl der richtigen Ausrüstung und das richtige Werkzeugdesign sichergestellt werden.

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### **Оптимизация литевого оборудования**

**А. В. Ануфриев А. А. Ухин**

ФГБОУ ВО «Тамбовский государственный технический университет», г. Тамбов, Россия  
*e-mail: andryushka.anufriev.00@mail.ru, ukhin.leha@bk.ru*

**Аннотация.** Целью данного исследования является оптимизация литевого оборудования. В исследовании рассмотрены все секции литевого оборудования.

**Ключевые слова:** литье под давлением, литевая машина, полимеры.

УДК 535.361.2  
ББК 22.344

# Simulation of Structural OCT Images Based on Pixel Intensity Gamma Distributions

**V.O. Chereshnev, I.V. Kuleshov**

Tambov State Technical University, Tambov, Russia

*E-mail: vitaliy-cha1999@yandex.ru*

### Abstract

In this paper, we present an algorithm for modeling structural images of optical coherence tomography based on gamma distributions of pixel intensity. The basis of the presented algorithm for modeling structural images is the classical Monte Carlo method for photon transport. Modernization of the classical approach was carried out using a function of a certain probability density corresponding to the correct form of the gamma distribution. Comparison of individual experimental and simulated A-scans using the proposed method demonstrates a good agreement between the obtained data.

**Keywords:** coherence probing depth (CPD), image processing, optical coherence tomography (OCT), speckle structure, variance matrix

### Introduction

OCT is based on the registration of the back-reflected probing radiation on optical inhomogeneities with the measurement of the corresponding support and the construction of a three-dimensional image on these data. To increase the depth of coherent sensing and increase the signal-to-noise ratio in optical systems, it is necessary to identify the underlying phenomena that play a decisive role in this process. When forming an optical image, there is no absorption of light energy with conversion into electrical, chemical, thermal or other types of energy; diffraction phenomena play a decisive role in image formation, which means that wave optics methods should be the basis for adequate modeling of this phenomenon.

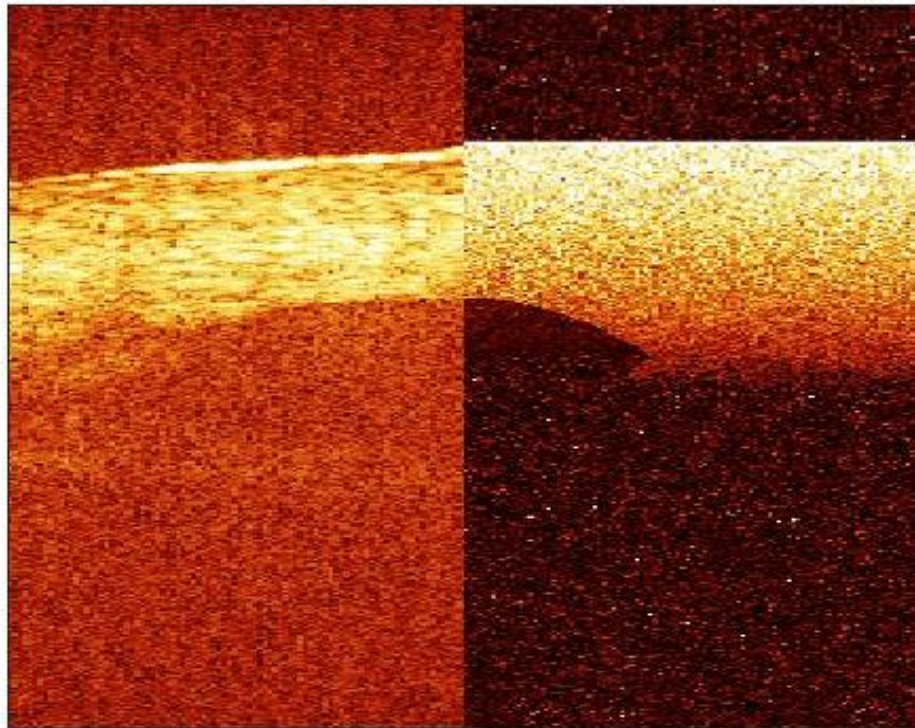
### Simulation reflected and least scattered photons in optical coherence tomography

Most often, when modeling OCT images, a method is used in which a mesh polygon is implemented, representing the distribution of optical properties for Monte Carlo simulation. The weak point of this method is the large number of cells required to represent the object and, consequently, a large amount of irradiation of the intersection boundaries, which require tracking the trajectory of photon migration into tissues.

To make a simulation of one A-scan for the reconstruction of OCT images using the Monte Carlo method, it is required to use  $10^7 - 10^9$  photon packets. Therefore, the simulation time can be significantly increased, especially if the number of A-scans obtained is important.

The modernization of this approach was carried out using a function of a certain

probability density for the first scattering, which directs the photon in the direction of the detector position. To calculate the furthest trajectory of motion, the scattering of photons is determined in advance with a predetermined probability and can also be directed to the detector. As a probability distribution, gamma distributions were used, the parameters of which were obtained as a result of the study of the variation matrix of OCT images [1,2]. The results obtained are shown in Figure 1.



*Figure1 - Experimental B-scan (2D structural OCT image) of a human blood vessel in vivo (left) and the result of structural OCT image modeling (right)*

Using the results of the above calculations, further research will be carried on 2D and 3D OCT image processing, as well as with the dedicated software package development based on. The development of this algorithm together with the differentiation of the structures of the skin, blood vessels and blood by analyzing the distribution of the histogram of pixel intensities. Therefore, it will possible to create anatomical maps of the subcutaneous blood vessels of humans and animals *in vivo*.

The use of this method has significantly increased the speed of modeling, which makes it much faster to build not only models of high-resolution OCT images, but also to simulate changes in the position of biological tissues over time, such as, for example, the movement of blood flow in a blood vessel [3].

### **Conclusion**

The described method of modeling structural images makes it possible to obtain A- and B-scans that are in good agreement with experimental data. However, the exact correspondence during modeling may be lost due to the simplicity of the description of the presented voxels, which do not allow to construct an arbitrary shape of the

boundaries of the object. Another weak point of the described method is its low calculation speed. There are several other approaches to improving computing speed, including computing on graphics processing units (GPUs). The scattering functions used make it possible to significantly increase the speed of calculations; however, to date no studies have been conducted that demonstrate high accuracy in modeling structural OCT images with arbitrary geometry.

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## Моделирование структурных ОКТ изображений на основе гамма-распределений интенсивности пикселей

**В.О. Черешнев, И.В. Кулешов**

ФГБОУ ВО «Тамбовский государственный технический университет», Тамбов, Россия  
*e-mail: vitaliy-cha1999@yandex.ru*

**Аннотация.** В настоящей работе представлен алгоритм моделирования структурных изображений оптической когерентной томографии на основе гамма-распределений интенсивности пикселей. Основой представленного алгоритма моделирования структурных изображений является классическим методом Монте-Карло для переноса фотонов. Модернизация классического подхода была осуществлена с помощью функции определённой плотности вероятности, соответствующей правильной форме гамма-распределения. Сравнение отдельных экспериментальных и моделируемых А-сканов при использовании предлагаемого метода демонстрирует хорошее соответствие между полученными данными.

**Ключевые слова:** глубина когерентного зондирования (ГКЗ), матрица дисперсий, обработка изображений, оптическая когерентная томография (ОКТ), спекл структуры

## Parameters of the Artificial Lung Ventilation Apparatus and their Classification

**E.P. Dolgov**

Tambov State Technical University, Tambov, Russia  
*E-mail: Toveg2@yandex.ru*

### Abstract

Artificial lung ventilation (ALV) devices are the most complex type of anesthesia and respiratory equipment. To work correctly with an artificial lung ventilator, it is necessary to have an understanding of the physical parameters used in the ALV.

**Keywords:** artificial lung ventilation, pressure indicators, resuscitation, temporary indicators, volume indicators.

### Introduction

Artificial lung ventilation is carried out with the help of special technical means and is the most effective, and sometimes the only, method of treating life-threatening respiratory failure that occurs due to infectious diseases, serious abnormalities of the nervous system and respiratory organs, etc [1].

To work correctly with an artificial lung ventilator, it is necessary to have an understanding of the physical parameters used in the ALV.

### Classification of ALV parameters and indicators

The main parameters of mechanical ventilation, it is advisable to classify into three groups [2]: Volumetric indicators, temporal, pressure indicators.

*Volume indicators:*

Tidal volume ( $V_T$ , l) is the volume of gas that enters the patient's lungs in one respiratory cycle. It is rather difficult to measure directly, since the connection of the ventilator to the patient is rarely completely sealed. For an adult patient, most often  $V_T = 0,65 - 0,8$  l / kg of weight and depends on the height, weight, age, sex and condition of the patient.

Minute ventilation ( $V$ , l/min) is the volume of gas that has passed through the patient's lungs in 1 minute. It is this indicator that is most important, as it reflects the intensity of ventilation. It is usually determined by multiplying the measured values of respiratory volume and ventilation frequency. The required minute ventilation depends on many factors. Only approximately it can be assumed that for an adult patient without significant cardiopulmonary pathology, it is in the range of 150 – 220 ml / min per 1 kg of weight.

*Time indicators include:*

The duration of inhalation ( $T_I$ , s) is the time interval from the beginning of gas entry into the lungs to the beginning of gas exit from the lungs.

Exhalation duration ( $T_E$ , s) is the time interval from the beginning of gas exit from the lungs to the beginning of gas entry into the lungs.

The duration of the respiratory cycle ( $T_C$ , c) is a set of consecutive intervals of

inhalation and exhalation.

Ventilation frequency ( $f$ ) is the number of breathing cycles per 1 minute. This indicator is determined by recalculating the duration of an integer number of complete respiratory cycles. For normal (not high-frequency) Ventilator this indicator can most often be in a wide range; for an adult from 10 to 20 Hz.

The relative duration of inspiration ( $C, \%$ ) is the percentage ratio of the duration of inspiration and the respiratory cycle.

The parameters used in the ALV operation are shown in Fig.1.

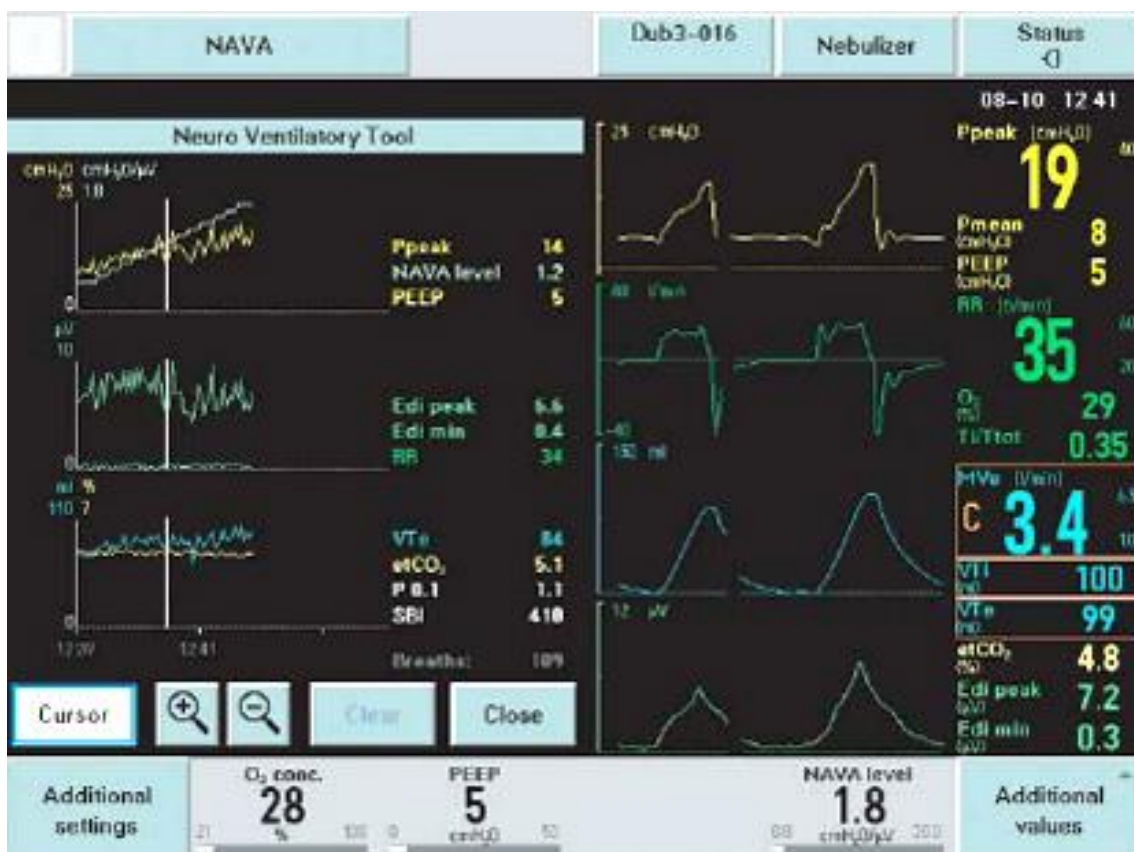


Figure 1 - ALV parameters

Pressure indicators:

Peak (maximum) inhalation pressure ( $P_{max}$ ) is the maximum instantaneous pressure value at the interval of the respiratory cycle. It is determined by the respiratory volume and characteristics of the respiratory organs. The peak intrapulmonary pressure is usually less than the peak pressure at the entrance to the respiratory tract, where it is measured. Peak pressure is often, but not necessarily, created at the end of gas injection into the lungs. The safe pressure that can be created by modern ventilators is 80...100 gPa, however, the operator has the ability to limit the pressure to a lower value [3 – 4].

Minimum pressure ( $P_{min}$ ) is the minimum instantaneous pressure value at the interval of the respiratory cycle. As a rule, it is created at the end of exhalation and is usually zero. According to certain indications, the operator can create a positive end-of-exhalation pressure in the range of 2 - 25 gPa.

Inhalation pause pressure ( $P_p$ ) is the minimum pressure created at the end of the

inhalation pause. It is usually less than  $P_{max}$  by 15 – 30%, and this difference is due to the resistance of the respiratory tract.

Mean pressure ( $P_m$ ) - the average integral value of the pressure of the respiratory cycle is usually positive and is a quantitative measure of the effect of the ventilator on the patient's body. The average pressure is easy enough to determine by processing an electrical pressure signal, but without much difficulty, it can be obtained using a pneumatic filter with a selected high time constant.

### **Conclusion**

Recently, there has been a sharp jump in improving the efficiency of ALV. This is primarily due to the increase in ALV operating modes, which in turn is due to the competent use of parameters and indicators. The parameters considered in the article allow the qualitative and effective use of ALV in clinical practice. The study of dynamically changing parameters, of course, is of scientific and technical interest, but, unfortunately, their description is beyond the scope of this article.

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## **Параметры аппарата искусственной вентиляции легких и их классификация**

**Е.П. Долгов**

ФГБОУ ВО «Тамбовский государственный технический университет», Тамбов, Россия  
*E-mail: Toveg2@yandex.ru*

**Аннотация.** Аппараты искусственной вентиляции легких (ИВЛ) это наиболее сложный тип наркозно-дыхательной аппаратуры. Для корректной работы с ИВЛ необходимо иметь представление о физических параметрах, используемых в ИВЛ.

**Ключевые слова:** искусственная вентиляция легких, объемные показатели, показатели давления.



## Early Diagnosis Method of Eye Glaucoma

**D. D. Grechukha, A. S. Myasoedova**

Tambov State Technical University, Tambov, Russia

*e-mail: grechuha.darya@yandex.ru*

### **Abstract**

With this method, the age threshold for the detection of the eye glaucoma is reduced. The developed method of eye glaucoma uses a combined video-thermal imaging system operating in synchronous mode. Also, when using this method, the determined coordinates of the eye position in the video image are used to highlight the eyes in the thermal image. The eye detection algorithm in the video image uses adaptive threshold selection to refine the vertical coordinates of the eyes. The developed method of screening eye glaucoma control makes it possible to diagnose this disease at an early stage, increase the throughput of the screening system, and also reduce the amount of workload on medical employees. The developed system will be effective not only when the head is in a straight position, but also if the head is turned.

**Keywords:** primary open angle glaucoma, thermal imaging, develop method.

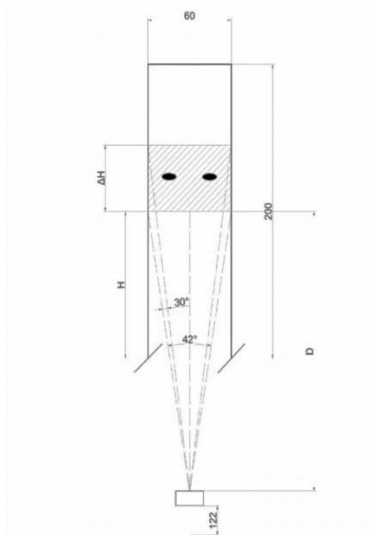
The relevance of the subject of the article is due to the need to monitor and evaluate the progression of primary glaucoma at an early stage in an automatic mode.

There is a known method for diagnosing primary open-angle glaucoma in patients by assessing the surface temperature of the eye. This method includes thermal imaging measurements carried out to determine the temperature of the anterior part of the eye at 5 points located on a horizontal line crossing the surface of the eye.

Figure 1 shows the geometry of the eye glaucoma screening system. The video thermal imaging system, located at a distance of one and a half meters and at a height of 1 meter, will capture the examination area measuring 60x40 cm.

It is known that the average height of schoolchildren in grades 2 and 3 according to the World Health Organization is  $123 \pm 10.5$  cm. Therefore, it is enough to place the video thermal imaging system on a 1-meter-high rack, then the system will capture an area from 1 meter to 1 meter 40 cm. Taking into account the fact that it is necessary to analyze only the area of the face, the system will be able to screen students of 2-3 grades of any height.





*Figure 1 - Geometry of the glaucoma screening system*

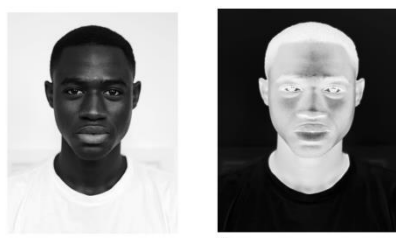
With a thermal imager matrix of 320x240 pixels, there are 11 pixels per eye horizontally, which is enough to implement the selected diagnostic method (5 pixels are required).

A person, in our case a student, approaches the frame, stands in the center and blinks. With the help of the camera, continuous photographing and highlighting of the eye area is performed, the moment of closing and opening of the eyes is determined, with the help of a thermal imager, the temperature of the eyes in the selected areas is measured. After passing a group of students, the average eye temperature for the group is determined and students whose eye temperature is below the average in the group are singled out. These students are sent to the polyclinic for an in-depth medical examination with suspected glaucoma.

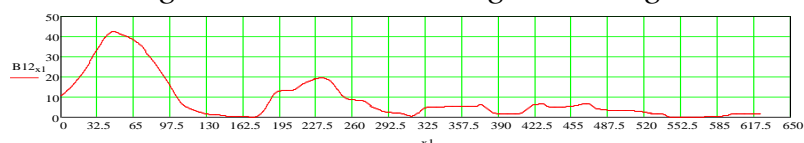
Advantages: 1. Low cost. 2. Automatic selection of the eye area from the photo and projecting it onto a thermal image. 3. The time of screening is 1 minute per person.

To implement a method for diagnosing glaucoma, it is necessary to isolate the eye area. An isolation algorithm has been developed for this purpose.

The main elements of the algorithm are shown below.



*Figure 2 - Initial and negative images*



*Figure 3 - Vertical eye area selection graph*



Figure 4 - Vertical image of the selected eye area

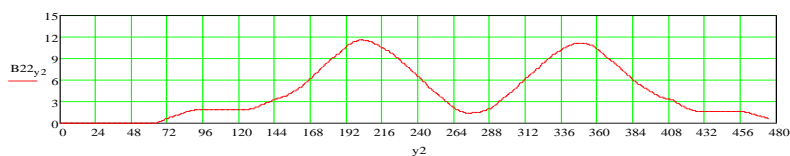


Figure 5 - Horizontal eye area selection graph

As a result of processing, the coordinates of the left right eye are obtained.

Thus, a budget video thermal imaging system for screening glaucoma of the eyes has been developed.

So, a low-cost video thermal imaging system of eye glaucoma screening has been developed, which allows diagnosing eye glaucoma at an early stage, increasing the throughput of the screening system, as well as reducing the burden on medical personnel.

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## Способ ранней диагностики глаукомы глаз

Д. Д. Гречуха, А. С. Мясоедова

ФГБОУ ВО «Тамбовский государственный технический университет», Тамбов, Россия  
e-mail: grechuha.darya@yandex.ru

**Аннотация.** Данный метод позволяет снизить возрастной порог обнаружения глаукомы глаз. Разработан метод скрининг-контроля глаукомы глаз, отличающийся тем, что используется совмещенная видео-тепловизионная система глаукомы глаз, работающая в синхронном режиме, так же тем, что определяемые координаты положения глаз на видео изображении используются для выделения глаз на тепловизионном изображении. Разработан алгоритм обнаружения глаз на видео изображении, отличающийся тем, что для уточнения координат глаз по вертикали используется адаптивный выбор порога. Разработанный метод скрининг-контроля глаукомы глаз позволяет диагностировать данное заболевание на ранней стадии, увеличить пропускную способность системы скрининга, а также снизить нагрузку на медицинский персонал. Разработанная система будет эффективна не только при прямом положении головы, но и если голова будет повернута.

**Ключевые слова:** первичная открытоугольная глаукома, тепловизионное изображение, тепловизор.

## Software für die Analyse und Interpretationen von Elektrokardiosignalen

L. A. Orechova

Staatliche Technische Universität Tambov, Tambov, Russland

\*e-mail: ljuba.orehova@yandex.ru

### Zusammenfassung

Die moderne Phase der Entwicklung der Informationstechnologie zeichnet sich durch die massive Anwendung von Systemen aus, die verschiedene Algorithmen zur Verarbeitung, Analyse und Interpretation von Signalen verwenden, insbesondere Elektrokardiogramme (EKG). Der klassische Ansatz in der Elektrokardiologie besteht darin, verschiedene Methoden zur Analyse temporärer Abhängigkeiten der Amplitude des Kardiosignals zu verwenden: Standard-EKG-Messung, Messung der Herzfrequenz, Repolarisationsdispersion. Die vorhandenen Standardmethoden zur Zeitbereichsanalyse reichen jedoch nicht immer aus, um alle Merkmale eines EKG-Signals zu beschreiben und seine charakteristischen Merkmale nicht vollständig aufzudecken. Automatisierte medizinische Entscheidungsunterstützungssysteme (ASPVR) sind ein medizinisches Informationssystem, das für die Software entwickelt wurde, um den Ärzten und anderen medizinischen Fachkräften bei der Arbeit mit Aufgaben im Zusammenhang mit der klinischen Entscheidungsfindung (SCR) zu helfen.

**Stichwörter:** Kardiosignalanalyse, Elektrokardiogramm, Software.

### Einführung

Derzeit sind Programme wie "M" von Schiller, das NI LabVIEW Biomedical Toolkit und das Programm "ArMaSoft - 12 – Cardio" verbreitet.

1. Das Programm "M" von Schiller.

Schiller hat ein "M" -Messprogramm entwickelt, in dem automatische EKG-Messwerte dem Arzt bei seiner täglichen Arbeit wesentlich helfen. Das Interpretationsprogramm spart Zeit, und die Messergebnisse sind im Vergleich zu den manuellen Messungen genauer.

Schiller hat eigene Programme entwickelt. Dies ermöglicht die Verbesserung der Software und ermöglicht es Ärzten, nach dem Kauf der Ausrüstung aktualisierte Versionen der Software zu erhalten. Das Programm wurde vielseitig getestet.

Die Computerinterpretation des EKG wurde entwickelt, um dem Arzt bei seiner Arbeit zu helfen, ersetzt jedoch in keiner Weise die Schlussfolgerungen eines Spezialisten. Bei der Diagnose muss der Arzt alle verfügbaren Informationen über den Patienten berücksichtigen.

Eigenschaften:

- Das Messprogramm "M" von Schiller zeigt eine Tabelle mit den Messergebnissen für alle 12 synchron empfangenen EKG-Ableitungen von Ruhe und Belastung an.

- Das C-Interpretationsprogramm von Schiller unterscheidet sich von dem M-Programm dadurch, dass es sich um ein EKG-Interpretationsprogramm handelt und dem Arzt mehr als tausend Entschlüsselungsmöglichkeiten bietet.

## 2. NI LabVIEW Biomedical Toolkit.

Das LabVIEW Biomedical Toolkit ist eine Ergänzung zur Software, die Tools bereitstellt, die die Verwendung der LabVIEW—Software bei der Sammlung physiologischer Daten, der Signalverarbeitung und der Bildverarbeitung vereinfachen sollen. Das Add-In enthält einen Biosignaldatenlogger mit mehreren Kanälen, um Biosignale zur Wiedergabe und Analyse auf eine Disc zu streamen. Zu den weiteren Funktionen gehören ein Dateibetrachter, ein Dateikonvertierungsprogramm für das Streaming-Format für das technische Datenmanagement (TDMS), ein Biosignalgenerator, ein EKG-Zeichenextraktions-Tool und vieles mehr. Das LabVIEW Biomedical Toolkit kann mit der NI Engineering Laboratory Virtual Instrumentation Suite (NI ELVIS) und den meisten CompactDAQ-Controllern und -Modulen verwendet werden. Das Add-In erfordert, dass auch das LabVIEW Advanced Signal Processing Toolkit auf Ihrem Entwicklungscomputer installiert ist.

## 3. Das Programm "ArMaSoft - 12 - Cardio".

Das Anwendungsgebiet der Software "ArMaSoft-12-Cardio" ist die Registrierung und Computerinterpretation von in Ruhe registrierten Elektrokardiogrammen in einem System von 12 allgemein anerkannten Leitungen.

"ArMaSoft-12-Cardio« kann mit dem Kardioregistrator CRP-01 sowie mit jedem Elektrokardiographen verwendet werden, der von «NPP Monitor» hergestellt wird.

Wenn Sie den Kardiographen an einen Computer anschließen, wird eine qualitativ hochwertige synchrone Aufzeichnung von 12 EKG-Ableitungen gewährleistet.

Die Entwicklung und Einführung von CAD in die Praxis gehört zu den wichtigsten Entwicklungsrichtungen der biomedizinischen Technologien.

Grundlegende Optionen für die automatische Analyse

- Konturanalyse (mehr als 250 Ergebnisse in allen EKG-Klassen von Änderungen);
- Diagnose von Rhythmusstörungen (mehr als 200 Schlussfolgerungen);
- Bewertung der EKG-Dynamik (Vergleich von bis zu 4 Studien).

Erweiterte Optionen für die automatische Analyse

- Analytischer Betriebsmodus (Wahl eines beliebigen Komplexes für die automatische Interpretation – ermöglicht eine genaue syndromale Interpretation bei komplexen Herzrhythmusstörungen);

- Berechnung des linken ventrikulären Massenindex (LVMI g/m<sup>2</sup> der Körperoberfläche). Die Verwendung von LVMI - erhöht die Genauigkeit der Diagnose einer Hypertrophie des linken Ventrikels des Herzens erheblich, ermöglicht die Diagnose der frühen Stadien der hämodynamischen Überlastung;

- Programm zur Messung der Varianz der Dauer des QT-Intervalls (QTd) - zur Beurteilung der elektrischen Instabilität des Myokards;

- Thrombolysis-Programm - Quantifizierung der Wahrscheinlichkeit einer akuten Myokardischämie – Diagnose eines "elektrokardiographisch stummen Myokardinfarkts»;

- Programm zur Analyse der Variabilität des Herzrhythmus im spektralen und zeitlichen Bereich.

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## **Программное обеспечение для анализа и интерпритации электрокардиосигналов**

**Л. А. Орехова**

ФГБОУ ВО «Тамбовский государственный технический университет», Тамбов, Россия  
*\*e-mail: ljuba.orehova@yandex.ru*

**Аннотация.** Современный этап развития информационных технологий характеризуется массовым применением систем, использующих различные алгоритмы обработки, анализа и интерпритации сигналов, в частности, электрокардиограммы (ЭКГ). Классический подход в электрокардиологии состоит в использовании различных методик анализа временных зависимостей амплитуды кардиосигнала: стандартное ЭКГ - измерение, измерение частоты сердечных сокращений, дисперсия реполяризации и т. д. Однако существующие стандартные методы анализа временной области не всегда достаточны для описания всех особенностей ЭКГ - сигнала и не позволяют в полной мере выявить его характерные черты.

Автоматизированные системы поддержки принятия врачебных решений (АСПВР)— медицинская информационная система, предназначенная для помощи врачам и иным медицинским специалистам в работе с задачами, связанными с принятием клинических решений (ПКР).

**Ключевые слова:** анализ кардиосигнала, программное обеспечение, электрокардиограмма.

## Multifunctional Physiotherapy Equipment with Vacuum Mode

**D. V. Pankin**

Tambov State Technical University, Tambov, Russia

*e-mail: pankin112@bk.ru*

### Abstract

The purpose of the study is to analyze multifunctional therapy devices with a vacuum therapy mode. In the first place, the article is illuminated the advantages of multifunctional therapy and considers a new operating mode of the device as a way to improve procedures. The relevance of the study is that electrodes that are used in physiotherapy for low-frequency therapy have a number of limitations, while vacuum electrodes almost completely correct these limitations. Consequently, it is necessary to illuminate the advantages of vacuum therapy to improve procedures.

**Keywords:** physiotherapy; multifunctional physiotherapy equipment; vacuum therapy; biomedical systems.

### Introduction

Physiotherapy is a support procedure for restoring the body after illness and injury. Such treatment uses light, heat, ultrasound, electrical impulses [1,2].

Electrodes are often used in physiotherapy with electric impulses, but electrodes for low-frequency therapy often used in medical practice today have a number of disadvantages, in turn, vacuum electrodes almost completely correct them. Vacuum electrodes will significantly simplify the procedures for patients and doctors. The creation of Russian equipment which combines low-frequency, ultrasound and vacuum therapy, with vacuum electrodes acting as holding electrodes and vacuum therapy, will have several advantages:

The electrodes are fixed on the necessary part of the patient's body and provide a reliable connection;

The multifunctional device improves the ergonomics of physiotherapy;

The device will have all the advantages and therapeutic properties of vacuum therapy.

The multifunctional equipment is worked out on the basis of a microcontroller, which has three input-output ports (RA, RB, PC). Information from the keyboard of the device is supplied to the introductory part of the "RA" port. Through this port, the data collected by the microcontroller is also transferred to the display of the device and an audio signal is given.

A signal is set in the control block to provide frequency and type of impact on the human body are determined, and through the "RS" port, the current is supplied to the generators necessary to provide the desired signal, the current is regulated through the "PB" port. Current amplifier is necessary to a doctor can set the required power for a particular patient, using a microcontroller, generator and current measurement sensor. Sensor tracks the strength of the current and information of the current change period is sho by the display.

A functional diagram of a multifunctional physiotherapy equipment with a vacuum

therapy mode is shown in Fig. 1.

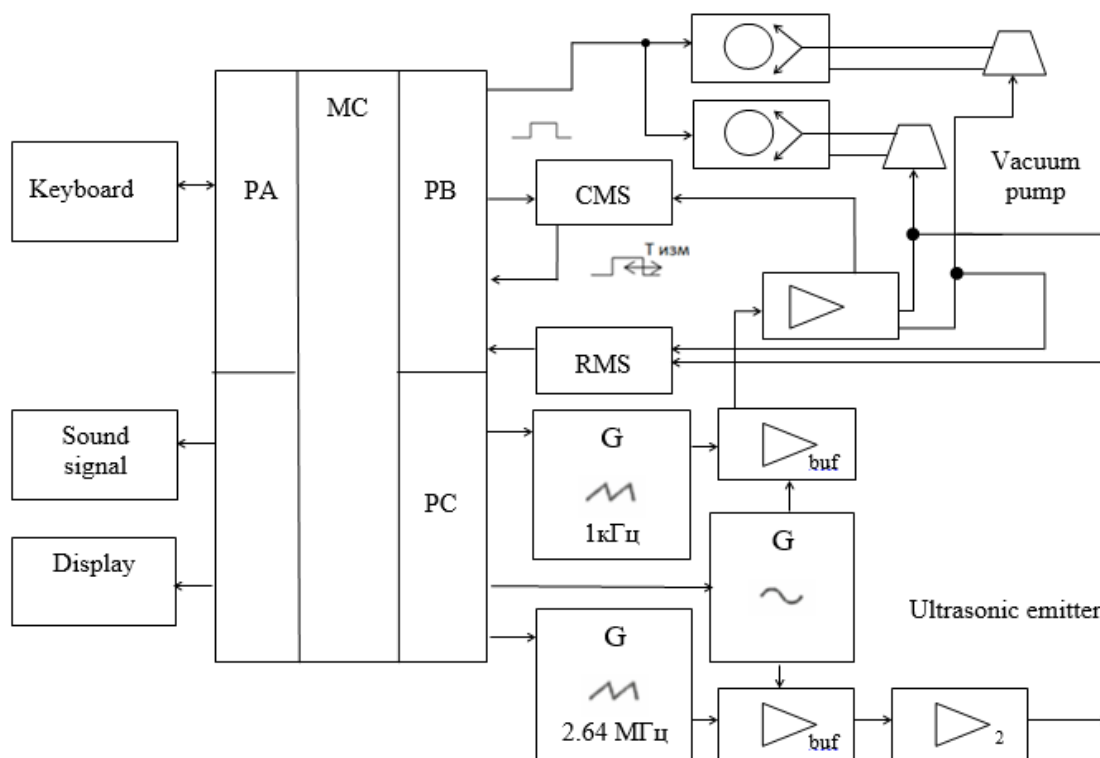


Figure 1 - Functional diagram of a multifunctional physiotherapy equipment with a vacuum mode

The resistance measurement sensor provides the proper quality of the electrode application besides a resistance measurement sensor provides a security procedure. The device automatically turns off when the resistance value increases. Port "PB" is needed to show the value of atmospheric pressure in the vacuum electrodes.

For work from low-frequency and high-frequency generators, and the chains are related to them, to the emitters, the "PC" port is responsible for outputting the signal processed, depending on the signal received from the MC, low-frequency or ultrasonic generator. With the output of the "PC" signal, the HF and LF generators are consumed. If it is required to supply a pulse signal to the emitter, then from the microcontroller with the output of the "PC" port, a signal is then sent to the generator of the modulating signal, designed to implement the pulse signal. Further, the signal is consumed by the LF or HF buffer stage adjacent to the generator.

The buffer includes energy consumption without loss of quality. A two-stage amplifier controls and raises the voltage level to a signal for the normal operation of the emitter and requires the consumption of vacuum electrolytes or an ultrasonic emitter. In front of the case there are sockets for emitters and vacuum electrodes, on the side there are sockets for connecting a vacuum pump and USB wires.

In the event of a gap between the electrode-skin stage, an alarm is triggered on the resistance measurement sensor, after which the device turns off. Under optimal operating conditions of the apparatus, the resistance will be close to zero.

The sound signal is intended for sound confirmation. The device turn on and off, as well as the beginning and end of the procedure.

The keyboard is easy input of patient data and minimal device control.

The vacuum pump is necessary for fixing the vacuum electrodes, which act as strong holding electrodes, and are using in vacuum therapy.

### **Conclusion**

In general, a multifunctional physiotherapy equipment with a vacuum mode has a number of advantages unlike narrow-profile devices. In spite of it, most Russian devices don't have vacuum electrodes, but I am sure that with proper implementation and mass production, this equipment can fully use its advantages.

### **Acknowledgements**

We also gratefully acknowledge advice and contributions from sub-faculty Biomedical Technologies of Tambov State Technical University.

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## **Многофункциональный аппарат физиотерапии с режимом вакуумной терапии**

**Д. В. Панькин**

ФГБОУ ВО «Тамбовский государственный технический университет», Тамбов, Россия  
*e-mail: pankin112@bk.ru*

**Аннотация.** Целью исследования является анализ аппаратов многофункциональной терапии с режимом вакуумной терапии, которые в краткой форме изложены в статье. В свою очередь статья освещает преимущества многофункциональной терапии и рассматривает новый режим работы аппарата, как способ улучшения процедур. Актуальность исследования заключается в том, что часто используемые в наше время в физиотерапии электроды для низкочастотной терапии имеют ряд недостатков, в свою очередь вакуумные электроды практически полностью исправляют их. В связи с этим необходимо освещать преимущества вакуумной терапии для улучшения процедур.

**Ключевые слова:** физиотерапия; многофункциональный аппарат физиотерапии; вакуумная терапия; биомедицинские системы.



## Ultrasound Diagnostic Device with Advanced Functionality

**D. G. Starykh**

Tambov State Technical University, Tambov, Russia

*e-mail: staryh.danya@yandex.ru*

### **Abstract**

The purpose of the study is to analyze ultrasound diagnostic devices, which are briefly described in the article. In turn, the article highlights the advantages of ultrasound diagnostics and considers the modernization of the device as a way to improve procedures. The solution a number of issues can be applied in the design and in the process of developing domestic ultrasound diagnostic devices. This is especially important from the point of view that the development and application of computing tools affects the improvement of the logical structure, software, element base and the effective use medical equipment.

**Keywords:** ultrasound diagnostics; ultrasonic scanners; biomedical systems.

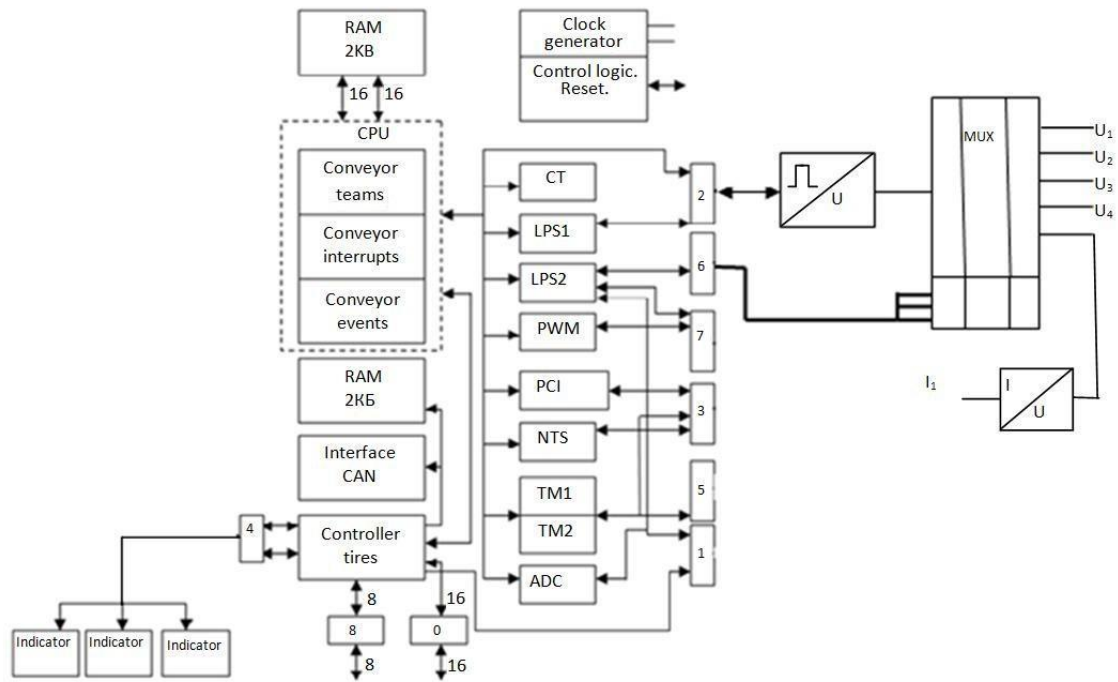
Ultrasound diagnostic method is a modern method of clinical imaging based on the reflection of ultrasonic waves. Modern ultrasound equipment is a universal high-resolution digital system that can scan in any mode.

The improvement of ultrasound diagnostics equipment is associated with a constant increase in the level of integration of high-speed digital circuits. To control the scanning and dynamic concentration of multi-element ultrasonic transducers, a special microprocessor is used, which provides greater flexibility in the formation of ultrasound images with high spatial and contrast resolution. The possibility of obtaining a color Doppler image in "real time" is also the result of the emergence of high-speed microprocessors. Choosing the right ultrasound scanner model and providing different models is not an easy task, and it takes time to make objective decisions. It is important for users to understand the principle of operation of ultrasonic equipment and the equipment of ultrasonic sensors.

These devices must provide rapid movement (scanning) of the ultrasonic beam in a fan-shaped or rectangular area using mechanical or electronic means.

To improve the quality of equipment and simplify repairs, it is recommended to upgrade the ultrasound scanner using the built-in self-diagnosis system. This design change allows us to quickly prepare the equipment for operation, determine exactly which equipment has failed in the event of a failure, and constantly check whether the amplitude of the acoustic wave of the equipment sensor coincides with the amplitude of the acoustic wave of the prototype.

The multichannel voltage meter consists of voltage measurement sensors with an amplifier (DIN), a current-voltage converter (PTN), a microcontroller (MC) with generator outputs, and an indication system.



*Figure 1 - Functional diagram of a multichannel voltage and current meter*

The current converter converts the measured current value of the piezoelectric element into a proportional voltage for further measurement. The voltage meter consists of voltage measurement sensors, MC and an indication system. Voltage measurement sensors and an indication system are connected to the MC via I/O ports. The MK ROM is used to store the MK work program, the MK RAM is used for temporary storage of the results obtained. The measurement result is generated in one of the general-purpose registers of the microcontroller. The operation of the meter is as follows. The sensor of the voltage meter converts an analog voltage signal into a pulse, the duration of which is proportional to the value of the measured voltage, and the amplitude corresponds to the level of the logical unit for the selected series of MP. The microprocessor system generates trigger pulses with preset durations and a repetition period corresponding to the accuracy of voltage measurement.

The MC, in the circuit of the voltage meter, performs the task of programmatically controlling the polling of the voltage meter, forming trigger pulses with a given duration and repetition period.

Thus, with each survey, the voltage measurement result increases by one, etc. This process continues until the pulse formation ends at the output of the analog part of the voltage meter (this indicates the appearance of log. 0). The resulting measurement result is recorded in the memory of the MC, and then output to the display system.

The improvement of medical equipment is due to the constant development of technology and medicine. I am sure that with proper implementation and mass production, this modification will be able to fully use its advantages.

### **Acknowledgements**

We also gratefully acknowledge advice and contributions from sub-faculty

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## **Многофункциональный аппарат физиотерапии с режимом вакуумной терапии**

**Д. Г. Старых**

ФГБОУ ВО «Тамбовский государственный технический университет», Тамбов, Россия  
*e-mail: statyh.danya@yandex.ru*

**Аннотация.** Целью исследования является анализ устройств ультразвуковой диагностики, которые кратко описаны в статье. В свою очередь, в статье освещаются преимущества ультразвуковой диагностики и рассматривается модернизация аппарата как способ улучшения процедур. Решение ряда вопросов может быть применено при проектировании и в процессе разработки отечественных ультразвуковых диагностических устройств. Это особенно важно с точки зрения того, что разработка и применение вычислительных средств влияет на совершенствование логической структуры, программного обеспечения, элементной базы и эффективное использование медицинского оборудования.

**Ключевые слова:** ультразвуковая диагностика; ультразвуковые сканеры; биомедицинские системы.

## Study of the Effectiveness of Antibiotic Properties of *Chlorella* Microalgae Metabolites

A. K. Bryankina\*, V. O. Milenina, A. A. Paramonova

Tambov State Technical University, Tambov, Russia

\*e-mail: alex.tambov.ru@mail.ru

### Abstract

An experimental study of antimicrobial properties of the green microalgae *Chlorella vulgaris* Beijer IPPAS C-1 was carried out using the disk-diffusion method. Microalgae cultivation was carried out on Tamiya OPTIMUM. Gram-positive bacteria *Bifidobacterium bifidum* were taken as a test sample. Microalgae suspension disrupted by microwave, ultrasound, and enzyme solution was used as the analyzed samples. An undisrupted suspension of microalgae, the antibiotic ciprofloxacin (positive standard), and distilled water (negative standard) were taken as controls. It was revealed that the suspension of microalgae destroyed by the enzyme exceeds the antiseptic properties of the antibiotic.

**Keywords:** antibiotic properties, disk-diffusion method, enzyme, microalgae *Chlorella*, microwave radiation, ultrasound.

### Introduction

Currently, the problem of increasing antibiotic resistance in bacteria due to the repeated use of drugs of synthetic origin is particularly acute. In order to cover this problem, various intakes of substances that do not have side effects are studied. One of the potential sources of such substances is the microalgae *Chlorella vulgaris* due to numerous methods of directed cultivation and the ability to rapidly accumulate biomass under fairly unpretentious conditions. Among its components, the following substances with antibiotic activity are distinguished: flavonoids, phenolic compounds, terpenes, glycosides, carbohydrates, proteins, triglycerides, fatty acids, long-chain alcohols, etc. [1, 2]. A number of factors can stimulate the accumulation of metabolites with antibiotic properties. The most important factors include the deficiency of certain nutrients (nitrogen and phosphorus) in the culture medium, light intensity, temperature and pH of the medium.

In view of the value of metabolites with antibiotic orientation, the stage of their isolation from microalgae cells is especially important, because it is at this moment that the probability of disruption of the compounds of interest is high. The antibiotic properties of intracellular metabolites of *Chlorella* microalgae largely depend on the method of their isolation.

The purpose of the study is to evaluate the effectiveness of the antibiotic properties of *Chlorella* microalgae metabolites.

### Methods and materials

The study used a strain of *Chlorella vulgaris* Beijer IPPAS C-1, obtained at the Institute of Plant Physiology Timiryazev RAS. Microalgae cultivation was carried out

on Tamiya OPTIMUM medium. The process was carried out under the following conditions: 1) inoculum was 10% of the total volume of the suspension (cell titer - 180,000 cells/ml); 2) microalgae suspension was cultivated at a temperature of 28 °C; 3) the pH value was set within 6.2-8.0; 4) a gas-air mixture was bubbled through the suspension with a carbon dioxide content of 0.03% and a flow rate of 80 l/h.

The culture liquid was taken on the eighth day of cultivation (stationary phase) [2].

To extract intracellular metabolites from a suspension of chlorella, the following methods for destroying cell walls were implemented: exposure to ultrasound with a power of 150 W for 5 minutes; the action of microwave radiation with a power of 280 W for 15 seconds; treatment with a solution of pepsin enzyme at a concentration of 1 mg/ml for 10 hours. After destruction, cell meal was separated from the culture liquid in a Sigma 2-16 RK/2-16P centrifuge at a rotation speed of 3000 rpm for 12 minutes.

The antibiotic activity of *Chlorella vulgaris* microalgae metabolites was determined by the disk diffusion method. Gram-positive bacteria *Bifidobacterium bifidum* were taken as a test sample. In Petri dishes with Muller-Hinton agar medium, 1 ml of the test culture was sown, spreading over the entire surface with a sterile spatula. The plates were incubated in a thermostat at 30°C for 18-24 hours; the diameter of growth inhibition zones was measured with an accuracy of 1 mm.

### Results and discussions

Table 1 presents the results of a study of various methods for the destruction of biomass on the antibiotic properties of intracellular metabolites.

Table 1 - Zones of inhibition of bacterial growth

Sample number	1	2	3	4	5	6
Zone of inhibition, mm	1	1	5	2	1	0

Disks impregnated with the studied samples were placed on the surface: 1 - microalgae suspension disrupted by microwave; 2 - suspension of microalgae disrupted by ultrasound; 3 - suspension of microalgae, disrupted by an enzyme solution (pepsin) at a concentration of 1 mg/ml; 4 - control (undisrupted suspension of microalgae); 5 - 10% solution of the antibiotic ciprofloxacin (positive control), 6 - distilled water (negative control).

The effect of the samples obtained during the disruption by microwave radiation and ultrasound is comparable to that of an antibiotic: the zone of inhibition was  $1 \pm 0.1$  mm. Presumably, this is due to the fact that in the ultrasonic field there is a change in the structure, shape and function of molecules, and with prolonged exposure leads to denaturation. The size of the zone of growth inhibition in sample 4 (undisrupted suspension of *Chlorella* microalgae) was  $2 \pm 0.1$  mm.

The largest zone of inhibition was observed in the sample obtained as a result of the disruption of microalgae cells by the enzyme and amounted to  $5 \pm 0.1$  mm, which is five times greater than the zone of inhibition observed in the antibiotic. This result is presumably due to the amphiphilic nature of protein compounds and peptides, which are contained in microalgae in a significant volume (40-55% of dry biomass [3]),

allowing them to interact with polar and non-polar regions of membranes and selectively bind to lipopolysaccharides,  $\beta$ -glucans and peptidoglycans of the bacterial cell wall [4].

### Conclusion

Thus, the result obtained proves the possibility of using microalgae metabolites isolated by this method as an antiseptic preparation alternatively to synthetic preparations. Also, the antimicrobial activity of *Chlorella vulgaris* can be used in food production to prevent bacterial contamination.

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## Исследование эффективности антибиотических свойств метаболитов микроводоросли *Chlorella*

А. К. Брянкина, В. О. Миленина, А. А. Парамонова

ФГБОУ ВО «Тамбовский государственный технический университет», Тамбов, Россия  
\*e-mail: alex.tambov.ru@mail.ru

**Аннотация.** Диско-диффузионным методом проведено экспериментальное изучение антимикробных свойств зеленой микроводоросли *Chlorella vulgaris* Beijer IPPAS C-1. Культивирование микроводорослей проводили на Tamiya OPTIMUM. В качестве тест-образца были взяты грамположительные бактерии *Bifidobacterium bifidum*. В качестве анализируемых образцов использовали суспензию микроводорослей, разрушенную микроволновым излучением, ультразвуком и раствором фермента. В качестве контроля использовали неразрушенную суспензию микроводорослей, антибиотик ципрофлоксатин (положительный стандарт) и дистиллированную воду (отрицательный стандарт). Выявлено, что суспензия микроводорослей, разрушенная ферментом, превосходит по антисептическим свойствам антибиотик. **Ключевые слова:** антибиотические свойства, диско-диффузионный метод, микроводоросль *Chlorella*, СВЧ-излучение, ультразвук, фермент.

## Calculation of Reactivity Indices of the Carboxyl Group in the Graphite Molecule

**E. V. Bubnova**

Tambov State Technical University, Tambov, Russia  
*email: veta.bubnova@mail.ru*

### Abstract

The aim of the work was to analyze the physicochemical properties of the graphite molecule. Computer modeling of the molecule and quantum-chemical calculation have been performed. Reactivity indices were calculated: absolute hardness ( $\eta = 5.3717$  eV) and electrophilicity index ( $\omega = 51.0982$ ). It was found that the graphite molecule with a carboxyl group is rigid and has nucleophilic properties.

**Keywords:** carboxyl group, graphite, reactivity indices.

### Introduction

Graphene-based nanomaterials are of great interest due to their unique physical and chemical properties and their application in various fields of activity. Graphene structures have found application as an additive in composite materials, motor oils, which significantly improve their properties.

There are many works in which various graphite defects are considered [1], the analysis of materials modified with graphite was carried out, but the effect of the carboxyl group on the properties of the molecule has not been studied. This graphite is synthesized by electrochemical exfoliation [2].

### Materials and methods

The simulation was carried out in the software package ORCA. The molecule was optimized by the ONIOM method, in which the carboxyl group was optimized by the DFT method with the functional PBEh-3c, and the four graphene layers were optimized by the semi-empirical method XTB2.

The reactivity of molecules is estimated based on the analysis population and energy characteristics of molecular orbitals. Assignment of molecules to nucleophilic or electrophilic reagents can be made according to the sign of the energy of the lower vacant molecular orbital (LUMO) of the molecule: the "+" sign is a nucleophile; sign "-" - electrophile. In our case, the lower orbital has positive energy values, therefore, the molecule is a nucleophile.

Boundary molecular orbital (MO), upper occupied MO (HOMO) and lower vacant MO (LUMO), valid estimate of reasonable capacity and kinetic probability of the molecule. The HOMO is cautious about the system of donating an electron, and the LUMO is sympathetic to the acceptance of an electron.

Electrophilicity index [3] is often taken as one of the quantitative characteristics of electrophilicity / nucleophilicity:

$$\omega = \frac{\mu^2}{2 \cdot \eta} \quad (1)$$

$\mu$  - chemical potential:

$$\mu = \frac{E_{LUMO} + E_{HOMO}}{2} \quad (2)$$

Pearson Absolute Stiffness:

$$\eta = \frac{E_{LUMO} - E_{HOMO}}{2} \quad (3)$$

### Results and discussion

For the carboxyl group of graphite:

$$1) \eta = \frac{0.4878 - (-9.7680)}{2} = 5.3717 eV$$

$$2) \mu = \frac{0.4878 + (-9.7680)}{2} = -4.3962 eV$$

$$3) \omega = \frac{(-4.3962)^2}{2 \cdot 5.3717} = 51.0982$$

The large HOMO–LUMO energy gap characterizes the high chemical stability of the compound. The chemical rigidity  $\eta$  of a molecule is determined by its resistance to deformation due to the electric field and the effect of chemical reactions.

The overall electrophilicity index  $\omega$  of a compound is determined by the stabilization energy upon receiving additional electron density and characterizes electron transfer and stability, so it describes well the overall reactivity of the compound.

The absolute rigidity of a molecule determines the preferred reaction mechanism: charge or orbital. The higher the index, the more preferable the charge mechanism becomes for the molecule. In our case, the charge mechanism.

A conditional boundary between soft and hard reagents can be drawn at  $\eta \approx 4-5$  eV. According to the obtained value of 5.3717, it can be judged that the molecule is rigid.

Possible centers of nucleophilic and electrophilic attacks are determined by the charges on atoms for hard reagents and the electron density of frontier orbitals for soft reagents. As we can see in figure 1, the nucleophilic center is the oxygen atom at the double bond.

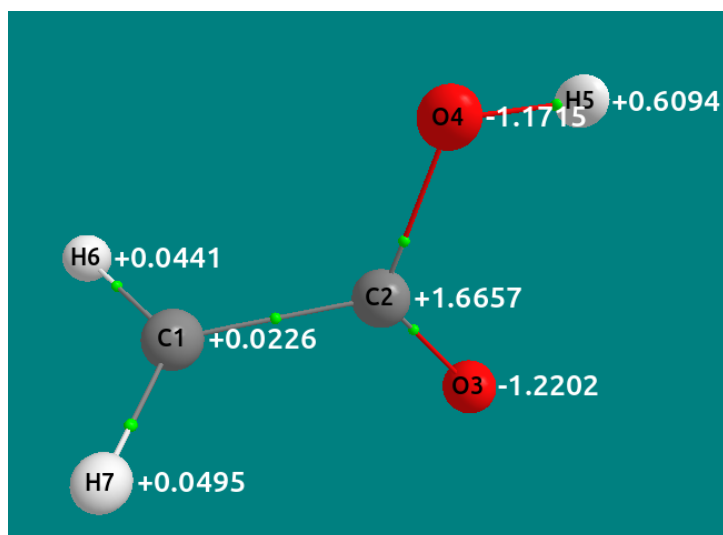


Figure 1 – The distribution of atomic charges, reflecting the real picture in the molecule

Another index characterizing the electrophilicity and the nucleophilicity of a



molecule is the molecular electrostatic potential (MEP). It allows you to localize the attachment sites of molecules with a well-localized positive or negative charge.

The MEP minima correspond to the localization of nucleophilic regions, while the maxima correspond to electrophilic ones (Fig. 2).

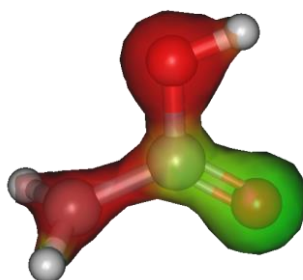


Figure 2 - MEP of graphite functional group.

## Conclusion

As a result of the conducted calculation, the following conclusions made:

1. The carboxyl group of graphite is a nucleophilic reaction center.
2. The molecule is rigid.
3. The preferred reaction mechanism is charge.
4. The reaction centers of the molecule are oxygen atoms. Slightly more reactive is the oxygen at the double bond.

The calculated reactivity indices allow predicting the properties of the synthesized graphite: absolute hardness ( $\eta = 5.3717$  eV) and electrophilicity index ( $\omega = 51.0982$ ).

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## Оценка реакционной способности карбоксильной группы в молекуле графита

Е. В. Бубнова

ФГБОУ ВО «Тамбовский государственный технический университет», Тамбов, Россия  
email: veta.bubnova@mail.ru

**Аннотация.** Целью работы являлся анализ физико-химических свойств молекулы графита. Выполнены компьютерное моделирование молекулы и квантово-химический расчет. Рассчитаны индексы реакционной способности: абсолютная жесткость ( $\eta = 5.3717$  эВ) и индекс электрофильности ( $\omega = 51.0982$ ). Было установлено, что молекула графита с карбоксильной группой является жесткой и обладает нуклеофильными свойствами.

**Ключевые слова:** графит, карбоксильная группа, индекс реакционной способности.

## An Isostatic Anti-Friction Composite on Fine Graphite Basis

**T.P. Dyachkova, R.D. Balabanov\***

Tambov State Technical University, Tambov, Russia

\*e-mail: balabanoff98@gmail.com

### Abstract

A method for obtaining antifriction isostatic graphite is proposed. A full-factor experiment was carried out in order to find the optimal composition and modes of extrusion mixing. The compressive strength of the obtained samples was determined (a maximum of 73 MPa was reached).

**Keywords:** antifriction; composite; graphite; self-lubricating materials.

### Introduction

Due to the development of aviation, space, nuclear and other industries, new working conditions are being formed in the friction units of machines, namely: high temperatures and sliding speeds, large physical and mechanical loads, dried gases, oxidizing media, etc. In these and other extreme conditions, the use of modern materials working with lubrication is impossible. Hence, there was an urgent need to develop completely new antifriction self-lubricating materials. Graphite has self-lubricating antifriction properties, i.e., the ability, paired with a metal counter body, to provide low wear and a low coefficient of friction (0.1-0.15) during friction [1] without introducing additional lubrication. Due to this property, it has found wide application in the production of carbon antifriction materials [2].

As some works put it, graphite-based antifriction materials are used for compression in most cases, with the exception of the structural features of the friction unit, they can also work for bending [3]. Therefore, an important characteristic of such materials will be considered the limit of mechanical compressive strength. According to [2] pure graphite has a strength equal to 30-130 MPa. In the production of antifriction materials, fine additives are used to increase this value [4], as a result of which the strength increases by 20-40%.

In connection with the above, the purpose of this work is to develop an antifriction self-lubricating composite based on carbon fiber. To achieve this goal, it is necessary to solve the following tasks: the choice of material components, the method of obtaining the composite, the definition of research methods and testing of prototypes.

The main component is selected graphite of the AOC brand, which is an ultrafine powder. As a binder – coal pitch (softening temperature 154-158 °C). Prototypes were obtained according to the following principle: pitch crushing, joint vibrogrinding, extrusion mixing, grinding, isostatic pressing, heat treatment.

To determine the optimal composition of the composite and the mode of extrusion mixing, the method of a full-factor experiment was chosen. The factors influencing the response function were revealed - the percentage of pitch content (35-45%), temperature (240-280 °C) and the extrusion speed (rotation of the extruder screws 100-260 rpm). For the response function, the density of heat-treated work pieces and their compressive strength

limit were chosen in the form of a polynomial:

$$y = a_0 + a_1x_1 + a_2x_2 + a_3x_3 + a_{12}x_1x_2 + a_{13}x_1x_3 + a_{23}x_2x_3 + a_{123}x_1x_2x_3$$

The experiment matrix is presented in Table 1.

Table 1. Experiment's matrix

	1	2	z	3	1	2	3	x	x	x	x1x	ρ	σ
								1x2	1x3	2x3	2x3		
	5	80	2	3	1			1	-	1	-1	1,5	46,
	5	40	2	3		1		1	-	1	-1	1,5	43,
	5	40	2		1	1	1	1	1	1	-1	1,5	44,
	5	40	2			1	1	1	-	1	1	1,5	46,
	5	80	2				1	1	-	1	-1	1,5	43,
	5	80	2	3				1	1	1	1	1,5	43,
	5	40	2	3	1	1		1	-	1	1	1,4	27,
	5	80	2		1		1	-	1	-	1	1,5	21,

According to the obtained data, the criteria of Kohren, Student, Fisher and the coefficients of mathematical regressions were calculated (Table 2).

Table 2. Adequacy criteria

Criteria	Density		Hardness	
	calculated	table	calculated	table
Kohren	0,5	0,68	0,39	0,68
Fisher	150858	5,32	1,23	3,01

Analyzing the found value of the Fisher criterion for the density response function, we conclude that the mathematical model is not adequate. In this regard, the result of the experiment is only one function of the response of the compressive strength:

$$\sigma(x_1, x_2, x_3) = 39,6192 + 4,6683x_1 + 5,5567x_2x_3 - 4,9042x_1x_2x_3$$

Analyzing its coefficients, it can be concluded that the compressive strength increases with an increase in the pitch percentage, and the pressure parameters of extrusion do not significantly affect the value of the described characteristic.

Based on the results of the experiment, blanks with a pitch content of 50% and 55% were prepared without changing the extrusion mode. During the manufacture of samples for measuring the compressive strength, cracks were found in the work piece with a pitch content of 55%. And the strength of the other billet was 73 MPa, which is

higher than those obtained earlier.

### **Conclusion**

Thus, the optimal content of the composite was found, the operating parameters of extrusion mixing were determined and the technology of production was proposed. The continuation of the work will be as follows: the study of the material using TG DSC in order to determine the time and temperature of heat treatment, RAMAN spectroscopy and tribotechnical characteristics.

### **Acknowledgements**

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## **Изостатический антифрикционный композит на основе мелкодисперсного графита**

**Т.П. Дьячкова, Р.Д. Балабанов\***

ФГБОУ ВО «Тамбовский государственный технический университет», Тамбов, Россия  
*e-mail: balabanoff98@gmail.com*

**Аннотация.** Предложен способ получения антифрикционного изостатического графита. Проведен полнофакторный эксперимент с целью нахождения оптимальных состава и режимов экструзионного смешивания. У полученных образцов определен предел прочности при сжатии (достигнут максимум - 73 МПа).

**Ключевые слова:** антифрикция, графит, композит, самосмазывающиеся материалы.

## Production of Corrugated Cardboard Packaging

**A. M. Lapteva, A. D. Illarionov**

Tambov State Technical University, Tambov, Russia  
*e-mail: annalapteva738@mail.ru lexa98685@yandex.ru*

### Abstract

The purpose of this study is to analyze the production of corrugated boxes in manufacturing. The study will cover all sections of the corrugated product industry. The relevance of the research lies in the fact that container manufacturers must comply with internal dimensions, design and printing, and their deviations must comply with GOST.

**Keywords:** corrugated boxes, paperboard; rotary die cutting.

The first corrugated boxes were produced in the United States in 1894 by Henry Norris and Robert Thompson. A year later they were sold to Wells Fargo for shipping purposes. Not only were these cardboard boxes cheaper and lighter than traditional wooden boxes, but they were also easier to store. But despite their countless advantages, these boxes did not win the sympathies of Wells Fargo carriers who did not trust their strength and robustness.

Finally, experience and their use proved that corrugated cardboard boxes were an ideal packaging due to their characteristics: lightness, versatility, low costs and resistance. Their popularity grew at the beginning of the 20th century and has remained intact to the present day.

The technological process when a blank sheet or sheet with a seal turns into a ready-made box is called processing of the manufacture of corrugated packaging or the process of making a box. Usually the box passes through a printing section, a die-cutting section, a folding section or through a flexo-folding machine (FFS).

Any processing equipment has weaknesses and strengths, so manufacturers of corrugated packaging are looking for a compromise to satisfy the consumer demands and bring profit to the plant.

### Miniline 9PA

The Miniline 9PA high-speed converter line from TCY (Taiwan) is used for the production of four-valve boxes made of corrugated cardboard with flexo-printing of up to 3 colors.



*Figure 1 Miniline 9PA*

Technical specifications: Production capacity - 300 boxes/min; Maximum blank size from 633 to 660 mm; Minimum blank size 80x200 mm;

Let's look at the production of transport containers from corrugated cardboard using the example of a corrugated box with internal sizes of 380x250x200 mm.

Corrugated box is a three-layer cardboard with a brown coating layer, the cardboard grade T-23, the profile "C" with a wall thickness of 4 mm.

The quality indicators must comply with GOST 9142-2014:

-The delamination resistance must be at least 0.2 kN/ m;

- The resistance to end compression along the corrugation must be at least 1.1 Mpa;

- Humidity must be 6-12%;

- The specific resistance to rupture with the application of a destructive force along the corrugation along the line of the reeling, after performing one double bend at 180 ° must be at least 7kN / m;

Blanks for transport container are produced on a corrugated press. The cardboard passed through the heating shaft enters the corrugated press, where it is preheated and corrugated, then glue is applied to the corrugated layer and glued under pressure with the heated top layer.

Blanks for transport container are fed manually in the loading area. When manually feeding, the stack of cardboard is shifted up and down, the direction of the side depends on which FFS is used with a seal on top or bottom. Then the sheet enters the feed rollers, which move it from the self-laying zone to the printing zone.

#### *Flexographic Printing Section*

On the printed sections of the FFS a flexographic system with fast drying, which consists of a raster shaft, a shaped cylinder and a printed cylinder, is used. The paint is dosed with using a rubber scraper roller or a squeegee system.

The vacuum system maintains the sheet in a stable position while passing it through the printing section and ensures high-quality alignment when printing.

After printing, the sheet is moved to a longitudinal cutting where hot air is usually used.

#### *Creasing die-cutting section*

The die-cutting section is used for applying vertical slots to the sheet in accordance with the specified shape of the box with carved valves. The width of the slot can be from 6.35 to 9.52.

#### *Rotary die cutting*

The rotary die-cutting unit consists of a cylinder for the installation of tooling and a lower cylinder covered with a polyurethane layer. The knives on the snap-in cut the corrugated sheet providing a high-quality cut. Creasing knives on the snap-in crease the cardboard relative to the polyurethane layer.

#### *Folding- gluing section*

The section consists of two pairs of upper and lower rails. The sheet is passed through a folding device using grips mounted on belts that push the blank through the machine. When the blank passes through the machine, the grippers lift the panels in such a way that they come into contact with the profile rails that form a bend along the blank. This is how they get a ready-made box. Before folding, PVA glue is applied to

the valve. Glue is applied using a wheel.

#### *Counting and output device*

The function of the counting-output device is to supply a given number of boxes in a pack (20 boxes) and output the pack for stacking, strapping and stacking on a pallet. The boxes arriving at this section are counted using a photoelement. After the specified number of boxes in a pack has been typed, the pack is moved to an packaging machine, where it is aligned and tied. Now the products are ready to be stacked on a pallet.

Given the variety of sizes and designs of cardboard boxes, their universal capabilities are obvious. Additional parts and accessories may be located on such packaging, which have a very insignificant effect on the cost price or do not require additional costs at all, since it is enough to change the shape of the workpiece for their manufacture.

The cardboard box copes with all its functions quite successfully. Being at the same time a container for goods, it carefully protects it, and also plays a very important role in the transportation and sale of goods. It is also important that a cardboard box is much more convenient than any other types of packaging, from the point of view of the habits of modern consumers who independently choose products of certain brands in stores.

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## **Производство транспортной тары из гофрокартона**

**А. М. Лаптева, А. Д. Илларионов**

ФГБОУ ВО «Тамбовский государственный технический университет», г. Тамбов, Россия  
*e-mail: annalapteva738@mail.ru lexa98685@yandex.ru*

**Аннотация.** Целью данного исследования является анализ производства гофрокоробов на производстве. В исследовании будут рассмотрены все секции производства гофроизделия. Актуальность заключается в том, что изготовители тары должны соблюдать внутренние размеры, конструкцию и нанесение печати, а их отклонения должны соответствовать ГОСТу

**Ключевые слова:** гофрокороб; картон; ротационная высека.

## Production and Modification of Greases from Used Engine Oil

**P. O. Kortunov\*, M. A. Abyzov**

Tambov State Technical University, Tambov, Russia  
*email: petr\_kortunovk@mail.ru*

### Abstract

The purpose of this study is the synthesis of lubricants from used engine oils, the modification of lubricants with blue phthalocyanine pigment 15:1 a-modification grade B. The study examined the improvement of antiwear properties before and after modification of the lubricant. The relevance of the study is to improve the properties of base lubricants by modifying the pigment and giving it a marketable appearance. As a result, a test was carried out, indicators of anti-wear properties were obtained before and after modification. The feasibility this procedure was determined.

**Keywords:** natural solidol, lubricant, modification parameters with copper phthalocyanine.

### Introduction

Greases based on used engine oils are of great interest due to the current environmental situation. Greases have found application in sliding friction units, electrical and mechanical tools, and as a conservation composition.

There are many works that consider the manufacture of greases from motor oils, but the production from waste materials and the effect of modification with copper phthalocyanite on the properties of lubricants have not been studied. The aim of the paper is production and modification of greases from used engine oil.

### Materials and methods

Synthesis of grease was carried out in laboratory conditions. The reactor was a three-necked flask connected to a thermostat and a mantle heater.  $\text{Ca}(\text{OH})_2$  mixed with water forming a suspension. Vegetable oil with used motor oil was placed in a reactor, where it was heated to a temperature of 65 °C. After that, a  $\text{Ca}(\text{OH})_2$  suspension was added to the reactor and heated to 90 °C, starting the saponification process. The synthesis time is 140 minutes, after which the heating is turned off and the second part of the used engine oil is added. The mixture is stirred for 10 minutes and poured into a storage container.

The ratio of components is presented in the table (Table 1).

*Table 1- lubricant composition.*

H <sub>2</sub> O	not more than 100 ml
Ca(OH) <sub>2</sub>	12 g
regenerated engine oil	100 ml
plant oil	80 ml

Fulfilling the tasks, a modification of the grease was made, synthesized according to a new recipe with blue phthalocyanine 15:3 brand A. The choice fell on form A, due



to its structure of the crystal lattice ( Fig. 1). The crystals are stacked on top of each other, forming a layered structure, which should improve extreme pressure, anti-wear properties and give a marketable appearance.

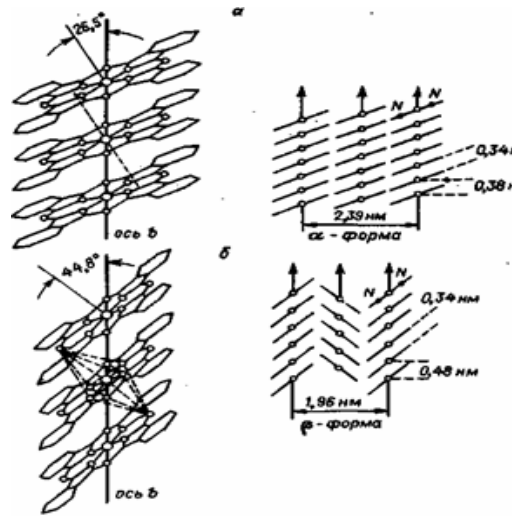


Figure 1- Crystal lattice structure

The pigment was in the ratio of 5%, 0.5% and 0.05%. To do this, the required amount of phthalocyanine pigment was measured on an analytical balance and ground in a mortar with lubricant until a homogeneous structure was achieved.

After that, each lubricant was tested on a friction machine

### Results and discussion

The resulting lubricant was tested on a friction machine, where it showed a contact patch of 0.22 mm. This indicator is 0.06 mm better than the control sample. The structure of the lubricant is uniform.

Pigment modification of the resulting lubricant showed the following. During testing, it was found that this additive does not improve extreme pressure and antiwear properties, but, on the contrary, deteriorates when added in large volumes. According to the results of the experiment, the effect of modifying the lubricant with pigment blue phthalocyanine 15:3 brand A was established. Contact spots were recorded using an electron microscope. Test results are presented in the diagram (Fig.2).

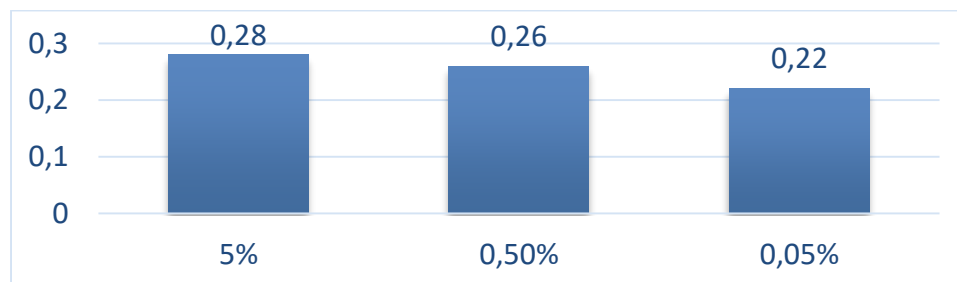


Figure 2- Contact patch diagram

## Conclusion

As a result of the conducted calculation, the following conclusions made:

1. Grease made from used motor oil is as good as industrial grades in friction.
2. The lubricant has the correct structure.
3. Modifying the grease with blue phthalocyanine 15:3 brand A does not improve the anti-wear properties.

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## Оценка реакционной способности карбоксильной группы в молекуле графита

П. О. Кортунов\*, М. А. Абызов

ФГБОУ ВО «Тамбовский государственный технический университет», Тамбов, Россия  
*email: petr\_kortunovk@mail.ru*

**Аннотация.** Целью данного исследования является синтез смазочных материалов из отработанных моторных масел, модифицирование смазочных материалов голубым фталоцианиновым пигментом 15:1 а-модификация марки Б. Определение противоизносных свойств до и после модификации смазочного материала. В результате было проведено испытание, получены показатели противоизносных свойств до и после модификации. Определено влияние пигмента на противоизносные свойства.

**Ключевые слова:** жировой солидол, смазка, параметры модификации голубым фталоцианиновым пигментом 15:1 а-модификация марки Б.

## Analyse der Anwendung von Elektrodialysatoren

A.V. Krylov\*, S.I. Lazarev

Tambov State Technical University, Tambov, Russia

\*e-mail: a.a.author@gmail.com

**Zusammenfassung:** Elektrodialyse ist eine der gängigsten Methoden der elektrochemischen Membranreinigung. Der Zweck des Artikels ist die Analyse der Bereiche, in denen die Elektrodialyse verwendet wird. Die Elektrodialyse wird in der Energie-, Chemie-, Lebensmittel- und Galvanotechnik von Maschinenbauunternehmen zur Abwasserbehandlung und zur Herstellung von Prozesslösungen eingesetzt. Die Analyse zeigt, dass der Prozess der Elektrodialyse gefragt und vielversprechend ist.

**Stichwörter:** Elektrodialyse, Entsalzung, Entsorgung, Abfälle, Galvanik

### Einleitung

Die Elektrodialyse ist der Prozess der Übertragung von Ionen durch eine Membran unter dem Einfluss eines elektrischen Feldes. Die Hauptanwendungen der Elektrodialyse sind die Entsalzung von Wasser und die Freisetzung von Salzen aus Lösungen.

Die Elektrodialyse wird in Energieunternehmen weit verbreitet eingesetzt. In der Arbeit [1] wird ein elektrodialisiertes Verfahren zur Entsorgung von flüssigen alkalischen, hochineralisierten Abfälle des Wärmekraftwerks untersucht. Die Anwendung dieser Methode ermöglicht es, die jährliche Menge an Abwasser zu reduzieren und deren Ableitung von einem Wärmesalzkomplex auszuschließen. Die Arbeit untersucht die Reinigung von zusätzlichem Wasser in Wärmekraftwerken durch Elektrodialyse. Jetzt gehen 30% des Quellwassers in der Arbeit verloren. Die Anwendung der Elektrodialyse kann bis zu 80% Konzentrat in Permeat umwandeln, das im Kraftwerksarbeitszyklus wiederverwendet werden kann.

Die Elektrodialyse wurde in der Lebensmittelindustrie verbreitet. In der Arbeit [2] wird die Elektrodialysenreinigung in der kollapopulären Produktion untersucht. Die Verwendung der Elektrodialyse verbessert die organoleptischen und technologischen Parameter von Melasse und Sirup und reduziert die Kontamination von Produktionsabflüssen. Die Arbeit untersuchte die Elektrodialyse von Zuckersirupen. Eine Erhöhung der Betriebsspannung während der Elektrodialyse führt zu einer Erhöhung des Demineralisierungsgrads des Zuckersirups und einer Verringerung der Prozessdauer. Die Arbeit untersucht die Verwendung von Elektrodialyse zur Reinigung von dicken Zwischenprodukten der Zuckerproduktion. Die Verwendung des Schemas mit der Behandlung von verdünntem gereinigtem Sirup mit gereinigtem Saft ist kostengünstig und erhöht die Ausbeute des fertigen Produkts.

Die Arbeit untersucht die Verwendung einer Elektrodialyse zur Reinigung von Diffusionssaft. Bei der Anwendung der Elektrodialyse kann die Sättigung, zusätzliche Stuhlgang und Sulfitation aus dem Reinigungs-Schema des Diffusionssaftes

ausgeschlossen werden, wodurch die Zuckerausbeute erhöht wird. Die Arbeit untersucht die Verwendung von Elektrodialyse zur Stabilisierung von Weinen. Die Verwendung der Elektrodialyse verbessert die Weinqualität, verklebt die Kleberbildung, reduziert das Abwasservolumen und den Energiekosten. Die Arbeit untersucht die Elektrodialyse bei der Behandlung von Quarkserum. Die Verwendung der Elektrodialyse ermöglicht es Ihnen, den Säuregehalt zu regulieren und überschüssige Mineralstoffe zu entfernen.

Die Elektrodialyse wurde auch in Unternehmen der chemischen Industrie verbreitet. Die Arbeit untersucht den Prozess der elektrochemischen Verarbeitung von Ethylendiamindihydrochlorid unter Verwendung eines Elektrodialysators [3]. Bei der Herstellung von Ethylendiamin entsteht konzentriertes Abwasser. Das vorgeschlagene Verfahren zur Verarbeitung von Ethylendiamindihydrochlorid ermöglicht es, Natriumhydroxid zu reduzieren, um es zu neutralisieren und die Menge an Abwasser zu reduzieren. Die Arbeit untersucht die Herstellung von Glykolsäure unter Verwendung von Elektrodialyse. Das betrachtete Verfahren ermöglicht es, Glykolsäure in industriellen Mengen und minimalen Umweltschäden zu erhalten.

Die Elektrodialyse wurde auch in der Landwirtschaft verbreitet. Die Arbeit untersucht die Verwendung von Elektrodialyse bei der Wasseraufbereitung in der Landwirtschaft. Die Verwendung von elektroaktiviertem Wasser durch Elektrodialyse erhöht den Ertrag.

Die Elektrodialyse wurde auch in der galvanischen Produktion verbreitet. Galvanische Abflüsse sind eine gefährliche Quelle für Umweltverschmutzung. In der Arbeit wird die Elektrodialyse für die Abwasserbehandlung von galvanischen Erzeugnissen untersucht [4]. Die Verwendung einer Schaltung mit einem Elektrodialysator ermöglicht die Rückführung des gereinigten Wassers in die Produktion.

### **Schlussfolgerung**

Basierend auf einer analytischen Überprüfung der Arbeiten [1-4] kann festgestellt werden, dass die Prozesse der Elektrodialyse vielversprechend und gefragt sind. Die zunehmende Verwendung von Elektrodialysatoren zur Reinigung von Abflüssen von Mehrkomponenten-Galvanikproduktionen wird die Umweltverschmutzung durch Schwermetallionen reduzieren.

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## **Анализ применения электродиализаторов**

**А. В. Крылов\*, С.И. Лазарев**

ФГБОУ ВО «Тамбовский государственный технический университет», Тамбов, Россия  
*e-mail: frost.8998@mail.com*

**Аннотация.** Электродиализ один из самых распространенных методов электрохимической мембранной очистки. Цель статьи анализ областей где используется электродиализ. Электродиализ применяется на энергетических, химических, пищевой промышленности и гальванических цехов машиностроительных предприятий для очистки сточных вод и получения технологических растворов. Анализ показывает, что процесс электродиализа является востребованным и перспективным.

**Ключевые слова:** электродиализ, опреснение воды, утилизация, отходы, гальваника.

## Investigation of the Method for Determining the Thermal Conductivity of Coatings

**A. S. Kutukov**

Tambov State Technical University, Tambov, Russia  
*e-mail: AlexanderKutukov.00@yandex.ru*

### **Abstract**

The purpose of this study is to study the method of determining the thermal conductivity of coatings on aluminum alloy products. The non-destructive determination method is considered. The essence is to heat a local area surface of the object and study its temperature response. The relevance of the study lies in the increasing need for information about the thermophysical properties of materials and the need to use energy-saving measures.

**Keywords:** Thermal conductivity, aluminum alloy coatings, non-destructive method.

### **Introduction**

Thermal conductivity is an operational property of heat-shielding coatings. These coatings not only preserve the base material, but also reduce heat loss and protect the base material from heat flux.

Stationary methods for determining thermal conductivity are widely used. They are different, but unchanged in the process of observing the temperature at a particular point of the coating in the direction of the layer perpendicular to the heat flux passing through it.

In the methods of non-destructive testing of thermal power plants, the thermophysical properties of interest are revealed by the temperature response of the body under study to thermal exposure, subjected to a specially organized experiment.

### **The essence of the method**

The modern level of the theory of heat transfer allows us to identify an unambiguously analytical definition of a fairly simple form of the body temperature field for a wide class of thermal effects on this body within the framework of the problem being solved. The thermophysical properties in the heat equation remain constant coefficients.

When developing methods and means of measuring the thermophysical properties of materials that depend on temperature, the main difficulty is the choice of such isothermal sites at which the temperature gradient and the penetrating specific heat flux can be determined with sufficient accuracy. At the same time, the structure of the temperature response mainly depends on the geometry of the body, the type of thermal effect and the stage of the thermal process caused by this effect. Therefore, when developing a method for determining the thermophysical properties of materials, only the simplest internal inverse problem of the theory of thermal conductivity and explicit coefficients of thermal conductivity, heat capacity, thermal conductivity and thermal activity are of practical importance.

The most acceptable method for non-destructive testing of thermophysical properties of materials and products is a measurement method based on determining the parameters of a non-stationary temperature field at the early stages of the heat exchange process. In these methods, the object under study is modeled as a semi-bounded body.

The non-destructive method of measuring the thermophysical properties of two-layer materials and products is based on a physical model using a measuring probe including a flat round heater, an insulating substrate and a heat sink. The measuring probe is mounted on a coated metal plate.

### **The procedure for performing measurement operations when implementing the method in question**

1. Calibration of the measuring system.

2. The measuring probe is placed on the free surface of the coating of the two-layer product.

3. Thermostabilize the system.

4. Ensure constant heater power.

The active stage of the research process records time measurements of temperature and power values at control points.

5. Determine the working area corresponding to the linear equation according to the mathematical model of the method.

6. At the end of the active part of the experiment, the heater is turned off and the received data is processed:

determine the values of the coefficients of the model describing the thermogram of the working area, calculate the thermal conductivity.

The solution of the direct heat transfer problem in relation to the mathematical model of heat distribution of the considered two-layer system allows us to obtain an equation for a coating with low thermal conductivity on a basis with high thermal conductivity [1]. A mathematical model of heat transfer in two-layer products has been developed [2]. It describes the regularity of changes in the temperature field as a result of the action of an infinitely homogeneous heater of constant power, which can be applied to technological processes from working with circular local heaters.

Heating modes at different heater power are investigated, since when the heating temperature is exceeded, the heater must be switched off. Otherwise, further heating may lead to the destruction of the test material or the substrate of the measuring probe.

The determination of the thermal conductivity of coatings of various thicknesses on aluminum alloy products showed that the error in determining the thermal conductivity by the described method is 2 – 5%.

### **Conclusion**

A non-destructive method for determining the thermal conductivity of coatings has been experimentally carried out using a mathematical model of heat propagation in a two-layer body in which a constant power heater is used.

Experimental studies have confirmed the operability of the method for determining the thermal conductivity of coatings based on metals according to the measuring scheme [3].

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## **Исследование метода определения теплопроводности покрытий**

**А. С. Кутуков**

ФГБОУ ВО «Тамбовский государственный технический университет», Тамбов, Россия  
*e-mail: AlexanderKutukov.00@yandex.ru*

**Аннотация.** Целью данного исследования является изучение метода определения теплопроводности покрытий на изделиях из сплава алюминия. В исследовании будет рассмотрен метод неразрушающего определения теплопроводности покрытий, суть которого заключается в нагреве локального участка поверхности объекта и изучении его температурного отклика. Актуальность исследования заключается в возрастании потребности в информации о теплофизических свойствах материалов и необходимостью применения энергосберегающих мероприятий.

**Ключевые слова:** Теплопроводность, покрытия на сплаве алюминия, неразрушающий контроль.



## Prospects of Nanocomposites Based on Thermoplastic Polymer Materials

**M.A. Lishnih**

Tambov State Technical University, Tambov, Russia  
*email: nikel917@yandex.ru*

### **Abstract**

This article discusses the types and properties of composite materials based on polymers. They are compared with traditional materials and substantiated for the improved characteristics of nanocomposites.

**Keywords:** composite, nanomaterials, nanocomposite, polymer, polymer composite.

### **Introduction**

The modern state of technologies puts forward new requirements for the physical and mechanical properties of polymer composite materials, which are widely used in structural materials and special-purpose products, which makes the problem of creating polymer nanocomposites with high physical and mechanical characteristics so urgent.

This problem is successfully solved by methods of polymer matrix structural modification. One of the promising structural modification method is the incorporation of ultrafine structures into the polymer matrix, for example, carbon nanotubes and nanofibers.

### **Discussion**

Depending on the configuration, CNTs can have a metallic or semiconductor type of conductivity. They have excellent mechanical and thermal properties. These physicochemical properties make carbon nanotubes promising for use as components of micro and nanodevices, fillers in composite structural materials, gas distribution layers in fuel cells, components of lubricants, filters, carbon cells in lithium batteries, adhesive composites, electrochemical catalysis electrodes and catalyst carriers, sources of cold electron emission, antistatic, shielding and absorbing microwave and radiation shells and coatings, modifying additives in building materials, etc.

Compared to nanotubes, nanowires have a diameter of several tens of nanometers, while their length can reach hundreds of micrometers. Typically, nanowires have a larger diameter compared to nanotubes; it varies from 50 to 200 nm, and the morphology of the wires also varies. As in the case of single-walled and multi-walled nanotubes, different fiber morphology leads to wide variations in the characteristics of the final material. Wires deposited on a substrate are used to modify many polymers, such as polypropylene, nylon, and epoxy resin.

One of the promising materials is a composite made of carbon nanotubes and thermoplastic polyurethane. Polyurethane is one of the most versatile polymers, the

properties of its variations can be directly opposite, from rigid and hard to flexible and ductile. The creation of a nanocomposite based on this material makes it possible to improve its properties by incorporating various nanoparticles into the polymer matrix, for example, silicon nanoparticles, layered nanoclays, or carbon fibers. In particular, carbon nanotubes have been studied in some detail as a filler to improve the mechanical and electrical properties of polyurethane-based composites.

Such composite material can be produced on an industrial scale by extrusion. However, the safety problem of using nanomaterials in such composites remains open. As is known, carbon nanotubes can be hazardous if inhaled. During the wear of polymer products, gradual degradation of the material occurs over time, which can cause the release of carbon nanoparticles into the environment. The study [1] deals with this issue.

Composite used in this research consisting of thermoplastic polyurethane and 3 wt.% carbon nanotubes. Three different degradation scenarios for the composite were considered, general use, machine processing and weathering. Machining included sawing, drilling and grinding, during which mechanical shear forces are generated. It has been found that the relative softness of the material actually enhances the incorporation of carbon nanotubes in degraded polymer portions and released material particles.

The size distribution of particles showed the predominance of particles with a size of at least 10  $\mu\text{m}$ , which indicates the absence of nanotubes leaving the structure of the polymer matrix. Individual nanomaterial particles, including the study of aerosol particles, were not detected by any of the applied methods. Also, it was found that the particles of the composite, released during mechanical action, do not have increased cytotoxicity compared to a polymer that does not contain nanotubes.

As far as weathering is concerned, the polymer degrades at a very low rate over many years, as expected for polyurethane, so the entangled nanotubes can come to the surface to a very small extent. According to a preliminary assessment, we can say that this composite is safe for professional and consumer use.

Another study [2] shows that a composite material based on polyurethane and carbon nanotubes demonstrates a significant improvement in performance under cyclic tension and compression loads. The addition of carbon nanotubes made it possible to enhance the fatigue characteristics of the composite under tensile load, in particular, the fracture energy increased by 38% at a concentration of nanotubes of 0.3 wt.%. Also, the addition of nanotubes increased the number of load cycles by 248% at high test amplitude. With this increase in strength characteristics, this composite is superior to epoxy resin composites, which have many applications in various fields.

It was also shown a mechanism that increases the material endurance under long-term cyclic loads. It was found that during the formation of nanosized cracks in the polymer matrix, nanotubes extended in the bulk of the material remain in the gaps and, as loads continue to be applied, are pulled out of the bulk of the polymer, thus slowing down the growth of the crack size and increasing the number of load-unload cycles up to destruction.

Another possible material based on polyurethane and carbon nanotubes is shown in the study [3]. In this work, composite fibers were obtained from polyurethane and multi-walled carbon nanotubes. The composite was obtained using the twin screw extrusion method. At a concentration of nanotubes up to 9.3 wt.%, a significant increase in tensile strength is observed, while maintaining a high elongation at break. Also, at this concentration, a homogeneous distribution of nanotubes in the polymer matrix and a strong degree of interfacial adhesion between functionalized nanotubes were achieved, which leads to improving the mechanical characteristics of composite fibers. The unusual combination of increased strength, Young's modulus and high elongation at break detected in the study is important for the further development of composites based on thermoplastic polyurethane.

## Conclusion

As the number of studies on the modification of polymeric materials grows, it becomes clear that composites based on carbon nanomaterials, can significantly improve the performance of thermoset polymers, for example, increase their stiffness, thermal stability, crack resistance and resistance to impact loads.

Due to the wide range of applications of CNTs, it is reasonable to use them in the creation of new composite materials as fillers, which can significantly affect the performance and strength characteristics.

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## Перспективы нанокompозитов на основе термопластичных полимерных материалов

М.А. Лишних

ФГБОУ ВО «Тамбовский государственный технический университет», Тамбов, Россия  
*email: nikel917@yandex.ru*

**Аннотация.** В данной статье рассматриваются виды и свойства композиционных материалов, созданных на основе полимеров. Проводится их сравнение с традиционными материалами и дается обоснование повышенных характеристик нанокompозитов.

**Ключевые слова:** композит, полимер, полимерный нанокompозит, наноматериалы, нанокompозит.

## Modernisation of a Combined Type Electric Baromembrane Apparatus for Mechanical Engineering Industries

**P.M. Malin**

Tambov State Technical University, Tambov, Russia  
*e-mail: malin.pavlik@mail.ru*

### **Abstract**

This paper presents an upgraded design of an electrobaromembrane apparatus for the separation of solutions, which has applications in the chemical, mechanical (electroplating) industries.

**Keywords:** apparatus, separation, solution.

The development of various designs of electromembrane apparatuses used for regeneration of process solutions at engineering plants and other various industries, is today an urgent task, but at the same time problematic for production because of expensive treatment facilities and with unproven technology of treatment of industrial solutions, although the purification of solutions and waste water is an integral part of the technological completion of the industrial enterprise, as well as resource saving and environmental friendliness of the process [1-3].

The prototype of this design is an electric baromembrane apparatus of combined type, the design of which is given in Patent RU 2712599 C1, 29.01.2020. Bulletin No. 4 [4].

The electric membrane combination machine works as follows (Fig. 3). The initial solution under transmembrane pressure exceeding osmotic pressure of the substances dissolved in it, through the inlet fitting of the separated solution 3, located on the cover 2, is fed into the first separation chamber of the flat-chamber module, formed by the bottom cover 2, the gasket 22, support ring 14 and anode membrane 20, then it passes through the flow-through windows 29, throughout the unit entering the last separation chamber of the flat module formed by the upper lid 1, gasket 22, support ring 14 and postathode membrane 31 and is discharged as a retentate through retentate outlet connection of the first stage 5. Middle separation chambers are formed by intermembrane channels located between anode and anode membranes 20 and 31 where the separated solution passes from one intermembrane channel to other ones through flow-through windows 29 of the unit.

When the entire apparatus is filled with separating solution, anode 27 and cathode 28 (cylindrical threaded rods with round through holes 35 and 36) are connected to the terminals of the current feeder, which sets the current density in the solution.

The dissolved substances in the solution to be separated dissociate into anions and cations.

Under the influence of electric current from the first, third and fifth separation

chambers, the anions penetrate through the anode membrane 20, porous substrate 19 and through the anode drainage grid 18 via the gasket with a channel for draining the anode permeate 23, Further through the circular through-products 36 in the threaded cylindrical studs acting as the terminal device for supplying electric current - anode 27, in the anode permeate flow through the channel for anode permeate outlet 15 with the check valve 17 open fills the anode permeate chamber 8 of the first stage and cations pass through the pre-cathode membrane 31, porous substrate 19 and through the pre-cathode drainage grid 32 via the gasket with the channel for pre-cathode permeate outlet 24, further through the circular through pre-cathode gaps 35 in the threaded cylindrical studs in the flow of submerged permeate through the channel for submerged permeate outlet 16 with the check valve 17 open, fills the chamber for submerged permeate 9 of the first stage.

When the chambers for anode and anode permeate 8, 9 of the first stage are filled, the supply of separated solution through the separated solution inlet 3 into the unit is stopped and the compressors forcing pressure into the chambers for anode and anode permeate 8, 9 of the first stage are activated. The check valves 17 installed in the unit prevent the flow from the anode and anode permeate chambers 8, 9 of the first stage back to the anode and anode permeate outlet channels 15, 16. The level of anode and anode permeate in chambers for anode and anode permeate 8, 9 of the first stage is monitored by float level gauges 21.

The feed solution which enters at the separating solution inlet connection 3 and passes through the flow-through windows 29 of the entire apparatus from the first, middle and last separation chambers is purified from anions and cations and is taken out of the apparatus through the retentate outlet connection of the first stage 5, upper cover 1.

Under the pressure exerted by the compressors through the air supply fittings 7, from the chambers for anode and subcathode permeate 8, 9 of the first stage, anode and subcathode permeate is fed into the tubes of the tube module 12, where it is separated into the second stage retentate, which enters the retentate outlet chamber of the second stage 37, and is discharged from the unit through connectors 4, and permeates formed as a result of penetration through the tubes of the tube module 12 pass through the overflow holes 41 of the 3-ring cooling module 40 of the "tube-in-tube" type and are discharged through connectors of the second stage permeate output 6.

When the chambers for anode and pre-cathode permeate 8, 9 of the first stage are emptied, the compressors are switched off and the air supply through connection 7 is stopped. At the same time the feed solution is resumed through the separating solution inlet connection 3 and the process repeats.

Simultaneously with the supply of the separated solution through the cooling water inlet fitting 38, a cooling agent, e.g. tap water, is supplied to fill, through the bypass 42, the 3-circuit cooling modules 40 of the "tube-in-tube" type located between the tubes of the tube module 12 from the chambers for preanode and pre-cathode permeate 8 and 9 of the first stage to the retentate outlet 37, removing

excess heat from the second stage permeate and outlet 39 through the cooling water outlet fitting.

Increase of the solution separation area per unit volume of the flat chamber module of the apparatus, improvement of quality and efficiency of solution separation is achieved due to the fact that the flat chamber module consists of first, third and fifth anode separation chambers and second, fourth and last subcathode separation chambers with equal area of anode and subcathode membranes that allow maintaining the same current density in the separation chambers.

Second stage permeate cooling is achieved by installing 3-circuit tube-in-tube cooling modules with overflow holes, overflow channels, cooling water inlet and outlet connections between the tubular module from the first stage preanode and anode permeate chambers to the second stage retentate outlet chambers.

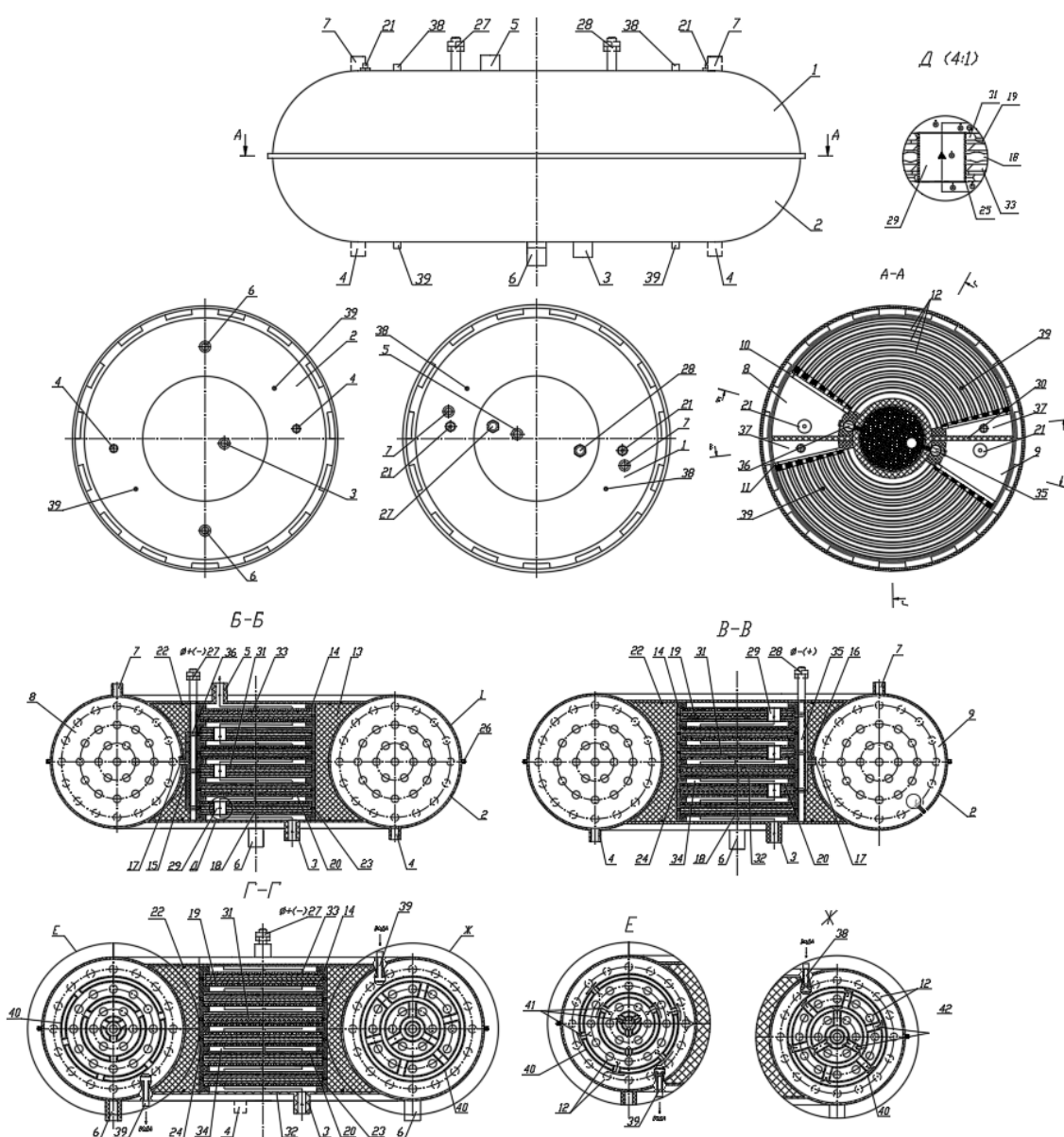


Figure 1 - Electrobaromembrane apparatus combined type

Thus, the solution is separated in two stages: in the first stage the solution to be separated passes through the first, middle and last separation chambers in the electromembrane flat chamber module, and in the second stage through two tubular membrane modules, which ensures a high degree of solution purification.

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## Модернизация электробаромембранного аппарата комбинированного типа для машиностроительных производств

П.М. Малин

ФГБОУ ВО «Тамбовский государственный технический университет», Тамбов, Россия  
*e-mail: malin.pavlik@mail.ru*

**Аннотация.** В работе представлена модернизированная конструкция электробаромембранного аппарата для разделения растворов, находящее применение в химических, машиностроительных (гальванических) производствах.

**Ключевые слова:** аппарат, разделение, раствор.

## Transportation of Oil Products

**S. M. Nagd-Ali\*, M. S. Tesyelkin, M. A. Pozdnyakova**

*Tambov State Technical University, Tambov, Russia*

*e-mail\*: sofiya.nagd-ali@mail.ru*

### **Abstract**

The purpose of this study is to analyze rolling stock intended for the transportation of petroleum products. The study will consider the types of vehicles and types of oil products. The relevance of the study lies in the fact that transportation has many features and dangers. As a result, it is necessary to develop a set of measures to ensure safety during the transportation of petroleum products through the use of innovative technologies and modern vehicles.

**Keywords:** modern vehicles; oil products; transportation of petroleum products.

Russia possesses the richest reserves of black gold, which led to the prevalence of cargo transportation of products of the distillation of crude oil. The most popular option for such transportation is the use of road transport. But it should be borne in mind that the transportation of this product is associated with risk.

This type of material belongs to the category of flammable liquids, the main hazard during transportation of which is the high risk of fire / explosion. Approximately the same level of danger comes from vapors of petroleum products, which can also be flammable, and in addition, toxic to humans and other highly organized representatives of the animal world. Another danger inherent in the transportation of oil products is the likelihood of a spill, which threatens to cause serious damage to the environment, which is equivalent to a local environmental disaster.

There are several generally accepted criteria for classifying petroleum products. In particular, according to the state of aggregation of a substance in natural conditions (pressure / temperature), they are divided into the following categories: gaseous oil products in a liquid state, solid.

Only the last two categories can be transported by road. According to the totality of physical and chemical properties, oil products can be divided into the following large groups: fuel (diesel, jet, gasoline, aviation kerosene); oils (industrial, for internal combustion engines and electric motors, transmission, ship, transformer, for insulating products, hydraulic, etc.); technological viscous lubricants, substances for the preservation of equipment; solid petroleum products (bitumen, paraffin); special substances.

Most of the varieties of petroleum products are delivered to their destination using the bulk method, which involves the use of specialized rolling stock. ATP classification: fuel trucks, tankers, bitumen trucks, gas carriers equipped with pumping equipment for pumping LH into stationary tanks, asphalt distributors, gas carriers specializing in the transportation of household cylinders with liquefied gas.

Transportation of liquid petroleum products by general-purpose vehicles in bulk volumes is carried out using flexitanks - elastic multilayer bags designed for placement in containers. The volume of such containers varies between 10,000 and 25,000 liters. But



most often, tankers are used to transport petroleum products, ensuring compliance with all safety requirements and rules for the transport of dangerous goods. With a fully sealed oval-shaped body (optimal in terms of aerodynamics), they are equipped with: a wedge-shaped gate valve for convenient discharge of transported products, a special nozzle designed for pouring oily liquids into a container, a rod-type liquid level indicator, a breathing valve that ensures reliable sealing of the tank, pumping equipment with a pump and a hose system, removable wave cutters designed to minimize the shock wave arising during acceleration / deceleration while the vehicle is moving.

Delivery of fuel oil and other light / dark oil products by road should be carried out along the route agreed with the representatives of the traffic police. Transportation in the dark is unacceptable. A vehicle that meets all of the above requirements is admitted in accordance with the ADR rules for a specific type of oil refined products.

The oil industry is rapidly becoming an extremely high-tech industry. The growth rates of consumption volumes, the discovery of new oil fields directly lead to the improvement of existing and the creation of new types of transport.

To ensure safety, it is necessary to change the vehicle fleet in a timely manner, observe safety precautions and transportation rules, and apply innovative technological solutions.

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## Транспортировка нефтепродуктов

С. М. Нагд-Али\*, М. С. Тесёлкин, М. А. Позднякова

ФГБОУ ВО «Тамбовский государственный технический университет», Тамбов, Россия  
*e-mail: softya.nagd-ali@mail.ru*

**Аннотация.** Целью данного исследования является анализ подвижного состава, предназначенного для перевозки нефтепродуктов. В исследовании будут рассмотрены виды транспортных средств и виды нефтепродуктов. Актуальность исследования заключается в том, что транспорт имеет множество особенностей и опасностей. В связи с этим необходимо разработать комплекс мероприятий по обеспечению безопасности при транспортировке нефтепродуктов за счет использования инновационных технологий и современных транспортных средств.

**Ключевые слова:** нефтепродукты, современные технологии, транспортировка нефтепродуктов.

## Unterscheidung der Laserlöttechnologie in der Chirurgie

**I. A. Nebogin**

Tambov State Technical University, Tambov, Russia

*e-mail: boss.tankwot@mail.ru*

### **Zusammenfassung**

Laserlöten ist eine aktuelle biophotonische Technik zur chirurgischen Wiederherstellung der Integrität von Weichteilen. Diese Technologie beinhaltet die Verwendung einer Vorrichtung, die Laserbelastung an den Schnittkanten der Wunde mit einem aufgetragenen Lot bereitstellt. Die Tests der neuen Methode zeigten nicht nur eine wirksame Heilung linearer Hauteinschnitte, sondern auch eine damit verbundene Verringerung der Entzündung, keine Durchblutungsmikrostörungen, beschleunigte das Wachstum des Bindegewebes an der Stelle der Wunde, sagten die Macher.

**Schlüsselwörter:** biophotonische Technik, Laserlöttechnologie.

Lasertechnologien sind in der modernen Chirurgie weit verbreitet. Das Hauptprinzip der Lasertherapie ist die gezielte Beeinflussung einer Problemzone. Lichtstrahlung verhindert die Ausbreitung der Krankheit, lindert Schmerzen, Entzündungen, stimuliert die Durchblutung, stärkt die Immunität.

Die Gesamtzahl der Verfahren zur Laserverjüngung der Haut und zur Faltenentfernung stieg von 120.000 im Jahr 2000 auf 550.000 im Jahr 2006 mit einer entsprechenden Steigerung der Produktion von Er-Lasern, einschließlich Er-Faserlasern. Noch vielversprechender war der Markt für Diodenlaser zur Haarentfernung (~ 44% des Gesamtumsatzes mit medizinischen Lasern) - die Zahl der Verfahren stieg von 480.000 im Jahr 2000 auf 1.5 Millionen im Jahr 2006 und sollte sich bis 2010 verdoppeln [1].

Laser (optische kohärente Tomographie), jährliche Steigerung von 25% (> 15% des Gesamtumsatzes). Gleichzeitig hat sich der augenärztliche Bereich der mit Excimerlasern durchgeführten Sichtkorrektur in den letzten drei Jahren nicht verändert. Der Umsatz mit medizinischen Lasern steigt jährlich um 10%. Wie wir sehen, die Popularität der Lasertechnologie steigt auch heute [1].

Laserstrahlung hat mehrere Vorteile gegenüber herkömmlichen Methoden (Nahtmaterial, Heftklammern, Fibrinkleber) aufgrund einer spezifischen Wirkung auf biologisches Gewebe. Lasersysteme mit der hohen Energie der erzeugten Strahlung sind zur chirurgischen Entfernung, mechanischen Zerstörung oder thermischen Nekrose von zu eliminierenden Zellen, Geweben oder anderen Gegenständen erforderlich [1]. Die Möglichkeit einer hohen Konzentration von Lichtenergie in kleinen Volumina erlaubt es, das biologische Gewebe selektiv zu beeinflussen und den Grad dieses Einflusses von der Gewebekoagulation bis zur Verdunstung zu regulieren [2]. Diese berührungslose Entfernung ausgewählter Gewebe erfolgt mit hoher Präzision und mit minimalem Organtrauma. Laserstrahlung entfernt die ausgewählten Bereiche des Gewebes unter ständiger visueller Kontrolle, ohne das umliegende gesunde Gewebe zu beschädigen.

Neben den erwähnten positiven Effekten der Laserstrahlung auf biologische Gewebe ist es möglich, beschädigte biologische Gewebe mit Laserschweiß- und Löttechnologien zu reparieren [2]. Solche Techniken helfen, den geschweißten Bereich (Dichtigkeit der Wunde) wasserdicht zu machen, kleine Gefäße abzudichten und dadurch die Dauer der Blutung zu reduzieren und Gewebekompression und marginale Nekrose zu vermeiden, so dass das Gewebe heilt, ohne eine raue Narbe zu erzeugen. Laserverfahren sind berührungslos, so dass das Risiko einer Infektion in die Wunde minimal ist. Im Vergleich zu anderen berührungslosen Verfahren (Ultraschall und elektrisches Schweißen) ermöglicht der Einsatz von Faseroptik bei Laserverfahren eine endoskopische und laparoskopische Chirurgie.

Die wichtigsten Nachteile der Laserbehandlung sind eine übermäßige thermische Schädigung des Gewebes [2] und die schlechte Zugfestigkeit der Schweißnähte, die auf herkömmliche Nahttechniken mit Nahtmaterial schließen [1].

Der Grad der thermischen Gewebenekrose hängt von den Eigenschaften des Lasers ab, wie der Strahlungsleistung, den geometrischen Abmessungen des den biologischen Geweben ausgesetzten Strahls, dem Lötverfahren, der Belichtungszeit und der resultierenden Gewebeheizungstemperatur. Um thermische Schäden zu minimieren, muss jede Art von biologischem Gewebe an die individuellen Eigenschaften angepasst werden. Histologische Untersuchungen des laserbelichteten Gewebes haben gezeigt, dass bei korrekter Auswahl der Laserbestrahlung eine Verdampfung der Oberflächenschicht der Gewebezellen erfolgt und keine thermische Schädigung nachgewiesen werden kann. Beispielsweise gibt es Einschränkungen, die mit einem hohen Flüssigkeitsspiegel bei der Laserschleimhautrekonstruktion verbunden sind. In diesem Fall führt die Laserbelastung zu Entzündungen und Schrumpfungen der Schleimhäute, die sich nicht vollständig erholen [2]. Je höher der Gewebeabsorptionskoeffizient ist, desto größer ist die photothermische Wirkung der Bestrahlung. In diesem Fall wird die Eindringtiefe der Laserbestrahlung begrenzt und das Löten tieferer Gewebeschichten schwierig sein. Bei niedrigen Gewebeabsorptionskoeffizienten kann die Laserbestrahlung tiefer eindringen, aber der photothermische Effekt ist schwächer und die Zugfestigkeit ist niedriger.

Einer der ersten in der Chirurgie verwendeten Laser ist der neodym-dotierte Yttrium-Aluminium-Granat (Nd: YAG) -Laser mit einer Wellenlänge  $\lambda = 1064 \text{ nm}$ . Diese Wellenlänge fällt mit dem Absorptionspeak von Melanin und Hämoglobin zusammen und wirkt somit hämostatisch auf Weichgewebe. Die Nd: YAG Laserstrahlung wird schlecht von Wasser absorbiert, so dass es erlaubt ist, das Gewebe in Tiefen von mehr als 5 mm zu durchdringen. Der Hauptvorteil der Verwendung eines Nd: YAG-Lasers ist die Fähigkeit, tief in das biologische Gewebe einzudringen, aber eine übermäßige Energiedichte kann tiefe unkontrollierte thermische Schäden am umgebenden Gewebe verursachen. Daher ist der Einsatz des Nd: YAG-Lasers in der Mikrochirurgie begrenzt [2].

Dagegen wird der Kohlendioxid (CO<sub>2</sub>) laser mit einer Wellenlänge  $\lambda = 10.600 \text{ nm}$  nur in der Mikrochirurgie eingesetzt. Die Wellenlänge des CO<sub>2</sub> Lasers entspricht der Absorptionsspitze des Wassers. Da Wasser der Hauptbestandteil der meisten Gewebe ist, wird der größte Teil der Laserenergie in den äußeren Schichten des Gewebes absorbiert [2].

Diodenlaser mit unterschiedlichen Wellenlängen sind die am weitesten verbreiteten

Laser zum Schweißen und Löten von biologischen Geweben. Halbleiterlaser mit einer Wellenlänge  $\lambda = 810$  nm haben aufgrund ihrer geringen Größe, ihres geringen Leistungsverbrauchs und der geringen Bauteilkosten im Vergleich zu anderen Lasertypen eine Reihe von Vorteilen. Diodenlaserstrahlung kann effektiv in eine faseroptische Leitung injiziert werden, die für endoskopische chirurgische Anwendungen von entscheidender Bedeutung ist [2]. Die Verwendung von Diodenlasern kann jedoch Einschränkungen aufweisen, da die Spitzenausgangsleistung der Strahlung geringer ist als die von CO<sub>2</sub> und Nd: YAG-Lasern. Dieser Nachteil wird durch die Verwendung spezieller Substanzen, die auf den Wundbereich - Lötmedium - aufgebracht werden, minimiert. Eine wesentliche Funktion eines Lotes besteht darin, die Gewebeabsorption im Wundbereich zu erhöhen. Laserlöten verwendet bioorganische Lötmedium, die auf die Wundränder verschiedener Organe aufgebracht werden. Das Lot absorbiert die Laserstrahlung intensiv und trägt damit nicht nur zur anfänglichen Bondwirkung der Wundkanten bei, sondern auch zur Lokalisierung der Laserstrahlung, wodurch thermische Gewebeschädigungen um die gebildeten Laserschweißungen herum reduziert werden.

Für Laserlötoperationen wurde ein spezielles System entwickelt, das aus folgenden Basismodulen bestand. Das optische Modul erzeugt und liefert die Laserstrahlung, das Temperaturmodul misst und hält die Temperatur (Temperaturreückkopplung) der Schweißnaht und das Steuermodul liefert die notwendigen Parameter für den Laserlötvorgang.

Das optische Modul basiert auf einem Galliumaluminiumarsenid (GaAlAs) -Laser, der kontinuierliche Wellenlängenstrahlung  $\lambda = 808 \pm 3$  nm erzeugt. Wellenlängen im Nahinfrarot-Spektrum sind für laserchirurgische Eingriffe weit verbreitet [2]. Die maximal zulässige Leistung der Laserstrahlung beträgt 5 W. Das Laserlicht wird um 600  $\mu$ m Lichtleitfaser zum Schweißbildungsbereich transportiert. Ein planparalleler Strahl wird durch einen Kollimator mit der Brennweite  $f = 10,99$  mm gebildet. Der Durchmesser des Laserstrahls beträgt  $\sim 2$  mm.

Die Laserlöttechnologie wurde für die chirurgische Rekonstruktion der Integrität biologischer Gewebe entwickelt. Die Verwendung eines Lasersystems hat unbestreitbare Vorteile gebracht, darunter Einfachheit und Geschwindigkeit des Prozesses, klare Visualisierung des Bildrandes, die Möglichkeit, an jedem Abschnitt des Körpers zu arbeiten, einschließlich Schleimhaut und beweglicher Teil des Jahrhunderts, Ästhetik des Ergebnisses, schnelle Heilung. Heute sind Lasertechnologien überall im Einsatz und ermöglichen es der Medizin, ein neues Niveau zu erreichen.

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## Различные технологии лазерной пайки

И. А. Небогин

ФГБОУ ВО «Тамбовский государственный технический университет», Тамбов, Россия  
*e-mail: boss.tankwot@mail.ru*

**Аннотация.** Лазерная пайка - это современный биофотонный метод хирургического восстановления целостности мягких тканей. Данная технология предполагает использование устройства, обеспечивающего лазерное воздействие на разрезанные края раны с нанесенным припоем. Тесты нового метода показали не только эффективное заживление линейных надрезов кожи, но и связанное с этим снижение воспаления, отсутствие нарушений кровообращения, ускорили рост соединительной ткани на месте раны, рассказали создатели.

**Ключевые слова:** биофотоническая техника, технология лазерной пайки.

## Investigation of Moisture Permeability of Oil-Based Corrosion Protection Materials Modified with Colloidal Graphite

A. Y. Osetrov, D. A. Luzhnova\*

Tambov State Technical University, Tambov, Russia

\*e-mail: *daria.luzhnova@yandex.ru*

### Abstract

The absorption of water by conservation anticorrosion compositions based on used motor oil modified with colloidal graphite and triethanolamine has been studied. The protective effect of the inhibition of water mass transfer increases and changes slightly in the presence of the additive throughout the entire exposure time.

**Keywords:** colloidal graphite, relative humidity, triethanolamine, waste motor oil, water mass transfer.

### Introduction

Corrosion of metals (from late lat. *corrosio* — corrosion) is a physical and chemical interaction of a metallic material and a medium that leads to a deterioration in the operational properties of the material, medium or technical system of which they are parts.

Protection of metals and their alloys from corrosion damage is one of the major urgent problems. The problem of developing and using non-metallic anticorrosive coatings remains extremely acute. To a large extent, this also applies to oil-based protective compounds with their own niche of use, which are very effective in the conditions of measures related to temporary anti-corrosion protection of equipment and spare parts, including when it is stored in an open area and under a canopy and in an unheated room.

The purpose of the work is to study the mass transfer of water through a barrier film of oil-based protective compositions modified with colloidal forms of graphite (KG), which are proposed to be used to protect steel products from atmospheric corrosion.

### Specifying activities

Protective compositions are regenerated treated engine oil (MMO) (at least 500 m-h of operation) containing 1.0 wt. % of the active additive (AA), which was used as a suspension of colloidal graphite (0.01 ... 0.03 wt. %) in triethanolamine. The number of graphene layers is less than 100, the average lateral particle size reduced to spherical is 50 microns.

Water is a corrosive agent. Usually it takes a direct part, both in the anode and cathode conjugate electrode reactions of the corrosion process, it is known that a polymolecular water layer is formed under and above the oil films, the thickness of which is related to the relative humidity of the air. The kinetic dependences of the mass transfer of water through the obtained anticorrosive compositions were studied in

a sealed desiccator with a constant set relative humidity (H) of 70 and 100%, for 1 to 7 days. The relative humidity of the air was set distilled water or saturated solutions of NH<sub>4</sub>Cl and KNO<sub>3</sub> salts. Plastic cells containing 1.0 g of desiccant (zeolite of the Na-X-V-2G brand), closed with lapped perforated lids, were placed in the desiccators in parallel experiments. The sorbent is granules with a diameter of (2 ± 0.6) mm. The zeolite was pre-calcined in a muffle furnace at a temperature of 400 ° C. A barrier layer of oil or an oil composition was applied to the surface of the lid, the thickness of which (2 mm) was controlled gravimetrically [1].

The presence in the cells of a certain amount of moisture from the air before the experiment was taken into account, the mass of which was calculated by the formula [2]:

$$m = \frac{P_{H_2O}^{act} \cdot V \cdot M_{H_2O}}{RT}$$

where  $P$  is the actual water vapor pressure (Pa) at room temperature, K;  $V$  is the cell volume, ml;  $M$  is the molar mass of water.

The moisture permeability of the developed compositions was studied at different values of relative humidity. The results obtained at H = 100% are presented in Table 1.

From the data in Table 1, it can be seen that the initial, which does not contain AA, has significant moisture permeability. Introduction of blood pressure containing 0.01 wt. % KG and 0.99 wt. % triethanolamine, reduces the amount of water absorption by 1.1... 1.3 times. Adding 0.02 wt. % and 0.03 wt. % KG does not lead to significant changes in the value of moisture permeability. It is quite natural that in all the cases considered, the mass of moisture that has passed through the barrier layer increases over time.

*Table 1 - The dependence of the mass of water absorbed by the zeolite on the duration of the experiment at a relative humidity of 100%.*

$\tau$ , day	$\Delta m$ uncoated	$\Delta m$ without AD	$\Delta m$ 0,01 mass. % kg	$\Delta m$ 0,02 mass. % kg	$\Delta m$ 0,03 mass. % kg
1	0.1309	0.1192	0.1145	0.1113	0.1116
2	0.1579	0.1382	0.1233	0.1173	0.1138
3	0.1668	0.1382	0.1298	0.1240	0.1223
4	0.1709	0.1428	0.1318	0.1301	0.1323
5	0.1746	0.1464	0.1339	0.1350	0.1399
6	0.1799	0.1564	0.1339	0.1345	0.1371
7	0.1814	0.1633	0.1415	0.1426	0.1462

It is worth noting that with an increase in the duration of the experiment, the effect

of inhibition of water transfer through a barrier film containing BP changes quite slightly, decreasing in some cases by only 3%. Obviously, emulsions of the type water in oil or micellar-solubilized structures formed over time as a result of water absorption also have the ability to reduce the amount of water mass that has passed through the film, as well as the initial compositions. It can be noted that the obtained oil compositions, both in the absence and in the presence of an active additive, cannot prevent the supply of water to the surface of the desiccant, and, consequently, to the metal surface in real conditions. It is possible that there are discontinuities in the oil composition forming the barrier layer, representing channels of various types. The cross sections of these discontinuities may change over time, for example, their fusion may occur.

### **Conclusion**

Thus, the presence of a braking effect when applying oil coatings can be explained by a slight, but occurring, increase in viscosity with the introduction of an active additive. In addition, the particles of KG can be embedded in the gaps in the coating and prevent water from accessing the desiccant.

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## **Исследование влагопроницаемости консервационных материалов для защиты от коррозии на масляной основе, модифицированных коллоидным графитом**

**А. Ю. Осетров, Д. А. Лужнова**

ФГБОУ ВО «Тамбовский государственный технический университет», Тамбов, Россия

**Аннотация.** Изучено поглощение воды консервационными антикоррозионными композициями на основе отработанного моторного масла, модифицированными коллоидным графитом и триэтаноломином. Защитный эффект торможения массопереноса воды в присутствии добавки возрастает и незначительно изменяется в течение всего времени экспозиции.

**Ключевые слова:** массоперенос воды, отработанное моторное масло, относительная влажность воздуха, триэтанолламин.



## Einfluss des Kohlenstoffnanomaterials "Taunit" auf die physikalisch-chemischen Eigenschaften der Grundierung Gf-021

D. P. Rostova, A. V. Trishina, A. V. Zdereva  
Tambow State Technical University, Tambov, Russia  
e-mail: rostova.dariya@yandex.ru

**Zusammensetzung:** Die Ergebnisse der Untersuchung der Eigenschaften von Primerproben mit einem unterschiedlichen Prozentsatz an Kohlenstoff-Nanoröhrchen (0%, 0,01% und 0,001%) sind vorgestellt.

**Schlüsselwörter:** Kohlenstoff-Nanomaterial "Taunit", Grundierung GF-021, Härte, Viskosität.

Die Verwendung von Kohlenstoff-Nanomaterialien ist vielversprechend für die Modifizierung von Lackmaterialien, um ihnen Eigenschaften zu verleihen, die ihre qualitativen Eigenschaften verbessern [1] oder ihnen neue Eigenschaften zu verleihen, die in den Ausgangsmaterialien nicht vorhanden sind [2].

Das Ziel dieser Arbeit war es, die Auswirkungen von Kohlenstoff-Nanoröhren (CNT) der Marke Taunit auf die qualitativen Indikatoren eines auf Glyftal-Oligomeren basierenden Lackmaterials - der Grundierung GF-021 - zu untersuchen. Die Eigenschaften des verwendeten CNT sind in Tabelle 1 angegeben.

Außendurchmesser, nm	15-40
Innendurchmesser	3-8
Länge, nicht weniger als $\mu\text{m}$	2
Das Gesamtvolumen der Verunreinigungen, (einschließlich amorpher Kohlenstoff 0,3-0,5%), nicht mehr als, %	1.5
Schüttdichte, $\text{g}/\text{cm}^3$	0.4-0.5
Spezifische geometrische Oberfläche, mindestens $\text{m}^2/\text{g}$ Temperaturstabilität:, nicht weniger als , $^{\circ}\text{C}$	120
Temperaturstabilität:, nicht mehr als, $^{\circ}\text{C}$	700
Mittleres Porenvolumen, $\text{cm}^3/\text{g}$	0.22
Durchschnittliche Porengröße, $\text{Å}$	70

Tabelle 1. Eigenschaften des Kohlenstoff-Nanomaterials "Taunit"[3]

Die Grundierung GF-021 wurde standardmäßig gemäß GOST 25129-82 hergestellt.

Die Herstellung der modifizierten Grundierung erfolgte in einer Laborperlenmühle der Serie LDU-3 MPR. Zuerst wurden eine Aufhängung von CNT und dann die restlichen Zutaten gemäß der Formulierung in das Glas gelegt. Diese Reihenfolge ist

notwendig, um eine gleichmäßige Verteilung der CNT über die Oberfläche zu erhalten.

In der Anfangsphase wurde ein Fräsmischer verwendet, der mit einer Geschwindigkeit von 150-200 Umdrehungen pro Minute betrieben wurde. Nach 20 Minuten wurde der Fräser entfernt, die Klingen wurden aufgestellt und die Perlen wurden im Verhältnis 1:1 nach Masse zu der Mischung gefüllt. Das Dispergieren wurde mit einer Geschwindigkeit von 260 durchgeführt, als es mit Wasser auf 5 ° C abgekühlt wurde.

Die Analyse der Proben wurde innerhalb von 48 Stunden nach der Zubereitung unter Laborbedingungen durchgeführt. Die Ergebnisse der Experimente sind in Tabelle 2 angegeben.

Benennung der Indikatoren	UNT-Konzentration, %		
	0	0,001	0,01
Farbe des Grundierfilms	Schwarz	Schwarz	Schwarz
Aussehen des Films	Nach dem Trocknen ist der Film glatt, homogen, halbgläzend	Nach dem Trocknen ist der Film glatt und gleichmäßig, matt	Nach dem Trocknen ist der Film glatt und gleichmäßig, matt
Bedingte Viskosität bei Temperatur von 20±2 °C Viskosimeter B3-246	45	55	65
Verdünnungsgrad Lösungsmittel, nicht weniger als	20	20	20
Massenanteil nicht flüchtig Substanzen, %	57	57	58
Mahlgrad, µm, nicht mehr als	40	40	40
Trocknungszeit bis zu einem Grad 3, nicht mehr als bei (105 ± 2) °C min, 20 ± 2	35 24	35 24	35 24
Filmhärte nach Pendelgerät M-3, Bezugseinheit, nicht weniger als	0.35	0.55	0.6
Elastizität des Films bei Biegung, mm, nicht mehr als	1	1	1
Stärke des Films beim Aufprall am Gerät, Y-IA, OM, cm, nicht weniger als	45	45	45
Filmhaftung, Punkte, nicht mehr als	1	1	1
Beständigkeit der Folie gegenüber statischer Einwirkung	48	48	48

Natriumchlorid mit Masse 3% bei (105 ± 2) °C, h, nicht weniger als			
Delamination, ml, nicht mehr als	5	5	5
Beständigkeit der Folie gegenüber statischer Einwirkung Wasser bei (105 ± 2) °C, h, nicht weniger als	48	48	48

*Tabelle 2. Testergebnisse der Grundierung GF-021 mit unterschiedlichem Taunitgehalt*

So ist während der Studie festgestellt, dass die Einführung von CNT „Taunit“ in die Grundierung GF-021 eine Reihe von Eigenschaften beeinflusst:

1. Der Indikator für die bedingte Viskosität nimmt mit zunehmendem Nanomaterialgehalt zu. Die resultierende Erhöhung der Viskosität kann keine eindeutig positive Veränderung sein, da das Material bei hoher Viskosität schlecht aufgetragen werden kann und sich nicht über das Substrat ausbreitet, was zu einer Heterogenität der Beschichtung führt.

2. Die Härte des Films nimmt ebenfalls zu, was zusammen mit der gleichbleibenden Elastizität zu einer längeren Lebensdauer des Materials beiträgt.

3. Die nicht veränderten Werte sind: Mahlgrad, Trocknungszeit bis 3 Grad, Biegefestigkeit des Films, Schlagfestigkeit des Films, Haftfähigkeit des Films, Beständigkeit gegen statische Einwirkung von Natriumchlorid, Delamination und Beständigkeit gegen statische Einwirkung von Wasser.

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### **Влияние углеродного наноматериала «Таунит» на физикохимические свойства грунтовки гф-021**

**Д.П. Ростова, А.В. Тришина, А.В. Здерва**

ФГБОУ ВО «Тамбовский государственный технический университет», Тамбов, Россия  
*e-mail: rostova.dariya@yandex.ru*

**Аннотация.** Представлены результаты исследования свойств образцов грунтовки с различным процентным содержанием углеродных нанотрубок (0%, 0,01% и 0,001%).

**Ключевые слова:** углеродный наноматериал «Таунит», грунтовка ГФ-021, твердость, вязкость.

## Preparation of Nanostructured Carbon Materials from Plant Raw Materials for Water Purification

**K. A. Shurykina\*, I. V. Burakova, A. E. Burakov**

Tambov State Technical University, Tambov, Russia

\*ksunyasmelaya@yandex.ru

### Abstract

New sorption materials based on vegetable waste of agro-industrial complex (AIC) of Tambov region (grass meal, canola seed, sunflower, soybean) are developed to ensure the protection of hydroecosystems of AIC. An important task in industry is the treatment of water from different types of pollutants: organic (e.g. synthetic dyes) and inorganic (heavy metals). At the moment, one of the leading positions for the purification of aqueous media are sorption purification methods.

**Keywords:** agroindustrial complex, environmental monitoring, liquid-phase sorption, plant waste.

The agro-industrial complex (AIC) is the largest socially important sector of Russia's national economy. The efficiency of the agroindustrial complex has a decisive influence on the health and quality of life of the population, ecological and food security and the state of the Russian economy as a whole. Ecologically safe, economically efficient and socially oriented development of agroindustrial complex to a great extent depends on the condition and functioning of reclamation and water management complex, especially in connection with changes in climatic conditions.

In accordance with the Report on the condition and protection of the environment of the Tambov region, prepared by the Tambov Region Department of Environmental Protection and Nature Management, the total volume of wastewater discharge in 2020 was 73.54 million m<sup>3</sup>. The content of pollutants in wastewater increased by 264.9 tons or 0.61%. There was an increase in nickel, lead, magnesium, iron, zinc, chromium, cadmium, phenols, petroleum products, synthetic dyes, etc. [1].

The structure of polluted wastewater discharge into surface water bodies according to All-Russian Classifier of Types of Economic Activities in Tambov region is represented by branch A (agriculture, forestry, hunting, fishing, etc.). agriculture, hunting, fishing and fish farming) amounts to 6.26 million m<sup>3</sup>. A significant amount of toxic pollutants resulting from the activities of agricultural enterprises and the implementation of compulsory agricultural activities significantly worsens the condition of hydrosystems in the region. In this connection, the solution of the problem of effective treatment of water environments used for the needs of agroindustrial complex, as well as waste and waste water of agricultural purposes is one of the most important environmental tasks of the Tambov region [1].

A modern approach to solving such problems is the use of liquid-phase sorption methods based on the application of new types of complex nanostructured adsorbents.

Carbon nanomaterials and their modified forms possessing unique physicochemical and operational characteristics allow providing the highest efficiency of purification of agricultural water objects containing standard agroindustrial pollutants (heavy metals, pesticides, herbicides, hardness salts, etc.) [2, 3].

The aim of the study is to develop innovative nanoporous and nanodisperse sorption materials with specified characteristics for complex high-tech solution of two main problems of water consumption of agroindustrial complex of the Russian Federation - remediation of polluted agricultural objects and improvement of water treatment quality for the needs of agroindustrial complex and environmentally friendly agricultural and aquatic farms.

Sorbents made of natural materials are increasingly used for the extraction of metal cations. Disposable plant wastes of the agroindustrial complex are promising natural materials for obtaining carbon sorbents. In recent years for removal of impurities contained in water sorption materials based on vegetable wastes are successfully used: canola, grass meal, sunflower, soybean, coconut and pine nuts, husks of rice, buckwheat, wood chips, straw and many others. The cost of such sorbents is much less than the known industrial samples, which, in turn, will significantly improve the ecological condition of aquatic ecosystems due to the wide use of available and inexpensive material [4]. Their use in water purification makes it possible to eliminate the stage of regeneration of the sorbent. Absorption qualities of natural materials can be dramatically increased by chemical or physical influence.

Grass meal is a product of herbs. For the flour fit field and meadow herbs, these include clover, tutsan, wheatgrass, tansy, alfalfa and more. This product is very common in our area. Therefore, purchase costs are minimal.

Oil of spring and winter canola seeds was used only for technical purposes. From canola seed oil sorption materials were made, which were then used as a basis for purification of various media. Unlike other technical compositions, such materials are cheaper, while having all the necessary properties.

Materials from sunflower husks that have undergone acid-alkaline treatment show high purification efficiency in relation to ions of iron, manganese, copper, lead, phenol, protein. The efficiencies are 90.8%, 91.5, 93.5%, 55.4%, 41.3% and 39.0%, respectively.

Scientific and technical progress of many spheres of industry involves the formation of effluents that include ions of heavy metals such as  $\text{Fe}^{2+}$ ,  $\text{Cr}^{6+}$ ,  $\text{Cu}^{2+}$ ,  $\text{Ni}^{2+}$ ,  $\text{Zn}^{2+}$ . The presence of these pollutants in water bodies implies a risk to both humans and the environment. In order to clean such environments it is necessary to reduce the concentration of polluting components down to the minimum values.

There is a powder, mainly consisting of coagulant, made from fermented soybeans, which contribute to the rapid sorption of impurities in water. Such material is unique because the safety and environmental friendliness of the product promotes the use in the food industry, etc.

To summarize, at present, innovative nanoporous and nanodisperse sorption materials are being developed to solve the problems of ecological safety of water

systems - remediation of polluted objects of various purposes and improving the quality of water treatment.

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## Получение наноструктурированных углеродных материалов из растительного сырья для очистки водных сред

К. А. Шурыкина\*, И. В. Буракова, А. Е. Бураков

ФГБОУ ВО «Тамбовский государственный технический университет», Тамбов, Россия

\**ksunyasmelaya@yandex.ru*

**Аннотация.** Разрабатываются новые сорбционные материалы на основе растительных отходов агропромышленного комплекса (АПК) Тамбовской области: травяная мука, рапс, подсолнечник, соя – для обеспечения охраны гидрогеосистем АПК. Важной задачей в промышленности является очистка вод от различных типов загрязнителей: органических (например, синтетические красители) и неорганических (тяжелые металлы). На настоящий момент одним из лидирующих позиций по очищению водных сред являются сорбционные методы очистки.

**Ключевые слова:** агропромышленный комплекс, жидкофазная сорбция, растительные отходы, экологический мониторинг.

## Infinite Plate Vulcanization Process Simulation

**A.I. Skomorokhova\*, A.O. Glebov**

Tambov State Technical University, Tambov, Russia

\*e-mail: *nasta373@mail.ru*

### Abstract

The article discusses the process of vulcanization of the rubber mixture. The equations describing the induction period and the vulcanization period are given. Graphs of changes the state of cure and temperature are obtained with and without taking into account the heat generation of a chemical reaction.

**Keywords:** kinetics, modeling, rubber products, state of cure.

### Introduction

Research in the field of the rubber industry is of interest due to the wide scope of application of its products. The greatest attention is paid to the process of vulcanization, as the main stage in the creation of rubber products. The appointment of rational vulcanization parameters helps to improve the quality of products while reducing energy consumption for their production. In particular, a significant amount of research is devoted to the study of the kinetics of vulcanization in order to identify the optimal temperatures and time of the process [1]. Vulcanization proceeds in three stages: induction period, vulcanization period, and reversion period. Of greatest interest is the determination of the moment when the reversion period begins. This stage is accompanied by deterioration in the properties of the product up to the loss of its suitability for use.

### Methods and Materials

When studying the kinetics of vulcanization of a rubber compound, it is necessary to describe each of the stages of the process. First of all, the time of the induction period is determined, according to the formulas given in [2]:

$$t_i = t_0 e^{T_0/T}, \quad (1)$$

$$\bar{t} = \int_0^t \frac{dt}{t_i(T)}, \quad (2)$$

where  $t_0$  and  $T_0$  are two material constants, which are independent of temperature;  $T$  is temperature, K;  $t$  is time, s;  $t_i(T)$  is the temperature dependence of induction time, described by equation (1). When the value of dimensionless time  $\bar{t}$  becomes equal to one, the upper limit of  $t$  in integral (2) is considered as induction time.

The numerical expression for the state of cure in method based on the Kamal and Sourour model [3] is given as:

$$\left(\frac{\alpha_i}{1-\alpha_i}\right)^{1/n} = \left(\frac{\alpha_{i-1}}{1-\alpha_{i-1}}\right)^{1/n} + \left(\int_{t_{i-1}}^{t_i} k^{1/n} dt\right), \quad (3)$$

where  $\alpha$  is a state of cure;  $n$  is the order of reaction;  $k$  is a rate constant with an Arrhenius-type temperature dependence form:

$$k = k_0 e^{(-E/RT)}, \quad (4)$$

where  $k_0$  is a constant called pre-exponential factor,  $E$  is the activation energy, J/mol and  $R$  is the gas constant, J/(mol·K).

When making calculations, it is necessary to take into account the heat of the chemical reaction of vulcanization and the change in the thermal conductivity of the rubber mixture depending on temperature. For rubbery materials thermal conductivity is assumed to be a linear function of temperature expressed by:

$$\lambda = 0.1612 - 0.0002(T - 273). \quad (5)$$

An infinite plate with a heating temperature specified on the surface was chosen as the calculation model. The initial temperature of the model is 20°C. As the properties of the material of the rubber compound, the data given in [4] were taken: heat capacity 717 J/(kg·K), density 1127 kg/m<sup>3</sup>. The values of the constants used in the calculations were also taken from this work.

The calculations were carried out in the ANSYS 2019 R2 finite element analysis system. 4-node PLANE55 finite elements were used to build the mesh.

According to the calculations, with an increase in the thickness of the plate, the effect of heat generation on the course of the vulcanization process increases. On Figure 1 shows graphs of changes state of cure and temperature in the part of the rubber plate that is farthest from the heat source, with and without taking into account the heat generation of a chemical reaction at a plate thickness of 0.1 m.

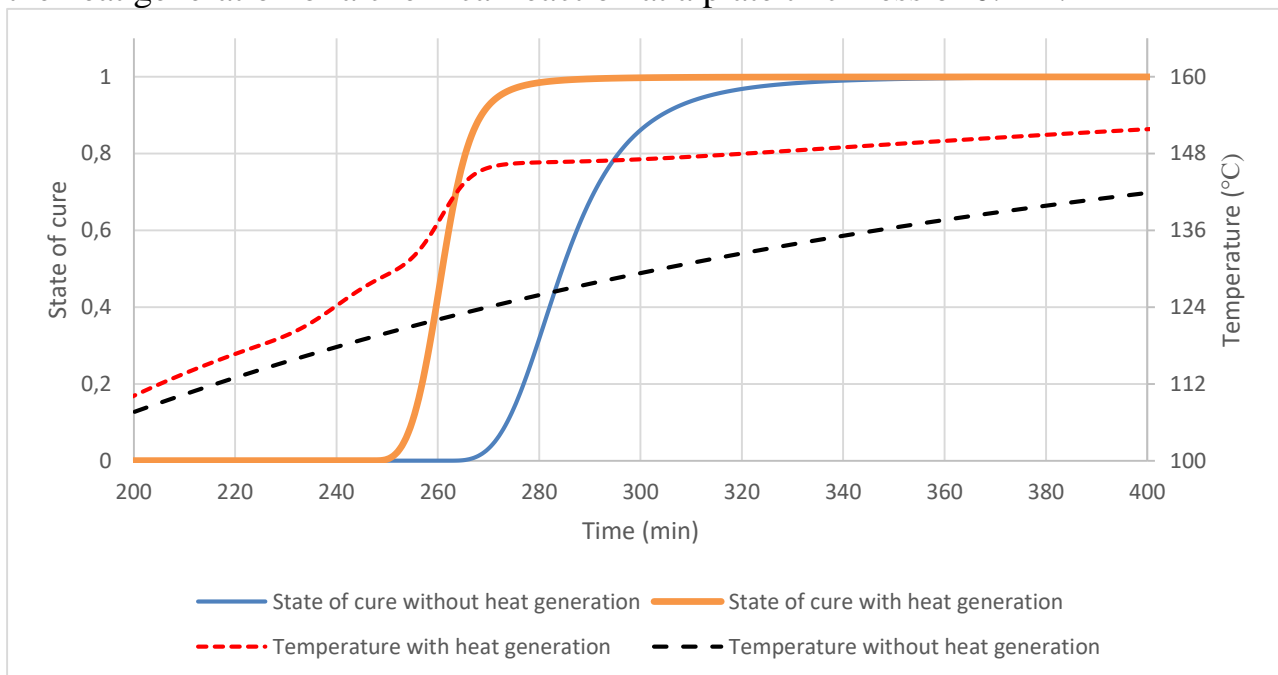


Figure 1- Change state of cure and temperature with and without heat generation



As can be seen from the graphs, without taking into account the heat generation of the vulcanization reaction, the temperature graph gradually increases. When the reaction heat generation is used in calculations, temperature jumps are observed. In the first case, at the time instant of 235 min, the faster rise in temperature is explained by the vulcanization of the region of the rubber plate adjacent to the considered part of the rubber mixture. The second jump is caused by the heat of reaction in the region under consideration.

### **Conclusion**

The described approach makes it possible to investigate the induction period and the vulcanization period of the rubber compound. However, these calculations do not consider the reversion period, which strongly affects the properties of the rubber product. For this reason, the prospect of further research is the study of approaches to the description of the reversion period and the inclusion of appropriate models in the calculation of the vulcanization kinetics.

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## **Моделирование процесса вулканизации бесконечной пластины**

**А.И. Скоморохова\*, А.О. Глебов**

ФГБОУ ВО «Тамбовский государственный технический университет», Тамбов, Россия  
*\*e-mail: nasta373@mail.ru*

**Аннотация.** В статье рассматривается процесс вулканизации резиновой смеси. Приведены уравнения, описывающие индукционный период и период вулканизации. Получены графики изменения степени вулканизации и температуры с учетом и без учета тепловыделения химической реакции.

**Ключевые слова:** кинетика, моделирование, резинотехнические изделия, степень вулканизации.

## **Applications of Coagulation-Flocculation and Ballast Flocculation for Water Treatment**

**B. S. Taha**

Tambov State Technical University, Tambov, Russia  
*e-mail: bilalsaad\_t@yahoo.com\_*

### **Abstract**

Coagulation and ballast flocculation are widely used in the water industry for the purification of drinking water, domestic, storm and industrial water. This method is based on the force of gravity in the physicochemical separation process. The removal of suspended solids (turbidity) from the water occurs by introducing a ballasting agent, usually microsand, to increase the density and size of the flocs. This review focuses on the interaction between ballast agent, coagulant and polymer flocculant. This study will be useful in understanding the interaction mechanisms of those factors, which are being studied by various researchers in this field to control water pollution.

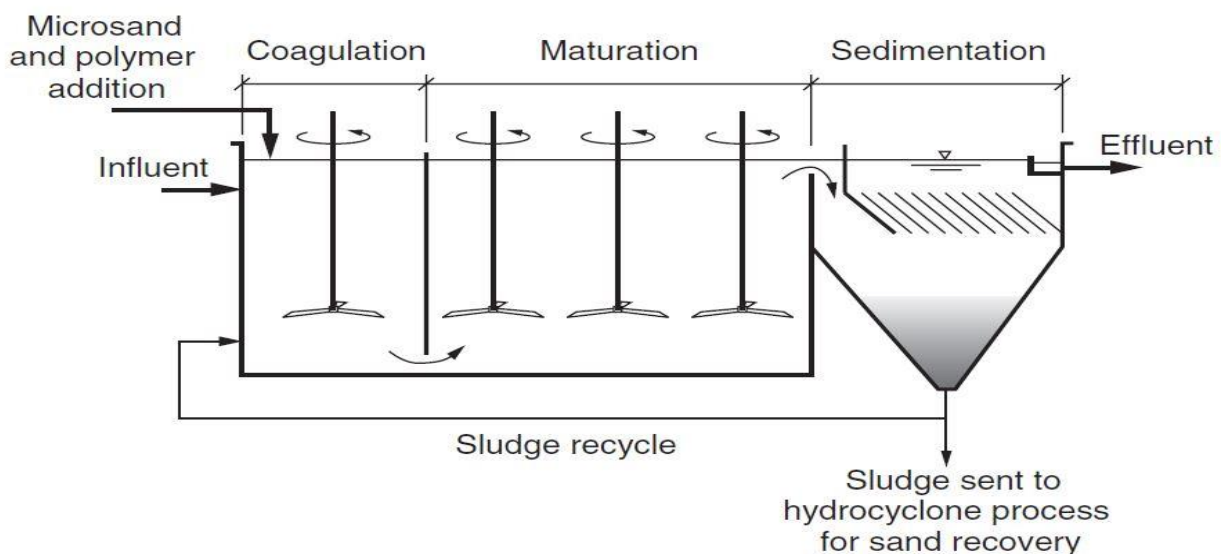
**Keywords:** coagulation-flocculation; ballasted flocculation; turbidity removal; water treatment

### **Introduction**

Physicochemical method helps to remove turbidity, color and chemical oxygen demand reduction. The present study focuses on the performance of coagulation and ballast flocculation. The use of ballast flocculation serves for floc formation and ballast to increase floc density and settling velocity and also used in treatment plants to reduce the clarifier surface area. For instance, Young et al (2003) studied the influence of numerous factors affecting the efficiency of ballasted flocculation separately [1]. Ghanem et al (2007) studied the mechanism of ballasted flocculation through different tests: bench scale observations, microscopic observations, density tests, and centrifugal settling tests [2]. He et al (2019) studied ballasted flocculation to comparatively analyze combined behaviors of maturation, breakage and reformation for ballasted flocs formed from AS and PACl coagulants under different dosing amount conditions [3]. Zafisah et al (2020) investigated the performance of ballasted flocculation in removing turbidity using different dosages of sand and polymer flocculant [4]. Besides, Sieliechi et al (2016) used pozzolana as the alternative ballasting agent in their study with attention given to the floc compaction in the presence of ballasting agent [5].

Description processing of the coagulation and ballast flocculation involves the addition of ballast (usually microsand) that increases the settling velocity of the floc particles by increasing their density (providing ballast). The concept of ballasted sedimentation was first applied to water treatment in the 1970s. Currently, there are a number of proprietary sedimentation processes that employ the ballasted flocculation principle. Two well-known processes are the Actiflo process and the Densideg dense-sludge process. These processes have been used in water treatment for both the production of potable water and the treatment of filter-to-waste washwater. A schematic of the Actiflo process is shown on Fig.1. The Actiflo process involves adding an inorganic coagulant (alum or ferric) to the raw water and allowing floc to

form in the first stage of flocculation. Subsequently, a high-molecular-weight cationic polymer and microsand particles (20 to 200  $\mu\text{m}$ ) are added to the second stage, and the microsand particles flocculate with the preformed floc particles in the second and third stages. After flocculation, the ballasted floc is settled and the sludge containing the microsand is sent through a hydrocyclone (not shown) where the microsand is recovered and reused and the sludge is sent on for further treatment. The microsand is fed at a rate that is approximately 0.15 to 0.4 percent of the influent flow rate and the sludge ultimately contains 10 to 12 percent sand by weight. The surface loading rate for an Actiflo unit ranges from 35 to 62 m/h, which can be up to 50 times greater than the surface loading rate for a conventional rectangular sedimentation basin. The small size of the Actiflo unit can be attributed to the use of high mixing energy [6].



*Fig.1. Schematic of Actiflo process*

Desjardins et al (2002), studied a laboratory methodology of three drinking water production plants using the ballasted flocculation process [7]. This study has permitted the development of a laboratory methodology that predicts the performance of ballasted flocculation. The ballasted flocculation technology is based on the addition of microsand and polymer during coagulation–flocculation. The modified jar-test procedure was able to predict the performance of the full-scale process with good accuracy. The use of an optimised statistical approach enables identification of the principal parameters controlling ballasted flocculation through a reduced number of experiments. Besides the microsand and polymer, the major parameters were the coagulant dosage and the pH of coagulation, as in conventional coagulation–flocculation- settling. Ghanem et al (2007) studied the mechanism of ballasted flocculation through different tests: bench scale observations, microscopic observations, density tests, and centrifugal settling tests[2], they found firstly, after adding the ballasting agent (BA) to coagulated water, during rapid mixing, the number of particles in the water increases, initiating an increase in collision frequency.

Because BA particles possess a greater mass than the preformed microflocs, the former have more energy than the latter during the collision process, which allows BA particles to hit the microflocs and enter into the floc matrix by momentum. During slow mixing, these microflocs aggregate to form larger ballasted flocs. If some BA remains in the water, the BA will continue to be incorporated into the floc matrix until the flocs cannot hold additional BA grains. Some of these flocs will begin to break up and aggregate again until they maintain a relative uniform size when a steady-state condition is reached. Above this limit, the floc becomes unstable and is not able to hold greater amounts of BA. Secondly, density tests demonstrated that the ballasted floc bulk density is linearly related to the amount of BA added, increasing up to a point after which the BA is no longer incorporated into the floc matrix. Thirdly, density tests and centrifugal settling tests indicated that when a BA is incorporated into a floc matrix, the BA takes the place of the bound water (BW) content causing a reduction of the amount of water present in the floc. Therefore, the amount of BW is inversely proportional to the BA dose. Besides, He et al (2019) studied ballasted flocculation to comparatively analyze combined behaviors of maturation, breakage and reformation for ballasted flocs formed from AS and PACl coagulants under different dosing amount conditions [3], the major findings of their study were summarized as follows:

1. For either aluminum sulphate (AS) or polyaluminum chloride (PACl) as coagulant during ballasted floc formation, the value of zeta potential after either Al-based coagulant addition increased from negative to positive with increasing dosing amounts, whereas after injecting anionic polymer and microsand, a distinct decrease took place at a given coagulant dosage. Interestingly, no significant differences in zeta potential were observed at sub-stages of maturation and reformation.

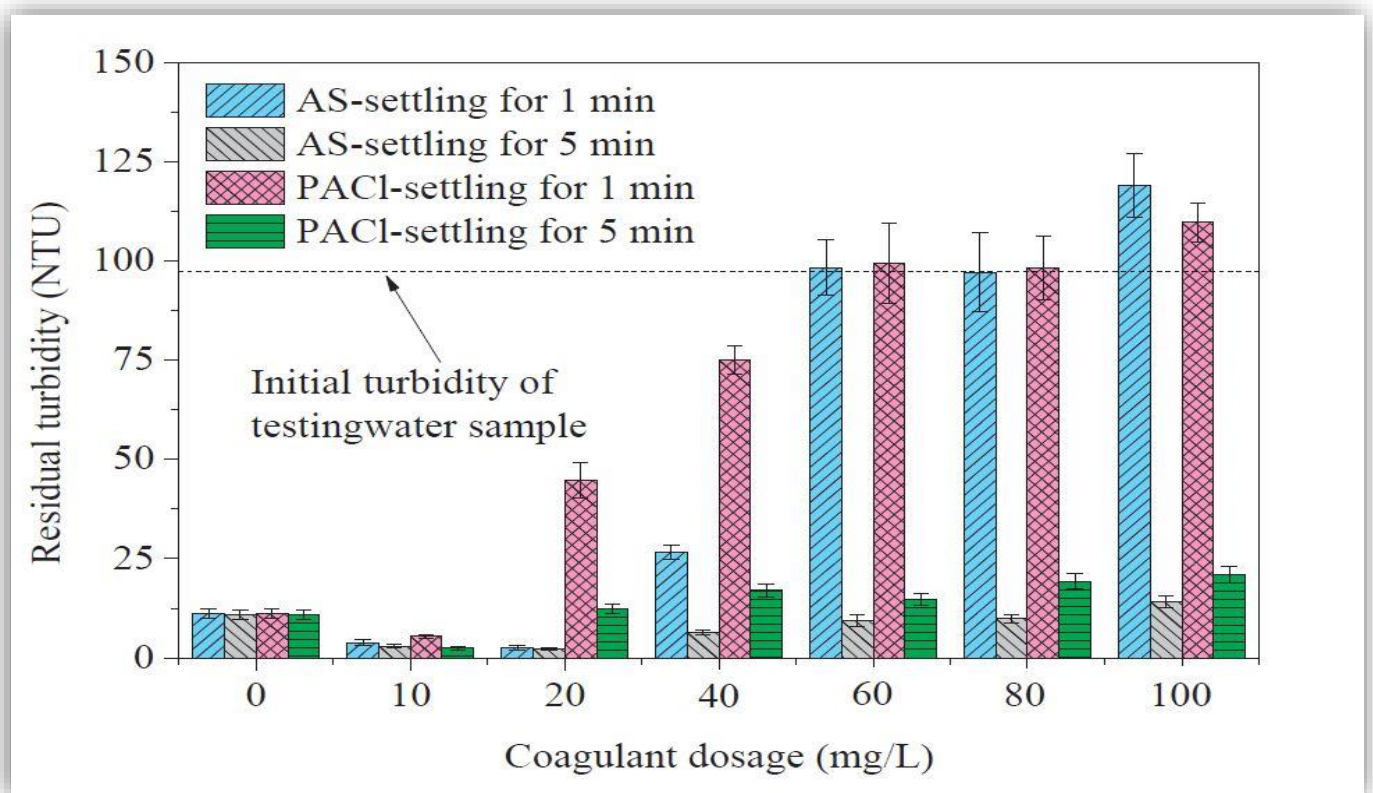
2. The coagulant dosage effect on the characteristic size and corresponding size distribution of ballasted flocs indicated that surface charge characteristics of pre-formed micro-floc aggregates after coagulant addition would take a crucial role in the occurrence of incorporation for ballasting agent (BA) particles into the aggregate matrix, thereby affecting the development of ballasted floc size for different dosing-amount cases of both AS and PACl.

3. Whatever the Al-based coagulant, a turning point was observed on the changing curve for the median particle size ( $d_{50}$ ) of ballasted flocs after breakage, probably caused by increased abilities of those stretched polymer-molecular chains to effectively adsorb pre-formed floc aggregates (with a much higher surface charge) in the highershear suspension. After reformation, a similar turning point appeared to occur with the PACl coagulant, and however, seemed not to show up when the AS was used, likely due to the fact that the former coagulant gave rise to much stronger and more binding bonds holding the floc together than the latter at the same coagulant dosages.

4. During the process of breakage, those ballasted floc aggregates formed after maturation were found to break up in the fragmentation- like way at lower dosages of either Al-based coagulant, but in the erosion-like way within the higher-dosage ranges.

5. Poor incorporation could produce a greater number of ballasted floc aggregates with fewer or even no BA particles before settling, and unfortunately, a larger portion of these newly-formed flocs might be possibly remained in the settled water as a result of a lower density and settling velocity, thus worsening the whole settling performance.

6. In order to confirm the occurrence of chain reconfiguration for the polymer molecule under a relatively higher shear-rate condition, further investigations would focus on the determination of polymer chain by dynamic light scattering or some other modern morphological characterization techniques. Also, the effect of much higher shear rates on the stretched configuration of polymer chain should be involved for understanding ballasted floc formation mechanisms based on this study.

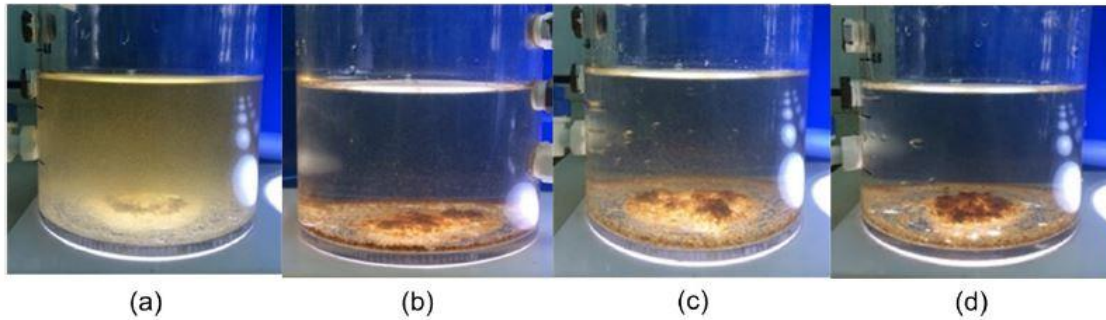


*Fig.2. Residual turbidity after settling for 1 min and 5 min at different coagulant dosages of AS and PACl*

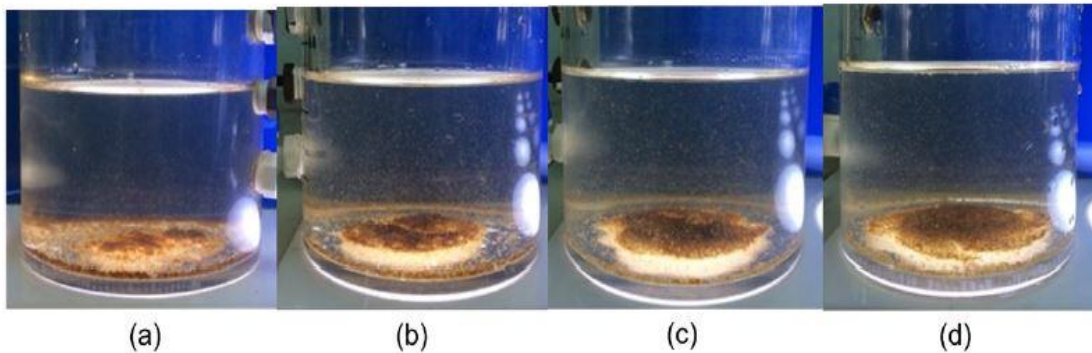
Zafisah et al (2020) investigated the performance of ballasted flocculation in removing turbidity using different dosages of sand and polymer flocculant[4], the results presented in this study provided understanding about the interaction between sand and flocs in the ballasted flocculation process. The optimal dosage for this study was 2 mg/L of flocculant and 1 g/L of sand that gave rise to 90% of turbidity removal. The settling time for the ballasted flocs was much shorter (3 s) compared to nonballasted flocs due to the incorporation of sand that caused the premature flocs to become heavy and settle quickly. However, the turbidity removal efficiency was



slightly compromised due to presence of lesser suspended flocs to enmesh the residual turbidity during sweep coagulation stage.



*Fig. 3. Floc formations of different flocculant dosage after settling; (a) 1 mg/L (b) 2 mg/L (c) 3 mg/L (d) 4 mg/L*



*Fig. 4. Floc formations of different sand dosage after settling; (a) 1 g/L (b) 2 g/L (c) 3 g/L (d) 4 g/L*

## Conclusion

The raw water from natural resources contains high percentage of suspended solids which are known as turbidity, hence required treatment of water before use it. The chemical coagulation-flocculation is one of the simplest methods for the treatment of water but one of the disadvantages is production of sludge. The ballast flocculation as it is applied for water and wastewater treatment for turbidity and COD, BOD removal. It requires less area for clarifier, less duration so it is an efficient and cost-effective too.

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## **Применения коагуляции-флокуляции и балластной флокуляции для очистки воды**

**Б. С. Таха**

ФГБОУ ВО «Тамбовский государственный технический университет», Тамбов, Россия  
*e-mail: bilalsaad\_t@yahoo.com*

**Аннотация.** Коагуляция и балластная флокуляция широко используются в водном хозяйстве для очистки питьевой воды, коммунально-бытовых, ливневых и промышленных вод. Этот метод основан на силе тяжести при физико-химическом процессе разделения. Удаление взвешенных твердых частиц (мутность) из воды происходит при введении балластирующего агента, обычно микроспеска, для увеличения плотности и размера хлопьев. В этом обзоре основное внимание уделяется взаимодействию между балластным агентом, коагулянтом и полимерным флокулянтom. Это исследование будет полезно для понимания механизмов взаимодействия этих факторов, которые изучаются различными исследователями в этой области для контроля загрязнения воды.

**Ключевые слова:** коагуляция-флокуляция; балластная флокуляция; удаление мути; очистка воды

## Colloidal Graphite Modified Oil-Based Corrosion Protection Preservatives

**D. K. Veselova\*, I. V. Zarapina**

Tambov State University, Tambov, Russia

\*e-mail: veselova\_2016@bk.ru

### Abstract

Preservative protective compositions based on used motor oil modified with colloidal graphite and triethanolamine have been obtained. Their physicochemical characteristics have been studied. It is shown that with the introduction of an active additive, a slight increase in density, kinematic viscosity and thickness occurs.

**Keywords:** Waste motor oil, colloidal graphite, triethanolamine, St3 steel, density, kinematic viscosity.

### Introduction

Currently, based on the high cost of corrosion-resistant metal materials, significant anticorrosive solutions at the design and construction stages are minimal. Therefore, anticorrosive measures are carried out mainly at the stage of operation, for which a wide variety of conservation materials are used. The relevance of this study is due to the need for rational use and storage of metal products. Oil-based formulations allow technologically and timely re-preservation and deconservation of equipment, which is often impossible when using most other non-metallic protective materials, for example, paint and varnish. The purpose of the work is to determine some physico-chemical characteristics of oil coatings modified with colloidal forms of graphite, which are proposed to be used for the preservation of equipment, including when it is stored in an open area and under a canopy, as well as spare parts, for example, in an unheated room.

### Materials

Anticorrosive compositions containing regenerated used engine oil and 1.0 wt as a solvent-base were proposed for experimental studies. % of the modifying additive. As this component, a suspension of colloidal graphite was used (0.005 ...0.05 wt. %) in triethanolamine. These preservation compositions are proposed to be used to protect steel products from atmospheric corrosion.[2]

The MO was obtained by draining directly from the crankcase of the tractor engine after ~ 500 hours of operation. Table 1 shows the physico-chemical characteristics of the engine oil.

*Table 1- Physico-chemical characteristics of engine oil*

Indicator	Engine oil
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Flash point in an open crucible, °C, not lower	100
Mass fraction of mechanical impurities, mass%, no more	1
Mass fraction of water, %, no more	2
The content of mechanical impurities, mass. %	1
Base number mg KOH/g	1.85
Acid number mg KOH/g	0.4

Engine oil is a mixture whose composition is of an average nature. Fractional composition of the used engine oil Table 2.[1]

*Table 2 - Fractional composition of the engine oil*

Fractional composition	Contents, mass. percent
Inorganic part	0.03...4.0
Water	0...0.5
Mechanical impurities	0.2...5.0
Organic part	90.5...99.7
Volatile hydrocarbons	0.5...3.0
Mineral oil	71.6...75.3
Hydrocarbon oxidation products (heavy hydrocarbons):	18.9...20.4
neutral oils	8.0...8.6
neutral resins	2.5...2.7
asphaltenes	3.6...3.9
asphaltogenic acids	4.8...5.2

## Methods

Colloidal graphite in this case refers to structures with no more than 100 graphene layers. The average lateral particle size reduced to spherical is 50 microns. The production process in a simplified form consists of intercalation of ions into the interlayer space of graphite and directly splitting of the material.

The preparation of these compositions was carried out using a homogenizer.

The density of the composed oil compositions was determined by an AN-type hydrometer.

The kinematic viscosity of the preservation compositions was determined using a viscometer of the HPV type. The composed oil compositions flowed through the capillary under the influence of gravity. The time of its expiration was fixed and, knowing a certain volume, the viscosity was calculated at a given temperature

according to the formula:

$$\nu = \frac{g}{9,807} \cdot T \cdot k,$$

here  $\nu$  is the kinematic viscosity of the solution,  $\text{mm}^2/\text{s}$ ,  $k$  is the viscometer constant,  $T$  is the expiration time,  $s$ ,  $g$  is the acceleration of gravity,  $\text{m/s}^2$ .

The thickness of the applied protective films formed on the metal surface under isothermal conditions was evaluated as follows. To coat the studied compositions, samples made of St3 steel were immersed in a bath with the composition (room temperature) for 10 seconds, after which they were kept suspended in air at room temperature for a day to drain excess oil composition and form a protective film. The thickness of the coating  $h$ , microns was determined by the change in mass in accordance with the formula:

$$h = \frac{(m_1 - m_2)}{\rho \cdot S} \cdot 10^4,$$

where  $m_1$ ,  $m_2$ , respectively, the mass of the uncoated and coated sample,  $r$ ;  $\rho$  the coating density,  $\text{g/cm}^3$ ;  $S$  the surface of the samples,  $\text{cm}^2$ .

Some characteristics of the obtained preservation compositions from engine oil is presented in Table 3.

*Table 3- Physico-chemical characteristics of oil compositions*

Colloidal graphite content, mass. percent	Density, $\text{g / cm}^3$ at 20°C	Kinematic viscosity, $\text{mm}^2/\text{s}$ at 20°C	Coating thickness $h$ , microns
0	0.860	23	12
0.005	0.925	25	16
0.01	0.919	25	16
0.02	0.920	25	16
0.03	0.916	24	15
0.05	0.917	24	15

Table 3 shows that when an active additive is introduced, there is a slight increase in the density and viscosity of the obtained preservation compositions.

### **Results and discussion**

Thus, we can talk about a small thickening capacity of the modifying additive. Moreover, it practically does not depend on the ratio of the components – colloidal graphite and triethanolamine.

There is also a slight increase in the thickness of the coating and, consequently, the consumption of material per unit surface area increases. The dependence on the concentration of colloidal graphite or triethanolamine is still not observed. It is

assumed that the thickening of the oil base in the presence of an active additive is due to the formation of a micellar structure in the compositions. The increase in the viscosity of micellar solutions obviously occurs as a result of the aggregation of micelles.

In addition, the presence of a nitrogen atom and a hydroxyl group in a triethanolamine molecule can lead to a significant strengthening of intramolecular hydrogen bonds. It is possible that associates (dimers) are formed, which are the basis for the formation of lamellar micelles.

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## **Консервационные составы для защиты от коррозии на масляной основе, модифицированные коллоидным графитом**

**Д. К. Веселова\*, И. В. Зарапина**

ФГБОУ ВО «Тамбовский государственный технический университет», Тамбов, Россия

*\*e-mail: veselova\_2016@bk.ru*

**Аннотация.** Получены консервационные защитные композиции на основе отработанного моторного масла, модифицированные коллоидным графитом и триэтаноламином. Исследованы их физико-химические характеристики. Показано, что при введении активной добавки происходит незначительное увеличение плотности, кинематической вязкости и толщины.

**Ключевые слова:** отработанное моторное масло, коллоидный графит, триэтаноламин, сталь Ст3, плотность, кинематическая вязкость.

## Management of the Technological Process of Caramel Mass Production

I. A. Zavrazhin, N. V. Gruzdev\*, V. N. Nazarov

Tambov State Technical University, Tambov, Russia

\*e-mail: *gru.nikita@yandex.ru*

### Abstract

The analysis of the technological process and the currently existing control system is carried out. The structure and complex of technical means are chosen. The currently existing control system for the technological process of caramel mass production does not meet modern requirements for modern technical means, since the cost of production is quite high and resource and energy costs are too high.

**Keywords:** Automatic control system (ACS), technological process, caramel syrup, caramel mass production, programmable logic controller (PLC), mathematical model.

### Introduction

Caramel is a sugar confectionery product consisting of caramel mass. The caramel mass is obtained by boiling a sugar solution with starch molasses to a content of 95-99% solids. The caramel mass has an amorphous structure.

In modern economic conditions at the enterprises of the confectionery industry, the issue of reducing the cost of production while ensuring the specified quality indicators and the volume of products is particularly acute [1].

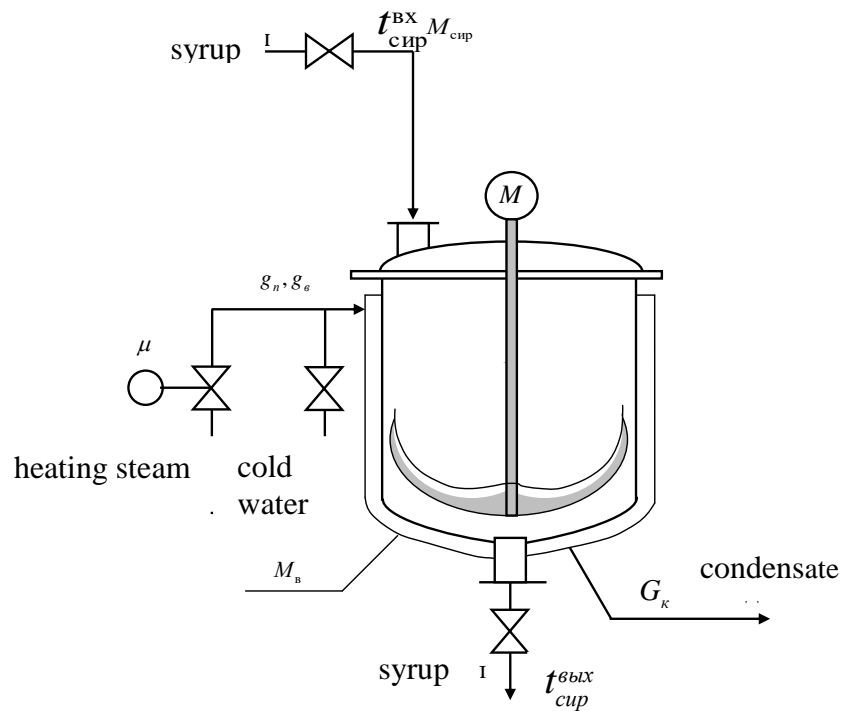
The main stage of the production of caramel mass is the preparation of caramel syrup. Effective management of this process at this stage largely determines the value of the cost and the quality of the products received. The experience of industrial operation shows that the main share of energy consumption (heating steam needed for heating, electricity) and raw material costs (granulated sugar, molasses, food additives, cold water) falls on the process of making caramel syrup [1].

Thus, in the condition of high prices for raw materials and energy carriers, the task of conducting the process according to strictly regulated consumption standards is urgent. The use of automation tools will reduce the wear of technological equipment, save energy resources, reduce emergencies, and improve the quality of the products received.

The aim of the study is to create an automated control system for the production of caramel mass, on which, with the help of real equipment, for example, a programmable logic controller (PLC), a mathematical model of maintaining the temperature at a given level in the syrup collector will be tested and optimal settings for the automatic control system will be selected [1].

### Materials, Results and Discussion

Maintaining the temperature at a given level in the syrup container is one of the most important tasks of the production of caramel mass. The process is carried out in a periodic type apparatus (Fig.1).

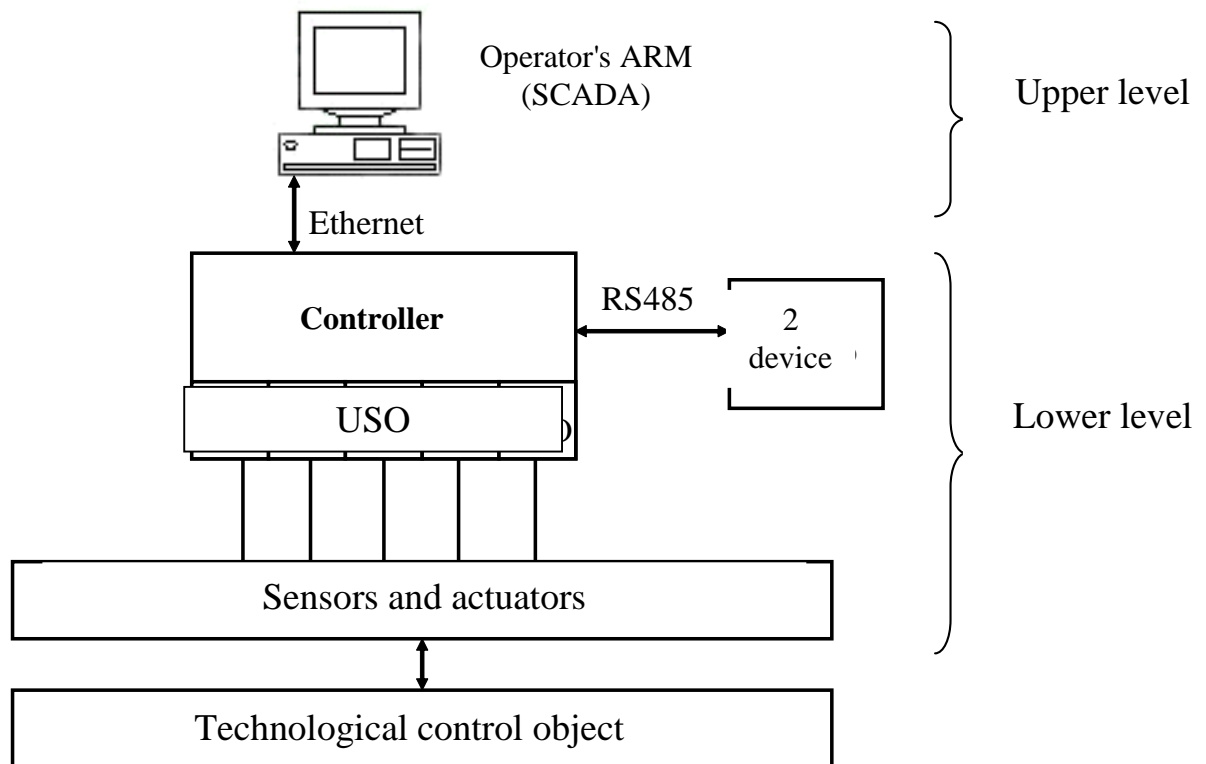


*Figure 1 – Simplified scheme of the syrup container*

This device is a vertical cylindrical vessel with an elliptical bottom and a lid made of stainless steel, with a volume of  $0.5 \text{ m}^3$ , equipped with an anchor stirrer rotating at a speed of up to 70 rpm. The device is cooled by the supply of cold water through the jacket, and the device is heated by the supply of a hot steam-water mixture [2].

For this process, the two-level automated process control system is most relevant (Figure 2). All the features of this system are clearly divided into two levels.

The lower level provides data collection on the parameters of the technological process. Technical means of the lower level: PLC, sensors, actuators, I/O modules. The programmable logic controller provides automatic control of the equipment, start and stop of the technological process, as well as emergency shutdown and protection [2].



*Figure 2 - Block diagram of the automated control system of the caramel mass production process*

The lower level of the technological process is implemented on the basis of the PLC-110- 30R controller and 110 series I/O modules from OWEN. Also, the lower level of the automated process control system includes devices for technological control and management [3].

The upper level of the automated process control system is based on the operator's station (APM), implemented using a SCADA system. With the help of a SCADA system connected to a logical controller, all technological parameters are monitored and controlled, process data is visualized and archived, as well as software diagnostics and correction, without leaving the workplace [3].

The PLC-110-30P controller is programmed in the CODESYS V2.3. The controller application software implements algorithms for controlling valves with electric drives that will regulate the supply of heating steam and cold water to the steam jacket [4].

The implementation of the technological control object is carried out in the dynamic programming environment of Matlab. In the Simulink dynamic modeling environment, it is possible to exchange data using OPC technology. To do this, one need to install an additional extension package for Matlab called OPC Toolbox.

Data exchange between a mathematical model in the Simulink environment and a program in CODESYS is carried out using OPC technology. To do this, it is necessary to make settings, both for the program and for the mathematical model itself.

### **Conclusion**

Using a mathematical model of the control object, the controller software of this

control system is configured. The controller itself is being configured: control circuits, various operating modes (blocking and protection) are being tested, controller control algorithms are being tested and the controllers of the mathematical model are being configured.

Thus, the following tasks were solved:

- Pre-configuration of the control system in accordance with the mathematical model used.
- In operation mode, the controller software is being refined, which will improve the object management system used.

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## Управление технологическим процессом производства карамельной массы

**И. А. Завражин, Н.В. Груздев, В.Н. Назаров**

ФГБОУ ВО «Тамбовский государственный технический университет», Тамбов, Россия  
*\*e-mail: gru.nikita@yandex.ru*

**Аннотация.** Производится анализ технологического процесса и существующей в настоящее время системы управления. Выбирается структура и комплекс технических средств из-за того, что существующая в настоящее время система управления технологическим процессом производства карамельной массы не удовлетворяет современным требованиям за счёт современных технических средств, так как довольно высока себестоимость продукции и слишком большие ресурсы и энергозатраты.

**Ключевые слова:** система автоматического управления (САУ), технологический процесс, карамельный сироп, производство карамельной массы, программируемый логический контроллер (ПЛК), математическая модель.

## Protection of Products from Corrosion with Films Based on Used Engine Oils

**Yu. V. Zhirkova\*, I. V. Zarapina**

Tambov State Technical University, Tambov, Russia

\*e-mail: zhirkova.iu@yandex.ru

### Abstract

The effectiveness of coatings based on used petroleum motor oils for corrosion protection on steel in a neutral electrolyte solution has been studied. This makes it possible to reuse waste raw materials, improve the environmental performance of production. A literature review and gravimetric laboratory tests were carried out. As a result of the study, it was shown that synthetic used motor oil has a great protective effect, what can be useful knowledge for further tests in this area.

**Keywords:** steel, film, waste oil, corrosion.

### Introduction

According to experts, up to 84% of all used oils are discharged into the lithosphere and hydrosphere. Such a large amount of pollution poses a great danger to the environment. Unlike oil and other petroleum products, waste oils, when released into the environment, are even less naturally detoxified (oxidation, photochemical reactions, biodegradation, and other processes). It is of interest to apply used engine oils to protection of metal products from atmospheric corrosion [1].

The relevance of the selected study is undoubted, since an alternative use of used motor oils as an anti-corrosion agent is being considered which, in turn, makes it possible to rationally use and preserve the country's metal fund.

### Materials and methods

An important factor in the development of metal corrosion damage is the degree of surface moisture. The composition and thickness of the electrolyte films, under which atmospheric corrosion develops on the metal, are variable and depend on the cycles of wetting and drying of the surface.

Atmospheric corrosion is the destruction of metals at ordinary temperatures in moist water and proceeds in thin layers of moisture. This is the most common type of corrosion that machines, equipment and structures are exposed to during operation in contact with a humid and polluted atmosphere. Moisture absorbs industrial gases (sulfur dioxide, chlorine, hydrogen chloride, nitrogen oxides, sulfur oxides and other gases).

The main factor determining the mechanism and rate of atmospheric corrosion is the humidity of the surface of metal structures. A feature of the occurrence of atmospheric corrosion is that the metal surface is covered with a thin film of electrolyte. Both moisture itself and corrosion products that have absorbed moisture can act as an electrolyte.

The aim of the work is to study the protective effectiveness of conservation compositions based on mineral and synthetic used motor oils (MMO).



Film-forming oil compositions are used as means of anticorrosive protection, inhibiting the course of redox reactions on metals and increasing the efficiency and manufacturability of conservation. These compositions are dispersed systems containing film-forming substances, corrosion inhibitors, plasticizers, modifiers and solvents. They belong to washable coatings.

Oil-based formulations allow technologically and timely re-preservation and deconservation of equipment, which is often impossible when using most other non-metallic protective materials, for example, paint and varnish[2].

Film-forming substances (bitumens, waxes, soaps of synthetic fatty acids, polymeric thickeners, etc.) contribute to the formation of a film, and a change in their nature leads to the formation of films of various states - solid, semi-solid, soft, etc.

Both types of oil have worked for at least 500 hours in agricultural machinery.

For experimental studies, samples were made of St20 steel with an average surface area of 14.7 cm<sup>2</sup>. The steel surface was preliminarily prepared by chemical etching with 2 M hydrochloric acid, mechanical grinding, degreasing, after which the samples were dried in an oven and weighed on an analytical balance.

To apply the coating of the studied composition, the samples were immersed in bottles with a protective composition. After that, they were kept in a suspended state in air at room temperature for a day for the excess of the oil composition to drain and form a protective film. Further, excess oil was removed mechanically.

Corrosion resistance was evaluated by conducting the following gravimetric laboratory tests. The samples were kept in a neutral solution of sodium chloride with a mass fraction of 3%. The test time was 2, 4, 6 and 8 days. After that, the samples were washed, mechanically cleaned of corrosion products, degreased and weighed on an analytical balance. The weight loss of the samples was determined by the formula:

$$\Delta m = m_1 - m_2,$$

Where  $m_1$  is the sample weight before corrosion testing;  $m_2$  is the mass of the sample after corrosion testing.

Subsequently, corrosion losses (corrosion rate) of steel were estimated using the formula:

$$K = \Delta m / (S\tau),$$

where  $S$  is the surface area,  $\tau$  is the test time.

The magnitude of the protective effect of oil compositions was determined by the formula:

$$Z = (K_0 - K) \cdot 100\% / K_0,$$

where  $K_0$  and  $K$  are the values of the corrosion rate of steel samples without coating and with applied preservative material, respectively.

### **Results and discussion**

A visual inspection of the samples was carried out in order to identify the nature and determine the area of corrosion damage. On steel samples coated with both mineral and synthetic MMO, no obvious centers of corrosion are observed.

The results are presented in Table. 1.

*Table 1 - Results of gravimetric measurements on uncoated and film-coated steel of the studied compositions in 3% NaCl solution*

$\tau$ , day	$K \cdot 10^6$ (without digging)	$K \cdot 10^6$ (mineral MMO)	$K \cdot 10^6$ (synthetic MMO)
2	24.15	6.08	4.13
4	31.89	6.54	4.37
6	39.59	6.81	5.10
8	48.84	8.07	6.03

According to the data obtained, in all cases, an increase in the steel corrosion rate is observed over time. However, the application of protective oil compositions leads to a decrease in corrosion losses. Moreover, this effect is maximally observed for oxide coatings protected by synthetic waste oil. The increase in the corrosion rate can be explained as follows. The oil film covering the steel sample is certainly not a reliable barrier and is quite permeable. It should be assumed that in the oil composition that forms the barrier layer, there are discontinuities, possibly representing channels of variable cross section directed normally, tangentially, or at an arbitrary angle to the surface of the protected steel. Thus, through the existing discontinuities, it is possible to supply the electrolyte.

According to corrosion tests, the protective effectiveness of oxide and oil coatings on the steel surface was evaluated (Table 2).

The maximum protective effect is observed for St20 steel coated with synthetic MMO and is 70...75%. In the case of an oil film of mineral oil, the protective effect is about 60...65%. Lesser the protective effectiveness of mineral used motor oil is obviously due to the fact that the film of preservative materials covering the metal is not a reliable barrier and is quite permeable to water vapor.

*Table 2 - Protective effectiveness of mineral and synthetic MMO films*

$\tau$ , ч	Z, %(mineral MMO)	Z, %(synthetic MMO)
2	57.95	71.44
4	61.93	75.57
6	64.81	72.57
8	60.99	73.60

The increased protective effect of synthetic MMO compared to mineral oil can be explained by the fact that natural petroleum oil contains an increased content of inorganic compounds (inorganic acids, salts, etc.), which increase the aggressiveness of the corrosive environment.

### **Conclusion**

It was found that used engine oils can be used as an anticorrosive agent during the operation and storage of metal products.

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## **Защита от коррозии изделий пленками на основе отработанных моторных масел**

**Ю. В. Жиркова\*, И. В.Зарапина**

ФГБОУ ВО «Тамбовский государственный технический университет», Тамбов, Россия

*\*e-mail: zhirckova.iu@yandex.ru*

**Аннотация.** Исследована эффективность покрытий на основе отработанных нефтяных моторных масел для защиты стали от коррозии в растворе нейтрального электролита. Это позволяет повторно использовать отработанное сырье, улучшить экологические показатели производства. Был проведен обзор литературы и гравиметрические лабораторные испытания. В результате исследования было показано, что синтетическое отработанное моторное масло обладает большим защитным эффектом, что может быть полезным знанием для дальнейших исследований в этой области.

**Ключевые слова:** сталь, пленка, отработанное масло, коррозия.

## Calculation of the Geometry of the Yellow 2 "z" Pigment by Molecular Modeling Methods

**A. V Zdereva\*, D. P. Rostova**

Tambov State Technical University, Tambov, Russia

\*e-mail: alenazdereva@yandex.ru

### Abstract

The paper studied the influence of the modeling method on the accuracy of determining the geometric characteristics of the P. Yellow 3. The influence of the functional, basis and dispersion corrections was investigated. It was found that the best result is shown by the B3LYP functional with Dunning's two-exponential basis set, including diffusion functions. The transition from dispersion corrections D3BJ to D4 increases the calculation accuracy, but insignificantly.

**Keywords:** P. Yellow 3; molecular modeling; density functional theory (DFT); root-mean-square deviation (RMSD).

### Introduction

The paper studied the influence of modeling methods on the accuracy of determining the geometry of the molecule. Errors in the calculation of the geometry of molecular systems have a significant impact on the accuracy of the calculation of infrared and electronic spectra.

The pigment Yellow 3 was chosen as the studied substance, which is widely used in the printing, paint and varnish industry and the production of pencils. Increasing the accuracy of calculating its spectral characteristics will improve its identification in mixtures and more accurately determine impurities in the pigment itself, as well as increase the accuracy of predicting the color characteristics of the substituted pigment.

A measure of the accuracy of determining the geometry will be the root-mean-square deviation (RMSD) value (a measure of the deviation of the coordinates of atomic positions of calculation methods and X-ray diffraction analysis data given in [1]).

### Materials and methods of research

The simulation was carried out in the software packages ORCA and Priroda.

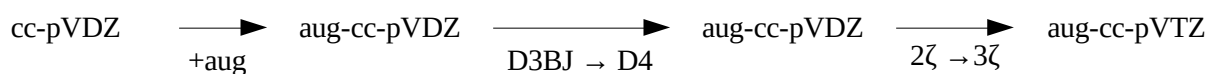
As a modeling method, we will take the density functional theory (DFT with two- and three-exponential basis sets. We will use the functionals of the GGA family (PBE [2]) as the least computationally expensive and global hybrid functionals (B3LYP [3]), which are considered sufficient for calculating the geometry of molecular systems. In addition, to check the accuracy of the selected functionals, we add a range-separated (wB97x) functional and a method of second-order perturbation theory (MP2).

Grimm's corrections D3BJ and D4 were used to account for the dispersion forces in the ORCA software package.

For PBE, we will use a two-exponential basis set L1 in Priroda and a three-

exponential basis set with correction D3BJ in ORCA. In ORCA, we use correlation-consistent Dunning basis sets [4].

The accuracy of the method when using the B3LYP functionality will increase according to the algorithm:



Thus, the complete set of modeling methods is represented by a list:

1 – PBE/L1; 2 – PBE-D3BJ/aug-cc-pVTZ; 3 – B3LYP-D3BJ/cc-pVDZ; 4 – B3LYP-D3BJ/aug-cc-pVDZ; 5 – B3LYP-D4/aug-cc-pVDZ; 6 – B3LYP-D4/aug-cc-pVTZ; 7 –  $\omega$ B97x/cc-pVTZ; 8 – MP2/cc-pVTZ.

In the future, the given numbering will be used instead of the method designation. For the methods  $\omega$ B97x and MP2, diffusion functions in the basic set were not used due to poor convergence of the self-consistency procedure. The following parameters were calculated: RMSD between geometries obtained by various methods; RMSD of interatomic distances obtained experimentally and by the studied modeling methods; error of dihedral angles characterizing the geometry of the molecule, as which the angle between the NO<sub>2</sub> group and the benzene ring and the angle between two benzene rings were taken. In addition to this, the calculation time for one step of geometry optimization was estimated.

### Research results

The structure of the molecule of the pigment Yellow 3 is shown in Fig. 1.

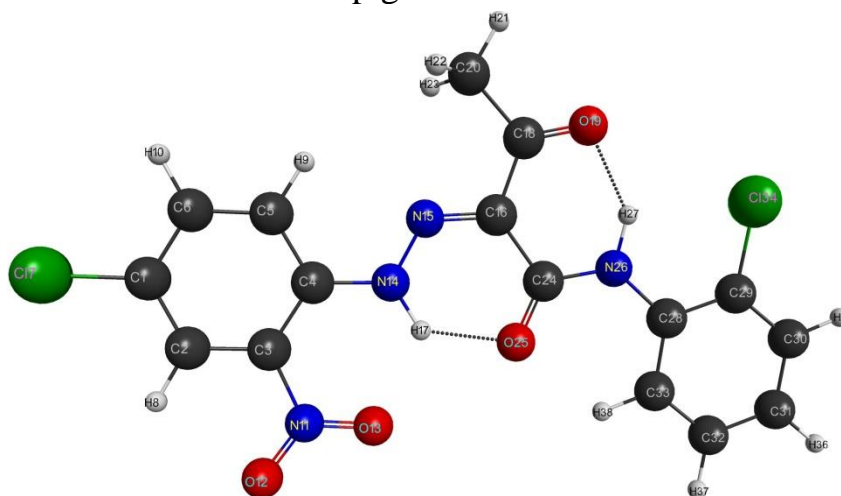


Figure 1 - Geometry and numbering of atoms of the molecule of the pigment Yellow 3.

Geometry deviations (RMSD between calculation methods) are presented in Table 1.

Table 1 -. The difference between geometries calculated by different methods, Å.

	1	2	3	4	5	6	7	8
1	-	0.016	0.031	0.061	0.061	0.049	0.107	0.126
2	0.016	-	0.026	0.057	0.057	0.037	0.102	0.127
3	0.031	0.026	-	0.043	0.042	0.028	0.083	0.113
4	0.061	0.057	0.043	-	0.003	0.052	0.055	0.126

5	0.061	0.057	0.042	0.003	-	0.051	0.054	0.124
6	0.049	0.037	0.028	0.052	0.051	-	0.079	0.115
7	0.107	0.102	0.083	0.055	0.054	0.079	-	0.117
8	0.126	0.127	0.113	0.126	0.124	0.115	0.117	-

Deviations of experimental and calculated bond lengths are presented in Table 2.

Table 2 -. The difference between the experimental and calculated bond lengths, Å.

Method	1	2	3	4	5	6	7	8
Average error	0.022	0.020	0.020	0.020	0.018	0.017	0.019	0.019

The values of the angles involved in the comparison are given in Table 3.

Table 3 - Experimental and calculated values of angles, Å.

Method	Experiment	1	2	3	4	5	6	7	8
∠ NO <sub>2</sub> and ring	7.9	0.23	0.02	2.57	7.04	7.07	2.11	12.35	3.21
∠ two rings	2.6	0.24	0.11	0.53	1.46	1.51	0.27	5.44	14.2

## Discussion

The RMSD comparison data between the calculation methods suggests that the geometries are close for methods 1-6 and quite different for 7 and 8, both among themselves and from 1-6. The smallest difference is observed between methods 4 and 5, which corresponds to the transition from the correction D3BJ to D4, this indicates a small difference in geometry when using these methods.

The data in Table 2 indicate that the difference in the lengths of the connections between the calculated data and the experiment does not depend much on the method, however, we can note a slightly smaller average error of methods 5 and 6, that is, the use of global hybrid functionals, basic sets with diffusion functions and Grimm corrections according to the D4 algorithm.

Based on this, it can be concluded that the calculation of bond lengths is not difficult even for the lightest methods, and the main error should be sought in the calculation of angles.

Based on the data in Table 3, only two methods provide good accuracy in calculating angles, methods 4 and 5, that is, B3LYP-D3BJ/aug-cc-pVDZ and B3LYP-D4/aug-cc-pVDZ, there is a deterioration in geometry prediction when moving to a broader basis. Perhaps this is due to the fact that the experimental geometry is given for a crystal structure, and the calculated ones for a single molecule. It can also be explained by the fact that the parametrization of the B3LYP functional was carried out on a two-exponential basis and an increase in the basis does not always lead to an increase in accuracy.

The calculation time for methods 4 and 5 is identical (~52 min), for method 6, much longer – 17 hours 37 min.

Based on this, the optimal method can be recognized as B3LYP-D4/aug-cc-pVDZ, as having slightly greater accuracy than B3LYP-D3BJ/aug-cc-pVDZ, and the same computational costs.

### Conclusion

In the work, the influence of the calculation method on the accuracy of determining the geometry of the pigment yellow 3 was studied. The influence of functional, basis and dispersion corrections was investigated. It was found that the best result is shown by the B3LYP functional with a two-exponential basis set including diffusion functions. The transition from variance corrections according to the D3BJ algorithm to D4 increases the accuracy of the calculation, but not significantly.

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## Расчет геометрии пигмента желтого светопрочного 2 «З» методами молекулярного моделирования

А. В. Здерева\*, Д. П. Ростова

ФГБОУ ВО «Тамбовский государственный технический университет, Тамбов, Россия  
\*e-mail: alenazdereva@yandex.ru

**Аннотация.** В работе изучалось влияние метода моделирования на точность определения геометрических характеристик пигмента желтого светопрочного 2 «З». Исследовалось влияние функционала, базиса и дисперсионных поправок. Было выявлено, что наилучший результат показывает функционал B3LYP с двухэкспоненциальным базисным набором Даннинга, включающим диффузионные функции. Переход от дисперсионных поправок по алгоритму D3BJ к D4 увеличивает точность расчета, но несущественно.

**Ключевые слова:** пигмент желтый светопрочный 2 «З»; молекулярное моделирование; теория функционала плотности (DFT); среднеквадратичное отклонение (RMSD).

УДК 62-408  
ББК 55.19.11

## **Rational Modes Determination of Gas-Plasma Cutting of Stainless Steel Blanks**

**M. S. Balabaev\*, V. A. Krylova, D. V. Lapin**

Tambov State Technical University, Tambov, Russia

*e-mail: BalabaevMS@yandex.ru*

### **Abstract**

Plasma cutting machines are designed for machine cutting with minimal use of manual labor. These types of installations are used in various industries. They provide to cut quality without additional processing of the resulting parts with the perfect. Machine tools equipped with CNC (computer numeric control) are almost complete automation of cutting products process according to a given required contour with any geometric shape, even a very complex one.

**Keywords:** CNC (computer numeric control) ; cut ; industrial ; metal ; Plasma ;

### **Introduction**

Metal processing is an important part of the production processes of numerous industrial and other enterprises. Plasma cutting machines are widely used on them, providing high quality and productivity.

The main trends in the development of modern industrial technologies are associated with the use of technological process parameters in high values: speed, time, contacts, etc. But the main industries that provide people with energy, metal, plastics, etc. are characterized by a number of shortcomings associated with a large tonnage, bulkiness, high energy and resource costs, as well as the formation of large volumes of industrial waste. The development of technology and electronics goes with the need for a qualitative improvement in traditionally used materials and with the creation of new materials that are unique in their characteristics (purity, thermal and chemical resistance, hardness, etc.). This was the reason for the research and development of new technical solutions in metallurgy, chemical industry, energy, mechanical engineering, etc.

All plasma machines are divided into two types according to power, method of application and general design: portable and stationary.

Portable ones are installed directly on the workpiece (sheet or pipe), during operation they move along guides, a circular device, a marking or a flexible copier;

Stationary machines are divided by design into:

1. Portal;
2. Portal-console;
3. Hinged - for vertical cutting.



According to the type of motion or plasma cutter motion control system, stationary machines are divided into:

1. Linear - for straight cutting;
2. Photocopying (photoelectronic) - for curly cutting according to a drawing;
3. Magnetic copying (electromagnetic) - for curly processing on a steel sample or copier;
4. CNC settings - cutting according to a given program.

### **Results and discussion**

Plasma cutting is superior in performance to oxygen flame cutting. But if a thick metal or titanium is cut, then preference should be given to the latter. Plasma cutting machines are indispensable for cutting non-ferrous metals and alloys based on them (especially aluminum). The use of this equipment is economically feasible in cases of processing products from:

- cast iron - up to 90 mm;
- carbon and alloyed steel fusions up to 50 mm thick;
- copper and its alloys - up to 80 mm;
- aluminum and alloys based on it - up to 120 mm.

Cutting low-carbon steels on plasma machines is most effective when compressed air is used (primarily for products up to 40 mm thick). When working with parts more than 20 mm thick, cutting can also be carried out using nitrogen-hydrogen compounds or pure nitrogen. For carbon steels treatment, oxygen and its mixture with nitrogen, compressed air are used (usually with a workpiece up to 40–50 mm thick).

Plasma cutting of high-alloy steel fusions is effective and used only for products up to 100 mm thick (oxygen-flux cutting is used for thicker workpieces). Moreover, air-plasma cutting can be carried out for products up to 50–60 mm thick and a mixture of nitrogen and oxygen is used for thicker products. Stainless steels up to 20 mm are usually treated with nitrogen and steels 20-50 mm thick - using nitrogen-hydrogen gas (50% hydrogen and 50% nitrogen mixture). It is also possible to use compressed air.

Copper is cut using nitrogen (product thickness 5-15 mm), argon and hydrogen mixture, compressed air (for small and medium thicknesses). Since this metal has high heat capacity and thermal conductivity, an electric arc of greater power is required to process it than for cutting steels. In the case of air plasma cutting of copper, a burr (easily removed metal overlays) is formed on the edges of the parts. Brass cutting is performed at a higher (20-25%) speed, using the same gases for plasma formation as for copper.

Plasma cutting of aluminum and its alloys with 5-20 mm thick, as a rule, is performed with nitrogen, 20-100 mm - using nitrogen-hydrogen gas (65-68% nitrogen is needed to obtain the desired mixture, and hydrogen - 32-35 %), more than 100 mm thick - argon-hydrogen gas composition (hydrogen 35-50%) and with the use of special plasmotrons where an additional function of stabilizing the electric arc with a compressed air flow is implemented.

Air plasma processing of aluminum is most often used for a separating cut of parts intended for further mechanical processing. Good cutting quality is usually achieved

only for products up to 30 mm thick, when the applied current is 200 A.

The following books contain the issues of providing a product quality at the technological preparation stage of production that are considered in a decision support system design for choosing regime and design parameters.

### **Conclusion**

Plasma chemical processing processes have the following advantages over traditional processes and technologies: significantly increase the productivity of the equipment; they are low-stage, do not require intermediate treatments, the use of appropriate reagents and their production; they are less sensitive to the composition of raw materials and can work on less scarce raw materials, including industrial waste; they are well modeled, controlled and automated.

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## **Определение рациональных режимов газо-плазменной резки заготовок из нержавеющей стали**

**М. С. Балабаев\*, В. А. Крылова, Д. В. Лапин**

ФГБОУ ВО «Тамбовский государственный технический университет», Тамбов, Россия  
*e-mail: BalabaevMS@yandex.ru*

**Аннотация.** Станки плазменной резки предназначены для машинного раскроя с минимальным использованием ручного труда. Такие установки применяют на различных производствах. Они позволяют получать идеальное качество реза, когда дополнительная обработка получаемых деталей не требуется. Станки, оснащенные ЧПУ, обеспечивают практически полную автоматизацию процесса раскроя изделий по заданному требуемому контуру, геометрическая форма которого может быть любой, даже очень сложной.

**Ключевые слова:** металл ; промышленность ; плазма ; резка ; ЧПУ (компьютерное числовое управление) ;

## Solar Tracking System

**S. S. Baranov**

Tambov State Technical University, Tambov, Russia

\*e-mail: baranov.sergey127@gmail.com

**Abstract:** As the world trend is going towards renewable energy, solar power stations are becoming more and more wide-spread. Efficiency of solar panel systems must be maximized in order to make solar energy more usable. This paper presents a device that can significantly increase the efficiency of solar panels – a solar tracker.

**Keywords:** solar tracker, automation, stepper motors, controllers, dual-axis tracker.

A solar tracker is a device that can trace the movement of the sun across the sky and move the solar panel to a position where the absorption of sunlight is most efficient. Solar trackers can increase the efficiency of solar panels up to 40-45%. Due to the increase in the performance of a single panel, there is no need to install additional panels, which in turn reduces the cost of the entire solar power plant.

The location of the Sun is determined either by sensors tracking the sun, or by a GPS system. The design of the movement system can be of various types, depending on which, solar trackers are divided into two types:

- single axis trackers, devices with one degree of freedom. For this type of trackers, the degree of freedom is determined by the axis of rotation, which is oriented from north to south.

- dual axis trackers. devices with two degrees of freedom. This type of trackers has two axes of rotation, which determine the degree of freedom of the device. The axes of rotation are independent of each other, but are linked into a common set of devices that sets the tracker in motion, in accordance with the specified parameters.

The functional diagram of the solar tracker is shown in Fig. 1.

To create an energy-efficient power generation system, it is necessary to develop a structural and functional diagram of a solar tracking system including a two-coordinate electromechanical actuator with a stepper motor and a two-coordinate solar position sensor. The solar tracking system must provide self-diagnostics, communication and control with an external operator in emergency modes. At the same time, the tracking system must ensure the specified accuracy of tracking the Sun while minimizing the cost of electrical energy spent by the two-coordinate electromechanical actuator with a stepper motor.

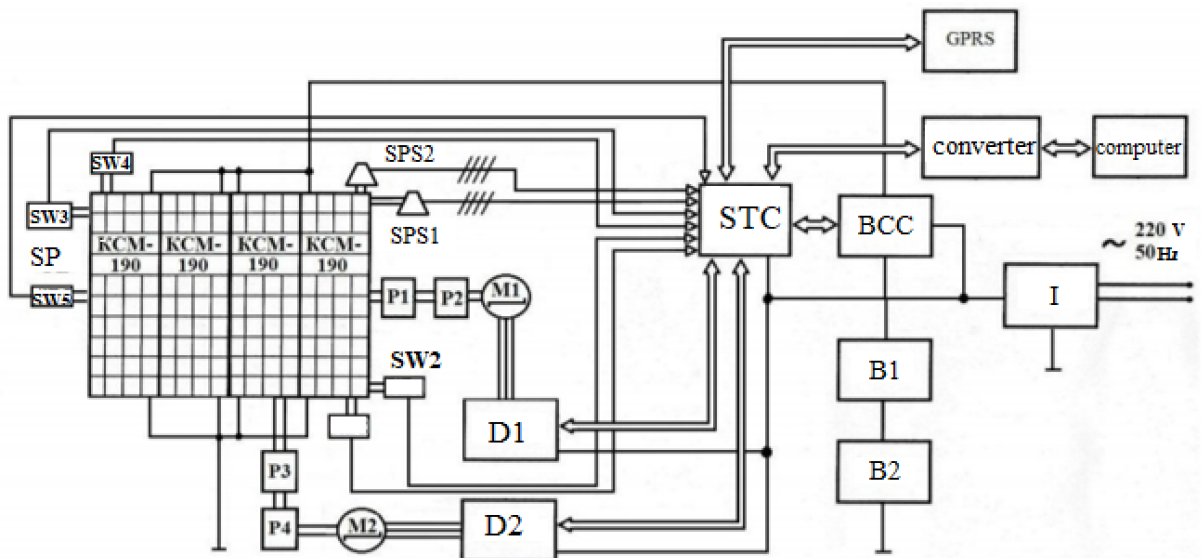


Figure 1 - Solar tracker diagram

*SP-solar panel; STC - solar tracker controller; D1, D2 – stepper motor drivers; SPS1, SPS2 – sun position sensors; SW1–SW5 –switches; M1, M2 –stepper motors; P1–P4 –reduction gearboxes; BCC – battery charge controller; I – inverter; B1, B2 –batteries, converter (type I-7561) - a device for communication between the computer and the controller via RS 485 interface; GPRS –GPRS line adapter.*

When developing a functional and structural diagram of a solar tracker, the following should be used: modern solar batteries (SB) with high technical and economic characteristics; a special controller that ensures the operation of the tracking mechanism with the required accuracy, implements an asymmetric positioning mode and control of peripheral devices with diagnostics of the entire system; battery charge controller with the implementation of the maximum power take-off mode from the SB; two-coordinate photoelectric solar position sensor with high sensitivity to ensure high tracking accuracy; stepper motors to provide a given movement in both coordinates.

Summing up, we can say the following: the use of solar trackers can accomplish a significant increase of the efficiency of solar panels. Modernization of existing solar power plants can increase their electricity production by about 10% in winter, and by 40% in summer.

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# Солнечный трекер

С. С. Баранов

ФГБОУ ВО «Тамбовский государственный технический университет», Тамбов, Россия  
*\*e-mail: baranov.sergey127@gmail.com*

**Аннотация.** Поскольку мировая тенденция в энергетике направлена на использование возобновляемых источников энергии, солнечные электростанции получают все большее распространение. Для того чтобы солнечная энергия стала более пригодной для использования, необходимо увеличивать КПД солнечных панелей. В данной работе представлено устройство, способное значительно повысить эффективность солнечных батарей – солнечный трекер.

**Ключевые слова:** солнечный трекер, автоматизация, шаговые двигатели, контроллеры, двуосный трекер.

## Microwave-Conducted Polymer-Carbon Materials

A. A. Chuprikova\*, T. V. Fizhbach, A. S. Ermakov

Tambov State Technical University, Tambov, Russia

\**chuprikova-anastasia21@yandex.ru*

### Abstract

The article deals with features of microwave treatment of polymer composite materials. Short-term microwave exposure allows concluding on non-thermal modification of the physical and mechanical properties of polymer composites. The use of microwave for modifying polar polymers is particularly effective. Nonpolar polymers need to be further modified with electrically conductive materials to increase microwave energy absorption.

**Keywords:** fluoroplast 4, carbon nanotubes, polymer composite, microwave processing.

### Introduction

Methods of nanomodification of the polymer matrix and the use of methods of processing plastics with energy flows, including microwave, are promising methods for obtaining reinforced plastics for structural purposes. Bulk microwave processing allows to obtain materials with increased physical and mechanical characteristics. Previous studies have shown the effectiveness of using short-term microwave processing. [1, 2]

The following frequencies are commonly used: 915 MHz; 2.45; 5.8 and 24.124 GHz.

Microwave heating is an alternative to the conductive heat transfer mechanism. The advantage of microwave heating is the direct heating of the volume of the material and its speed, as well as the possibility of electrol heating in the volume of the composite.

The efficiency of microwave heating is determined by the dipole polarization of the material and its conductivity [1, 2]. These factors are also disadvantages of microwave heating.

Most polymer materials ignore microwave frequencies due to their low dipole moment. In this regard, the use of microwaves for most polymers is impractical. It has been established that the addition of a number of modifiers makes it possible to increase the efficiency of the microwave. Additives must be conductive or have dielectric properties significantly different from the polymer matrix.

### Experimental

Carbon nanotubes of the brand "Taunit" were used as a modifier to increase the electrical absorption of the polymer matrix. [3]

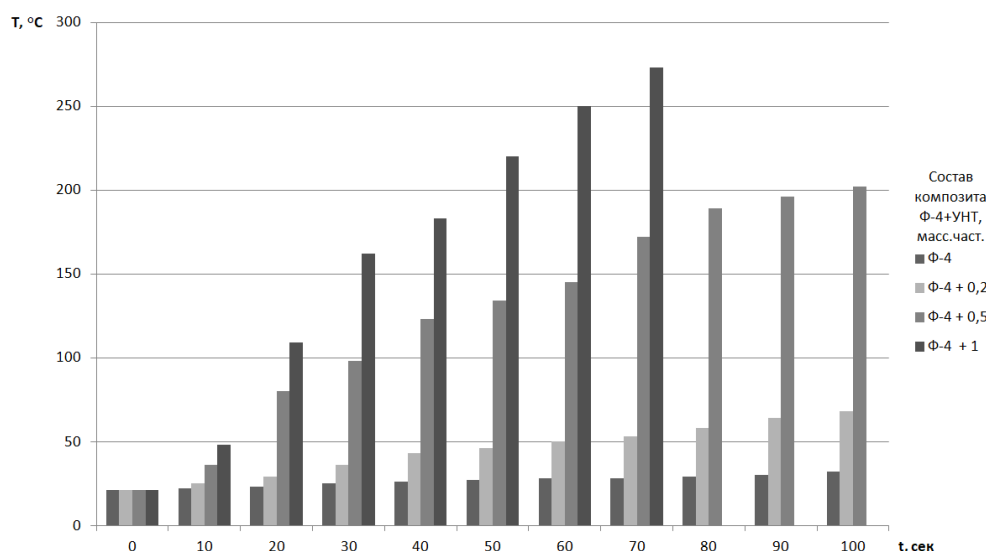
Microwave irradiation was carried out for tens of seconds (0÷100 seconds) in a microwave chamber with a magnetron radiation frequency of 2450 MHz. The output power is 700 watts. Water in the volume of 200 ml was used as a ballast load. [4]

The study of the physical and mechanical characteristics of the samples was carried out using the TCB 101-5 testing machine.

## Results and discussion

In the course of work, we obtained the following scientific and scientific-technical results: experimental samples of nanomodified polymer materials based on F-4 with a carbon nanotube content from 0.2 to 1 wt.parts were depending on the volume of the initial polymer; a method of microwave processing for modifying composites; was developed and the modes of microwave processing of the objects of study were determined; the physicomaterial properties of the obtained materials modified in the microwave electromagnetic field were investigated.

Due to the nonpolarity of the polymer matrix F-4, the absorption coefficient of microwave energy is very low and the material practically does not heat up: in 100 seconds of processing, an increase in its temperature by 10 degrees was registered. This effect is formulated as a non-thermal microwave exposure. The introduction of a carbon nanomodifier, even with minimal volumes, makes it possible to increase the efficiency of microwave heating of the matrix. With non-thermal microwave processing, the energy modification of the polymer matrix occurs, accompanied by a change in the values of the physical and mechanical parameters of the material.



*Fig.1. Kinetics of microwave heating of samples of F-4 and composites based on it.*

*\*Note: system of F-4 + 1 mass part CNM at the heating time above 70 seconds, it heats up above the melting point.*

It is based the increase in strength is noted depending on the microwave processing time (it varied from 0 to 40 seconds in increments of 10 seconds) for fluoroplast 4 and composites. It is possible to note the positive effect of the actually microwave processing of the material: with short-term microwave processing (implementing the mechanism of non-thermal modification of polymer materials), within 10-20 seconds an increase in the maximum destructive voltage by 45%. 50% is observed while maintaining the values of the yield strength. Similar values of strength gain are observed for composites with a content of 0.2 and 1 mass fraction CNT.

## Conclusion

The experimental data obtained testify the increase in strength depending on the time of microwave processing. The positive effect of the actually microwave processing of the material can be noted: with short-term microwave processing (implementing the mechanism of non-thermal modification of the material), to 30 seconds an increase in tensile endurance when stretched by 45-50% is observed. The introduction of a significant amount of carbon nanomodifier increases the degree of absorption of microwave energy and converts it into thermal energy, i.e. warming up is happening the polymer matrix.

### **Acknowledgements**

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## **СВЧ-проводимые полимер-углеродные материалы**

**А. А. Чуприкова\*, Т. В. Фижбах, А. С. Ермаков**

ФГБОУ ВО «Тамбовский государственный технический университет», Тамбов, Россия  
*\*e-mail: chuprikova-anastasia21@yandex.ru*

**Аннотация.** В статье рассмотрены особенности СВЧ обработки полимерных композиционных материалов. Кратковременное СВЧ воздействие позволяет сделать вывод о нетепловой модификации физико-механических свойств полимерных композитов. Особенно эффективно использование СВЧ для модификации полярных полимеров. Неполярные полимеры необходимо дополнительно модифицировать электропроводящими материалами для повышения поглощения СВЧ энергии.

**Ключевые слова:** фторопласт 4, углеродные нанотрубки, полимерный композит, СВЧ-обработка.



## Additives for Creating Biodegradable Polymers

**D. A. Efanova\*, N. A. Myakinin**

Tambov State Technical University, Tambov, Russia

*e-mail: efanova.dasha@mail.ru*

### **Abstract**

The analysis of scientific papers and studies on the topic of biodegradable polymers showed that at present the issue of herbal supplements has not been fully studied. In this regard, the purpose of the article is to study herbal supplements for the creation of biodegradable polymers, which are formed in the Tambov region in large quantities.

**Keywords:** biodegradation, decomposition, fragmentation, polymer, plastic

The modern world is filled with plastic products. Plastic is a group of synthetic polymers. Polymers are large organic molecules that are made up of repeating carbon molecules or chains.

The popularity of polymer products is explained by many criteria.

One of the most valuable properties of plastic is its strength characteristics. This often allows plastic to replace other materials. Also, plastic is better suited for storing food and medicines. In addition, polymer packaging is considered the most popular among manufacturers due to its cost-effective production and ease of manufacture.

However, most of the polymers that make up the packaging decompose in the normal environment for almost decades and cause great harm to the environment.

Despite the fact that at present there is a concept of waste separation for its further processing, this cannot completely rid the world of the problems that the use of plastic products entails.

In connection with this acute environmental problem today and the need to conserve natural resources, biodegradable polymers are becoming increasingly popular.

The term "biodegradable polymers" refers to polymeric materials that can spontaneously degrade as a result of natural microbiological and chemical processes.

The most relevant use of biodegradable polymers relates to applications in two areas - medicine and environmental protection.

Currently, there are already some types of biodegradable polymers. Biodegradable polymers can be classified into three main classes, classified according to the monomers used and the structure of the resulting biopolymer: polynucleotides, polypeptides and polysaccharides.

The translated text will appear here. Biodegradable polymers from natural raw materials include: polymers based on starch and cellulose, PHA (polyhydroxyalkanoate), and other polyesters.

One of the well-known biopolymers has become a polymer based on corn

starch. In this case, specialized varieties of corn are grown. From the biomass obtained during the harvest, starch or sugar is extracted, purified and subjected to chemical and biotechnological (with the help of enzymes and microorganisms) processing. Subsequently, the resulting biopolymer is often mixed with a synthetic polymer.

One of the earliest biopolymers was a cellulose-based polymer. The first polymer from modified cellulose was created in the 20th century and was called celluloid. The cellulose was treated with a mixture of nitric and sulfuric acid and then mixed with camphor. Now Celluloid is a plastic based on colloxylin (cellulose nitrate), a plasticizer (castor oil) and a dye.

Polyhydroxyalkanoate or PHA is a polymer synthesized by bacteria, also known as a biopolymer. Some polymers of some microorganisms are synthesized in the absence of nitrogen and phosphorus in the presence of carbon and energy. They accumulate in microorganisms in the form of granules and, if necessary, split. PHAs are excellent competitors to the polymers we are used to, but, what is their distinguishing ability, they are easily degraded in the environment.

Whatever biopolymers are made of, which are eventually mixed with a synthetic polymer, the question of their processing and disposal still remains. Since such polymers are only partly biodegradable, they are also worth collecting, sorting and sending to waste disposal plants.

Our goal is to create a biopolymer that can degrade in normal environments. To do this, it is necessary to choose an economically and environmentally correct additive that can strengthen the position of biopolymers in the market and in the whole world.

Analyzing the plants located on the territory of the Tambov region, we can conclude that in the course of technological processes in various industries, waste is obtained, which is not fully used or whose application has not yet been found.

Beet sugar factories are notorious for their amount of waste. The main waste products of this production are beet pulp, filter cake and molasses. Beet pulp is a fibrous material. The pulp is supplied in the form of dry flakes or in pressed granules. One of these factories is the Kirsanovsky sugar factory. With an average sugar yield of 10-12% of the total mass of processed beets, up to 80% of pulp is formed in it. This waste is mainly used as feed for livestock. However, annually the pulp is formed in tons. The amount of this waste simply has nowhere to go. Therefore, the question of the use of beet pulp is quite relevant for the economy.

The chemical composition of beet pulp (in terms of dry matter) is: 45-47% cellulose, up to 50% pectin, 2% protein, 0.6-0.7% sugar, about 1% minerals, and in a small amount also amino acids and vitamins are present. The composition of amino acids includes: alanine, valine, leucine, arginine, phenylalanine, tyrosine, proline and tryptophan. Depending on the storage conditions, the pulp may have an acidic reaction. In the course of already known studies, by spectral analysis, boron, iron, copper, manganese, nickel, silver, zinc and other components were also found in the pulp.

Based on the chemical composition of beet pulp, previous studies on

biopolymers, and the relevance of using beet pulp as an additive for biopolymer production in the Tambov region, it can be concluded that beet pulp can be excellent as an additive for biodegradable polymer production. Based on theoretical data, biodegradable beetroot polymer will degrade 3-4 times faster than conventional plastic.

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## **Добавки для создания биоразлагаемых полимеров**

**Д. А. Ефанова\*, Н. А. Мякинин**

ФГБОУ ВО «Тамбовский государственный технический университет», Тамбов, Россия  
*e-mail: efanova.dasha@mail.ru*

**Аннотация.** Проведенный анализ научных работ и исследований по теме биоразлагаемых полимеров показал, что в настоящее время вопрос растительных добавок изучен не в полной мере. В связи с этим целью статьи является изучение растительных добавок для создания биоразлагаемых полимеров, которые образуются в Тамбовской области в больших количествах.

**Ключевые слова:** биоразложение, полимер, пластик, разложение, фрагментация

## Entwicklung eines kombinierten Pneumatikantriebs

**I. N. Fedotsrчук, A. A. Nikulin**

Staatliche Technische Universität Tambow, Tambow, Russia  
*e-mail: ivan.fedorchuk.42@gmail.com*

**Zusammenfassung:** In dem Artikel werden Probleme bei der Auswahl eines Antriebs für Robotersysteme betrachtet, verschiedene Antriebsarten behandelt und verglichen, theoretische Berechnungen durchgeführt und ein kombinierter pneumatischer Antrieb entwickelt.

**Schlüsselwörter:** Robotik, pneumatische Antriebe, elektrische Antriebe, hydraulische Antriebe, kombinierte pneumatische Antriebe, Kompressor.

In diesem Stadium der Entwicklung der Robotertechnologie gibt es eine große Anzahl von Antriebsarten, von denen jeder seine eigenen Vor- und Nachteile hat. Bei der Entwicklung eines humanoiden Roboters (Android) gab es jedoch erhebliche Probleme mit der Auswahl eines Antriebs, der alle notwendigen Parameter erfüllt. Bei relativ geringen Abmessungen, geringem Eigengewicht und entwickelter Kraft hat keine der auf dem Markt vorgestellten Antriebsarten die richtige Energieeffizienz gehabt.

Elektrischer Antrieb verliert auch unter Berücksichtigung eines hohen Wirkungsgrades (etwa 75%) [1] an pneumatischen und hydraulischen Systemen mit geringem Budget in der Entwicklungsleistung bei den gleichen Abmessungen.

Der hydraulische Antrieb wurde ebenfalls abgelehnt, da seine Verwendung mit vielen Schwierigkeiten bei der Einstellung und dem Betrieb verbunden ist, außerdem hat er hohe Anforderungen an die Herstellung von Arbeitselementen und daher weist er im Vergleich zu elektro- und pneumatisch angetriebenen Systemen einen hohen Preis auf. Der pneumatische Antrieb hat jedoch bei all seinen Vorteilen einen erheblichen Nachteil, da der pneumatische Antrieb für den Betrieb einen hohen Druck benötigt, der normalerweise vom Kompressor bereitgestellt wird. Kompressoren mit hoher Leistung [2], die für die Druckentlastung ab 0.8 MPa ausgelegt sind, haben ziemlich sperrige Installationen, die ihre Verwendung in Projekten im Zusammenhang mit mobilen Geräten einschränken. Wenn Sie jedoch einen Kompressor mit geringer Leistung von bis zu 100 Watt und einem Druck von etwa 1 MPa verwenden, ist er kompakt genug, um die Abmessungen zu erfüllen, so dass der Pneumatikantrieb von allen vorgestellten Antriebsarten am besten zu den gegebenen Bedingungen passt.

Nach vorläufigen Berechnungen beträgt die erforderliche Kraft für den pneumatischen Antrieb  $\sim 150$  N, bei einem Druck von 1 Mpa berechnen wir die Fläche des erforderlichen pneumatischen Zylinders nach der Formel:

$$S = \frac{F}{P}$$

F – die Kraft des Pneumatikzylinders in N

P – systemdruck in MPa

S – die Fläche des Pneumatikzylinders in mm<sup>2</sup>

Wir erhalten den Flächenwert des Pneumatikzylinders von 150 mm<sup>2</sup>.

Wenn nur ein pneumatischer Zylinder verwendet wird, muss entweder ein großer Druck (etwa 30 bar) aufgeblasen werden, was die Verwendung eines Gesamtkompressors und eines Empfängers zur Folge hat, oder ein dimensionaler pneumatischer Zylinder verwenden. Daher wurde beschlossen, die Biegefunktion an zwei pneumatischen Aktoren im Luftröhrenformat zu übertragen [3], und die Streckfunktion wird ausschließlich auf den pneumatischen Zylinder [4] übertragen. Diese Konfiguration ermöglicht die maximale Effizienz des Antriebs bei minimalem Leistungsaufwand. Die Antriebszeichnung ist in Abbildung 1 dargestellt, die 3D-Visualisierung des Antriebs ist in der Abbildung 2 dargestellt.

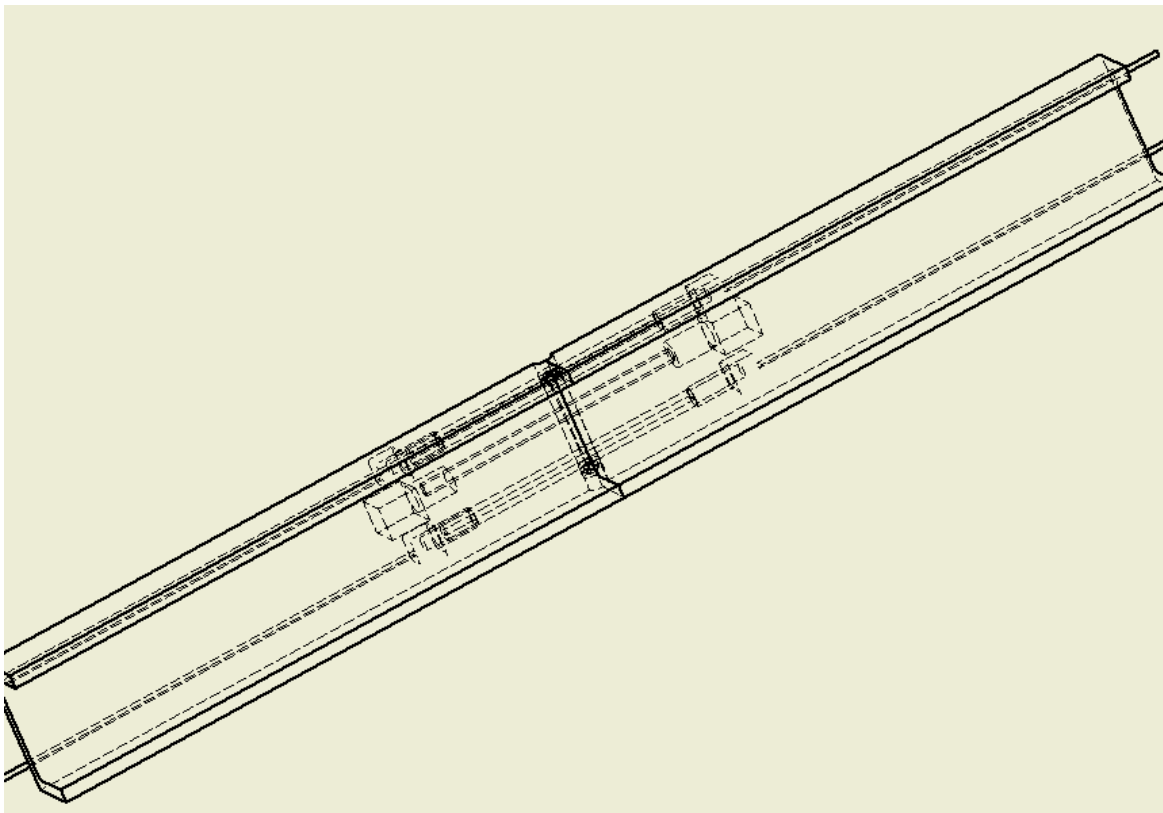
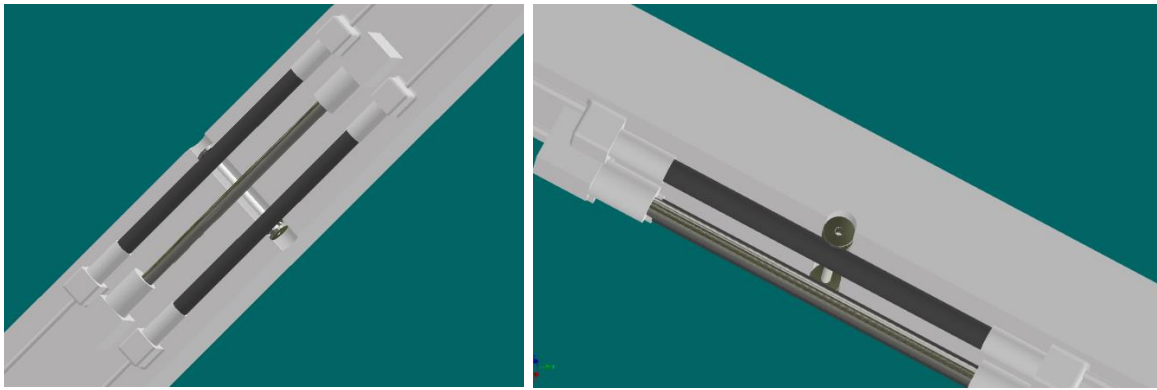


Abb. 1 – Zeichnung des kombinierten Pneumatikantriebs



*Abb. 2 – 3D-Visualisierung eines kombinierten Pneumatikantriebs*

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## **Разработка совмещенного пневмопривода**

**И. Н. Федорчук\*, А. А. Никулин**

ФГБОУ ВО «Тамбовский государственный технический университет», Тамбов, Россия  
*e-mail: ivan.fedorchuk.42@gmail.com*

**Аннотация.** В данной статье рассмотрены проблемы выбора привода для робототехнических систем, проведено сравнение нескольких видов приводов, проведены теоретические расчёты и произведено проектирование совмещенного пневмопривода.

**Ключевые слова:** робототехника, пневмоприводы, электроприводы, гидроприводы, совмещенные пневмоприводы, компрессор.

## **Kinematic Structure of Gear Machines with Hydraulic Shaping Links**

**V. Kh. Fidarov, K. R. Nachinkin\***

Tambov State Technical University, Tambov, Russia

\*e-mail: kirill.kirikan@yandex.ru

### **Abstract**

Designing and constructing a rational structure of internal (forming) circuits that provide a rigid kinematic connection between the workpiece and the tool in metal-cutting machines of various technological significance with complex shaping movements to obtain high accuracy of Functionally related movements is a difficult task when creating a new machine design or upgrading an existing model that is optimal in accuracy, metal consumption and other indicators.

**Keywords:** Optimal construction, metal-cutting machine, stepper hydraulic motor, hydraulic pulse generator

### **Introduction**

The modular principle of rational construction of internal circuits of metal-cutting machines can be implemented on the basis of hydraulic connections in the form of a discrete stepper hydraulic drive, where a stepper hydraulic motor with mechanical step reduction is used as a power executive.

As a power executive body in such a scheme, a special hydraulic stepper motor (GSHD) is used. The output shaft processes discrete control signals with high accuracy and high power gain. The link for setting up such a transmission is a hydraulic pulse generator, which is connected to a stepper hydraulic motor by a pipeline system and converts the energy of the working fluid into hydraulic pulses and distributes them in a certain sequence through the working chambers of the hydraulic motor.

The rotation speed and the total angle of rotation of the output shaft of the GSHD are proportional, respectively, to the frequency and number of control pulses. When using a stepper hydraulic drive in the internal circuits of metal-cutting machines, the gear ratio between the hydraulic coupling actuators depends on the ratio of the frequencies of the control pulses generated by the commutating device (hydraulic pulse generator) and supplied to the executive stepper motors of the workpiece and tool drive [1,2].

Since in order to obtain a formative motion, it is necessary to provide a rigid kinematic connection between the workpiece and the tool to implement the required functional dependence between the movements of the working bodies, in this case, of all types of stepper hydraulic motors, the most acceptable for use in internal kinematic circuits are motors with mechanical step reduction.

The stepper hydraulic drive consists of autonomous functionally and structurally completed blocks (modules) that can perform specified functions either independently or together with other similar modules, depending on the complexity and purpose of

the kinematic chain, the number of shaping movements, and the accuracy of the kinematic chain.

All units of the stepper hydraulic drive have standard connecting dimensions and docking devices, which ensures the possibility of connecting with the final links of kinematic chains by dividing worm or screw gears and performing their specified functions either independently or together with other similar modules, depending on the purpose and complexity of kinematic chains, the number of shaping movements, accuracy of kinematic circuits. The construction of internal kinematic circuits based on a step hydraulic drive in the form of hydraulic connections is possible due to the fact that when using hydraulic connections,:

- 1) rigid functional kinematic connection between executive bodies while maintaining an accurate gear ratio,
- 2) the possibility of regulating the speeds of movement of executive bodies and their gear ratios in a certain range;
- 3) the malleability of a hydraulic chain is not lower than the malleability of a chain made up of mechanical links

### **Experimental part**

The use of hydraulic connections in the internal circuits of machine tools makes it possible to significantly simplify the control system, to obtain sufficient accuracy with an open control system due to the unambiguous correspondence between the number and frequency of control pulses and the magnitude and frequency of processing of specific movements (angular or linear) at the output of the executive body.

Using the high layout qualities of a hydraulic stepper drive, it is possible to apply hydraulic connections to the construction of internal kinematic circuits that require precise interconnected movements of the workpiece and the tool. This is most clearly manifested in machines with complex branched multi-link chains of considerable length, where the presence of heavily loaded extended power circuits subject to significant mechanical and thermal deformations and wear requires the use of bulky mechanical devices.

Fig. shows a block diagram of a gear-cutting machine with internal hydraulic connections for cutting non-circular wheels with standard chisels [6].

The process of processing a non-circular wheel consists in rolling a non-circular centroid of the processed track along a round

This process is realized by three interrelated movements

1. By rotating the chisel
2. By rotating a non-circular wheel (workpiece) fixed on the machine table
3. longitudinal movement of the table, which is the movement of the center of the non-circular wheel along the line connecting the centers of the workpiece and the chisel

The machine includes a tool 10 that performs reciprocating motion from the electric motor D through the tuning link  $i_v$  using the rocker mechanism 11

The chisel 10 is mounted on the ram of the machine and is connected to the workpiece for the purpose of division. It receives rotation from a hydraulic stepper



motor 8, kinematically connected to a ram and controlled by a hydraulic pulse generator 7. The spool sleeve of which receives rotation from a hydraulic motor 4. The workpiece 12 mounted on a round table 13. receives rotation from a hydraulic stepper motor 3. kinematically connected through a differential 25 with a round table and controlled by a hydraulic pulse generator 2, the spool sleeve of which receives rotation through a non-power gear of replaceable gears 5 from a hydraulic pulse generator 7

To carry out the processing of non-circular wheels, the machine is equipped with an additional hydraulic chain, including a cam 20, the profile of which corresponds to the law of change of the dividing circle (centroids) of the processed wheel. The rocker arm 28, on which the roller 21 is mounted, interacting with the cam profile, has the ability to rotate around the axis 22. A gear sector 23 is placed on the rocker arm, interacting with the gear wheel 24. The cam 20 receives rotation from a hydraulic stepper motor 19, which is controlled by a hydraulic pulse generator 15, the spool sleeve of which rotates from a gear wheel 14 rigidly fixed to the shaft 11. In this case, this kinematic chain is kinematically connected to the dividing table 13 through a summing mechanism 25 in the form of a differential with conical wheels by means of a worm gear 26.

The longitudinal movement of the table is carried out from a stepper hydraulic motor 17, kinematically connected to a longitudinal travel screw 18 and controlled by a hydraulic pulse generator 16, the spool sleeve of which receives rotation from a gear wheel 27 mounted on the shaft of the worm wheel 26. The working fluid is fed to the hydraulic pulse generators from the pumping unit 1 through pipelines 6

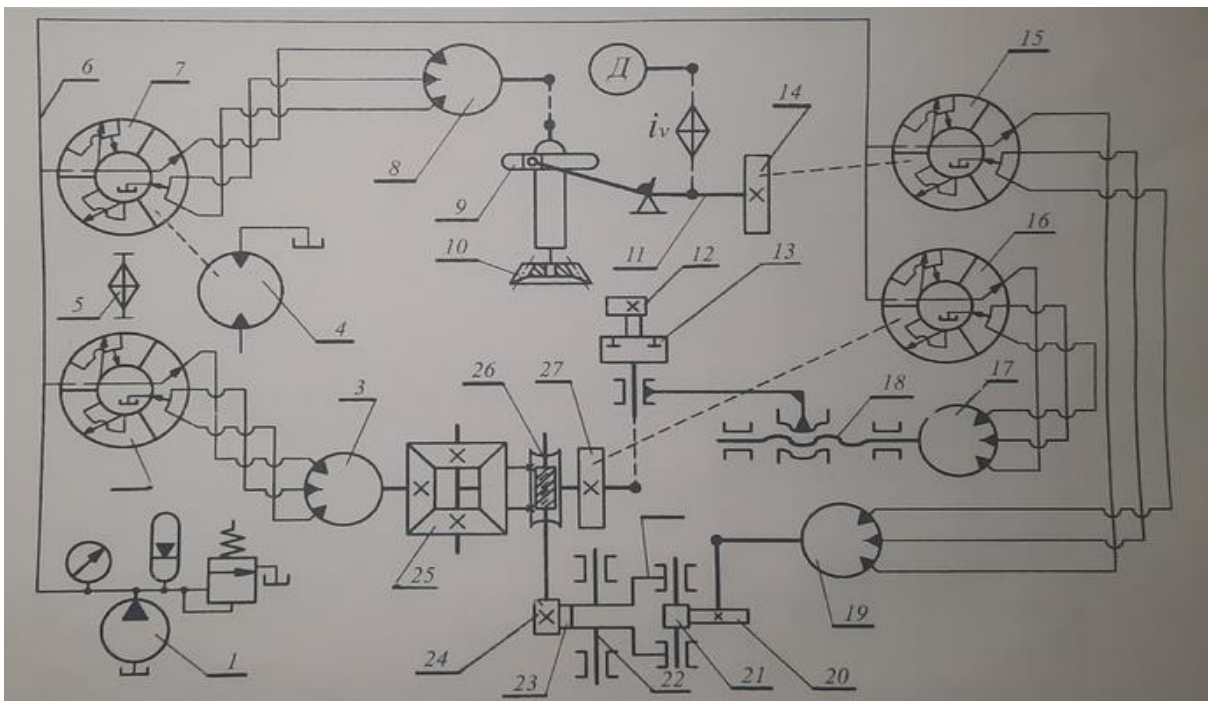


Figure 1 Structural diagram of a hydraulically coupled gear shaping machine

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## Кинематическая структура зубообрабатывающих станков с гидравлическими формообразующими связями

В. Х. Фидаров, К. Р. Начинкин\*

ФГБОУ ВО «Тамбовский государственный технический университет, г. Тамбов, Россия  
\*e-mail: kirill.kirikan@yandex.ru

**Аннотация.** Проектирование и построение рациональной структуры внутренних (формообразующих) цепей, обеспечивающих жесткую кинематическую связь между заготовкой и инструментом в металлорежущих станках различного технологического назначения со сложными движениями формообразования для получения высокой точности функционально связанных перемещений, представляет собой сложную задачу при создании новой конструкции станка или модернизации существующей модели, оптимальной по точности, металлоемкости и другим показателям.

**Ключевые слова:** Оптимальное построение, металлорежущий станок, шаговый гидравлический двигатель, генератор гидравлических импульсов.

## Modern Automation Technologies Production of Blue Phthalocyanine Pigment 15:3

A. V. Ilin, I. A. Firsov, V. P. Engovatov

Tambov State Technical University, Tambov, Russia

e-mail: kosmanavt5@gmail.com

### Abstract

An approach to the construction of a multi-level distributed automated process control system (ACS TP) for the production of blue phthalocyanine pigment 15:3. The structure of the automated control system is presented, built using "intelligent" sensors and actuators with developed network capabilities.

**Keywords:** blue pigment, automated control system, programmable logic controller, SCADA system.

In many industries, such as printing inks, plastics, coatings and others, phthalocyanine pigments are widely used. In connection with the refusal of imported products, demand for domestic product has increased significantly in recent years.

The blue phthalocyanine pigment 15:3 is used in the production of masterbatches for the coloration of thin films and polypropylene fibers, manufacture of ink flexographic and gravure printing, as well as in the textile and paint industries.

The production process of the blue phthalocyanine pigment 15:3 refers to complex multistage technological processes. through high-performance automatic control systems. It is only possible to maintain process parameters in a given range, in the aggregate perturbing external influences, through high-performance automatic control systems.

This task can be effectively solved only by using modern management tools and principles of building automated systems using modern network technologies.

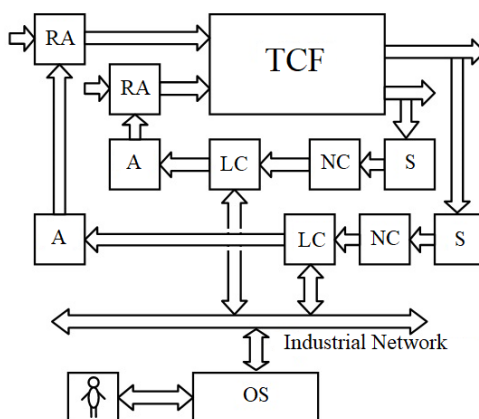


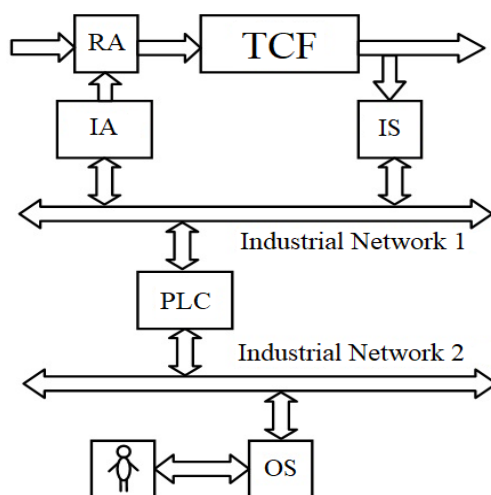
Figure 1 – Modern distributed ACS TP: TCF – Technological Control Facility, S – Sensors, NC – Normalizing Converters, LC – Local Controllers, A – Actuators, RA – Regulatory Authorities, OS – Operator Station

Currently, the number of distributed ACS is increasing (Figure 1), through to the introduction of industrial networks.

The wide distribution of distributed ACS TP is facilitated by the use of microprocessors at the lower level of control consisting of «intelligent» sensors and actuators. Such devices are connected via an industrial network connected to controllers. In addition, microprocessors built into the devices allow the sensors to perform self-diagnostics, calibration and, in some cases, verification [1].

Created by ACS TP for chemical-technological process of pigment production of blue phthalocyanine 15:3. This process takes place in several stages where the main processes are considered to be pigmentation and drying. In order to obtain a high-quality product, it is necessary to monitor many parameters such as temperature, pressure and precise mass of substances.

Structure of ACS TP pigment production of blue phthalocyanine 15:3, built using «intelligent» sensors and actuators with integrated microprocessors (Figure 2). The system of automatic control of the pigment production process of blue phthalocyanine 15:3 can include multi-channel microcontroller «PLC110[M02]» of «OWEN» Russia and «intelligent» actuators of Emerson USA.



*Figure 2 – ACS TP based on «intelligent» sensors and actuators: IS – «Intelligent Sensors», IA – «Intelligent Actuators», PLC – Programmable Logic Controller*

Increased reliability, flexibility and modifiability are acquired by the control system based on «intelligent» sensors and actuators.

The lower level of such a control system consists of «intelligent» sensors and actuators, programmable logic controllers (PLC). The PLC collects signals from the sensors and preprocesses them, generates control signals on the operating mechanisms of the control object, and receives and transmits information from the industrial network. In the development application software for controllers should be guided by the international standard for programming languages of controllers IEC 61131-3.

The upper level of the control system is realized in the form of an operator station with an automated workstation realized thereon. Automated workstation is a software

and technical complex. Automated workstation of the operator operates under the operating system of the Windows family. Open Platform Communications (OPC) technology is used to solve communication problems, which is now an industry standard based on Microsoft's COM/DCOM object model.

The basis of the AW software is the SCADA system, which implements all basic functions of visualization of measured and controlled information, separation of emergency and pre-emergency situations, data transmission and commands to the lower level of the control system [3].

It should be noted that in the creation of modern ACS TP there is a trend towards worldwide integration and unification of technical solutions based on open standards in the field of automation. The main requirement for modern ACS TP is the openness of the system. The system is considered open if the used interfaces and data formats are defined and described for it, which allows to connect to it «external» independently developed components.

The proposed approach to the construction of a distributed system of control of the production process of pigment blue phthalocyanine 15:3 using modern open automation standards will increase the economic and technological efficiency, as well as the safety of the production.

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## Современные технологии автоматизации процесса производства пигмента голубого фталоцианинового 15:3

А. В. Ильин, И. А. Фирсов, В. П. Энговатов

ФГБОУ ВО «Тамбовский государственный технический университет, Тамбов, Россия  
*e-mail: kosmanavt5@gmail.com*

**Аннотация.** Предложен подход к построению многоуровневой распределенной автоматизированной системы управления технологическим процессом (АСУ ТП) производства пигмента голубого фталоцианинового 15:3. Представлена структура АСУ ТП, построенная с использованием «интеллектуальных» датчиков и исполнительных механизмов с развитыми сетевыми возможностями.

**Ключевые слова:** автоматизированная система управления, пигмент голубой, программируемый логический контроллер, SCADA-система.

## Automation of the Technological Process Creation

**S. V. Poroshin**

Tambov State Technical University, Tambov, Russia  
*e-mail: slp18360@mail.ru*

### **Abstract**

The paper discusses the basic concepts of automation of the creation of technological processes in the chemical industry, and also analyzes the problems of automation.

Great attention is paid to the complex automation and mechanization of chemical industry productions, since the flow of chemical and technological processes is characterized by complexity, high speed and sensitivity to deviations from the specified modes. The problems of automation of the chemical industry are the lack of information about the flow of complex technological processes of the chemical industry, as well as difficulties in comparing available data for conducting a qualitative analysis of the activities of a chemical industry enterprise in order to optimize its work.

**Keywords:** mechanization of the process, technological process automation.

Any production process organized for processing raw materials into certain types of finished products is a set of machines and apparatuses connected by technological lines. In the production processes of the chemical, oil refining and petrochemical industries related to the processes of chemical technology, machines and apparatuses are pumps, compressors, heat exchangers, refrigerators, and technological lines are pipelines and conveyors. Raw materials are processed in technological apparatuses, raw materials, reagents, catalysts, heat carriers, refrigerants and other materials are moved from one apparatus to another using pumps and compressors along technological lines. The purpose of the production process is to obtain finished products of a certain range and the required quality.

The production chemical-technological process is a system in which the flows of raw materials, reagents, and catalysts move from the beginning to the end of the process. In the technological process, they are interconnected through appropriate devices, aggregates, machines in which transportation, heating, cooling, evaporation, condensation, purification and other processing of substances that cause a change in their nature and condition is carried out.

Each production process has a well-defined purpose and is characterized by its technological scheme, the presence of one or another technological equipment and the types of substances involved in the process. Automation of a specific production process is understood as its organization, in which all technological operations to achieve the set goal are performed automatically without direct human involvement. Automation is the highest stage of mechanization. Automation is based on automatic control systems that serve to maintain technological parameters at a given level. Automatic control is understood as the field of automation, which covers methods and means that facilitate or release a person from monitoring a particular production process, the state of operation of a particular machine, apparatus, unit. The object of

control is understood to be a machine, an aggregate or a process in which one or more quantities are measured. To judge the quality of the target product, it is necessary to characterize it by certain indicators, measuring them. Such indicators may include, for example, density, viscosity, chemical or fractional composition, the content of undesirable components, the concentration of the target product in the mixture, the temperature of the beginning or end of the boiling of the product. Quantifying these indicators, it is possible to judge in which direction the process is moving. Deviation of temperature and pressure from certain values usually leads to a change in the quantity and quality of the target products. Usually, for each production process, there is a certain set of parameter values, called the normal technological mode. Deviations of parameters from their values under normal technological conditions lead to deterioration of the results of the production process. There is a need to intervene in the course of the process in order to bring it to a normal technological regime in one way or another. This is achieved manually or by automatic action on the appropriate controls. In most processes of chemical technology, pressure is one of the main parameters determining the course of these processes. The pressure value determines the state of many substances, such as gases and vapors. Technological equipment is designed based on the permissible maximum pressure.

The temperature limits of the process determine the quality of the products obtained, their vapor pressure, density and viscosity of liquids and vapors. Appropriate measuring instruments are needed to measure the temperature. It is known that temperature is understood as the degree of heating of a substance, which means a value that characterizes the thermal state of a body in terms of heat exchange between it and other bodies. Solid materials are capillary-porous bodies with moisture in their pores. [<http://electricalschool.info/automation/2520-avtomatizaciya-teh-processov-himicheskoy-promyshlennosti.html>] For such materials, the dependence of some of their electrical properties on moisture content is characteristic. Dry solid materials are usually dielectrics, and wet capillary-porous bodies become conductors of electricity. The oil coming for processing always contains a certain amount of water with salts dissolved in it. Water is an undesirable component in oil, so it is removed from oil at dewatering plants. There are several methods for measuring the water content in oil, based on the dependence of the electrical parameters of the watered oil on the amount of water contained in it and on other dependencies.

In the chemical, oil refining and petrochemical industries, technological processes are associated with the production and processing of various liquid and gaseous substances. These substances are characterized by various indicators by which the quality of the relevant substances is assessed. The measurement of the composition of gases is reduced to determining the content of one or several components of the mixture. For these purposes, the industry produces and is widely used in factories a large number of devices, which are based on various methods.

### **Conclusion**

Thus, by quantifying certain indicators during and as a result of the production process, we exercise control, which means we check whether the numerical values of

the indicators correspond to other values of these indicators, considered as benchmarks, as desired or as required.

Based on the control carried out, we can find a discrepancy, which means to analyze the problems of automation of technological processes for the manufacture of chemical production devices.

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## Автоматизация создания технологического процесса

С. В. Порошин

ФГБОУ ВО «Тамбовский государственный технический университет», Тамбов, Россия  
*e-mail: slp18360@mail.ru*

**Аннотация.** В статье рассматриваются основные концепции автоматизации создания технологических процессов в химической промышленности, а также анализируются проблемы автоматизации. Большое внимание уделяется комплексной автоматизации и механизации производств химической промышленности, поскольку протекание химических и технологических процессов характеризуется сложностью, высокой скоростью и чувствительностью к отклонениям от заданных режимов. Проблемами автоматизации химической промышленности являются недостаток информации о протекании сложных технологических процессов химической промышленности, а также трудности в сравнении имеющихся данных для проведения качественного анализа деятельности предприятия химической промышленности с целью оптимизации его работы.

**Ключевые слова:** автоматизация технологического процесса, механизация технологического процесса.



## Intelligent Vision System for Object Tracking in Sorting Process

N. A. Koscheev\*, P. V. Shunyaev, A. S. Egorov

Tambov State Technical University, Tambov, Russia

*e-mail: nikitakosheev2014@yandex.ru*

### Abstract

The approach to presetting and calibration is considered. The method of camera calibration by means of checker-board is given. Software tools used are given and their brief characteristics are given.

**Keywords:** Basler camera, checkerboard method, OpenCV, Pylon

At the moment technical vision is widely used in such areas as medicine, military equipment, manufacturing, and including agriculture. Cameras are used to implement navigation systems for agricultural automated equipment, as well as for sorting and rejection of various fruits. This article deals with calibration of Basler camera and the process of object tracking specifically for finding low-quality fruit. Calibration is the process of estimating camera parameters. This means that we have all the information (specifications or estimated coefficients) about the camera needed to determine the exact relationship between a 3D point in the real world and the corresponding 2D image, the projection (each pixel) in the image captured by the calibrated camera. There are usually two types of parameters that need to be obtained:

Internal parameters of the camera/lens system include focal length, optical centre and radial lens distortion coefficients. External parameters related to the orientation (rotation and displacement) of the camera relative to some world coordinate system. In order to set up and connect the camera for its further use, the necessary software is required. The Pylon software is used for this purpose and contains a set of necessary functions as well as calibration tools. There are several methods to perform camera calibration, namely: template-based calibration (when we have full control over the image formation process, the best way to perform calibration is to take several images of an object or template of known dimensions from different viewpoints), geometric primitives (sometimes there are other geometric primitives in the scene, such as straight lines and intersection points, which can also be used for calibration) and based on deep machine learning (when we have very limited control over the image settings but it is still possible to get information for camera calibration using deep machine learning). This article presents the checkerboard method, which falls under the category of pattern-based calibration. Initially a board of a known size will be required on which the actual world coordinates of the points will be determined. In this case these points will be the corners of the cells. It doesn't matter which corner is chosen as the origin of the world coordinates. All points will be on a two-dimensional coordinate plane, as the third axis will be perpendicular, hence it can be neglected. It is necessary

to take pictures of the chessboard from different angles without shifting it, with the world coordinates being related to the corners of the cells. Due to the fact that the points have the same location, it is possible to take one point as the origin and determine the other relative to it (figure 1). The next step is to calculate the two-dimensional coordinates of the chessboard cells in pixels. This will require the OpenCV library, which is used for computer vision algorithms, as well as image processing and machine learning. This library provides a built-in function called "findChessboardCorners" that searches for a chessboard and returns the coordinates of the corners. Once the camera has been calibrated, the object tracking process needs to be implemented.



*Figure 1– Chessboard*

This will require the use of a pre-trained neural network. For the task of finding an object the architecture of the ResNet50 neural network was the preferred option. Its advantage is the possibility of increasing the accuracy by increasing the number of layers. It also has a high learning rate and a fairly high mAP (mean Average Precision). Having received a frame, the neural network algorithm converts it into the dictionary "detections" containing three data arrays. The first array is "detection\_boxes", which is needed to display the coordinates of object boundaries. The second array is "detection\_classes", which displays the number of classes in the image, based on the task of finding only low-quality fruit, two classes "bad" and "good" are entered, meaning low-quality or high-quality fruit respectively. A third array is "detection\_scores", which determines the extent to which an object belongs to one class or another.

Boundary conditions are inserted to correctly indicate poor quality fruit: "detection\_scores" must be greater than 0.75 (this criterion value is chosen from the consideration that it will allow to determine exactly which class the object belongs to); "detection\_classes" is 2 (only poor quality fruits belong to this class); "detection\_boxes" is less than 0.78 (the criterion limits the ingress of third party

objects into the array of data used). Failure to meet one of the conditions results in exiting the loop and waiting for the required data. If the criteria are met, the search for the object's centre is implemented. From the "detection\_boxes" array, the first and last elements (left and right border of the object) are used, which are added together and divided in half. The result is converted into pixels, by multiplying by the resolution width of the screen. In this work, the resolution width is 1920 pixels. This is how the object tracking process is carried out.

After testing this system, the accuracy of the detection of substandard fetuses was around 80 per cent. Further work will be aimed at increasing the accuracy rate by increasing the number of frames and testing different neural network architectures.

### **Acknowledgements**

We gratefully acknowledge the help of Andrey Sergeyevich Egorov, our supervisor, in this project, as well as our Department of Mechatronics and Robotics for the opportunity to work on special equipment.

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## **Интеллектуальная система технического зрения для отслеживания объектов в процессе сортировки**

**Н. А. Кощеев\*, П. В. Шуняев, А. С. Егоров**

ФГБОУ ВО «Тамбовский государственный технический университет, г. Тамбов, Россия  
*\*e-mail: nikitakosheev2014@yandex.ru*

**Аннотация.** Рассмотрен подход к предварительной настройке и калибровке. Дан способ калибровки камеры с помощью шахматной доски. Приведены используемые программные средства, дана их краткая характеристика.

**Ключевые слова:** камера Basler, метод шахматной доски, OpenCV, Pylon.

## Evaluation of the Formability of UHMWPE Products Based on Polygonal Pressing Models

**T. V. Kozharina\***, **V. A. Krylova**, **A. A. Chuprikova**

Tambov State Technical University, Tambov, Russia

*\*e-mail: tata.vladimirovna@gmail.com*

### Abstract

The article presents an algorithm for quality control of polymer materials based on the measurement of complex geometric models obtained using 3D scanning, which reduces the error in assessing the quality of manufactured objects. The results of the analysis of the profiles of UHMW PE under various conditions of solid-phase pressing are presented.

**Keywords:** 3D scanning, polygonal model, quality control, UHMW PE.

### Introduction

Due to the low density, corrosion resistance, strength and low cost, polymer materials have been widely used. Continuous improvement of operational properties makes it possible to use them for special purposes, especially as a full-fledged replacement for metals and alloys. At the same time, in many cases, the manufacture of complex geometry is required. But the use of mechanical processing has a negative impact on the tribological and physico-mechanical properties of polymer products. In this regard, a promising method of manufacturing products implemented in one technological operation is solid-phase processing based on plastic deformation in special molds. However, in this case, there are difficulties associated with the need to work out and justify rational pressing modes.

Among the potential new applications of polymer materials, agricultural engineering can be considered, where they can be used as additional protection of tillage organs from intensive abrasive wear. An example of such a material is UHMWPE, which has the following properties:

1. very low water absorption and no negative change in properties when exposed to water;
2. resistance to most acids and alkalis, ultraviolet and gamma radiation, as well as microorganisms;
3. low density (8 times less than that of steels) and high fatigue strength, which ensures the competitiveness of UHMWPE products in terms of “strength/own weight” with products made of low-strength structural steels and even surpass them.
4. very high wear resistance, low coefficient of friction and high fracture toughness (low temperature reliability)

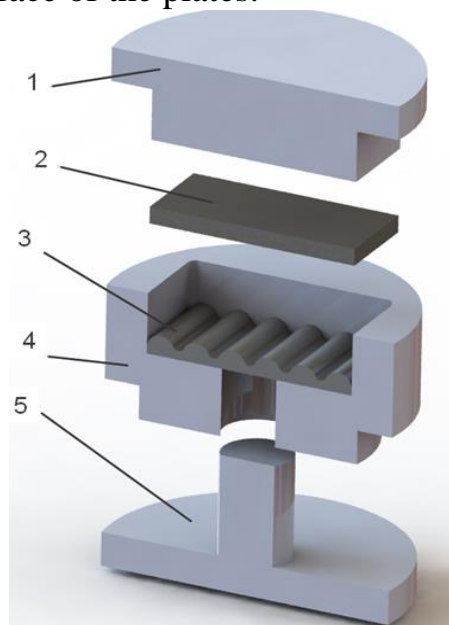
However, due to the high molecular weight, viscosity and elasticity, problems arise with the processing of this material. We propose a method of solid-phase volumetric stamping of UHMWPE in metal molds, in which it is possible to obtain a complex geometry of the product in one technological operation. In this case, the actual task is

to work out and substantiate the modes of processing UHMWPE. In addition, it is necessary to take into account the desire of the material to restore its original geometry over time.

### Experimental part

To evaluate the geometry, the method of analysis of polygonal models of compressions was used [1], which allows reproducing complex geometry with high accuracy. Of particular interest is the surface of the products formed by volumetric solid-phase pressing. Its value can be used to quantify the degree of conformity of the resulting geometry to the final product. To do this, you can use the value of the product shape coefficient  $K_f$ , which is calculated as the ratio of the nominal formed surface (ideal) to the resulting surface.

Rectangular plates 60x40x5 mm made of UHMWPE, which were placed in a metal mold, were considered as the object of the study. The location of the workpiece in the mold is shown in Fig. 1. With the help of a special forming plate 3, a special surface was formed on the treated surface of the plates.



*Figure 1. Location of the sample in the mold  
1 - punch, 2 - blank, 3 - forming plate, 4 - matrix, 5 ejector*

During preliminary experiments on the abrasion resistance of bionic structures [2], it was found that the shark skin structure [3] has increased abrasion resistance. This geometry was chosen as an object, but it is impossible to make an exact copy, since due to sharp corners and protrusions during pressing, instead of plastic deformation, the insert is embedded into the workpiece. Consequently, it was decided to adjust the geometry: adding smooth transitions between protrusions and depressions.

2 series of samples of 7 pieces each were prepared, which were kept on a laboratory press at a pressure of 40 kt \* s for 3 and 10 minutes, respectively.

A rectangular blank of 60x40 mm was placed on a forming plate 3 inside the matrix 4, after which it was pressed with a punch 1 and held on a laboratory press at a pressure of 40 kt \* s for 3 and 10 minutes for the “1” and “2” series, respectively.

After the pressing time expired, the mold was opened using the ejector 5, after which the geometry of the resulting pressing was scanned.

After extraction from the mold, the samples were scanned using an EinScan Pro 2X Plus 3D scanner, then the resulting polygonal geometry was post-processed in the Autodesk Fusion computer-aided design system: the values of the protrusions areas were found for all samples (a total of 5 complete protrusions). Further, similar measurements were implemented after 7, 14 and 21 days.

Next, the values of the  $K_s$  for each product in two batches were calculated. Figure 2 shows the average values of the shape coefficient for the processed samples.

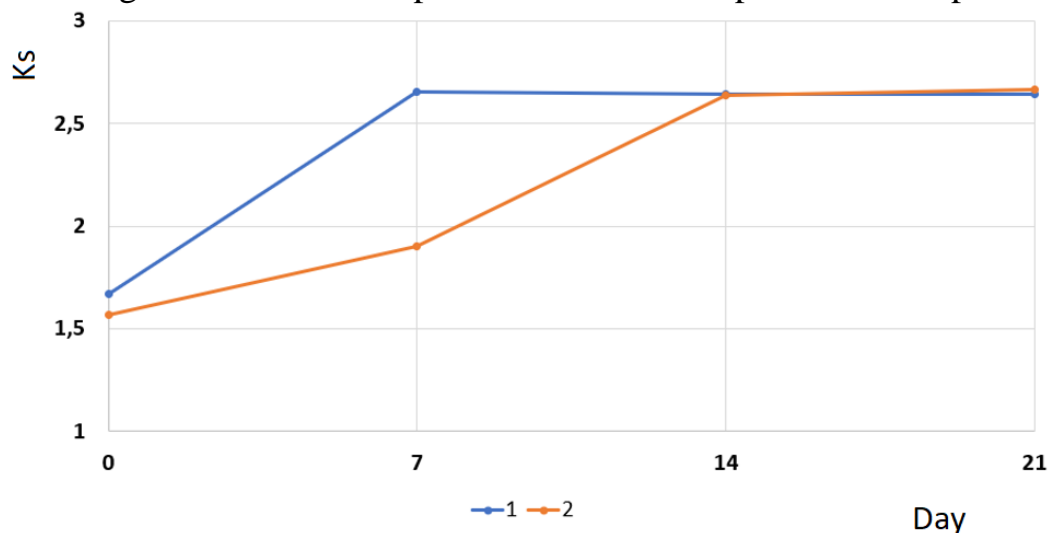


Figure 2. Values of the shape coefficient for two series of samples

As can be seen from Fig. 2, the values of  $K_s$  immediately after pressing differ slightly: 1.67 for batch “1” and 1.57 for batch ”2”. After a week, the difference increases: 2.65 and 1.9, respectively. After two weeks, the coefficient values are identical and amount to 2.64. A longer exposure does not affect the values of  $K_s$ .

### Conclusion

Thus, at room temperature, the value of the holding time has a negligible effect on the geometry of the resulting presses. However, over time, a significant change in the resulting shape is observed for UHMWPE. After exposure for more than 2 weeks, the formed surface of the samples decreases by more than 1.6 times. This desire of the material to restore its initial flat shape must be taken into account when designing press equipment and working out pressing modes.

Another conclusion is that the holding time under pressure does not affect the final geometry of the products. Only the recovery rate of the pressing profile depends on this parameter: for a lower pressure, the time to return to the “equilibrium” geometry will be longer. In this paper, the formability of the UHMWPE 9000 was investigated during uniaxial pressing in a metal mold at room temperature. It is shown that when obtaining products of complex geometry, the desire of the material to restore its initial geometry should be taken into account. The change in the formed profile was more than 1.6 times, which must be taken into account when designing molds and conditions

of the technological process of solid-phase processing.

The holding time of products under pressure at room temperature affects only the rate of shape recovery, but does not affect the final geometry of the sample. The analysis of polygonal models used is an effective and highly accurate method for assessing the formability of polymer materials.

Further research will be aimed at studying the influence of the temperature regime during solid-phase processing of polymer materials in obtaining a similar geometry optimized to reduce abrasive wear.

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## **Оценка формруемости изделий из СВМПЭ на основе полигональных моделей прессовок**

**Т. В. Кожарина\*, В. А. Крылова, А. А. Чуприкова**

ФГБОУ ВО «Тамбовский государственный технический университет», г. Тамбов, Россия

*\*e-mail: tata.vladimiirovna@gmail.com*

**Аннотация.** В статье представлен алгоритм контроля качества полимерных материалов, основанный на измерении сложных геометрических моделей, полученных с помощью 3D-сканирования, обеспечивающий снижение погрешности при оценке качества изготовленных объектов. Представлены результаты анализа профилей прессовок из СВМПЭ при различных условиях твердофазного прессования.

**Ключевые слова:** 3D-сканирование, полигональная модель, контроль качества, СВМПЭ.

## The Main Directions for Improving Equipment for the Vulcanization of Gas Masks

V. A. Krylova\*, T. V. Kozharina, M. C. Balabaev

Tambov State Technical University, Tambov, Russia

\*e-mail: valeraakrylova@gmail.com

### Abstract

The issues of the manufacturing process of the polymer front part of the personal respiratory protection equipment (gas mask) are considered. The existing approaches to optimizing structures and improving the technological process of manufacturing tooling for vulcanization pressing equipment are presented. Rough processing is simulated in the NX CAM system.

**Keywords:** CNC, mold, NX CAM, vulcanization.

The gas mask was made of thick rubber, which was tough for the skin and presented a number of inconveniences when putting on and subsequent use 15 years ago. Personal respiratory protection equipment is created in the conditions of large industrial enterprises and modern technologies from high-quality elastomers, which have less weight and good mechanical properties, currently. All this makes it possible to operate the gas mask for quite a long time at high thermal loads without discomfort.

The front part of the gas mask (Fig. 1) is made by hot pressing the rubber mixture in a special mold (Fig. 2), where the vulcanization process takes place. Elastomers have low thermal conductivity and, therefore, at the stage of heating in molds or other media (for example, in an autoclave), as a rule, wide temperature ranges and degrees of vulcanization are inevitable – this is one of the main difficulties of the manufacturing process of the front part. In addition, this process requires a lot of energy.

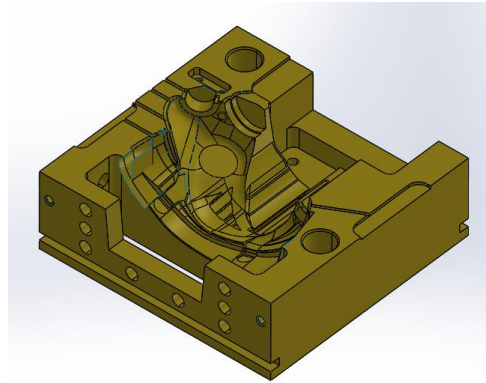


*Figure 1 – Gas mask*

In order to maintain a balance between the expected properties of the product and the reduction of the manufacturing process time, the heating process of vulcanization equipment is optimized. The main task is to ensure a uniform degree of vulcanization



over the entire volume of the rubber mixture. The analysis of publications [1-3] shows that there are different approaches to solving this problem: 1) optimization of the heating plates of the vulcanization press; 2) optimization of molds; 3) solving a complex problem taking into account the kinetics of the vulcanization reaction.



*Figure 2 – The lower plate of the mold for the manufacture of the front part of the gas mask*

The first approach is based on the assumption that uniform heating of plates ensures uniform heating of molds and rubber mixture. Therefore, optimization in this case is carried out according to the criterion of uniformity of the temperature field on the working surfaces of the heating plates.

According to the second approach, optimization is carried out according to the criterion of uniformity of the temperature field over the volume of the rubber mixture. In this case, the kinetics and thermal effects of the vulcanization reaction are not taken into account. It is assumed that the degree of vulcanization directly depends on the temperature of the rubber compound.

The third approach is a solution to a direct problem – the calculation of the degree of vulcanization of the rubber compound during temperature treatment. A wide variety of rubber compounds and the complexity of conducting experimental studies on the study of kinetic dependencies constrain the widespread use of the third approach.

In addition to the presented methods of optimizing the heating system, the task of improving the technological process of manufacturing press equipment tooling is relevant, including the development of control programs for CNC machines based on new machining strategies.

As an example, Figure 3 shows the visualization of the tool trajectory during rough machining of the lower plate of the mold. The development of the control program was carried out in the NX CAM system. As can be seen from the presented results, even the roughing of this part contains a large number of passes. Due to the abundance of inclined and curved surfaces, it is necessary to find a rational balance between accuracy and processing time. You can solve this problem by using a combination of different processing strategies.

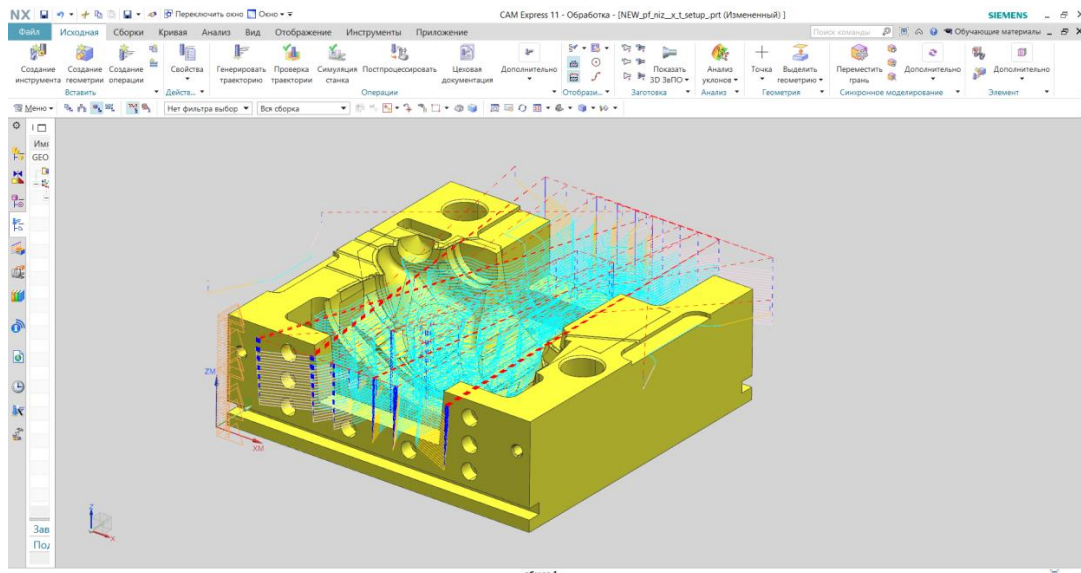


Figure 3 - Visualization of the trajectory of the end mill during rough machining

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## Основные направления совершенствования оснастки для вулканизации противогазных масок

В. А. Крылова\*, Т. В. Кожарина, М. С. Балабаев

ФГБОУ ВО «Тамбовский государственный технический университет», Тамбов, Россия

\*e-mail: valeraakrylova@gmail.com

**Аннотация.** Рассматриваются вопросы процесса изготовления полимерной лицевой части средства индивидуальной защиты органов дыхания (противогаза). Представлены существующие подходы к оптимизации конструкций и совершенствованию технологического процесса изготовления оснастки вулканизационного прессового оборудования.

**Ключевые слова:** вулканизация, пресс-форма, ЧПУ, NX CAM.

## **Automated Workplace of the Operator of the Process Control System for the Production of Ethyl Alcohol**

**A. O. Mashkova\*, V. D. Avdyukhova, Y. A. Rudakova**

Tambov State Technical University, Tambov, Russia

*\*e-mail maschkova.alina@yandex.ru*

### **Abstract**

The article discusses the organization of an automated operator's workplace using the MasterSCADA SCADA system. The purpose of automating the process of producing rectified ethyl alcohol is to increase the efficiency of this process. To achieve this goal, it is necessary to create effective and reliable automated control systems based on new technical and software, build a mathematical model of the process and its implementation. The most promising technology of automated control, today, are SCADA systems. They are especially effective when creating automated control systems of production facilities with restrictions on human and material resources.

### **Keywords**

Automatic control system (ACS), control object, operator's automated control system, rectified ethyl alcohol production process, SCADA system.

### **Introduction**

Alcohol "extra" is used as a solvent in the electronics industry, in the chemical and pharmaceutical industry, in medicine and in household chemicals. Ethyl alcohol of the highest and first grade is used as a raw material for the production of chemical products.

To improve the process of distillation, it is necessary to create effective and reliable automated control systems based on new technical and software, build a mathematical model of the process and implement it.

Automated process control system is designed to automate operational control, protection and control of the technological process of production of rectified ethyl alcohol

The purpose of delivering automated process control systems is to ensure efficient and safe operation of the technological process using modern microprocessor tools.

The automated control system has a hierarchical three-stage architecture:

– at the lower level are: sensors, measuring transducers, actuators, secondary devices;

– at the middle level there are: software-logic controllers (PLCs) installed in monitoring and control panel (MCP), providing reception, primary processing of information from sensors and actuators, as well as the formation of control commands in accordance with the tasks received from local consoles implemented using operator touch panels and automated working station (AWS) implemented on a PC;

– at the upper level, an automated working station is implemented, providing a human-machine interface with the control system and information exchange with controllers.[1]

Management of technological processes in modern automated production facilities is carried out from operator or control rooms (control points).

A special feature of the developed automated process control system for the production of ethyl alcohol is that all information about the progress of the technological process is displayed on the display of the CPU (central control panel). The software package is used for this purpose "MasterSCADA"– a software product for creating monitoring, management and data collection systems. This package allows you to create complete high-quality software for operator's consoles, implemented on various types of PCs (personal computers) and workstations, work networks. SCADA- system "MasterSCADA" provides network loading and modification of the controller software and performs diagnostics of the controller and its modules in the mode.

Communication between the operator's workstation and the controller is performed using OPC servers.[2]

OPC (OLE for Process Control) is a standard for interaction between data acquisition and control system (SCADA) software components based on the COM/DCOM object model. OPC technology is designed to provide:

- a universal mechanism for data exchange between intelligent sensors and actuators, controllers, communication devices with the object and systems for presenting technological information;
- operational dispatching control;
- data archiving by database management systems.

### **Methods, results and discussion**

The developed automated process control system implements the following functions:

- Monitoring of process parameters, condition of process equipment, condition of shut-off and control valves and displaying information on the screen of the automated control system operator;
- Automated control of shut-off and control valves;
- Display current and historical information on the display (implementation of mnemonic schemes and trends);
- Identification of emergency and pre-emergency situations with automatic alarm generation;
- Ensuring accurate dosing of loaded components;
- Ability to select the control mode

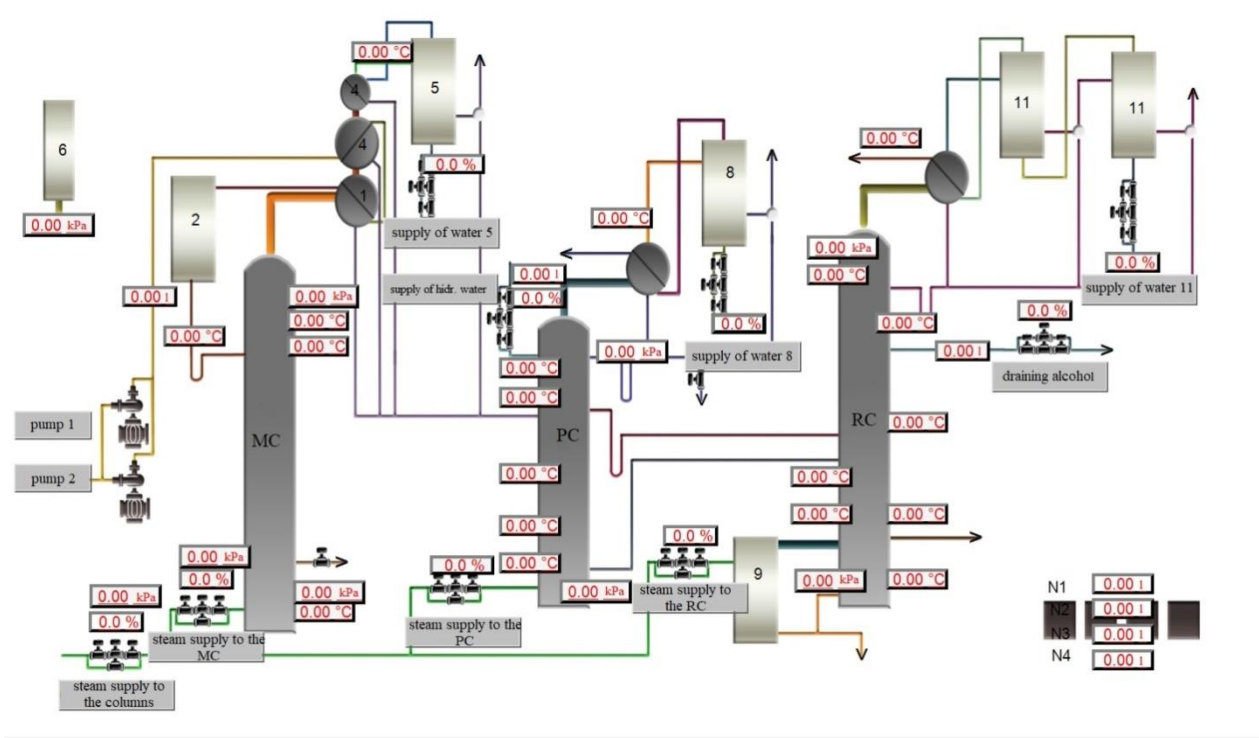


Figure 1 – SCADA-systems "Start window".

This mnemonic allows the operator to track the flow of the technological process. This window (Figure 1) contains adjustable valves with position sensors.

Additional windows allow you to get more detailed information about the map item. This information may include both system settings and other process parameters necessary for evaluating the process status.

Information from sensors is displayed next to the objects to which these sensors are attached.

### Conclusion

Based on the materials studied and the needs of small-capacity enterprises, an example of an automated control system operator was developed to improve the efficiency and reliability of ethyl alcohol production.

Software package "MasterSCADA" gives the operator a clear idea of the processes taking place on the production line and allows to save on the number of jobs and upgrade the existing monitoring system.

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## **Автоматизированное рабочее место оператора системы управления процессом производства спирта этилового**

**А. О. Машкова\*, В. Д. Авдюхова, Ю. А. Рудакова**

ФГБОУ ВО «Тамбовский государственный технический университет», Тамбов, Россия

*\*e-mail: maschkova.alina@yandex.ru*

**Аннотация.** В статье рассматривается организация автоматизированного рабочего места оператора с использованием SCADA-системы «MasterSCADA». Целью автоматизации процесса производства спирта этилового ректификованного является повышение эффективности данного процесса. Для решения поставленной цели необходимо создание эффективных и надежных систем автоматизированного управления на базе нового технического и программного обеспечения, построение математической модели процесса и её реализация. Наиболее перспективной технологией автоматизированного управления, на сегодняшний день, являются SCADA системы. Особенно они эффективны при создании АСУ ТП производств с ограничениями на кадровые и материальные ресурсы.

**Ключевые слова:** SCADA-система, автоматическая система регулирования (АСР), АРМ оператора, объект управления, процесс производства спирта этилового ректификованного.

## Designing of Aerostatic Guideways

**N. I. Mayorov**

Tambov State Technical University, Tambov, Russia

*e-mail: del00x@mail.ru*

### **Abstract**

The quality of the guideways is one of the most important factors for the implementation of positioning systems. As a rule, ultra-precise positioning systems have aerostatic guideways that minimize friction and backlash. This research is aimed at designing and optimizing the characteristics of aerostatic guideways that provide fast and high-precision positioning. For this purpose, it is planned to use an aeromagnetic guideway, where the aerostatic forces are compensated by magnetic attraction, which increases the rigidity of the system. However, the movement of the magnet relative to the attracted surface causes an induction eddy current, which degrades the efficiency of high-speed positioning. In order to minimize eddy current losses, a positioning system is proposed, consisting of a positional table and a movable table following it, which eliminates their relative movement.

**Keywords:** aerostatic guideways, eddy currents, precision positioning, preload.

The principle of operation of aerostatic guideways is to use instead of lubricants a stream of compressed air forming a stable gap, which significantly reduces friction. When working, they emit less heat, have a long service life. There are many holes on the sliding surface in all directions; the gas supplied by the air pump passes through these holes and can form a stable air gap[1]. The main advantages of lubricating the guideways with compressed air are low friction, which is almost zero at low speed. Although the elasticity of the air gap is usually lower compared to other lubricants such as oil, at the same time it emits less heat and has less surface adhesion, which gives the guideway an extremely long service life and a low damping coefficient. Aerostatic guideway has the smallest movement errors among all types of guideways used in industry, which allows guideways with gas lubrication to compete very favorably with other types of guideways in ultra-precise machining, where high dimensional accuracy and surface quality are required[2].

The characteristics of the aerostatic guideway, is stiffness, damping and air flow, depend on the gap, which in turn can be adjusted by means of tension by magnetic attraction forces. The gap or thickness of the air gap is one of the most important factors determining the characteristics of the aerostatic guideway. Therefore, in order to improve the characteristics of the aerostatic guideway, an optimization of the gap is required. Since the air has a low density, the thickness of the air gap or the internal gap inside the aerostatic guideway must be very small so that it is possible to maintain a reasonable working pressure inside the guideway and reduce air consumption to an acceptable level for economic reasons. The acceptable thickness of the air gap is in the range of 5-20 microns [3].; with such small gaps, each small deviation will have a big impact on the performance of the guideway.

The parameters of each part, the number, diameter and distribution of holes, air supply pressure, air gap thickness, etc. will affect the static rigidity and load capacity

of the guideway at various scales.

In order to achieve and maintain extremely high accuracy and stability in various operating conditions, the aerostatic guideway control system often needs to be re-debugged before and after operation.

Low rigidity and low damping ability lead to movement errors, and high flow leads to vibrations of the positional table. These problems can be avoided by choosing a suitable preload method. There are several of them: weight, vacuum, electrostatic and magnetic [4]. Although the weight method of preloading can give a lot of effort, it reduces the response of the system. The preloading method, which uses vacuum and the force of electrostatic attraction, does not allow obtaining a large force. The method of magnetic preloading with permanent magnets allows you to apply a large force without generating heat, however, the relative velocity between the permanent magnets and the attracted surface causes an eddy current, which acts as a viscous resistance.

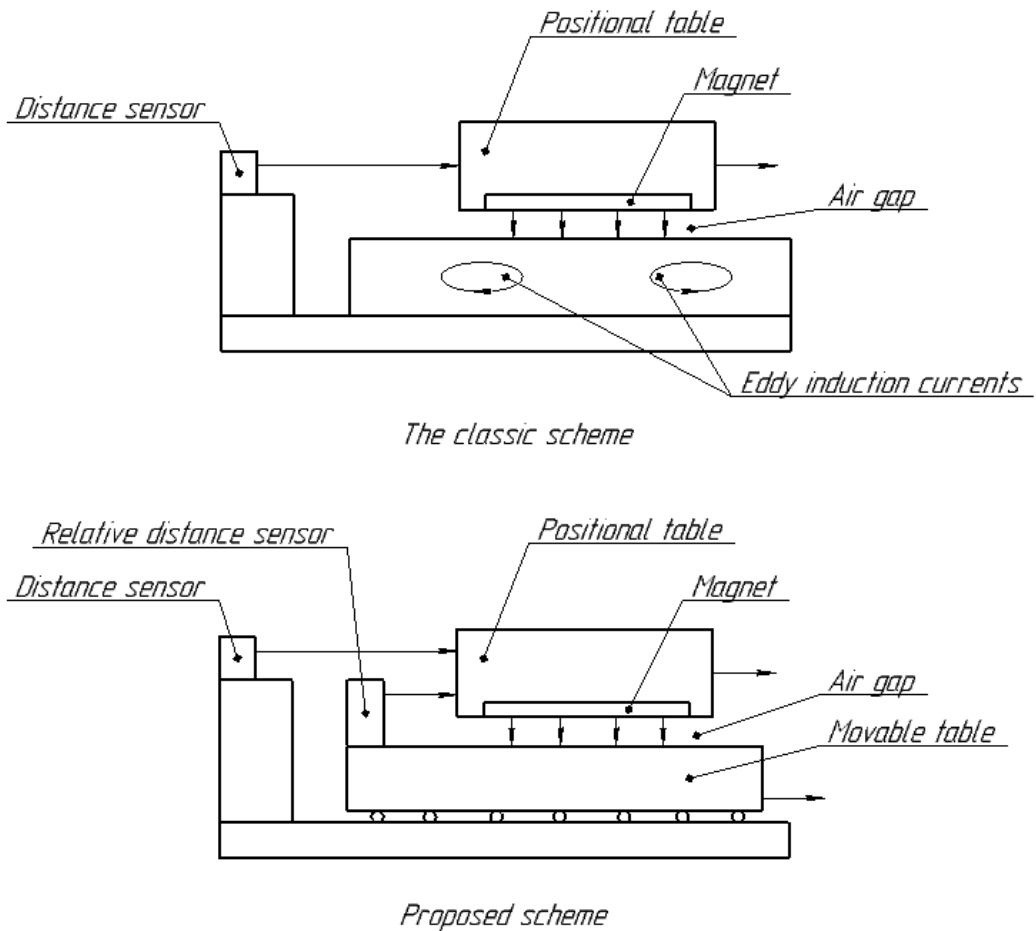


Figure 1 – Aerostatic guideway, scheme

In order to reduce the influence of induction eddy currents, the following design of an aerostatic guideway is proposed. Eddy current is caused by a change in the magnetic flux in the conductive material, therefore, eddy current can be prevented by



placing the conductive material in a permanent magnetic field. The proposed design prevents the appearance of eddy currents due to the absence of a relative velocity between the magnet and the conductive material. Figure 1 shows a scheme of the proposed positioning system. In it, the force of magnetic attraction acts on an additional table, which is controlled in such a way that the positional table follows it. This prevents the appearance of eddy current due to the lack of relative velocity between the magnet and the attracted surface.

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## Проектирование аэростатических направляющих

Н. И. Майоров

ФГБОУ ВО «Тамбовский государственный технический университет», Тамбов, Россия  
*e-mail: del00x@mail.ru*

**Аннотация.** Качество направляющих является одним из наиболее важных факторов для реализации систем позиционирования. Как правило, сверхточные системы позиционирования имеют аэростатические направляющие, которые минимизируют трение и люфт. Это исследование направлено на проектирование и оптимизацию характеристик аэростатических направляющих, обеспечивающих быстрое и высокоточное позиционирование. Для этой цели планируется использовать аэромагнитную направляющую, где аэростатические силы компенсируются за счёт магнитного притяжения, что повышает жесткость системы. Однако движение магнита относительно притягиваемой поверхности вызывает индукционный вихревой ток, который ухудшает эффективность при высокоскоростном позиционировании. Чтобы минимизировать потери на вихревые токи предлагается система позиционирования, состоящая из позиционного стола и подвижного стола, следующего за ним, что исключает их относительное перемещение.

**Ключевые слова:** аэростатические направляющие, вихревые токи, предварительная нагрузка, прецизионное позиционирование.

## Classification of Typical Technological Processes Using Neural Networks

**I.V. Nagaytsev**

Tambov State Technical University, Tambov, Russia  
*e-mail: nagan68@mail.ru*

### **Abstract**

This research article focuses on the use of neural networks for the classification of typical technological processes for the manufacture of flanges, depending on their geometrical parameters. Flanges are an essential component used in various industrial, and their manufacturing process can be complex and time-consuming. The design of the technological process for the manufacture of flanges is critical to ensure the production of high-quality products. In this study, we propose a method to classify the typical technological processes used for manufacturing flanges using neural networks. The neural network is trained on a dataset of historical process data, and the output is used to classify the manufacturing processes based on the geometrical parameters of the flange. The results of the study show that the proposed method can accurately classify the typical technological processes used for manufacturing flanges.

**Keywords:** manufacturing; neural networks; typical technological processes.

### **Introduction**

Flanges are an essential component used in various industrial and mechanical products, including pipelines, vessels, and apparatus. The manufacturing process of flanges can be complex and time-consuming, involving several stages such as cutting, forging, heat treatment, and machining. The design of the technological process for the manufacture of flanges is critical to ensure the production of high-quality components that meet the required specifications. In this study, we propose the use of neural networks to classify the typical technological processes used for manufacturing flanges based on their geometrical parameters, which can help improve the efficiency and quality of the manufacturing process.

### **Methodology**

The proposed method of using neural networks to classify typical technological processes used for manufacturing flanges is a complex process that involves multiple stages. The neural network used in this method is trained on a dataset of historical data that contains information on the various stages of the manufacturing process, including cutting, forging, heat treatment, and machining. The dataset is preprocessed to extract relevant features and normalize the data to improve the performance of the neural network. This preprocessing step is essential as it ensures that the neural network can accurately classify the typical technological processes used for manufacturing flanges based on their geometrical parameters. The input to the neural network includes the geometrical parameters of the flange, such as its outer and inner diameters, plate thickness, number of

fasteners holes, and various boolean values such as whether it is made from parts or not. The output of the neural network is one of the typical technological processes used for manufacturing flanges. This output is essential as it ensures that the manufacturing processes are accurately classified, leading to the production of high-quality products.

To train the neural network, the back propagation algorithm is used, which involves adjusting the weights of the network to minimize the difference between the predicted and actual results. This process ensures that the neural network is trained on accurate and reliable data, leading to accurate classification results. The performance of the neural network is evaluated using the accuracy score of the classification results, and the hyper parameters of the neural network are tuned to optimize its performance. This tuning process ensures that the neural network is optimized for accuracy, speed, and efficiency.

## **Results**

The results of the study show that the proposed method can accurately classify the typical technological processes used for manufacturing flanges based on their geometrical parameters. The neural network was trained on a dataset of historical, and the classification results were obtained by using the trained network. The evaluation criteria used show that the classification accuracy is high, indicating that the proposed method is effective in classifying the typical technological processes used for manufacturing flanges.

The performance of the neural network is compared to other machine learning algorithms such as logistic regression, decision acceptance tree, and the results show that the neural network outperforms these algorithms in terms of classification accuracy.

## **Conclusion**

In conclusion, the proposed method of using neural networks to classify the typical technological processes used for manufacturing flanges based on their geometrical parameters is effective and efficient. This study highlights the potential of machine learning techniques to automate and optimize the manufacturing process.

The neural network is trained on a dataset of historical process data, and the output is used to classify the manufacturing processes based on the geometrical parameters of the flange. The results of the study show that the proposed method can accurately classify the typical technological processes used for manufacturing flanges, making it an attractive option for the industry.

Further work could be done to improve and extend the proposed method. One potential avenue is to incorporate more data and parameters into the model, such as material properties and production environment conditions. This would increase the complexity of the model, but could also lead to more accurate and comprehensive classifications.

In addition, it may be useful to apply the proposed method to other components in the industry and evaluate its effectiveness. This would help to determine the extent to which the method can be generalized and applied to other manufacturing processes.

Overall, the use of machine learning techniques for the optimization and automation of the manufacturing process is an important area of research with

significant potential for improving the efficiency, quality, and cost-effectiveness of industrial processes. The proposed method of using neural networks for the classification of typical technological processes used for manufacturing flanges is a promising example of how machine learning can be applied to this field. [1-3] Further research and development in this area are likely to lead to even more significant advances in the future.

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## Классификация типовых технологических процессов с использованием нейронных сетей

**И. В. Нагайцев**

ФГБОУ ВО «Тамбовский государственный технический университет», Тамбов, Россия  
*e-mail: nagan68@mail.ru*

**Аннотация.** Данная научная статья посвящена использованию нейронных сетей для классификации типовых технологических процессов изготовления фланцев в зависимости от их геометрических параметров. Фланцы являются важным компонентом, используемым в различных отраслях промышленности, и процесс их изготовления может быть сложным и трудоемким. Построение технологического процесса изготовления фланцев имеет решающее значение для обеспечения выпуска качественной продукции. В данном исследовании мы предлагаем метод классификации типовых технологических процессов изготовления фланцев с использованием нейронных сетей. Нейронная сеть обучается на наборе исторических данных процесса, а выходные данные используются для классификации производственных процессов на основе геометрических параметров фланца. Результаты исследования показывают, что предложенный метод позволяет достаточно точно классифицировать типовые технологические процессы, используемые для изготовления фланцев.

**Ключевые слова:** нейронные сети; производство; типовые технологические процессы.

## The Newest Materials for Space Industry

**E. B. Panchenko\***, **N. S. Konyahina**, **K. S. Lyubovskij**

Tambov State Technical University, Tambov, Russia

\*e-mail: [evgenpvh@mail.ru](mailto:evgenpvh@mail.ru)

### Abstract

This article is survey and introduces to reader the new ultra-tough nanocomposite material that has developed for spacecraft. In article characteristics of material are described, also there is method of microwave heating that has used for making the material. Equipment that was used for creating material also mentioned. In the text indicated where and how material can be applied.

**Keywords:** microwave heating, nanocomposite, ultra-tough.

In space industry is always changing and we should adopt. The development of the new spacecraft is required more modern materials that will satisfy specified characteristics. Materials usually must stand cryogen temperatures, not provide gases and have required mechanical specification. The selection of components for composite is carried out very carefully. Products for instrument making must be strong, resist to destruction, deformation and sometimes conduct electro-magnetic radiation. Another one important feature in space industry is no gas released from material, because it can get on sensitive elements of spacecraft. Limitation of weight is also important. All of this requirements, limitation and special conditions can be managed with application of composites [1].

There is no regulation in engineering of spacecraft, so there is a lot of freedom in methods and technologies. The list of composite materials that are used in space industry includes carbonplastic, fiber-glass, kevlar, polyurethanes, silicone etc. Recently this list was added with new ultra-tough material – dense nanocomposite ceramics based on magnesium oxides and yttrium oxides [2]. Powders of magnesium oxide and yttrium oxide are represented in Fig. 1.

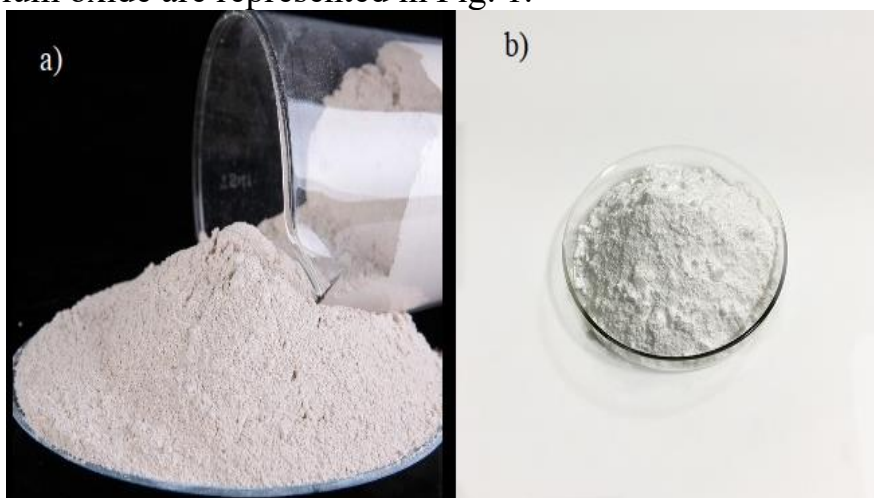


Figure 1 – a) magnesium oxide; b) yttrium oxide

Nanoparticles of magnesium oxide and yttrium oxide are made composite very hard, heat-resistant and high chemical durable. The magnesium oxide has absolute reflectivity in wide diapason of specter and passes this feature to material. Meanwhile, the yttrium oxide is transparent for light. For this reasons the material is unique: it's transparent in infrared and has high strength. All of those characteristics were achieved because of the new method of sintering of powders. Such experiments were carried out in gyrotron complex [3]. One of them is shown in Fig. 2.



*Figure 2 – Gyrotrone*

The high-temperature sintering at temperature 1500 °C in high vacuum conditions were realize because of volumetric and zero lag of super-high frequency heating (SHF heating). The technology without heating elements was used and this make possible to achieve ultra-fast heating of the composite with speed higher than 100 °C per minute. Due to this the pure mineral with ductility of sintering atmosphere was synthesized. Conditions of microwave sintering specially were optimized with nanodisperse powders.

Using this method managed to get nanostructure high-dense ceramics with transmission coefficient equals 78 percent on length of wave equals 6 μm.

The operator can make large products for space industry made of newest ultra-tough nanocomposite because of exclusive method of SHF-heating [4].

Using method of SHF heating operator can produce large details made of new composite, frame for spacecraft, for example. Also it can be used in aircraft. We can note that variety of making composite materials and amount of materials themselves is positively effect on perspectives of future researches.

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## Новейшие материалы для космической отрасли

**Е. Б. Панченко\*, Н. С. Коняхина, К. С. Любовский**

ФГБОУ ВО «Тамбовский государственный технический университет», Тамбов, Россия  
*e-mail: evgenpyh@mail.ru*

**Аннотация.** Данная статья является обзорной, и знакомит читателя с новым сверхпрочным нанокomпозитным материалом, разработанным для космических летательных аппаратов. В статье описаны свойства полученного материала, метод микроволнового нагрева, которым он был изготовлен. Упомянуто и о приборах, с помощью которых был осуществлён процесс получения. В изложенной информации также указано, где и как может быть применён полученный материал.

**Ключевые слова:** сверхпрочный, нанокomпозит, микроволновой нагрев.

## Proportional Gas Flow Control in the Feed Boiler

M. A. Popov<sup>1</sup>, A. M. Shuvalov<sup>1</sup>, M. N. Makeeva<sup>2</sup>

<sup>1</sup>All-Russian Research Institute for Use of Machinery and Petroleum Products in Agriculture

<sup>2</sup>Tambov State Technical University, Tambov, Russia

*e-mail: vniiti@mail.ru*

### Abstract

This article describes the device, the principle of operation and the main characteristics of semiconductor modules constructed from Peltier elements. The advantages and disadvantages of devices implemented on Peltier modules are noted. The possibility of their application in a gas-using feed boiler is considered.

**Keywords:** feed boiler, gas consumption, Peltier element, thermoelectric battery.

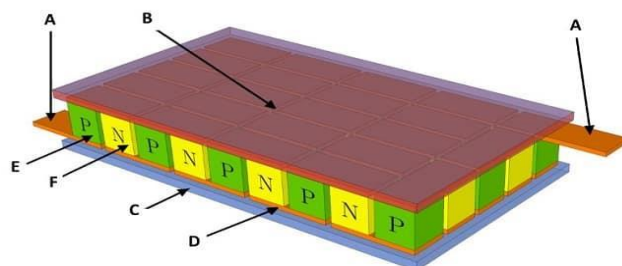
### Introduction

During the period of large-scale gasification of the countryside, in such energy-intensive processes as fodder preparation, gas-using feed boilers are used, in which one or two-stage gas flow control is applied. This leads to frequent switching on and off of the gas burner, premature wear of the ballasts and to a decrease in the gas burner reliability.

At the same time, during the feed heat treatment, the power of the gas burner should change in proportion to the consumed heat flux [1-2] from the maximum in the initial heating period to the minimum in the quiet boiling mode. On the basis of patent information studies, it has been established that advanced Peltier semiconductor elements can be used to proportionally control of the gas flow [3-4].

### The feasibility of Peltier elements application

A device assembled from Peltier elements is a structure that consists of two insulator plates (usually ceramic), with thermocouples connected in series between them (Fig. 1).



*Figure 1 - Device from Peltier elements.*

*A - contacts for actuator connection; B - the hot surface of the elements; C - cold surface; D - copper conductors; E is a p-junction semiconductor; F is an n-type semiconductor.*

To assess the feasibility of using Peltier elements, we have developed a structural and technological scheme for a gas flow control system proportional to the consumed



heat flow. The Peltier elements are mounted on the bottom of the brewing vessel and, due to the temperature difference on the inner and outer walls of each element, an electrical signal is generated, the value of which varies in proportion to the temperature difference. As a result, a power supply system for the feed boiler with proportional gas flow control was obtained. This is an important advantage of such a scheme, since the set of equipment for the gas flow proportional control system is simplified and the reliability of its operation is increased.

To assess the relationship between the voltage at the output of the Peltier elements and the temperature difference on opposite surfaces, a laboratory experiment was carried out. As a result, it was found that the electrical signal at the output of the device with Peltier elements changes in proportion to the temperature difference on their surfaces.

Experimental studies have shown that the best sensitivity of the automatic control system is achieved if nine Peltier elements are installed in the control device (Fig. 2).

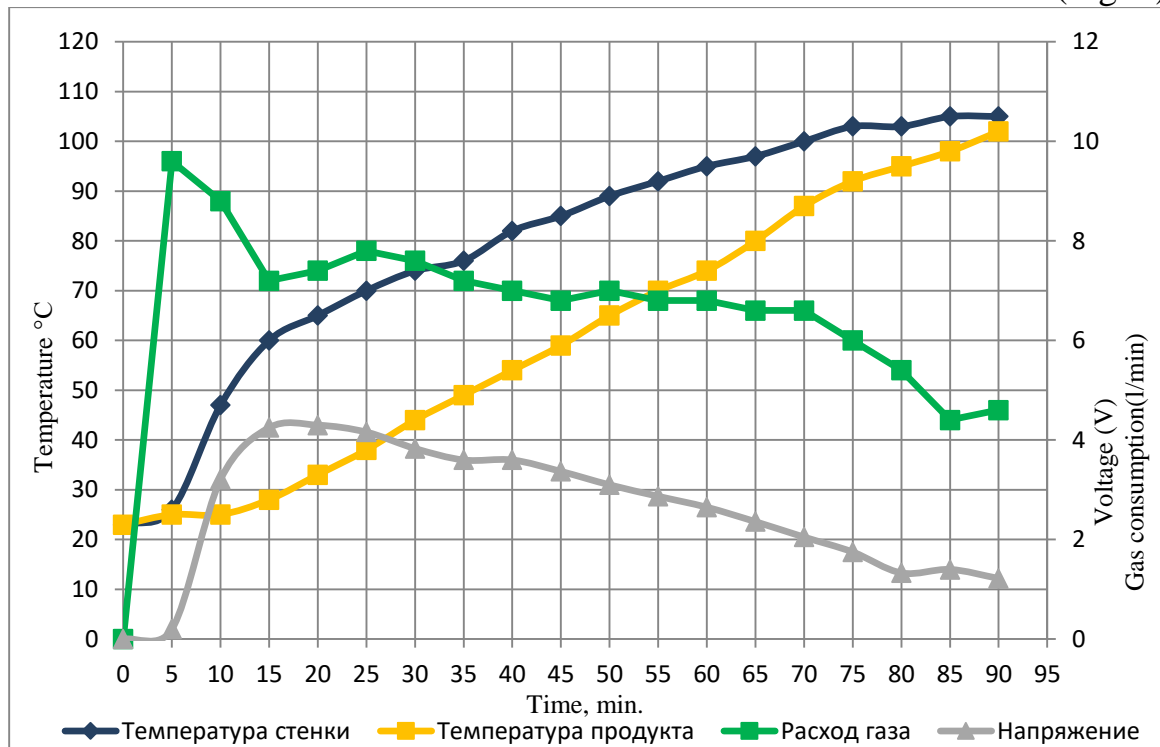


Figure 2 - Gas consumption during heating to a boil of 100 liters of the feed boiler contents.

It follows from Fig. 2 that the gas flow rate changes in proportion to the change in voltage at the output of the thermoelectric device. At the same time, the voltage decreases in proportion to the temperature difference, and the temperature difference decreases in proportion to the heating temperature of the feed in the brewing vessel. As a result of the new control device, the gas consumption has decreased from 747 liters with step regulation to 618 liters with regulation in proportion to the consumed heat flow, i.e. gas savings of 17.3%. This confirms the expediency of using a Peltier semiconductor device with thermoelements in the system of automatic control of a feed boiler gas flow.

## Conclusion

The use of Peltier elements in the structural-technological scheme allows for gas flow proportional regulation, simplifies its design, increases reliability and helps to reduce gas consumption by 17.3%.

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## Пропорциональное регулирование расхода газа в кормоварочном котле

М. А. Попов<sup>1</sup>, А. М. Шувалов<sup>1</sup>, М. Н. Макеева<sup>2</sup>

<sup>1</sup>ФГБНУ «Всероссийский научно-исследовательский институт использования техники и нефтепродуктов в сельском хозяйстве»

<sup>2</sup>ФГБОУ ВО «Тамбовский государственный технический университет»  
*e-mail: vniiti@mail.ru*

**Аннотация.** В данной статье описывается устройство, принцип работы, основные характеристики полупроводниковых модулей из элементов Пельтье. Отмечаются преимущества и недостатки реализованных на модулях Пельтье устройств. Рассматривается возможность их применения в газоиспользующим кормоварочном котле.

**Ключевые слова:** элемент Пельтье, термоэлектрическая батарея, варочный котел, расход газа.

## Overview of Navigation Systems of a Mobile Robotic Platform for Agriculture

**P. V. Shunyaev\*, N. A. Kosheev, A. S Egorov**

Tambov State Technical University, Tambov, Russia;

\*e-mail: *petr.shunyaev@yandex*

### Abstract

Various means of navigation are analyzed; their disadvantages and advantages are revealed. A decision was made on the necessary method of navigation, and already existing analogues were considered. It is concluded that it is necessary to create your own navigation system.

**Keywords:** Cognitive Pilot navigation system, navigation aids, technical vision, ZED-2I stereo camera.

### Introduction

Tambov State Technical University is implementing the creation of a mobile robotic platform for agriculture, which will move around a predetermined orchard and collect information about the ripeness of fruits (apples) and their harvesting as needed. The robot must memorize the map of the orchard, bypass obstacles that have been recorded on the map, and which may appear during the passage of a given route. The main problem is that the obstacles recorded on the garden map can be bypassed by analyzing the map, and the bypassing of unexpected obstacles cannot be predicted in advance.

One of the current challenges in robotics is the task of navigating the robot in space, i.e., analyzing the situation and selecting a route by the robot itself without human involvement.

There are several basic types of navigation:

- visual;
- inertial;
- radio navigation.

Visual navigation is realized on the basis of vision. The main way to collect information are cameras.

The use of cameras for mobile robot navigation is justified by the fact that they have a wide bandwidth compared to other sensor systems and, accordingly, the greatest semantic capabilities for pattern recognition in mapping, thereby providing an opportunity to perform movement along external landmarks, as well as the number of sensors used.

There are ready-to-use navigation systems for mobile robots, such as Cognitive Pilot (image 1). This system uses a set of sensors, such as a sensor of the angle of rotation of the wheels, IMU. The principle of the navigation system is based on a stereo camera.



*Figure 1 – Cognitive Pilot sensors*

Inertial navigation system is a navigation system based on the use of IMU (inertial measurement units).

This navigation system can transmit data about the position of the robot with high accuracy. However, its problem is that on the basis of this system alone it is impossible to organize navigation on the ground, as well as the accumulation of error. This navigation system is suitable for solving the problem, but only as an auxiliary system.

Radio navigation is a way to navigate the device, by using radio frequencies to determine the position of objects on the ground.

Since GPS technology is used in a larger spectrum, it is necessary to take into account its peculiarities. Positioning accuracy for civilian applications is 7.8 m. Such accuracy is unacceptable for positioning a robotic platform in an inter-row with a typical width of 5 m, so the use of radio navigation is acceptable only as an auxiliary system.

LiDAR technology is a system for determining the location of objects using sensors - LiDAR (Light Detection and Ranging). The lidar principle is based on sending short laser pulses and analyzing the time structure of the back-scattered signal. The time between sending and receiving the laser pulse is directly proportional to the distance to the target. The disadvantage of LiDAR-based navigation systems is that at least 3 expensive sensors must be installed to obtain information about the space around the robot, which increases the final cost of the product.

### **Conclusion**

Based on the analysis of existing solutions in the field of robot navigation systems, it was decided to create a navigation system based on a stereo camera with an auxiliary built-in inertial navigation system. We chose the ZED 2I stereo camera. This camera has a data processing unit inside and an auxiliary inertial navigation system based on a gyroscope, accelerometer, compass and barometer. There is also a freely available library for this camera, which makes working with the camera much easier. The camera is able to build a depth map, memorize an ordinary map, get information about its location relative to the beginning of movement, determine the distance to objects, and recognize objects. The next stages of work on this topic will be the development of algorithmic and software for the implementation of the navigation system.

### **Acknowledgements**

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## Обзор систем навигации мобильной робототехнической платформы для сельского хозяйства

П. В. Шуняев\*, Н. А. Кошечев, А. С. Егоров

ФГБОУ ВО «Тамбовский государственный технический университет», Тамбов, Россия,  
*\*e-mail: petr.shunyaev@yandex.ru*

**Аннотация.** Проанализированы различные средства навигации, выявлены их недостатки и достоинства. Принято решение о необходимом способе навигации, а также рассмотрены уже существующие аналоги. Сделан вывод о необходимости создавать собственную систему навигации.

**Ключевые слова:** система навигации Cognitive Pilot, средства навигации, стереокамера ZED-2I, техническое зрение.

## Research Study of Cardboard Containers Production for Soldering Stations

**E. A. Talalaeva**

Tambov State Technical University, Tambov, Russia  
*e-mail: talalaewa95@yandex.ru*

### **Abstract**

Containers serve as the main means for ensuring the safety of manufactured products during their transportation, storage and consumption. The technology for manufacturing containers from cardboard and corrugated cardboard depends on the equipment available at the enterprise. Equipment for carton packaging is selected based on the planned production volumes, range and design of the box. The study examines the technology for manufacturing cardboard containers for a soldering station, as well as comparing materials for its manufacture.

**Keywords:** corrugated cardboard, corrugated cardboard production, cardboard packaging.

The cardboard packaging remains of current interest despite emergence of new materials. In 2020, production of corrugated cardboard containers has increased by 15% in comparison to 2019.

For the production of cardboard and paper containers, cardboard, paper, plywood, tin, thread, twine, metal tape, metal wire, adhesives and sealants, waterproof and other coatings.

Corrugated cardboard is made by pressing of cellulose or wastepaper, has a thickness of 0.3-5mm and consists of one or more layers.

Such a container has many advantages, for example, it is eco-friendly, weighs a little, and protects the goods from damage.

The article examines the production of the container for soldering stations. We will look at the production of a container using cardboard T-23C and T24B as a materials for packaging.

What is the difference between them?

First of all, it is their colour. T24 brand of cardboard has a deeper brown colour. Meanwhile, T23 brand of cardboard has lighter beige undertones.

Secondly, density of cardboard under the brand T24 is 170 g/m<sup>2</sup>, while the density of corrugated cardboard T23 by the standard starts at 130 g/m<sup>2</sup>. The maximum carry load of cardboard boxes T23 is up to 35kg, while T24 is almost double – 60kg.

T24 cardboard has increased water resistance; meanwhile, T23 brand has a regular level of water resistance.

The thickness of cardboard of both brands is the same and remains in the span of 2.8 to 3.2 mm.

However, boxes made out of T24 cardboard are more expensive than those made out of T23 brand. Boxes made out of T23 cardboard are classified as “standard”, cardboard boxes made out of T24 cardboard are “premium class”.

Regardless of their profile, these brands may have a mixed composition (cellulose/wastepaper), as well as pure composition.

The main criterion for division of material in different types is the number of layers in its structure. Type “T” – its structure has 3 layers (“corrugation” is located between two smooth layers of cardboard). This type is very dense, often manufactured as sheets and has the highest demand around the world. Profile “C” – corrugation is considered to be average. Its height is from 3.2 to 4.4 mm, while the step is from 6.5 to 8.0mm. The materials of this profile are very firm and are almost not sensitive to mechanical impact. It responds well to die cutting, folds compactly and ergonomically. Profile “B” has small corrugation of 2.2 to 3.2mm in height. The distance between the peak points of neighbouring waves is 4.5-6.4mm. The materials have low amortisation, but their rigidity is increased.

The use of boxed made out of normal cardboard (T23) is justified during transportation of cargos which are not susceptible to humidity and in the instances when the weight of the transported cargo placed in one box is no more than 35kg. Therefore, taking into account the above and the cost of such corrugated cardboard, we use exactly this cardboard for the production of a container for the soldering station.

Production of the corrugated cardboard should take place in specialised premises with an area of roughly 800m<sup>2</sup>. Presence of a lifting mechanism, such as a hoist, is essential.

The temperature in the manufacturing area should not be lower than 18°C and humidity – no more than 80%.

Before the production begins, the paper rolls for corrugation and smooth layers of cardboard should remain in the process of air conditioning for one day in a room where the air temperature is no lower than 15°C.

The first stage consists not only of preparation of the raw materials, but also of organisation of the work process. In this time, the unit is equipped with paper rolls of different density. For the inner layers the density should be 100-140 g/m<sup>2</sup>, for the outer layers – 150-235 g/m<sup>2</sup>. The paper is unrolled and passed on to the intermediate rollers where it is moisturised and heated. The quality of corrugated cardboard depends on the quality of this stage.

The second stage is corrugation, appliance of glue and gluing. For corrugation, the flat paper is passed through the rollers with a wavy profile, which are heated to 150 – 180 °C. The glue is applied automatically using a special block. It is only applied on the peaks of corrugation. Then, the corrugated layer is fed through a special block. This is where the gluing together of the corrugated and the smooth layer takes place under pressure. A similar process takes place to put glue on the second side of the corrugated layer and gluing it to the second smooth sheet. Afterwards, drying takes place. It helps the glue to harden.

The third stage consists of cutting and scoring of the corrugated cardboard. Afterwards, it is laid on the pallets and sent to storage. The surface of the material is stamped if required.

The production of corrugated cardboard packaging consists of a few stages:

- The rolls of corrugated cardboard are cut into sheets of required dimensions using special cutting and scoring machines.
- A unicoloured or multi-coloured stamp is applied at the flexographic station.
- Billet formation for the boxes.
- Stitching of the boxes with a metal tape. Riveting of the edges of the box with a metal tape (ornament) is a relatively expensive method, but the box ends up being well presented and very firm. Boxes riveted with an ornament are usually used for long term storage of various goods. The metal tape (ornament) is made out of thin tinplate (0.25 mm). The ornaments on the ornament tape can be of various shapes.



*Figure 1 - Packaging for the soldering station*

Thus, for the production of cardboard containers for soldering stations, it is better to use a three-layer cardboard with a “C” profile, and use a metal thread to stitch the walls to increase the reliability of the package.

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## Исследование производства картонной тары для паяльных станций

**Е. А.Талалаева**

ФГБОУ ВО «Тамбовский государственный технический университет», Тамбов, Россия  
e-mail: talalaewa95@yandex.ru

**Аннотация.** Тара служит основным средством для обеспечения сохранности производимой продукции в процессе ее транспортирования, хранения и потребления. Технология изготовления тары из картона и гофрокартона зависит от имеющегося оборудования на предприятии. Оборудование для картонной упаковки выбирается исходя из планируемых объемов производства, номенклатуры и конструкции коробки. В исследовании рассматривается технология изготовления картонной тары для паяльной станции, а так же производится сравнения материалов для ее изготовления.

**Ключевые слова:** гофрокартон, картонная упаковка, производство гофрокартона.



## Modeling Problems of Rapid Gravity Flow of Granular Media

A.A. Zhilo

Tambov State Technical University, Tambov, Russia

\*e-mail: : zhilo97@mail.ru

### Abstract

Modeling of fast gravitational flow of granular media presents several challenges due to the complex nature of the phenomenon. This article reviews the current understanding of the mechanisms and kinetics involved in the particle separation of granular materials, as well as the quasi-thermal effects that occur during fast gravity flow. The formation of shear stress and transversal mass transfer during rapid gravity flow, and the difficulties associated with accurately modeling these phenomena are examined. The article highlights the need for further research to improve our understanding of fast gravity flow of granular media, and to develop more accurate and effective modeling approaches.

**Keywords:** behavior patterns, granular media, mass transfer, phenomenological analysis, rapid gravitational flow, segregation.

Granular media are materials consisting of a large number of individual particles that interact with each other through contact forces. The behavior of granular media is often characterized by their fast gravity flow, which is a result of their unique physical properties, such as high compressibility and low permeability. Modeling the fast gravity flow of granular media is an important research topic in various fields, including chemical engineering, geophysics, and civil engineering. However, this problem poses several challenges due to the complex nature of the phenomena involved.

One of the main challenges in modeling fast gravitational flow of granular media is the lack of a comprehensive understanding of the underlying physics. The behavior of granular media is strongly influenced by various factors such as particle size, shape, and density, as well as the surrounding environment, such as temperature, humidity, and pressure. These factors can affect the interparticle forces, resulting in complex and nonlinear behaviors such as segregation, jamming, and fluidization [1]. Moreover, granular media can exhibit different flow regimes, including plug flow, chute flow, and avalanche flow, which require different modeling approaches [2].

Another challenge in modeling fast gravity flow of granular media is the difficulty in accurately characterizing the material properties. Granular media are often heterogeneous, with particles of different sizes and shapes, as well as internal voids and cracks. These features can affect the flow behavior and make it challenging to measure material properties such as porosity, permeability, and dynamic friction [3]. Moreover, granular media can experience significant deformation during flow, leading to changes in the particle size distribution and shape, which further complicates the modeling process.

The third challenge in modeling fast gravity flow of granular media is the need to

account for various transport processes, such as mass transfer, heat transfer, and momentum transfer. These processes can significantly affect the flow behavior and require the use of advanced modeling techniques, such as computational fluid dynamics (CFD) and discrete element method (DEM) [4]. However, these techniques are computationally expensive and require significant computational resources, making it difficult to apply them to real-world applications.

Despite these challenges, significant progress has been made in modeling fast gravity flow of granular media. Researchers have developed various modeling approaches, including continuum models, discrete models, and hybrid models, to capture the complex behaviors of granular media. Moreover, new experimental techniques, such as X-ray tomography and particle image velocimetry (PIV), have been developed to better understand the flow behavior and validate the models [1].

In conclusion, modeling fast gravity flow of granular media is a challenging problem due to the complex nature of the phenomena involved. The behavior of granular media is strongly influenced by various factors, and the lack of a comprehensive understanding of the underlying physics makes it difficult to accurately model. However, significant progress has been made in this area, and new modeling approaches and experimental techniques continue to be developed to better understand the flow behavior of granular media.

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## Проблемы моделирования быстрого гравитационного течения гранулированных сред

А.А. Жило

ФГБОУ ВО «Тамбовский государственный технический университет», Тамбов, Россия  
*e-mail: zhilo97@mail.ru*

**Аннотация:** Моделирование быстрого гравитационного течения гранулированных сред представляет собой ряд проблем из-за сложной природы этого явления. Рассмотрено современное понимание механизмов и кинетики, участвующих в быстром гравитационном течении гранулированных материалов, а также квазитепловые эффекты, возникающие во время быстрого гравитационного потока. Изучены особенности формирования напряжения сдвига и поперечного массопереноса во время быстрого гравитационного потока, а также трудности, связанные с точным моделированием этих явлений. Отмечается необходимость дальнейших исследований для улучшения нашего понимания быстрого гравитационного течения гранулированных сред, а также для разработки более точных и эффективных подходов к моделированию.

**Ключевые слова:** модели поведения, гранулированные среды, массоперенос, феноменологический анализ, быстрый гравитационный поток, сегрегация.

## The Issue of Destructive Effects on a Distributed Information System

**Almali Aaya Adnan Latif**

Tambov State Technical University, Tambov, Russia

*e-mail: Ayaalmali@outlook.com*

### Abstract

Destructive influences that have an impact on the functioning of distributed information systems are studied. A model of a distributed information system is described, considering their influence, which will underlie the optimization task of finding the optimal structure of such a system.

**Keywords:** distribution information system, optimizing, model.

### Introduction

Due to their prevalence and harmful effects, the topic of toxic influences is still relevant today. The primary cause of humanity's troubles is the damaging impact of information systems. The world of modern computing consists of a vast and extremely complicated array. The entire multifarious and integrated system manages a vast array of duties in various spheres of human activity, from simple computer-based homework to controlling intricate technological operations [1, p. 290].

One of the reasons for the complexity of ensuring the security of software systems is the presence of programs that were originally designed to perform destructive actions, thereby creating a security risk. These programs have been given the generic term destructive influence programs [2, p. 89].

Many leading companies have built complex distributed systems to process billions of requests and updates without downtime [3, p. 3]. A distributed system is a collection of computers working together to form the end user's computer. The interdependent computers are networked to easily share and exchange information. Noteworthy is the fact that distributed systems must share a common network to connect their components. In contrast to traditional databases archived in a single system, in a distributed system a user should be able to communicate with any system without knowing that it is a single information system. [4, p.45]

In a homogeneously distributed database, each system uses a data model as well as a database management system and data models. They are generally easier to manage by adding nodes. Heterogeneous databases, on the other hand, allow for multiple data models or different database management systems that use gateways to transform data between nodes. Distributed systems are used everywhere [5, p.347].

The success in almost all areas of social life largely depends on the output of modern computer networks. Each year, the spatio-temporal pattern of destructive impact scenarios, characterized by the presence of a destructive impact force that involves either a massive attack on the attacked object (e.g., a DDoS attack) or a covert attack to penetrate the target, is increasing allows. Moreover, the process of automating destructive impact scenarios allows you to calculate vulnerabilities to

find entry points into a destructive system, with the possibility of changing it during "gap patching", with cybersecurity tools. Another peculiarity is the decentralization of the regulating systems of destructive influences.

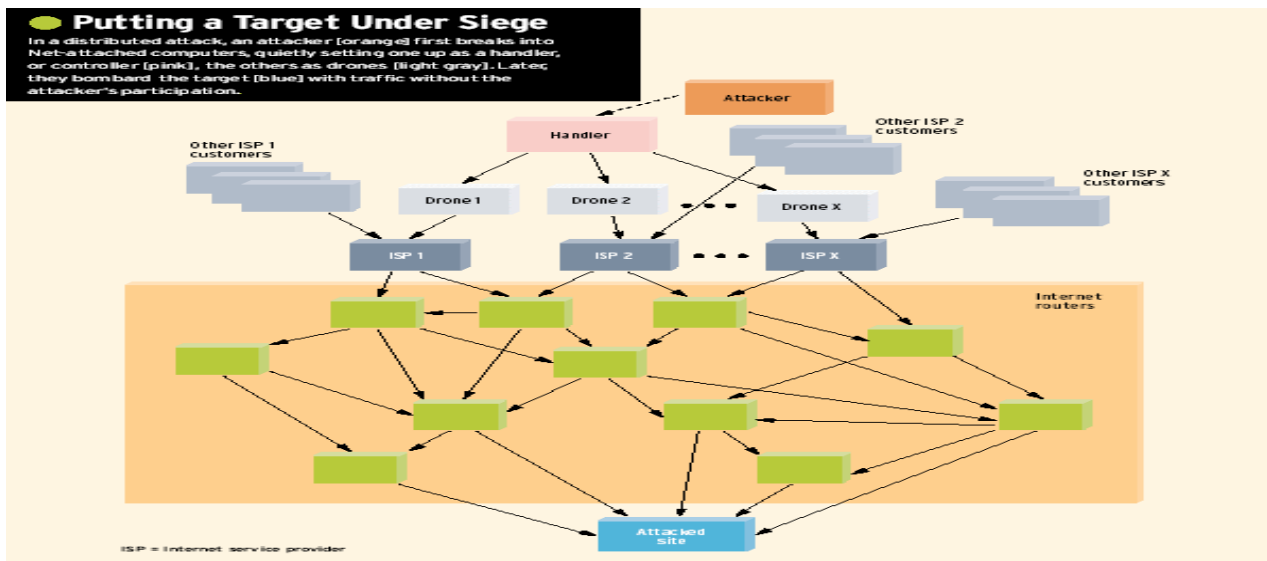


Figure 1 - Ddos attack

Protective devices do not have time to detect harmful effects during the dynamic change of phases of harmful effects.

The damage caused by disruptions in the operation of computer networks; this threat is caused by vulnerabilities in antivirus protections. Implementation of this threat is possible if: the user uses third-party distributions; there is no virus check before installing the distribution. The danger connected to the use of vulnerable software versions is the possibility that the author may have destructive effects on the system by exploiting vulnerabilities in the software. This threat is caused by vulnerabilities in software vulnerability scanning mechanisms. The implementation of this threat is possible if the software is not checked for the presence of vulnerabilities before use. The following is a representation of the distributed information systems model:

$$F = (H, S, Q, M, Z) \quad (1)$$

where  $H$  is a set of elements of the system ;  $S$  is the structural topology of the system;  $Q$  is the set of states the performance of the system ;  $M$  is the intruder model;  $Z$  is the set of means of protection.

Moreover, the, the perpetrator model of attacking elements of a distributed system is formulated as follows:

$$H_{almask} = (Alg, EL, S, B, T), \quad (2)$$

where  $H_{almask}$  is the model with the attackers;  $Alg$  is a set of destructive algorithms run by an attacker on a system component;  $EL$  are structural and functional elements arranged according to the topology  $S$ , on which destructive algorithms are executed;

$B$  is the attacker's knowledge base;  $T$  is the running time of the algorithm. Since one of the main characteristics for the success of a destructive impact is the minimization of its execution time and the search for the optimal configuration of distributed negative elements, the elements of the structural topology of a distributed information system are located in order to protectively build mechanisms that counteract these destructive influences. This analyzes the most sensitive elements of the system and optimizes the design of the security system.

### **Conclusion**

A model of a distributed information system is described. This model will serve as the foundation for the optimization task of determining the best possible structure for such a system. The output of contemporary computer networks, which seeks to minimize its execution time and find the ideal configuration of scattered negative aspects, heavily influences the outcome of operations in practically all spheres of social life.

### **Acknowledgements**

I would like to express my gratitude to my supervisor Yori Minin and my family, who guided me and enabled me to complete this work.

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## **К вопросу о деструктивных воздействиях на распределенную информационную систему**

**Алмали Аайя Аднан Латиф**

ФГБОУ ВО «Тамбовский государственный технический университет», Тамбов, Россия  
*e-mail: Ayaalmali@outlook.com*

**Аннотация.** Изучаются деструктивные воздействия, оказывающие свое влияние на функционирование распределенных информационных систем. Описывается модель распределенной информационной системы с учетом их влияния, которая будет лежать в основе оптимизационной задачи поиска оптимальной структуры такой системы.

**Ключевые слова:** распределительная информационная система, оптимизация, модель.

## Increasing the Accuracy of the Estimation Distance to the Target

E.A. Antonov\*, S.N. Danilov

Tambov State Technical University, Tambov, Russia

\*e-mail: e.a-nov98@mail.ru

### Abstract

The purpose of this study is to analyze the effectiveness of applying a motion model based on a system of second-order differential equations in servo filters. For this, a mathematical model of the tracking filter was synthesized and a study of the dependence of the change a rms estimation distance to the target on the filter settings was made.

**Keywords:** distance to the target, filter, movement model.

### Introduction

The efficiency and safety of using the airspace of the Russian Federation is ensured by Joint ATM System. The main sources of radar information in this system are radar stations and radar complexes. Therefore, it is necessary to ensure high accuracy of the output data from the radar for the correct operation of the entire system.

The real trajectory of the target is a continuous space-time function that can be approximated by a certain system of equations expressing the main laws of the process of target movement. Since the movement of targets occurs under the influence of many forces and factors, which cannot be fully taken into account, simplified models are used in practice.

In practice, alpha-beta, alpha-beta-gamma and simplified Kalman filters are the most widely used as a model of target movement. However, studies show that the trajectories of most aircraft contain a significant harmonic component [1]. The spectral representation of the change in the relative distance of the radar-target for two typical trajectories (turn – 1 and traverse flight – 2) has the form (Fig. 1).

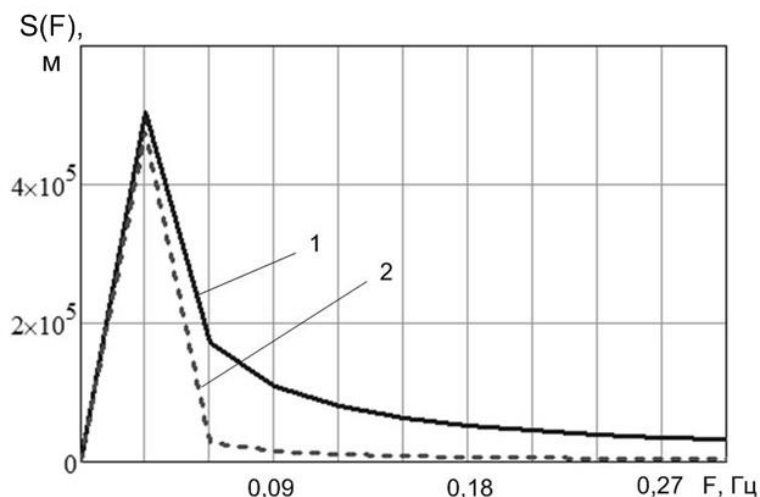


Figure 1- Spectral representation

Figure 1 shows the presence of a clear oscillatory component at a frequency of approximately 0.03 Hz. And this is typical for most types of maneuvers.

Therefore, it seems appropriate to apply a model based on a system of second-order differential equations. The matrix representation of this model is shown in Fig. 2 ( $\alpha$  and  $b$  are constant coefficients characterizing the main frequency of the link and damping.)

$$F := \begin{bmatrix} 1 - \alpha \cdot dt & (1 - \alpha \cdot dt)^2 \\ -b^2 \cdot (1 - \alpha \cdot dt)^2 & 1 - \alpha \cdot dt \end{bmatrix}$$

Figure 2 - Second-order equation

A model of a secondary data processing system in the Mathcad software environment has been developed. The model uses a data evaluation filter built on the basis of Markov linear filtering algorithms using data from a rangefinder.

As input data for the filter, a signal was formed in a discrete form (Fig. 3). The result of the filter is the estimated distance to the target.

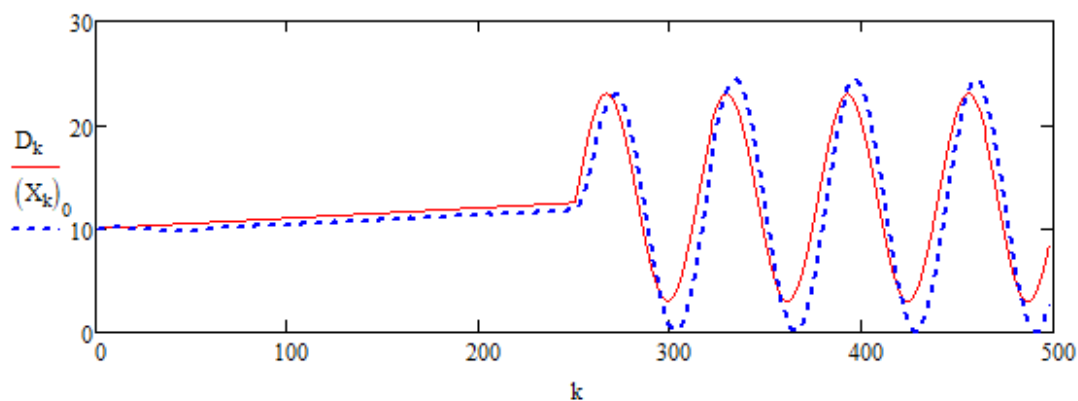


Figure 3- Signals at the input and output of the filter

The variable  $\Delta D$  was introduced to determine the accuracy of the estimate. This variable represents the difference between the estimated distance to the target and its true value. Then the standard deviation of this variable was found.

Based on this mathematical model, a study was made of the change in the accuracy of estimating the distance to the target depending on the coefficient  $\alpha$  and the average intensity of the maneuver  $\sigma$ . A plot of rms  $\Delta D$  (Fig. 4, vertical axis, m) versus  $\alpha$  and  $\sigma$  (horizontal axis) is shown below.

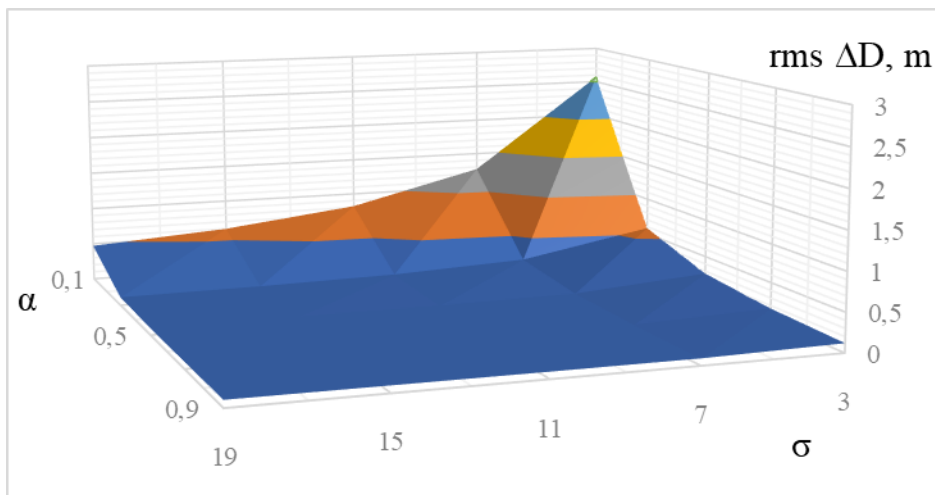


Figure 4 - A plot of the rms  $\Delta D$  versus  $\alpha$  and  $\sigma$

### Conclusion

On the basis of the data obtained, it can be concluded that the use of the second-order equation as a model and the selection of the optimal values of  $\alpha$  and  $\sigma$  make it possible to achieve high accuracy in estimating the distance to the target.

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## Повышение точности оценки расстояния до цели

Е.А. Антонов\*, С.Н. Данилов

ФГБОУ ВО «Тамбовский государственный технический университет», Тамбов, Россия

\*e-mail: e.a-nov98@mail.ru

**Аннотация.** Целью данного исследования является анализ эффективности применения модели движения, основанной на системе дифференциальных уравнений второго порядка, в следящих фильтрах. Для этого была синтезирована математическая модель следящего фильтра и проведено исследование зависимости изменения среднеквадратичной величины погрешности оценки дальности до цели от параметров настройки фильтра.

**Ключевые слова:** модель движения, расстояние до цели, фильтр.



## **Information Protection of Software for Automated Scheduling of Medical Procedures**

**A. P. Bagryantseva\*, S. V. Ivanov, K. I. Patutin**

Tambov State Technical University, Tambov, Russia

\*e-mail: bagryantseva2000@yandex.ru

### **Abstract**

This article touches on the topic of protecting information from unauthorized access by intruders to confidential information. The relevance of this problem is growing every year as the methods of interception of information improve. The protection of personal data of patients and employees of the sanatorium by encoding user passwords in the system database is considered. The process of data encryption by the DES-ECB (Data Encryption Standard - Electronic Code Book) algorithm is described. The rationale for choosing this method is also given.

**Keywords:** block, conversion round, databases, DES-ECB, information protection.

### **Introduction**

Information protection is an activity aimed at preventing leakage of protected information, unauthorized and unintended impacts on protected information [1]. Every year, attackers are developing new and improving old methods of intercepting important information, which requires constant improvement in the reliability and security of data storage. Therefore, in systems that have access to people's personal data, it is necessary to take measures to protect this data [2]. The purpose of this study is to organize the protection of personal data of users of the developed scheduling software.

### **Organization of information protection in software**

In the developed system for automating the scheduling of appointments in treatment rooms, all the necessary information is stored in a database, namely: personal information about clients, employees, medical information about clients, data on the organization of the treatment process, and more. Interaction with this information is carried out through the application.

It is necessary to implement data protection against interception by intruders. It can be done by encoding passwords that are used for authorization when logging in.

Authorization is one of the most important elements of this system, since there are many users working in it, and each group of persons (administrator, doctors, medical staff, clients) must have different access rights to information. This is done by entering the user ID and his personal password, which is issued at the stage of registration in the system of an employee or vacationer.

Encoding in the system is used to protect user passwords from being used by intruders. Passwords are stored in encrypted form in the database, during authorization, the password is encoded and compared with the one recorded in the database. The decrypted passwords are displayed in the user tables in the admin section. Thus, even if an attacker intercepts passwords from the database, he will not be able to log in.

A block symmetric encryption algorithm based on the Feistel DES network in ECB mode is used for encoding (Fig. 1).

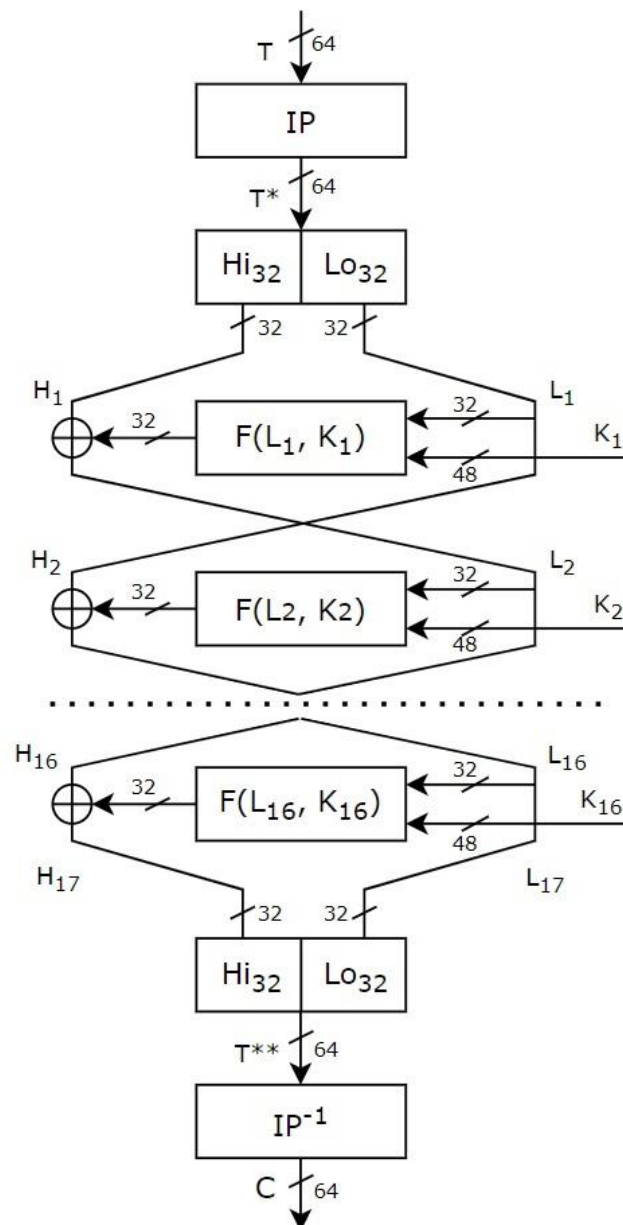


Figure 1 - DES-ECB block encryption scheme

The DES-ECB algorithm uses several encryption methods:

- replacement;
- permutation;
- gamming.

The DES-ECB algorithm looks like this:

1. The encoded message is divided into blocks of 64 bits, if the message length is less than 64 bits, then the missing bits are added to the right. Each block is encoded independently of the others.
2. An initial bit permutation is applied to each block.
3. The block is divided into two halves of 32 bits each.
4. The right half is modified by the encryption function using a key element.
5. We scale the left half and the result of point 4.
6. We get two new blocks: as the left half we take the unmodified right part, as the right - the result of paragraph 5.

7. Paragraphs 4-7 are repeated 16 times (16 rounds of conversion). In the last round, the two blocks do not exchange values.

8. The half-blocks are folded into a whole block, to which the final permutation of bits is applied. The resulting 64-bit sequence is an encrypted message block.

Each round of conversion uses different key elements generated from the encryption key.

The decryption process follows an identical algorithm, but the key elements are used in reverse order.

### **Conclusion**

In that way, information protection is a necessary component for most systems working with personal and other important data. Coding is a good way to hide important information from intruders. The DES-ECB algorithm used is easy to implement, which ensures high speed of information processing. This is necessary for authorization, and encoding passwords in the form of simple sequences of numbers does not require more complex algorithms.

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## **Защита информации программного обеспечения автоматизированного составления расписания лечебных процедур**

**А. П. Багрянцева\*, С. В. Иванов, К. И. Патугин**

ФГБОУ ВО «Тамбовский государственный технический университет», Тамбов, Россия

*\*e-mail: bagryantseva2000@yandex.ru*

**Аннотация.** В данной статье затрагивается тема защиты информации от несанкционированного доступа злоумышленников к конфиденциальной информации. Актуальность данной проблемы растет с каждым годом по мере улучшения способов перехвата информации. Рассматривается защита персональных данных пациентов и работников санатория с помощью кодирования паролей пользователей в базе данных системы. Описывается процесс шифрования данных алгоритмом DES-ECB (Data Encryption Standard - Electronic Code Book). Также приводится обоснование выбора данного метода.

**Ключевые слова:** DES-ECB, базы данных, блок, защита информации, раунд преобразования.

## **Informationssystem zur Verwaltung der Interaktion mit Café-Kunden**

**V. Y. Barsukova**

Staatliche Technische Universität Tambow, Tambow, Russland

*E-mail: barsukova\_valeria@mail.ru*

### **Zusammenfassung**

Das Ziel dieser Studie ist es, ein Informationssystem für das Management der Interaktion mit den Kunden des Cafés zu entwickeln. Die Studie wird den Prozess der Gestaltung eines Informationssystems zur Verwaltung der Interaktion mit Café-Kunden untersuchen. Die Dringlichkeit der Studie besteht darin, dass Mitarbeiter in jedem Unternehmen ihre beruflichen Fähigkeiten verbessern müssen. In diesem Zusammenhang ist es notwendig, ein Informationssystem zu entwickeln, das die Erfüllung dieser Anforderung ermöglicht.

**Schlüsselwörter:** Interaktion mit Kunden, Café, Industrieunternehmen, Modell, Informationssystem.

Die Aktualität des Themas wird dadurch begründet, dass in den heutigen Realitäten des sich schnell entwickelnden technologischen Fortschritts Fragen der Optimierung von Kundenregistrierungsprozessen und Bestellungen in Unternehmen von entscheidender Bedeutung sind. Es gibt auch ein Problem des verpassten Gewinns von Handelsunternehmen, das durch die Notwendigkeit einer langen Reaktion auf die Bestellung oder Registrierung des Kunden verursacht wird, was die Entwicklung neuer Wege und Ansätze zur Verwaltung des Ausführungs- und Registrierungsprozesses von Aufträgen und Kunden erfordert. Daher ist die Entwicklung der Forschung zu den Problemen der Organisation, Registrierung und Verwaltung von Aufträgen im Unternehmen sowie die Interaktion von Kunden und Dienstleistern ein wesentliches Element bei der Lösung vieler wirtschaftlicher Probleme. Um dieses Problem zu lösen, ist es erforderlich, eine spezielle Software für das Auftragsmanagement und die Kundenrechnungskontrolle unter Berücksichtigung der Besonderheiten von Café-Dienstleistungsunternehmen zu entwickeln.

Die Bequemlichkeit der Automatisierung und Informatisierung der Prozesse des Cafés ist offensichtlich, da dies die Zeit für die Registrierungsprozesse der Kunden und ihrer Bestellungen erheblich reduzieren wird, den Prozess des Eingangs und der Annahme der Bestellung durch den Manager vereinfacht und die Berechnung in kürzester Zeit ermöglicht. Bei der Gestaltung der Struktur wurden folgende Punkte berücksichtigt: Die Lösung der gleichen Probleme und Aufgaben wird nicht von verschiedenen Abteilungen verwaltet; Die effektive Lösung der Probleme einer Abteilung (Abteilung) wird anderen Abteilungen nicht zugewiesen. Dies wiederum stellt eine unabhängige Position jeder Abteilung gegenüber anderen sicher. Jede Abteilung hat einen eigenen Vorgesetzten (Abteilungsleiter), dem bestimmte Aufgaben in der Leitung der Abteilung zugewiesen sind. Der Abteilungsleiter bereitet die Materialien für die Veröffentlichung in den entsprechenden

Arbeitsbereichen vor.

Das Management des Unternehmens erfolgt auf der Grundlage seiner Organisationsstruktur, die vom Leiter selbst bestimmt wird. Die Organisationsstruktur des Cafés ist in Abbildung 1 dargestellt.

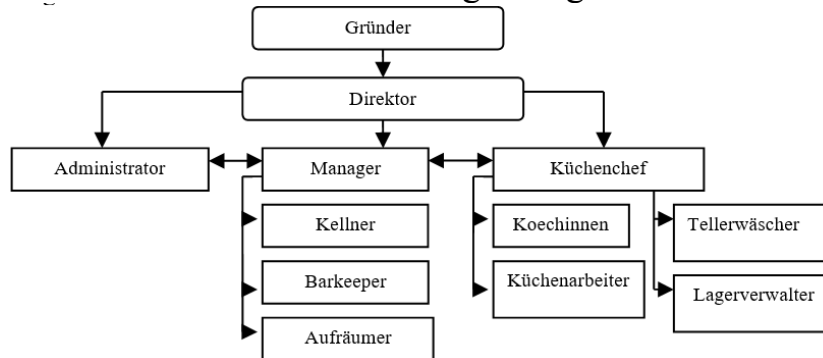


Abb. 1 – Die Organisationsstruktur des Cafés

Das Hauptproblem, das bei der Arbeit des Vertriebsleiters für die Kundenbetreuung auftritt, ist das Fehlen eines automatisierten Informationssystems, das die Effizienz der Abteilung verbessert.

Die IDEF0-funktionelle Modellierungsmethodik ist eine Teilmenge der SADT-Strukturanalyse- und Konstruktionsmethodik. Die IDEF0-Methodik kann verwendet werden, um eine Vielzahl von automatisierten und nicht automatisierten Systemen zu modellieren.

Die Hauptkomponenten eines IDEF0-Diagramms sind Blöcke, die einige Arbeiten, Funktionen und Aufgaben anzeigen, die innerhalb einer bestimmten Zeit auftreten oder ausgeführt werden und einige Ergebnisse aufweisen. Die Blöcke werden als Rechtecke angezeigt. Jede Seite der Funktionseinheit hat einen anderen Zweck.

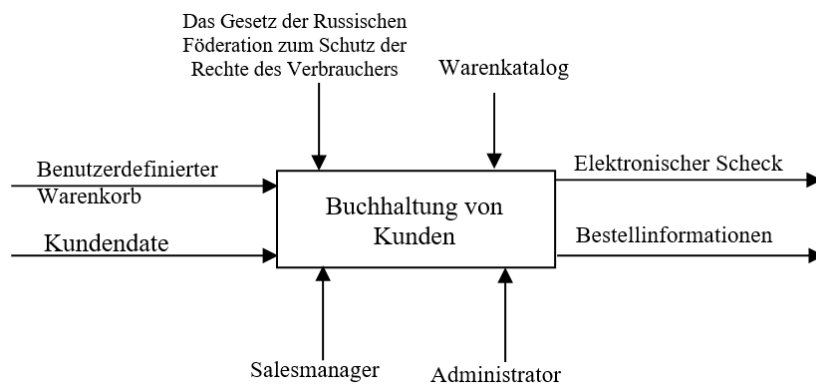


Abb. 2 - Kontextdiagramm

Die linke Seite ist für den Eingang vorgesehen. Eingang → Material oder Informationen, die verwendet oder konvertiert werden, um ein Ergebnis (Ausgabe) zu erhalten.

Die rechte Seite ist für den Ausgang vorgesehen. Ausgabe → Ergebnis der Funktionsausführung.

Die Oberseite wird zur Steuerung verwendet. Management → Bedingungen, Regeln, Strategien, Standards, die die Funktionsausführung beeinflussen.

Die Unterseite wird für Mechanismen verwendet. Mechanismus → Ressourcen, mit denen die Arbeit ausgeführt wird.

So ist auf der Grundlage der erhaltenen Funktionsmodelle eine Software (Software) entwickelt, die den Betrieb des Cafés steuern soll. Nach der Einrichtung des Informationssystems wird das Café durch die Entwicklung eines Kundeninformationssystems verbessert, das es ermöglicht, die Arbeitseffizienz und den Gewinn des Unternehmens zu verbessern.

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## **Информационная система управления взаимодействием с клиентами кафе**

**В. Ю. Барсукова**

ФГБОУ ВО «Тамбовский государственный технический университет», Тамбов, Россия  
*e-mail: barsukova\_valeria@mail.ru*

**Аннотация.** Целью данного исследования является разработка информационной системы управления взаимодействием с клиентами кафе. В исследовании будет рассмотрен процесс проектирования информационной системы управления взаимодействием с клиентами кафе. Актуальность исследования заключается в том, что на любом предприятии сотрудникам необходимо повышать свои профессиональные навыки. В связи с этим необходимо разработать информационную систему, которая позволит обеспечить выполнение данного требования.

**Ключевые слова:** взаимодействие с клиентами кафе, промышленное предприятие, модель, информационная система.

## **Internet User Classification and Identification without Using Personal Data**

**N. R. Bekkulov**

Tambov State Technical University, Tambov, Russia  
*e-mail: nbrmailteens@yandex.ru*

### **Abstract**

The tasks of developing new accurate methods for identifying and classifying Internet users are relevant at the present time. The article discusses the existing methods for solving these problems: data storage, user classification technologies from Google and Apple, fingerprint identification, cloud services. Their strengths and weaknesses are analyzed. It is shown that a common disadvantage of these methods is the lack of accuracy in user identification. This study presents a new method that uses machine learning algorithms and public anonymized user data. Its main advantage is the ability to identify a unique user for several devices, as well as high accuracy for one specific terminal. Potential areas of application of the new online identification method: internet marketing and anti-fraud technologies.

**Keywords:** cookies, personal data, unique user signature technology.

### **Introduction**

In the next few years, the world of Internet marketing and online anonymity will be undergoing significant changes: global IT giants are struggling with the use of personal user data by various services.

For the first time, Apple limited the use of users' personal data in its Safari browser in 2016 [1]. In 2018 [4] Firefox prohibits the use of personal data on its browsers for ad targeting. In 2023 [5], Google plans to completely refuse cookies in its Chrome browser.

The main claim to the technologies for storing user data on the network is the lack of a guarantee of their confidentiality [6]. Third party data files installed on websites collect too much information about users. Using this data (history of search queries, page views, filling in fields in data entry forms, etc.) it is possible to identify a specific person, which is a serious threat to privacy.

### **Technology review**

First, it is necessary to explain what cookies are. Cookies are first-party cookies set directly by the domain, and third-party cookies set by a third-party script. Stored on the device either permanently or temporarily. First-party cookies are created when a user takes an action on a website they visit. Third-party cookies are created by other resources, for example, using the code integrated into the site. When you add the Google Analytics or Yandex.Metrica code, third-party cookies are generated on the site - these are the ones that large IT companies plan to completely abandon.

Alternatives for identifying and personalizing the user in the web without using of cookies.

### **Data storages**

SessionStorage and localStorage, unlike cookies, do not send data to the server, but are stored locally by the user. The widespread use of data warehouses is hindered by the fact that the technology does not support not only cross-domain transitions, but also sub-domain ones. Thus, companies will not be able to collect data for analytics even from their own subdomain. In addition, most browsers already impose a limit on the storage of localStorage, and this calls into question the existence of technology in principle.

### **FLoC**

IT giant Google has introduced its alternative to cookies - Federated Learning of Cohorts (or simply FLoC) technology, which uses artificial intelligence algorithms. According to the company, Google will provide results up to 95% of the cookie technology.

If cookies are aimed at personalization and collect data about a specific user, then the main principle of this technology is to combine users into groups (cohorts), the upload of which data is impossible for marketers.

The possibility of refusing cookies when using this technology raises doubts. For example, many companies, including Brave and Vivaldi, will disable the technology in their browsers and websites as they question user safety. An alternative point of view is as follows: one of the drawbacks of the technology is the possibility that companies can learn about user preferences without proper permission. For example: a user searched for flower delivery on Google, and Facebook found out about it. Thus, due to refusals of companies to deploy FLoC technology, its effectiveness is currently being questioned.

### **SKAdNetwork**

This technology is developed by Apple; it is an analogue of the FLoC technology from Google described above. According to the developers, the goal of SKAdNetwork is “to help advertisers measure the effectiveness of their marketing, but protect user privacy” [3].

Analytics is also built around user groups, but a significant difference from FLoC is that the next day after the user's action; the information received cannot be edited or supplemented in any way. Accordingly, if the client uses the site constantly for a long time, then it will be impossible to calculate some metrics, for example, LTV (profit from the client for all time), which makes it difficult for this technology to work in general.

At the moment, companies use this technology more often than Google's analogue FLoC [2]. However, it is noteworthy that after changing the privacy policy regarding IDFA (Unique User Identifier), the situation may change rapidly. The user will additionally be prompted for permission to obtain an IDFA similar to push notifications or geolocation access. It is expected that due to a direct request for the use of data, less than 20% of users will agree to this.

### **Fingerprint identification**

The technology has been around for quite some time, but is only used for part of the traffic - if IDFA is not available due to a user ban. The principle is based on collecting various information (IP address, operating system version, screen size, phone model, installed extensions, etc.) to assign a unique user ID.



Fingerprint identification could be a great replacement for cookies, but the accuracy of the technology is rather low. Someone uses the preset phone settings, while someone, on the contrary, often changes the settings of their device. It turns out that different users can be assigned either the same identifier, or vice versa – one user can install several.

However, fingerprints are even more effective than cookies in some situations. For example, if a person turns on incognito mode, then new cookies are generated, and as a result we will have two identical users under different identifiers. But thanks to the information received from fingerprints, we can uniquely identify these two identical cookies and assign them the same identifier.

Fingerprint technology is beginning to be limited, but so far this applies only to some browsers. Even if it is completely banned in all browsers, there are new implementation options. For example, American specialists have developed CBF, that is, cross-browser fingerprinting, which takes into account only system indicators, regardless of the browser.

### **Server-side Tagging**

An alternative to the cookie tracking method. The principle is based on the creation of an intermediate cloud server between the user's computer and the end service. First, the user sends a request to the cloud server, where it is processed and sent to a third-party end server.

One of the main advantages of this method is security. The user will be limited in access to the logic that is used to transfer data, which means that third-party services will not be able to get information from the cloud intermediate server.

The use of this technology can also extend the life of first-party cookies for a period set by a specialist (for example, two years). If we talk about third-party, then it is important to set up end-to-end analytics, because without it, third-party cookies are incompatible with Server-side Tagging technology.

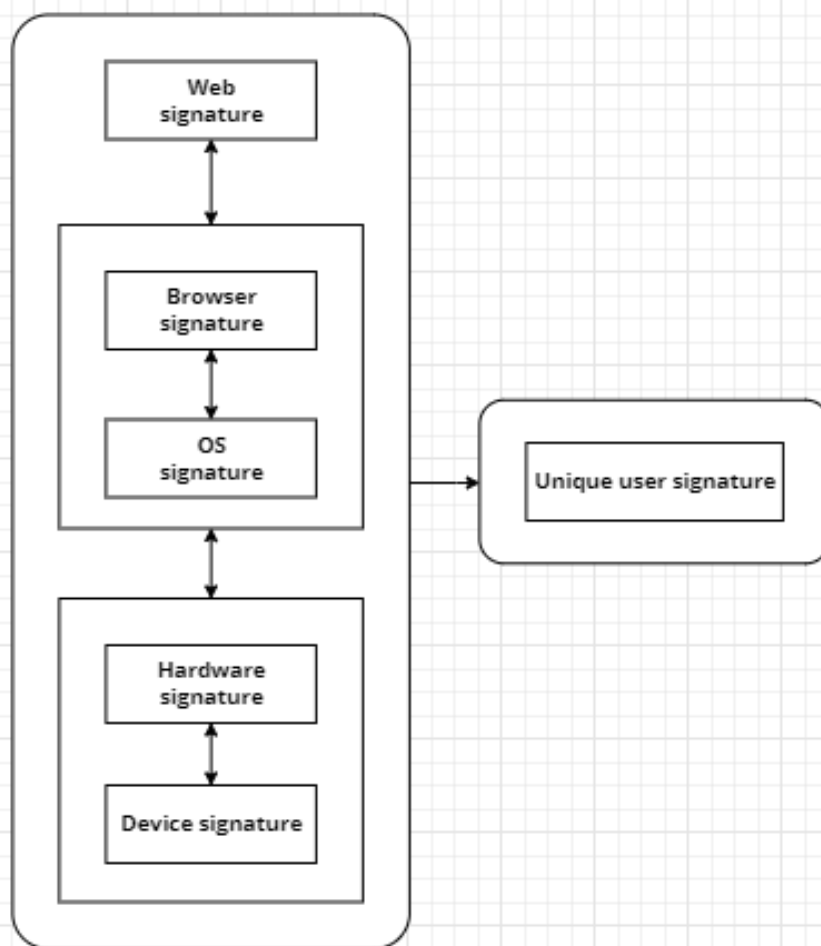
In view of the foregoing, we can conclude that a common drawback of these technologies is the lack of accuracy in user identification, as well as the danger of deanonymizing a particular person.

The forecast for the use of these technologies is that in the next few years they will show lower efficiency compared to the outgoing cookie technologies. It will take them one to three years to reach cookie performance level and increase their efficiency.

### **Unique User Signature**

To solve these problems, another technology that determines a unique user on the network using an array of anonymized data using machine learning algorithms – “Unique User Signature” can be applied.

This technology is based on the use of several layers of data to determine and assign a unique digital identifier to a specific user on the network. There are five main layers of data in this technology: device-specific footprint, individual digital terminal hardware configuration footprint, operating system footprint, browser footprint, general network footprint (Fig. 1).



*Figure 1 -UUS technology block diagram*

As can be seen from Fig. 1, the data are collected, subdivided into levels and analyzed in aggregate by machine learning algorithms to identify a unique user in the network.

It is assumed that due to the deep analysis of general data ranked by levels this technology will enable to determine with high accuracy a unique user on the network, as well as to determine the various devices that the same person uses to access the Internet. The UUS uses only non-personal data.

### **Conclusion**

In connection with the rejection of cookie technologies, ensuring greater security and privacy of user data, Internet giants, a host of IT companies and Internet marketers are striving to find or develop an effective alternative for classifying and identifying users on the network.

Most of the existing no-cookie technologies currently allow identifying unique users on the network with reduced accuracy and do not allow identifying one specific user for several devices.

The UUS technology, in theory, will allow you to identify with high accuracy a unique user on the network, as well as all his devices with Internet access. Further research will be aimed at establishing qualitative characteristics in the effectiveness of the developed the UUS technology.

No-cookie technologies will also be actively used in Internet marketing and anti-fraud. It is assumed that new technologies for classifying and identifying users on the web will completely replace the use of cookies in the next 1-3 years.

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## Классификация и идентификация пользователей в сети без использования личных данных

Н. Р. Беккулов

ФГБОУ ВО «Тамбовский государственный технический университет», Тамбов, Россия  
*e-mail: nbrmailteens@yandex.ru*

**Аннотация.** Задачи по разработке новых точных методов для идентификации и классификации интернет-пользователей являются актуальными в настоящее время. В статье рассмотрены существующие методы решения этих задач: хранилища данных, технологии классификации пользователей от компаний Google и Apple, отпечаток пальца, использование промежуточного облачного сервиса. Проанализированы их сильные и слабые стороны. Показано, что общим недостатком этих методов является недостаточная точность в идентификации пользователей. В работе представлен новый метод, использующий алгоритмы машинного обучения и общедоступные обезличенные данные пользователя. Основным его преимуществом является возможность идентификации уникального пользователя для нескольких устройств, а также высокая точность для одного конкретного терминала. Потенциальные сферы применения нового метода идентификации в сети: интернет-маркетинг, технологии противодействия мошенничеству.

**Ключевые слова:** cookies, личные данные, технология unique user signature.

## **Development of an Information System for an Online Store of Computer Components**

**V. O. Chukanov\***

Tambov State Technical University, Tambov, Russia

*\*e-mail: chukanov.00@mail.ru*

### **Abstract**

The purpose of this study is to develop an information system for an online store of computer components. The paper will consider the advantages and necessity of an electronic store. The relevance of the study is due to the fact that with the advent and development of electronic money and electronic payment systems, an increasing number of people prefer electronic payments. This is convenient and profitable for both the buyer and the seller.

**Keywords:** online store, information system, Internet.

### **Introduction**

The rapid development of the Internet, the use of the latest technologies and communications in commercial activities and everyday life has led to the emergence of new economic phenomena, such as e-commerce. In the field of trade, the Internet provides new channels for the sale of goods, opens up wide opportunities for advertising and marketing research, which is especially important from the point of view of acute competition in a market economy.

### **Description of the subject area**

The electronic store will not cease to be relevant. Moreover, its relevance is only increasing. You can visually compare the pros and cons of electronic and traditional stores. The advantages of the traditional are in personal contact with the product. However, the advantages of an electronic store are convenience. In an online store, you can view huge lists of products in a short period of time. As well as payment from any convenient point. In an online store, you can view huge lists of products in a short period of time. As well as payment from any convenient point. On the part of the store owner, the benefit is also a plus. An online store can serve several hundred customers at the same time. The cost of the online store, including delivery, is significantly lower than that of a regular one.

The following departments are usually present at an enterprise that trades via the Internet:

- sales department
- marketing department
- purchasing department
- accounting department
- Information Technology Department
- postal department

The main functions of the sales department include: online consultations with customers, resolution of various situations that arose when placing an order.

Managers have the opportunity to add products to the catalog, edit the description and characteristics of products, create new catalog sections, check customer reviews left about the product. The marketing department is responsible for analyzing the current market situation, promoting the store's brand through advertising, analyzing demand and forming a list of goods needed for purchase and transferring it to the purchasing department.

Employees of the purchasing department are responsible for purchasing various goods from suppliers to sell them in the virtual store, their responsibilities also include searching for suppliers and contacting them. The accounting department performs payroll of employees, distribution of profits for other needs related to the work of the store and other financial responsibilities. The information technology department should have such employees as a programmer and a system administrator.

The duties of the postal department employees include receiving goods in the warehouse and sending the ordered goods to the buyer by mail.

### Functional diagrams

Functional modeling IDEF0 is a functional modeling methodology and graphical notation designed to formalize and describe business processes.

The construction of an information system model begins with a description of the functioning of the system as a whole in the form of a context diagram. The description looks like a "black box" with inputs, outputs, controls and a mechanism that is gradually detailed to the required level. This model is used in the organization of business projects and projects based on modeling of all processes: both administrative and organizational.

Consider the context diagram [1] *Online store operation* (Fig. 1).

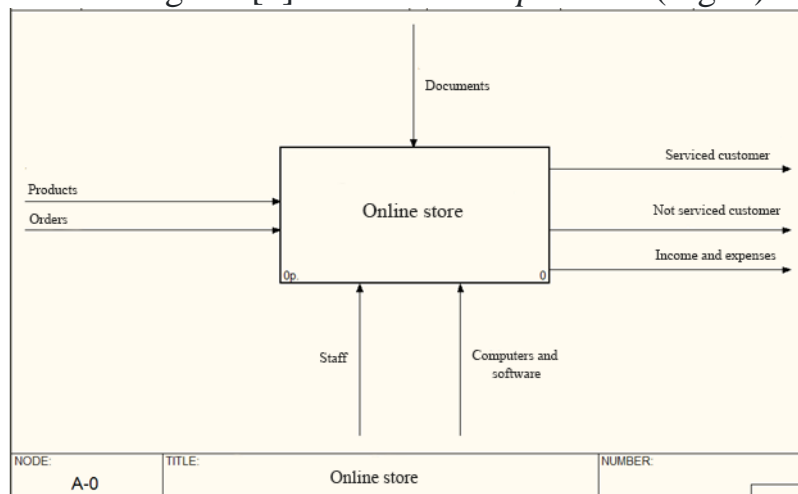


Figure 1 – Context diagram "Online store operation"

The interaction of the system with the environment is described using inputs – "Products" and "Orders" made by customers, outputs – "Serviced customer", "Not served customer" and "Income", management – "Documents", and resources needed to solve the task – "Staff", "Software" and "Computer".[2]  
 Products – Products purchased for sale.  
 Orders – orders made by customers.

Documents – various documents that include regulatory legal acts, including the law on consumer protection, store regulations, rules for the return of goods, internal orders and orders, etc.

Employees – store staff distributed by departments.

A serviced customer is a customer who has received a product or service provided.

An unserved customer is a customer who, for one reason or another, has not received the product, is not satisfied with its quality, or refused service.

Income – the profit received, the sum of all payments for services rendered.

### **Conclusion**

An online store is a software that is specially designed for the convenience of shopping and selling from a website. Currently, there are more and more online stores. Online business becomes attractive for large offline sellers with a well-established and developed infrastructure. To achieve the maximum result at the lowest cost will allow the correct use and understanding of the factors of online trade development in their activities. There are some advantages of online stores in comparison with traditional ones: the goods do not have to be available in a showroom, no retail space is required, there is no need to hire a large number of staff, there is no attachment to a certain territory, and there is also an opportunity to expand the geography of your business.

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## **Разработка информационной системы для интернет-магазина компьютерных комплектующих**

**В. О. Чуканов**

ФГБОУ ВО «Тамбовский государственный технический университет», Тамбов, Россия  
*e-mail: chukanov.00@mail.ru*

**Аннотация.** Целью данного исследования является разработка информационной системы интернет магазина компьютерных комплектующих. В работе будут рассмотрены преимущества и необходимость электронного магазина. Актуальность исследования связана с тем, что с появлением и развитием электронных денег и электронных платежных систем все большее количество людей предпочитают электронные расчеты. Это удобно и выгодно как для покупателя, так и для продавца.

**Ключевые слова:** онлайн магазин, информационная система, интернет.

## **Database of Characteristics of Metal Blanks of a Machine-Building Enterprise**

**G. N. Fedorova**

Tambov State Technical University, Russia, Tambov

*e-mail: galinaf144@mail.ru*

### **Abstract**

The article presents the structure of a relational database designed to store information about the quality of metal supplied to machine-building enterprises. This information is further taken into account in the products' manufacture. Metal quality indicators are: tensile strength, yield strength, long-term strength limit, creep limit, impact strength, etc. The database is compiled in such a way that the user can add new quality indicators himself.

**Keywords:** metal quality, database, machine-building enterprise.

### **Introduction**

The characteristics of metal blanks largely determine the quality of the final products manufactured by machine-building enterprises. Therefore, much attention is paid to quality control of the metal entering the enterprise.

There are destructive and non-destructive methods of metal quality control.

Destructive testing allows you to determine the limits of strength and creep of the metal.

Non-destructive testing methods make it possible to determine the presence of internal defects.

Information about the quality of the metal supplied to the enterprise must be stored and subsequently associated with information about the product made from this raw material. Information about the quality of incoming metal raw materials is stored in a relational database. The structure of the database is shown in Fig. 1.

### **Structure of the database**

The "Assortment" table is a register of the metal assortment. The full name of the assortment is entered in the name field, such as "List BT-PV-O-08x1250x2500 GOST 19904-74 II-VG-08Yu GOST 9045-93".

The "Supplies" field is a waybill.

The "Supply Specification" field describes what is supplied and in what quantity.

The "Quality indicators" field contains a register of all metal quality indicators, for example, "Strength limit", "Hardness", etc.

In the "Delivery\_quality\_display" field, the "Indicator\_value" field contains the measured value of the metal quality indicator received under a specific invoice.

The "Standards" and "Indicators\_by\_standard" fields contain data on quality indicators regulated by the corresponding standard.

The presented database structure is simplified and used only to describe the principle of storing quality indicators of the metal supplied to the machine-building enterprise.

This structure is used when creating a system of automated design and management of a machine-building enterprise with the participation of the author [1-4].

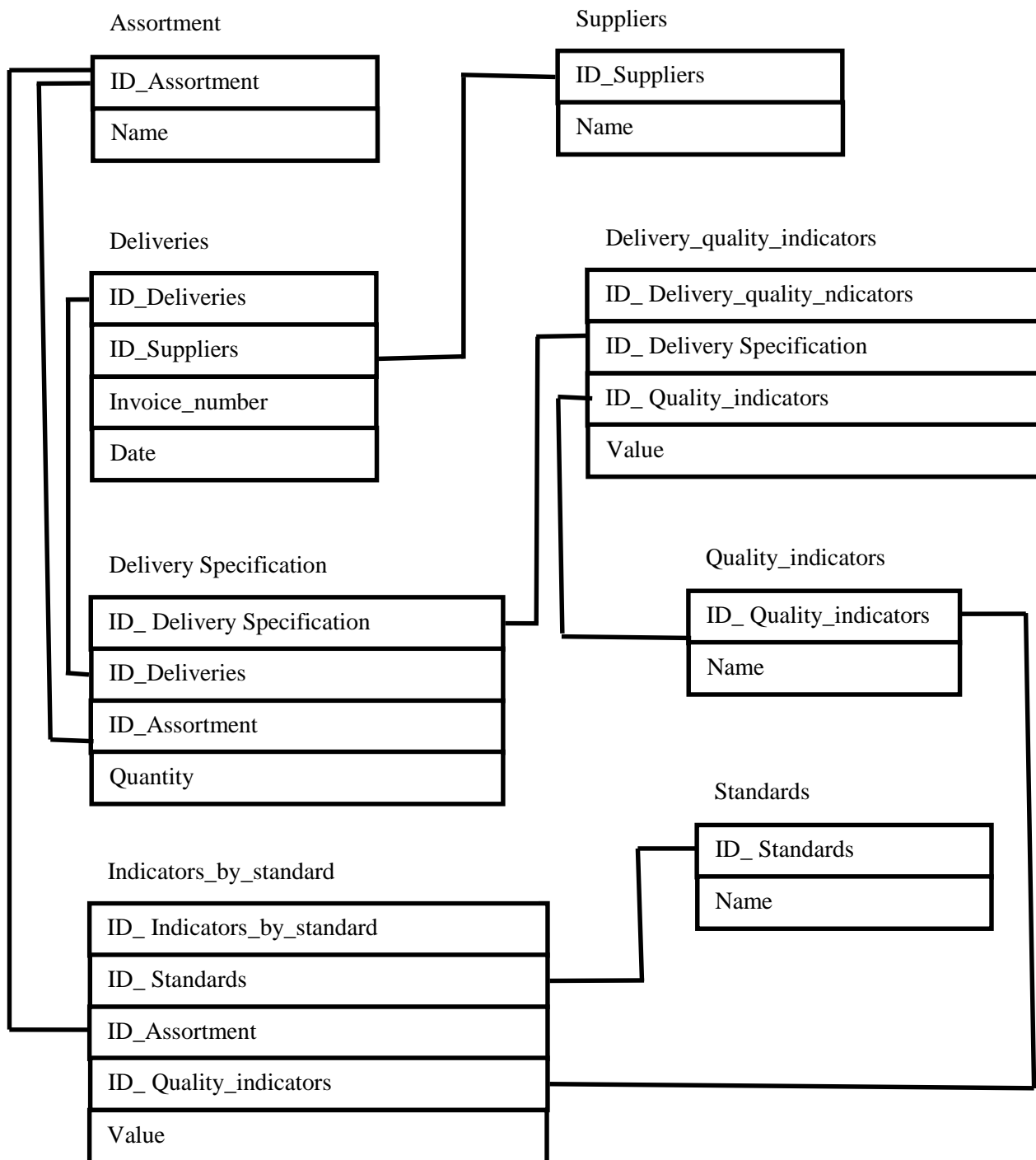


Figure 1 - The structure of the database for the quality of the metal assortment account

### Conclusion

Creating this database solves the following problem: with the given quality indicators of raw materials, it is possible to select the technological parameters of production in such a way as to ensure the production of a product with the given quality indicators.



This task is relevant for the shop technologist, when the raw materials have already been purchased and entered the shop, and it is necessary to produce a product that meets the requirements of the regulatory document for its production, or the product.

### **Acknowledgements**

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## **База данных характеристик металлических заготовок машиностроительного предприятия**

**Г.Н.Федорова**

ФГБОУ ВО «Тамбовский государственный технический университет», Тамбов, Россия  
*e-mail: galinaf144@mail.ru*

**Аннотация.** Представлена структура реляционной базы данных, предназначенной для хранения информации о качестве металла, поступающего на машиностроительные предприятия. Эта информация в дальнейшем учитывается при изготовлении изделий. Показателями качества металла являются: предел прочности, предел текучести, предел длительной прочности, предел ползучести, ударная вязкость и др. База данных составлена таким образом, что пользователь сам может добавлять новые показатели качества.

**Ключевые слова:** качество металла, база данных, машиностроительное предприятие.

## Analysis of Software Products in the Activities of Legal Counsel

**M. G. Furletov**

Tambov State Technical University, Tambov, Russia

\*e-mail: [mfurletov@mail.ru](mailto:mfurletov@mail.ru)

### **Abstract**

This article analyzes the software and hardware of the legal counsel, the results of which can be used to eliminate existing shortcomings; building models of the process of drafting and accounting contracts and the process of representing interests in court, drafting an application.

**Keywords:** information technology, legal counsel.

The activity of a legal counsel is connected with the conduct of several court cases at the same time, claims and contractual work. In this regard, there is a need for precise planning, preparation for court sessions, compliance with the deadlines for appealing judicial acts and deadlines for performing other tasks entails the need to remember a large amount of information.

Today, the development of technologies provides lawyers with an effective opportunity to plan and optimize their activities through the use of specialized software and services.

We will analyze the functionality of some software and online services available on the IT market designed to automate the work of a lawyer.

Every day a lawyer needs background information. Therefore, to facilitate the work of lawyers, there are specialized network resources with reference information (for example, SoftUrist – [https://softurist.ru/category\\_info](https://softurist.ru/category_info) ) containing arrays of data that are issued at the request of users. Many services have created official sources that allow obtaining information for use in judicial work, verification of counterparties. It presents the service "Reference information", which is part of the structure of the SoftUrist website.

The service "Checking counterparties" is also presented, which is used to search for information about legal entities and individual entrepreneurs and allows you to find data on their types of activities, the turnover of the company, the presence of judicial and tax claims.

In addition, the services of the SoftUrist website allow a lawyer to quickly obtain an extract from the Unified State Register of Legal Entities in relation to participants in a court case.

Convenient software, which appeared around 2013-2014, became "Document Designers". Thanks to these software developments, it is possible to create the required document from a simple template, for example, a rather complex contract in which it is necessary to take into account all the requirements of the parties and possible situations. This possibility is provided by selecting the necessary items from the lists available in the constructor. The services of the designer are provided by the company "ConsultantPlus", the company "Krok" (the Designer of FreshDoc documents) and other manufacturers.

Most online services provide an opportunity to design not only contracts, but also other legal documents: statements of claim, documents for the creation and registration of companies, powers of attorney and others. Using document designers allows you to quickly solve the task of creating the necessary document, they are a good assistant for a lawyer, but all these programs are paid, their prices range from 10 to 40 thousand rubles or more and depend on the number of templates and features provided.

To date, business process optimization services are not a product developed for lawyers, however, they can be successfully used in legal activities. In particular, G Suite is a combination of a cloud service for working and exchanging documents, corporate mail, voice and video chat. The disadvantage of universal or general optimization services is the lack of consideration of the specifics of legal activity, as well as complex configuration (if CRM is used), which necessitates the presence of a system administrator in the staff.

Also for lawyers, programs have been created to facilitate work with courts. These software products allow you to install performers and organize the information available to the lawyer on cases.

Legal practice has a long history of existence and development. Previously, lawyers conducted all their cases "manually", but now many programs for lawyers have been developed in the modern world. Now it is possible to purchase many professional and ordinary programs for lawyers for free and for a fee. These are relatively simple programs, and serious software.

For example, the Juristassistant program, which is designed for many processes of legal activity. The program allows you to work with various documentation, various reference books, work accounting, statistics. It also includes some additional programs that are responsible for specific types of work. For example, LawMatic Editor, MyLiteSync, All Courts. These programs will allow you to find any body of interest quickly enough according to certain criteria.

There are simpler programs for lawyers, often used for specific legal and legal tasks. The Law Office 2.5 program is used in law offices or automates the work of the legal department at enterprises.

The Expert 4.4 Lawyer Account program is also used, which makes various calculations for debt amounts.

These programs are available for purchase on the Internet and can be used by any legal agency, private lawyers, lawyers, judges.

There are also programs for lawyers that can be installed for free, such as "Casebook" and "Consultant Plus".

There is also a free program for finding new customers "Contour.Focus", which allows you to: search for new clients, evaluate counterparties, study arbitration cases, analyze relationships between companies and reduce commercial and tax risks of the transaction.

The program also analyzes and updates data from: Federal Tax Service (USRLE/EGRIP), Treasuries (state contracts), Rosstat (accounting reports), Supreme Court of the Russian Federation, dozens of other reliable sources.

Among the programs referred to as computer programs for lawyers, the judicial record-keeping system "SUDiDELO" occupies a separate place. The system is a program for lawyers, and is distributed in 2 versions for free and for a fee. The system is designed

to systematize data of various kinds of court cases, provides an opportunity to organize collective work with court case data, which is important for large organizations with a large staff of lawyers.

As a result of the analysis, such IS have been identified that automate the activities of the legal adviser.

Also, as a result of the analysis, a number of shortcomings and emerging problems were identified, such as an inconvenient interface, insecurity of personal data, the created IP does not cover the entire activity of the legal adviser.

Despite the sufficient number of software products created for the automation of legal activities, it should be noted that it is inappropriate to purchase and use them by small legal services that have one or two lawyers on staff.

We propose the creation of a local system with the following advantages: the system will be located on a local server, this will protect the personal data of users, the user notification function will be developed, local acts and legislation will be located on the server, added a calendar planner that allows you to view the scheduled dates and plan further events, database, with search and updating of customer information, documents with ready-made templates, with the possibility of making changes to existing templates and adding new ones.

Thus, the proposed system will simplify and make the activities of the legal adviser more organized, as well as the system will automate most of the processes and professional tasks.

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## Анализ программных продуктов в деятельности юрисконсульта

**М. Г. Фурлетов**

ФГБОУ ВО «Тамбовский государственный технический университет», Тамбов,  
Россия

*e-mail: mfurletov@mail.ru*

**Аннотация.** В данной статье анализируется программное и аппаратное обеспечение юрисконсульта, результаты которого могут быть использованы для устранения существующих недостатков; построения моделей процесса составления и учета договоров и процесса представления интересов в суде, составления заявления.

**Ключевые слова:** юрисконсульт, информационные технологии.

## **Justification of the Introduction of an Automated Information System for Personnel Department Employees**

**N. V. Gomzov\*, A. A. Kuznetsova**

Tambov State Technical University, Tambov, Russia

\*e-mail: *gnik2000@mail.ru*

### **Abstract**

The purpose of this study analyzes the activities of personnel department employees. The study examines the process of accounting, collection, registration, processing and storage of documents and data used by employees of the HR department in the process of performing their duties during the recruitment of personnel for the company. The relevance of the study lies in the fact that the state of informatization of the activities of recruitment agencies does not correspond to the level of modern technologies. As a result, it is necessary to develop an automated information system for personnel department employees.

**Keywords:** HR department (HR), information, online service, recruitment, technology.

The HR department is a structural unit in the organization, which is engaged in all the work on personnel management.

The main goal of the HR department is to contribute to the achievement of the company's goals by providing the company with the necessary personnel and the effective use of the potential of employees.

Recruitment of employees is carried out using different strategies: submission of information about vacancies in the media, in various Internet resources, selection of candidates using various methods of selection, testing and interviews.

The main function of the HR department in the company is the competent selection of personnel, namely:

- determination of the organization's personnel needs and recruitment together with the heads of departments;
- analysis of staff turnover, search for methods to combat high levels of turnover;
- implementation of labor motivation systems;
- preparation of the company's staffing table;
- registration of personal files of employees, issuance of certificates and copies of documents at the request of employees;
- carrying out operations with workbooks (receiving, issuing, filling in and storing documents);
- keeping records of vacations, scheduling and registration of vacations in accordance with current labor legislation;
- organizing employee certifications;
- preparing professional development plans for employees.

HR specialists are intermediaries between management and employees in the company. Depending on what the business is doing, what size it is and at what stage of development now, the HR department may have different responsibilities:

– *Personnel accounting*: personnel officers keep personal files of employees, military records, draw up a staff schedule and a vacation schedule, issue disciplinary penalties, prepare orders on personnel issues and perform other duties of the employer, which are established by the labor Code;

– *Occupational safety*: occupational safety is all that needs to be done to preserve the life and health of employees in the process of work. For example, HR specialists organize a special assessment of working conditions. The HR department is also investigating accidents that have occurred at the workplace;

– *Recruitment*: search and hiring of employees. HR specialists help with the search, selection and hiring of personnel. In some companies, the entire employment process is entirely on them. In others – only separate stages;

– *Staff training and development*: in some companies, HR department employees organize trainings, interview employees on the topic of development, together with managers draw up professional growth maps. This helps to increase the competence of employees, find tasks where a co-worker will be able to bring the most benefit, and keep burning out employees.;

– *Dispute resolution*: one of the tasks of the HR department is to help resolve conflicts between employees or employees and management;

– *Development of a motivation system*: usually, an employee's motivation is taken up by his immediate supervisor, but in some companies, a specialist from the personnel department also participates in this. It helps to determine what motivates an employee to work more efficiently. Some are motivated by the ability to influence the level of their earnings; others value stability, or flexible schedule.

The structure of the HR department is determined by the head of the company or entrepreneur, depending on the total number of employees and business tasks. Usually, if a department is formed, at least two people work there: a manager and a specialist. But sometimes there is a personnel department consisting of one employee who deals with everything.

If only 10-15 people work in the company, one or two personnel officers are enough.

If there is a lot of staff in the company, and HR specialists are engaged not only in personnel accounting and labor protection, but also perform other functions, more specialists will be needed.

In the HR department, all employees can do the same tasks or share them among themselves. For example, a recruiter is engaged in the search and hiring of specialists, and an HR specialist works with current employees.

Thus, the work of personnel department employees is multifaceted. They have to work with a huge amount of information and communicate with a lot of people. Most often, all the data obtained is collected, entered and analyzed manually by employees of this department, however, to simplify this work, there are various software products, both installed on a PC and those that work online. Depending on the purpose of the company and its organizational structure, HR officers may be given other tasks. The range of duties of personnel officers should be fixed in internal documents and job descriptions so that employees of the personnel department understand what the company's management expects from them.

The activity of an employee of the HR department, as a rule, is associated with working with several employees or even departments at once. The need to obtain, store and process a large amount of information, view resumes, questionnaires, meet various deadlines and other tasks entail great responsibility and the need to remember a large amount of information.

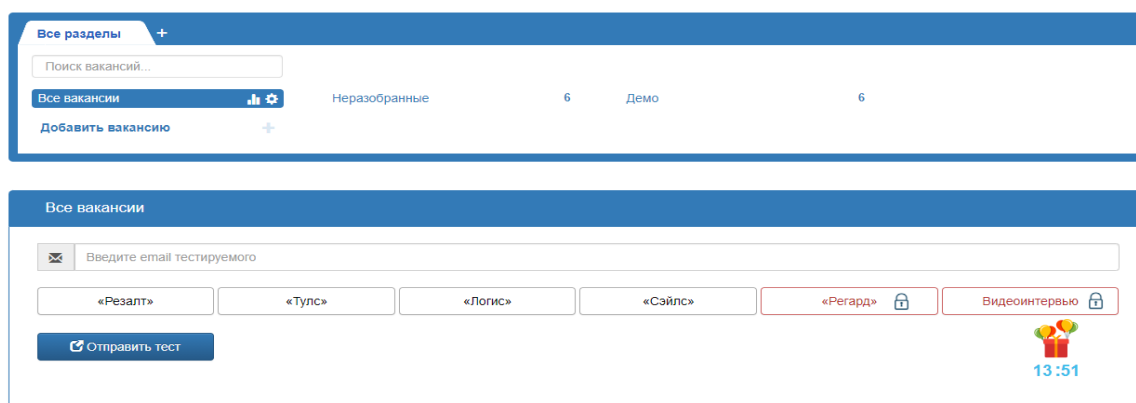
The development of modern technologies allows HR department employees to work efficiently, conveniently and quickly with a huge amount of information. This possibility is provided thanks to software, both installed on a personal computer and used online. It should be noted that online services at the same time have an undeniable advantage, since their use does not require the installation of any additional software, any browser installed on any computer is sufficient.

We consider an example of two popular online services for working with company personnel.

The *Hrscanner* is an online service for evaluating candidates and staff for small and medium-sized businesses, aimed at increasing the speed and ensuring the error-free recruitment process.

The Hrscanner software product from Langes Pils is designed to test and measure the knowledge and skills of candidates, as well as current employees, by answering text questions and using video interviews. Hrscanner includes a set of five specialized tests and a platform for conducting video interviews.

The Hrscanner cloud system, by conducting tests, allows you to measure the personal qualities of employees and candidates, their productivity, engagement, and intelligence. The user can create tests, define lists of interviewees, use video interview functions for simplified interviewing and competency assessment.



*Figure 1 – A set of system tests «hrscanner.ru»*

The positive aspects of this online service include the following:

- ease of use;
- a set of various tests for a multi-faceted assessment of a candidate submitting a resume for a job;

The disadvantages of this system include:

- The free demo version lacks some important features;
- lack of access to some tests and video interviews in the free version;
- test packages that can be carried out must be purchased separately;

- video interview packages that can be conducted must be purchased separately;
- high cost of paid services.

Based on the above, we can conclude that hrscanner.ru a convenient system for selecting employees, but you have to pay a considerable amount of money for each function here.

The second online service for finding employees in your company is Mirapolis.

The *Mirapolis HCM* cloud system implements the functions of management and information support for the following processes:

- recruitment of personnel;
- staff adaptation;
- learning management and learning outcomes analysis;
- distance learning, testing and certification;
- budgeting and planning of staff training;
- competence management and staff development;
- personnel reserve management;
- Performance and Efficiency management (KPI);
- personnel assessment using the "360 degrees" method.

The disadvantages include the fact that there is no trial version here, that is, to use this service, you also need to pay a large amount. And also, an inexperienced user of this resource may not immediately find what he needs on the presented site, because it has a fairly complex and confusing structure in which it is difficult to navigate.

Offline services and additional modules to them are more popular. One of these is the "Kadry" module, which is connected to the "Parus" program.

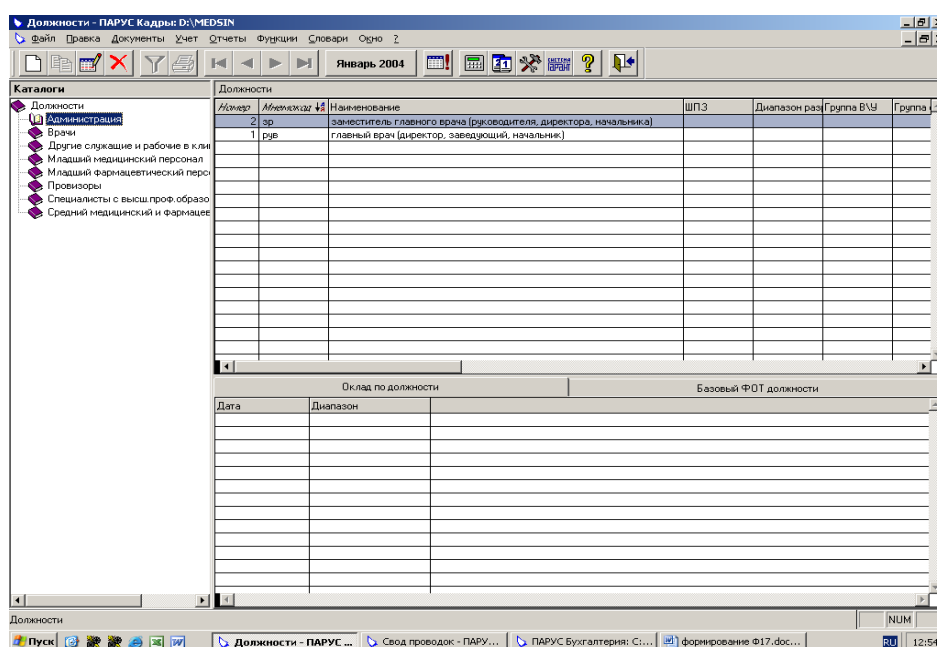


Figure 2 – The interface "Sail. Personnel"

This is a Russian product containing the functionality of personnel accounting only. Allows you to conduct basic HR records management operations:

- staffing and organization structure, including accounting of freelance departments;



- hiring and appointment of employees;
- accounting of personal information of employees;
- journal of vacation and sick leave;
- accounting for personnel transfers other transfers;
- accounting of qualification categories and certifications;
- personnel reporting of the enterprise.

The positive aspects of this product include the following:

- orientation to work for the civil service;
- if necessary, payroll can be used with the "Salary" module;

The disadvantages include the following points:

- there is no full-fledged module for personnel management;
- outdated interface;
- high cost of the product.

Thus, despite the fact that there are many offline and online recruitment services, many of them are paid, and in the free versions the set of functions is very limited. Small companies may not have the funds for such large-scale purchases. Therefore, we consider it expedient to create such a platform for free in the process of completing the final qualifying work, which will be free and convenient to use, and finances to support such a system can be collected by voluntary donations from users who have already used this system and were satisfied.

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## **Обоснование внедрения автоматизированной информационной системы для сотрудников отдела кадров**

**Н. В. Гомзов, А. А. Кузнецова**

ФГБОУ ВО «Тамбовский государственный технический университет», Тамбов, Россия  
e-mail: [arina.dashko3008@outlook.com](mailto:arina.dashko3008@outlook.com)

**Аннотация.** Целью данного исследования является анализ деятельности сотрудников отдела кадров. В исследовании будет рассмотрен процесс учета, сбора, регистрации, обработки и хранения документов и данных, используемых работниками отдела кадров в процессе исполнения своих должностных обязанностей во время подбора персонала для компании. Актуальность исследования заключается в том, что состояния информатизации деятельности кадровых агентств не соответствует уровню современных технологий. В результате этого необходимо разработать автоматизированную информационную систему для сотрудников отдела кадров.

**Ключевые слова:** информация, онлайн-сервис, отдел кадров, подбор персонала, технологии.

## The Structure of Material and Information Flows in the Business Process Management System of the Catering Plant of the Agricultural Holding

R. Y. Habarov, V. A. Nemtinov

Tambov State Technical University, Tambov, Russia

\*e-mail: romychhabarov@gmail.com

### Abstract

The article deals with the issues of developing the structure of material and information flows in the business process management system of a catering plant of an agricultural holding.

**Keywords:** business processes of a food plant, business processes, structures of material and information flows, a food plant of an agricultural holding.

Using the example of the Pobeda peasant farm, a model of business processes for a food plant was built. At the first stage of building the model, the main business processes are identified.

The main business processes in the agro-industrial complex are typical, since the main task of the food complex is the same as in other catering establishments: to produce goods: food, to provide a service: customer service.

At the second stage, special business processes are identified that are typical only for enterprises within the agro-industrial complex.

A feature of catering establishments on the territory of the agro-industrial complex is that part of the products that are grown are not sold, but stored for cooking [1-3].

To describe business processes, the structures of information and material flows of the Pobeda peasant farm, presented in Fig. 1 and Fig. 1, have been developed. 2.

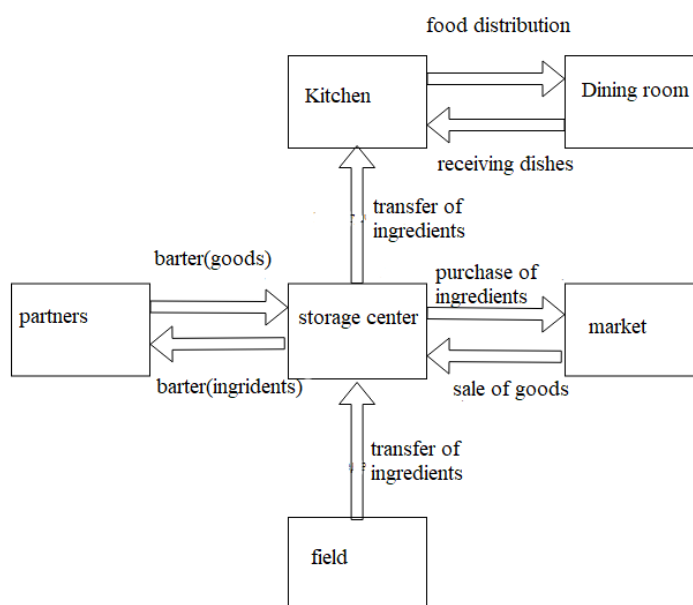


Figure 1 – Flowchart of material flows

Set A includes reports on the state of the equipment, the number of ingredients in stock, lists of ingredients for purchase.

Set B includes proposals for improving the quality of service, proposals for changing the menu, information on the schedule and work schedule of the food plant.

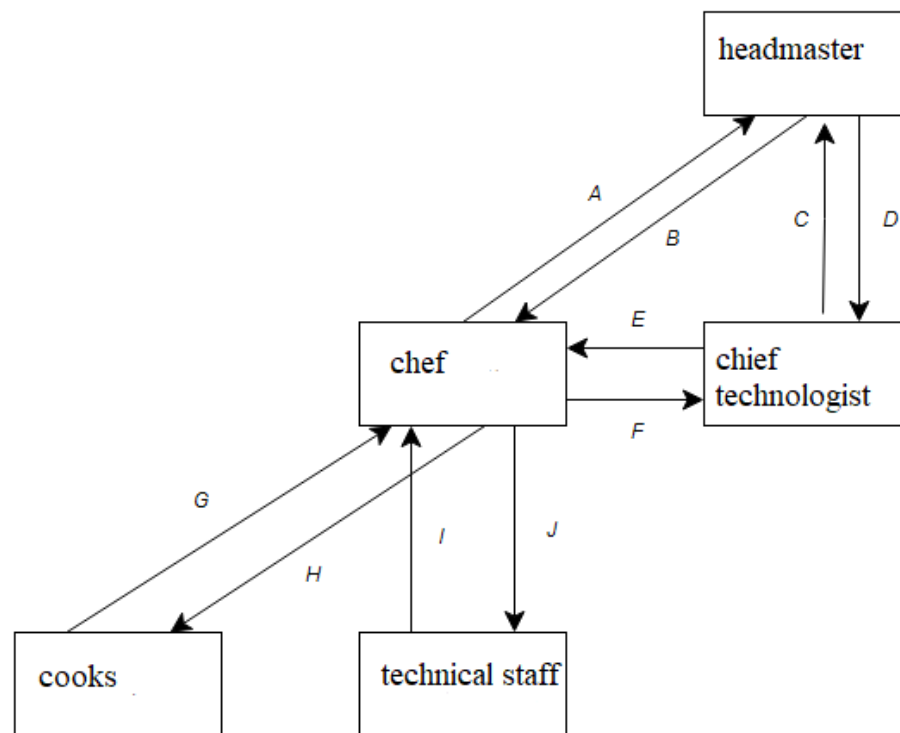


Figure 2 - Information flows of the power plant

Set C includes plans for the introduction of advanced technological processes, types of equipment and equipment, development of enterprise plans, material cost standards, plans for organizing jobs and placing equipment, plans for the modernization of production.

Set D includes instructions, orders and regulatory documents that relate to the technological preparation of production, job descriptions, specifications and standards, production technology, energy consumption rates, materials, raw materials, labor protection rules in the company.

The E set combines recipe flow charts, recipe and ingredient quality standards, indication of commodity neighborhood standards

The set F includes the cost and quantitative indicators of the audit, information about personnel and equipment.

The set G is information about the state of personnel and the health of equipment

The set H includes technical charts, menus, and the number of service personnel.

Set I - a report on the implementation of diagnostics and troubleshooting of equipment, a report on the technical condition of workplaces.

The set J is information about malfunctions identified during the operation of the power plant. Optimal management of an enterprise, it is necessary to determine the main business processes that take place in it. The stage of business process modeling plays an important role in subsequent work. Currently, integrated systems for computer-aided design of technological agro-complexes are widely used. Their use

significantly increases the efficiency of the functioning of the peasant farm (PFH), automating routine operations and paperwork for typical tasks.[3]

As a result, the structure of material and information flows of the agro-industrial complex nutrition plant was developed. This model will be used in the development of a business process management system for a catering plant of an agricultural holding. The time we are interested in falls on March-September, we take the summer angle of inclination — 40° relative to the earth. At the same time, the average daily insolation for this area is 4.73.

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## **Структура материальных и информационных потоков в системе управления бизнес-процессами предприятия общественного питания агрохолдинга**

**Р. Ю. Хабаров\*, В. А. Немтинов**

ФГБОУ ВО «Тамбовский государственный технический университет», Тамбов, Россия

*\*e-mail: romychhabarov@gmail.com*

**Аннотация.** В статье рассматриваются вопросы разработки структуры материальных и информационных потоков в системе управления бизнес-процессами предприятия общественного питания агрохолдинга.

**Ключевые слова:** бизнес-процессы пищевого комбината, бизнес-процессы, структуры материальных и информационных потоков, пищевой комбинат агрохолдинга.

## Filtern von verstärkten Daten in der Steuerung eines Umweltroboters

S. V. Ivanov\*, A. P. Bagryantseva

Staatliche Technische Universität Tambow, Tambow, Russia

\*e-mail: iva.s3rge@yandex.ru

**Zusammenfassung.** Das Papier betrachtet die Lösung des Problems des Filterns verrauschter Daten sowie das Finden des optimalen Werts des Filterparameters.

**Schlüsselwörter:** Filtern, ökologische Roboter, Informationsverarbeitung.

Als Themenfeld wird die Analyse der ökologischen Situation auf dem Gelände betrachtet. Die ökologische Situation ist eine Raum-Zeit-Kombination verschiedener, einschließlich positiver und negativer lebens- und zustandsbezogener Bedingungen, Bedingungen und Faktoren, die eine bestimmte ökologische Situation in einem Gebiet mit unterschiedlichem Grad an Wohlbefinden oder Benachteiligung schaffen. Unter der ökologischen Situation versteht man den spezifischen Zustand der menschlichen Umwelt, der durch das Zusammenspiel von Natur und Wirtschaftstätigkeit des Menschen verursacht wird.[1]

Das Umweltroboter-Steuerungssystem sollte eine Reihe der folgenden Aufgaben zulassen:

Robotersteuerung;

Datenerfassung von Sensoren;

Filtern der empfangenen Daten vor Störungen;

Erstellung eines Berichts über die Umweltsituation auf dem Gelände.

Im Rahmen dieser Studie werden Lösungen für das Problem der Filterung der vom Sensor empfangenen Rauschdaten untersucht.

Sie können für jeden Sensor eine Legende eingeben:

$R(t) = x_t$  – Eingangssignal vom Sensor zu einem Zeitpunkt  $t$ .

Dann  $X = \{x_1, x_2, \dots, x_T\}$  – dies ist die Menge aller Signale von 1 bis  $T$  Zeitpunkten.

Das Eingangssignal enthält Geräusche  $N(t)$ .

Dann

$E(t) = R(t) - N(t) = e_t$  – Referenzsignal ohne Rauschen zu einem bestimmten Zeitpunkt  $t$ .

Unter der Filterfunktion verstehen wir die Funktion  $F_i(P_i, x_t)$ , die viele Parameter an den Eingang annimmt  $P_i = \{p_{i1}, p_{i2}, p_{in}\}$ , wird für jeden Filter festgelegt und wandelt das Eingangssignal in gefiltertes um:

$F_i(P_i, x_t) = fx_t$ ,

$fx_t$  - gefiltertes Signal zu einem Zeitpunkt  $t$ .

Dann ist es notwendig, eine solche Filterfunktion zu finden  $F^*(P^*, x_t)$  aus einer

Vielzahl möglicher Filter, für die viele Parameter definiert werden müssen  $P^* = \{p_1^*, p_2^*, \dots, p_m^*\}$ , bei dem die Zielabweichungsfunktion des gefilterten Signals vom Referenzsignal minimal ist:

$$Q(F^*, P^*) = \sum_{i=1}^T \frac{\sqrt{(F^*(P^*, x_i) - E(t))^2}}{T} \rightarrow \min$$

Das heißt, der optimale Filter ist eine Funktion, die für jedes Signal verwendet wird  $x_t$  zum Zeitpunkt gibt  $t$  Folgendes zurück  $f x_t$ , was:

$$|f x_t - e_t| \rightarrow \min.$$

Betrachten wir in der Filterqualität das F1 - Laufende arithmetische Mittel: numerisch gleich dem arithmetischen Durchschnitt der ursprünglichen Funktion über einen festgelegten Zeitraum (Puffer) [2]

Liste der Parameter:  $p_{11}$  – Puffergröße für die Mittelung

Filter-Formel:

$$F_1(p_{11}, x_t) = \frac{1}{p_{11}} \sum_{i=0}^{p_{11}-1} x_{t-i}$$

In experimentellen Studien wurde ein optimaler Parameterwert erzielt  $p_{11} = 9$ . Der Wert wurde durch eine vollständige Durchbruchmethode gefunden. Bei optimalem Pufferwert  $p_{11}$   $Q(F_1, P_1) = 0.289$ . Der Prozess, den optimalen Parameterwert zu finden, ist in Abbildung 1 zu sehen.

Die Ergebnisse der Filterung durch diesen Filter verschiedener Signale sind in Abbildung 2 dargestellt. [3]

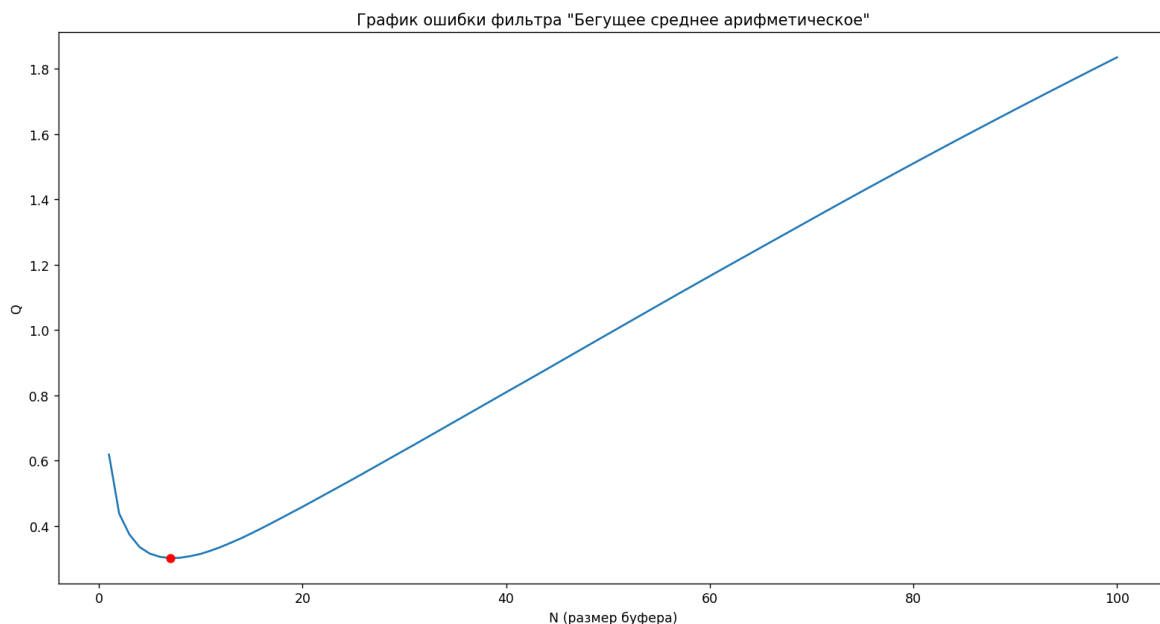
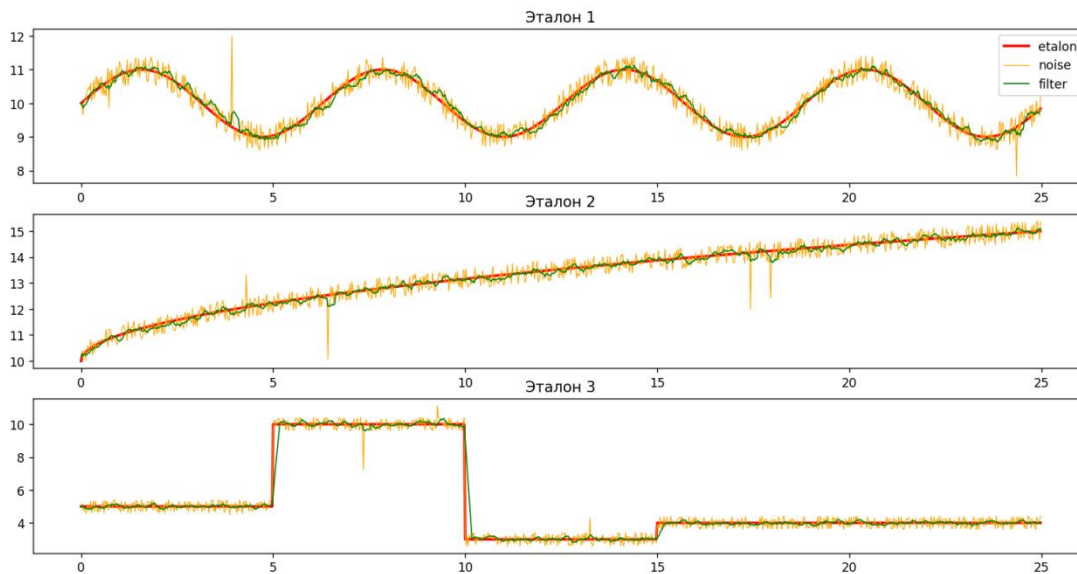


Abbildung 1 - Verfahren zum Finden des optimalen Parameters  $p_{11}$



*Abbildung 2 - Das Ergebnis des Filterns "Laufendes arithmetisches Mittel»*

Die Arbeit untersucht daher die Einrichtung und Lösung des Problems der Filterung von Sensordaten im Umweltroboter-Steuerungssystem.

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## **Фильтрация зашумлённых данных в системе управления экологическим роботом**

**С. В. Иванов\*, А. П. Багрянцева**

ФГБОУ ВО «Тамбовский государственный технический университет», Тамбов, Россия  
\*e-mail: iva.s3rge@yandex.ru

**Аннотация.** В работе рассматривается решение задачи фильтрации зашумленных данных, а также нахождения оптимального значения параметра фильтра.

**Ключевые слова:** фильтрация, экологические роботы, обработка информации.

## Analysis of the Smart Home Approach to Peasant Farming and Its Everyday Life with the Help of Solar Energy

A. M. Karnishev\*, V. A. Nemtinov

Tambov State Technical University, Tambov, Russia

\*e-mail: a.karnisheff2014@yandex.ru

### Abstract

The article considered the types of solar panels, their relevance and the analysis of the optimal choice of the panel. To apply the method in practice, a comprehensive assessment of constructive solutions was made.

**Keywords:** smart home, optimal choice of solar panels, smart grid.

### Introduction

The rapid rise in the cost of resources with strict market regulation today simply eats up the profitability of farmers. Private solar power plants help to save a lot on electricity, and enterprises in various industries are already starting to install them in masse. However, it is in the field of agriculture that alternative generation can give the most tangible economic effect.

### Description of the subject area

Currently, the most developed application of IoT technologies is "Smart Grids" in the energy sector. The operation of this network is based on the fact that the supplier and the consumer get an objective picture of the use of energy resources through monitoring on all sections of the network and, as a result, get the opportunity for operational management. In case of accidents, such networks are able to automatically identify problem areas and, within a short time, direct electricity through backup circuits, restoring power supply [2].

The power grid is managed using the following systems (Figure 1): "smart" routing of energy flows (Smart Routing) – load and quality control systems, self-repair of networks as a result of emergency events, energy storage, etc.; "smart" measurements (Smart Metering) - modern intelligent metering devices (Smart Meter), intelligent building systems (Smart Home), "smart" household appliances.

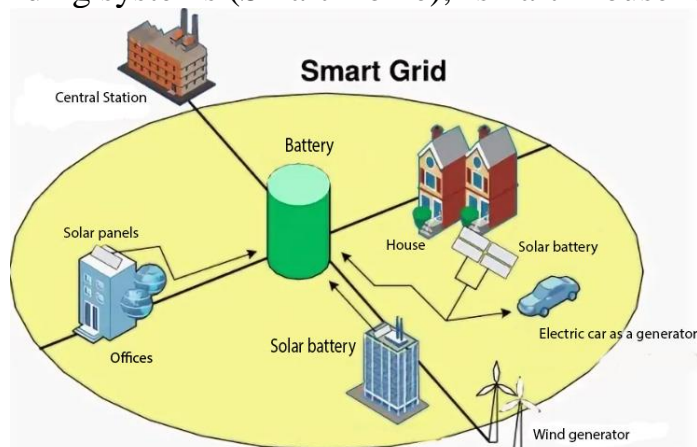


Figure 1 – The scheme of the "smart" network Smart Grid



Today there are three main options for placing solar modules in farms:

- As a canopy
- On roofing
- On agricultural plots

Based on the type of silicon semi-conductors used for manufacturing, heliopanel modules are divided into two types:

- polycrystalline;
- Monocrystalline.

Polycrystalline crystals have the shape of a flat square with a heterogeneous surface due to the presence of heterogeneous crystals. Silicon melt is used for their manufacture. First, the raw materials are poured into special molds, then the blocks obtained by melting are cut into square plates. During the production process, the molten silicon mass is subjected to gradual cooling.

Monocrystalline panels are more efficient and produce more energy at the same size, but polycrystalline panels are cheaper. The module consists of 36 or 72 polycrystalline plates. A panel consists of a set of such nodes. The technology is relatively simple, does not involve the use of expensive equipment and does not require large financial investments. The disadvantage of these modules is one — efficiency, not exceeding 18%.

The power of the solar AB is calculated using the following formula:  $P_{cm} = (1000 \times E_{sut}) / (K \times \sin)$  In it:

$P_{cm}$  is the battery power in Watts, which is equal to the sum of the solar panel capacities, 1000 is the photosensitivity of solar cells in kW/m<sup>2</sup>,

$E_{sut}$  — the required daily electricity consumption in kWh (for the selected region — 18). The coefficient  $K$  takes into account all losses seasonally: for summer — 0.7, for winter — 0.5.

$\sin$  is an avalanche of solar radiation in kWh/m<sup>2</sup> (table value) with the most favorable inclination of the panels. You can find out this parameter in the service of the region. The optimal angle at which solar panels should be installed is identical to the latitude value in spring and autumn.

In summer, you should spend 15°, and in winter — add 15°. The panels themselves must be oriented to the south. The region from the example is located at latitude 55°.

### **Conclusion**

Since the time we are interested in falls on March-September, we take the summer angle of inclination — 40° relative to the earth. At the same time, the average daily insolation for this area is 4.73.

We substitute all this data into the formula and perform the action:

$$P_{cm} = 1000 \times 12 : (0.7 \times 4.73) \approx 3,600 \text{ Watts.}$$

If the modules that make up the battery will have a power of 100 watts, then it is necessary to purchase 36 pcs. To accommodate them, you will need a platform of 5 x 5 m, and the structure will weigh about 0.3 tons [1].

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## **Анализ подхода умного дома к крестьянско-фермерскому хозяйству и его быта при помощи солнечной энергии.**

**А. М. Карнишев\*, В. А. Немтинов**

ФГБОУ ВО «Тамбовский государственный технический университет», Тамбов, Россия  
*\*e-mail: a.karnisheff2014@yandex.ru*

**Аннотация.** В статье были рассмотрены виды солнечных панелей, их актуальность и анализ оптимального выбора панели. Для применения метода на практике было сделано комплексное оценивание конструктивных решений.

**Ключевые слова:** умный дом, оптимальный выбор солнечных панелей, smart grid.

## Using a Deep Learning Algorithm with Reinforcement for Job Search Services

I. V. Khvorov, D. A. Cheremisin, D. V. Tulupov

Tambov State Technical University, Tambov, Russia

e-mail: [ilya.hvorov@list.com](mailto:ilya.hvorov@list.com), [thedenhil2000@gmail.com](mailto:thedenhil2000@gmail.com), [dmitry.tulupov68@gmail.com](mailto:dmitry.tulupov68@gmail.com)

### Abstract

The purpose of this study is to analyze the possibilities of using a deep learning algorithm with reinforcement to implement recommendations in job search services. In this paper, the algorithms currently used will be considered and a more accurate implementation will be proposed. The relevance of the study lies in the fact that the use of reinforcement learning algorithms to generate recommendations for job seekers and employers on job search sites will increase the accuracy of recommendations.

**Keywords:** neural networks, a reinforcement learning algorithm.

### Introduction

The recommendation methods used by job search services are based on a search of similar keywords in employer vacancies and applicant resumes. Machine learning methods, which are improving yearly, allow the software to extract relevant information about the applicant and select the most suitable employer vacancies [1]. The purpose of this study is to analyze the possibilities of using a deep learning algorithm with reinforcement to implement recommendations in job search services.

### Implementation of the system

Popular algorithms carry out preliminary filtering and preparation of initial data, since employers make up job requirements in a free unstructured form, just as applicants make up a resume in a free weakly structured form, so the task arises to make preliminary preparation and filtering of this data for subsequent work [2]. The data entering the software package goes through three stages of processing: parsing, segmentation and tokenization. These steps are shown in Figure 1.

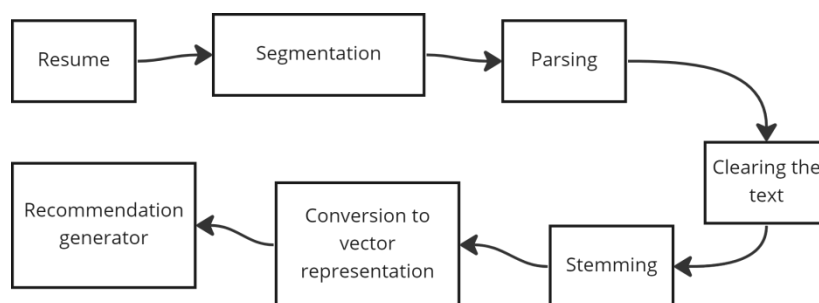


Figure 1 – Steps of operation of most systems

To find the most similar vacancies or the most similar resumes, the Jacquard coefficient given in formula 1 is often used [2].

$$K_j = \frac{c}{a+b-c} \quad (1),$$

where  $a$  is the number of words  $X$  in the resume,  $b$  is the number of words  $X$  in vacancies,  $c$  is the number of words common to resumes and vacancies.

The problem with this method is that vacancies with a large amount of text and as a result of using larger vectors have a higher chance of getting a high score than shorter vacancies, even if shorter vacancies may be relevant. To avoid the problems associated with this method of implementation, we use a more suitable implementation option – a deep learning algorithm with DDQN reinforcement [3].

As input data, we consider the previous vacancies to which the applicant responded [4]. The input data for the model are combined vectors of vacancy signs. For the model to work, we will generate a history of user responses to vacancies. We also generate a set of vectors of vacancy signs, shown in Figure 2:

Position	Salary	Experience (years)	...	stress resistance	responsibility	ready for business trips	possession of a driver's license
1	60000	8	...	1	1	0	0
2	30000	2	...	0	0	1	1
...	...	...	...	...	...	...	...

Figure 2 – Vectors of job signs

During the training of the model for each applicant, the recommendation pipeline runs for  $N$  epochs, and the input data is an array of source data for each applicant [4]. Every 100th epoch, a target model is created to fix the optimal value of  $Q$  (formula 2):

$$Q_{tar:DoubleDQN}^{\pi}(s, a) = r + \gamma Q^{\pi_{\phi}}(s', \max_{a'} Q^{\pi_{\theta}}(s', a')) \quad (2)$$

As a result, the neural network outputs recommendations for each possible user story [1]. The recommendations received are presented in Figure 3:

	C1	C2	C3
1	Bid Recommended	To User With History	With a Score of
2	3	(1, 2)	691.9347534179688
3	6	(1, 3)	442.01702880859375
4	3	(1, 4)	776.9649658203125
5	4	(1, 5)	201.15625
6	3	(1, 6)	212.4738006591797
7	1	(2, 3)	381.4257507324219
8	3	(2, 4)	821.8407592773438
9	4	(2, 5)	201.05079650878906
10	3	(2, 6)	218.00083923339844

Figure 3 – Model Recommendations

The demonstrated model turned out to be significantly more accurate than other solutions based on the generated test data.

### Conclusion

In the course of the study, a deep learning algorithm with reinforcement for job search services was developed. In the process, it was found out that using the DDQN model allows you to achieve higher accuracy as compared to existing solutions.

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## Использование алгоритма глубокого обучения с подкреплением для сервисов поиска вакансий

И. В. Хворов, Д. А. Черемисин, Д. В. Тулупов

ФГБОУ ВО «Тамбовский государственный технический университет», Тамбов, Россия  
*e-mail: ilya.hvorov@list.com, thedenchil2000@gmail.com, dmitry.tulupov68@gmail.com*

**Аннотация.** Целью данного исследования является анализ возможностей применения алгоритма глубокого обучения с подкреплением для реализации рекомендаций в сервисах для поиска вакансий. В работе будут рассмотрены используемые на данный момент алгоритмы и будет предложена более точная реализация. Актуальность исследования заключается в том, что использование алгоритмов обучения с подкреплением для генерации рекомендаций для соискателей и работодателей на сайтах поиска работы позволит увеличить точность рекомендаций.

**Ключевые слова:** нейронные сети, алгоритм обучения с подкреплением.

# The Main Threats to the Security of Distributed Information Systems

**E. V. Koshelev**

Tambov State Technical University, Tambov, Russia  
*e-mail: lyutsian-zzz@yandex.ru*

## Abstract

The purpose of this article is to analyze various threats affecting distributed information systems. The study will consider destructive impacts, both external and internal, that have a negative impact on the quality of work and the overall performance of distributed information systems. The relevance of the study lies in the fact that at the moment there are more and more threats to information security and the success of countering them depends on the competent identification and systematization of these threats.

**Keywords:** distributed information systems (DIS), information security (IS), IS threats.

## Introduction

A distributed information system is a system whose data and processes are stored in two or more databases geographically remote from each other, but having common parameters.

Threats to the security of DIS within the framework of this article are understood as potentially possible processes, events, phenomena aimed at causing damage to both the DIS itself and the data it operates with (stores, processes, transmits).

The main types of threats to the safety of DIS are:

- accidents and natural disasters (fire, earthquake, flood, hurricane, etc.);
- operational errors (users, system administrators and other personnel);
- failures of equipment and databases, failures of nodes DIS;
- consequences of mistakes made during the design and development of the components of the DIS (hardware, data processing technology, software, data structures, etc.);
- deliberate actions of violators and intruders (disgruntled personnel, hackers, spies, saboteurs, etc.).

## Types of threats to information security

All types of threats to information security can be classified according to different criteria, which make it possible to select information security tools more effectively.

The whole set of potential threats is divided into two categories: natural (objective) and artificial (subjective).

Natural threats are objective, independent of a person, events that can cause damage to DIS. The most frequent among these threats are fires. But in quantitative terms, natural threats are much inferior to artificial threats.

Artificial threats, unlike natural ones, are caused by intentional (intentional threats) or unintentional (unintentional) human activity:

- intentional threats – appear from the selfish goals of people (intruders);
- unintentional threats – caused by design errors at the stages of development and configuration of DIS, errors in software, in the actions of personnel, etc.

Sources of threats in relation to DIS are divided into:

- internal threats are structural elements of DIS, including hardware, software and maintenance personnel;
- external threats are all others.

The main unintentional artificial threats of DIS are actions committed by the staff accidentally, out of ignorance, inattention or negligence, out of curiosity, but without malicious intent:

- unauthorized activation of equipment or changing the operating modes of devices or software;

- unintentional damage or destruction of media;

- unintentional actions of users leading to partial or complete failure of DIS, its components (hardware and software), damage to DIS information resources (unintentional damage to equipment, deletion of data, distortion of files with important information, including system files, etc.);

- the launch of programs that, if used incorrectly, can cause a loss of performance of the DIS (freezes or crashes) or cause irreversible changes in the operating system (database restructuring, formatting of media, data deletion, etc.);

- infection of the computer with viruses;

- illegal installation and use of unaccounted-for programs (gaming, training, application, etc.), which leads to the consumption of DIS resources (CPU usage, filling of RAM and memory on external media, etc.);

- design of the DIS architecture, data processing technologies, development of application programs with functionality that poses a potential danger to the DIS operability and information security in it;

- careless actions of the user leading to the disclosure of confidential information (related to the structure of the DIS, its components, software, etc.), or making it publicly available;

- entering erroneous data;

- working with DIS bypassing security measures (loading an extraneous operating system from removable media, etc.);

- ignoring organizational restrictions (established rules) when working in DIS;

- incompetent operation, setting up or illegal disconnection of protective equipment and security services by personnel;

- sending data to the wrong address of the subscriber (device);

- disclosure, transfer or loss of access control attributes (passwords, passes, identification cards, encryption keys, etc.);

The main possible ways of deliberate disorganization of work, disabling of DIS, penetration into the system and unauthorized access to information:

- physical destruction of the system or the failure of all or individual components of DIS;

- recruitment (by bribery, blackmail, etc.) of personnel or individual employees with access to DIS;

- destruction of subsystems to ensure the functioning of the network DIS;

- introduction of agents into the number of personnel working with DIS (including the administrative group responsible for security);

- unauthorized copying of media;
- theft of media;
- interception of secondary electromagnetic, acoustic and other radiations of devices and communication lines, as well as active radiation leads on auxiliary devices not directly involved in information processing (telephone lines, power supply networks, heating, etc.);
- use of listening devices, remote photo and video recording, etc.;
- interception of information, communication channels, and their analysis in order to clarify the exchange protocols, rules for entering the network and user authorization, followed by an attempt to simulate them for penetration into the DIS;
- illegal receipt of passwords and other access control details with their further use;
- opening cryptographic ciphers;
- theft of industrial waste (decommissioned media, printouts, records, etc.);
- reading information from areas of RAM used by the operating system (including the protection subsystem) or other users in asynchronous mode using a gap in the protection of operating systems and programming systems;
- illegal connection to data transmission lines for the purpose of working “between the lines”, at the time of inaction of the legitimate user on his behalf, followed by the entry of false data or modification of transmitted messages;
- illegal use of user terminals with unique physical characteristics, such as the number of the workstation in the network, physical address, address in the communication system, hardware coding unit, etc.;
- reading of residual data from the computer RAM or from external storage devices;
- introduction of hardware and software «bookmarks» and computer viruses;
- illegal connection to data transmission lines for the purpose of direct substitution of a legitimate user by physically disconnecting him after logging in and successfully authenticating, followed by the introduction of misinformation and the transmission of false messages.

In order to build reliable protection of a distributed information system, it is not enough to know what threats there are in principle. It is necessary to understand which of the threats can be implemented in a particular DIS. It is clear that in practice there are no such situations when all types of threats act (or can be implemented) at once. There are systems, for example, in which there is no network. Accordingly, those threats that are implemented through the network can be discarded and not work out protection against them. And it often happens that several threats act on DIS at once. Or, one successfully implemented threat opens up the possibility for the implementation of another threat (a virus program intercepts the user's password and transmits it to an attacker, who in turn gets remote access to the user's computer over the network).

Natural threats should not be discounted either. It is often impossible to prepare for them in advance. But it is desirable to work out means of protection against them (lightning rods, fire extinguishers, uninterruptible power supplies, emergency switches, etc.). If tornadoes are not so common in Russia, then thunderstorms and



fires are quite common. There is no need to talk about ignition from a short circuit at all.

But it should also be understood that it is impossible to protect yourself from all kinds of threats at all. There are no absolutely secure systems. Accordingly, it is necessary to systematically analyze the vulnerabilities of the distributed system and the effectiveness of the selected means of its protection, followed by the development of measures to improve the protection of DIS, and minimize potential harm in the event of the possible implementation of any of the threats.

## **Conclusion**

The article provides a classification and description of threats to information security of distributed information systems. Special attention is paid to the main unintentional and intentional artificial threats. Therefore, the goal has been achieved.

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## **Основные угрозы безопасности распределённых информационных систем**

**Е. В. Кошелев**

ФГБОУ ВО «Тамбовский государственный технический университет», Тамбов, Россия  
*e-mail: lyutsian-zzz@yandex.ru*

**Аннотация.** Целью данной статьи является анализ различных угроз, действующих на распределённые информационные системы. В исследовании будут рассмотрены деструктивные воздействия, как внешние, так и внутренние, оказывающие негативное влияние на качество работы и работоспособность в целом распределённых информационных систем. Актуальность исследования заключается в том, что в настоящий момент угроз информационной безопасности становится всё больше и от грамотного выявления и систематизации этих угроз зависит успешность противодействия им.

**Ключевые слова:** распределённые информационные системы (РИС), информационная безопасность (ИБ), угрозы ИБ.

## Decision Support Methods Based on Information Technology

Yu.V. Kulakov, Al-Imari Mustafa Jafar Baker\*, Al Sudani Zaid Ali Hussain

Tambov State Technical University, Tambov, Russia

\*e-mail: [Mustafa.jb84@gmail.com](mailto:Mustafa.jb84@gmail.com)

### Abstract

The article is devoted to the analysis of existing decision-making methods based on information technologies. The purpose of the work is an attempt to single out one of the decision-making methods as the main one. The relevance of the topic lies in the lack of a unified approach to the study of decision support methods and the selection of one method as the base one. The authors state the fact that the modern world cannot be considered without the constant improvement of information technologies.

**Keywords:** information technology, support methods, pandemic.

With the rapid development of the IT sphere, everything around acquires special value. The pandemic, sanctions, and instability of the global economic and political situation have demonstrated an even greater need for the development of information technologies. According to the data of the analytical company IDC, in 2022, more than half of the world economy is heavily dependent on information technology in various business sectors. According to experts' forecasts, in 2024 more than 50% of investments will be implemented in digital technology industries.

Considering the trends that were characteristic in 2022, we can distinguish the following:

1. *Updated "clouds"*. The goal is to protect and improve the work with the cloud to maximize the positive result of the organization.
2. *Accelerated approach to cloud technologies*. More than 70% of companies will switch to the cloud. This process takes half as much time as it did in 2022.
3. *Enhanced control over the correct use of data*. This trend will affect the increase in the share of expenses for working with data.
4. *Artificial intelligence*. IDC analysts predict that more than 25% of companies from Forbes Global 2000.
5. Ecology will use a startup based on artificial intelligence. IT and environmental protection and conservation are two industries that complement each other and go together.

The use of IT technologies is not just fashionable; it is an objective necessity that guarantees the company the most positive effect.

The analysis of the existing modern literature has shown that there are a large number of decision support methods that are based on information technology. Despite this, there is no unity of approaches. Many ordinary people, however, as well as professional managers are lost if they have many alternatives when making a decision. In our opinion, the result of the work can be as effective as possible if we highlight the basic method of decision-making.

In modern practice, the following methods of decision support based on information technology are used:

1. *Information search*, the purpose of which is to search for any information that will be further analyzed by specialists. This method involves a certain process of collecting and transmitting information directly to the customer/interested person. Information search can be implemented using address, documentary and semantic methods.

2. *Data mining* includes statistical analysis and machine learning models. Important in data analysis is the correct classification of the information found, its gradation. When identifying any deviations, it is important to predict possible ways to solve problems.

According to Grigory Piatetsky-Shapiro, this method can be defined as the process of detecting previously unknown, non-trivial, practically useful and interpretable knowledge necessary for decision-making in various spheres of human activity in raw data[1].

Among the advantages of using the data mining method are the following:

- the information collected and subsequently analyzed will help the organization to find, attract new and retain old customers.

- this method allows you to analyze a large amount of information, while the analysis of information does not require large expenses.

- it allows you to find information that you initially did not expect to receive.

- the method has a high degree of reliability of the data obtained, so you can check everything using statistical analysis.

- the method allows you to minimize costs and use financial resources for new startups.

- having the baggage of certain knowledge and skills, the management will be able to avoid many mistakes.

3. *Simulation modeling*, which is a model describing the existing system with high accuracy. This method is used only if it is difficult / impossible to build an analytical model and experiment on a real object.

Based on life experience and scientific knowledge, it is easier for a person to build the most complex models – from origami to spaceships. The stronger our imagination, the faster our consciousness helps us to reach heights, including in modeling. In our opinion, it is simulation modeling that is the most effective means of decision support.

Among the software products that use the simulation modeling method, the following can be distinguished: Arena, Extend, AnyLogic, AutoMod, and Promodel. In the socio-economic spheres, AnyLogic is mainly used in addition to the named sphere, this program is used in the healthcare and transport sectors.

4. *Artificial neural networks*, which are mathematical algorithms based on modern machine learning. When artificial neurons are combined into a large network with a specific control mechanism, these neurons can perform many functionally complex tasks. In modern practice, the pure neural model is practically not used. Despite this, it is at the heart of an artificial neuron.

5. *Precedent-based reasoning* is a method that helps solve a new problem by using or transforming an already accepted solution to a specific problem.

The precedent-based approach emerged in the process of developing research in

the field of creating expert systems (knowledge-based systems). Expert systems of the first generations were systems based on rules (production type), which assumed the presence of fairly well-formalized tasks. To solve such problems, either methods of reliable inference were used, which, based on the initial data, in accordance with the set of rules available in the system, formed a conclusion on the current problem, or methods of plausible inference for cases of uncertainty of a probabilistic nature [2].

### **Conclusion**

Thus, taking into consideration of some decision support methods based on information technology, the following conclusions can be drawn:

1. There are many methods of decision-making, each of which, depending on the type of activity, policy and financial capabilities of the company can be applied.
2. In our opinion, the best method that can be used to support decision-making in any field is the method of data mining.
3. The information collected and subsequently analyzed will help the organization to find, attract new and retain old customers.
4. This method enables to analyze a large amount of information, while the analysis of information does not require large expenses.
5. The method has a high degree of reliability of the data obtained, so you can check everything using statistical analysis.
6. The method allows you to minimize costs and use financial resources for new startups.
7. The method having the baggage of certain knowledge and skills, the management will be able to avoid many mistakes.

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## **Методы поддержки принятия решений на основе информационных технологий**

**Ю.В. Кулаков, Аль-Имари Мустафа Джафар Бакер\*, Аль Судани Зайд Али Хуссейн**  
ФГБОУ ВО «Тамбовский государственный технический университет», Тамбов, Россия  
*\*e-mail: Mustafa.jb84@gmail.com*

**Аннотация.** Статья посвящена анализу существующих методов принятия решений на основе информационных технологий. Цель работы – попытка выделить один из методов принятия решений в качестве основного. Актуальность темы заключается в отсутствии единого подхода к изучению методов поддержки принятия решений и выделении одного метода в качестве базового. Авторы констатируют тот факт, что современный мир невозможно рассматривать без постоянного совершенствования информационных технологий.

**Ключевые слова:** информационные технологии, методы поддержки, пандемия.

## Technical and Software Automation Tools for Warehouse Systems

I. V. Kuleshov\*, V.A. Nemtinov

Tambov State Technical University, Tambov, Russia

\*e-mail: ilya2000kulash@gmail.com

### Abstract

Technical and software tools for automation of warehouse functioning systems are considered.

**Keywords:** software tools for the functioning of the warehouse, technical means of warehouse operation, warehouse, warehouse robots.

### Introduction

For the autonomous operation of the warehouse, many conditions must be met, including the provision of software and hardware, high qualification of personnel, etc. But if it turns out to make the warehouse work offline, then this will increase profitability and profit.

### Description of the subject area

Robots can be used for various aspects of order fulfillment, including picking (to reduce all or some of the movements that reduce productivity), physical assembly and placement (to reduce the number of touches), packaging and transporting the product between intermediate areas for storage or restocking. Diagram of the organizational warehouse management system is shown in Fig.1. Automation through robotization would reduce the number of manipulations with the object.

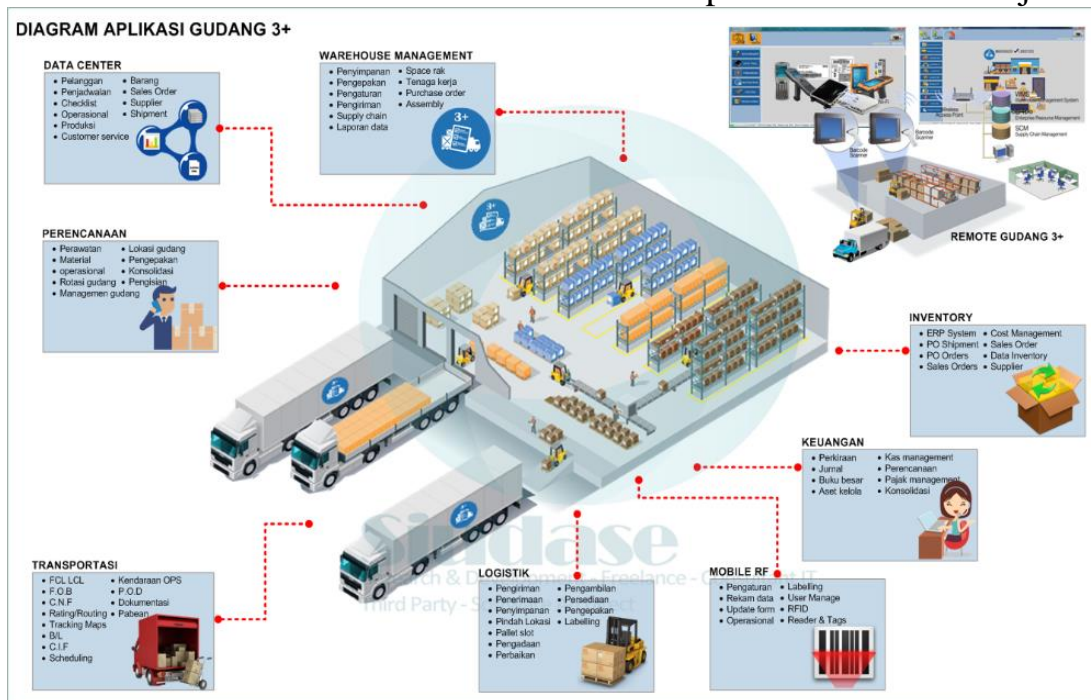


Figure 1 – Diagram of the organizational warehouse management system

### Robotic arms

Robotic manipulators have been used for decades in manufacturing and

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distribution systems for many years. Achievements in the field of visual control systems and technologies of finite elements (grips) currently allow us to improve the process of picking up parts and operations of selection and laying. Manipulators can be used at the workplace to transfer goods to a person or mounted on a mobile robot for each configuration. They can also be mounted on site to perform repetitive tasks, such as loading empty cardboard boxes, sorting on shipping routes, etc.

The advantages of these robots include: reducing dependence on labor at pick-up stations, stacking walls, sorting stations and in the shipping dock, as well as improving accuracy in picking and stacking. Key issues related to operational deployment:

- Visualization software. The depth and size sensors of robotic visual systems have improved their ability to determine the boundaries of an object, but the problem is that the lighting should be good and the object well reflective. It is also difficult for robots to look into small compartments;

- Variety of items and restrictions. The range of weight that a robot arm can handle is still a limitation in some cases, and depending on the range of processed products, various manipulators may be required during design.

#### *Bots for collaboration "Co-bots"*

The main advantage of "co-bots" is their ability to reduce the trips of collectors working together with them. Pickers spend most of their time traveling on foot, and these bots reduce (but do not eliminate) part of the wasted walking, which reduces productivity.

#### *Meeting bots "Meet-Me Bots"*

These robots move around the selection area, stopping and waiting at the selection site for the worker who performs the selection. Workers move from bot to bot within the bot's work area, rather than crossing the entire warehouse space.

#### *Tracking bots "Follow-Me Bots"*

When filling out, the bot is sent to the packing station, and another bot is deployed at the location of the picker.

#### *A mobile rack for transporting goods from person to person*

Mobile shelving robots deliver inventory via mobile shelving systems to workstations optimized for increased productivity. These bots provide the greatest flexibility when storing products, among others. Robot racks transport products located on warehouse sites of various configurations to workstations. The main problem associated with these robots is poor performance.

#### *Roaming shuttle*

Roaming shuttle robots are used to store and transport products in a high-density storage environment, which is usually part of a mobile shelving solution. The main advantage of these robots is that they allow the user to scale the storage space and throughput relatively independently. That is, when more storage space is needed, it can be added with little to no additional investment needed to increase throughput (which may not have changed).

Mobile shuttles help to reduce the total area of the building, taking full advantage of the height of the warehouse. Some systems of moving shuttles are configured in such a way as to take advantage of spaces of unusual shape. They are gaining

momentum as part of local solutions or solutions for micro-realization.

To achieve a higher storage density, deep rows or high columns are used. However, these strategies require additional access time, which can limit bandwidth. Some vendors have solved this problem by using algorithms that "learn" and place fast-moving articles in places that are more easily accessible, which reduces access and transportation time. The end result is that roaming systems will become "saturated" at some point (i.e. adding more shuttles does not increase throughput).

*Autonomous, mobile, transport robots for the transportation of individual goods*  
These robots are often used to transport the product to the warehouse, transport pallets over long distances, for example, from the place of reception to the place of storage or from the place of storage to shipment. There are several problems with these robots:

- Security. Their speed, the likelihood of collision damage, and sensors that are not sophisticated enough to detect human movement or react quickly enough to avoid a collision are safety concerns when working in close proximity to people. Suppliers are working to solve such problems, including the ability to “see” the forks of loaders that are located low above the ground;

- Restrictions on Vertical Ascent. These robots often do not have a mast with a lifting/lowering mechanism, which limits their reach and current scope of application;

- Loading and unloading stands. Robots require special sets of stands for loading and unloading in order to work with the goods [1].

*Warehouse robotics: automated storage and retrieval systems*

Automated storage and retrieval systems are a technology that moves inventory to and from the warehouse. It is usually paired with warehouse management software that manages operations.

Automated storage and search systems are presented in different forms, depending on the type of tasks, the necessary system or the goods with which they will work. They can work either as a shuttle on a stationary track, or as a crane that moves goods between aisles. There are robots for moving through the aisles, such as "Skypod", which can also receive customer orders.

Order completion can be 50% or more, especially in large warehouses. By reducing the number of workers and the time spent searching, workers can focus on more complex processes, such as packaging and product placement.

Alibaba, the largest retailer in the world, has proved how useful automated storage and search systems can be in their warehouse in China. Using 60 robots, they reduced labor costs in the warehouse by 70%. Their robots work over Wi-Fi, delivering inventory to workers for packing and shipping. As a result, their speed of operations has greatly increased, which has tripled the volume of production.

## **Conclusion**

Based on all of the above, it can be concluded that today, due to the size and load capacity, robots are more suitable for warehouses related to the sale of general-purpose products. But automation of even a small warehouse would allow the company to reduce the cost of warehouse maintenance.

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## Технические и программные средства автоматизации складских систем

**И. В. Кулешов\*, В.А. Немтинов**

ФГБОУ ВО «Тамбовский государственный технический университет», Тамбов, Россия

*\*e-mail: ilya2000kulash@gmail.com*

**Аннотация.** Рассмотрены технические и программные средства автоматизации систем функционирования склада.

**Ключевые слова:** программные средства для функционирования склада, технические средства складской эксплуатации, склад, складские роботы.



## **Information Technologies in the Activities of Internal Affairs Bodies: Interface of the Physical Evidence Accounting System**

**A. A. Kuskova**

Tambov State Technical University, Tambov, Russia

*e-mail: ms.alinka.2016@mail.ru*

### **Abstract**

The purpose of this study analyzes approaches to ensuring the safety of physical evidence and the implementation of their automated accounting. The study considers the requirements for the interface of an automated system for recording physical evidence. The relevance of the study lies in the fact that the creation of an automated information system interface implies obtaining a positive effect in the work of internal affairs officers. As a result, it is necessary to develop a program for recording physical evidence, through modernization and introduction of new technologies.

**Keywords:** automated information system, information technologies, interface, accounting of physical evidence, IDEF diagram.

The process of development of automated information systems has been going on for several decades. As a result, automated information systems have been transformed from the simplest programs with a set of typical functions to flexible adaptive integrated systems with elements of artificial intelligence.

GOST R 59853-202, which fixes the terms and definitions for automated systems, understands an automated system as a complex of automation tools that implement information technology for performing established functions, and personnel who implement the work of this complex.

The employee who keeps records of physical evidence does a lot of paperwork, so how he has to fill out cards, evidence logs and other documents.

It is necessary to understand what the interface of the designed system should include; it is rational to present the entire process of the system in the form of diagrams of IDEF0 data models. IDEF0 is a very simple and at the same time visual language for describing processes. It is important to note that the mechanism for managing the process of recording material evidence is the Criminal Procedure Code of the Russian Federation (articles 81, 82 of THE Code of Criminal Procedure of the Russian Federation).

The requirements to the interface of the automated information system AIS of accounting of real are investigated:

- to be intuitive;
- include a set of convenient functions for entering, searching and editing information;
- have user authorization;
- include a set of functions for searching (filtering) data;
- have the functionality to track the life cycle of registered items;
- only the database administrator should care about the possibility of creating, deleting and editing a user.

The creation of an information system for the registration of physical evidence will

allow automating most of the functions related to the registration, accounting and storage of objects registered during the investigation of a criminal case as physical evidence.

In addition, the creation of such a program will speed up the speed of registration of physical evidence.

The Criminal Procedure Law establishes in detail the procedure for disposing of material evidence in a criminal case, and judicial practice should be consistently guided by it.

The IDEF0 data model of accounting for physical evidence consists of the incoming and outgoing information. The incoming information is the information about the subject obtained during investigative actions, provided upon request and information about the materials of the criminal case. The outgoing information is the assigned number, information about the connection of the subject with the criminal case, information about the subject and the place of its storage, as well as accounting documentation.

The interface allows you to implement the following system functions:

- entering new and correcting existing information, searching for the necessary information;
- query execution;
- viewing the execution of requests, ensuring the interaction of the user's interface with the information system, storing information in the database;
- access control;
- maintaining the database and keeping it up to date;
- Implementation of an electronic archive.

The created interface makes it possible to simplify and speed up the work of employees on keeping a log of physical evidence due to the presence of drop-down lists, calendars and navigation buttons. The system windows are not overloaded with unnecessary commands, each window contains only three tabs, as a result of a small number of functions the system interface is up-to-date and understandable.

In modern times, in most areas of law enforcement agencies, old paper file cabinets have been replaced with electronic databases that allow you to quickly process various requests. We also consider it reasonable to automate the storage and accounting of physical evidence, since physical evidence plays an important role in the investigation of criminal cases.

During the investigation of a criminal case, physical evidence retains evidentiary information for quite a long time than human memory. This is of great importance, both when resuming suspended criminal cases and when initiating criminal proceedings.

Accounting for physical evidence can be an application developed using a database and a shell, but also a website.

Thus, the interface of an automated information system for recording physical evidence must meet the requirements of the user, i.e. the specialist responsible for recording and storing physical evidence. Since the convenient location of functions, quick input and access to information will allow the employee to register physical evidence much faster.

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## **Информационные технологии в деятельности органов внутренних дел: интерфейс системы учета**

**А. А. Кускова**

ФГБОУ ВО «Тамбовский государственный технический университет», Тамбов, Россия  
*e-mail: ms.alinka.2016@mail.ru*

**Аннотация.** Целью данного исследования является анализ подходов к обеспечению сохранности вещественных доказательств и внедрению их автоматизированного учета. В исследовании будут рассмотрены требования к интерфейсу автоматизированной системы регистрации вещественных доказательств. Актуальность исследования заключается в том, что создание интерфейса автоматизированной информационной системы подразумевает получение положительного эффекта в работе сотрудников органов внутренних дел. В результате необходимо разработать программу регистрации вещественных доказательств путем модернизации и внедрения новых технологий.

**Ключевые слова:** автоматизированная информационная система, информационные технологии, интерфейс, учет вещественных доказательств, схема IDEF.

## **Cyber-Physical Systems and Their Role in the Organization of Smart Manufacturing**

**D. S. Lavrinov**

Tambov State Technical University, Tambov, Russia  
*e-mail: texlavrds@gmail.com*

### **Abstract**

Due to the rapid development of technologies and constant demand for their integration, the implementation of Cyber-Physical Systems is becoming an indispensable requirement. These systems take a place among the leading trends in the information technology industry. The present article reveals the main views on the Concept of Cyber-Physical Systems, discusses the main functions of this type of systems, and states the role of Cyber-Physical Systems in organizing the Smart Manufacturing Concept.

**Keywords:** cyber-physical systems; smart manufacturing; integration; systems interaction.

### **Introduction**

Observing the processes happening around us, it is hard not to notice the rapid changes. With each passing day, the era of intellectual technologies, which are considered revolutionary, is becoming everyday reality. Systems start dealing with automatic analysis, optimization of data and physical processes, decision making, and many other real-world related functions. Human-machine interaction is intensifying, starting to demand newer and more interactive control models. The efficiency of work processes is increasing, however the interactions themselves are beginning to require the solution of increasingly complex problems associated with the rapid development of digital technologies. One of the concepts focusing on the creation of actual control models is Cyber-Physical Systems that could solve many problems concerning integration and interaction between the information and physical worlds. It is required to analyze the level of the study of the present concept in order to identify directions for its further development.

### **Cyber-Physical Systems Concept**

Business processes in modern industry are constantly evolving. Manufacturing is becoming more and more intelligent, moving to new concepts of interactions, in which Cyber-Physical Systems play a central role. Thanks to the present Concept, the state of manufacturing is monitored in real time at any stage of product creation, in particular:

- collection of indicators from objects;
- indicators and characteristics changes are monitored;
- data processing is carried out within the framework of previously established rules;
- on the basis of the received and processed data a decision is made and control commands are given.

At the hardware and software level a Cyber-Physical System is either centralized or distributed. In a general sense, it implements the collection, processing, storage, accumulation and use of data both in the physical and in the information and

communication space, interacting between them through physical processes [1].

In connection with the mass digitalization of our society, there is a need to create completely new models that bring together information and material flows, but at the same time do not allow them to be unrelated to each other due to the principle of cybernetic systems [2].

These systems reveal themselves at the intersection of the cyber-physical and physical worlds. Control, analysis, interaction and management of physical space are carried out with the help of cyber-physical space highlighting the cooperation of computing systems and control systems, their integration and communication both among themselves and with third-party systems.

As a term, the Cyber-Physical System can be defined as a system consisting of many physical objects, man-made subsystems and controllers that allow all of them to interact as a single organism. These systems use feedback based both on the influence of what is happening in the physical space on computing processes, and vice versa. Due to this feature, a very close relationship is formed between physical resources and computers with their computing power. The efficiency of integration and communication between system elements is increased [3].

From the point of view of the hierarchical structure, it is necessary to distinguish three levels on which Cyber-Physical Systems are based. The first level is where the processes of intelligent monitoring and control are. The second level provides interconnection by means of the system level. And on the third level, the System of Systems (SoS) is implemented.

### **The role of Cyber-Physical Systems in the Concept of Smart Manufacturing**

In the era of rapid development, new technologies require continuous improvement from manufacturers of goods and providers of services. The level of modernization of business models and management strategies is increasing for a company to be able to maintain a place among the market leaders [4].

Therefore, it is only natural for Cyber-Physical Systems to begin to develop and spread to different areas of life. The leading trend now is the Concept of Smart Manufacturing.

The Concept of Smart Manufacturing implies devices and production facilities that independently control each other and are capable of exchanging information, autonomously setting tasks for themselves and starting to complete them.

This Concept significantly affects the efficiency and productivity of the enterprise through participation in almost the entire production cycle, including control of development, logistics, distribution of resources and materials, schedules and models of production processes. Intelligent machines and devices are becoming an essential part of the plant, capable of real-time monitoring of their ongoing status, storing and analyzing historical data, interacting with other devices at the plant using more flexible means of information exchange, identifying themselves as a unique entity and giving maintenance and support tasks to their components [4].

With the help of Cyber-Physical Systems, it becomes possible to combine heterogeneous components into an integral and structured system, in which both actuators and process controllers are clearly connected, as well as wide control loops for production processes and the entire enterprise. It allows the Concept of Smart

Manufacturing to advance significantly in the areas of versatility, flexibility and adaptability.

The complexity and scale of the Smart Production Concept set the requirements for theoretical works describing the physical models of Cyber-Physical Systems. There is a trend towards creation of methods for reproducing and refining these models, for a more subtle study of the interactions of managing such vast structures.

### **Conclusion**

Cyber-physical systems are a new stage in the information technologies development, through which it becomes possible to realize the interaction of physical processes with a vast amount of devices and systems responsible for analysis, forecasting and adaptation, for the continuous improvement of production management processes, taking into account the tendency to increase the amount of data received for analysis.

Despite the incredible potential, existing concepts are not perfect. There are still problems with data heterogeneity, reliability, privacy and security. By eliminating these problems, Cyber-Physical Systems will be able to reach a completely new level of efficiency.

Considering the impact that Cyber-Physical Systems have on people's lives, we can surely say that this Concept plays a huge role in the onset of the Fourth Industrial Revolution.

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## **Киберфизические системы и их роль в организации умного производства**

**Д. С. Лавринов**

ФГБОУ ВО «Тамбовский государственный технический университет», Тамбов, Россия

*e-mail: texlavrds@gmail.com*

**Аннотация.** Благодаря бурному развитию технологий и постоянным запросам на их интеграцию, неотъемлемым требованием становится внедрение Киберфизических систем. Данные системы относятся к лидирующим направлениям в индустрии информационных технологий. В данной статье раскрываются основные взгляды на концепцию Киберфизических систем, рассматриваются основные затрагиваемые данным типом систем функции, приводится роль Киберфизических систем в организации концепции Умного производства.

**Ключевые слова:** киберфизические системы; умное производство; интеграция; взаимодействие систем.

## Information Technologies in Law

**O. A. Nepodkosova\*, V. A. Cherepyansky, D. Y. Bykov**

Tambov State Technical University, Tambov, Russia

\*e-mail: olesyanepodkosova@gmail.com

### Abstract

The purpose of this study analyzes a set of measures to ensure the usability of information technology for lawyers. The study considers various technical tools for lawyers, depending on the specifics of their work. The relevance of the research lies in the fact that information technologies simplify the routine work of lawyers. As a result, it is necessary to develop a new unified tool to ensure the comprehensive work of a lawyer.

**Keywords:** automated information system, automated workplace, applied informatics in law, legal consulting.

Information technology has become an integral part of every person's life, both in everyday life and at work. Modern IT is used in all spheres: economy, industry, business, politics, law and many others. Such popularity is clear, because in the XXI century, ignoring the benefits and convenience of using technology means complicating the performance of everyday tasks.

The activities of modern specialists are closely related to the search, processing and use of information. For lawyers, working with various data sets is a necessity. The usage of printed and outdated media nowadays only worsens the working conditions, taking up useful time for the process of searching, decrypting information, as well as correcting possible errors, including ones occurring due to data loss.

The development of information technologies in recent years allows us to solve most of these problems and simplify the user's interaction with information. For this purpose, special tools are being created – automated information systems, automated workplaces for professional use, web applications, Internet services.

The software for automation of legal activity makes it possible to simplify the process of performing daily tasks and working with various data. Such software includes: legal reference systems, programs for statistical data processing, automated information systems for digital document management, etc.

In the situation of a prolonged pandemic of the COVID-19 coronavirus, when the usual, full-time office format of work was impossible, most employees came to the same conclusion: working remote, in semiautomatic mode, with information, document flow, customer requests presents an additional opportunity to make any service even more convenient for the user and the employee by transferring it to the online space.

The provision of counseling services by professionals is of an immaterial nature. During the counseling, the client of the law firm receives clear instructions for further actions to resolve the legal problem that has arisen. Lawyers who provide assistance help clients draw up contracts, certificates, execute transactions, check the legal literacy of documents.

This type of service is called counseling. Counseling is the activity of advising applicants in various specialized fields. The purpose of counseling is to achieve the stated goals. This activity is used in the legal sphere, creating the sphere of legal counseling.

Legal counseling are legal services that the customer receives from qualified specialists with higher legal education and practical experience.

The activity of lawyers providing counseling services requires working with a large flow of information: legal codes, international treaties and other regulatory legal acts of the Russian Federation, as well as client statements.

A lawyer can help with the documents: draw up a contract, evaluate someone else's contract, make a complaint, register a company, apply for registration of a trademark or industrial design, write a new version of the charter for the company, write statements, appeals. He can also advise on the rights of citizens and their obligations under the law, be a representative in court, as well as help with negotiations.

Automated information system (abbreviated AIS) is a set of various software and hardware, which uses mathematical methods designed to automate any type of activity that is associated with the processing, transmission, storage of information.

AIS helps increase the productivity and efficiency of employees, improve the quality of services provided. Thus, the labor costs for routine and monotonous repetitive work are reduced, while the speed of processing various information increases.

There are four types of AIS:

- covering 1 process or operation in 1 company;
- combining several processes in 1 company;
- ensuring the functioning of 1 process on the scale of several interacting companies;
- implementing the work of several processes or systems on the scale of several organizations.

One of the main approaches to the classification of automated legal information systems is related to the types of processed socio-legal information and others.

AIS can be represented as a complex of automated information technologies that make up an information system designed for providing digital service to consumers. The automated workplace of a specialist is a kind of automated information system that is fully intended to be used by people of the same specialty, united by the similar or identical tasks. In the activity of any lawyer, the use of specialized software simplifies the work and makes it more efficient. For this purpose, many automated



workplace suites have been created, for example: an investigator's (inquirer's) automated workplace, a lawyer's automated workplace.

As a rule, a lawyer's automated workplace consists of a database, a lawyer's calendar, a task manager, a document designer, implementations for macros and templates, statistical tools for analytics and reporting, and others. When creating an automated workplace, you can rely on four basic principles: efficiency, consistency, stability, flexibility.

Thanks to the use of various kinds of automatic and automated control systems, technological processes are optimized. The more employees work in the company, the higher the need to use an automated workplace, as it will allow you to coordinate the work of each of them, creating a single information space. And also, the more customers there are, the higher the need to use workflow automation.

Thus, it was found out that there are 4 types of automated information systems, which are a combination of various software and hardware using mathematical methods. They are designed to automate any type of activity that is associated with the processing, transmission, storage of information. In this way, the legal foundations of lawyers' activities were studied. It was found out that when providing counseling services, lawyers are guided by regulatory legal acts of various branches of government.

The main powers and functional responsibilities of lawyers were also clarified. It was revealed that these are specialists of a wide range working with an array of customer data, they collect and take into account the necessary information, prepare various legal documents. In light of the high demand for legal counseling among citizens, automation of this process is necessary. This capability increases the efficiency of employees and convenience for clients. Characteristics of the main functions of an automated information system for receiving applications from citizens to a lawyer providing legal assistance have been studied as well. The concept of AIS was analyzed. This is a combination of various software and hardware using mathematical methods designed to automate any type of activity that is associated with the processing, transmission, storage of information.

The characteristics of the main functions of an automated information system for receiving applications from citizens to a lawyer providing legal assistance to create a new comprehensive solution are identified.

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## Информационные технологии в юриспруденции

О. А. Неподкосова\*, В. А. Черепянский, Д. Ю. Быков

ФГБОУ ВО «Тамбовский государственный технический университет», Тамбов, Россия  
*e-mail: olesyanepodkosova@gmail.com*

**Аннотация.** Целью данного исследования является анализ комплекса мер по обеспечению удобства использования информационных технологий для юристов. В исследовании будут рассмотрены различные технические средства для юристов, в зависимости от специфики их работы. Актуальность исследования заключается в том, что информационные технологии упрощают рутинную работу юристов. В результате исследования пришли к выводу о необходимости разработки нового единого инструмента для обеспечения комплексной работы юриста.

**Ключевые слова:** автоматизированная информационная система, автоматизированное рабочее место, прикладная информатика в юриспруденции, юридический консалтинг.

## Predicting the State of a Person on an Adaptive Platform

**K. I. Patutin\*, A. P. Bagryantseva, Y. A. Averin**

Tambov State Technical University, Tambov, Russia

\*e-mail: kirill-patutin@mail.ru

### Abstract

This article describes an approach to predicting the human condition on an adaptive platform, and also builds an algorithm for preventing dangerous situations using computer vision. The architecture of a multilayer neural network is described and built, with the help of which the position of a person is predicted. This neural network and algorithm improve the quality of interaction with the platform and improve the management of adaptive information systems.

**Keywords:** adaptive information system, adaptive platform, person's position, neural network, state prediction.

### Introduction

In the modern world, virtual reality technologies are developing rapidly. They are used in various fields of human activity, both in an entertaining format and in various professions for personnel training, for example, industrial safety. In applications created for virtual reality, movement is tied to controllers, which reduces naturalness and causes discomfort. To eliminate such problems, various adaptive information platforms are being created. The simplest example is running platforms that allow a person to move in one strictly defined direction. At the moment, many different adaptive platforms have been created [1] to increase the comfort of human movement in a virtual environment.

Various approaches are used to control such platforms: tracking, computer vision, manual control, neural network methods, etc. [2-3]. But even on such systems, there is a chance of getting various injuries, for example, a person may fall and before the adaptive platform is stopped, a certain time period will pass, which can aggravate the emergency. To prevent such situations, it is necessary to develop an algorithm for predicting the state of a person and send a command to stop any actions to move the user.

Therefore, the purpose of this work is to predict the human condition on an adaptive platform.

### State Prediction

The algorithm for predicting a person's position is constructed as follows. Data on the movement of a person and their states (standing, walking, falling) were prepared, the MediaPipe algorithm [4] was launched on the received frames, which recognized the person in the frame and marked out his skeleton with 33 key points. Each point consists of two normalized coordinates. These coordinates are sent to the input of the prediction neural network.

This network is a multilayer neural network consisting of 8 Dense layers with different activation functions (linear and ReLu), two Dropout layers to avoid network retraining, and one LSTM (Long short-term memory) layer with a hyperbolic activation function. Each layer consists of 2000 neurons. The architecture of this

network is shown in Figure 1.

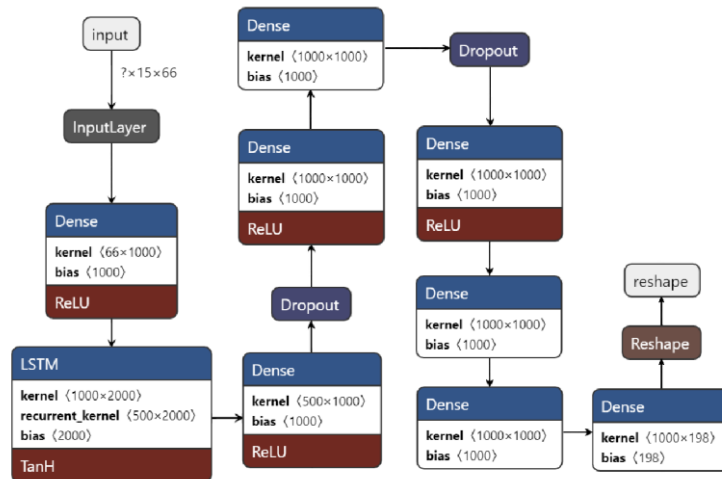


Figure 1 - Neural network architecture

To teach forecasting, several videos were initially prepared in which people were in different states, their skeletons with the coordinates of key points were built using MediaPipe. These coordinates are redirected to the input of the neural network, which trains for 30 epochs to predict the next 5 frames in 10 frames and identify the predicted state of a person.

The process of this training is shown in Figure 2. After training, the final accuracy of state prediction was about 70%, on test data – 75%.

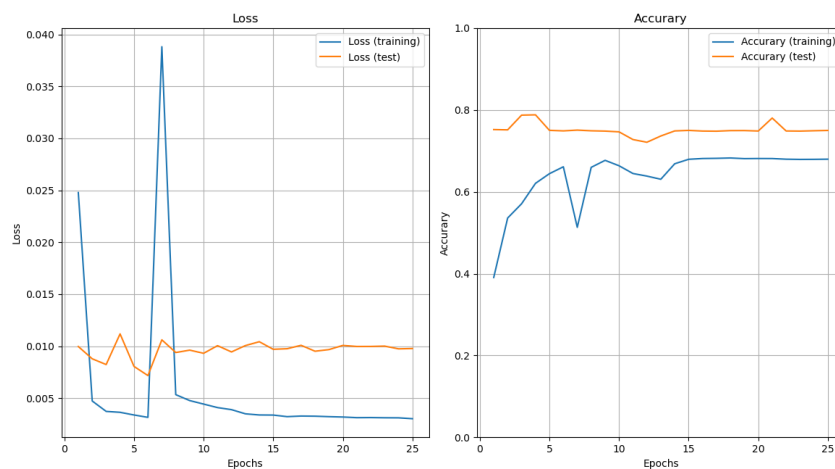


Figure 2 - Graph of the neural network training process

The result of the neural network was used to build an algorithm to prevent dangerous situations. When classifying a dangerous position of a person, which can lead to serious consequences for the user's health, commands are sent to the adaptive information system to stop the running platform and stop receiving any other commands until it returns to a steady state.

### Conclusion

The paper considers the problem of organizing a prediction of the human condition on an adaptive platform and an algorithm for preventing emergencies in the management of adaptive information systems. However, it is worth mentioning the shortcomings of this system for predicting the human condition. At the current stage,

the algorithm consumes too much computing power of a personal computer, which heavily loads the entire adaptive information system and the running platform control system in particular.

In the future, it is planned to modify the architecture of the neural network by reducing the number of layers, neurons in these layers, to try other activation functions and errors, to increase the amount of data for the learning process, which will more accurately determine the state of a person, it is possible to expand the number of states, which will allow more accurately determine its further actions and situations that can be predicted.

### **Acknowledgements**

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## **Прогнозирование состояния человека на адаптивной платформе**

**К. И. Патутин\*, А. П. Багрянцева, Я. А. Аверин**

ФГБОУ ВО «Тамбовский государственный технический университет», Тамбов, Россия

*\*e-mail: kirill-patutin@mail.ru*

**Аннотация.** В данной статье описывается подход к прогнозированию состояния человека на адаптивной платформе, а также построен алгоритм предотвращения опасных ситуаций с использованием компьютерного зрения. Описана и построена архитектура многослойной нейронной сети, с помощью которой происходит прогнозирование положение человека. Данная нейронная сеть и алгоритм повышают качество взаимодействия с платформой и улучшают управление адаптивными информационными системами.

**Ключевые слова:** адаптивными информационными системами, адаптивная платформа, нейронная сеть, положение человека, прогнозирование состояния.

## **Probabilistic Model of Computer Confrontation in Terms of Situational Awareness**

**M.A. Pelivan\*, A.V. Yakovlev**

Tambov State Technical University, Tambov, Russia

\*e-mail: *witcher89158779996@yandex.ru*

### **Abstract**

The problems of ensuring information security in modern conditions of increased activity of hackers are considered. The main attention is paid to the construction of a probabilistic model of computer confrontation taking into account situational awareness. Taking into account situational awareness should make it possible to more accurately assess the current situation of information confrontation and make decisions more effectively in conditions of constant variability of the process of computer confrontation.

**Keywords:** probabilistic model; computer confrontation; situational awareness.

### **Introduction**

At the moment, there has been a strong development and spread of information technologies, while criminal activity has also shifted to committing offenses in the field of computer information. In this connection, it is necessary to pay great attention to ensuring information security, and taking into account the current geopolitical situation, there is a need to ensure information security and the sustainable functioning of critical information infrastructure facilities. To meet the ever-growing requirements, information security specialists conduct research on security components and the formation of computer warfare models. At the same time, it should be considered that the process of computer confrontation can be represented in the form of a game (game theory) with several opposing sides, constant variability and a large flow of information.

### **Results and discussion**

A characteristic feature of computer warfare in information systems is that the participants of the confrontation – information security officers (players) receive only probabilistic information about the results of their actions, the actions of the enemy and the rules of the confrontation (game). In particular, players may lack information about other players or their winning functions, about physical capabilities (software, hardware, etc.), strategies of partners or opponents, including themselves, regarding the awareness of partners about various aspects of the game, etc. In a situation with incomplete information, even if a player observes the actions of another player, he still does not reliably know the type of player (the opponent's skills and his position relative to the attacked object), and the beginning of the stage of active actions, that is, does not form a well-defined subgame until his posteriori ideas about computer confrontation are formed. The reasons for incomplete awareness are related to the fact that players can be divided in relation to each of them into two classes: internal and external [1]:

- if the game simulates a situation in which players receive and process information about the enemy using information tools that have spatial and temporal limitations

(completeness of vulnerability databases and malware, frequency of information updates, etc.), then they talk about internal information noise (interference), leading to incomplete awareness of the players;

- if the reliability of information can be influenced by the actions of the enemy, leading to its distortion, they talk about external information noise (interference).

Computer confrontation (game)  $G$ , can be represented in the following equivalent normal forms:

$$\pi(G) = (S_1^*, \dots, S_n^*; W_1, \dots, W_n), \quad (1)$$

where:  $S_1^*, \dots, S_n^*$  are the space of normalized strategies of the  $i$ -th player. The normalized strategy  $s_i^*$ , is an expression defining the strategy  $s_i = s_i^*(c_i^*)$  of the  $i$ -th player through the information vector (situational awareness)  $c_i$ . From a mathematical point of view, the normalized strategy  $s_i^*$ , is a function that transforms the space  $C_1^* = \{c_i\}$  information vectors  $c_i$  into the strategy space of the  $i$ -th player  $S_i = \{s_i\}$ .

That is, the expansion of situational awareness of the information security officer  $c_i$  has a direct impact on the strategy of his behavior in a computer confrontation. In (1) the mathematical expectation of the winning of the  $i$ -th player, obtained by averaging that of the winning function  $M^*$  over the entire space, is denoted by  $W_i$ :

$$C = \{c\} = (C_1 \times \dots \times C_n), \quad (2)$$

$$W_1(s_1^*, \dots, s_n^*) = \int_C M_i^*(s_1^*, \dots, s_n^*; c) d(c) R^*(c), \quad (3)$$

at the same time, the true strategies of each player depend on the conditional expected winnings [2].

Consider a situation where only the opposing sides  $A$  and  $B$  interact with opposite goals, which before the interaction begins have  $x_i(0)=x_i(t_0)$  and  $x_j(0)=x_j(t_0)$  elements of the  $i$ -th and  $j$ -th types, respectively. Each opposing side, by its behavior, seeks to lower the survivability of its opponent. By the survivability of the opposing side, we will understand its property to preserve the ability to perform its functions, determined by some given level of value of functioning elements. We will assume that the side (object)  $A$  at time  $t$  is a full participant in the game if the inequality holds:

$$\sum_{i \in A} \Theta_i^{(A)} a_i x_i(t_0) \geq \sum_{i \in A} \Theta_i^{(A)} a_i x_i(t), \quad (4)$$

where:  $a_i$  is the value of the  $i$ -th element in conventional units, the parameters  $\Theta_i^{(A)}$  are determined by a constructive set of means to ensure the functioning (detection, localization and neutralization) of the opposing side.

## Conclusion

A change of the situational awareness significantly affects the probability of defeat, which is primarily due to the information vector (situational awareness) of the participants in the computer confrontation and their ability to form a strategy for their behavior, and ultimately occupy a tactically advantageous position. The construction, application and further development of computer warfare models, taking into account situational awareness, will allow determining the expected results of computer warfare in which the parties exert mutual informational influence on each other.

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## Вероятностная модель компьютерного противоборства с учетом ситуационной осведомленности

М. А. Пеливан, А. В. Яковлев

ФГБОУ ВО «Тамбовский государственный технический университет», Тамбов, Россия  
*e-mail: witcher89158779996@yandex.ru*

**Аннотация.** Рассмотрены проблемы обеспечения информационной безопасности в современных условиях повышенной активности хакеров. Основное внимание уделено построению вероятностной модели компьютерного противоборства с учетом ситуационной осведомленности. Учет ситуационной осведомленности должен позволить точнее оценивать текущую ситуацию информационного противостояния и эффективнее принимать решения в условиях постоянной изменчивости процесса компьютерного противоборства.

**Ключевые слова:** вероятностная модель; компьютерное противоборство; ситуационная осведомленность.



## **Analysis and Forecast of the Profits of a Horticultural Enterprise**

**M. Yu. Shcheglov\*, V. A. Nemtinov**

Tambov State technical University, Tambov, Russia

\*e-mail: maxsheglov2001@yandex.ru

### **Abstract**

The article discussed the relevance of income forecasting, methods for forecasting income and expenses of an organization, and developed a method for forecasting income. To apply the method in practice, the MC Excel software was used.

**Keywords:** income forecasting, fruit crops, gross harvest.

### **Introduction**

The main indicator of a company's success is its annual profit. And it is important to predict this indicator at an early stage. Income forecasting or budgeting is used for the operational management of the organization's financial activities. It allows the head of the organization to make timely decisions about the future plan for the functioning of the organization, all its business processes and costs.

### **Description of the subject area**

Organization JSC "Dubovoe" carries out as the main production activity, storage, sale of agricultural products and provision of services to agricultural producers. Installed capital RUB 3,957,381 Income for 2021 amounted to 240 million rubles. of which net profit is 116 million rubles. The number of permanent workers is: 106 people. For the period from 2012 to 2020, the company's revenue and net profit have grown, which indicates the right strategy for the development and functioning of the company [1].

Today, there are 3 methods of planning income and expenses in an organization [2]:

1) The direct calculation method: causes an adjustment of the amount from the sale using the determination of the presence of goods in warehouses (input and output). This option turns out to be the most accurate for forecasting, since it is based on guaranteed demand;

2) The remainder method: is based on adjusting the amount from sales by determining the balance of goods in warehouses (at the entrance and exit). Required in situations where it is impossible to use accurate data on the number of sales of products;

3) The indexing method: at the beginning, the indices of the influence of the season on the amount of sales and their ratio between the periods are determined. Further, the average value for each period is taken as an index.

At the moment, in the organization JSC "Dubovoe", forecasting income from sales was blocked with reliable reliability of outcomes from previous years, the scale of comparison of fruit-bearing trees and observation of orchards. This approach is

inefficient due to the fact that it is not accurate enough and takes a lot of working time.

For more accurate and convenient forecasting of income from the sale of fruit crops, a method for calculating this indicator was developed. Of the existing methods, the direct calculation method is best suited, that is, for each variety of apples from the assortment, the volume of sales is calculated at selling prices. A formula was developed for calculating the forecasted income from the sale of apples:

$$\begin{aligned}\Delta_1 &= S_{1 \text{ га}} * (Y_{\text{ц/га}} * ku) \\ \Delta_2 &= S_{2 \text{ га}} * (Y_{\text{ц/га}} * ku) \\ &\dots \\ \Delta_n &= S_{n \text{ га}} * (Y_{\text{ц/га}} * ku) \\ \text{Sun} &= \Delta_1 + \Delta_2 + \dots + \Delta_n\end{aligned}$$

$\Delta$  – gross harvest of the n-th grade;

$S_{\text{га}}$  – the area under a certain variety;

$Y_{\text{ц/га}}$  – average yield of centners per hectare equal to 100;

ku – yield coefficient (from 0 to 3 with an accuracy of 0.05).

Sun – total gross collection;

$\Pi_{\text{Д}}$  – projected profitability without taking into account costs;

Sun – total gross collection;

C – average selling price of apples.

#### *Formula 1 - Calculation of Projected Return*

The result of the calculations is the projected income from the sale of the apple. To calculate, you need to know the area of orchards by variety, yield coefficient and estimated sales. The yield coefficient should be determined by the percentage of deviations of the arithmetic mean of the number of apples from 10 apple trees, taken at random.

To perform calculations in practice, the MC Excel program was chosen. This program is well suited for performing such calculations because it is easy to use, allows you to automate calculations, all data is presented in a convenient format in the form of a table, Figure 1.

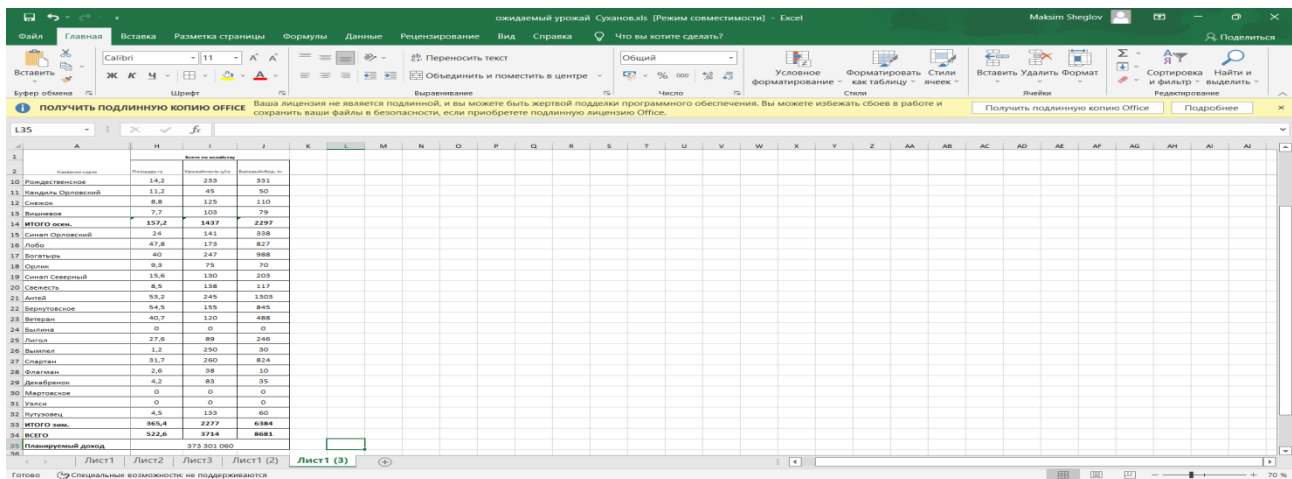


Figure 1 - Calculation of income forecasting in MS Excel

## Conclusion

The result is a ready-to-use method for forecasting the organization's income from the sale of fruit and apple crops. Such a method allows the head of the organization to make timely decisions on the future plan for the functioning of the organization.

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## Анализ и прогнозирование дохода садоводческого предприятия

М. Ю. Щеглов\*, В. А. Немтинов

ФГБОУ ВО «Тамбовский государственный технический университет», Тамбов, Россия,  
\*e-mail: maxsheglov2001@yandex.ru

**Аннотация.** В статье были рассмотрены вопросы актуальности прогнозирования дохода, методы прогнозирования дохода и расхода организации, был разработан способ прогнозирования дохода. Для применения метода на практике было использовано программное обеспечение MS Excel.

**Ключевые слова:** прогнозирование дохода, плодовые культуры, валовый сбор.

## Development of Algorithmic Software Using Deep Learning Framework for Autonomous Radio Vision Systems

A. O. Smirnov\*, A. A. Trishakov, S.A. Svincov  
Tambov State Technical University, Tambov, Russia  
\*e-mail: [lexa.smirnov.00@mail.ru](mailto:lexa.smirnov.00@mail.ru)

### Abstract

The article is devoted to the analysis of popular deep learning frameworks for autonomous radio vision systems.

**Keywords:** deep learning, framework, radio vision systems.

### Introduction

The implementation of deep learning algorithms in various fields is growing rapidly. One of these areas is radio vision, which allows you to determine an object using radio waves, while not inferior in detail to optical systems. Radio vision has the advantage of being able to simultaneously detect objects over a wide range and at a considerable distance, regardless of weather conditions and natural light, as well as detect objects that are invisible in the optical range. But such systems are not automated and cannot automatically detect and determine the type of object. In this case, deep learning and neural networks come to the rescue.

### Organization of information protection in software

Since the adoption of deep learning has developed at a rapid pace, the progress of the ecosystem has inevitably developed at the same pace. In connection with this, many open-source projects have appeared and the development of libraries has begun in large technology companies, due to which the choice of suitable frameworks capable of satisfying the needs has become more than enough. These frameworks provide an abstract set of classes and methods that allow you to reuse them, from which you can in turn create your own logical blocks, as well as various additional modules useful for creating a deep learning model.

The field of deep learning can be divided into two types: low-level and high-level. Low-level frameworks offer more basic abstraction features while still providing a lot of customization and transformation. High-level frameworks make it easy for us to work with their more advanced abstraction, but limit us in making changes. High-level frameworks use low-level frameworks on the back-end and in the process convert the source code into the desired low-level framework for execution. Low level frameworks:

- TensorFlow
- MxNet
- PyTorch

High level frameworks:

- Keras
- Gluon

Consider the pros and cons of the most popular frameworks. Tensorflow is one of

the most popular frameworks that allows you to create multi-level neural networks and simplify mathematical calculations. The developer is Google and the main languages for creation were Python and C. Thanks to this framework, it became possible to recognize voice, images or text. The pros are:

- There is a large database of technical documentation and detailed guides for beginners;
- Provides such a powerful tool as Tensorboard, which allows you to visualize and monitor the process;
- Distributed learning support;
- Ability to create a multi-platform neural network to work on mobile devices using TensorFlow Lite;

The disadvantages include the speed of work, which is inferior to other libraries, as well as a high entry threshold, unlike PyTorch or Keras. The debug process is much more complicated due to the fact that there is a lot of low-level code inside the framework, which requires a lot of boilerplate code. There is another significant limitation: the only fully supported language is Python.

PyTorch is an analogue of the Torch library written for Lua, combining the advantages of the Python language and the mathematical capabilities of matlab, such as real-time graph computation and automated tools for differentiation. The developer is Facebook and is a big competitor to TensorFlow.

PyTorch allows you to effectively and quickly train a model, which is why I can get such a high popularity among developers. It has many important benefits:

- Ability to monitor and control all stages of model creation;
- Ability to use such popular IDEAs as PyCharm, pdb, ipdb;
- Support for declarative data parallelism;
- Thanks to a large community of developers, a lot of trained models and modular parts are being created in the public domain, which will allow you to produce any combination of different neural networks;

But this framework also has several undeniable disadvantages:

- Models do not have support, thus their further training is not going on;
- It is in the testing phase and has many flaws;
- Compared to TensorFlow, it does not have such monitoring and visualization tools.

### **Conclusion**

Choosing the right algorithmic framework for autonomous radio vision systems can be extremely difficult. It is necessary to take into account the type of neural network being developed, the programming language used, the number of additional tools and options required, and the project budget. But the simplification of mathematical calculations, full focus on functionality and fast analysis will allow the most efficient use of deep learning for modern algorithmic solutions in the field of radio vision.

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## **Разработка алгоритмического обеспечения с использованием фреймворков глубокого обучения для автономных систем радиовидения**

**А. О. Смирнов\*, А. А. Тришаков, С.А. Свинцов**

ФГБОУ ВО «Тамбовский государственный технический университет», Тамбов, Россия

*\*e-mail: lexa.smirnov.00@mail.ru*

**Аннотация.** Статья посвящена разбору популярных фреймворков глубокого обучения для автономных систем радиовидения.

**Ключевые слова:** Глубокое обучение, фреймворк, системы радиовиденья

## **Information System of Distance Learning of Industrial Enterprise Personnel**

**A. D. Smirnov**

Tambov State Technical University, Tambov, Russia

*\*e-mail: angelina68tmb@gmail.com*

### **Abstract**

The purpose of this study is to develop an information system for distance learning. The study will consider the process of designing an information system for distance learning. The relevance of the study lies in the fact that employees need to improve their professional skills at any enterprise. In this regard, it is necessary to develop an information system that will ensure the fulfillment of this requirement.

**Keywords:** distance learning, industrial enterprise, model, information system.

### **The structure of the Information System of Distance Learning**

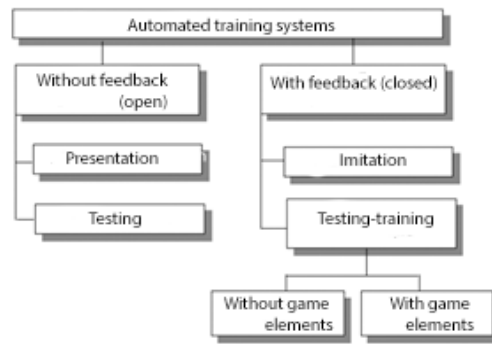
Distance learning is increasingly being used to improve the skills of company personnel. Successful companies that strive to become leaders in their field of activity actively invest money in the development of professional skills of staff.

There are quite a lot of different software tools for distance learning. Each of them is individual and has its pros and cons, but they are all aimed at preparing materials that are provided to the user in a convenient way and organizing testing based on the results of training.

The most convenient and operational means of providing information on the Internet is a website. Video lectures, presentations, interactive knowledge testing system, forum, chat, mailing list, guestbook, news feed – all these are integral parts of a modern distance learning website.

Any program is a set of algorithms (components) that interact with each other to solve the task. In this case, the program will be a software system if it is a set of interrelated components, each of which performs well-defined functions. In general, any training program can be considered a software system, since it necessarily has a user interface component and a component implementing the proposed methodology. In an automated training system, a number of tasks, such as displaying information or analyzing the correct answer, are performed without human intervention. Each automated training system has a specific structure based on a group of elements indicating the relationships between them and giving an idea of the system as a whole. Therefore, the structure of the system can be characterized by the types of connections available in it.

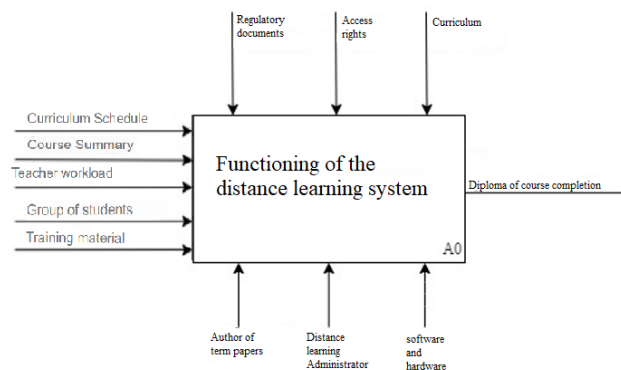
Each learning system has a well-defined structure, and these structures can be classified. One of the possible classifications of the construction of training systems is shown in Figure 1.



*Figure 1 – Classification of the construction of training systems*

The description of the development process of the designed distance learning system will be presented in the IDEF0 notation. These diagrams show the structure and functions of the system, as well as the flows of information and material objects linking these functions.

First, a description of the system as a whole and its interaction with the surrounding world is carried out (context diagram), after which a functional decomposition is carried out – the system is divided into subsystems, and each subsystem is described separately (decomposition diagrams) [1]. Then each subsystem is divided into smaller ones and so on until the desired degree of detail is achieved. Figure 2 shows a contextual diagram of the functioning of the staff distance learning system.



*Figure 2 – Context diagram*

The distance learning system operates in accordance with regulatory documents, as well as the curriculum. The right of access to the system is delimited among users. These restrictions apply throughout its activities. At the input of the process "Functioning of the distance learning system" – "Student", "Educational material" and "Goals and objectives of the course". At the output of the process – "Learning outcomes", "Learned material" and "Advanced training". The control mechanisms are: "Software and hardware", "Distance learning Administrator" and "Course author" [2].

After the description of the main function, a functional decomposition is performed, that is, the functions that make up the main one are determined.



Further, the functions are divided into subfunctions and so on until the required level of detail of the system under study is reached. Diagrams that describe each such fragment of the system are called decomposition diagrams.

The decomposition of the diagram breaks down the process of "Functioning of the distance learning system" into subprocesses that reflect its detailed description.

The first subprocess "Scheduling" (A0-1) has one object at the input: the goals and objectives of the course, at the output – information about the schedule and the schedule. The administrator of the training system compiles the schedule. In the process of scheduling, the date of the training courses is selected, and the time at which they will be held is also set [3].

The second subprocess "Study of course materials" (A0-2) has two objects at the input: information about the schedule and students, at the output – information about the studied materials and the learned material.

The third subprocess "Final testing" (A0-3) has two objects at the input: information about testing and training material, at the output – learning results.

The developed functional models formed the basis for designing an information system for distance learning of industrial enterprise personnel. Based on them, software was developed for creating and editing test tasks and passing testing.

### **Conclusion**

Thus, on the basis of the obtained functional models, software has been developed designed for creating and editing test tasks and passing testing. The developed software is able to provide affordable and effective training of personnel at the enterprise due to the possibility of creating test tasks for a specific user, which allows a deeper assessment of the level of knowledge of the student in a specific area.

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## **Информационная система дистанционного обучения персонала промышленного предприятия**

**А. Д.Смирнова**

ФГБОУ ВО «Тамбовский государственный технический университет», Тамбов, Россия  
*e-mail: angeline68tmb@gmail.com*

**Аннотация.** Целью данного исследования является разработка информационной системы дистанционного обучения. В исследовании будет рассмотрен процесс проектирования информационной системы дистанционного обучения. Актуальность исследования заключается в том, что на любом предприятии сотрудникам необходимо повышать свои профессиональные навыки. В связи с этим необходимо разработать информационную систему, которая позволит обеспечить выполнение данного требования.

**Ключевые слова:** дистанционное обучения, промышленное предприятие, модель, информационная система.

## Information System of Automation of Customer Support Service Center

A. S. Ursulenko

Tambov State Technical University, Tambov, Russia  
*e-mail: nasteka.ursulenko@mail.ru*

### Abstract

The purpose of this study is to develop an information system for distance learning. The study will consider the process of designing a distance learning information system. The relevance of the study lies in the fact that in any enterprise, employees need to improve their professional skills. In this regard, it is necessary to develop an information system that will ensure the fulfillment of this requirement.

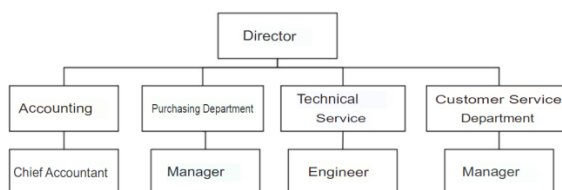
**Keywords:** database, information technology, object-oriented programming, database management system.

### Introduction

Today, automation is increasing in all spheres of human activity. Everything is automated in order to facilitate the labor activity of a person and improve the quality of the labor process. In the modern realities of a rapidly developing technological process, processes, effective processes for registering and ordering customers in enterprises are extremely important.

Information resource management is of particular importance for the activities of any enterprise. In the modern world, companies are faced with the need to process a huge amount of information [1]. The level of organization of interaction between departments and the procedure for exchanging information is important.

In order to achieve each element of the system of clearly defined tasks and the effective performance of duties at the enterprise, a linear-functional structure of the organization was used. The organizational structure of the service center is “shown in Figure 1.



*Figure 1 - Organizational structure*

### Description of functional models

To describe the development process of the designed system, several IDEF0 diagrams have been constructed. These diagrams display the structure and functions of the system, as well as the flows of information and material objects that link these functions [2].

First, a description of the system as a whole and its interaction with the outside world is carried out, after which a functional decomposition is performed [3].

The context diagram of the business process of interaction with customers is

shown in Figure 2.

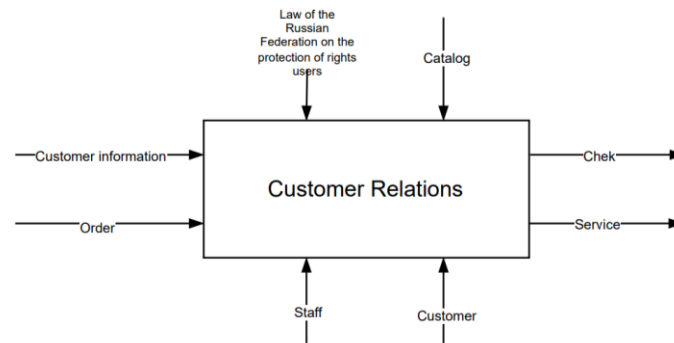


Figure 2 - Business Process Context Diagram

The decomposition of the main business process, which describes the business process of interaction with customers, is shown in Figure 3.

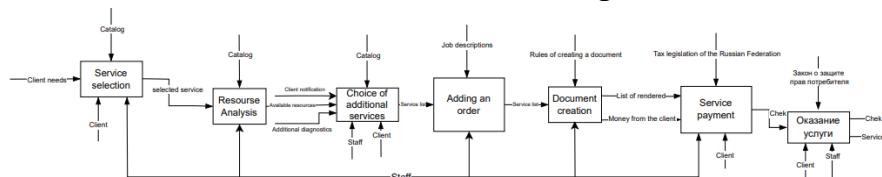


Figure 3 - Business process decomposition diagram

The diagram shows that in the business process "Customer Interaction" there are several stages that precede the receipt of the service by the client.

First, the client needs to decide on the service he needs. When the list of necessary services is ready, the staff draws up a work order.

After that, a document "Customer Interaction" is created. Then payment takes place, and the client receives this service and a check as confirmation that he paid for it.

To increase efficiency, it is necessary to implement AIS, which removes some of the tasks from the employee. Now the processing of the service, keeping records and checking the availability of this product is carried out by the system. AIS helps to carry out the business process "Customer Interaction". Thanks to this, employees spend less time on paperwork, which will allow them to serve more customers in the same time.

### Description of the software

The developed functional models formed the basis for the design of an information system for automating the customer support service of the service center. Based on them, software (SW) was developed. The main user interface window of the developed software is shown in Figure 4.



Figure 4 - The initial window of the application

## Conclusion

Thus, the developed software provides an increase in the efficiency of the service center.

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## Информационная система автоматизации службы поддержки клиентов сервисного центра

А. С. Урсуленко

ФГБОУ ВО «Тамбовский государственный технический университет», Тамбов, Россия  
*e-mail: nastenka.ursulenko@mail.ru*

**Аннотация.** Целью данного исследования является разработка информационной системы автоматизации службы поддержки клиентов сервисного центра. В исследовании рассмотрен процесс проектирования информационной системы: описаны функциональные модели бизнес-процесса, на основе которых разработано программное обеспечение информационной системы автоматизации службы поддержки клиентов сервисного центра.

**Ключевые слова:** база данных, информационные технологии, объектно-ориентированное программирование, система управления базами данных.

## The Possibility of Introducing Artificial Intelligence Technologies in Judicial Procedure

G. A. Vlasov\*, V. I. Kopelnik

Tambov State Technical University, Tambov, Russia

\*e-mail: *gleb.vlasov.00@mail.ru*

### Abstract

The purpose of this study analyzes the integration of artificial intelligence into the judicial system of the Russian Federation. The study will consider the range of possible spheres where artificial intelligence will be introduced at the professional level, and will also disclose the question of why it is necessary to do so in the sphere of judicial proceedings. The relevance of the study lies in the fact that for a long time in the sphere of judicial proceedings requires a global change and a huge modernization, as well as its simplification.

**Keywords:** artificial intelligence, machine learning, automation, litigation, algorithm, litigation.

Today artificial intelligence is not something unusual or fantastic. The very first mention that only indirectly referred to the science of artificial intelligence is considered to be the work of Rene Descartes «Discourse on Method» of 1637, in which the philosopher argued that the animal is a kind of complex mechanism, thanks to which he formulated the mechanistic theory [3]. However, more specific information about this appeared much later. Today, artificial intelligence is considered to be a property of artificial systems that can perform creative functions, which in turn traditionally belong to the prerogative of man. In Russia, artificial intelligence has been studied since the time of the USSR, but received a legal definition only in the Presidential Decree № 490 of October 10, 2019 «On the development of artificial intelligence in the Russian Federation». According to this normative legal act, artificial intelligence implies a complex of technological solutions that allows to imitate the cognitive functions of a person (including self-learning and finding solutions without a predetermined algorithm) and obtain results, when performing specific tasks, comparable, at least, with the results of human intellectual activity. A set of technological solutions includes information and communication infrastructure, software (including that which uses machine learning methods), processes and services for data processing and solution search [1]. Artificial intelligence is currently being actively implemented in many spheres of life, but there is still the unresolved question of whether artificial intelligence can be used in the judicial and legal format.

The prerogative of using artificial intelligence in modern science, in addition to automating processes, is to find new solutions depending on the experience gained. This practice came to life when the machine learning mechanism (machine learning) began to be used. Regarding the tasks solved by artificial intelligence thanks to the machine learning mechanism, the following can be listed: financial sphere (fight against fraud), industrial management (minimization of accidents), economic sphere

(market analysis and forecasting), and logistics (selection of optimal connection ways). In the sphere of judicial proceedings, artificial intelligence has also spread, for example at the moment there are such systems as GAS “Justice”, “My Arbitrator”, “Bank of Arbitration Court Decisions” and others. However, there are no variations of court proceedings that would include artificial intelligence to assist in adjudication today.

The issue of using artificial intelligence in making court decisions has already been raised more than once not only in Russia, but also in the territories of other countries, thereby affecting the entire world community, however, the mechanism of full automation of legal proceedings in the framework of making a decision is unacceptable, since can cost much more than, for example, a property dispute and this may require additional proceedings. As for litigation within the framework of administrative or civil proceedings, the integration of machine learning should even be considered necessary, since this implementation will have a large number of advantages: many administrative and civil cases will be resolved by analogy, but the final decision will be made after verification; artificial intelligence, as the judicial practice is filled, will only improve and thereby solve many contradictions that will already be on the agenda for the legislator; the workload of courts in civil and administrative cases will be significantly reduced. Despite this, this system will also have its drawbacks: it will take time to build a well-functioning system of “smart” legal proceedings, which is why it is impossible to predict the time frame for full implementation in the judicial system throughout the country; the possibility of data leakage directly will be present; to exclude the possibility of third-party interference in the algorithms for making a “smart” judgment, it is necessary to build a security system; if this system can prove itself properly, then the number of judges will fall significantly; to integrate "smart" legal proceedings, it will be necessary to expand the staff of computer operators, as a result of which only advanced training is not enough.

On the issue of the use of artificial intelligence in criminal proceedings, maybe only at the advisory level in the form of automatic selections of judicial practice, perhaps for crimes of small or medium gravity automated systems will suggest a certain outcome of events, which will certainly be supported by certain arguments, based on which such a decision has been formed. Nevertheless, modern society is of the opinion that the resolution of criminal cases should always remain in the hands of the judge, as a living person who is able to make sense of what happened independently, but not in the hands of an artificial intelligence algorithm. The active use of artificial intelligence in criminal law can be established at the stage of preliminary investigation, when there is the collection of various evidence, when various versions of what happened are found out, where the artificial intelligence can prepare a lot of versions of what happened. Thanks to such an algorithm, criminal cases will end much faster.

From all of the above we can conclude that the inclusion of artificial intelligence in court proceedings is possible in the case of consideration of cases in administrative and civil proceedings and necessarily with the participation of a judge [2]. Consideration of cases by courts of criminal collegiums is possible only at the level of consultative

intervention, but not at the level of automation with control of a judge-operator.

Reducing the duration of court proceedings, reducing the burden on the courts and allowing only judges with advanced qualifications will make the judicial apparatus a real automated machine, which will be based only on fair principles, promptly solving the problems of society and will prove only more effective in modern society, and in the society of the future.

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## Возможность внедрения технологий искусственного интеллекта в судопроизводстве

Г. А. Власов\*, В. И. Копельник

ФГБОУ ВО «Тамбовский государственный технический университет», Тамбов, Россия  
*\*e-mail: gleb.vlasov.00@mail.ru*

**Аннотация.** Целью данного исследования является анализ интегрирования в судебную систему Российской Федерации искусственного интеллекта. В исследовании будет рассмотрен спектр возможных сфер, где на профессиональном уровне будет внедрен искусственный интеллект, а также будет раскрыт вопрос о том почему это необходимо сделать в сфере судопроизводства. Актуальность исследования заключается в том, что в сфере судопроизводства уже долгое время требуются глобальные перемены и колоссальная модернизация, а также её упрощение.

**Ключевые слова:** искусственный интеллект, машинное обучение, автоматизация, судопроизводство, алгоритм, судебное разбирательство.

## Technological Process of Crystallite Production at JSC "Corporation Roskhimzashchita"

**A. V. Vokhmintsev**

Tambov State Technical University, Tambov, Russia  
*e-mail: andrey.vohmincev.01@mail.ru*

### **Abstract**

The paper considers the process of crystallite production at JSC "Corporation "Roskhimzashchita". The analysis of the technological process and the existing control system is carried out. The structure of the automated process control system is being developed and a set of technical and software tools are selected. A functional automation scheme, power supply schemes, external connections, installation and switching, a general view of the control and control panel, a schematic electrical diagram are being developed.

**Keywords:** crystallite, automated control system, SCADA system, mathematical model.

### **Introduction**

Crystallite production is a multi-stage process that includes several interconnected stages, such as crystallite synthesis, aging, crystallization, filtration, washing, and preparation of a washing solution. Crystallite is a semi-product for the manufacture of zeolite sorbents F-1 lithium and F-1 calcium. It is a fine white powder. Zeolite sorbents are designed for deep drying and fine purification of gases and liquids from harmful impurities.

Currently, there is a significant increase in demand for zeolite sorbents, which is associated with a wide range of their use. The existing level of automation of the production line of of crystallite at JSC "Corporation "Roskhimzashchita" is quite low. At the production stages, the loading of the initial components, control and maintenance of the process parameters within the specified limits is carried out manually. Deviation of these parameters from the norm leads to overspending of raw materials and energy, a decrease in the yield of the final product, a decrease in quality, rapid wear of equipment, etc.

The automated process control system will increase the efficiency of the crystallite production process due to more accurate implementation of technological parameters, prevention of accidents, and will ensure a reduction in production costs.

The aim of the study is to analyze the process of creating a crystallite and the existing automated control system of the process, identify the advantages of automated control systems based on modern technologies and describe the main points of the development of automation schemes.

### **Analysis of the technological process of production**

The crystallite is a fine white powder. The chemical composition of anhydrous crystallite corresponds to the formula[1]:

$(Na_2O)x \times (K_2O)y \times Al_2O_3 \times 2SiO_2$ , where  $x=0.5$  to  $0.6$ ,  $y=1-x$ .

The technological process of crystallite production consists of 6 stages:

1. Preparation of raw materials;



2. Synthesis of crystallite;
3. Aging;
4. Crystallization;
5. Filtration and washing;
6. Flushing of containers.

### Analysis of the process as an object of management

To select operating modes, to build a system of automatic regulation of the dissolution process occurring during the production of crystallite, it is necessary to analyze the input and output flows of the technological process and obtain a mathematical description of the control object.

The analysis of literary sources [1-4] and the experience of industrial operation of such equipment revealed that possible sources of disturbance should include:

- The temperature of potassium hydroxide entering the container pos.1  $T_{in}^{ph}$ ;
- The temperature of sodium hydroxide entering the container pos. 1  $T_{in}^{sh}$ ;
- The temperature of aluminum hydroxide entering the container pos. 1  $T_{in}^{ah}$ ;
- The temperature of the coolant entering the tank jacket pos.1  $T_{in}^T$ ;
- Mass of loaded potassium hydroxide  $M^{ph}$ ;
- Mass of loaded sodium hydroxide  $M^{sh}$ ;
- Weight of loaded aluminum hydroxide  $M^{ah}$ ;
- The mass of the loaded water  $M^w$ ;
- Ambient temperature  $T^{en}$ ;
- The pressure of the coolant in front of the tank jacket pos.1  $P^{in}$ .

The degree of opening of the valve  $\mu$  on the coolant (cold water) supply line to the process tank pos. 1 can be attributed to the regulating influences

The temperature of the mixture in the container pos.1 (Fig.1)  $T^{CM}$ , the temperature of the coolant in the tank jacket pos.1  $T^1$ , the mass of the mixture in the tank pos.1  $M^{CM}$  are the output coordinates of the process.

The dissolution process as a control object is shown in Figure 1.

In the process of dissolution of the initial components, disturbances that allow stabilization will be the masses of the initial components in the technological container pos.1, due to their precise dosing.

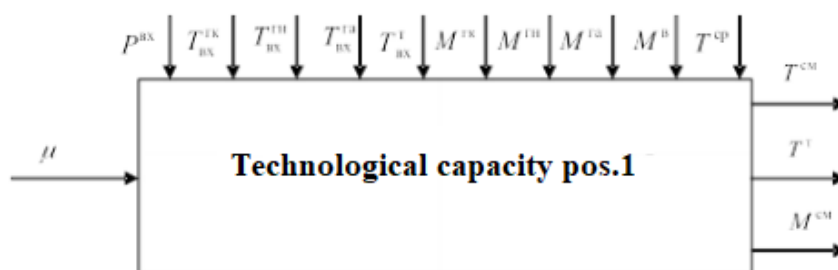


Figure 1 – The dissolution process as a control object

As a regulating effect, the flow of heating steam into the jacket can be selected since there is a certain amount of cold and hot water in the jacket, which enters the jacket and allows this water to be heated to heat the syrup. This effect allows you to maintain the necessary temperature of the syrup in the collection.

The other input effects are perturbations.

As an adjustable parameter, we select the temperature of the reaction mass in the container, since maintaining it at a set level ensures the quality of the resulting crystallite [2].

Based on the above analysis of the technological process of maintaining the temperature in the container pos.1 as a control object, the following automation tasks can be formulated:

1. It is necessary to control the temperature of the reaction mass;
2. It is necessary to stabilize the temperature in the container pos.1;
3. It is necessary to provide technological signaling of the maximum and minimum temperatures of the reaction mass of the crystallite to avoid emergency situations.

### **Critical analysis of crystallite production process control systems**

When solving the automation problem, it is required to carry out automatic control and management of a large number of different parameters while simultaneously ensuring the possibility of changing each parameter in a wide range[3].

The existing automated process control system uses outdated technical means of controlling the production of crystallite, which entails a decrease in the overall quality of products and non-compliance with modern energy requirements.

The design of the automated control system based on modern technical means will allow implementing the information, information-computing and control functions of a modern control system.

### **Assessment of the feasibility of creating an automated control system**

The main purpose of the developed automated process control system for the production of crystallite is economic efficiency. It should help to reduce the costs of product production and increase the quality of products, which will lead to an increase in the company's revenue.

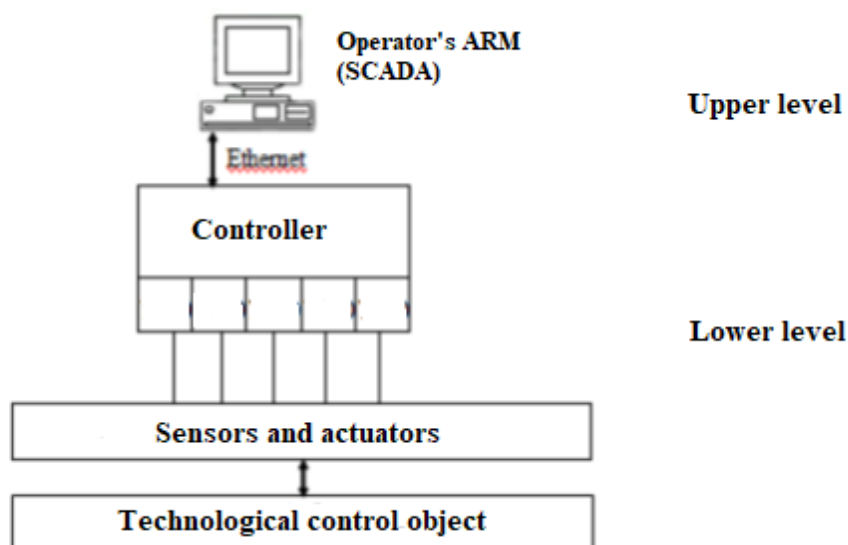
Automated control system for the production of crystallite helps to reduce the percentage of defective products, which leads to an increase in the volume of production of the product, an increase in labor productivity. Automation of the production of crystallite allows you to control the course of processes when dosing the components provided by the recipe; mixing the components in the process tank; mixing the reaction mass, etc. Due to the automated control system for the production of crystallite, it is possible to reduce the preparation time of the product, ensure accurate maintenance of the parameters of technological processes, as well as control and manage the production process in an automated mode.

### **Development of a functional automation scheme**

Automated process control systems are human-machine control systems in which technical means receive information about the state of the technological control object, calculate quality criteria, find optimal control, and the operator analyzes these controls and their implementation using local ASR or remote control by regulatory authorities.

Currently, process and production management systems are built according to different principles. In this paper, a two-level automated process control system has

been developed (Fig. 2). All the functionality of the system is clearly divided into two levels. The lower level consists of local automation tools (controllers, sensors and actuators), the upper level is the operator's workstation, which can be represented by a workstation or an industrial computer.



*Figure 2 - Structural diagram of the automated control system of the production process crystallite*

### **Justification of the choice of a set of software and hardware tools and the choice of the main technical and software tools of the automated process control system**

When developing functional and other types of automation schemes and choosing technical means, the following provisions should be taken into account: the type and nature of the technological process; parameters and physico-chemical properties of the measured medium; the distance from the installation sites of sensors, auxiliary devices, actuators, machine drives and shut-off organs to control and control points; the required accuracy and speed automation tools. The information measuring channel should be built on the basis of commercially available sensors and devices. The use of the same type of equipment gives an advantage during installation, commissioning, operation, provision of spare parts, etc.

#### **Development of a schematic diagram of power supply**

The power supply system must be sufficiently reliable and safe when operating the equipment. When producing crystallite for control panels, we choose a two-wire single-phase 220V circuit with a grounded neutral and a frequency of 50Hz. For power equipment, we will choose a four wire three-phase 380V circuit with a grounded neutral. The equipment in the power supply circuit must ensure uninterrupted operation of the equipment in normal mode and protection of the equipment in case of overloads and short circuits.

#### **Development of the scheme of external connections**

The diagram of external electrical connections shows equipment located outside the shields, as well as primary measurement devices installed directly on the objects. The diagrams of external electrical connections indicate the boxes, cable type, protective pipes, length of cables and pipes, their diameter or cross-section.

Several types of cables were selected for the crystallite production process, depending on the purpose, as well as a protective tube with a diameter of 20mm.

### **Justification of the choice of the control object**

The cost and quality of finished products always depend significantly on the technology of execution and management of the most complex, lengthy and responsible processes.

The preparation of the reaction mass is one of the most important in the process of crystallite production, since at this stage the volume of the resulting product is formed. Maintaining a given temperature regime ensures the quality of the resulting product, since overheating or low temperature leads to a change in the quality of the resulting product [4].

Therefore, the process of production of the reaction mass, which takes place in the technological tank pos.1, is one of the limiting production crystallite [1, 3].

### **Conclusion**

Based on the analysis of the crystallite production process carried out above, the following conclusion can be drawn - the existing automated control system is outdated and it is necessary to develop a new automated control system based on modern technologies. This step will significantly increase production efficiency, reduce the percentage of defects, reduce costs and improve product quality. Also, a modern automated control system will reduce the risk of emergency situations.

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## **Технологический процесс производства кристаллитов в ОАО "Корпорация Росхимзащита"**

**А. В. Вохминцев**

ФГБОУ ВО «Тамбовский государственный технический университет», Тамбов, Россия  
*e-mail: andrey.vohmincev.01@mail.ru*

**Аннотация.** В статье рассматривается процесс производства кристаллитов на ОАО "Корпорация "Росхимзащита". Проведен анализ технологического процесса и существующей системы управления. Выбрана структура разрабатываемой автоматизированной системы управления технологическим процессом и набор технических и программных средств. Разрабатывается функциональная схема автоматизации, схемы электроснабжения, внешних подключений, монтажа и коммутации, общий вид пульта управления, принципиальная электрическая схема.

**Ключевые слова:** кристаллит, автоматизированная система управления, SCADA система, математическая модель.

## Justification for the Introduction of an Automated Information System for Recording Physical Evidence

**E. S. Zatsepina**

Tambov State Technical University, Tambov, Russia  
*e-mail: zhs68@bk.ru*

### **Abstract**

The purpose of this study discloses the basic position of the need to create an automated information system for recording physical evidence. The study consider the concept and classification of physical evidence, as well as the theoretical justification for the introduction of an automated information system for recording physical evidence. The relevance of the study is due to the fact that at present the accounting of physical evidence is not automated, but is conducted on paper – a book. As a result of the research, it is to argued the need to create an automated information system for recording physical evidence.

**Keywords:** automated information system, physical evidence, accounting of physical evidence

Currently, information technologies play an important role, and the importance of information in all spheres of human activity at the present stage is constantly increasing. As a result, information has become an important object used and protected by the state.

To date, new tasks are assigned to law enforcement agencies related to the introduction and use of modern information technologies in their professional activities [2].

According to Part 1 of Article 81 of the Criminal Procedure Code of the Russian Federation, any objects are recognized as material evidence [1]:

- which served as tools, equipment or other means of committing a crime or retained traces of the crime;
- criminal actions were directed;
- money, valuables and other property obtained as a result of the commission of a crime;
- other items and documents that can serve as means for detecting a crime and establishing the circumstances of a criminal case.

In the process of working with physical evidence, their classification is of great importance, helping to determine the place of each of them in the system of evidence in the case. The general grounds for classifying all types of evidence as a whole are also applicable to physical evidence.

In relation to the subject of proof, material evidence is divided into direct and indirect. In relation to the original source, they are divided into initial and derivatives. According to the legal significance of the established circumstances, material evidence is divided into accusatory and exculpatory.

Physical evidence, by virtue of the preserved signs or properties, are carriers of evidentiary information, therefore they are of great importance in the criminal

process during the investigation and disclosure of crimes, since thanks to properly collected and studied evidence, investigators and participants in the trial can restore the full picture of the crime.

Automated information systems today are not only an effective means to simplify the internal work of investigative bodies, but also contribute speeding up the process of solving a criminal case. Let's consider the main advantages of document management automation for investigative bodies.

Document management automation is the design of systems and workflows that help in the creation of electronic documents.

Automation of document flow consists in the reception, registration, control of execution, formation of cases, storage and reuse of documents, including reference work. In addition, document management automation, or electronic document management, is a single mechanism for working with documentation presented in electronic form.

The transfer of the organization's document flow from paper to electronic form gives advantages in various fields of activity.

First of all, it allows you to simplify the work of employees who report manually. The duration of work for copying documents, processing them, and entering data into the accounting book will be significantly reduced. Due to time savings, the duration of document transfer between departments will be reduced by fully automating part of the operational processes. In this regard, the productivity of employees will increase due to the reduction of routine work.

A well-organized document search system makes it possible to find a document by attributes within a short period of time, having only minimal information about it.

And the main advantage of such a system, in our opinion, is a single database of documentary information, which allows you to completely eliminate the possibility of duplication of documents and ensures the storage of a large volume of documentation and their safety.

The main task of document management automation is not to transfer the functions of a traditional system to an electronic form, but to introduce new functions into the system, which are made possible thanks to the modern level of electronic programming [3].

The introduction of an automated information system will significantly reduce the time of work, improve accuracy and facilitate the work of specialists. The efficiency of employees' activities will be increased due to automated accounting and processing of data on the receipt of material evidence, their registration and determination of the future fate of existence.

So, the advantages of automating the processes of storage and accounting of physical evidence include:

- improving labor productivity;
- improving the quality of interaction between departments of state bodies;
- minimization of material storage costs;
- providing quick access to the necessary documents;

- reducing the likelihood of intentional damage or accidental loss of important information;
- reducing the probability of error caused by the «human factor»;
- simplification of reporting;
- the ability to archive documents.

Thus, the study of the advantages of automating the processes of storage and accounting of physical evidence showed how much the productivity of employees who register and record physical evidence would increase. Since the main feature of document management automation is the reduction of manual labor and the gradual disposal of paper media, an automated information system for recording physical evidence will fully allow this to materialize, in this regard, we propose to develop a system for recording physical evidence.

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## **Обоснование внедрения автоматизированной информационной системы учета вещественных доказательств**

**Е. С.Зацепина**

ФГБОУ ВО «Тамбовский государственный технический университет», Тамбов, Россия  
*e-mail: zhs68@bk.ru*

**Аннотация.** Целью данного исследования является раскрытие основного положения о необходимости создания автоматизированной информационной системы учета вещественных доказательств. В исследовании будут рассмотрены понятие и классификация вещественных доказательств, а также теоретическое обоснование внедрения автоматизированной информационной системы учета вещественных доказательств. Актуальность исследования обусловлена тем, что в настоящее время учет вещественных доказательств не автоматизирован, а ведется на бумажном носителе – книге. В результате исследования аргументирована необходимость создания автоматизированной информационной системы учета вещественных доказательств.

**Ключевые слова:** автоматизированная информационная система, вещественные доказательства, учет вещественных доказательств.

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ББК 38.22

## Design Solutions of a Romanesque-Style Mansion House

**V. A. Chasovskih, A. V. Erofeev**

Tambov State Technical University, Tambov, Russia

*e-mail: chasovskikhvladik@rambler.ru*

### **Abstract**

The article describes the architectural and constructive solutions of the house-mansion in the Romanesque style. The characteristics of the main load-bearing elements of the building are given. Brief information about the technology of organization, timing and cost of construction of the projected object is presented.

**Keywords:** brickwork, organization of construction, foundation, structural scheme, structural analysis, reinforced concrete.

The active development of construction in Russia, as well as the impact of the pandemic has increased the demand for the design and construction of individual residential buildings. Many people realized that they were not ready to live only in apartments, in the absence of the possibility of walking in the fresh air. The new format of remote work has further contributed to this.

An urgent task is to develop projects of individual residential buildings that meet the requirements of functionality, safety, reliability and durability, as well as having a memorable architectural appearance, which should not lead to an increase in the time and cost of construction.

In this regard, the architectural, construction, design, organizational, technological and economic sections of the project for the construction of a mansion house in the Romanesque style were developed.

The plot of the projected mansion house is located in Tambov, MD. Suburban forest has a calm relief and a regular shape with dimensions in plan – 23.62 x 16.21 m. There are no noisy industries and highways near the site. Landscaping of the territory is carried out by deciduous and coniferous high-growing trees, shrubs, flowers and grass.

Since the house was designed in a special architectural style, its exterior design was selected in a complex taking into account the following means of expression — composition, tectonics, scale, proportions, rhythm and color of materials.

The adopted color solutions, combined with the frontally asymmetric composition and the unique proportionality of individual volume elements, determine the high architectural expressiveness of the projected building. The exterior decoration of the building is made of advanced materials with the best performance indicators. The facade and plan of the projected building are shown in Fig. 1.



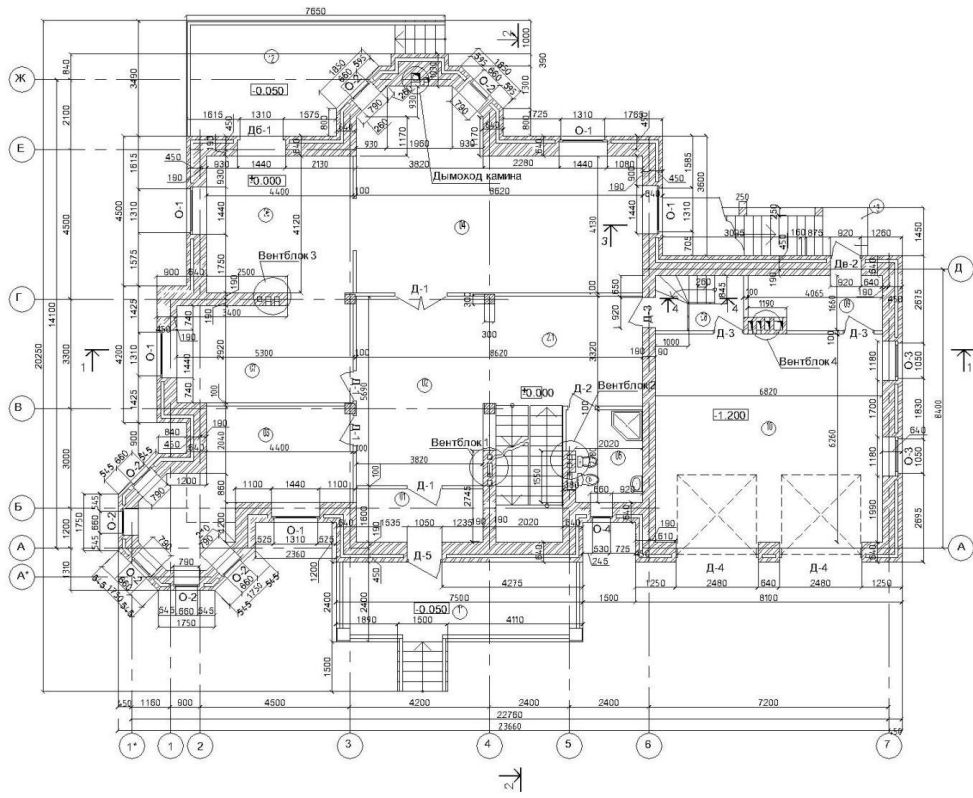


Figure 1 – Facade and ground floor plan of the mansion

The structural system of the building is combined, since the vertical bearing elements are external brick walls and internal reinforced concrete columns. The design scheme is cross- with longitudinal and transverse arrangement of load-bearing walls [1].

The spatial rigidity of the building is ensured by the joint work of longitudinal and transverse load-bearing walls, a staircase node and a hard disk of floors formed from prefabricated hollow slabs connected by anchors to each other. The dressing of bricks in masonry and the dressing of foundation blocks further increase the stability of the building.

The space-planning solution of the mansion, characterized by the presence of internal columns and rooms with a large area, required non-standard design solutions for brick buildings. Therefore, in the project, a reinforced concrete crossbar made of class B25 concrete with a length of 4.2 m was designed for the installation of floor-to-floor ceilings

A reinforced concrete staircase with a total length of 6.2 m and a height of 1.65 m was also designed and calculated. The soils of the base are soft-plastic loam. Since the house has an exploited basement, the depth of laying the sole of the tape foundation under the exterior walls is assumed to be 2.7 m.

During the calculation, a foundation with a sole size equal to 1.6 m was selected for load-bearing walls, and for self-supporting walls - 1 m. Due to the complex shape of the building, there were monolithic sections, they had to be designed in the places where the bay window was built [2]. Also, with the help of the software package, the calculation of the columnar foundation for internal columns was performed. The size of its sole was 1.5 m, and the depth of the foundation is 3.6 m.

In the technological section, a technological map was developed for the installation of the aboveground part of the building, in particular the installation of brickwork and the installation of floor slabs. The selection of the pneumatic-wheeled crane KS-5363 was carried out, the network schedule and the schedule of labor movement were designed, the calculation of temporary and warehouse premises was made, the construction plan was designed [3]. The duration of the construction of the building was 159 days.

A local estimate was also developed for the construction of the building, including finishing and landscaping works. The estimate is calculated in the base prices of 2001, which are recalculated with the help of indices for 2022. The results of the summary estimate showed that the cost per square meter is 39 thousand rubles.

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## Проектные решения дома-особняка в романском стиле

**В.А. Часовских\*, А.В. Ерофеев**

ФГБОУ ВО «Тамбовский государственный технический университет», Тамбов,  
Россия

*\*e-mail: chasovskikhvladik@rambler.ru*

**Аннотация.** В статье описываются архитектурное и конструктивное решения дома-особняка в романском стиле. Приведены характеристики основных несущих элементов здания. Представлены краткие сведения о технологии организации, сроках и стоимости строительства проектируемого объекта.

**Ключевые слова:** кирпичная кладка, организация строительства, фундамент, конструктивная схема, расчет конструкций, железобетон.

## Experience in Designing Buildings of River Stations in Soviet Russia

A. V. Chernykh

Tambov State Technical University, Tambov, Russia  
*e-mail: shadeofblackanne@gmail.com*

### Abstract

This article analyzes the emergence of river stations, their characteristic features. The author considers various options for implemented and standard conceptual designs of buildings for the corresponding purpose. The experience of Soviet Russia in the development of the design of river stations is described. Floor plans, perspective images are considered.

**Keywords:** river station, Soviet period, water transport.

In the context of the development of Russian water transport, the construction and architecture of river stations has become of great importance. The heyday of designing this type of public buildings and adjacent structures began only in the Soviet period [1].

There is no such practice in tsarist Russia, although at that time the construction of small and large station buildings for the railways was carried out. One of the first buildings of the river station is the building in Arkhangelsk. Towers and an expressive entrance appear in the architectural image of the building [3].

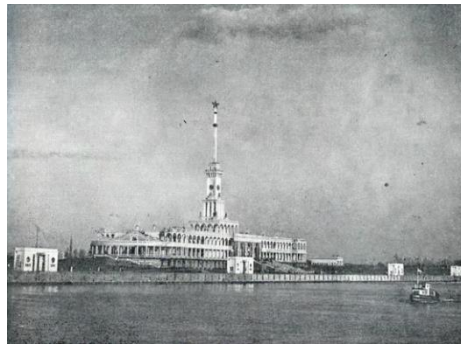


*Figure 1 - Passenger building in Arkhangelsk*

The building in Khimki, Moscow, becomes the main link in creating the concept of designing river stations in Russia. The river station, built in 1938, consolidates its characteristic image, becoming an example for the design of all subsequent buildings. The project of the river station in Khimki belongs to the architect A. M. Rukhlyadev [2].

The building itself is designed for 450-500 passengers who are simultaneously in all rooms. The total cubic capacity of the station is 45,000 meters. Of these, 30,000 cubic meters are considered heated. The height of the building with the spire reaches 103 meters. The place of the station is the bank of the Moscow Canal. From here there is a departure from the capital. Two highways adjoin the station: one for arriving cars, the other for departing cars - they lead from the station to Leningradskoe shosse. In front of the station building there is a wide square with a

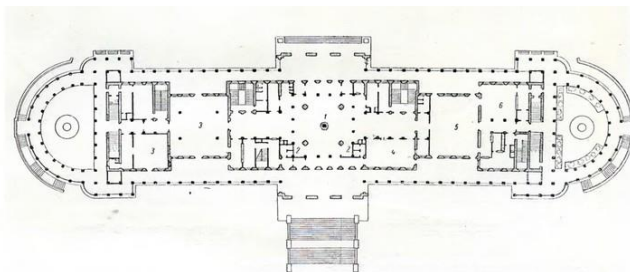
designated parking space. A large park with trees and shrubs, flower beds and flower beds has been designed near the station [3].



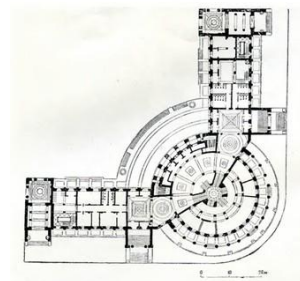
*Figure 2 - River station in Khimki. Author A. M. Rukhlyadev. General form*

On the side of the city infrastructure, the building is two-story, and on the side of the river, three. This is due to the fact that the basement is located in the fall of the transverse relief. The composition of the building is symmetrical, has a pronounced high-rise composition with a central volume and side wings. The building is surrounded by a colonnade, which makes it airy and light. An arcade runs along the second floor, and it ends with cakes where the galleries are connected by stairs. From the terraces, passengers enjoy beautiful views [4].

a)



b)



*Figure 3 - Plan of the first floor of the River Station; a) in Khimki; b) Tver, Kalinin*

Structurally, the building is reinforced concrete and brick. Outside, the building is faced with natural stone slabs, and the plinth was trimmed with red polished granite.

Another important example of a river station project is the building in Tver, ex. Kalinin. It was built in 1939 according to the project of architects P. P. Raysky and E. I. Gavrilova. The station is designed for 600 passengers. The cubic capacity of the

building is 40,000, i.e., 67 cubic meters per passenger. The ground floor is processed by an arcade of the lateral and central parts [3].

The construction of the building consists of simple elements: the pitch of the columns in the wings is 4 meters, and the round part of the building, including walls and ceilings, is made of brick and reinforced concrete [3].

These design examples formed the basis of all existing projects. It was in the 30s of the last century that the artistic appearance of the building was formed, the basic concepts and trends in the development of such types of public buildings were formed.

Arguing about the conclusion, we can say that the architect of river stations in the Soviet Union was of an experimental nature. The design used the existing methods of designing public spaces.

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## Опыт проектирования зданий речных вокзалов в советской России

**А. В. Черных**

ФГБОУ ВО «Тамбовский государственный технический университет», Тамбов, Россия

*e-mail: shadeofblackanne@gmail.com*

**Аннотация.** Данная статья анализирует возникновение речных вокзалов, их характерные особенности. Автор рассматривает различные варианты реализованных и типовых концептуальных проектов зданий соответственного назначения. Описывается опыт Советской России в становлении проектирования речных вокзалов. Рассматриваются планы этажей, перспективные изображения.

**Ключевые слова:** речной вокзал, речной транспорт, Советский период.

## Functional Zoning of a Modern City

**T. F. Elchishcheva, V. A. Popova, E. A. Chesnokova, E. Yu. Voyakina**

Tambov State Technical University, Tambov, Russia

*e-mail: popova.va68@ya.ru*

### Abstract

Urban planning design of a modern city, based on the established functional zoning of territories by the nature of their use, requires significant changes in the conditions of the development of the urban environment and the needs of society. This article provides a comparative analysis of development stages of the general plan of Tambov and its functional zones.

**Keywords:** master plan, urban planning, urban environment, modern city, functional zoning.

The main task of urban planning of the territory is the competent division of the city into parts and functional zones, taking into account the spatial planning organization. The modern needs of society, the need to expand the areas of residential and public areas, an increase in population density per square meter leads to changes in existing master plans and city boundaries [1].

On the example of the city of Tambov, the analysis of the principles of functional zoning of the territory, as well as urban development, is carried out.

Zoning of the urban area is necessary for the formation of comfortable living and working conditions for the population. Cities with a favorable environment are steadily developing, effectively engaged in economic and economic activities.

The city district – the city of Tambov, in accordance with the master plan of 2008, is divided into the following functional zones (Figure 1):

1. The residential zone consists of multi-storey and higher, medium-storey, low-rise and mixed buildings;
2. the public and business zone includes administrative and business, multifunctional, religious and educational institutions, healthcare institutions;
3. the recreational zone is divided into landscaping of public areas, recreation and sports facilities, natural landscape, collective gardens, forests, rivers, watercourses and reservoirs;
4. zones of industrial enterprises and communal storage facilities;
5. special and special purpose zones are divided into technopark, investment sites, regime enterprises, cemeteries and special territories;
6. zone of engineering and transport infrastructure for rail, road and air transport;
7. zones of special protection of natural and water territories.

One of the priority areas for the development of territories is the transformation of the Northern part of the city, as well as areas free from development on the borders of the district, which can be traced on the current master plan (Figure 2). The new territories are occupied by residential buildings with a public and business zone and recreational areas [2]. Dense multi-storey buildings require public space for recreation



and entertainment of residents. There are trends in the construction of community centers, general education and preschool institutions in areas with established buildings. Some territories have changed their purpose for manufacturing enterprises, including administrative buildings.

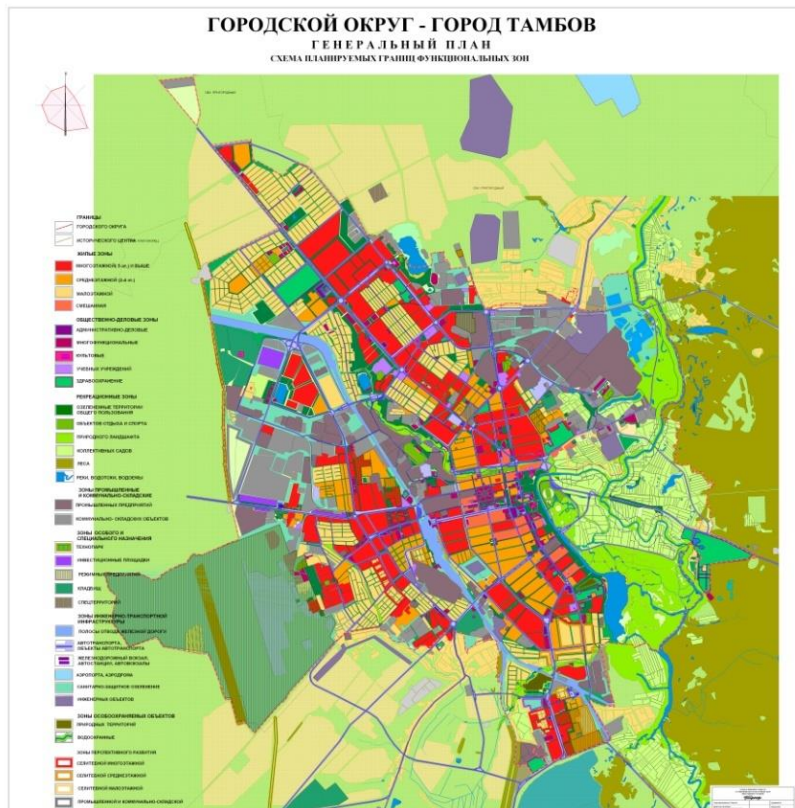


Figure 1 – General plan of the city of Tambov, 2008

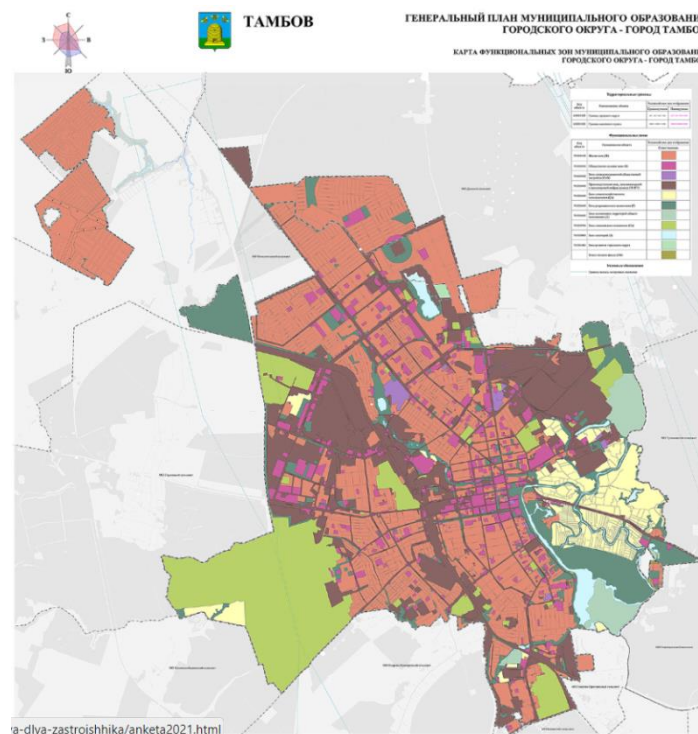


Figure 2 – The General plan of the city of Tambov, 2022

The historical center of the city is gradually being restored and supplemented with modern architecture and new functions [3].

The population growth of any city requires significant changes. The city of Tambov is gradually developing and increasing its borders at the expense of territories suitable for housing construction. The most global development is currently underway in the northern direction of the city. New residential complexes and park areas are being built within the city limits, industrial infrastructure and transport infrastructure are developing [4].

In this work, the drawings of the master plans of the functional zoning of the city district Tambov for 2008 and 2022 were analyzed, their differences and principles of modern development of the territory were revealed.

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## Функциональное зонирование современного города

Т. Ф. Ельчищева, В. А. Попова, Е. А. Чеснокова, Е. Ю. Воякина

ФГБОУ ВО «Тамбовский государственный технический университет», Тамбов, Россия  
*e-mail: popova.vab8@ya.ru*

**Аннотация.** Градостроительное проектирование современного города, на основе сложившегося функционального зонирования территорий по характеру их использования, требует значительных перемен, в условиях развития городской среды и потребностей общества. В данной статье проводится сравнительный анализ этапов развития генерального плана г. Тамбова и его функциональных зон.

**Ключевые слова:** Генеральный план, градостроительство, городская среда, современный город, функциональное зонирование.



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ББК 38.9

## **Green Roofs as the Key to Improving the Environment and Raising the Standard of Living of the Population**

**M. V. Dolzhenkova<sup>1</sup>, I. E. Goryushinskaya<sup>2</sup>**

<sup>1</sup>Tambov State Technical University, Tambov

<sup>2</sup>Tambov Construction College, Tambov

*e-mail: dmv20101@yandex.ru*

### **Abstract**

Currently, attention to green technologies is growing, in particular in Russia. Green roofs, their beneficial effect on the environment, on human health and his positive emotional state are considered. Examples of using green roofs at different times and in different countries are given.

**Keywords:** green roof, eco-roofs, roof greening, roof system reconstruction, photo modules, "green" construction standards.

“Green roof” is an innovative technology that transforms even the most nondescript building, increases the efficiency of engineering solutions.

It should be noted that such structures were in demand even in the Stone Age during the construction of dugouts and huts; this suggests that roofs on which grass or other plants grow are not a new invention at all. Bright examples of this architectural tradition of using vegetable roofs are the turf dwellings of Icelanders, which date back to the 18th century. Moss-covered houses are a characteristic feature of the peoples living on the territory of modern Norway, Canada, Great Britain, and Switzerland (Fig.1).



*Figure 1- Moss-covered houses*

Residents of countries characterized by a harsh, cold, windy climate immediately noticed that a roof covered with vegetation protects better from low temperatures, retains heat inside the house, forming a pleasant microclimate inside the

dwelling.

The first information about the arrangement of green gardens on roofs in Russia dates back to the XVII century.

In the Kremlin of Rostov the Great, a hanging garden was arranged by Metropolitan Jonah. The garden was located on the second floor level between the buildings of the palace. The supports of the hanging garden were massive arches and ceilings, which were covered with lead slabs for water resistance. Such gardens were arranged in boyar estates and estates of the highest clergy. For their beauty and originality, they were called Red. The gardens of Afanasy Ordyn-Nashchekin and V. V. Golitsyn in Moscow were especially famous.

A hanging garden is known, created by order of Peter I in Riga in 1717. It occupied a limited space and was located on an open terrace above the Daugava River at the level of the second floor, supported by massive supports. Peonies, white and yellow daffodils, tulips, melissa, sage and other plants grew in it (Fig. 2) [1].



*Figure 2 - The gallery is on the 2nd floor level with a grass or "turf" roof.*

In modern conditions, eco-roofs used for planting a lawn or laying out a mini-vegetable garden is rather a fashionable trend that allows you to take care of nature, your own health and rationally organize your living space. Interestingly, in modern megacities, where the level of air pollution and stress exceeds all reasonable limits, it is necessary for a person to organize green recreational areas, that is, "green" recreation areas (Fig. 3).

Even in the projects of Soviet modernist architects, eco-roofs appeared, designed for walking, relaxing or placing greenhouses.



*Figure 3- Eco-roofs designed for walking, relaxing or placing greenhouses*

Roof landscaping is used today in many countries, including Russia. The popularity of such systems is explained by their versatility: they can be erected in any climate where there is a vegetative soil cover [2]. In addition, such a solution plays an important role from an environmental point of view:

- The climate is improving. Due to the greened roof, the air is humidified, as a result, natural coolness is provided. The positive effect of a green roof in office spaces is especially noticeable.

- The air is cleaned, and dust and harmful substances are absorbed: the green roof most often has a large landscaping area, and the vegetation on the roof absorbs about 20% of dust from the air, trapping and assimilating nitrates and other toxins.

- Noise insulation increases: the vegetable coating on the roof helps to improve sound insulation, which is especially important if a building with an operational roof is erected next to an airport and other structures with a high noise level.

- Part of the green spaces damaged or completely lost during the construction of buildings is compensated.

- In addition, recycled environmentally friendly materials are used to create the system: the drainage system is made of rubber, polyethylene, polystyrene foam, which guarantees the environmental safety of the structure.

Currently, in Russia, "green roofs" are already beginning to be implemented in large cities such as Moscow, St. Petersburg, Yekaterinburg, Kaliningrad, Tver, Voronezh, and some others. One of the striking examples is the green roof of the Crowne Plaza business center in the Pulkovo Airport complex in the northern capital. In a project carried out back in 2011, a roof with extensive landscaping was created, with an area of more than 2000 m<sup>2</sup>.

In Russia, green roofs were built at international-level facilities: for the 2014 Sochi Olympics and the 2018 FIFA World Cup.

The real estate market is increasingly feeling the need to design eco-roofs in residential buildings, since the economic effect of their presence in the implementation of development projects (that is, the most risky and most profitable types of real estate

investments) has the prospect of exceeding the cost of arrangement by more than a third.

Meanwhile, it is impossible not to notice the factors slowing down the development of this idea in our country. And they are connected not only with economic conditions, but also with the absence of "green" standards for the design and construction of exploited roofs for a long time, with established stereotypes that need to be broken, because it is profitable to erect a "green" roof. This happens for the following reasons:

1. *The cost of reconstruction of the roofing system is getting lower.* The vegetation layer allows you to protect the roof from ultraviolet rays, temperature changes. Accordingly, landscaping significantly increases the service life of roof waterproofing up to 40 years.
2. *Thermal insulation increases.* Due to landscaping, good heat-protective properties are provided throughout the year of operation of the roofing system, which makes it possible to reduce the costs of heating the room.
3. *Moisture is well retained.* The effect of moisture retention is manifested in the fact that the green roof is able to retain up to 90% of the moisture that is formed due to precipitation. Thanks to the green roof, the likelihood of flooding is reduced. Some of the moisture evaporates, some is absorbed by plants, and some part goes into internal drains. Such a design reduces the cost of installing pipelines and drainage systems.
4. *Strengthening of the structure – the vegetation layer reliably protects the roof from various mechanical damage, temperature fluctuations and adverse effects of natural phenomena.* The roof, covered with a green layer, can be used for more than 25 years.
5. *Construction is possible in any climatic zone.* This is possible due to the fact that plants are used that are resistant to moisture, temperature changes in a particular region. The landscaping system can be implemented on any roof at any stage of the construction process.

The disadvantages of vegetable "green roofs" are considered to be:

- A lot of weight. A layer of drainage, soil and plants is added up to 50 kg / m<sup>2</sup> of area, so the green structure significantly increases the load on the floors and the foundation of the structure.

- High cost due to the complexity of installation. Due to the heavy load on the foundation and floors, a project based on an accurate calculation is necessary for the installation of a vegetable roof. Therefore, it is quite difficult to do this work with your own hands, most often you have to resort to the services of contractors.

Today, such a roof is a complex system, which should be built according to a certain technology, taking into account the design features of the building itself. "Green roofs" place increased demands on the entire roof structure. To create a "green roof", it is recommended to use light steel structures, on which profiled flooring is laid, which serves as the basis for the entire roofing system, however, both wooden and reinforced concrete bases are used. Thermal insulation materials for flat roofs are used



as insulation. [3]

“Green Roof” is a centuries-old tradition and national environmental policy in many countries of the world. Germany is now the leader in the development of innovative technologies for the installation of “green roofs”. It is not only creating modern methods of landscaping roofs using revolutionary materials – here, in principle, it is customary to break up green areas on roofs, and plan it at the design stage of buildings. In Germany, technologies for greening roofs with a large slope angle are actively used. And for owners of buildings who have not arranged gardens on their roofs, special tax fees and sanctions have been introduced (Fig.4).



*Figure 4- Modern methods of landscaping roofs using revolutionary materials*

However, many other countries do not lag behind Germany in terms of the prevalence of green roofs. So, in the cities of Switzerland, about a quarter of all flat roofs are covered with lawns. And in Japan, on flat roofs, the size of which is more than 100 sq. m., by law it is necessary to create gardens.

Roofs of industrial buildings are the most convenient for landscaping, and the damage caused to nature by industry would become less noticeable.

Today it is possible to make an exploited “green roof” of two types - extensive and intensive. An intense green roof is a covering in which low plants are combined with shrubs and trees (Fig. 5).



*Figure 5- Intensive green roofing*

Currently, dense multi-storey and medium-storey buildings in the central districts of cities have been developed in Russia. It is advisable to create a public space with recreation areas and container landscaping on the roofs of such houses.

In this regard, we propose to consider the simplest in operation, but having all the above advantages, the "green roof" system used by us in the pre-design development of a 5-storey apartment building in a densely populated development of Tambov (Fig. 6). The base of the "Green Roof" is a w/w coating plate. The extensive system involves the use of only grass cover on the roof, evenly distributed on a thin layer of soil. The remaining plants are simply planted in separate containers with a mixture of soil (e.g., in wooden flowerpots). The green roof, in our version, is obtained due to lawn grass, for this purpose we use ready-made rolled lawns with drought-resistant plants, which are not difficult to purchase in stores. They need to be watered only during the growth period and for the winter period, carefully roll up and remove until spring. The soil mixture placed in wooden pots is a mixture of gravel, expanded clay, sand and organic substances that are collected in a certain ratio (Fig. 7).



Figure 6- Residential building of medium height

The loggias of our house have transparent fences providing an open view of the city. Access to the roof can be carried out in any section from the stairwell (Fig. 6).






-  -hard coating
-  -landscaping
-  -wooden flowerpots

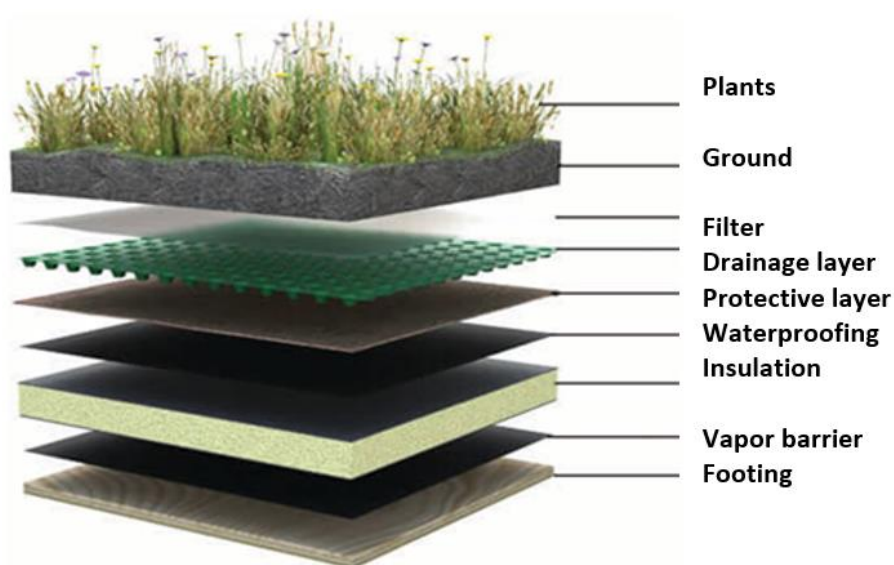
Figure 7-Perspective image of roofing

The aesthetic function is carried out by photomodules, which are additional elements of landscaping (Fig. 8).



*Figure 8- Phytomodule*

In our pre-project development, the "roofing pie" for the "green roof" is not used, since at present its device is not sufficiently developed. It is a complex system (Fig. 9).



*Figure 9- "Roofing pie" for a green roof*

This project development is presented in order to draw attention to the possibility of wider use of "green" technologies in the design and construction of both housing and other facilities that contribute to the improvement of the ecology of cities and their population.

"The Ministry of Construction of Russia sees as one of its priorities the introduction of "green" construction standards and the adaptation of building codes to

global climate change", Deputy Minister of Construction and Housing of Russia Sergey Muzychenko said at the international construction forum and exhibition 100+ TechnoBuild [5].

To this end, a Technical Standard was approved and put into effect by the Order of the Federal Agency for Technical Regulation and Metrology dated May 28, 2020 N 245-st, aimed at ensuring compliance with technical and environmental requirements in the design, construction and operation of landscaped and operated roofs, to create a safe and healthy human environment, the use of high-tech materials, the use of energy-efficient technologies and constructive engineering solutions and the reduction of negative impacts on the environment [6].

The introduction of this Standard will allow designers to use green roofs more widely in their work, thus introducing innovative technologies, without which it is impossible to imagine the rapidly developing modern world. The cost of work on the installation of "green roofs", respectively, will be included in the estimate of construction costs paid by the Customer. The operating costs, as for common areas, will be borne by the Management Company.

State events of this scale inspire hope that in the near future "green roofs" will become an obligatory part of the architectural appearance of cities and towns, which will be the key to improving the environment and raising the standard of living of the population of our country.

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### **«Зеленые крыши» – залог улучшения экологии и повышения уровня жизни населения**

**М.В. Долженкова\*<sup>1</sup>, И.Е. Горюшинская<sup>2</sup>**

<sup>1</sup>ФГБОУ ВО «Тамбовский государственный технический университет»,

<sup>2</sup>ТОГБПОУ «Строительный колледж», Тамбов, Россия

*e-mail: dmv20101@yandex.ru*

**Аннотация.** Внимание к зеленым технологиям растет, в частности в России. Приводятся примеры применения зеленых крыш в разные времена и в различных странах. Рассматриваются зеленые крыши, их благотворное влияние на окружающую среду, на здоровье человека и его положительное эмоциональное состояние.

**Ключевые слова:** Зеленая кровля, эко-крыши, озеленение крыши, реконструкция кровельной системы, фотомодули, «зеленые» стандарты строительства.



## Unterirdische Räume als Wichtiger Teil der Struktur der Stadt

**E. A. Iljina**

Tambow Staatliche Technische Universität, Tambow, Russland  
*e-mail: katyaili99@mail.ru*

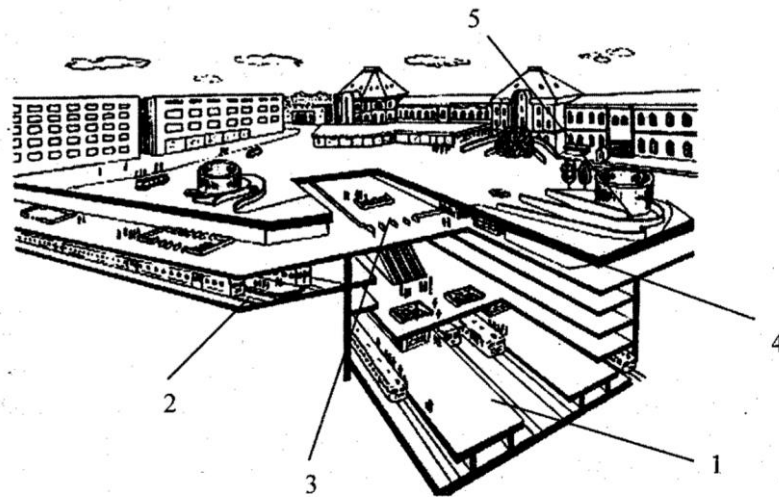
### **Zusammenfassung**

Der Artikel untersucht das Konzept von unterirdischen Räumen. Um besser zu verstehen, was unterirdische Räume sind, wird in der Arbeit eine kurze Geschichte der Erschließung von unterirdischen Räumen und Problemen vorgestellt, die bei der Erschließung des unterirdischen Teils der Stadt auftreten. Die Dringlichkeit der Studie besteht darin, dass es in der heutigen Zeit ein globales Problem der Territorialknappheit gibt. Dies begründet die Notwendigkeit der Ausarbeitung eines theoretischen Modells der unterirdischen Räume großer Städte.

**Schlüsselwörter:** der unterirdische Raum, die städtische Umgebung, das Relief.

In den letzten Jahren hat das Interesse an der Erschließung von unterirdischen Räumen exponentiell zugenommen. Dies ist nicht nur auf technologische Innovationen zurückzuführen, die es ermöglichen, den unterirdischen Raum problemlos zu meistern, sondern auch auf eine Reihe von Problemen. Das ständige Bevölkerungswachstum, der Mangel an städtischen Gebieten, die Erhöhung der Anzahl der Fahrzeuge, was zu einer Ansammlung großer Fahrzeugmassen auf den Straßen führt, zu einer zunehmenden Belastung der städtischen Infrastruktur und zu einer Verschlechterung der ökologischen Situation – all diese Probleme führen Architekten dazu, um unterirdische Räume zu erschließen.

Was ist ein unterirdischer Raum? Der unterirdische Raum ist ein Raum unter der Tagesoberfläche der Erde, der als eines der Mittel zur Überwindung des Trends zur Erweiterung der Stadt verwendet wird, Gegenstand der Entwicklung neuer Konzepte zur Schaffung und Erhaltung natürlicher Lebensräume, zur Erreichung der Prioritäten des ökologischen und wirtschaftlichen Wohlergehens und der nachhaltigen Entwicklung und zur Schaffung von Bedingungen für das Leben der Menschen unter extremen Bedingungen ist [1]. Der unterirdische Raum der Stadt umfasst Engineering- und Transporteinrichtungen, Handels- und Gastronomieunternehmen, Spektakuläre-, Verwaltungs- und Sportgebäude, Objekte des öffentlichen Haushalts, Objekte für industrielle Zwecke, Netzwerke von Ingenieurausrüstungen [2]. Die komplexe Erschließung des unterirdischen Raumes (Abb.1) ist typisch für große Städte und Metropolen, hauptsächlich in der Zone des Stadtzentrums.



*Abbildung 1 - die umfassende Nutzung des unterirdischen Raums (am Beispiel eines Bahnhofs in Tokio): 1- der Bahnhof, 2- die U-Bahnlinie, 3- der Umsteigebahnhof, 4- das Handelsunternehmen, 5- die Einfahrt zum Parkplatz*

Aber wenn man die Leute fragt, was unterirdische Räume sind, wird das erste, was ihnen in den Sinn kommt, die U-Bahn oder die technische Kommunikation sein. Aber nur wenige wissen, dass die unterirdischen Bauten schon in der Vorzeit ihre Geschichte begonnen haben. Diese Baulichkeiten waren Höhlen, die von Vorfahren als Unterkunft genutzt wurden, und später entdeckte der Mensch ähnliche Baulichkeiten für die Lagerung von Lebensmitteln, religiösen Riten, Militäreinsätzen, Bergbau usw. Mit der Entwicklung des menschlichen Denkens und der Technologie hat die Menschheit den unterirdischen Raum mehr beherrscht. Zum Beispiel wurde bereits im Jahr 2150 v. Chr. unter dem Euphrat in Babylon ein 900 m langer Unterwassertunnel eingerichtet. Die Wände waren aus Mauerwerk [3]. Später wurden noch viele verschiedene Tunnel gebaut: Fußgänger-, Schifffahrts-, Kraftfahrzeugtunnel. Und 1862 wurde der erste U-Bahn-Abschnitt in London eröffnet. Seine Länge betrug 3,6 km. Die U-Bahn erreichte Russland wenig später - im Jahr 1935. Seine Länge betrug 11,2 km.

In der modernen Welt werden unterirdische Räume breiter genutzt: Tiefgarage, viele Untergeschosse und sogar ganze unterirdische «Städte». So wurde zum Beispiel in Montreal neben der U-Bahn eine riesige Fußgängerzone von 12 Quadratkilometern gebaut. Und bei schlechtem Wetter ziehen die Bewohner dorthin. Aber es gibt auch Projekte, die nicht realisiert werden können. Dies ist das mexikanische Projekt "der Bagger" (Abb.2).

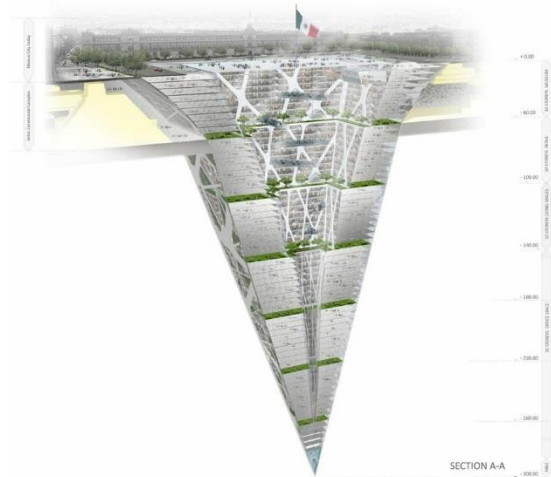


Abbildung 2 – "Bagger", mexikanisches Architekturbüro BNKR Arquitectura

Dieses Projekt ist 300 Meter tief und hat 65 Stockwerke. Und seltsamerweise haben die Architekten ein großes Bevölkerungswachstum und einen Mangel an Grundstücken verursacht, um ein solches Projekt zu erstellen. Das Projekt ist jedoch nur auf dem Papier geblieben, und es gibt eine Reihe von Gründen dafür.

Warum ist es im 21. Jahrhundert nicht immer möglich, unter die Erde zu fallen? Der Hauptgrund ist das Gelände. In vielen Städten der Welt gibt es Karstprozesse, die aufgrund der Ausbreitung von Sedimentgesteinen nicht sehr kurzlebig sind, aber es ist schwierig, sie zu bekämpfen, da ihre Intensität ausreicht, um ganze Gebäude zu zerstören. Suffosionsprozesse oder die Zerstörung und Entfernung von feinen Grundwasserkomponenten durch den Grundwasserstrom schwächen den Boden und bilden unterirdische Hohlräume und Kanäle, die später zu Ablagerungen und Erdbeben führen können. Es ist ziemlich schwierig, einen solchen Prozess zu kontrollieren. Aber es gibt nicht nur natürliche Suffosionen, sondern auch vom Menschen verursachte.

Die Anzahl der unterirdischen Versorgungsleitungen, wie Heizungs- und Wasserleitungen, nimmt zu, und ihre Ausbrüche und Undichtigkeiten führen zu einer Erodierung des Bodens. Ein weiterer geologischer Prozess wird durch das Abpumpen von Grundwasser verursacht. Dadurch kann sich die Oberfläche absetzen. Es ist erwähnenswert, dass diese Prozesse oft zu Verformungen der unterirdischen und oberirdischen Kommunikation führen, was zu gefährlichen Situationen führt, z. B. zum Aufdecken von elektrischen Kabeln, zum Ausbruch von Gasleitungen usw. [4].

Wir sollen auch die seismischen Gebiete nicht vergessen. Erdbeben und Überschwemmungen beeinflussen das Gelände stark, indem sie bestehende Gebäude sowie das Gelände verformen und zerstören.

Auf der Grundlage des Vorstehenden können wir schließen, dass die Verwendung von unterirdischen Räumen eine vielversprechende Richtung bei der Lösung von Baufragen unter beengten Bedingungen ist. Die Entstehung neuer Technologien ermöglicht es, eine Reihe von technischen Schwierigkeiten bei der Erschließung von unterirdischen Räumen zu beseitigen. Um effektiv mit unterirdischen Räumen arbeiten

zu können, ist es notwendig, ein theoretisches Modell für die Bildung eines Systems von unterirdischen Räumen in Städten zu untersuchen und zu erstellen.

Abschließend kann man sagen, dass das Thema unterirdischer Räume interessant und relevant ist, aber es gibt eine Reihe von Problemen, die noch schwer zu lösen sind, aber die Intensität der Entwicklung moderner Technologien ermöglicht es, sie zu lösen.

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## **Подземные пространства как важная часть структуры города**

**Е. А. Ильина**

ФГБОУ ВО «Тамбовский государственный технический университет», Тамбов, Россия  
*e-mail: katyaili99@mail.ru*

**Аннотация.** В статье рассмотрена концепция подземных пространств. Для того, чтобы лучше понять, что такое подземные пространства в работе представлена краткая история освоения подземных пространств, а также проблемы, возникающие при освоении подземной части города. Актуальность исследования заключается в том, что в современности появилась глобальная проблема нехватки территорий. Это обосновывает необходимость теоретической модели подземных пространств крупных городов.

**Ключевые слова:** подземное пространство, городская среда, рельефю

## **Light–Conducting Concrete as an Innovative Eco-Friendly Material Using Glass Waste in Architecture and Construction**

**I.E. Goryushinskaya<sup>1</sup>, M.V. Dolzhenkova<sup>2</sup>**

<sup>1</sup>Tambov Construction College, Tambov

<sup>2</sup>Tambov State Technical University, Tambov  
e-mail: dmv20101@yandex.ru

### **Abstract**

The historical information about the technology of concrete production from ancient times to the present is given, an analysis of its main characteristics and use is made. An innovative material of the 21st century – light-conducting concrete is presented. The manufacturing technology of this material and its advantages over classical concrete are considered. The introduction of light-conducting concrete into production will ensure environmentally safe construction, energy benefits, and reduce economic costs due to the partial replacement of cement in concrete with glass waste. In addition, concrete translucent slabs will create a more favorable sensory environment from an architectural and psychological point of view.

**Keywords:** light-conducting concrete, architectural environment, technological progress, ecology

Due to its strength, durability and ability to withstand various atmospheric influences, concrete has been considered a popular material in construction since ancient times. According to archaeologists, the age of buildings in which concrete was present is about 6000 thousand years. It is believed that in 5600 BC, archaeologists discovered one of the earliest types of concrete. A hut with a floor made of a mixture of red lime and gravel was found in the village of Lapenski Vir on the banks of the Danube. Lime for the mixture was extracted more than 400 km from the place of construction. That is, even then people understood the advantages of the concrete mixture, despite some difficulties in extracting its components.

Since the end of the 4th century BC, this building material was especially widely used in ancient Rome. The residents of the city were the first to come up with a competent composition of the binder, and all because of the geographical features of the location of their territory, namely, due to the presence of volcanoes. The Romans thought of mixing the volcanic ash of Vesuvius with slaked lime, as a result of which they received a building material that could maintain its strength even under water [1,2].

It is interesting to note that the use of concrete also existed in Asian countries. For example, the Great Chinese Country, the construction of which was started in the 3rd century BC, is built mainly of concrete. It was built and destroyed for many millennia, but only in the 14th-17th century A.D. a unique cement mortar was created from slaked lime and boiled rice, which allowed preserving this unique wonder of the world.

After the decline of the Western Roman Empire at the beginning of the 5th century AD, the technology of concrete production using pozzolan binder was lost for many centuries.

Concrete on a cement binder, as we know it now, became known only with the advent of Portland cement in 1824. It got its name in honor of the city of Portland, where natural stone is mined, similar in color to cement. The composition of Portland cement was proposed by the Englishman Joseph Aspdin, and a year later a similar method of making cement was brought out by Egor Cheliev in Tsarist Russia. The mixture, invented in the early 19th century, is used in construction to this day. Undoubtedly, over the past two centuries, cement has been manufactured with finer grinding, and the composition has undergone optimal rationing. But the methodology itself has remained unchanged. It was a scientific breakthrough, the world received a completely new building material, concrete with high performance properties, resistant to fire, moisture and frost.

But time passed, technological progress continued to move forward, and new requirements for building materials appeared. The commonly used concrete in its usual form, despite all its advantages, began to lose against the background of other modern materials. An important role in the formation of such an assessment was played by the environmental crisis of the 21st century, because one Portland cement production (this material is the main component of concrete), according to statistics, increases the carbon dioxide content in the atmosphere by 7-8%. The Guardian in 2019 called concrete "the most destructive material on Earth." In addition, the reserves of natural sand used in the concrete mix are not infinite and may run out. All these environmental factors force humanity to look for a more practical alternative to concrete[3].

As for the architectural and construction aspects, at the beginning of the 21st century, concrete began to lose its attractiveness. In the 20th century, when it was necessary to organize rapid mass construction, concrete performed its functions perfectly, but in the end it gave the cities a dull, gray and unattractive appearance. One of the disadvantages of concrete is its unsightly appearance, in addition, cement, which is part of the material, absorbs water fairly quickly, which subsequently creates the likelihood of cracks and ruptures.

After analyzing these characteristics, a person living in the modern world faces the question: how to get a similar building material with higher performance properties, a more attractive appearance, but with less serious negative consequences from production?

Hungarian architect Aron Loshonzi found the answers to this question in 2001. At the innovation exhibition in Hungary, Loshonzi demonstrated a designer lamp made of transparent concrete blocks. Already in 2005, the German architect Jurgen Lohman created the first building from a new material: a high-tech mansion. So how did it happen to give concrete the function of light transmittance? And what characteristics did this material eventually possess?

Wondering how to add sunlight to a concrete room, Loshonzi created something he did not expect. "Litracon", which means in translation, has unique properties: its

external attractiveness is combined with high strength. The secret lies in the use of secondary raw materials, namely in the addition of recycled crushed glass to the solution, while the percentage of cement in the material decreases, due to which not only light transmittance appears, but also the chemical composition of the mixture improves. The building material becomes lighter, and cement, which is a component of new concrete, absorbs water differently from ordinary cement. As a result, the strength and durability of the material increases. In addition, the use of recycled glass reduces its amount in landfills, which reduces the emission of carbon dioxide into the atmosphere, and CO<sub>2</sub> is known to be an undesirable by-product of cement production.

The technology of production of light-conducting concrete consists of a step-by-step multi-layer pouring of the solution, while the fibers are arranged in layers along the entire concrete monolith. After that, the workpiece is cut into blocks or slabs of the required size. The described technique allows you to get blocks with chaotic patterns, but if necessary, you can create a specific pattern on the outside of the block. After removing the mold, the plate or block is ground. Blocks or slabs of such concrete are only partially transparent: behind the light-conducting concrete, you can guess the shadow or outline of an object. At the same time, sufficient strength of the material makes it possible to construct internal enclosing structures (floors, walls, ceilings, partitions) from it. Also, the characteristics of concrete allow it to be used for decorative decoration of buildings[4].

If the construction of buildings made of "transparent" concrete becomes widespread, then natural daylight can be used to illuminate offices, shops and other buildings. Thus, the use of light-transmitting concrete blocks can lead to great energy savings. In addition, a sufficient amount of daylight will create a more favorable sensory environment for people from the point of view of architecture. And, more importantly, the production of translucent concrete will have a positive impact on the environmental situation in the world, because its production uses recycled glass, which, as we all know, decomposes in the ground for centuries.

The use of such concrete in construction would not only bring huge benefits to the environment, but could also transform the familiar look of the architectural environment and bring many positive changes to small cities in Russia, for example, such as Tambov. Thus, light-emitting concrete would be perfect for decorating the park environment, creating unusual benches, fountains and some types of decorative lighting, which would undoubtedly give the parks and squares of Tambov a more attractive appearance, not only at night, using electricity, but also during the daytime, when the sun's rays would penetrate structures and installations from translucent concrete, while casting bizarre shadows and patterns[5].

If we touch on more expensive construction, then this material would look great in many public buildings, creating a kind of atmosphere of a large space filled with air and light. This idea could be implemented during the construction of a shopping center, cafe, store or, for example, a kindergarten (Fig. 1).



*Figure 1 - Light-transmitting concrete*

Until recently, light-transmitting concrete was produced only in Japan and some European countries [5]. But the new technology gradually began to appear in Russia. However, due to the high cost, the material, unfortunately, has not yet become widespread and is currently used only in individual projects. With the subsequent reduction in the price of manufacturing, this type of concrete has every chance of being used in mass construction in the future.

Scientists from the technical universities of Berlin and London in 2022 are developing a universal type of concrete due to the use of recycled trash glass as a filler. Their research conducted using modern 3D printing technologies shows exceptionally positive results. Therefore, it is already safe to say that the new practice of concrete production with partial replacement of cement with glass waste, based on the competent principles of the chemical industry, will provide significant environmental, economic and energy benefits, and in addition, will allow architects, builders and designers to implement their conceptual ideas.

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## Светопротядющий бетон – инновационный экологичный материал с использованием отходов стекла в архитектуре и строительстве

И.Е. Горюшинская<sup>1</sup>, М.В. Долженкова<sup>2</sup>

<sup>1</sup>ТОГБПОУ «Строительный колледж», Тамбов

<sup>2</sup>ФГБОУ ВО «Тамбовский государственный технический университет»,  
Тамбов

*e-mail: dmv20101@yandex.ru*

**Аннотация.** Дана историческая справка о технологии изготовления бетона с древних времен по настоящее время, сделан анализ основных его характеристик и использования. Представлен инновационный материал 21 века – светопротядющий бетон. Рассмотрена технология изготовления данного материала и его преимущества перед классическим бетоном. Внедрение в производство светопротядющего бетона обеспечит экологически безопасное строительство, энергетические выгоды, сократит экономические расходы за счет частичного замещения цемента в составе бетона отходами стекла. Кроме того, бетонные светопротядные плиты позволят создать более благоприятную сенсорную среду с архитектурной и психологической точки зрения.

**Ключевые слова:** светопротядющий бетон, архитектурная среда, технологический прогресс, экология.

## Color as an expressive means of architectural composition

**A. P. Kozeltsev\*, M. A. Ulybina**

Tambov State Technical University, Tambov, Russia

\*e-mail: kozelcev99@bk.ru

### **Abstract**

The topic of this article is color as an expressive means of architectural composition. This article presents an analysis of the role of color in the creation of the architectural image by periods, from the pre-industrial period to the present, taking into account the factors influencing its semantic meaning. At the same time, the evolution of the use of color as an independent element of the architectural language is considered. In addition, the article highlights the main characteristics of color, external and internal factors influencing the perception of color on the example of architectural objects.

**Keywords:** architecture, color, color in architecture, colorism, influence of color.

In all periods of human development color has been a means of information, symbol and decoration. Since the formation of the first cities, color in architecture has corresponded to the type of cultural and political structure of the city. At the same time, architects of antiquity and the early Middle Ages considered color to be an integral part of form, one of the main factors determining the impression created by an architectural object. The color effect in architecture depends on color, neighboring colors, background, light source.

We consider the change in the role of color in the creation of the architectural image by periods. In the pre-industrial period, colors of natural tones prevailed, namely the colors of the materials used in construction or the colors of dyes of mineral origin. For example, the blue-blue gates of Ishtar surrounding Babylon indicated the religious component of society, namely the glorification of the sky goddess. In the ancient polis, in order to emphasize the transparency of political decisions, a white center was designed against a background of red-brown buildings. In medieval cities the color became a symbol of divine light and began to be applied not only to the outer space, but also to the interior.

In urban colorism the most common were natural colors of the materials of the facades of buildings, in some cases the facades could be painted in light shades. The 17th-18th centuries were marked by the emergence of the first projects of color organization of the city. Thus, color palettes approved by the commission on stone construction were in Dresden, Rome, Turin, Paris and St. Petersburg. At the same time, the color planes of the cities prescribed strict rules of coloring, as well as requirements for the preservation and maintenance of the existing color scheme.

In the 19th century, due to scientific discoveries, a large selection of pigment dyes based on metal compounds appeared, which expanded the color palette of available materials. Thus, during the Eclecticism period, red paintings based on Roman *thermae*, decorative elements «a la russe», and after the Art Nouveau style with blue, green and

gold hues appeared. The first to use color as an independent element in the design of the architectural appearance of the building was Gaudi (Casa Batlló in Barcelona). He used ceramic cladding on facades ranging from white to blue, green to purple.

The style of modernism in architecture was characterized by brevity and austerity of forms, working with light and texture. At this time, however, Kandinsky (a teacher at the Bauhaus school) was studying the influence of color on the viewer, as reflected in his books «On the Spiritual in Art» (1910) and «Point and Line on the Plane» (1926). An example of the use of color on the facades of modernist buildings is the concrete seventeen-story apartment complex designed by Le Corbusier. To emphasize the individuality of each resident, the sides of the balconies were painted red, green and yellow.

In 1997 Jenks published a book on the use of color, "The Language of Postmodernism Architecture. In the same year in Paris, the Pompidou Center (a glass parallelepiped) was decorated. All the technical structures were on the outside of the building, namely the fittings were painted white, the ventilation pipes were blue, the water pipes were green, the electrical wiring was yellow, and the escalators and elevators were red. Thus, color no longer emphasizes the individuality and function of the space, but is an independent element of the architectural language. The same idea can be traced to another postmodernist, Sottsass, who, as head of the Memphis group, always considered open color as a primary element.

At the turn of the 20th and 21st centuries, projects where color was focused on improving the quality of life were often applied. For example, poor neighborhoods in Albania and Poland were repainted into colorful neighborhoods. To enhance the social reputation of the Trellick Tower building in London, the corridors were painted yellow. Also, architects began to use color as a highlighting mechanism for metropolitan city offices.

In the USSR, the color concept of the city represented a combination of natural shades, as color expressed the idea of stability and durability. At the end of the 20th century, Russian architects, in order to create accents and urban landmarks, began to apply different colors in the urban environment, such as: pink, turquoise shades of Disney houses of the Red Hills complex, bright red color of the egg house, but not all of the above color solutions were successful. In addition, color was also added to high-rise neighborhoods, namely entrances, blocks and houses, which began to be painted in all the colors of the rainbow. There are several successful examples of the use of color: the kindergarten in the Otrada housing estate and the interior space, the Rumyantsevo metro station in Moscow.

Thus, on the example of the above analysis, we can say that in the process of development of society, color has become an integral element of the architectural environment. At the same time, color concepts are formed under the influence of the visual perception of individuals, the level of industrial development of the country, climatic and geographical characteristics, as well as the cultural and social evolution of society.

Architects, as creators of comfortable urban space, pay special attention to the

characteristics of color and their impact on people in the long term. The main characteristics of color are tone, brightness, and saturation. Also, in practice, a division is applied to external factors, which depend on the environment, such as light, distance and type of surface, and internal factors arising from the structure of the human brain and eye, that is, for each person there will be a different system of «figure - background, color temperature, severity and remoteness of color». Consider the influence of color on architecture and individual elements of architecture.

For example, the color composition of the walls and roofs of buildings, as color planes, can be both harmonious and chaotic, taking into account the influence of their texture, size, shape and orientation in space.

Thus, saturated colors have a special shine on materials with a smooth, glossy surface, while matte surfaces or coarse and fibrous textures look better with less intense colors that approximate natural shades in color.

Thus, saturated colors have a special shine on materials with a smooth, glossy surface, while matte surfaces or coarse-grained and fibrous textures look better with less intense colors that approximate natural shades in color.

Equally important is the background for the architectural object. So, if the accent-background relationship is readable, it creates a positive effect. When accents cluster, there is a sense of chaos. The background for details is the color of the façade on which they are placed. Color planes, such as the walls and roofs of objects dominate the volume of the building, so the above elements must be combined with the background. Color, scale, proportion, and texture of materials are major factors in the visual relationship between the object and the background.

All people have different perceptions of the same color, but there are common reactions to color tones that are the same for all people. Science gives architecture many opportunities to use the influence of color on people, for example, colors cold and warm, near and far, light and heavy. In architecture, heavy colors are commonly used for plinths, which emphasize the connection to the ground, and also for roofs in order to create a sense of completeness in the overall volume of the building. However, for supporting elements such as columns, heavy colors are used to enhance the sense of security. As for light colors, they are most often used to paint the walls of buildings.

If we consider the color organization of space, the warm colors are perceived by people as more comfortable and create a visual approach us to the architectural object, while the cold colors move away from the object, creating a sense of depth of space. In this case, the main characteristic in determining the closeness or remoteness of colors is saturation. For example, a saturated cold color will be perceived visually closer than a warm color with less saturation.

Nowadays, buildings can be decorated in all kinds of colors, with color being applied not only by means of paint on concrete or plaster, but also in the form of colored glass and painted aluminum panels. A characteristic example is the work of architects Sauerbruch and Hutton, who advocate the use of color as a building brick in the exterior of their structures. Using the Natural Color System (NCS), they create

buildings that have a varied but carefully modeled range of colors and shades.

Thus, at present, the color is considered an independent element used to create the architecture of the city, which can change the urban environment for the better, but to abuse this expressive means of architectural composition is not worth it. Also, in the design of architectural projects is important to set out and solve the following problems: the interaction of light and color, their formative role in the creative method of the architect, and consideration of the objective factors that determine the choice of color in the architectural design.

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## Цвет как выразительное средство архитектурной композиции

А. П. Козельцев\*, М. А. Улыбина

ФГБОУ ВО «Тамбовский государственный технический университет», Тамбов, Россия  
*e-mail: kozelcev99@bk.ru*

**Аннотация.** Тема данной статьи – цвет как выразительное средство архитектурной композиции. В данной статье представлен анализ роли цвета в создании архитектурного образа по периодам, начиная с доиндустриального периода до настоящего времени, с учетом факторов, влияющих на его смысловое значение. Вместе с тем, рассматривается эволюция использования цвета как самостоятельного элемента архитектурного языка. Кроме того, в статье выделены основные характеристики цвета, внешние и внутренние факторы, влияющие на восприятие цвета на примере архитектурных объектов.

**Ключевые слова:** архитектура, влияние цвета, колористика, цвет, цвет в архитектуре.

## The Relevance of Reconstruction of Recreation Centers for the Creation of Multifunctional Complexes

O.N. Kozhukhina\*, A.A. Ivanova

Tambov State Technical University, Tambov, Russia

\*e-mail: olga1463@yandex.ru

### Abstract

The article provides brief historical data on the emergence of recreation centers in Russia and the development of their functions. The problems of recreation centers in the modern realization of their potential are considered and directions for their reconstruction are given in order to expand their demand.

**Keywords:** recreation center, reconstruction, cultural environment

### Introduction

The design and construction of recreation centers is a separate important component of the era of the socialist era of the Russian Federation. Recreation centers have undergone reorganization and transformation of their main functions. The mass appearance of these buildings in Russia falls on a fairly late time by world standards - in the second half of the 19th century. But at the same time, their development was faster than in other countries. In a shorter time, various types of objects were organized to meet the cultural needs and requirements of the new emerging socialist society.

The appearance of the first People's Houses in the late 1880s was mainly associated with the development of patronage. Club activities formed a collective community of people through their passion for home theater and painting. Thus, the clubs were the center of the implementation of the leisure needs of the population. The club was like an integral organism and was a prototype of a multifunctional urban center, uniting many processes that are a public environment for residents to communicate.

As a result of the evolution of the public space of clubs and the growth of the activity of the population, classes in public houses became more diverse. From the village to the district of cities, club activity flourished and was modified based on the needs and population into new types of mass activities.

In the last years of the existence of the USSR, the system of recreation centers was in crisis. Prior to this, most of the recreation centers belonged to industrial enterprises. During the period of decline, plants and factories first of all began to get rid of non-core assets – social institutions. At best, the recreation centers continued to function as a cultural institution. In another case, the recreation centers were owned by private individuals who either did not use it at all or rented it out to the owners of offices and shops. Since then, the number of cultural and leisure institutions has been declining. After the collapse of the USSR, 72571 recreation centers remained in Russia. In 2022, there are no more than 40 thousand of them left. The number of cultural and leisure

institutions continues to decrease every year by an average of a thousand buildings. It should be noted that not all buildings are really in disrepair, and during reconstruction or modernization, some of them can be used for many more years.

To this end, it is possible in the future to return recreation centers within walking distance to cities, for which recreation centers are the best fit. Depending on the geography, different materials were used in the projects of recreation centers; local artists made ornaments on the facades and painted the walls. Thus many recreation centers acquired obvious features of national architecture. In addition, these buildings are multifunctional: almost each of them has a concert hall, exhibition space, library, workshops, and studios. Thus, by reconstructing and re-profiling the buildings of the recreation centers to meet modern requirements, it is possible to significantly increase the cultural development of cities without the costly construction of new buildings.

Modernization and renovation of typical recreation centers fits well into the trend of recent and probably many future years - conscious consumption with a sub-item of reuse. Successful examples of the reconstruction of Moscow, Nizhny Novgorod and Voronezh make us look at the dilapidated and delimited buildings that exist in every city or residential area with completely different eyes. The idea of recreation centers within walking distance, in which spending time is clearly more interesting than in shopping centers, is completely fascinating.

At the moment, most recreation centers do not realize even one third of their potential. This happens for many reasons, but the main one is a lack of understanding of the requirements of the times and the demands of modern society. The demand of time today is the need for the development of a creative economy. This type of economy is based on the creative potential of people, thanks to which they develop new approaches in entrepreneurship, art, design and make scientific discoveries. With the reformatting, recreation centers will be able to provide all residents without exception with the opportunity to realize their creative potential.

Currently, recreation centers need to rethink their approach to providing services and prioritize those that are most in demand in today's society. The problem with the fading of the recreation center system is that the services of the recreation centers do not meet the needs of visitors:

1. Space is used inefficiently. Also, the decline is due to the fact that recreation centers work mainly in the evening, which significantly affects the number of visitors. Studios and sections are often placed unevenly in the recreation centers - many rooms are empty, being rented.

2. There is no influx of new visitors, since in typical recreation center buildings, as a rule, there are long corridors and offices, which are not often visited by ordinary people.

3. Visitors are mostly children and the elderly. These social groups are undoubtedly important, but without attracting solvent visitors, the recreation centers will not be able to reach the level of sustainable development and invest in social projects.

4. Most recreation centers do not have a quality infrastructure, so they do not seem

to be attractive venues.

Today, there is an urgent need to form a cultural environment that would meet the growing needs of the individual and society in any rural area and in places remote from large cities [1]. These include: improving the quality, diversity and efficiency of services in the field of culture, creating conditions for the accessibility of the participation of the entire population in cultural life, as well as the involvement of children and youth in active socio-cultural activities.

Thus, recreation centers will become in demand and effective when they meet the requirements of the time, the demands of society, earn money and be multifunctional. Also, the conditions for the successful further existence and development of the recreation center system are as follows:

1. The services of the recreation center are made up of the needs of visitors.
2. Full occupation of spaces.
3. Anyone can become a participant in the process.
4. People of all ages visit the recreation centers.

Based on successful projects for the reconstruction and further development of cultural centers in different cities, it is important to transfer best practices to the city of Tambov.

In Tambov, which was founded on April 17, 1636 by the sovereign's stolnik and Shatsk voivode Roman Boborykin as a stronghold of the Moscow State in the area of the Wild Field, on a hill at the confluence of the Tsna and Studenets rivers [2], the recreation center became the first and brightest representative of the buildings of "Banner of Labor" recreation centers.

The project of the Railway Workers' Club was presented on May 30, 1927. It consisted of two buildings - a club and a theater for a thousand seats, connected by a passage corridor.

According to the project, it is proposed to have the following premises in the club: on the 1st floor - a lobby, a gymnasium, two locker rooms with showers (at the gym), a library, a reading room, two rooms, a locker room for 400-500 people, a rest room, a buffet, two latrines, corridors and two stairwells; on the 2nd floor - a lecture hall [3] with a stage and a balcony with a total capacity of about 400 people, a room for a lecturer at the lecture hall, a foyer, ten rooms for study groups, a smoking room, two latrines and a corridor. At the level of the balcony (on the 3rd floor) it was planned to place a reinforced concrete movie booth. The kitchen and dining room were designed in the basement.

On January 26, 1929, the club building was put into operation, and later renamed the Znamya Labor Recreation Center of the Tambov Carriage Repair Plant (TVRZ). The enterprise of the plant actively participated in the activities of the club, various city and regional meetings, conferences were organized in it, club days were held monthly. For many years, in the largest factory club in the city, residents were engaged in amateur performances, spent their leisure time in the auditorium, and participated in competitions.

In December 1998, on the basis of the House of Culture (DK), the municipal



institution “Znamya Labor Recreation Center” was created, which in September 2011 became a municipal budgetary institution of culture. In 2016, the Znamya Labor Recreation Center was recognized as an architectural monument and an object of cultural heritage of regional significance. Various programs are staged here and classes are organized for children, youth and adults. Despite the time gap from the creation of the club, the Znamya Labor Recreation Center continues to meet the needs of Tambov residents using its experience as an example.

Currently, an active survey of the building is being carried out in order to determine the technical condition of the facility in order to assess the physical deterioration of structures and engineering systems. During this survey, numerous deviations and deformations of structures were found. Among them: the destruction of the plaster layer of the walls, the protective layer of concrete of structural elements, cracks in the brickwork, traces of moisture and biological damage to the walls, damage to the blind area. Based on this, it becomes obvious that the building needs a major overhaul. Also, the city administration plans to improve the quality of landscaping around the building and repair the fountain. It is very important that the "Znamya Labor Recreation Center" has a development prospect and the restoration of operational characteristics will make it even more in demand and significant for local residents and guests of the city.

After reconstruction, the building can accommodate a co-working space, a new generation library, modern exhibition spaces, places for performances, i.e. the possibilities of the recreation centers can be used several times more intensively, due to various functions. Citizens within the walls of the recreation center will be able to meet, communicate on an informal level, and learn the news of the region and the city. In such a recreation center, it is necessary to preserve the auditorium, but it is possible to expand the set of children's educational and entertainment formats. Thus, the recreation center can turn into a community center with the preservation of cultural, educational, educational, leisure and entertainment activities.

The development of an architectural project should be based on the existing experience in the reconstruction of cultural sites in Russia, for example, in Moscow and Voronezh, as well as taking into account the technical condition of the building.

### **Conclusion**

Recreation centers were an important component of the public space, they formed a cultural and creative environment, and brought up generations. Delicious cakes and lemonade were sold in cozy buffets, and the first Soviet rock bands and VIA gave their concerts in concert halls. Alas, far from all recreation centers have survived to this day, and even fewer have retained their original functions. Over time, some institutions were redesigned into Art Centers or became municipal institutions and perform populist functions, but many of them fell into disrepair, were destroyed and abandoned. Only a few of them manage to “survive” before the overhaul or reconstruction. But the significance of buildings, especially those that are objects of cultural heritage, is great both for society and for each person. An analysis of the current situation shows the need to take urgent measures to preserve cultural heritage

sites located on the territory of the city of Tambov [4]. It is necessary to preserve the features inherent only in the building that constitute the subject of protection, create conditions for the normal operation of the building and include it in the life of modern society in order to preserve the historical image of the city and cultural development.

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## Актуальность реконструкции домов культуры для создания многофункциональных комплексов

О.Н. Кожухина\*, А.А. Иванова

ФГБОУ ВО «Тамбовский государственный технический университет», Тамбов, Россия  
\*e-mail: [olga1463@yandex.ru](mailto:olga1463@yandex.ru)

**Аннотация.** В статье приведены краткие исторические данные о появлении домов культуры в России и развитии их функций. Рассмотрены проблемы ДК в современной реализации своего потенциала и приведены направления их реконструкции с целью расширения их востребованности.

**Ключевые слова:** Дом культуры, реконструкция, культурная среда.

## Functional and planning structure of urban housing for disabled people

Y. V. Makeeva\*, V. Y. Grishina

Tambov State Technical University, Tambov, Russia

*e-mail: grishina.wika@yandex.ru*

### Abstract

The article is devoted to the functional and planning structure of urban housing for people with disabilities. The basic requirements and conditions for the creation of a comfortable environment for low-mobile population groups (LMP) are considered. It formulates recommendations for the development of standard design solutions for urban housing for disabled people and families with disabled children.

**Keywords:** accessibility for people with disabilities, comprehensive improvement, layout, low-mobile population groups, model projects, residential environment, the adjacent territory.

The issue of creating housing for low-mobile population groups (LMP) is acute in Russia. As of January 1, 2022, there were 11.3 million people of all disability groups (7.8% of the population).

In the existing urban environment with increased population density, on the background of increased life expectancy, with a high rhythms of human flows, the social activity of people with disabilities of all categories is hindered. First and foremost, wheelchair users, the sick, the elderly, and people with young children and baby carriages.

The problem is that the typical apartment buildings of mass industrial development of the 1970s-1990s are not adapted for the needs of LMP and are not intended for prospective demolition or reconstruction, as they were built in the complete absence of an appropriate regulatory framework.

When designing residential buildings, the needs of disabled people should be taken into account depending on the type of object and specific conditions:

— available in full in a universal form (for all low-mobility groups of the population);

— in a specialized form - in the form of separate zones in buildings (buildings or parts of buildings), comprehensively equipped for all or for certain categories of disabled people.

The functional-planning scheme for apartments for people with impaired mobility, including wheelchair users, must be based on the need to create a living area for the disabled, which would facilitate self-care to the maximum extent possible.

When designing buildings with living quarters for people with disabilities moving in wheelchairs, the following should be ensured:

— accessibility of the living floor (including using ramps, elevators or lifts);

- arrangement of safe zones;
- the required dimensions of intra-house and intra-apartment communications;
- premises and areas of the apartment (living cell or room) due to the presence of spaces that provide maneuvering on a wheelchair in the living room, hallway, sanitary and hygienic premises, in the kitchen, in summer premises (on a balcony, loggia, terrace or veranda).

To achieve this goal, the following functional-planning techniques can be recommended:

- for one-room apartments: the formation of interconnected spaces of the hallway, common room, kitchen;

- for apartments with two, three or more rooms: proximity of the common room to the hallway, organization of the planning connection of these rooms by means of a corridor with a functional group of kitchen - bathroom - room of a family member with impaired mobility;

- the presence of a loggia in the disabled person's room with direct access to it, since for the majority of disabled people staying on the loggia is the easiest and most reliable way of contact with the outside world.

Design solutions should use a set of devices and equipment for moving in a wheelchair, versatile in its use by disabled adults and children with disabilities.

1. All buildings and structures must have at least one accessible entrance for disabled persons, which must be equipped with a ramp or other device that makes it possible for a disabled person to rise to the level of the entrance to the building.

2. When designing housing for families with blind and visually impaired people, special attention is required to the organization of the apartment communications, to the equipment of the apartment with sound alarm and warning systems, to the choice of sound-absorbing coatings of the surfaces of the rooms.

3. A special room for storing wheelchairs is provided next to the lobby or in the basement. For the convenience of disabled people, the room is equipped with special armchairs, with the help of which a disabled person can transfer from an armchair to a wheelchair and vice versa.

4. An area of at least 1.5 m in diameter should be provided in front of the entrance to the apartment for turning the wheelchair.

5. The layout of sanitary units must allow for the installation of equipment in them in accordance with the individual requests and physical condition of the disabled person.

6. The design of sleeping rooms should take into account the functional zones at the bedside, while ensuring unhindered access for a wheelchair user or access to a person with a disability who requires care and assistance from others.

7. If the kitchen area is less than 8 m<sup>2</sup>, it is advisable to combine the kitchen with the common room of the apartment. For the convenient placement of basic equipment in the kitchens of apartments of various types, when they are used by wheelchair users, kitchen equipment is installed, as a rule, of the console type, taking into account the unimpeded accessibility and reachability of wheelchair users.

8. When designing loggias, the minimum width must be established on the basis of a wheelchair turning 360°.

Operational requirements and functional-planning zoning for LMP should be mutually consistent in design sections, including architectural-planning and structural solutions for arrangement and finishing, engineering and technological equipment for LMP.

The development of planning solutions for residential facilities for persons with disabilities and families with children with disabilities provides a scientific and practical basis for further improvement of the regulatory and technical framework to ensure the full functioning of groups of people with limited mobility.

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## Функционально-планировочная структура городского жилья для инвалидов

Ю. В. Макеева, В. Ю. Гришина

ФГБОУ ВО «Тамбовский государственный технический университет, Тамбов, Россия  
*grishina.wika@yandex.ru*

**Аннотация.** Статья посвящена вопросам функционально-планировочной структуре городского жилья для инвалидов. Рассмотрены основные требования и условия создания комфортной среды для маломобильных групп населения (МГН). Сформулированы рекомендации по разработке типовых проектных решений городского жилья для проживания инвалидов и семей с детьми-инвалидами.

**Ключевые слова:** доступность для инвалидов, жилая среда, комплексное благоустройство, маломобильные группы населения, планировка, придомовая территория, типовые проекты.

## **Inspection of load-bearing structures of the church of the resurrection of christ the savior (Staraya Olshanka village)**

**S. V. Obukhov**

Tambov State Technical University, Tambov, Russia  
*e-mail: tarantul1994@yandex.ru*

### **Abstract**

The results of the survey of the load-bearing structures of the Church of the Resurrection of Christ the Savior in the village of Staraya Olshanka in the Tambov region are presented. The technical condition of the foundations, load-bearing walls, floors has been established. Recommendations for the preservation of the building's load-bearing structures are given.

**Keywords:** an object of cultural heritage, a temple, stone architecture.

The problem of preservation of architectural and historical heritage is currently particularly relevant. The creation of new tourist routes involves the revival of ancient Russian estates, whose history is closely linked with people who have left a significant mark on the history and culture of Russia. A sufficient number of noble estates have been preserved on the territory of the Tambov region. Among them, the estates of the Aseev manufacturers in Tambov and Rasskazov, the estate of S.V. Rachmaninov in the village of Ivanovka are particularly famous. Some of the objects under consideration, thanks to timely investments, have received a second life and their visit is included in the tourist program of the region, but many of them are still on the verge of extinction.

Such objects include the Church of the Resurrection of Christ the Savior in the village of Krasnoe Znamya (formerly Staraya Olshanka) of the Tambov region. The church is located on the territory of the former Olshanka estate, which belonged to V.N. Voeikova, the widow of Major General A.V. Voeikov, hero of the Patriotic War of 1812, grandmother of the famous Russian artist V.D. Polenov. To date, only the church, pond and part of the park have been preserved on the estate, restored and maintained by local enthusiasts, as well as the ruins of the manager's house [1]. Currently, urgent conservation work is required by the preserved temple.

The stone church in the village of Olshanka was founded in 1843. One of the authors of the project was academician K.A. Moldavsky, a famous painter and graphic artist. He developed plans for the building. The authorship of the facades of the temple belongs to academician, Professor of architecture R.I. Kuzmin. In temple construction, the architect is known as the author of the Pavlovsk Cathedral in Gatchina, the Cathedral of St. Alexander Nevsky in Paris [2]. After 1923, the building was used as storage facilities for agricultural products. In the period after 1945, the building was not used and was in an abandoned state. Currently, separate services are held in the building and the temple has the status of a cultural heritage site of regional

significance as an outstanding and rare monument of «Russian historicism».

The survey of the temple building was carried out in order to assess the technical condition of the bearing and enclosing structures of the building for the possibility of their further reliable and safe operation and to determine the type of work to preserve the object of cultural heritage. During the survey, measurement work was carried out, a space-planning and structural solution was established and the operational reliability of the building's load-bearing structures was evaluated.

The structural system of the building is columnar-vaulted. The main hexagon of the basement is covered with a faceted closed vault, the pillars are closed by low semicircular arches. The hexagon is framed by a bypass gallery, covered with cylindrical arches. The first tier consists of six pillars, closed by arches, on which a semi-light twelve-sided drum, covered by a dome, rests through a system of arches. A hexagonal box of light volume covers the light volume of the gallery, covered with cylindrical arches. Adjacent to the gallery on the east side is an apse, covered with a closed vault. Octagonal bell towers have a tent covering. All structures of the building as a whole are symmetrical to the west-east longitudinal axis. The supporting frame of the building consists of ribbon brick foundations, external brick walls of the main part of the temple, apses and bell towers, internal brick pillars, vaulted ceilings.

The foundations are made of clay bricks on lime mortar with the addition of crushed brick particles. It was found that the cracks in the walls are associated with deformations of the foundations caused by the absence of a blind area around the perimeter of the building, drainage and possible flooding of the territory.

The exterior walls are made of baked clay bricks on lime mortar with the addition of crushed brick particles. The "cross" masonry system. On the outside, the walls of the building are not plastered. The basement on all facades is lined with limestone blocks. There are decorative elements made of white stone on the cornice and window sills. There are separate cracks in the walls associated with previously occurring deformations of the foundation soils. The analysis of the position of cracks indicates uneven precipitation that occurs during uneven local soaking of the soils of the bases, the structure of which may change when exposed to moisture. Mold and fungal formations are observed on the moistened areas of the exterior walls from the facades.

The ceilings above the basements, the galleries of the choirs and the apse are vaulted with various design solutions. The central drum is covered by a domed vault. The arches are made of brick made of baked clay bricks of the "red" variety on lime mortar. The bearing capacity of the arches in intact areas is sufficient to perceive the loads acting on them. There are damages and destructions in the arches of the aboveground part of the building, there are areas with the loss of individual bricks from the vault, cracks in the places where the arches of the gallery rest on the outer walls. The existing damage and destruction are associated with soaking of the joints of the walls and arches with atmospheric moisture due to the unsatisfactory condition of the roof. There are mechanical damages in the vaults of the basement, individual cracks in the vaults associated with overload during operation of the building for storing agricultural products.

When planning work on the preservation of building structures, it is necessary:

- provide for the installation of a blind area around the perimeter of the building and the vertical layout of the territory adjacent to the building to ensure the removal of surface water from the building;

- to repair and restore the damaged lining of a part of the limestone walls, cleaning the soaked areas of the masonry walls from mold and fungal formations. Cracks in the walls should be filled with solutions by injection. To make up for the loss of brick masonry walls on the cornice areas, cleaning decorative elements of white stone;

- perform restoration of damaged sections of masonry vaults, make a complete replacement of plaster vaults aboveground, repair masonry vaults basement.

The proposed measures to preserve the cultural heritage site of regional significance «Church of the Ascension of Christ the Savior» will prolong the life of a unique monument of temple architecture.

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## **Обследование несущих конструкций церкви воскресения христа спасителя (с. Старая Ольшанка)**

**С. В. Обухов**

ФГБОУ ВО «Тамбовский государственный технический университет», Тамбов, Россия  
*e-mail: tarantul1994@yandex.ru*

**Аннотация.** Представлены результаты обследования несущих конструкций храма Воскресения Христа Спасителя в селе Старая Ольшанка Тамбовской области. Установлено техническое состояние фундаментов, несущих стен, перекрытий. Даны рекомендации по сохранению несущих конструкций здания.

**Ключевые слова:** объект культурного наследия, храм, каменное зодчество.



## **Modular construction as a solution of rapid construction of rural feldsher-midwife stations**

**D. S. Peshkun\*, T. V. Starkova**

Tambov State Technical University, Tambov, Russia

\*e-mail: *dash\_1999@icloud.com*

### **Abstract**

The article is devoted to the rapid construction of feldsher-midwife stations (FMS) for rural remote and hard-to-reach territories. The main advantages and disadvantages of the modular system are formed, a comparison of modular and capital construction is provided. The main types of modular systems and a classification of modular buildings are considered. Recommendations for the composition of blocks in feldsher-midwife station are formulated.

**Keywords:** block-module, feldsher-midwife station, hard-to-reach territory, modular construction, remote territory.

Due to seasonal diseases of colds, ARI, ARVI, flu, sore throat and other diseases, the number of visits of citizens to medical institutions increases. Making an appointment with a doctor during this period is complicated. This problem is faced not only by the urban population, but also by the rural population. Many people living in remote and inaccessible territories do not even have such an opportunity as a first medical aid. Citizens must travel a long and difficult way to regional, district and city medical centers. There is a growing need for the construction of medical buildings that provide skilled care.

Currently in Russia the construction feldsher-midwife station (FMS) for remote and hard-to-reach territories is widespread. When constructing buildings of any purpose in the real estate market, the following key factors come to the forefront - reducing the construction time and reducing its cost. These parameters are met by the objects of modular construction, as the urgent problem of the current time - to provide rapid medical care in remote and hard-to-reach territories.

To get a complete picture of the advantages and disadvantages of modular construction, a comparison with capital construction was carried out. The results of the study are shown in Table 1.

Health care facility of a typical modular design can be ready for installation in the shortest preparatory period. Under various climatic and geophysical conditions for the delivery of block-modules to the construction site is used a different specialized type of transport.




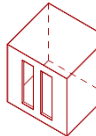
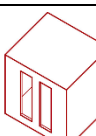
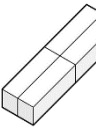
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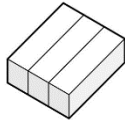
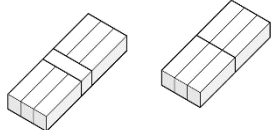
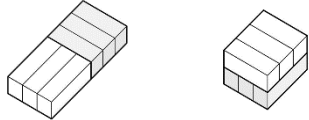
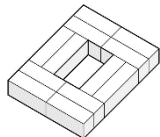
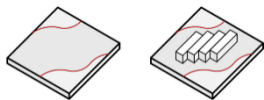
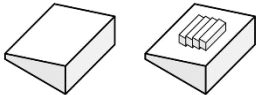
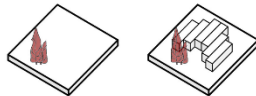
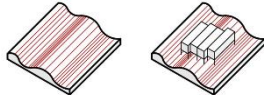
1. by block elements;
2. on the formation of volumetric and spatial solutions;
3. on the principle of adaptability to the terrain.

*Table 1. Comparison of capital and modular construction*

<b>№</b>	<b>Type of construction</b>	<b>Modular</b>	<b>Capital</b>
1	Timingofconstruction	prefabricated	longtime
2	Cost	nohigh	high
3	Weightofstructures	light	heavy
4	Foundation	notrequired	buried
5	Durability	to 50 age	to150 age
6	Mobility	multifaceted	immovable
7	Engineering communications	embedded	summarizing
8	Seasonalityofwork	unlimited	limited
9	Redevelopmentoptions	fast	long
10	Floors	low	high
11	Layout	typical	author 's

*Table 2. Classification of modular buildings*

<b>№</b>	<b>Typologicalpeculiarity</b>	<b>Graphic explanation</b>
1. Classification by block elements		
1	Individual components: - construction at the construction site; - roofing, flooring, glazing systems, etc. are delivered in a prefabricated form	
2	Panels: - 60% prefabricated; - use of non-volume modules (walls, floor, roof)	
3	Hydride: - combination of types 2 and 4; - volumetric modules without ceiling or interior walls	
4	Volumetric modules: - the three-dimensional modules are 80-90% prefabricated; - without interior and exterior finishes	
5	"Turnkey": - 90-95% prefabricated volume modules; - full equipment and interior finishing	
Options for the formation of volumetric and spatial solution		
1	Point: - displacement of modules relative to the two coordinate axes	

2	Single-row: - offset of modules relative to each other	
3	Multi-row: - use of additional modular elements	
4	Mixed: - rotation of the modules relative to each other; - placement of units with rotation in different levels	
5	Closed: - turning and combining blocks relative to each other into a closed figure	
Methods of shaping according to the principle of adaptability to place		
1	Adapting to the terrain	
2	Adaptation to relief	
3	Adaptation to vegetation	
4	Adaptation to the reservoir	

In most cases, a block-module has a form of a parallelepiped, but the construction of modules is not currently limited to the specified form, well as applied forms of trapezoids, triangles, polygons and other forms.

Thermotechnical calculation of the modules is made considering the climatic conditions of the construction area.

Feldsher-midwife stations from block-modules have a robust wall frame of sandwich panels with window and door openings, with internal engineering communications, interior and exterior decoration, furniture.

Modern modular feldsher-midwife stations may include the following units:

1. Clinical block (doctor's offices, isolation rooms for patients, vaccination rooms, rooms for examining pregnant women, delivery rooms);
2. Administrative block (staff lounge, clothes, sanitary rooms, dining room, kitchen)
3. Waiting block (waiting area and toilet).

The use of a modern block-modular system makes it possible to provide rural remote and hard-to-reach areas with medical care in the shortest possible time. The buildings feldsher-midwife station units are energy efficient and meet the requirements of sustainable development.

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## Модульное строительство как решение быстрого возведения сельских фельдшерско-акушерских пунктов

Д. С. Пешкун\*, Т. В. Старкова

ФГБОУ ВО «Тамбовский государственный технический университет», Тамбов, Россия

\*e-mail: [dash\\_1999@icloud.com](mailto:dash_1999@icloud.com)

**Аннотация.** Статья посвящена быстрому строительству фельдшерско-акушерских пунктов (ФАП) для сельских отдаленных и труднодоступных территорий. Сформированы основные преимущества и недостатки модульной системы, приведено сравнение модульного и капитального строительства. Рассмотрены основные виды модульных систем, дана классификация модульных зданий. Сформулированы рекомендации по составу блоков в фельдшерско-акушерском пункте.

**Ключевые слова:** блок-модуль, модульное строительство, отдаленная территория, труднодоступная территория, фельдшерско-акушерский пункт.

## Vision Impairment in Children, its Influence on Perception and Study of the Surrounding Space

**E. R. Popova**

Tambov State Technical University, Tambov, Russia

\*e-mail: *ekaterinapopova125@gmail.com*

### Abstract

The purpose of this study is to analyze the impact of children's visual impairment on their perception of the surrounding space. Modern means of designing an inclusive space for children with visual impairments and their integration into modern society are considered. The study considers the problem of forming a healthy space for children with visual impairments. Aspects of the design of special means in order to achieve the result of vision correction in children by architectural methods are investigated.

**Keywords:** blindness; inclusive environment; spectra of perception of space; visually impaired.

According to the 2019 World Health Organization, there are more than 2.2 billion cases of visual impairment or total blindness worldwide. This represents about 28.5% of the world's population [2]. Millions of people around the world are visually impaired and can't fully participate in society.

Vision impairment and blindness affect 19 million children. 12 million of them are visually impaired due to refractive errors. 1.4 million children are irreversibly blind [2].

According to the Ministry of Health, about 45,000 people in Russia become visually disabled each year. More than half of them are children and teenagers at the age under 18. The number of children suffering from diseases of the eye and its appendages is more than 3 million, more than 20,000 of which are partially or completely blind [2].

Depending on the degree of visual impairment, children with visual impairment are classified into the visually impaired and the blind. Blind – is a category of persons with visual impairments who have no visual sensation at all, have light sensation or residual vision, as well as persons with a narrowed visual field with visual acuity up to 0.08. Visually impaired – are people with visual impairments who have visual acuity between 0.05 and 0.2 on the better seeing eye with correction by regular glasses.

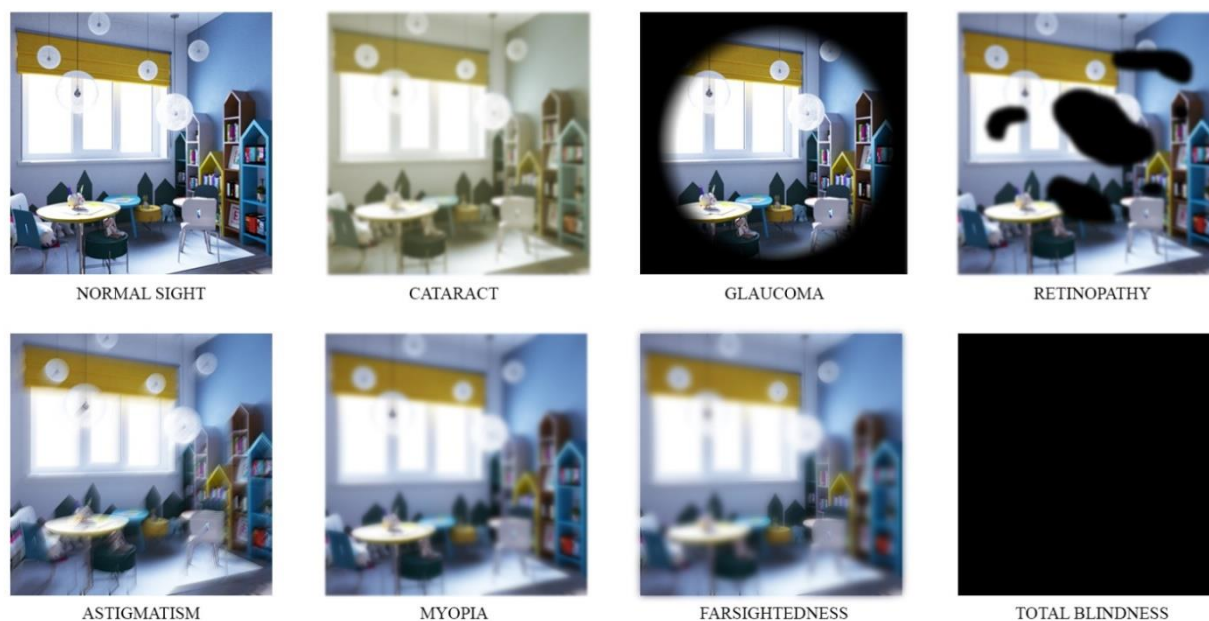
Visual impairments are mostly genetic or congenital in nature (92% of the visually impaired and 88% of the blind have a congenital disorder, with more than 30% being hereditary forms). Visual impairment may be accompanied by movement disorders, hearing, speech, intellectual disability and various somatic diseases.

Blind and visually impaired children can't fully see what is around them. But their other senses are particularly heightened: hearing, taste, touch. It is these that provide them with important information about their surroundings. Therefore, blind people are able to move independently in familiar places by acoustic and tactile landmarks. Sounds, including reflected sounds, acoustic signals of immediate surroundings, and

speech allow the blind to understand what is going on around them.

Through touch, visually impaired children can detect the presence of obstacles in the path of their movement in a timely manner. When walking, they can feel the characteristics of different surfaces, even when wearing shoes.

In unknown places and unaccompanied by family members, friends or acquaintances, the blind experience discomfort and limitations in independent movement due to the lack of information that can be obtained exclusively through the visual channel. The visually impaired also often have difficulty doing anything in public places. However, children with low visual acuity are able to concentrate particularly hard on what they can perceive with their eyes. Since other spectra of perception of space of such people are in most cases insufficiently sensitive.



*Figure 1 - Classification of visual perception impairment by type of eye disease*

Almost all types of visual impairment mean that contrast vision is impaired (fig. 1). Because of this, they do not notice or notice dangerous objects and obstacles too late. Visual disturbances lead to the fact that visual perception correctly reflects only some, often secondary features of objects, due to which the resulting images are distorted and are often inadequate to reality. A clear visual representation of space, in terms of contrast, illumination, color and shape, is particularly important in this context.

The potential of the architectural environment is of great importance, but its inferiority leads to the loss of certain capabilities of the child in the future. In the architectural space a variety of activities can be carried out, from perception of the environment to full-fledged intellectual work.

The complete development of blind and visually impaired children requires a multifunctional interactive environment. A sensory room can be such an environment. A sensory integration room is a specially organized educational environment where multifunctional interactive equipment is used for pedagogical purposes. This equipment allows a child to perform various practical and play activities in a familiar

space, to realize the need for safe movement and play in an adapted environment. The sensory room can become a starting point for teaching space perception to blind children.

It is also possible to consider techniques aimed at creating different sound sensations, and as a consequence - additional landmarks for the blind. The sound atmosphere is a characteristic that conveys information about the geometrical parameters of space. For blind people this characteristic can act as an indicator of the size and shape of space.

It is also possible to use a system of sound markers, characterized by the playback of sound signals in places that pose a danger to children with mild forms of visual impairment. Use of sound beacons in the system of orientation of the direction of movement.

Visually impaired children have poor color vision. The child's visual perception is impaired due to the lack of a reference of the presented object, absence of "past experience". They do not perceive white objects well. The colors most favorable for the retina are orange, blue, green and brown. Excessive red color can cause eye muscle tension and irritation. When showing color images, bright, saturated, contrasting, natural colors should be used.

For them it is necessary to provide the direction of individual sections of the wall, downhill and uphill, the boundaries of the staircase, as well as to apply different floor covering in different functional areas. Highlighting the doorway with methods of color and light will also ensure the comfort of using the room. For visually impaired children it is necessary to create a special lighting regime, which is characterized by an increase in natural illumination coefficient (CEO) or organization of artificial lighting of working surfaces in the rooms [1].

To do visual work at close distance, the plane of the work surface should be vertical or horizontal, depending on the type of disease. With myopia, glaucoma – is vertical, with hyperopia – is horizontal.

Children with high amblyopia find it difficult to perceive objects with a shiny surface and a fuzzy outline in space. In this case, it is possible to decorate the edges of walls and objects (outline) with contrasting colors.

Children with visual impairments usually attend specialized educational institutions. However, it is the involvement of such children in the educational process on an equal basis with others and the creation of a full inclusive environment of educational institutions that contributes to the most effective socialization and development of creative, intellectual opportunities for all children.

It is an inclusive environment that takes into account the needs of every group of people, regardless of the features of physical or mental health. The main thing is to make people feel needed and understood, with full access to various opportunities and resources. In other words, all users of the inclusive environment should be equal.

The methods discussed in the article can be successfully applied in practice. However, for the formation of scientific knowledge about the principles of designing an inclusive environment in the general complex of the problem of taking into account

the needs of people with visual impairments requires generalization and systematization of scientific and design experience, modern organization of space, the use of experimental design solutions, development of a certain methodology aimed at predicting the development of comfortable architecture for children in the aggressive environment of the modern city.

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## **Нарушение зрения у детей, и его влияние на восприятие и изучение окружающего пространства**

**Е. Р. Попова**

ФГБОУ ВО «Тамбовский государственный технический университет», Тамбов, Россия  
*e-mail: ekaterinapopova125@gmail.com*

**Аннотация.** Целью данного исследования является анализ влияния нарушения зрения у детей на их восприятие окружающего пространства. Рассматриваются современные средства проектирования инклюзивного пространства для детей с нарушениями зрения и их интеграции в современное общество. В исследовании рассмотрена проблема формирования здорового пространства для детей с нарушениями зрения. Исследованы аспекты проектирования специальных средств, с целью достижения результата коррекции зрения у детей архитектурными способами.

**Ключевые слова:** инклюзивная среда; слабовидение; слепота; спектры восприятия пространства.



## Trends in the Formation of Complexes of Extreme Sports in Russia

Yu. V. Pylskiy

Tambov State Technical University, Tambov, Russia

*e-mail: pylskyuv@gmail.com*

### Abstract

The article is devoted to the study of the emergence and evolution, the problems of designing and forming architectural complexes of extreme sports in Russia. As a result of studying this topic, the main stages in the formation of architectural complexes of extreme sports were determined. The article provides examples of these structures.

**Keywords:** extreme sports, formation trends, multifunctionality.

The relevance of the topic of the article is due to the popularity of such a direction of sports activities as extreme sports, as well as the need to organize a structure for young people to engage in extreme sports.

Some sports that have been promoted in the world since the 1950s have gradually come to be called extreme.

Extreme sports are a relatively new, but promising and rapidly developing industry associated with a high degree of risk. The number of popular extreme sports is growing rapidly. If 30 years ago there were less than a dozen of them, then in our time there are over 45 varieties of extreme sports. The most popular extreme sports are parkour, freerunning, skateboarding, street lagging, building, acrostreet, freestyle, snowboarding, extreme rollers, cycling - BMX, motofreestyle, bungee jumping, rope jumping, diving, surfing, rafting, rock climbing, mountaineering.

It is worth noting that some extreme sports (skateboarding, cycling - BMX, rock climbing) are included in the program of the Olympic Games and over time this direction is only gaining momentum.

In the 1990s, extreme sportsmen did not have any infrastructure, they had to ride where the surface was the smoothest, that is, on large areas near monuments [4].

As noted in [1], it is theoretically substantiated and empirically confirmed that the controlled development of extreme sports through the filling of the spatial and subject component of the extreme sports environment (creation of specialized infrastructure) contributes to the development of sports subcultures of extreme orientation, which in turn contributes to socialization and adaptation of young people to modern conditions of life, self-realization and self-actualization in the formation of the personality of an extreme sportsman.

Over time, the first open and closed skate parks began to appear in Russia.

The first indoor skate park "Adrenaline" was opened in Moscow in 2002 (Fig. 1). The area of the skate park is 7000 square meters. 1100 square meters are allotted under the rollerdrome. These are areas for fitness, slalom, hockey and figure skating. The most important part of the park is the Snickers Extreme Zone. This is an extreme zone

with ramps, fan boxes, rails, banks, jumps. The extreme zone covers an area of more than 2000 square meters and created by specialists from the European company IOU-Ramps.



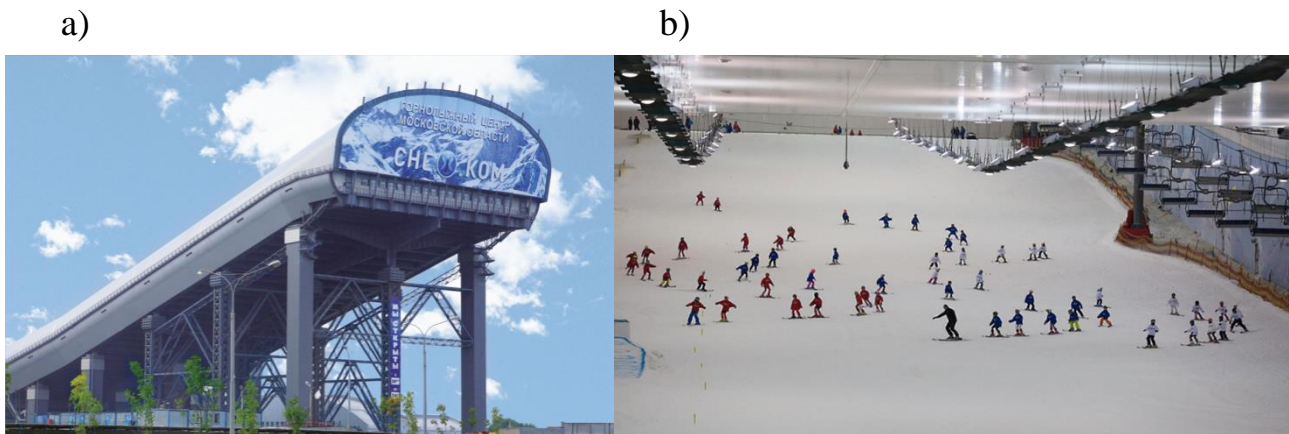
*Figure 1 - Skate park "Adrenaline", Moscow: a) extreme zone; b) ramp - an element of the extreme zone*

Thus, gradually, indoor areas for extreme sports began to appear in existing sports complexes, which provided favorable and safe conditions for extreme sportsmen.

Later, skate parks began to appear in other Russian cities. The Center for Modern Youth Sports "Zhest" in St. Petersburg, opened in 2009, became the first sports complex fully equipped for extreme sports. The center includes a climbing wall, BMX, a gym, aggressive rollers. Also in 2009, the Sportex skate park was opened in Krasnoyarsk, which today is one of the largest extreme sports centers in Russia. It houses a gym and a skate park.

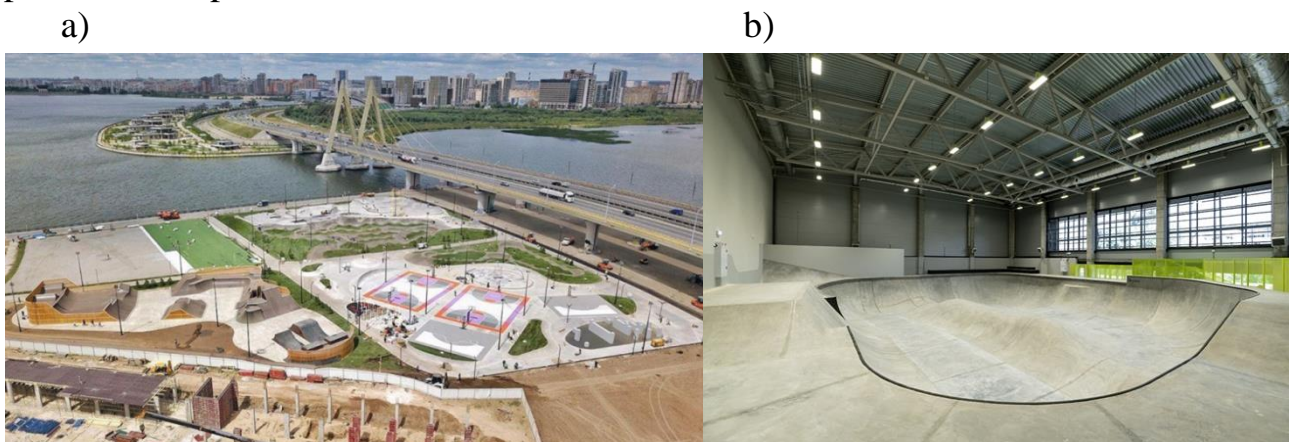
Sekeyev R.Y. says that it is fair that the emergence of new sports introduces new conditions and encourages the formation of an updated model of sports facilities with functionality, mobility, with increased amenities of buildings, interiors and the external environment [3]. A noticeable modern trend in design is the formation of new types of sports facilities, such as centers for extreme sports (all-season indoor ski slopes, skateboarding parks, roller arenas, cycling facilities, etc.).

Two examples can be cited to support these words. The first is the "Snezhkom" All-Union Ski Complex in Krasnogorsk, built in 2008. According to the technical description, the finished ski slope is a structural system of metal structures (bearing frames, trusses, connections) in the form of a pipe, which rests on lattice metal supports enclosed in a concrete "case" 15 m high from the ground level. The extreme 60-meter supports are made in monolithic reinforced concrete. Inside them are monolithic evacuation stairs. There are window openings in the walls of the supports, at the bottom there is an exit to the earth's surface (Fig. 2). Inside the structure there is a ski slope with a variable slope with a clear width of 60 m and a height of 12 m. The slope is equipped with chairlifts, ski lifts and belt lifts. The variable slope of the track allows skiers of various qualifications to ski (up to 600 skiers and snowboarders can ride on the slope at the same time) [2].



*Figure 2 - All-Union ski complex “Snezhkom” Krasnogorsk: a) outside view; b) interior space*

The second example is the all-season extreme park URAM built in Kazan in 2020 (Fig. 3). This is the largest park in Russia and Europe. The park consists of two parts - covered and open. In an open area of 20000 square meters you can practice skateboarding, BMX Freestyle, parkour, workout and streetball. The concept of the covered extreme park was developed by a consortium between Legato Sports Architecture and KOSMOS. The park is a unique sports and cultural space where you can relax all year round, develop in creativity and engage in both amateur and professional sports.



*Figure 3 - All-season extreme park URAM Kazan: a) open part of the park; b) one of the extreme zones of the covered part of the park*

The following main stages in the development of architectural complexes of extreme sports can be distinguished:

Stage I - the 90s, when extreme sportsmen did not have any infrastructure for extreme sports;

Stage II - the emergence of specialized facilities for extreme sports in existing sports complexes;

Stage III - the emergence of individual architectural complexes of extreme sports.

From the above, the following conclusions can be drawn:

- despite the fact that extreme sports became popular in Russia in the 80-90s, the first separate complex for extreme sports appeared only in 2009;
- every year new types of extreme sports appear, existing extreme sports also do not stand still and are constantly being improved;
- the emergence of new sports gives rise to the development of modern architectural complexes of extreme sports, which require new space.

The emergence of new architectural objects in the city system, such as complexes of extreme sports, contributes to the physical development of young people. As time passes, new types of sports appear and old ones disappear, thus, new sports facilities are formed. All these structures are regularly improved, new space-planning solutions are formed.

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## **Тенденции формирования комплексов экстремальных видов спорта в России**

**Ю. В. Пыльский**

ФГБОУ ВО «Тамбовский государственный технический университет», Тамбов, Россия  
*e-mail: pylskyuv@gmail.com*

**Аннотация.** Статья посвящена изучению возникновения и эволюции, проблемам проектирования и формирования архитектурных комплексов экстремальных видов спорта в России. В результате изучения данной темы определены основные этапы формирования архитектурных комплексов экстремальных видов спорта. В статье приведены примеры данных структур.

**Ключевые слова:** многофункциональность, тенденции формирования, экстремальные виды спорта.

## Modern Trends in the Formation of Exhibition Complexes

**M. A. Ryazanov**

Tambov State Technical University, Tambov, Russia  
*e-mail: maks-r00@mail.ru*

### **Abstract**

The article is devoted to the study of trends in the organization of exhibition expositions at the present stage of development of the architectural space of exhibition complexes, cultural and leisure and research centers. The relevance of this topic is due to the changing needs of society in the consumption of visual information. Over time, the type of perception of information changes, so it is important to understand the development of visual information.

**Keywords:** design exhibition, exhibition, exposition, museum, pavilion, space

The relevance of this topic is due to the changing needs of society in the consumption of visual information. Over time, the type of perception of information changes, so it is important to understand the development of visual information.

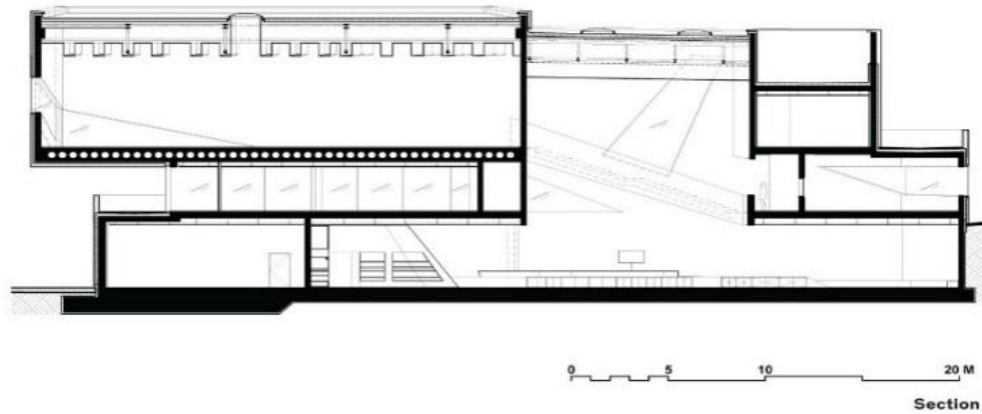
This period of time is characterized by an unlimited flow of information, and the growing rate of its consumption dictates a trend in the formation of a visual-verbal series. The rapid development of modern design technologies is the reason for changing the principles of building exhibition displays. The formation of an exposition that reflects the "exhibition scenario" implies theatricalization of space and plot action [1].

There is a gradual increase in the artistic expressiveness of the exposition space in the process of abandoning the classical canons of the formation of exhibitions. In general, this leads to an increase in information content and dynamics of perception. There is a development of stylistics and spatial methods of organizing an exhibition exposition, meeting the requirements of the times. Formation and subject content are guided by the main trends and criteria of society's needs in the ability to perceive the growing information flow [2].

Responding to all modern trends is the Research and Visitor Center Paläon, built in 2013 in Schöningen, Germany. Holzer Kobler Architekturen [3, 4] was involved in interior design and exposition design. The Paläon space scenario is an interactive journey from learning about the life of an ancient person to participating in the work of scientists. The spatial core is a hall with an area of 600 m<sup>2</sup>, three floors high (Fig. 1).

The center of the exposition was the seven "Schöningen copies" exhibited in a separate room, along with a 30-meter painting with fantasies on the theme of the world of the Heidelberg Man. Since this exposition positions itself as an archaeological exhibition, bones of ancient animals and images of flora and fauna of the era between the two ice ages, to which the finds belong, are appropriate continuations (Fig. 2).



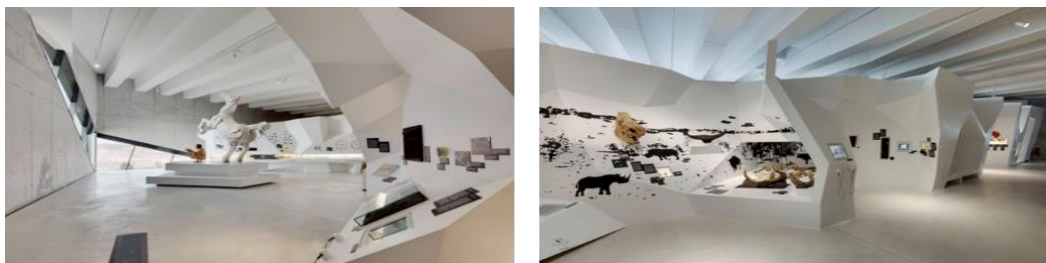


*Figure 1 - Paläon Research and Visitor Centre, 2013. Holzer KoblerArchitekturen*



*Figure 2 - Images of flora and fauna. Paläon Research and Visitor Centre, 2013. HolzerKoblerArchitekturen*

This space reflects all modern trends in the development of information consumption - it is interactive, multifunctional, and concise. The scenario of such development of the exposition makes it possible for an independent study of the architectural space. From each point of the room, a perspective opens up on the surrounding information resources, enriching the information field (Fig. 3)



*Figure 3 - Exhibition space. Paläon Research and Visitor Centre, 2013. HolzerKoblerArchitekturen*

The second example is whose memorable image, corresponding to the scenario of the exhibition, is decisive in the formation of modern expositions.

The project uses a high level of technology used in the organization of new

exhibitions.

For example, on June 4, 2009, Autostadt in Wolfsburg organized the new Level Green exhibition space. The exhibition, located on the first floor of the Volkswagen Group Forum in Autostadt, covers an area of approximately 1,000 m<sup>2</sup> and offers 25 exhibits. Level Green is a futuristic installation where the interior is based on bright green surfaces. There are displays on the walls with the help of which visitors can study information about Volkswagen and its environmental protection policy. The "green thread" of the exhibition, in the literal and figurative sense, is a sustainable way of preserving the environment. The space is designed in such a way that information screens and other elements of the exhibition are part of the design and means of dividing the space. The image of "environmental balance and sustainability" Achieved through the contrast of colors, through the compositional structure and the free formation of the exhibition space (Fig. 4).



*Figure 4 - Exhibition exposition space Level Green, 2009*

This technique, as the use of interactive components in the exposition, is actively used by modern expositions. These are, first of all, natural science museums. As, for example, exhibitions and museums of natural history, archeology, local history, ethnography, such as Natural History in London, American Museum of Natural History in New York, Leiden Anthropology Museum in Madrid. The techniques they use are not similar to each other - these are various thematic electronic kiosks that explain individual parts of the subject exposition, and information and exposition environments in which it is possible to plunge into the virtual world, Created with the utmost precision in the architectural space, electronic paintings and dioramas. At the same time, the exhibitions use both conventional presentation tools (monitors, touch and projection screens, plasma panels, including multi-screen ones), as well as specially made and built-in modules that combine mechanical and electronic elements.

After analyzing information above, we can formulate the following conclusions:

- the current stage of development of the exhibition sector is characterized by an increase in the number of various thematic expositions, as well as an actively ongoing process of reconstruction of existing exhibitions and museums.

- a significant difference between this process and the standard museum re-exposition is the complete rethinking of streaming information in search of interesting expositions.

- a special feature is the search for interesting interpretations and performances for the public, as well as modern methods of interaction with visitors.

Thus, the distinguishing feature is the spatial dynamics. It expresses not only a wide range of modern technologies, but also in the variety of author's decisions on the theme of the exposition. The information environment is organized with the help of functional zoning, using different surface colors. That provides the most comfortable environment for visitors.

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## Современные тенденции формирования выставочных комплексов

М. А Рязанов

ФГБОУ ВО «Тамбовский государственный технический университет», Тамбов, Россия  
*e-mail: maks-r00@mail.ru*

**Аннотация.** Статья посвящена изучению тенденции в организации выставочных экспозиций на современном этапе развития архитектурного пространства выставочных комплексов, культурно-досуговых и научно-исследовательских центров. Актуальность данной темы обусловлена изменением потребностей общества в потреблении визуальной информации. С течением времени тип восприятия информации меняется, поэтому важно понимать ход развития визуальной информации.

**Ключевые слова:** экспозиция, выставка, выставочный павильон, выставочное пространство, музей, оформление экспозиции



## Analysis of Co-Living as a New Typology of Housing

**S. S. Semko**

Tambov State Technical University, Tambov, Russia

*\*e-mail: semko.sofia@mail.ru*

### **Abstract**

The article deals with issues related to the history of the emergence of the ideas of collective living and the analysis of the formation of a new typology of housing - coliving. In modern large cities, serious urban changes are taking place, which lead to a change in the role of public spaces. They are connected with the popular idea of the "sharing economy" among the age group under 35. One of the manifestations of this concept is the combination of public and private zones on the same territory. Modern young people value not the possession of things and technologies, but the use of them. Therefore, coworking and coliving represent the optimal ratio between an office, housing and a place to relax. Currently, there is a need to create a new type of housing, combined with spaces for work and recreation.

**Keywords:** coliving, collective living, communes.

The idea of socialization, or, in other words, collective management of the economy and life, appeared in the 19th century. Thus, the French socialist Charles Fourier created the concept of phalansteres - a new format of housing where people could pool their resources, work together and get rid of household chores or reduce them to a minimum.

The building consisted of a central part and two wings. One of them housed noisy studios, workshops and kindergartens. The second was intended for living quarters. Common dining rooms, halls, salons, shops were also supposed. Residents could completely arrange their life without leaving the phalanstery. It is noteworthy that the guests had to pay for the opportunity to meet their fellow Communards. But the inhabitants themselves received a high salary for those times and even a pension.

The idea of liberating a person from everyday life quickly took root in Soviet Russia. The first communal houses were organized immediately after the 1917 revolution. On the similar principles, the revolutionary headquarters in the Smolny Palace was also equipped. At that time, about 600 people lived in it, they were served by 1,000 workers. There was a children's room, a library, a school and a canteen.

The new type of housing was called Council houses. At first, they were not rebuilt from scratch, but were placed in nationalized old buildings. For example, they used the National Hotel in Moscow, Astoria and European in Petrograd. Officials were settled in separate rooms, and kitchens and dining rooms worked as common ones. Accommodation and meals were free.

Similar hostels were created for people of other professions. So, in the Eliseev mansion in St. Petersburg, the House of Arts was organized. Writers and artists moved there, for example, Akhmatova, Gumilyov and Petrov-Vodkin. Meals were provided, meetings and creative evenings were organized. In a mansion on Basseinaya Street, a

similar commune was created - the House of Writers. The projects did not last long. Already in 1923 they were abolished by a special decree, and the tenants dispersed to separate apartments. However, the idea was picked up by the working youth. Communes were organized in barracks and other random buildings at plants and factories. Residents gave part of their earnings to the general budget; sometimes there were cases that it was all. In return, they received food, money for travel and tobacco.

Now the communes are dilapidated and in a deplorable state. But there are also positive examples - the Narkomfin building was restored in 2017-2020, now there is an elite residential complex there. Despite these shortcomings, the idea of communal houses is partly reflected in modern hostels, though in a mini version - they also provide separate rooms for guests, but kitchens, bathrooms and toilets are combined. Often there is a common dining room and a hall where you can eat, read, watch movies and chat with other guests.

The concept of co-living is not new, but today it is relevant and provides a new form for work and life. It is implemented in a space where young, creative people live and interact. The coliving centers have comfortable working areas and dining rooms, spaces for relaxation, meetings and conferences. The office and home are located in the same place, so it is easier and faster to share experiences and progress in a team of like-minded people without losing the opportunity to live comfortably in an individual home.

Such projects have only just begun to develop in Russia. The form of combining living and working is currently most relevant for science cities and technopolises, as this creates conditions for a comfortable life and effective scientific work that contributes to the generation of innovative ideas and their simultaneous implementation.

It is required to create space-planning elements for the formation, adaptive to changing modern conditions, of working areas, residential and public spaces in order to improve the quality of life, intellectual activity, ensuring the academic mobility of scientists, highly efficient work of creative people and the comfort of the living environment in these institutions.

Currently, there is no regulatory framework for the design and construction of new types of residential and public buildings, such as coliving, so modern structured approaches to the formation of public and residential spaces of a new type of housing are needed.

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### **Анализ возникновения новой типологии жилья – коливинг**

**С. С. Семко**

ФГБОУ ВО «Тамбовский государственный технический университет», Тамбов, Россия  
*e-mail: semko.sofiia@mail.ru*

**Аннотация.** В статье рассматриваются вопросы, связанные с историей возникновения идей коллективного проживания и анализом формирования новой типологии жилья - коливинга. В современных крупных городах происходят серьезные урбанистические изменения, которые ведут к изменению роли общественных пространств. Они связаны с популярной, среди возрастной группы младше 35 лет, идеей «экономики совместного пользования». Одно из проявлений этой концепции — сочетание публичной и частной зон на одной территории. Современные молодые люди ценят не обладание вещами и технологиями, а пользование ими. Поэтому коворкинги и коливинги представляют собой оптимальное соотношение между офисом, жильем и местом для отдыха. В настоящее время сформировалась потребность в создании жилья нового типа, совмещенного с пространствами для работы и отдыха.

**Ключевые слова:** коливинг, коллективное проживание, коммуны.

## **Das Konzept der Organisation und Entwicklung des Museums für Volksarchitektur und Alltagsleben im Dorf Moiseevo-Alabushka des Uvarovsky Bezirks Tambow**

**A. A. Senitschkin**

Tambow staatliche Technische Universität, Tambow, Russland  
*e-mail: 020304@mail.com*

### **Zusammenfassung**

Der Artikel ist dem Konzept der Organisation und Entwicklung des Museums für Volksarchitektur und Alltagsleben im Dorf Moiseevo-Alabushka im Bezirk Uvarov des Gebiets Tambow gewidmet.

**Schlüsselwörter:** die Architektur der Museumskomplexe, das Volksleben, das Volksgewerbe.

Die Relevanz des Themas des Artikels beruht auf dem Vorhandensein eines einzigartigen natürlichen und historischen und kulturellen Erbes in der Region Tambow. Auf ihrem Territorium konzentrieren sich 1316 Baudenkmäler, von denen 21 den Status von Bundesdenkmälern haben. Die meisten von ihnen sind als Tourismusobjekte von Interesse.

Gleichzeitig ist das am meisten besuchte «Museum-Gutshof von S.V. Rachmaninow Iwanowka» im Bezirk Uvarovsky am meisten besucht. Jährlich nimmt das Museum etwa 10.000 Menschen auf, auf seinem Territorium finden über 2.100 Exkursionen und 15-20 Ausstellungen statt. Im Rahmen des regionalen Zielprogramms «Entwicklung des Tourismus in der Region Tambow im Dorf Iwanowka ist ein Erbauer von Mini-Hotels vorgesehen.

Der Bau des „Museums für Volksarchitektur und Alltagsleben“ im Dorf Moses-in-Alabuschka, 6 km von Iwanowka entfernt, kann ein zusätzlicher Faktor sein, um Touristen in die Region Tambow zu locken.

Die Ausstellung des Museums besteht sowohl aus erhaltenen, in dem Gebiet der Region Tambow gebauten und nachgebauten Exponaten mit der Bewahrung der Identität eines bestimmten Zeitalters zu, als auch aus erhaltenen Gebäuden und Interieurfragmenten, die aus dem Gebiet der Region Tambow stammen, und nachgebauten Exponaten. Das Ziel der Ausstellung ist nicht nur die Demonstration der Architektur und des Lebens unserer Vorfahren, sondern die Wiederbelebung der ursprünglichen Volkstraditionen, Bräuche, Rituale und Handwerke. Volkskunst mit den reichsten Traditionen kann wiederbelebt werden und einen neuen Klang erzeugen. Die Einrichtung von Handwerksmeistern mit Meisterkursen und Tauchobjekten wird auch für die Entwicklung eines neuen perspektivischen Tourismus - Land oder Ökotourismus (Aufenthalt von Touristen im ländlichen Leben) im Museum einen Schub geben. Der kulturelle und völkische Aspekt kann der Entwicklung des kognitiven Tourismus in der Region Uvarov zugrunde liegen, und die Anwesenheit von touristischen Ressourcen und eine gute Verkehrsanbindung mit der Vorstadt-Zone von Uvarovo zum Hauptgebiet des kurzfristigen Tourismus - des Wochenendmarsches

machen.

Die Lage der Region Tambow in der Nähe von industriellen dicht besiedelten Regionen und die Erhaltung von wenig veränderten Landschaften in ihrem Hoheitsgebiet schaffen die Voraussetzungen, um Touristen aus anderen Regionen des Landes anzulocken.

Das Dorf Moiseevo-Alabushka entstand Anfang des 19. Jahrhunderts. Der erste Teil des Dorfnamens zeigt an, woher die Siedler stammen — aus dem Dorf Moise-evo. Der zweite Teil des Namens weist auf den Fluss Alabushka hin, an dessen Ufer sich ein neues Dorf niedergelassen hat. Innerhalb der Grenzen des heutigen Moses-Alabushki gibt es sieben Teiche, die alle entlang des Kanals und entlang der Nebenflüsse des Alabushki-Flusses liegen.

Das Dorf ist günstig gelegen: Es verläuft durch die regionale Ringstraße, die Straße nach Borisoglebsk, nach Muchkap und nach Tambov, sowie die Ausfahrt zur Autobahn «Moskau — Astrachan».

Die gute Verkehrsanbindung und die Nähe zum berühmten Museum «Ivanovka» ermöglichen es, dieses Dorf als einen Ort für die Entwicklung des Tourismus zu betrachten.

Der projizierte Museumskomplex der Volksarchitektur und des Alltagslebens besteht aus drei Teilen, von denen jeder in der Reihenfolge seiner Seltenheit errichtet werden kann und sowohl als Teil des Komplexes als auch unabhängig arbeiten kann.

Die erste Stufe ist das Gebäude des Museums des Volkslebens. Unter das Museum soll das Vereinsgebäude passen. Vor dem Gebäude befindet sich ein Platz für eine temporäre Außenausstellung.

Die zweite Stufe ist das Museum für Volksarchitektur, das historische Denkmäler und nachgebaute architektonische Objekte enthält.

Die Ausstellung basiert auf der Idee, in einer Siedlung zu bleiben, die die gesamte typologische Reihe ländlicher Gebäude in sich integriert.

Das Zentrum der Komposition ist die Lichtung für die Durchführung folkloristischer Feste. Die Landschaft bereichert den künstlichen Teich, an dessen Ufer eine Wassermühle aufgestellt werden soll. Rundherum befindet sich die Hauptausstellung des Museums für Volksarchitektur.

Zu Beginn der Ausstellung werden die Besucher mit den Häusern vertraut gemacht, entlang einer improvisierten Straße kann man zur Kapelle gelangen, die die Hauptposition einnimmt und die Haupteingangssachse schließt. Hinter der Kapelle befinden sich Nebengebäude, Wasser- und Windmühlen. Alle aufgeführten Bauten sind historische Denkmäler der Volksarchitektur der Region Tambow, die auf das Territorium des Museums gebracht sind. Dies können ganz oder teilweise erhaltene Objekte sein (verlorene Elemente werden mit absichtlicher Hervorhebung von «Neubau» wiederhergestellt).

Die Ausstellung schließt den Hof eines wohlhabenden Bauern ab, der nach den Beschreibungen des Forschers des Tambow-Hinterlandes des Ethnographen, Doktor der historischen Wissenschaften, Professors Paul Kushner (Mono-Graphik «Das Dorf von Virjatino in der Vergangenheit und Gegenwart» von 1958) neu erstellt wurde. Der

Bestand umfasst ein Wohnhaus, Nebengebäude, ein Bad. Alle Objekte sind für den weiteren Betrieb gebaut: im Haus ist ein funktionierender russischer Ofen, mit der Möglichkeit, darin zu kochen, Utensilien und alle Haushaltsgegenstände in der Hütte, das Inventar in den Nebengebäuden sind von modernen Handwerkern hergestellt.

Auf dem Hof arbeiten Handwerker eines der lokalen Kunsthandwerke. Die Besucher können die Grundlagen des Volkshandwerks kennenlernen, sich im Bad waschen, in der Hütte russische Gerichte probieren, die in einem Rosenofen zubereitet werden. Trotz der Tatsache, dass das errichtete Anwesen ein «Neubau» ist, ermöglicht eine solche Nachahmungsmethode, in die historische Umgebung einzutauchen und das Leben unserer Vorfahren näher kennenzulernen. Gegenstände, die geschickt nach historischen Analoga hergestellt wurden, tragen die historische Wahrheit in sich, sind jedoch im traditionellen Sinne keine Museumsausstellungen und können daher für ihren beabsichtigten Zweck verwendet werden.

Nach der Besichtigung der „Siedlung“ können sich die Besucher auf der Lichtung rund um den Wasserbrunnen ausruhen, hier sind auch Plätze zum Essen vorgesehen. Im Nebengebäude wird ein Café mit russischer Küche angeboten (vor der dritten Reihe kann ein Teil des Saals als Souvenirladen genutzt werden).

Die dritte Reihe ist die "Stadt der Meister“ und die Lichtung „russischer Spaß“.

An der Ecke (links vom Museum) befinden sich offene Verkaufreihen, direkt dahinter befindet sich ein Messegelände für den Outdoorhandel und die Durchführung von Feierlichkeiten.

Parallel zur Hauptstraße des Dorfes verläuft die «Straße der Meister» mit Handwerkerworkshops und Handwerksbänken durch das Museumsgelände. Die Straße der Meister schließt die Schmiede ab, rechts davon befinden sich offene Ambosse für die Durchführung von Meisterkursen und Wettbewerben der Schmiedekunst.

Handelsreihen, Messen, Werkstätten und Bänke – sie arbeiten ständig, was dem Museumskomplex zusätzliche Belebung verleiht und dem Dorf zusätzliche Arbeitsplätze bietet. Alle Gebäude sind im pseudorussischen Stil errichtet und unterstützen die russische Siedlungsatmosphäre, die in der zweiten Baustufe geschaffen wurde, so gut wie möglich.

Die Lichtung "Russischer Spaß" ist eine Spiel- und Unterhaltungszone für Erwachsene und Kinder.

Sie befinden sich zwischen der Siedlung und der „Stadt der Meister“ und bilden eine eigene Pufferzone zwischen historischen Denkmälern und der „Novode-Schrott“.

Auf einer Kinderlichtung ist eine Kinderstadt oder ein Kreml errichtet. Hier wird gelehrt, russische Volksspiele zu spielen: einen Basteltisch, Türkisen, einen Pfahl, einen Kessel und einen Kubar.

Das Museum für Volksarchitektur und Alltagsleben ist so konzipiert, dass die Besucher den ganzen Tag auf seinem Territorium verbringen können, um die Freizeit zu verändern. Russisch lernen wird durch einen Spaziergang ersetzt, das Kennenlernen des Handwerks kann mit Workshops kombiniert werden, das Spielen auf den Lichtungen sorgt für Abwechslung in der Freizeit, in Kiosken und auf dem Markt können Sie Souvenirs und Waren aus dem Volksmund gekauft werden, ein Café im

russischen Stil stellt die nationale Küche vor.

Derzeit ist das Gebiet Tambow, das über ausreichendes Potenzial für die Entwicklung des Tourismus verfügt, ein eher bescheidener Platz im Tourismussystem des Landes und gehört zu den Regionen mit günstigen und bisher ungenutzten Möglichkeiten.

Die Entwicklung des Tourismus in der Region Tambow wird zur Schaffung neuer Arbeitsplätze, zur Verbesserung von Siedlungen, zur Pflege der Landschaft, zur Eröffnung neuer Museen und zur Wiederbelebung des nationalen Selbstlebens der Region beitragen.

Das Museum kann sowohl für Gäste von Ivanovka als auch für Touristen, die direkt anreisen, um die Ausstellung dieses Museums kennenzulernen, zu einem Anziehungspunkt werden. Die Platzierung zweier Museumskomplexe in unmittelbarer Nähe zueinander wird die Gründung des «goldenen Rings» des dortigen Bov-Gebietes beginnen.

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### **Концепция организации и развития музея народной архитектуры и быта в селе Моисеево-Алабушка Уваровского района Тамбовской области**

**А. А. Сеничкин**

ФГБОУ ВО «Тамбовский государственный технический университет», Тамбов, Россия  
*e-mail: 020304@mail.ru*

**Аннотация.** Статья посвящена концепции организации и развития музея народной архитектуры и быта в селе Моисеево-Алабушка Уваровского района Тамбовской области.

**Ключевые слова:** архитектура музейных комплексов, народный быт, народные промыслы.

## **Analysis of the Parameters of Cultural and Entertainment Theme Parks in Russia**

**E. A. Tereshchenko\*, T. F. Elchishcheva**

Tambov State Technical University, Tambov, Russia

*\*e-mail: evangel.line2000@gmail.com*

### **Abstract**

The article examines several Russian thematic and non-thematic parks of cultural and entertainment type and compares them according to certain parameters such as territorial features of the park, the concept of the park and the filling of the park with elements. The analysis is carried out in order to identify the best model of a thematic cultural and entertainment park by highlighting the pros and cons of a particular architectural, compositional, constructive and functional solution in the parks selected for the study. Choosing the best model of the park will favorably affect its visit by a large number of people, as well as its further development. This will prevent the loss of interest among the intended target audience of the park and will subsequently remove the question of its possible closure. The study will be useful for further design of a theme park on the selected territory in Tambov.

**Keywords:** theme park, amusement park, attractions, park concept, domestic theme parks, evaluation criteria.

### **Introduction**

Modern conditions of workload among the population with work and study dictate the need to build recreation parks in which you can both relax, having been in silence alone with nature, and, if desired, get bright emotion. Such tasks are performed by theme parks that combine a variety of functionality: active and passive recreation, education, and a meeting place.

There are two actual problems related to the operation of parks: their availability and accessibility. There are quite a few such places throughout the country, in addition, they are located only in large cities. The subject of this study is included in the new list of “Priority directions for the development of fundamental scientific research in the sphere of architecture, urban planning and construction sciences” dated 06/16/2022, approved by the RAASN. The direction is “Identification of new social needs and the nature of their interrelations with architecture and urban planning”.

The goal is to determine what influences the choice of a particular model of the park in order to identify the best solution for further design. For comparison, the following amusement parks were selected: “Kudykina gora” Natural Wonder Park, Lipetsk Region (1), “Solnechnyy ostrov” Park, Krasnodar (2), “Sochi Park”, Sochi (3) and “Ostrov Mechty”, Moscow (4) theme parks, as well as an entertainment park “Divo Ostrov”, St. Petersburg (5).

The models of parks differ in individual components (parameters) identified by the authors during the study: 1 - territorial features of the park (location of the park, its location relative to the city/village, park area, type of park (indoor/outdoor), type of landscape); 2 - the concept of the park (the orientation of the park, the target audience



by age, the theme of the park); 3 - filling of the park (functional areas, the presence of attractions and their varieties, the use of small architectural forms, techniques to ensure the atmosphere of the park (decoration, lighting, musical accompaniment, etc.).

The basic orientation of the park should be taken into account. Its structure and functionality depend on it. When analyzing domestic theme parks, the classification of theme parks by the dominant direction was revealed (Fig.1). A theme park can have one or more directions (for example, an entertainment park with attractions and elements of the educational process) thereby being a mixed-type park.

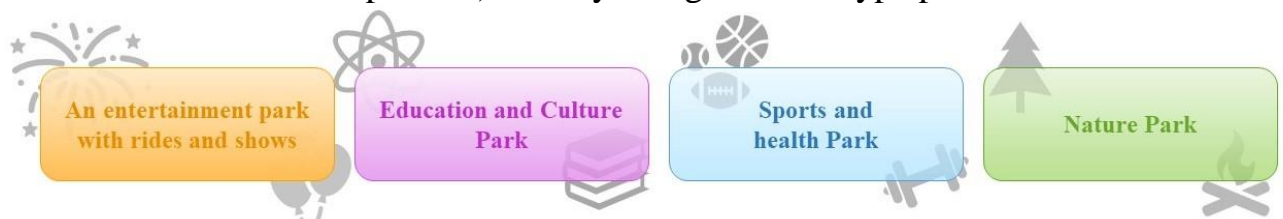


Figure 1- Basic directions of theme parks

### **Entertainment parks with rides and shows**

This type of park is focused on getting bright emotions by visitors through active recreation, using attractions or watching memorable shows and performances. The park is divided into zones: an amusement zone, a food court zone and recreation areas (optional), a technical support area for the park and staff (hidden from visitors). Most often, the attractions are divided geographically using the use of “fabulous locations”. This is achieved through the use of the “atmosphere of a fabulous location”: special lighting, decoration is used (the use of small architectural forms - sculptures of characters, decoration of facades of premises, etc.), as well as musical accompaniment (forest sounds, melodies from movies, etc.) that simulates being in a fabulous location.

This orientation is most noticeable in parks (4) and (3). “Ostrov mechty” has seven thematic zones for various works (cartoons and fairy tales) with various types of attractions and professional creation of the atmosphere of fairy-tale locations (floodlights create both night and day in a magical land; decoration is represented not only by the design of facades of rooms and sculptures, but also by the creation of different zones inside a specific location; musical the accompaniment “transfers” to the world of the fairy tale to which the location is dedicated). [1] “Sochi Park” has 8 thematic zones with different functionality. [2] The “Divo Ostrov” Park has a large number of rare attractions, but there is no theme park. [3] “Solnechnyy ostrov” has a small number of attractions, but different types. “Kudykina gora”, although it is not a park with attractions, surpasses due to the use of the general theme of the park in structures, sculptures and decor. [4]

### **Parks of education and culture**

It is focused on obtaining theoretical knowledge or skills in various forms of education: lecture-excursion (theoretical information without special fixation in memory) – is usually held for teenagers and adults interested in any topic; theoretical information in a spectacular form (unusual presentation of “boring” information through games, the use of scenery and light, theatrical performances, a movie, a

hologram, etc.) – is used for all ages; information in the form of interesting practical exercises (immersive performance, experiments in the laboratory, art and music lessons, craft classes (blacksmithing, soap making, clay modeling)) – suitable for all ages. The park is also no longer divided into functional zones, but into thematic and interest zones: a crafts zone, an indoor pavilion for scientific exhibitions or experiments, cinemas, lecture halls and reading rooms, stages and performance areas.

This orientation is clearly visible in the “Sochi Park”. The park has an entire area dedicated to science and fiction. There are: “Atomarium” – an exhibition pavilion explaining physical laws, “Gallery of Illusions” – the territory of projection attractions with augmented reality effects (develop dexterity, coordination, fine motor skills), as well as “House of Honey”, where creative workshops for children and adults are held. [2] The territory of the “Solnechnyy ostrov” has a planetarium, and the “Kudykina gora” is the “City of Masters”, where craft workshops are held. [4] Other parks do not have elements of this orientation.

### **Sports and health parks**

It is an open park, most often either of the dominant direction (with all the elements mentioned below and usually does not have a thematic character) or with some elements of the direction in theme parks. It is characterized by active recreation in the fresh air or in special pavilions (infrequently). A variety of games (competitions, contests, relay races) can take place. The park can include: fitness grounds (for yoga, Pilates, zumba), team sports grounds (basketball, football, tennis, ping pong, volleyball), playgrounds with exercise equipment, intellectual playgrounds (chess, go, checkers, dominoes), green areas (quiet park areas, where you can relax), tracks (bike and treadmills), a skatepark, as well as an inventory rental area and shops/cafes.

When analyzing five amusement parks, this trend was well observed in the “Solnechnyy ostrov” park. Birch and pine groves bring a favorable microclimate for residents to play sports. The park has bike paths, 4 fields for beach volleyball, and the beach itself is suitable for lovers of water procedures. The park has a basketball court, a gym complex and an ice rink. The Natural Park of Wonders “Kudykina gora” and “Sochi Park” had only some elements of this profile. In the first case – a sports ground, an ice rink and “winter fun”. [4] In the second case, there is the pavilion “Medvediya”, which includes a trampoline center, a game obstacle course and playgrounds, but only for the youngest. [2] “Divo Ostrov” and “Ostrov mechty” do not have such a focus.

### **Nature parks**

Its key features: outdoor recreation away from the city in an almost untouched part of nature; active recreation associated with the rejection of the latest non-environmentally friendly benefits of humanity. An alternative to this is nature (transport – walking, horseback riding or using bicycles; instead of hotels – campsites with tents or houses; cooking on fire; contact zoos, farms, safari park; vegetable gardens and gardens). The use of cable cars can be also specified.

Among the theme parks studied, this profile is observed as dominant in the park “Kudykina gora” and the park “Solnechnyy ostrov”. The Natural Park of Wonders “Kudykina gora” contains a “Safari Edge” – a large area inside which various animals

(domestic and exotic) live. The entire territory of the park (500 hectares) is explored on foot. There is a natural relief of the landscape – hilly, sometimes flat terrain with a decrease to the riverbed. Visitors can try riding, and also swim on the beach by the pond. [4]

The “Solnechnyy ostrov” also has a Safari Park, a zoo with rare animal species. Visitors have the opportunity to walk in a birch grove, feed ducks by the river, swim on the beach and even ride a horse. There is also a boat rental. At “Sochi Park”, this focus is not of primary importance: here you can see a Sovarium, watch a dolphin performance in a Dolphinarium, as well as feed rabbits, goats and huskies. [2] The parks “Ostrov mechty” and “Divo ostrov” do not have such a focus.

### **Conclusion**

The “Solnechnyy ostrov” turned out to be the most functionally diverse, and “Divo ostrov” was the least functional. Research has led to the conclusion that the main determining parameter in the design of a theme park is the age group for which this park is created. The second criterion, which will subsequently determine the functional zones and their occupancy by elements, is the planned orientation of the park.

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## **Анализ параметров культурно-развлекательных тематических парков в России**

**Е. А. Терещенко\*, Т.Ф. Ельчищева**

ФГБОУ ВО «Тамбовский государственный технический университет», Тамбов, Россия

*\*e-mail: [evangel.line2000@gmail.com](mailto:evangel.line2000@gmail.com)*

**Аннотация.** В статье рассмотрены основные российские тематические и нетематические парки культурно-развлекательного типа, которые сравниваются между собой по заранее выделенным авторами статьи параметрам, таким как: территориальные особенности парка, концепция парка и наполнение парка элементами. Анализ проводится с целью выявления лучшей модели тематического культурно-развлекательного парка посредством выделения плюсов и минусов того или иного архитектурно-композиционного, конструктивного и функционального решения в выбранных для исследования парках. Выбор лучшей модели парка благоприятно скажется на его посещении большим количеством людей, а также его дальнейшем развитии. Это предотвратит потерю интереса у предполагаемой целевой аудитории парка, и снимет впоследствии вопрос о его возможном закрытии. Исследование будет полезно для дальнейшего проектирования тематического парка на выбранной территории в г. Тамбове.

**Ключевые слова:** тематический парк, парк развлечений, аттракционы, концепция парка, отечественные тематические парки, критерии оценки.

## Proportions of the Historical Development of Tambov

**N. S. Tolmacheva\*, E. P. Filimonova**

Tambov State Technical University, Tambov, Russia

*e-mail: natashatolmacheva1903@yandex.ru*

### Abstract

The topic of this article is the study of the proportions of the historical buildings of Tambov, namely the central part of the city, which developed during the late XIX - early XX centuries. The article considers the ways of building formation, in addition, the types of buildings formed in different time intervals, namely the features of the proportions, spatial composition and the appearance of buildings. The analysis of stylistic directions, and also the factors influencing parameters of proportions of buildings and on features of design of architectural details are carried out.

**Keywords:** building types, cultural heritage, golden ratio, historic buildings, proportions, scale.

### Introduction

The formation of the historic buildings of Tambov was in 1781. The basis of the plan was a grid of straight streets, which formed regular quarters. The integrity of the architectural and urban appearance of Tambov was achieved through the uniform proportions and scale of buildings, which were commensurate with the size of blocks and streets.

However, in the 1930s, due to the change in the values of society, the principles of building and development of the city, proposed by Derzhavin, were violated. Thus the demolition of churches began, which played the role of the main urban planning landmarks of the city. Over time, this process accelerated, having received distinctive features: the destruction of the structure of neighborhoods and red lines of the streets; the development of the historic center of Tambov, spot building with faceless high-rise buildings, distorting its historic silhouette.

The historic center of Tambov is characterized by a combination of buildings from different historical periods as well as modern constructions and urban design elements. In addition, the historic center abounds with objects of cultural heritage, which is reflected in the map of protection zones of cultural heritage of Tambov.

### Analysis of the proportions of the historic buildings of Tambov

Since the time of "model" construction, a unified system of proportions of residential buildings was formed. According to this system, the roof was designed to be no more than a quarter of the width of the building, while the required indentation of the window from the roof was not more than 14 arshins. The proportions of the windows themselves were developed in accordance with the ratio of 2:1/2 to 1:1/4 arshins, and their number was determined depending on the placement of the window in the center of the facade.

Public buildings, such as public institutions, educational institutions, commercial banks, also had their general patterns. The most common way of their erection was on

the basis of regular schemes, because symmetry was "synonymous" to order, determining the logical completion of the function, concretization of its understanding. At the same time the other types of public buildings, such as private clubs, theaters, shopping and other revenue institutions, were characterized by a variety of methods of decorating the facades and designing a universal interior space.

A detailed analysis of residential and public buildings of the late 19th - early 20th centuries, divided by type, highlighting the features of the proportions, spatial composition and appearance of the building.

We consider the above features by building type:

- residential mansion: a narrow facade with access to the street, developed layout of the building, mainly in the depth of the land plot. These features of space organization remained in residential buildings for a long time, which allowed distinguishing enfilade and enfilade-corridor planning schemes. To decorate the facades, the front entrances of the houses were decorated with decorative elements such as risalits, pilasters or developed portals. The architectural appearance of the houses was with dynamic cornices and high parapets. The house of the Zamyatin brothers and the mansion of the Efanovs in Tambov can be cited as an example;

- manor complexes, early twentieth century, were based on the principles of palace construction, all the buildings were united by the space of a picturesque park with elements of landscaping. Also, it was assumed the presence of additional buildings different in their functions. All buildings are distinguished by stylistic and compositional unity, an abundance of decorative elements. Examples: Monyakovs' manor on Nosovskaya Street; V. Anosov's manor on Bolshaya Street; the house of the Aseevs factory owners in Tambov;

- apartment building - these were block houses with symmetrical, mirrored space, consisting of the same apartments. At the same time, full engineering support determined the repetitiveness of floor plans. The architecture of the building's facades did not reflect the specifics of the apartment building. I. Pozdnykin's mansion (an example of housing "for two families"); an apartment building for employees of the Kazan Monastery;

- income residences with a corridor scheme and g-shaped volume, the development of the building is similar to the configuration of the site. The accent of the building was its corner part, which was often executed in the form of a bay window with a domed ending and a spire. The abundance of decorations was explained by the idea of constructing a building reflecting the high level of the establishment, such as the hotel of the Nikolsky brothers;

- apartment houses (commercial functions), early twentieth century. Apartment houses in architecture repeat the form of the hotel, but in plan it is an asymmetrical composition. These houses were often located at the intersection of streets, and a bay window was designed on the entrance area as the main element of the facade decoration. Examples: commercial house of M. Shorshorov; profitable house of K. Nikonov; pharmacy of Lana; commercial house of A.A. Andreev;

- a complex income house (commercial, entertainment and residential functions).

Later on the basis of the two previous types of buildings, a complex apartment building was formed. The bay window, as a decorative detail (as well as turret, rotunda), becomes not only the central part indicating the main entrance, but also shows the multipurpose nature of the revenue building. This center of the composition in the corner part of the building allowed for the further development of the form in the allocated area while maintaining the unified composition. The exterior appearance of the building stood out through the use of decoration, namely the risalite, pilasters, parapets, etc. (building of the Railwaymen's Club of Tambov);

- public buildings (private clubs, theaters) were characterized by large volumes and versatility of the projected composition of the interior space for possible redevelopment. A distinctive feature - the allocation of the fundamental premises with decorative elements (auditorium, the entrance group), as in the electric theater "Modern" by A.M. Lapitskaya; theater "Mirror of Life" by F.N. Pikulin, the club of the society of reasonable entertainments;

- public buildings (government buildings) were state institutions, so their planning solution was based on symmetry, the architectural appearance was also designed based on regular schemes. The method of construction of architectural form: from the organization of interior space to the volumetric solution of the building. Examples: Land Bank, the building of the Provincial Office, Tolmachevo College.

This analysis showed the presence of common design techniques for the represented types of buildings, which contributed to the preservation of the integrity of urban development. At the same time, it should be noted that there was a stylistic development of architecture in Tambov, with the predominant direction was eclectic. Decorative elements of the Renaissance period (the Naryshkin Reading Room building, F. Pikulin's lodging house), Gothic (children's hospital building), Baroque (United Bank building), traditional Russian heritage (lodging house on the corner of Dvoryanskaya and Khristorozhdestvenskaya streets) and other stylistic trends were also used in decorating the facades of buildings.

When analyzing the proportions of the buildings, the fundamental factors were:

1. Identifying the relationship of the parts and each part to the whole (application of the golden ratio).
2. Developing certain proportional relationships in both the horizontal and vertical planes in accordance with the proportions of the human body.
3. Determining the scale of the building in relation to the environment and the human being.

According to the results of the analysis of the development, namely the above types of residential and public buildings in Tambov, the dependence of the individual image of buildings (proportions, decorative design) on the belonging of the building to a particular type was revealed. Thus, the most unique are the following types of buildings: manor complexes, a residential building, public buildings (private clubs and theaters), a small individuality of the image of buildings is observed in public buildings, hotels and profitable houses.

## Conclusion

Thus, in Tambov we can distinguish the historical part of the city and its boundaries by the concentration of objects of cultural heritage. This part of the city has common features of building design, namely similar characteristics of the proportions of the whole volume of the building and its individual elements. The above features allow to organize a harmonious and unified urban development in the central part of the city of Tambov, despite the many stylistic trends.

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## Пропорции исторической застройки г. Тамбова

Н. С. Толмачева\*, Е. П. Филимонова

ФГБОУ ВО «Тамбовский государственный технический университет», Тамбов, Россия  
*e-mail: natashatolmacheva1903@yandex.ru*

**Аннотация.** Тема данной статьи – изучение сложившихся на протяжении конца XIX – начала XX вв. пропорций исторической застройки г. Тамбова, а именно центральной части города. В статье рассмотрены способы формирования застройки, кроме того, выделены типы зданий, сформировавшихся в разные временные промежутки, а именно особенности пропорций, пространственной композиции и внешнего облика зданий. Проведен анализ стилистических направлений, а также определены факторы, влияющие на параметры пропорций зданий и на особенности проектирования архитектурных деталей.

**Ключевые слова:** золотое сечение, историческая застройка, масштаб, объекты культурного наследия, пропорции, типы зданий.

## Historical Transformation of Tenement Houses: The Modern Use

**A. V. Voyakina, Y. A. Danshova\***

Tambov State Technical University, Tambov, Russia

\*e-mail: yana.povarnicyna@mail.ru, e-mail: anastasiya.voyakina@yandex.ru

### Abstract

The topic of this article is the historical transformation of tenement houses and their modern use. The premises in tenement houses are provided for temporary use under the lease agreement. The article considers the stages of development and formation of volumetric-spatial solution of tenement houses up to the present time. The analysis of the functional purpose of tenement houses was carried out, the types of such houses were singled out, and the comparison of tenement houses as historical prototypes with modern residential buildings was carried out.

**Keywords:** communal apartments, historic buildings, mixed-use residential complexes, rentals, residential buildings, tenement houses.

### Introduction

The historical development of tenement houses began in the middle of the 19th century and corresponded to a variety of social needs and economic opportunities of the society of that period. Tenement houses influenced the formation of the concept of modern cities, becoming the first multi-family houses of a new type. They are a complex of apartments of the same type, centered around staircases in several entrances. Today the former tenement houses, many of which have been preserved or restored to their original appearance, remain masterpieces of pre-revolutionary architecture.

### **Analysis of the stages of development and formation of the volumetric-spatial solution of tenement houses up to the present time**

The first tenement houses, insulae, were built in the third century B.C. in Rome. As a rule, insulae had from four to seven stories. The insulae made up a large part of the mass building of ancient Roman cities. Unlike modern multi-storey buildings, the first floors in insulae were the most expensive. Further development of multistory construction was in Europe in the 18th century. The development of industry required more and more labor and, as a consequence, cheap housing to accommodate workers, so private entrepreneurs began to build buildings for 6-20 apartments.

In Russia, the first tenement houses appeared in Moscow in the 1780s. Housing of small and medium merchants was located in the upper floors, and shops and small stores - in the first floors. In the middle of the 19th century, the tenement house «for tenants» began to acquire its own specific features. Landowners began to build up plots more and more densely, seeking to increase the profitability of these plots. To regulate the density of building, the government approved the Building Charter of 1857. In late 19th century, almost all middle-class entrepreneurs were engaged in building tenement houses. Thanks to this trend, the historical center of most major



cities was formed. Since 1917, nationalization and densification of housing began throughout Russia, due to which the apartments of the tenement houses were converted into communal apartments. After the revolution, in 1920 - 1940, most residential buildings passed into state ownership, at the same time housing standards were introduced. Between 1940 and 1990 in the Soviet Union began construction of Stalinist high-rises, apartments which were also supposed to make communal. The government was interested in building state-owned tenement houses. Through the construction of tenement houses, the government met its targets for housing demand and replenished the budget by collecting taxes from the owners of tenement houses.

At the same time, the design of tenement houses in Russia was preceded by a number of reasons:

- the need for housing for students, workers, while not only buying, but also renting housing for these people was too expensive;

- population growth, the population by the XX century was steadily increasing by 16%, and the housing stock only by 8%, so one of the ways out of this situation was the construction of tenement houses;

- in the early XX century, the availability of free land gave rise to high development activity, with the plots proposed for the construction of buildings being on the territory of the old urban estates;

- free capital, the benefit of investing free capital is evidenced by statistics: in the summer of 1911, about 3,000 profitable houses were built with a height of 5 to 7 storeys.

Nowadays, renting has become almost the most popular type of real estate use. However, tenement houses were not always given as dwellings and often combined a variety of functions. The analysis of the functional purpose of the tenement houses has been carried out, and the following premises placed in the structure of the tenement house have been singled out: shops, dwellings, workshops, offices, the owners' apartment - these premises could be used either jointly or completely for dwelling. Also, tenement houses are divided into three types: houses for the well-to-do people; houses for the middle class; houses for the poor class.

The first multi-storey tenement houses were built of gallery type, located along the perimeter of the courtyard, with open galleries having an entrance to the apartment. The next type of planning solution is the centric layout. The main feature of the central composition is that its «core» in the tenement houses is the grand staircase or inner courtyard-well, around which the apartments, staircases and additional entrances to the buildings are grouped. Enfilade planning was used for houses for wealthy people, so the building facing the street was built bilaterally, namely with windows on the street and in the yard. The corridor layout should be noted separately: corridors divided the front end and the living enfilade in the buildings facing the street, in the one-side yard wings they ran along the blind wall. Since 1860, a combined layout appeared - enfilade and corridor layout.

### **Analysis of the modern use of tenement houses in Russia**

At present Russia has launched a project on renting housing with state support, in

the future it will be extended to other major cities. "Dom RF" has launched a pilot program, under which it will be possible to rent an apartment on favorable terms in special rental houses («tenement houses»). Separately, it should be noted that in addition to housing, additional services will be available to the population: video surveillance, concierge, pet walks, cleaning, and minor repairs.

Thus, in Russia there is a new direction in the development of tenement houses as rental houses with benefits for certain categories of the population. However, throughout the country has preserved a large number of historical buildings, represented by tenement houses, which should be taken into account in the construction of modern residential buildings. Thus, in the construction of modern residential buildings in the conditions of the historical development of tenement houses it is necessary to use the following stylization techniques: rhythmic proportions, artistic stylization, harmonization for a particular place, adaptation (proportioning and modularity), proportions and scale (application of architectural elements similar to the existing historical buildings).

The tenement house of the mid 19th - early 20th centuries is a socio-historical prototype of modern multifunctional residential complexes, which revealed the basic successive classification features, expressed in the social level and comfort of living, which is reflected in the architecture of the buildings. Thus, we can distinguish the following classification of tenement houses as historical prototypes of modern residential buildings: tenement houses for wealthy people are the prototype of modern residential buildings of elite type, tenement houses of middle class - business-class residential buildings, tenement houses «cheap housing» - comfort-class residential buildings, tenement houses for temporary residence - economy-class residential buildings.

In Tambov, unlike in other large Russian cities, the tenement houses immediately combined commercial and residential functions, later added the service of renting, due to a significant increase in the urban population. Tenement houses in Tambov went through all stages of development, from the increase in the number of functions, appearance of additional services, development of planning solutions (depending on the structural systems and needs of the population) to a combination of different architectural styles in the design of facades of such buildings.

Thus, tenement houses appeared in Tambov in the XIX century in the architectural solutions of merchants' shops, and in the process of development of the volume-spatial solution of tenement houses a new type of building was formed - a complex tenement house, which included a corner element, denoting the public function, and a complicated general volume, similar to the form of an apartment building. Currently, most of the tenement houses are in a dilapidated condition, due to lack of funding and unclaimed services by the population.

### **Conclusion**

Thus, tenement houses have taken a large place in the development of housing construction in Russia, being a competitive and in-demand form of rental housing. Tenement houses are unique objects, which modern society needs, in connection with

which they need to be restored with the adaptation of the interior space to the modern needs of the population in the context of the modern worldview and the development of new forms of architecture.

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## Историческая трансформация доходных домов: современное использование

А. В. Воякина, Я. А. Даньшова\*

ФГБОУ ВО «Тамбовский государственный технический университет», Тамбов, Россия  
\*e-mail: [yana.povarnicyna@mail.ru](mailto:yana.povarnicyna@mail.ru), e-mail: [anastasiya.voyakina@yandex.ru](mailto:anastasiya.voyakina@yandex.ru)

**Аннотация.** Тема данной статьи – историческая трансформация доходных домов и их современное использование. Помещения в доходных домах предоставляются во временное пользование по договору аренды. В статье рассмотрены этапы развития и формирования объемно-пространственного решения доходных домов до настоящего времени. Проведен анализ функционального назначения доходных домов, выделены типы таких домов, а также проведено сопоставление доходных домов как исторических прототипов с современными жилыми зданиями.

**Ключевые слова:** аренда, доходные дома, жилые дома, историческая застройка, коммунальные квартиры, многофункциональные жилые комплексы.

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## **Problems of organization of the territory of modern residential development**

**D. N. Botov**

Tambov State Technical University, Tambov, Russia  
*e-mail: tarantul1994@yandex.ru*

### **Abstract**

The analysis of territorial problems of modern residential development is carried out, the main ways of solving the problems of the organization of yard territories of residential complexes are determined.

**Keywords:** integrated territory planning, residential development, landscaping.

Urban planning in Russia since the mid-1990s has followed an extensive path, involving the construction of large residential complexes, usually located on the outskirts of cities. The consequences of the extensive method of development can be considered excessive territorial growth of urban development, loss of valuable agricultural land and forest lands, ecological imbalance in the built-up areas, manifested in a lack of water supply sources, excessive noise and gas contamination of the territory, the growth of social and psychological tension due to the predominance of multi-storey buildings and high population density. In addition, the extensive method of urban development leads to the dilapidation of urban centers due to the loss of residential function and the predominance of social and business.

The absence of integrated planning projects for newly built-up territories leads to social tension, manifested in residents' dissatisfaction with the lack of a developed network of social institutions, such as kindergartens, schools, medical institutions. In addition, there are no public transport routes, accessibility radii to its stops are not observed. In the case of predominance of residential buildings in the development, it is almost impossible to provide a sufficient number of places of employment for residents, which leads to the creation of daily congestion on city streets when moving them to other areas of the city where the main enterprises are located [1].

An example of a competent integrated development of the territory in the history of urban planning in Russia can be considered the period from the late 1950s to the late 1980s, when the practice of building large residential neighborhoods prevailed, on the territory of which all the necessary social and household infrastructure was located to ensure the full functioning and provision of residents of this neighborhood.

Considering the complex of problems arising in areas of modern residential development, they can be divided into two main groups: object-related buildings (layout, design and condition of building facades), and territorial (landscaping, environmental features, etc.).

Unlike typical buildings of the Soviet period, modern residential buildings are

distinguished by a variety of planning solutions that meet the existing requirements for providing a level of comfort, as a rule, economy and comfort class. The design of facades of residential buildings, as a rule, is the same within the same residential complex or block and depends on the proposed architectural solution. The main disadvantage of modern residential buildings is their increased number of storeys, due to the requirements of investors who are unprofitable for low-rise and medium-rise buildings during the development of vacant territories.

The territorial problems of the areas of modern residential development are mainly related to the organization of the yard space, transport accessibility, environmental problems.

The essence of the characteristic territorial problems of residential areas located on the outskirts of cities is considered on the example of the residential complex "Magistralny", located in the north-western part of Tambov. The residential complex is located in the most populated Oktyabrsky district of the city. The development of the complex is represented by sixteen-storey sectional residential buildings of two types, differing in design and planning solutions, as well as two-storey public buildings housing social service enterprises.

Field studies carried out on the territory of the residential complex allow us to identify the following disadvantages of the development:

- there are no playgrounds and sports grounds, quiet recreation areas in part of the yard spaces;

- there is practically no landscaping in the form of trees and shrubs;

- lawn landscaping is unkempt, undesirable (weedy) vegetation prevails;

- collection sites for solid household waste (MSW) do not meet sanitary standards, do not have fences and canopies;

- there are no commercial sites;

- insufficient number of parking spaces for personal vehicles leads to unauthorized parking of cars on the driveway of yard driveways, as well as on lawns, especially in winter;

- because of the cars parked in the yard driveways, there is a narrowing of driveways for special equipment of various services;

- it is difficult, and in some cases it becomes impossible, to clean yard driveways from snow in winter.

At the same time, it is necessary to note the state of the transport infrastructure:

- transport entrances to all houses of the residential complex are provided, but some of them do not have a hard surface;

- pedestrian connections are represented by sidewalks along courtyard driveways and pedestrian paths with paving slabs.

Poor accessibility of public transport can also be attributed to territorial problems. There are no public transport routes in the area under consideration due to the fact that Magistralnaya Street has not been put into operation on this site due to legal property problems. The nearest public transport stop is more than 1 km away, which is a violation of accessibility requirements. In this regard, most residents of the residential

complex use motor transport daily to move to their places of work and study. This leads to congestion on the streets adjacent to the development.

The residential complex is located near the traffic-saturated Main street, the speed of traffic flow on which is more than 60 km/h. The noise level on the facades of buildings oriented towards the carriageway of the street is more than 70 dB, which significantly exceeds the permissible values. Given the continuously increasing number of vehicles, this problem will only increase. In addition, noise from the railway line of the South-Eastern Railway penetrates into the territory of the development from the west. Traffic noise disrupts the ecological balance in the territory under consideration [2].

Unregulated construction of high-rise residential buildings creates a huge number of practically unsolvable problems in many cities. All the problems listed above could be solved if an integrated approach to urban development planning was applied to ensure conditions for creating a comfortable and safe urban environment with a favorable social microclimate.

Currently, the most feasible and profitable for investors is the mechanism of public-private municipal partnership, according to which the city creates conditions for construction, and the developer, in addition to the construction of square meters of housing, is obliged to create all elements of social infrastructure in residential development with subsequent reimbursement of costs by the state. At the same time, citizens should also be socially responsible and, when purchasing apartments, be guided not only by the low cost of housing, but also pay attention to the availability of the necessary infrastructure, pay attention to the quality of the urban environment.

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## Проблемы организации территории современной жилой застройки

Д. Н. Ботов

ФГБОУ ВО «Тамбовский государственный технический университет», Тамбов, Россия  
*e-mail: tarantul1994@yandex.ru*

**Аннотация.** Выполнен анализ территориальных проблем современной жилой застройки, определены основные пути решения проблем организации дворовых территорий жилых комплексов.

**Ключевые слова:** комплексное планирование территорий, жилая застройка, благоустройство территории.

## Investigation of Existing Types of Coatings in Civil Buildings

**D. E. Ermakov\*, K. A. Andrianov**

Tambov State Technical University, Tambov, Russia

\**e-mail*: Dim.ermackow@yandex.ru

### Abstract

Currently, thermal engineering calculations of building structures are carried out according to energy-saving conditions, whereas previously only sanitary and hygienic standards were taken into account. For roofing, a certain frequency of current and major repairs has been studied and, consequently, a period of their effective operation has been established. The listed requirements are often not fully met by technical organizations that service the roofs of buildings.

**Keywords:** attic floor, combined coatings, combined roofs, drainage, flat roof, pitched coverings, roof.

The coating is a set of structural elements that cover the building and protect it from environmental factors.

The slopes are formed by inclined planes of coatings that drain atmospheric water. There are the following types of coatings:

- by the magnitude of the slope: pitched, slope more than  $10^\circ$ , flat with a slope less than  $10^\circ$ ;
- according to the design solution: attic, semi-passable (with an attic height of 1-1.2 m), with a micro-attic, heartless (combined);
- according to the operating conditions: roofs-terraces, which are designed to accommodate sports grounds, gardens, etc., roofs-“baths” filled with water in the summer and thereby reduce overheating of rooms on the unused upper floors, which are arranged in most civilian buildings.

Building coverings must meet the following requirements:

- water resistance and weather resistance;
- strength and stability;
- durability, fire resistance;
- industriality;
- economy.

*Pitched coverings.* The shape of the pitched coverings depends on the architectural features of the building. Coverings can be single-pitched, double-pitched, four-pitched (hip), tent, attic. The supporting structures of the pitched coverings are slatted and hanging rafters, which form a spatial system.

*Combined coatings.* Combined coatings are coatings in which the roof is combined with the attic floor, and its lower part is the ceiling of the upper floor. Such coatings are erected by sequentially laying on a reinforced concrete slab covering the upper floor of vapor barrier and waterproofing materials, leveling screed and rolled waterproofing carpet.

*Flat coatings.* Flat coatings are coatings combined with low slopes (1-5%). Flat

coverings of buildings are called operational roofs, as they are designed to accommodate sports fields, gardens, etc. In contrast to the combined unused ones, floors should be arranged on them, which are most often made of concrete slabs laid on a layer of gravel (drainage) or concrete logs. According to the design, flat coverings can be: heartless, with semi-passable attics and attic. Attics have an increased cost, but the attic can be used to accommodate ventilation shafts, utilities and monitoring the condition of the coating. Fences are arranged on flat surfaces for safe operation. Drainage of combined coatings can be:

- unorganized – with free discharge of water along the overhang of the roof (used as the cheapest in buildings up to three floors, but leads to moistening of the walls, the formation of ice and icicles on the cornice);

- external organized with a slope of the roof – towards the exterior walls and with a system of gutters and downpipes;

- internally organized with a slope of the roof towards water intake funnels with risers diverting water to the storm sewer.

Access to the combined flat roofs is carried out through special superstructures, which are located above the stairwells and have flight ladders for lifting and quick evacuation from the coating.



Figure 1 - Impacts on the roof

1 – permanent loads (own weight); 2 – temporary loads (snow, operational loads); 3 – wind (pressure); 4 – wind (suction); 5 – exposure to ambient temperatures; 6 – atmospheric moisture (precipitation, humidity); 7 – chemically aggressive substances in the air; 8 – solar radiation; 9 - moisture contained in the air of the attic space.

Roofs for flat coverings are rolled roofing materials – roofing material and pergamine, which are construction cardboard impregnated with bitumen, glued on bitumen mastic (materials of the last century). On the basis of these materials, a surfaced roofing material was created – 2 or 4 layers of roofing material glued with bitumen mastic, a thin polymer film from below, a protective sprinkling of fine gravel, granite chips, etc. from above; glued to the screed surface by melting the surfaced layer with a burner. Rolled roofing waterproofing surfaced materials such as isoelast, “kineplast”, novoplast, rubitex, technoelast are based on fiberglass, fiberglass, and



polyester with double-sided application of bitumen-mineral binder. The top layer can have a sprinkling of colored granite chips on the front side and a polymer film on the back side, preventing sticking; glued to the base with a gas burner. Roofing membranes are used to cover flat roofs. In modern practice, three types of membranes are used in our country: EPDM, PVC, and TPO.

The advantages of such roofs are cost-effectiveness and ease of manufacture. The disadvantages are low water resistance and thermal protection. Humidity on the upper floors can reach 90%.

Combined roofs of building manufacture are erected by sequentially laying a vapor barrier layer on the building on the overlap of the upper floor, filling along the slope, a thermal insulation layer of a leveling screed and a waterproofing carpet. This design is the most labor-intensive and has the worst operational qualities.

In modern housing and civil construction, low-slope attic roofs with internal drainage, load-bearing and enclosing structures made of reinforced concrete are mainly used. Due to the fact that the residual service life of buildings with non-core coatings is quite high, the reserves of bearing capacity are not exhausted, there is a need to eliminate the shortcomings of existing roofing, develop methods and measures to improve the operational and heat-protective qualities of this roof, which will increase the service life of buildings as a whole.

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## Исследование существующих типов покрытий гражданских зданий

Д. Е. Ермаков\*, К. А. Андриянов

ФГБОУ ВО «Тамбовский государственный технический университет», Тамбов, Россия

\*e-mail: [Dim.ermackow@yandex.ru](mailto:Dim.ermackow@yandex.ru)

**Аннотация.** В настоящее время теплотехнические расчеты конструкций зданий производятся по условиям энергосбережения, тогда как ранее принимали во внимание только санитарно-гигиенические нормы. Для кровельных покрытий установлена определенная периодичность текущих и капитальных ремонтов и, следовательно, установлен срок их эффективной эксплуатации. Перечисленные требования зачастую не в полной мере соблюдаются техническими организациями, обслуживающими кровли зданий.

**Ключевые слова:** водоотвод, кровля, плоская крыша, скатные покрытия, совмещенные крыши, совмещенные покрытия, чердачное перекрытие.

## Evaluating the Possibilities of BIM Technologies in Graduation Design

**L. S. Filatieva**

Tambov State Technical University, Tambov, Russia  
*e-mail: larywork@mail.ru*

### **Abstract**

The article discusses the functionality and capabilities of BIM technologies in graduation design. This topic is of high relevance, since the introduction of BIM technology allows solving a sufficient number of problems: reducing design time and reducing the number of errors.

**Key words:** BIM modeling, design, technology, construction

In the modern world, where technologies are developing rapidly and constantly, none of the spheres of human activity remains without innovation. Planning, design, construction and exploitation of construction objects are gradually moving to the path of digital transformation. This path is associated with the rejection of traditional methods and the use of innovative technologies.

One of these key technologies is information modeling (BIM), which allows you to create a building design from the earliest concepts up to its demolition.

BIM (Building Information Modeling) is a technology in the building sphere which is based on the idea of constructing a virtual 3D model of a building from ready components which relate to building elements (windows, columns, walls, air ducts, etc.). All elements are filled with information describing geometric and other characteristics.

The totality of this information for all components is a database for the construction site as a whole. This allows you to extract information from the model in the form of specifications, bills of quantities, or in the form of marks on the drawings.

The more known about the future object, for example, the visual image, the material and its physical properties, economic characteristics, the more accurately the future model will display the object and provide accurate information about the structure. At the time of design, you can evaluate the internal and external design of the project, calculate the cost and quantity of materials, how many workers and equipment will be needed and how it will be used.

To realize the BIM concept, it is necessary to choose the right software. An information model of an object can be created using a variety of programs, each of which has its own advantages and disadvantages. The most popular software package is “Autodesk Revit”, or simply “Revit”, as it has extensive capabilities and provides a simple and efficient design of architectural solutions, engineering networks and building structures. The main principles of understanding BIM technologies are represent in [1-4].

It is also important to have the possibility of integrating the model and calculation programs. Revit allows you to create a physical and analysis model of structures. To describe each of them, it should be noted that a physical model is the geometry of model objects, such as walls, slabs, columns, beams, ties, etc. with a given material. With physical model student can make drawings and specifications. The calculation model is a description of the elements of the model from the point of view of the calculation - rods, plates, rigid inserts that are inside of physical model. Revit has the ability to apply loads to elements, form combinations of loads, and set boundary conditions. In addition, the software package provides editing for the calculation model regardless of the physical one, and what you should pay special attention to is a transfer it to the different complexes: SCAD Office, LIRA, Autodesk Robot Structural Analysis, SOFISTIK and others. This significantly increases the efficiency of work.

Objects in a BIM model are not just graphical elements, they are information that allows you to automatically create drawings and reports, perform project analysis, simulate a work schedule, etc. providing the designer with unlimited opportunities to make the best decision, taking into account all available data.

The use of BIM in graduation design has the following advantages:

- convenient visual assessment of the proposed solutions;
- convenience of creating a calculation model;
- possibility to study several options and choose the optimal one based on design data;
- elimination of errors in the project by assembling all sections in a single space;
- improving the visibility and quality of the transmitted information;
- reduction of terms of consideration of problem areas and decision-making;
- tracking changes;
- rapid release of accurate and up-to-date documentation.

Summing up, it is important to note that nowadays BIM technologies are a perspective direction of development in design, as they allow saving time at the design stage of an object due to automated receive of the necessary drawings and specifications. In addition, with the help of this technology, it is possible to constantly monitor and fill the object model with information.

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## **Оценка возможностей BIM технологий в дипломном проектировании**

**Л. С. Филатьева**

ФГБОУ ВО «Тамбовский государственный технический университет», Тамбов, Россия  
*e-mail: larywork@mail.ru*

**Аннотация.** В статье рассматривается функционал и возможности BIM-технологий в дипломном проектировании. Данная тема имеет высокую актуальность, поскольку внедрение технологии BIM позволяет решить достаточное количество проблем: сократить время проектирования, уменьшить количество ошибок.

**Ключевые слова:** BIM-моделирование, проектирование, технологии, строительство.

## Evolution of the Structure of Nursery School Buildings

**K. V. Filimoshkina\*, O. N. Kozhukhina**

Tambov State Technical University, Tambov, Russia

\**e-mail:kfilimoshkina@mail.ru*

### Abstract

At the moment, there is a large number of nursery school buildings in the Russian Federation that do not meet new modern requirements. This article discusses the question of why nursery school buildings of old construction are difficult to adapt to modern requirements. In order for the buildings of the old construction to meet new modern requirements, there is a need for reconstruction or modernization. Their implementation often requires changes in the functional and space-planning solutions of the building. At the same time, it is necessary to carry out redevelopment, extension, superstructure works in the building, taking into account all technical regulations and norms currently in force.

**Keywords:** nursery school buildings, extension, kindergarten, modernization, reconstruction, regulatory requirements.

In the USSR and later in Russia, a full-fledged and comprehensive regulatory framework was formed concerning the design, construction and functioning of nursery schools, on the basis of which, after the 1990s, the corresponding SNiPs, SanPiNs and other codes of rules were developed.

To date, the basic documents for the design of nursery schools are SP 118.13330.2012 "Public buildings and structures" and SanPiN 2.4.1.3049-13 "Sanitary and epidemiological requirements for the device, maintenance and organization of the mode of operation of nursery educational organizations". The regions also have territorial standards (TSN) that take into account the specifics of the design area. At the same time, it should be noted that currently there is no set of rules relating only to the design of preschool institutions.

At different stages of the construction of buildings in the country (from the post-war to the present time), the requirements for nursery school buildings were formed and changed, the tasks of streamlining the functional and spatial organization, giving buildings a full-fledged architecture, requirements for the composition and area of the main groups of premises of preschool institutions were solved.

Based on the "Recommendations for the reconstruction and modernization of nursery school buildings" [1], four stages of construction, design and development of the typology of nursery school buildings have been identified. Each stage involved specific changes in regulatory requirements for the composition and areas of premises, as well as adaptation to new trends in urban planning practice. All this influenced the overall capacity of buildings, their specialization and universalization. Let us consider the stages of formation and development of design and construction of nursery schools.

The first stage of construction was the post-war period of pre-industrial construction 1946-1956. During this period, the following types of nursery schools were adopted:

- nurseries serving children from several months to 3 years old;
- kindergartens serving children aged 3 to 7 years;
- nurseries-kindergartens or children's factories that serve children from several months to 7 years.

The next stage of construction was the period of industrial construction from 1956 to 1962. After the transition to industrial construction (after 1959), the main type of nursery school was recognized and the type of combined institution - a nursery-garden became widespread.

In 1960, the design tasks determined the capacity of the DOW already in the following form:

- nursery for 4 and 6 groups (80 and 120 places);
- kindergartens for 4 and 6 groups (100 and 150 places);
- kindergartens for 2, 4, 6, 8 and 12 groups (50, 90, 140, 185 and 280 places, respectively).

After the introduction of the norms of SNiP II-L.3-62 "Nursery schools. Design standards" combined nursery-garden buildings have become the only type of nursery schools of a general type. During this period, there were problems with the formation of groups of children of different ages, the so-called combined groups. The appearance of large buildings of nursery schools required a significant increase in the number of floors of residential buildings and an increase in the standard of provision of the population with nursery schools.

The analysis shows that buildings of the DOW, built in the 1950s and 1960s, have significant disadvantages. These include: the absence of premises for specialized classes, music and gyms; there are no sleeping rooms in group cells; office and household premises have a limited area.

The buildings built in the 70s and 80s have significant changes compared to the buildings of the previous stages. They have a new set of premises that meets modern requirements. In particular, in each group cell there were bedrooms used for daytime sleep of children. Group cells become universal. They were supposed not only for day stay, but also for round-the-clock maintenance of children. But in these large-capacity buildings there was no second hall, which makes it difficult to perform program and developmental classes with children. The design of nursery school buildings in the early 80s was carried out in accordance with SNIP II-64-80, in which the composition and area of the premises were not subjected to major changes.

Having analyzed the history of the development of the design of nursery schools, as well as their shortcomings, it can be concluded that the regulatory requirements for buildings are always undergoing changes, due to many factors. But when designing typical buildings of nursery schools of the Soviet period, all these factors (social characteristics, technical and economic capabilities of society, natural and climatic conditions, population growth and decline) were considered as constant values. The

possible change and dynamics of their development were not assumed. If the possibility of developing and improving the functional process is not provided for at the design stage of the object, then after the expiration of time, the moral deterioration of the object occurs and, consequently, there is a need to adapt it to new conditions. In this case, moral deterioration is associated with the inconsistency of old buildings with the new modern requirements of joint ventures, SNIPS, SanPiNs, as well as new ideas about a modern comfortable environment.

New forms of work with children define new requirements for buildings built according to standard projects. The appearance of new functional features changes the requirements for the overall space of buildings. At the same time, in existing buildings, innovative forms of nursery schools are forced to adapt to the hard-to-change parameters of the previously created kindergarten architecture [2]. For this reason, there is a need for reconstruction or modernization of old buildings.

If possible, it is necessary to find such a universal ratio of the number and area of premises, so that in case of changes in the requirements for nursery school buildings, easy adaptation can be carried out.

New forms of work with children define new requirements for buildings built according to standard projects. The appearance of new functional features changes the requirements for the overall space of buildings. At the same time, in existing buildings, innovative forms of nursery schools are forced to adapt to the hard-to-change parameters of the previously created kindergarten architecture [2]. For this reason, there is a need for reconstruction or modernization of old buildings with priority implementation of sanitary and hygienic and health measures and procedures. Consider the building of the municipal nursery school "Child Development Center – kindergarten No. 66 "Topolek", located in Tambov. The building was built in 1985 as a kindergarten for 140 children. During the operation of the building, its purpose was changed to a day hospital for children with impaired health without carrying out work on its modernization. At the moment, the number and composition of the premises does not meet modern requirements. There is a shortage of health-improving facilities. The building area is 1242 m<sup>2</sup>, this area is not enough to accommodate new premises. The superstructure will increase the useful area of the building without increasing the building area, but the day hospital assumes the stay of children with impaired health, who will find it difficult to climb to the third floor. The area of the territory of this hospital allows you to make an extension to the existing building. The area of the building will double, which will ensure compliance with all modern regulatory requirements for buildings of this type. The set and area of premises in the building must be taken in accordance with the instructions for the design of buildings and structures adapted to medical institutions in accordance with CH 515-79 "Instructions for the design of buildings and structures adapted to medical institutions".

If possible, it is necessary to find such a universal ratio of the number and area of premises, so that in case of changes in the requirements for nursery school buildings, easy adaptation can be carried out.

Buildings built several decades ago are uncompetitive in comparison with newly constructed facilities, as they have significant physical and moral deterioration. But the reconstruction or modernization of nursery school buildings is especially relevant in those regions where there is no possibility of constructing new buildings due to the limited municipal budget.

The problems discussed above indicate that preschool educational institutions are not just buildings for design, but a complex individual complex. A thorough rethinking of the structure of the network of nursery schools is required so that newly constructed buildings can freely adapt over time, taking into account the dynamics of changes in socio-pedagogical and demographic factors, the technical and economic capabilities of society, natural climatic and other conditions.

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## Эволюция структуры зданий детских образовательных учреждений

К. В. Филимошкина\*, О. Н. Кожухина

ФГБОУ ВО «Тамбовский государственный технический университет», Тамбов, Россия \*  
*e-mail:kfilimoshkina@mail.ru*

**Аннотация.** На данный момент в Российской Федерации имеется большое количество зданий детских образовательных учреждений (ДОУ), которые не отвечают новым современным требованиям. В данной статье рассматривается вопрос, по каким причинам здания детских садов старой постройки тяжело приспособить к современным требованиям. Для того чтобы здания старой постройки отвечали новым современным требованиям, появляется необходимость в реконструкции или модернизации. Их выполнение часто требует изменения функционального и объемно-планировочного решения здания. При этом необходимо проведение в здании работ по перепланировке, пристройке, надстройке, с учетом всех действующих на данный момент технических регламентов и норм.

**Ключевые слова:** детский сад, детское образовательное учреждение, модернизация, нормативные требования, пристройка, реконструкция, ясли



## Die Projektlösungen des Gebäudes des Autozentrums nach dem Verkauf und der Wartung der Autos

A. A. Glebov, V. M. Antonov

Staatliche Technische Universität Tambow, Tambow, Russia

*e-mail: sanekglebow@yandex.ru*

### Zusammenfassung

Der Artikel beschreibt die architektonischen und konstruktiven Lösungen des Gebäudes eines Autozentrums für den Verkauf und die Wartung von Autos. Die Eigenschaften der haupttragenden Elemente des Stahlbetonrahmens sind angegeben. Es werden kurze Informationen über die Organisationstechnologie, den Zeitpunkt und die Baukosten des projektierten Objekts vorgestellt.

**Schlüsselwörter:** der Stahlbetonrahmen, die Gebäude des Autozentrums, die Berechnung der Konstruktionen, die Organisation des Baus, die Wirtschaft des Baus.

Die aktive Entwicklung des Territoriums von Tambow wird von einer Zunahme der städtischen Bevölkerung mit privatem Straßenverkehr begleitet. Die steigende Nachfrage nach Autos führt zu einem Mangel an Unternehmen, die sie verkaufen, reparieren und warten. Die aktuelle Aufgabe ist es, ein Projekt für das Gebäude eines Autozentrums zu entwickeln, das den Anforderungen an Funktionalität, Sicherheit, Zuverlässigkeit und Langlebigkeit entspricht. Es ist jedoch notwendig, die organisatorischen und technologischen Merkmale des Baus dieses Objekts und seine Kosten zu berücksichtigen.

In diesem Zusammenhang wurden die architektonisch-baulichen, berechnungs- und konstruktiven, organisatorischen und technologischen und wirtschaftlichen Abschnitte des Projekts für den Bau eines Autozentrums für den Verkauf und die Wartung von Autos entwickelt.

Das projektierte Gebäude soll auf dem Territorium der Stadt Tambow im Wohnbezirk «Sloboda» errichtet werden. Der Boden der Baustelle ist durch folgende Böden gestapelt: schwarze Erde, schwarze Erde mit Lehm, halbharter Lehm, fließender Lehm. Der Boden der Basis ist halb hart, leicht staubig. Der Grundwasserspiegel liegt in einer Tiefe von 6 Metern vom Planungsniveau entfernt. Klimafreundliches Baugebiet - IIB.

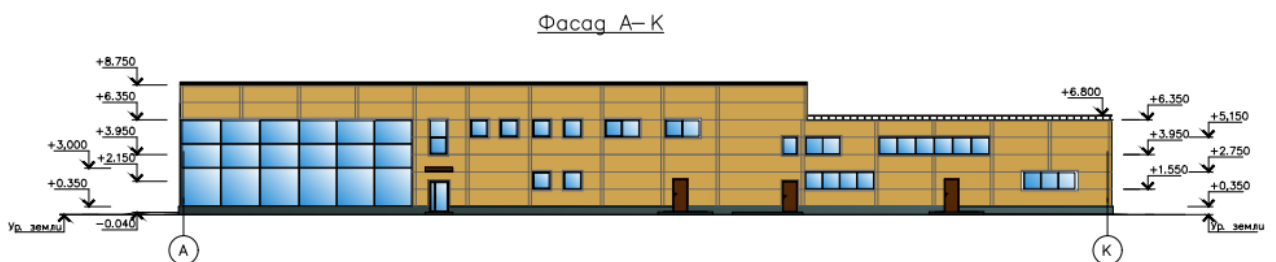
Die architektonisch-künstlerische Gestalt des projektierten Gebäudes ermöglicht es ihm, sich harmonisch in die bestehende Landschaft einzufügen. Die rechteckige Form des Gebäudes in Verbindung mit der Farblösung der Fassaden trägt dazu bei, die Integrität der architektonischen Einheit der städtischen Bebauung zu erhalten (Abbildung 1). Die Gesamtabmessungen des Gebäudes im Plan sind 64x47 m (Abbildung 2). Die Gesamtauflfläche beträgt 3101 m<sup>2</sup>. Die Kombination verschiedener Volumen in Höhe und Länge verleiht dem Objekt Ausdruckskraft. Die maximale Höhe des Gebäudes beträgt +8.750 m. (Abbildung 1). Die Originalität und Erkennbarkeit des Gebäudes wird durch die Verwendung moderner

Dekorationsmaterialien, die helle Farblösung der Fassaden und die Verwendung verschiedener Formen der Verglasung gewährleistet.

Das konstruktive System des Gebäudes ist ein Rahmenwerk. Der Rahmen besteht aus Stahlsäulen und Riegeln, Stahlbeton-Hohlplatten und Beschichtungen. Die vorherrschenden Maschenmaße der Säulen betragen 7 x 8 m und 7 x 6 m. Die Außenwände des Gebäudes sind aus wärmeeffizienten Sandwichplatten montiert [1].

Die Säulen haben einen festen Zweiaugenquerschnitt mit den Maßen 300x300 mm und eine Höhe von zwei Etagen. Die Platten werden in den unteren Regalen der Riegel verlegt. Die Decken und Beschichtungen bestehen aus mehrspurigen Platten mit den Abmessungen 1500x220mm und Spannweiten von 7000 und 6000 mm. Die Platten werden in den unteren Regalen der Riegel verlegt. Das Gebäude verfügt über eine unfertige Beschichtung, bei der vorgefertigte Stahlbeton-Hohlplatten als Basis für das Dach dienen. Auf den Platten wird ein Rolldach verlegt. Die Fundamente für die Säulen sind freistehende säulenförmige Fundamente mit einer Fußstütze und einem abgestuften Plattenteil mit einer Einlegetiefe von 1,55 m. [2]

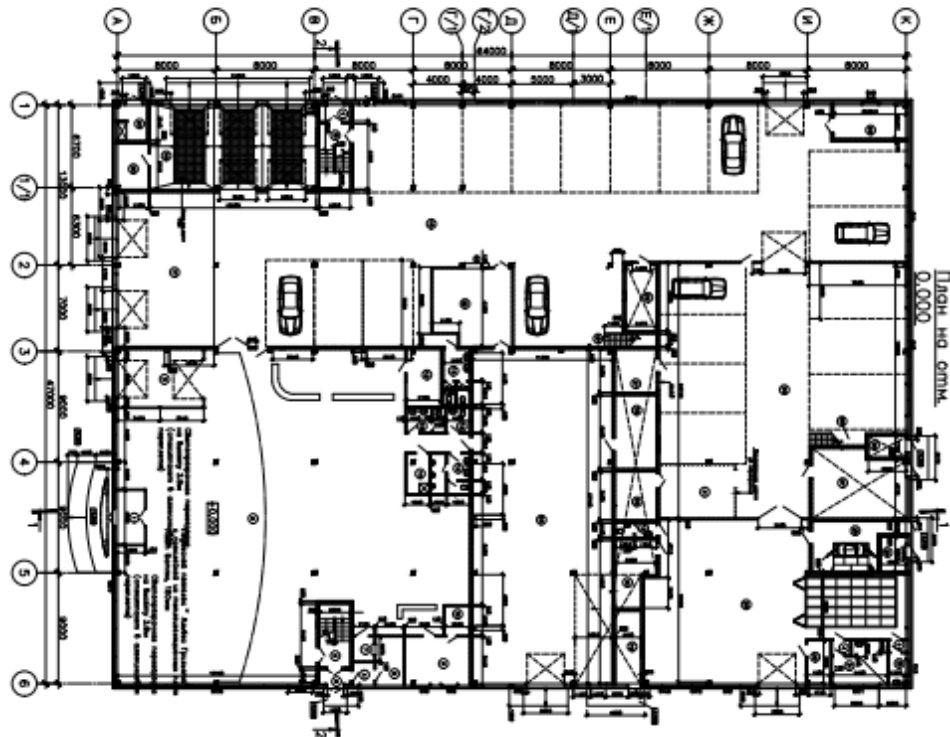
Die allgemeine Stabilität und räumliche Unveränderlichkeit des Rahmens wird durch das harte Einklemmen der Säulen in den Fundamenten und die Rahmenknoten der Kopplung der Riegel mit den Säulen sowie durch den Kern aus starren Längsrahmen gewährleistet.



**Abb. 1** - Die Fassade des projektierten Gebäudes

Im Berechnungs- und Konstruktionsabschnitt wurde die Berechnung der zwischengeschossigen Bodenplatte mit einer Spannweite von 7 m sowie die Berechnung der Säulengrundamente durchgeführt. Die Hohlplatte besteht aus Beton der Klasse B20. Die vorgespannte Platte wird mit einer Stabverstärkung der Klasse A-600 mit einem Durchmesser von 12 mm verstärkt. In den Vorspannabschnitten mit einer Länge von 1800 mm wird eine Bewehrung mit einem Durchmesser von 4 mm der Klasse B500 in Schritten von 110 mm konstruktiv platziert.

Betonklasse für das Fundament B15. Die Konstruktion der Fundamente mit der Software "Fundament 10.1" wurde unter Berücksichtigung der geologischen Bedingungen der Baustelle und der auf das Gebäude wirkenden Belastungen anhand der Abmessungen der Fundamentsohle ermittelt, die 2,4x1,8 m und 2,4x3,3 m betrug. Der berechnete Durchmesser der Arbeitsstahlstäbe betrug 12 mm und ihr Schritt beträgt 200 mm.



**Abb. 2** – Grundriss des Erdgeschosses

Im organisatorischen und technologischen Abschnitt des Projekts wurde eine technologische Karte für die Einrichtung von monolithischen Säulenfundamenten für die Säulen des Rahmens und der monolithischen Fundamentbalken entwickelt. Für die Montage der Fundamentelemente wurde ein Kran der Marke KRUPP KMK – 4070 unter Berücksichtigung des Gewichts des schwenkbaren Trichters mit einem Fassungsvermögen von  $2 \text{ m}^3$  Beton und des maximalen Abstands zur Zuführstelle des Betongemischs ausgewählt. Die Montage des oberirdischen Teils des Rahmens wird im Rahmen jeder Beschattung in folgender Reihenfolge durchgeführt: Säulen, Riegel, Deckenplatten, Dachbalken, Deckplatten, Wandzaun. [3] Die Einrichtung aller monolithischen Säulenfundamente mit einem Volumen von  $133,2 \text{ m}^3$  dauert gemäß dem Produktionszeitplan 13 Tage.

Die Planung für den Bau des gesamten Objekts erfolgte durch den Aufbau eines zeitbasierten Netzwerkmodells, das die Arbeit des Nullzyklus, die Errichtung des oberirdischen Teils, die Ausbaurbeiten, die Einrichtung der Ausrüstung, die Verschönerung des Territoriums und die Inbetriebnahme des Objekts berücksichtigt. Dabei wurde ein Arbeitszeitplan erstellt. Die geplante Bauzeit lag aufgrund der optimalen Anzahl von Arbeitnehmern auf der Baustelle und der fehlenden Ausfallzeiten bei 260 Tagen.

Die Wirtschaftlichkeit des Baus eines Autozentrums wurde durch die Erstellung lokaler und objektbasierter Schätzungen sowie durch eine konsolidierte Schätzung bewertet. Die Baukosten in den Preisen von 2022 beliefen sich auf 69113,31 Tausend Rubel, und der Preis für einen Quadratmeter beträgt -16,6 Tausend Rubel.

So wurde das Bauprojekt eines Autozentrums für den Verkauf und die Wartung

von Autos entwickelt, dessen architektonische und konstruktive Lösungen alle regulatorischen Anforderungen für solche Bauobjekte erfüllen.

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### **Проектные решения здания автоцентра по продаже и обслуживанию автомобилей**

**А. А. Глебов, В. М. Антонов**

ФГБОУ ВО «Тамбовский государственный технический университет», Тамбов, Россия  
*e-mail: sanekglebow@yandex.ru*

**Аннотация.** В статье описываются архитектурное и конструктивное решения здания автоцентра по продаже и обслуживанию автомобилей. Приведены характеристики основных несущих элементов железобетонного каркаса. Представлены краткие сведения о технологии организации, сроках и стоимости строительства проектируемого объекта.

**Ключевые слова:** железобетонный каркас, здание автоцентра, расчет конструкций, организация строительства, экономика строительства

## BIM Technologies in Graduate Design

A. V. Gridnev

Tambov State Technical University, Tambov, Russia

*e-mail: artemka363@mail.ru*

### Abstract

The article shows the use of information modeling technologies in graduate works in the construction industry. In particular, the development of the architectural part is considered. It also represents the tools with which the information model is developed.

**Keywords:** building information model, construction, information model.

Construction is one of the oldest sciences of mankind. For thousands of years, people have been constantly building something in order to provide themselves with a comfortable environment for existence and life. Over time, the industry, like all others, has developed significantly. So, if in the 20th century people developed project documentation using paper, pencil and other instruments, then at the end of the 20th and beginning of the 21st century, computer-aided design systems, or CAD, appeared, as well as such a phenomenon as BIM. The abbreviation BIM stands for Building Information Model.

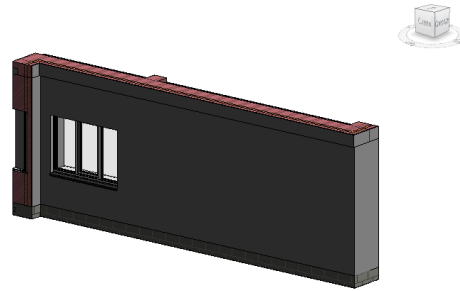
A key feature of information modeling technologies, in contrast to programs that use flat drawing (for example, Autodesk Autocad), is parametric drawing. In other words, in the information model, parts of a building (walls, ceilings, foundations, etc.) are not a set of two-dimensional lines, but an independent three-dimensional object that has many properties and parameters that the designer can independently configure. The article discusses the graduation design of the architectural part of the house – a mansion in the Autodesk Revit software package. The basics of Revit and how to use it are represented in [1,2,3].

As mentioned above, the model consists of objects. Figure 1 shows a general view of the outer wall of a residential building and its column of properties. Building a model is quite easy and intuitive understandable.

Depending on the category of an object, it may have unique properties that other categories do not have. For example, beams have a work plane parameter, while cells do not. After building a floor, it can be copied to other levels and edited if necessary.

Sections are an integral part of project documentation. In the Revit software package, the construction of sections does not cause any difficulties and saves a significant part of the time that the student are need in. The section is built in two clicks: the tool is selected on the panel; the view range is set with a mouse click and then placed on the view. Figure 2 shows a cross section of the building.

a)



b)

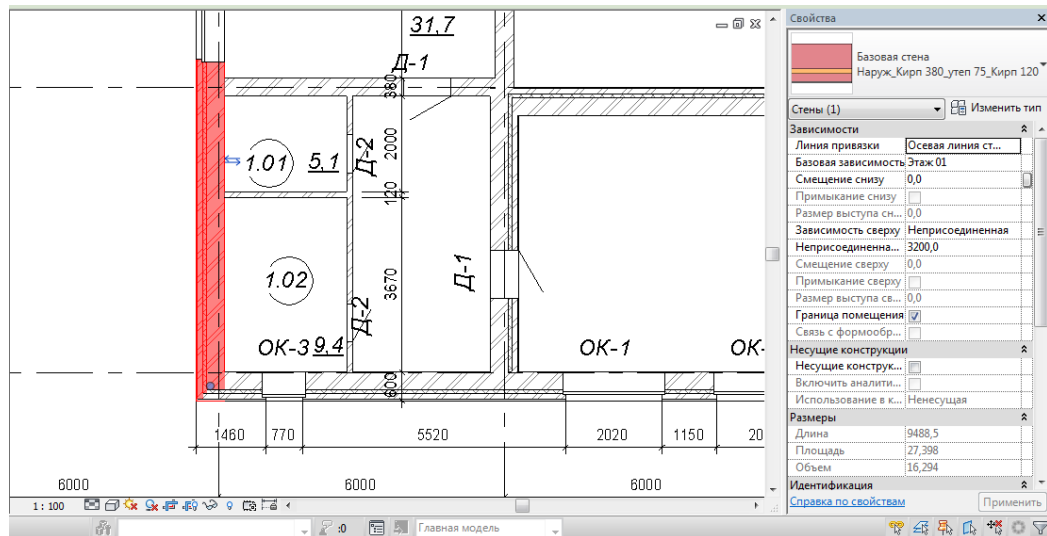


Figure 1 – Revit environment

a) wall in three-dimensional projection; b) column of properties on the same wall

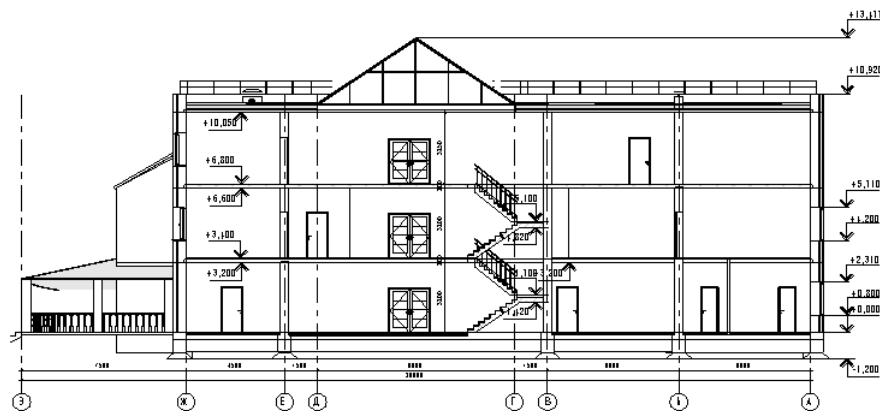


Figure 2 – Cross section of the building

Since the diploma design of a building consists of several sections, it is vital to know the information that is needed specifically in this section. So, for example, to develop a technological map, a list of work is needed. Specification instrument can solve this task. Specifications can show different information depending on the task at

hand. It can be made absolutely for any object in the model. The list of parameters is large, and if there are not enough of them, you can make your own. For example, Figure 3 shows the specification of elements for filling doorways on the 1st floor.

<Specification of elements for doorways on 1st floor>					
A	B	C	D	E	F
Id	Designation	Name	Quan.	Mass	Annotation
1	ГОСТ 6629-88	960x2080h	15		
2	ГОСТ 6629-88	760x2080h Л	2		
4	ГОСТ 6629-88	1800 x 2000 мм	3		

*Figure 3 – Specification*

In the course of the work, it was shown how BIM technologies can be used in the graduate design.

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## Использование BIM технологий в дипломном проектировании

**А. В. Гриднев**

ФГБОУ ВО «Тамбовский государственный технический университет», Тамбов, Россия  
*e-mail: artemka363@mail.ru*

**Аннотация.** В статье рассматриваются вопросы использования технологий информационного моделирования в выпускных квалификационных работах по строительному направлению. В частности рассматривается разработка архитектурной части. Также показаны инструменты, с помощью которых происходит разработка информационной модели.

**Ключевые слова:** информационная модель, строительство, технологии информационного моделирования,



## Residential Six-Storey Building with Office Space in Tambov

**G. G. Ivanov, F. A. Varfolomeev, O. A. Kiseleva**

Tambov State Technical University, Tambov, Russia  
*e-mail: 6bdfyjd8@mail.ru*

### Abstract

The article describes the architectural and constructive solution of a residential six-storey building with office space, characterized by the unique expressiveness of the facade and the complexity of forms in the plan. Information about the cost and timing of constructing the projected object is presented.

**Keywords:** architectural solution, building construction, building, constructive solution, design.

The actual problem of designing modern buildings is the selection of optimal structural and architectural solutions that do not cause an increase in the cost of construction and the cost of a square meter of housing.

The existing construction of many cities in Russia, which developed in the second half of the 20th century and is represented by faceless multi-storey panel houses, no longer meets modern international standards in the field of architecture and construction. Therefore, it was decided to develop a project of a six-storey residential building with an extraordinary facade and shape, which is planned to be implemented on the territory of the city of Tambov.

Functional and aesthetic principles should be interconnected in architecture. The expressiveness of the external appearance of the building is achieved by such means as: composition, tectonics, scale, proportions, and rhythm [1].

The projected building (Fig. 1) has a frontal asymmetric composition. At the same time, proportional relations between the individual elements of the building are observed, which determines its high architectural expressiveness.



*Figure 1 – Facade of the projected building*



The complex shape (Fig. 2), formed by numerous bay windows, which increase the illumination of the premises, together with the color scheme of the facade give a unique memorable appearance.

A multi-level four-pitched roof with hipped coverings over the bay windows, overlapping individual volumes on different floors, will help the projected building to stand out from the surrounding development.

The presence of underground parking allows using all adjacent territories to create green areas and playgrounds, which is relevant and necessary in modern conditions of a cramped urban environment [1].

The structural system of the building is an incomplete frame with external load-bearing brick walls with a thickness of 510 mm (Figure 3) and internal reinforced concrete columns with a cross section of 400x400 mm. Multi-hollow floor slabs are supported by load-bearing reinforced concrete crossbars, which transfer the load to the external brick walls and internal columns. This solution allows increasing the size of the premises and gives some freedom regarding their layout. At the same time, the dimensions of the cross sections of columns and crossbars are small and economically advantageous. The latter is also caused by the fact that only external brick walls perceive the wind load, without transferring it to internal load-bearing structures [1].

Concrete of strength class B30 and reinforcement of classes A600 and A400 are used for load-bearing reinforced concrete structures. [2] This combination of concrete and reinforcement strength is optimal for operating loads, which is confirmed by calculations to ensure load-bearing capacity.

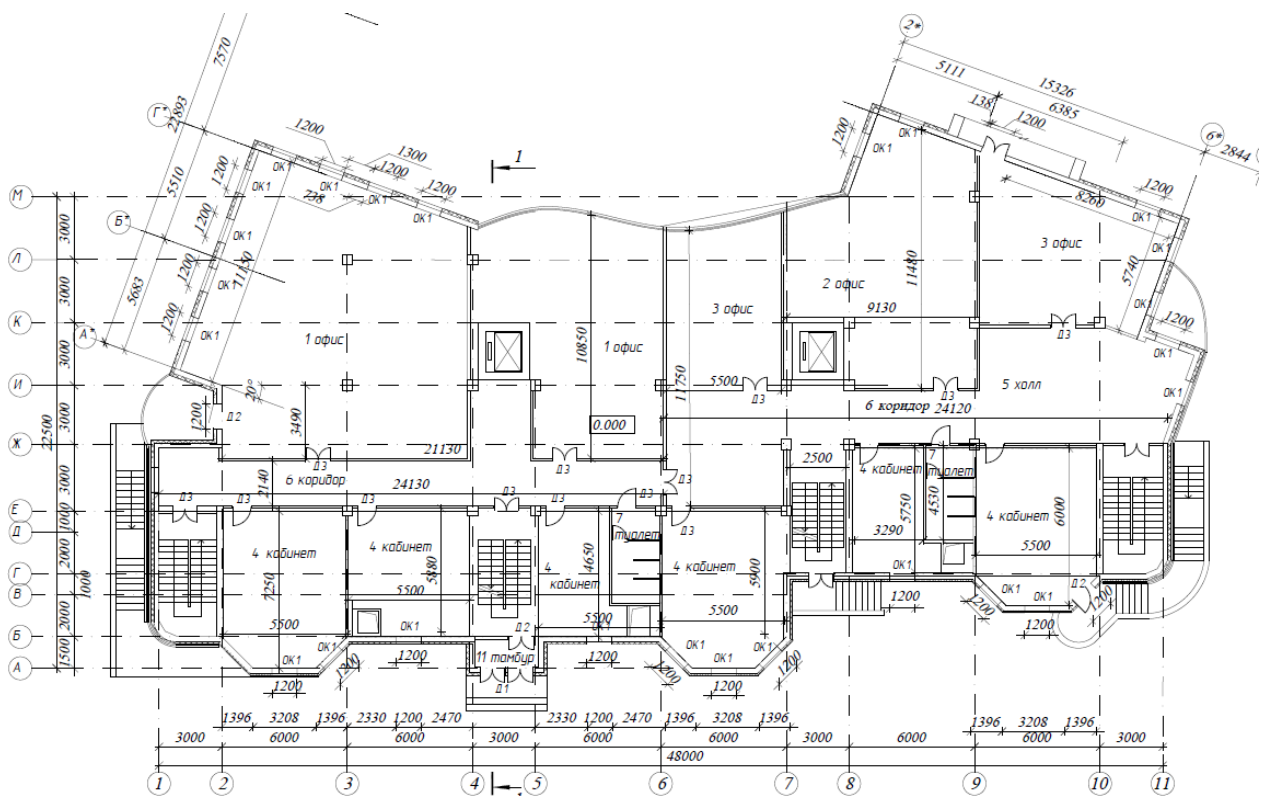
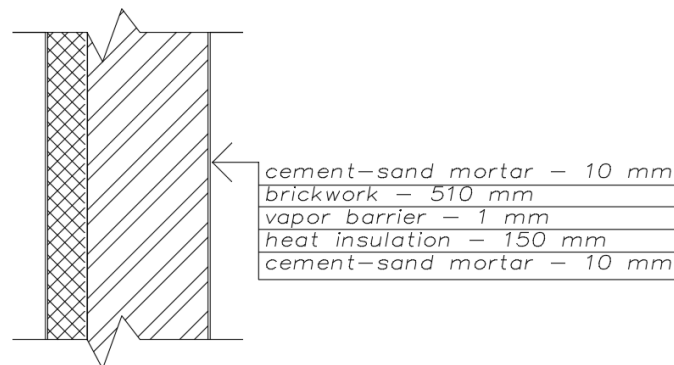


Figure 2 – Ground floor plan

The foundation is designed with a ribbon for external walls and columnar for

internal columns. The depth of the sole is 2.35 m. The basis for the ribbon and columnar foundation is coarse-grained sand, which evenly distributes the load on the underlying layers of soils. [3]



*Figure 3 – Structural solution of the outside wall*

The building is supposed to be mounted with a POTAIN MD-50 crane. The planned construction period, based on ensuring the optimal number of workers on the construction site and the absence of downtime, is 156 days.

The estimated assessment of the project showed that the cost of the construction object in the prices of 2022 is 74791.788 thousand rubles, the price per square meter is 60.6 thousand rubles.

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### **Жилое шестиэтажное здание с офисными помещениями в г. Тамбов**

**Г. Г. Иванов, Ф. А. Варфоломеев, О. А. Киселёва**

ФГБОУ ВО «Тамбовский государственный технический университет», Тамбов, Россия  
*e-mail: bbdfyjd8@mail.ru*

**Аннотация.** В статье описывается архитектурное и конструктивное решение жилого многоэтажного здания с офисными помещениями, отличающегося уникальной выразительностью фасада и сложностью форм в плане. Представлены сведения о стоимости и сроках возведения проектируемого объекта.

**Ключевые слова:** архитектурное решение, возведение здания, здание, конструктивное решение, проектирование.

## Designlösungen für den Bau des innovativen Bildungszentrums in Tambow

**E. A. Kalugina**

Tambow Staatliche Technische Universität, Tambow, Russland  
*e-mail: kalugina01@rambler.ru*

### **Zusammenfassung**

Der Beitrag geht auf die wesentlichen Entscheidungen des qualifizierten Abschlussarbeitsprojekts ein. Die architektonische und konstruktive Komponente des Gebäudes ist beschrieben. Es sind Informationen zu den Haupttragwerken des Rahmens und Methoden zu ihrer Berechnung gegeben. Es sind Informationen zur Technik, Organisation und Wirtschaftlichkeit des Bauens vermittelt.

**Schlüsselwörter:** architektonische Lösung, Stahlbetonkonstruktionen, Innovationszentrum, Bauorganisation, Bauökonomie.

Die Belastung kommunaler Bildungseinrichtungen variiert je nach Standort in der Stadt. Aus diesem Grund stellen sich Fragen nach der Notwendigkeit ihrer Platzierung und Konstruktion unter Berücksichtigung der Faktoren, die das bestehende Netzwerk von Bildungseinrichtungen und die Aussichten für seine Entwicklung beeinflussen. Im nördlichen Teil der Stadt Tambow wird intensiver Wohnungsbau betrieben und es besteht daher ein dringender Bedarf, die Kinder mit Lernplätzen zu versorgen.

In diesem Zusammenhang ist im Rahmen der abschließenden Qualifizierungsarbeit ein Projekt für den Bau eines innovativen Bildungszentrums in der Stadt Tambow entwickelt.

Die Hauptaufgabe, die bei der Arbeit mit dem Architektur- und Bauabschnitt gelöst wird, ist die Realisierung eines Architekturprojekts, das der Architekt Kotow D.S. mit BIM-Technologien im Programm Autodesk Revit durchgeführt hat (Abbildung 1).



*Abb. 1 – AR-Modell*

Das Baugrundstück befindet sich im Bezirk Maiski an der Kreuzung der Straßen Tambowski Zori und Kozma Prutkova.. Das geplante Gebäude hat eine komplexe e-förmige Konfiguration (Abbildung 2) und besteht aus neun Baublöcken, die durch Dehnungsfugen voneinander getrennt sind.

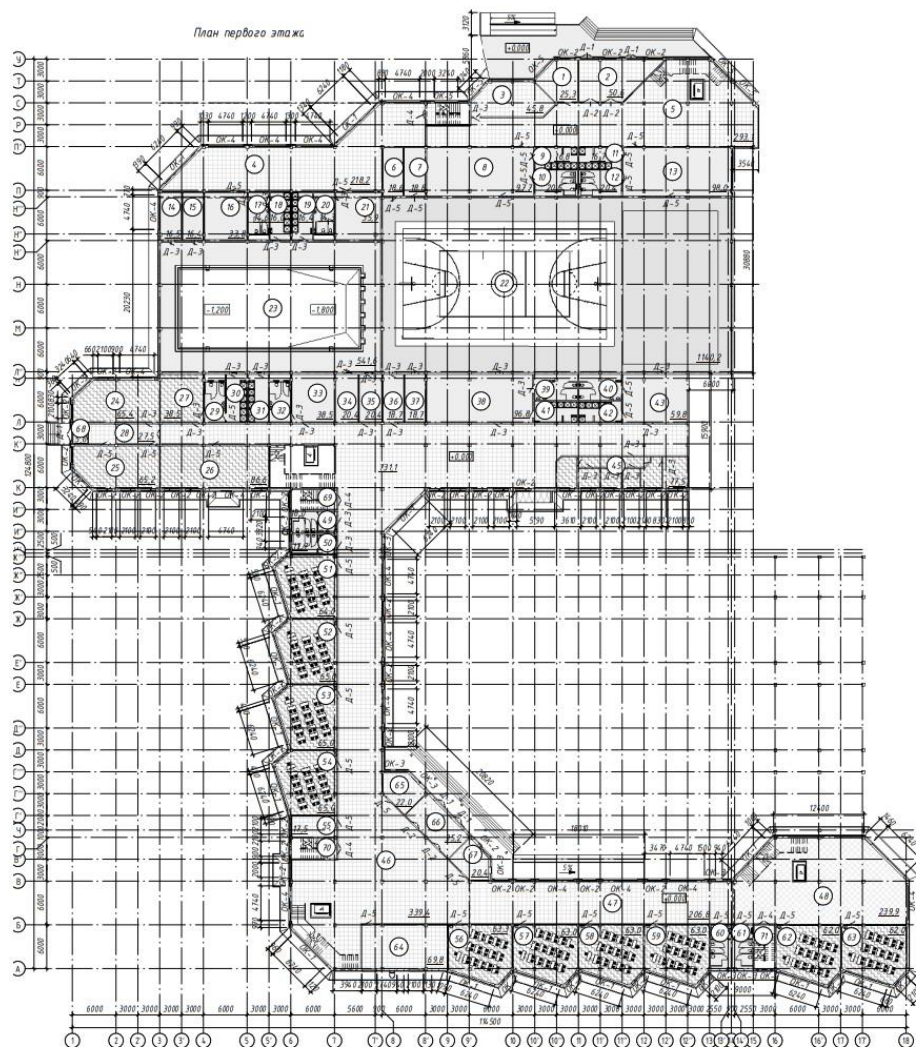


Abb. 2 – Grundriss des Erdgeschosses

Alle Blöcke in den Stockwerken sind durch ein System von Fluren und Innentreppen funktional miteinander verbunden. Die volumetrische und planerische Struktur des Gebäudes wird unter Berücksichtigung der Zonierung der Funktionsbereiche, der Isolierung, Beleuchtung und Belüftung der Klassenzimmer und der Möglichkeit der Fußgängerkommunikation im Inneren des Gebäudes erstellt.

Im Laufe der Arbeit ist die Berechnung von Strukturen durchgeführt, nämlich ein Giebelstahlbetonträger 24 m und Säulenfundamente für verschiedene Belastungen [1].

Die Berechnung des Giebelbetonträgers wurde manuell gemäß den Entwurfsregeln durchgeführt. Als Beton ist Beton B40, Spannverstärkung nach K1400 Berechnung gewählt.

Bei der Entwicklung des Projekts wurden je nach Belastung zwei Arten von Säulenfundamenten berechnet [2]. Das monolithische Fundament für die Abstützung

der Beckenschale und das vorgefertigte Fundament für den vierstöckigen Gebäudeteil wurden mit dem Programm FOUNDATION 14.0 berechnet. Basierend auf den Ergebnissen der Berechnung ist die Betonklasse B15 und die Klasse der Arbeitsbewehrung A400 bestimmt.

Das Projekt präsentiert auch eine technologische Karte für die Anordnung des oberirdischen Teils des Rahmens der Sporthalle. Für die Installation von Strukturen ist laut Berechnung ein Kran der Marke KRUPP KMK - 4070 ausgewählt [3]. Die Art der Installation von Strukturen ist je nach Installationsreihenfolge kombiniert. Durch einen separaten Montagefluss sind alle Säulen installiert, und unter Berücksichtigung sicherer Arbeitsbedingungen ist die Montage aller anderen Konstruktionen in einer komplexen Methode durchgeführt (Abbildung 3).

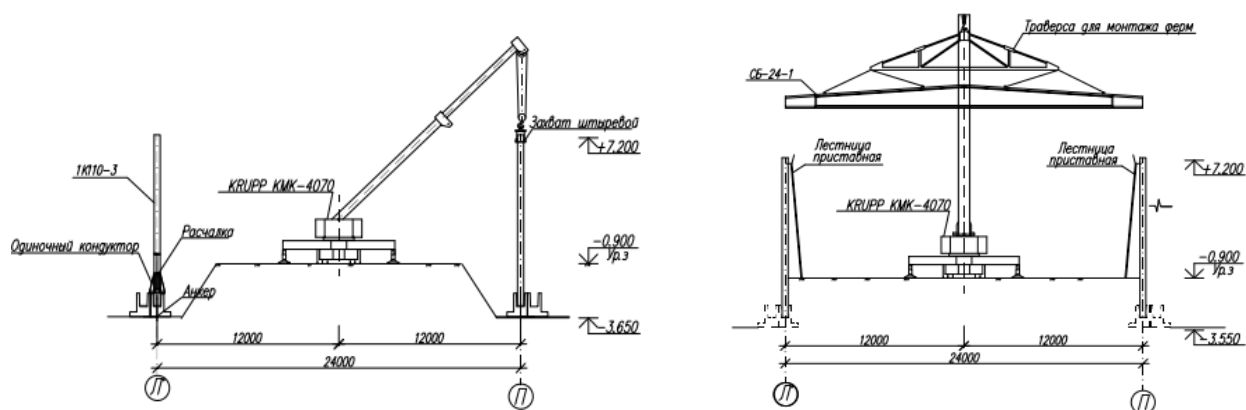


Abb. 3 - Montage des Rahmens der Sporthalle

Als Modell, das die technologischen und organisatorischen Zusammenhänge des Herstellungsprozesses der Bauarbeiten widerspiegelt, ist ein Netzwerkmodell entwickelt. Netzwerkmodelle zeigen schematisch den Ablauf von Bauprozessen und deren Beziehung zueinander. Basierend auf dem Netzmodell ist der kritische Pfad bestimmt, der die Bauzeit bestimmt, die 435 Tage beträgt.

Für die Erstellung von Schätzungen wurde das Basisindexverfahren zur Ermittlung der geschätzten Kosten angewendet. Um einen lokalen und objektbasierten Kostenvoranschlag zu erstellen, ist eine Liste der durchgeführten Arbeiten definiert und ihr Umfang ist berechnet. Die Baukosten im Jahr 2022 beliefen sich auf 145.123,24 Tausend Rubel, und der Preis für einen Quadratmeter betrug 86,8 Tausend Rubel.

Dieser Artikel behandelt die wichtigsten Entwurfsentscheidungen der Abschlussarbeit. Während der Umsetzung ist eine raumplanerische, gestalterische und technologische Lösung für den Bau entwickelt, ein Giebelstahlbetonbalken berechnet, ein Projekt für die Herstellung von Werken erstellt, die technologische Karte entwickelt und die Organisation des Baus geplant.

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## **Проектные решения здания инновационного образовательного центра в г. Тамбов**

**Е. А. Калугина**

ФГБОУ ВО «Тамбовский государственный технический университет», Тамбов, Россия  
*e-mail: kalugina01@rambler.ru*

**Аннотация.** В статье рассматриваются основные решения проекта выпускной квалификационной работы. Описана архитектурно-строительная составляющая здания. Приведены сведения об основных несущих конструкциях каркаса и способах их расчета. Представлены сведения о технологии, организации и экономике строительства.

**Ключевые слова:** архитектурное решение, железобетонные конструкции, инновационный центр, организация строительства, экономика строительства.



## **Merkmale der Anwendung von Beschichtungen in Wohngebäuden**

**P. V. Kastrikin**

Tambow staatliche Technische Universität, Tambow, Russland  
*e-mail: tarantul1994@yandex.ru*

### **Zusammenfassung**

Es ist eine Analyse der Betriebsparameter von unfertigen Beschichtungen von Wohngebäuden durchgeführt, ihre Vor- und Nachteile sind aufgedeckt.

**Schlüsselwörter:** Gebäudeabdeckung, Dachdeckung, Gebäudebetrieb.

Jedes Gebäude ist eine Struktur, die aus drei Systemen besteht: Architektur-, Bau-, Technologie und Ingenieurwesen. Das architektonisch-bauliche System umfasst zwei Hauptgruppen von Elementen: die Elemente der Gebäudehülle sind äußere Schutzkonstruktionen (Außenwände, Beschichtungen, Fenster- und Türfüllungen); die Elemente des konstruktiven Rahmens, der aus Fundamenten und inneren Baukonstruktionen besteht [1]. Als Teil der Außenhülle des Gebäudes verhindert die Beschichtung das innere Volumen und andere schutz- und tragende Strukturen des Gebäudes vor äußeren Einflüssen (atmosphärischer Niederschlag, Temperaturschwankungen, Luftfeuchtigkeit, Sonneneinstrahlung, Windeinwirkung). In diesem Zusammenhang muss die Gebäudeabdeckung eine hohe Leistung aufweisen, die Anforderungen an Wasserdichtigkeit und Witterungsbeständigkeit, Festigkeit und Haltbarkeit erfüllen und gleichzeitig wartbar sein.

In der modernen Konstruktion werden die folgenden Arten von Beschichtungen verwendet: geneigt mit einer Neigung von mehr als 10 °, flach mit einer Neigung von weniger als 10; Dachboden und unbarmherzig (kombiniert); betrieben (Dächer-Terrassen, Dächer-Badewannen) und nicht entflammbar.

Am häufigsten sind im Wohnungsbau geneigte Dächer, die für Gebäude bis zu 5 Etagen verwendet werden. Als Beschichtungen von mehrstöckigen Wohngebäuden werden auch Flachdächer und kombinierte Dächer mit einem internen Abfluss verwendet.

Die Stiftung für bürgerliche Gebäude in Tambow verfügt über eine große Anzahl von Wohngebäuden mit einer undurchsichtigen Art der Beschichtung. Sie wurden hauptsächlich nach typischen Projekten von Mitte der 1960er bis 1985 errichtet. Sie entsprechen derzeit nicht den gesetzlichen Anforderungen an die Wärmeschutzeigenschaften von Schutzkonstruktionen. Zum Beispiel wurden vor 1994 heiztechnische Berechnungen von Gebäudestrukturen unter Berücksichtigung der hygienischen Anforderungen durchgeführt, derzeit stehen die Anforderungen an die Energiespar-Bedingungen im Vordergrund.

Die Mindestdauer für den wirksamen Betrieb von Dachdeckungen in Wohngebäuden bis zur Überholung oder zum Austausch beträgt 10 Jahre, und die

Lebensdauer der Dämmschicht von kombinierten, nicht belüfteten Dächern aus Mineralwolle beträgt 10 Jahre - für ein belüftetes Dach und 5-7 Jahre - für ein nicht belüftetes Dach. In diesem Fall beträgt die Häufigkeit der Dachuntersuchungen im Rahmen der Instandhaltung des Gebäudes durchschnittlich 3-6 Monate. Nicht alle Verwaltungsgesellschaften erfüllen diese Anforderungen, da es häufige Probleme beim Betrieb von Wohnungen in den oberen Etagen gibt. Aus diesem Grund besteht die Notwendigkeit, die Mängel von Beschichtungen zu beheben und Empfehlungen zur Behebung dieser Mängel zu erarbeiten.

Kombinierte Dächer werden als Beschichtungen bezeichnet, bei denen das Dach mit der Konstruktion einer zwischengeschossigen Decke kombiniert ist. In Mehrfamilienhäusern werden die kombinierten Beschichtungen aus Stahlbetonelementen hergestellt. Die Kosten für kombinierte Beschichtungen liegen bei 10..15% niedriger als Dachdächer und die Betriebskosten sind 1,5 mal niedriger. Dabei ist diese Art der Beschichtung vorgefertigtes Material, das die Arbeitskosten bei der Einrichtung solcher Beschichtungen erheblich reduziert.

Die kombinierten Beschichtungen werden durch unbelüftete, teilweise belüftete und durch durchgehende Luftschichten belüftete Beschichtungen projiziert. Über Räumen mit trockenem und normalem Feuchtebetrieb werden nicht belüftete Beschichtungen angeordnet, über feuchten Räumen (in Bädern, Schwimmbädern) nur belüftete oder teilweise belüftete kombinierte Beschichtungen [2]. Um die Haltbarkeit von Beschichtungen zu verbessern, sollten klassische und moderne Rollmaterialien (Ruberoid, Glaskolben, Polymermembranmaterialien, Glasisol, Bicrost) als Dach verwendet werden.

Der Abfluss von kombinierten Dächern kann organisiert (außen oder innen) und unorganisiert sein. Bei der Einrichtung eines unorganisierten Abflusses ist zu beachten, dass bei freiem Wasserabfluss die Befeuchtung der Wände zunimmt, was sich nachteilig auf ihre Haltbarkeit auswirkt. Dabei bilden sich Eis und Eiszapfen an den Überhängen der Gesimse, die eine Gefahr für Fußgänger darstellen und die Umzäunungskonstruktionen des Gebäudes beschädigen.

Die am besten geeignete konstruktive Lösung für kombinierte Dächer ist die Organisation der internen Ableitung durch ein System von Wassertrichtern und Fallrohren. Ein Nachteil ist jedoch die häufige Verstopfung der Abflussgitter, was zu einer Ansammlung von atmosphärischer Feuchtigkeit auf der Beschichtung führt, wodurch die Belastung der Beschichtung und Undichtigkeiten des Daches erhöht werden. In der Regel ist die Reinigung eines Flachdachs von Schnee und Eis im Winter nicht erforderlich, da die Schneemassen unter dem Einfluss von Wärme, die aus den Innenräumen aufsteigt, aktiv schmelzen.

Ein wesentlicher Nachteil von Flachdächern ist das Fehlen der Möglichkeit, die Feuchtigkeit der Dämmschicht und die Dichtheit des Dachteppichs zu kontrollieren, die sich oft in Form von Lecks im obersten Stockwerk des Gebäudes manifestieren.

Eine Voraussetzung für die Einrichtung eines scherbenlosen Daches ist seine Isolierung unter Berücksichtigung der Energieeinsparanforderungen. Bei einer Generalüberholung des kombinierten Daches muss die vorhandene Wärmedämmung



durch eine Erhöhung des Wärmeschutzes der Beschichtung ersetzt werden. Im Falle der Überfeuchtung der Dämmung des Daches ist es notwendig, seine natürliche Trocknung durch Belüftungsöffnungen in den Gesimsen, die Produkte an den Brüstung sowie durch Belüftungsrohre sicherzustellen. Diese zusätzlichen Elemente können die Belüftung des Dämmstoffs gewährleisten und gleichzeitig die Dichtheit der Dachabdeckung beeinträchtigen und die Leistung beeinträchtigen [3].

Eine Verletzung der Dichtheit der Dampfsperre und des Dachteppichs führt zum Eindringen von Feuchtigkeit in die Isolierung. Die dichte Dichtungsschicht verhindert die Verdunstung, wodurch sich Feuchtigkeit in der Isolierung ansammelt, wodurch die Wärmedämmeigenschaften reduziert werden und nasse Flecken an der Decke entstehen. Darüber hinaus nimmt das gefrorene Wasser im Winter an Volumen zu und reißt die Abdichtung von der Basis ab. Durch mechanische Einwirkungen und Temperaturschwankungen entstehen Risse, die zum Auslaufen des Daches führen.

Angesichts des oben Genannten können die Nachteile eines Flachdachs zugeschrieben werden:

- Reduzierung der gesamten Lebensdauer des Daches aufgrund falscher Materialauswahl und verspäteter Reparaturarbeiten;
- die Ansammlung von viel Schnee bei starkem Schneefall auf dem Dach, die während des abwechselnden Einfrierens und Auftaus zu Undichtigkeiten des Dachteppichs führen kann;
- Überhitzung der oberen Stockwerke von Gebäuden im Sommer aufgrund unzureichender Dämmdicke, die den modernen Anforderungen des Wärmeschutzes nicht entspricht.

Bei der Wahl einer unfertigen Beschichtung beim Bau von Wohngebäuden ist es daher wichtig, die Anforderungen an die Materialauswahl unter Berücksichtigung zukünftiger Betriebs- und Witterungseinflüsse zu beachten, wobei nicht zu vergessen ist, dass die Elemente des Traggerüsts einzeln und als Ganzes als Konstruktionssystem des Gebäudes entworfen und dann auf der Grundlage der Notwendigkeit gebaut werden, die Anforderungen an Festigkeit, Steifigkeit und Stabilität während des gesamten Lebenszyklus des Objekts zu erfüllen.

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## Особенности применения бесчердачных покрытий в жилых зданиях

П. В. Кастрикин

ФГБОУ ВО «Тамбовский государственный технический университет», Тамбов, Россия  
*e-mail: tarantul1994@yandex.ru*

**Аннотация.** Выполнен анализ эксплуатационных параметров бесчердачных покрытий жилых зданий, выявлены их достоинства и недостатки.

**Ключевые слова:** покрытие здания, кровля, эксплуатация зданий.

## Tasks of RKS-Tambov LLC in Ensuring the Reliability of City Water Supply Networks

**T. A. Kislyakova**

Tambov State Technical University, Tambov, Russia  
e-mail: tanya392523@gmail.com

### **Abstract**

To meet the needs of the population and other consumers of Tambov in water, water supply and sanitation systems have been created and are functioning in the city. Due to the constant development of urban areas, the increase in the load on the water supply and sanitation networks, as well as due to the aging and failure of their elements, a large amount of repair and reconstruction work is necessary. In order to solve the above problems in Tambov, a concession agreement was concluded with RKS-Tambov LLC to provide all necessary services for cold water supply and sanitation. As a result of their implementation, the deterioration of existing networks will be reduced, the quality of drinking water will improve, and the leakage of industrial and domestic wastewater will decrease.

**Key words:** water supply, water disposal, concession agreement, RKS-Tambov LLC

To meet the needs of the population and other consumers of Tambov in water, water supply and sanitation systems have been created and are functioning in the city. The centralized water supply system is a complex of structures and devices designed to provide water to consumers of municipalities in the required quantity and with the required quality.

The centralized public sewerage system is designed to receive wastewater and treat it. It consists of a complex of engineering structures and devices designed to collect, transport and process wastewater from domestic, industrial and industrial activities, as well as to collect and transport rain and melt water.

Due to the constant development of urban areas, the increase in the load on the water supply and sanitation networks, as well as due to the aging and failure of their elements, a large amount of repair and reconstruction work is necessary.

At present, for the above reasons, the state of the city's water supply and sanitation systems should be considered unsatisfactory. In this regard, there are a number of problems that need to be addressed as soon as possible. These include: improving the quality of drinking water, reducing water losses during its transportation to the end consumer, improving the ecological state of soils and soil cover of the city's territories by reducing leakages of domestic and industrial wastewater.

In order to solve the above problems in Tambov, a concession agreement was concluded with RKS-Tambov LLC to provide all necessary services for cold water supply and sanitation. RKS-Tambov LLC is the successor of Tambov Communal Systems LLC and was established to implement a large-scale water and sewer modernization program in Tambov under a concession agreement that provides for an investment in Tambov municipal property in the amount of 8.8 billion rubles. for the entire period of validity. The planned activities have a social focus and are designed to

improve the quality of services provided and the environmental situation in Tambov. They are aimed at improving the quality of water purification, normalizing pressure, restoring networks that have the highest accident rate, and reducing the level of technological losses. The final consumers of the company are currently about 300 thousand people.

In accordance with the concession agreement, RKS-Tambov LLC is tasked with implementing measures for the construction, reconstruction and modernization of Tambov's water supply and sanitation systems. As a result of their implementation, the deterioration of existing networks will be reduced, the quality of drinking water will improve, and the leakage of industrial and domestic wastewater will decrease.

The first step in solving the above problems of the city is planning the development of water supply and sanitation systems.

Planning the development of water supply and sanitation systems is a complex task, the volume of necessary capital investments in these systems depends on its correct solution. An important indicator for assessing the possible development of systems is the forecast of demand for water supply services. The basis for this is the prospects for the development of the municipality, its demographic and urban changes.

Consideration of the magnitude of changes in the most general form begins at the stage of development of master plans, together with the solution of issues of changes in communal infrastructure. Decisions at this stage are preliminary predictive in nature. A justification is given for the need to build new or expand existing elements of a complex of water supply and sewerage treatment facilities (WTP, WWTP). This is necessary to cover the existing power shortage and increasing loads on the water supply and sanitation systems. Consideration of the issues of choosing the main equipment for WTP and WWTP, pumping stations, as well as laying routes for water supply and sewerage networks is carried out after a feasibility study of preliminary decisions.

The final list of measures planned for implementation includes priority measures for the creation and development of centralized water supply and sanitation systems, and improving the reliability of the functioning of these systems.

At present, measures for the development of the water supply system cover the following objects of communal infrastructure: water intake units, water treatment facilities, pumping stations, main and distributing water supply networks. Activities for the development of the sewerage system include work on collectors, intra-quarter and intra-yard sewer networks, sewer pumping stations, sewage treatment plants.

The fundamental documents in the process of planning and implementing measures for the development of water supply and sanitation systems in the city of Tambov are: The Town Planning Code of the Russian Federation of 29.12.2004 No. 190-FZ with amendments and additions; "Rules for the development and approval of water supply and sanitation schemes" and "Requirements for the maintenance of water supply and sanitation schemes", approved by Decree of the Government of the Russian Federation No. 782 of September 05, 2013; Federal Law of the Russian Federation dated December 7, 2011 No. 416-FZ "On Water Supply and Sanitation"; Federal Law

of the Russian Federation of November 23, 2009 No. 261-FZ "On energy saving and energy efficiency, and on amendments to certain legislative acts of the Russian Federation"; Decree of the Government of the Russian Federation of May 15, 2010 No. 340 "On the procedure for establishing requirements for programs in the field of energy saving and improving the energy efficiency of organizations engaged in regulated activities"; Decree of the Government of the Russian Federation dated July 29, 2013 No. 641 "On investment and production programs of organizations operating in the field of water supply and sanitation"; SP 131.13330.2020 Building climatology; SanPiN 1.2.3685-21 "Hygienic standards and requirements for ensuring the safety and (or) harmlessness of environmental factors for humans"; SanPiN 2.1.3684-21 "Sanitary and epidemiological requirements for the maintenance of territories of urban and rural settlements, for water bodies, drinking water and drinking water supply, atmospheric air, soils, residential premises, operation of industrial, public premises, organization and conduct of sanitary and anti-epidemic (preventive) measures"; SanPiN 2.2.1/2.1.1.1200-03 "Sanitary protection zones and sanitary classification of enterprises, structures and other objects"; SP 31.13330.2021 (a.r. SNIIP 2.04.02-84\* Water supply, external networks and facilities); SanPiN 2.1.3684-21 "Sanitary and epidemiological requirements for the maintenance of territories of urban and rural settlements, for water bodies, drinking water and drinking water supply, atmospheric air, soils, residential premises, and anti-epidemic (preventive) measures "; MU 3.2.1756-03 "Epidemiological surveillance of parasitic diseases"; SP 32.13330.2018 (a.r. SNIIP 2.04.02-84 Sewerage. External networks and facilities); "Rules for the technical operation of systems and facilities for public water supply and sewerage", approved by order of the Gosstroy of the Russian Federation No. 168 of December 30, 1999; "Rules for cold water supply and sanitation", approved by Decree of the Government of the Russian Federation of July 29, 2013 No. 644 "Rules for the organization of commercial accounting of water, wastewater", approved by the Decree of the Government of the Russian Federation of 04.089.2013 No. 776.

The implementation of the adopted program measures will improve the reliability and quality of drinking water supply, eliminate the claims of citizens, management organizations, city and regional authorities, improve the continuity of water supply, reduce accidents in networks, reduce water losses during transportation, improve the quality of stop valves, eliminate technological risks in water supply system, increase the reliability and quality of services, reduce the risk of untreated sewage entering groundwater.

The implementation of these measures is possible only if there is reliable and long-term funding. It is currently not possible to carry out these works only at the expense of the population. This is due to the fact that the previously existing constant underfunding of the work necessary to ensure the reliability of the systems cannot be passed on to the current consumers of resources. Other funding principles are needed. These, in particular, may include the principles used in financing the overhaul of buildings in Russia and in foreign countries [1].

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## **Задачи ООО «РКС-Тамбов» в обеспечении надежности городских сетей водоснабжения и водоотведения**

**Т. А. Кислякова**

ФГБОУ ВО «Тамбовский государственный технический университет, Тамбов, Россия  
e-mail: tanya392523@gmail.com

**Аннотация.** Для удовлетворения потребностей населения и других потребителей г.Тамбова в воде в городе созданы и функционируют системы водоснабжения и водоотведения. В связи с постоянным развитием городских территорий, увеличением нагрузок на сети водоснабжения и водоотведения, а также из-за старения и выхода из строя их элементов необходимо проведение большого объема ремонтно-реконструкционных работ. С целью решения указанных выше проблем в Тамбове заключено концессионное соглашение с ООО «РКС-Тамбов» по выполнению всех необходимых услуг по холодному водоснабжению и водоотведению. В результате их реализации сократится износ существующих сетей, улучшится качество питьевой воды, снизятся утечки промышленных и бытовых стоков.

**Ключевые слова:** водоснабжение, водоотведение, концессионное соглашение, ООО «РКС-Тамбов»

## Reinforcement of Bases of Buildings and Structures

**S. S. Kopylov\*, V. M. Antonov**

Tambov State Technical University, Tambov, Russia

\*e-mail: *sergey.kopylov.2000@list.ru*

### Abstract

The article describes a method of increasing the deformation-strength properties of the soil base by its reinforcement. The definition of reinforcement soil is given, the main purposes and tasks of reinforcement are presented, the scope of application of reinforced soils, requirements to reinforcement materials are indicated. Recommendations are given for choosing the main diagrams of soils reinforcement and reinforcing elements used.

**Keywords:** reinforcement of soils, reinforced soil structure, reinforcement materials.

Reinforcement of soils increases physical and mechanical characteristics as well as strength and deformation ones of the soil base by creating a composite material consisting of reinforcement which are exposed to shear and tensile forces, and the soil matrix, which in turn is expand compressive forces.

The main functions of reinforcement are strengthening and reinforcing embankments and slopes of earthworks, increasing stability of retaining walls by means of backfill reinforcement and increasing bearing capacity of foundations. The main advantages of reinforced massifs include rapid erection, greater durability, rational use of built-up areas, the possibility of building a variety of structures, reducing the cost of materials for the construction of foundations, etc.

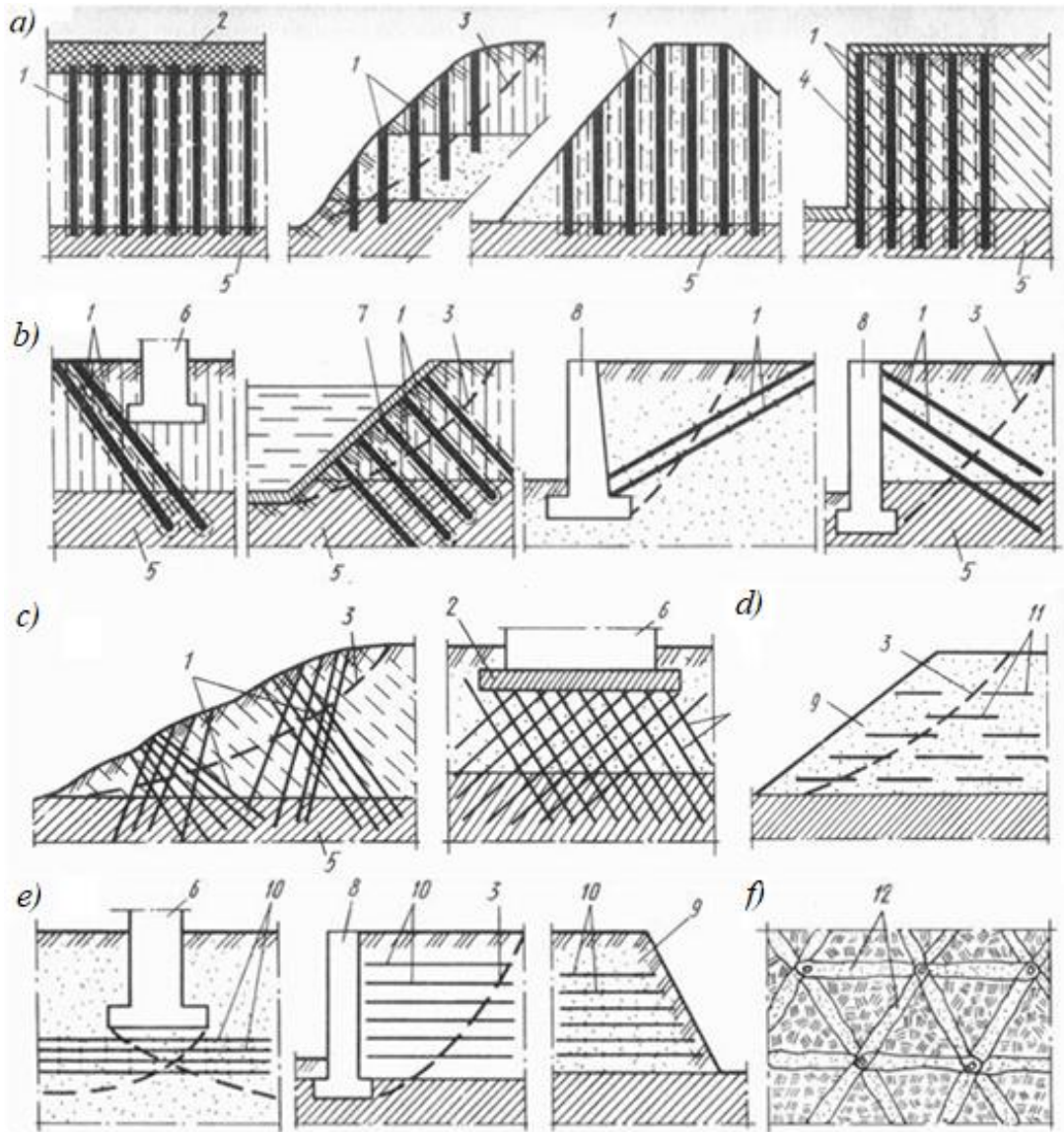
Reinforcement material is widely used in weak water-saturated, loose, bulk and sandy soils, in structurally unstable foundations in the construction of dams, dikes, bridge abutments, drainage, etc [2].

The reinforcement material is subject to the requirements of high adhesion, friction with the surrounding soil due to roughness; corrosion resistance, low cost, durability and workability. Such requirements meet: plastic, fiberglass, galvanized steel, geosynthetic materials (geotextile, geogrid, geogrid, polymeric geomembrane), polymeric fibers, aluminum alloys, rubber, etc. Soil piles and various types of injections are also used for reinforcement.

Backfill soils are subject to requirements for homogeneity of composition, moisture, electrical resistance, the value of the hydrogen index, the maximum content of  $SO_3$ , Cl [1].

The arrangement of reinforcing elements and the technology of their performance are selected depending on the physical and mechanical characteristics of the soil, the problems to be solved during reinforcement, and the peculiarities of the soil strata. Thus, the arrangement of reinforcing elements in soil masses can be vertical, horizontal, inclined in one, two or more directions, discontinuous or in the form of cellular structures (Figure 1) [4]. According to the technology of work, the

reinforcement of the soil base is divided into reinforcement by high-pressure injections, which makes it possible to perform reinforcement without losing the structure of the soil of the natural setting, with driving and indenting of inventory elements, with laying of reinforcing elements and subsequent backfilling.



*Figure 1 – Diagrams of reinforcement of soil masses:*

- a – vertical arrangement of reinforcement elements, b – inclined arrangement of reinforcement elements, c – arrangement of reinforcement elements in two directions, d – with interrupted arrangement of reinforcement elements, e – horizontal arrangement of reinforcement elements, f – cellular reinforcement of foundations;*
- 1 – continuous reinforcement elements, 2 – distribution pillow, 3 – soil sliding surface, 4 – vertical fence of the retaining wall, 5 – firm ground, 6 – foundation, 7 – slope lining, 8 – retaining wall, 9 – embankment, 10 – mesh and flexible rod reinforcement elements, 11 – discontinuous reinforcement elements, 12 – cellular reinforcement elements.*



The use of vertical reinforcement contributes to strengthening the soil base, improving the properties of the existing soil masses, reducing the settlement of existing buildings and underground utilities near the facility under construction, increasing the stability, strengthening the slopes and slopes. The distance between reinforcing elements is established based on the conditions of joint work with the adjoining ground mass and the required bearing capacity of the soil base. Reinforcing elements are concrete, reinforced concrete, slag concrete, soil cement (performed by drilling, grouting or injection) piles, metal elements, as well as cement-sand mixtures and columns of crushed stone or sandy soils.

Horizontal reinforcement is used to eliminate soil displacement from under the structure, increase the stability of embankments, soil bases, slopes and slopes, reduce the active and increase the passive pressure of the soil in the arrangement of backfill retaining walls. The materials used for reinforcement are steel rods and nets, polymer films, meshes, fabrics and fibers, geotextiles.

Inclined reinforcement in one or more directions should be used to increase the stability of slopes and slopes, increase the passive and decrease the active pressure of the soil on retaining walls, increase the strength and deformation characteristics of soil bases both in new construction and, for instance, in reconstruction. Inclined reinforcement can be performed by means of jetting and boring technology as well as with the use of piles. The materials for uniaxial reinforcement are the same as for vertical reinforcement with the exception of crushed stone, slag and soil cement. Concrete and reinforced concrete are used for sloping reinforcement in multiple directions.

Intermittent reinforcement is mainly used in the construction of embankments to increase their stability. Laying of reinforcing elements takes place during layer-by-layer embankment construction. The reinforcing materials are concrete, reinforced concrete, steel and plastics.

The use of reinforcement in the form of cellular structures contributes to the strengthening of soil masses, strengthening and increasing the stability of retaining walls, embankments and slopes. The main reinforcement materials are mortars based on cement, polymers and liquid glass.

For reinforcement of soil bases the technology of helical piercing of wells by spiral shells can be used [3]. Wells in the ground can be developed by the technology of deep compaction or deep consolidation. Ground consolidation around the boreholes can be accomplished by multiple penetrations and filling the boreholes with material. Materials such as cement-sand mixtures, concrete, slag, slag concrete, etc. can be used to fill the wells.

Thus, soil reinforcement, which improves many characteristics and properties of soil masses, is an important and promising direction in construction. Its application allows to significantly reduce the cost of construction of foundations and hence the cost of construction as a whole.

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## Армирование оснований зданий и сооружений

С. С. Копылов\*, В. М. Антонов

ФГБОУ ВО «Тамбовский государственный технический университет», Тамбов, Россия  
*\*e-mail: sergey.kopylov.2000@list.ru*

**Аннотация.** В статье описывается способ повышения деформационно-прочностных свойств грунтового основания его армированием. Приведено определение армогрунта, представлены основные цели и задачи армирования, обозначена область применения армированных массивов, требования к армоматериалам. Даны рекомендации по выбору основных схем армирования грунтов и используемых армоэлементов.

**Ключевые слова:** армирование грунтов, армогрунтовое сооружение, армоматериалы.

## The Use of Structural and Insulating Gas Silicate Blocks in Low-Rise Construction

**O. A. Korchagina, A. S. Miskov**

Tambov State Technical University, Tambov, Russia

*\*e-mail: amiskov666@gmail.com*

### Abstract

The analysis of gas silicate blocks of autoclave and non-autoclave hardening in low-rise construction is given. The main characteristics of this material are considered from both the structural and thermal engineering points of view.

**Keywords:** gas silicate block, autoclave hardening, construction, non-autoclave technology.

At present, in the Russian Federation, such a building material as a "gas silicate block" has become widespread. This building material raises many questions among those who decide to build their own home. The main reason why gas silicate blocks are chosen as a building material is their low cost, as well as a high energy efficiency.

This type of housing construction is very popular both in the northern and in the central and southern regions of the Russian Federation. One of the main factors of such houses is not only energy efficiency, but also environmental friendliness, speed of construction, as well as the economic component of the building.

Gas silicate has a lot of advantages, and this explains its great popularity. Approximately 60% of low-rise buildings in Tambov are built from this material. From the point of view of ordering materials, this is also simple, since Lipetsk is located near the city of Tambov with its own enterprise, high-quality products and good geometry for the manufacture of gas silicate blocks. It is them that we will apply to our object of study [1,2].

The technology of building a house from gas silicate blocks was studied, compared with the real situation for the installation of structures. Many private developers follow the wrong technology for installing gas silicate structures: they forget about masonry reinforcement, wall thickness is not taken from calculations and taking into account the thermal characteristics of the building, etc.

The construction of gas silicate blocks is shown in figure 1.

But if the correct procedure for the installation of structures made of gas silicate blocks is observed, then the object turns out to be very high-quality, warm and energy efficient, any finishing options are available, good noise absorption. But at the same time, one should not forget that more stringent requirements are imposed on the foundations. There are also obvious "cold bridges", in particular, vertical masonry joints, armored belt, or the use of concrete lintels above windows and doors. In this regard, it is often necessary to insulate the building also from the outside. There is also seasonality, i.e. wet work or work involving water.



*Figure 1 - The construction of gas silicate blocks*

Gas silicate blocks are made only by autoclave. Aerated concrete blocks can be made both by autoclave and non-autoclave method (natural hardening of the mixture):

Autoclave processing. This stage significantly improves the technical characteristics of gas silicate. Here for 12 hours at high pressure steam treatment is carried out, the temperature of which is almost 200°C. This heating process makes the texture more uniform, thereby improving the strength properties (not less than 28 kgf/m<sup>2</sup>). Its specific thermal conductivity is 0.09-0.18 W (m·K), which makes it possible to erect walls in one row (400 cm) in almost any climatic conditions, but excluding the northern regions.

Non-autoclave technology. It consists in the natural hardening of the mixture: moisturizing and drying in natural conditions. In this case, it is quite possible to make it yourself, since no special equipment is required here. The strength of blocks in such production does not exceed 12 kgf/m<sup>2</sup>.

As a comparison, we present the characteristics of both materials. Characteristics of materials are given in table 1.

Depending on the proportions of the initial ingredients, a product with different performance characteristics can be obtained. The thermal conductivity coefficient of the gas silicate block depends on its density and is determined by the marking: D300, D400, D500, D600, D700 [3-6].

*Table 1 - Characteristics of materials*

Characteristics	Non-autoclaved aerated concrete	Autoclaved aerated concrete
Density (kg/m <sup>3</sup> )	D600-D800	D400-D700
Frost resistance class	F15 — F30	F15 0
Thermal conductivity (W/ms)	0.19	0.15
Vapor permeability	0.2	0.18
Flammability class	incombustible	incombustible
Strength	B1.5 — B2.5	B2.5 — B5
Durability	50 years	150 years

The thermal conductivity of gas silicate depends on a number of factors:

- Dimensions of the building block. The greater the thickness of the wall block, the higher its heat-insulating properties.
- Environmental humidity. Material that absorbs moisture reduces the ability to store heat.
- Structure and number of pores. Blocks that have a large number of large air cells in their structure have increased thermal insulation performance.
- Density of concrete partitions. Building materials of increased density retain heat worse.

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## Применение конструкционных и утепляющих газосиликатных блоков в малоэтажном строительстве

**О. А. Корчагина, А. С. Миськов\***

ФГБОУ ВО «Тамбовский государственный технический университет», Тамбов, Россия

*\*e-mail: amiskov666@gmail.com*

**Аннотация.** Приведен анализ газосиликатных блоков автоклавного и неавтоклавного твердения в малоэтажном строительстве. Рассмотрены основные характеристики данного материала как с конструкционной, так и с теплотехнической точки зрения.

**Ключевые слова:** газосиликатный блок, автоклавное твердение, сооружение, неавтоклавная технология.

## Thermal Modernization of Enclosing Structures of Mid-Rise Residential Buildings

O. A. Korchagina, O. V. Semenova\*

Tambov State Technical University, Tambov, Russia

\*e-mail: [olgammusya@yandex.ru](mailto:olgammusya@yandex.ru)

### Abstract

A detailed description of energy-efficient facade systems of mid-rise residential buildings is given. The most energy-efficient heat-insulating and finishing materials for thermal modernization of buildings have been selected.

**Keywords:** thermal modernization, mid-rise buildings, construction, ventilated facade, wall construction.

When developing an energy-efficient thermal protection technology, it is necessary to proceed from the architectural and planning solution and the climatic area of construction, these parameters are decisive in the heat load on heating, ventilation or air conditioning systems.

As practice shows, about 40% of thermal energy in winter is actually spent on heating the air outside. Of this amount, approximately 40% of the losses are on the walls, 20% on window and door openings, 20% on the roof, 20% on the basement and the ventilation system. In relation to external walls, the following energy efficiency measures are taken to minimize these energy losses:

- insulation of enclosing structures with the creation of an inextricable contour of thermal insulation;
- the choice of thermal insulation that retains its qualities for many years of service.

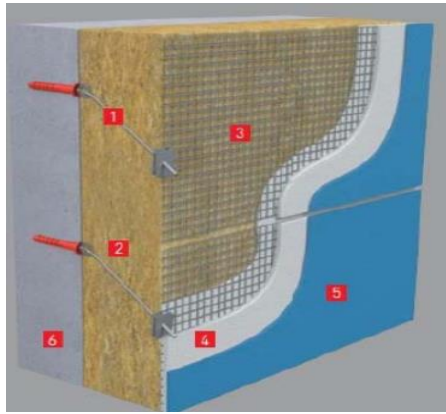
The main measures to improve the energy efficiency of facade systems depend on the types of facade systems themselves, which are divided into various subsystems.

Of the traditional facade systems, the most common is the option in which the wall performs not only a bearing function, but also the function of thermal insulation, while the facade layer created using clinker bricks is designed to provide decorative expressiveness and protection from negative environmental factors.

Plaster facade systems (“wet facade” with thin or thick plaster) are single-layer or multi-layer facade composites protected from the adverse effects of the external environment by conventional plaster compositions designed to create a smooth surface for protective and decorative painting. For thin plaster, both light plasters with a water-repellent covering (closing) layer and ordinary plasters reinforced with mesh are used [1,2].

The thick plaster system implies a multi-layer structure, shown in figure 1.

In the system of thick facade plaster, expansion joints are provided, which are located every 12 ... 15 m horizontally and vertically.



*Figure 1 - Thick plaster construction*

*1 - fastener of three parts (anchor part, movable hook and two fixing plates);  
2 - stone wool insulation; 3 - welded mesh; 4 - priming and wounding solution; 5 -  
lime-cement facade plaster; 6 - building envelope*

Usually, thin plastering refers to plastering work using traditional mortars or light innovative mortars with increased thermal insulation characteristics, which are then covered with decorative paints. Meanwhile, there is a multi-layer facade insulation on the market, called thin plaster (see figure 2).



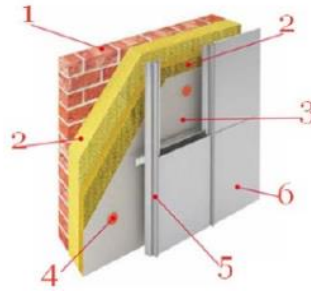
*Figure 2 - Fine plaster construction*

*1 - glue and reinforcing putty; 2 - stone wool insulation;  
3 - facade dowel; 4 - reinforcing putty; 5 - fiberglass mesh; 6 - soil layer; 7 -  
decorative mineral plaster; 8 - facade silicone paint; 9 - base profile; 10 - docking  
element; 11 - basement dowel; 12 - roughness compensator*

As can be seen from the design, the installation of multi-layer thin plaster is carried out not by fasteners, but by gluing, followed by layer-by-layer protection and surface finishing with plaster reinforcing and decorative layers in the form of facade silicone paint.

Ventilated façade systems are structural systems consisting of cladding plate and sheet materials and a sub-cladding structure, which is attached to the wall in such a way that a ventilated air gap is formed between the cladding and the wall.

The ventilated facade system consists of a supporting frame, insulation and cladding panels shown in figure 3.



*Figure 3 - The ventilated facade system consists of a supporting frame, insulation and cladding panels*

*1 - enclosing structure; 2 - mineral wool plate; 3 - waterproof membrane; 4 - fastener; 5 - guides; 6 - decorative cladding panel*

Due to the temperature difference between the room and the street, a heat flow is formed, the movement of which is directed from a heated environment to a cold one. The use of the construction of the considered type is effective in solving the problem associated with the migration of steam, since in this case it is supposed to create a special ventilated air gap between the cladding and the insulation, due to which the cold outside air, in contact with the warmer surface of the insulation, heats up and rises. This prevents the process of steam condensation and, as a result, prevents the increase in humidity.

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### **Термомодернизация ограждающих конструкций среднеэтажных жилых зданий**

**О. А. Корчагина, О. В. Семенова\***

ФГБОУ ВО «Тамбовский государственный технический университет», Тамбов, Россия

\*e-mail: [olgammusya@yandex.ru](mailto:olgammusya@yandex.ru)

**Аннотация.** Приведено подробное описание энергоэффективных фасадных систем среднеэтажных жилых зданий. Выбраны наиболее энергоэффективные теплоизоляционные и отделочные материалы для термомодернизации сооружений.

**Ключевые слова:** термомодернизация, среднеэтажные здания, конструкция, вентилируемый фасад, стеновая конструкция.



## **Analysis of wood as a structural building material and its use in low-rise housing construction**

**O. A. Korchagina, O. M. Shelesty\*, Yu. I. Kuznetsova**

Tambov State Technical University, Tambov, Russia

*\*e-mail: Olga-Shelestiy@yandex.ru*

### **Abstract**

An analysis of wood as a structural building material was made, a number of advantages, structural and thermal characteristics of the use of timber in low-rise construction were described.

**Keywords:** wood, glued laminated timber, construction, wooden structures, lumber.

The diverse properties of wood, its indescribable beauty, the ability to create various forms with it, as well as the reliability, strength of wood and its ability to withstand heavy loads, contributed to the construction of numerous valuable architectural structures.

Wood is the only building material renewable in nature. During the year, almost 1 billion m<sup>3</sup> of wood ripens in the forests, while less than half is harvested.

Wooden structures are used in buildings and structures for various purposes, especially if architectural expressiveness, chemical resistance, radio transparency, and lightness are required [1,2].

Wood construction has the following advantages:

- wood is a relatively light material;
- it is easy to process, both in factories and on construction sites;
- building parts made of wood can be connected in various ways;
- wooden structures allow you to create forms that are difficult or not feasible when using other materials;
- wooden structures are often more economical than concrete or other massive structures;
- wood has a number of valuable construction and physical properties, such as high heat capacity.

The ease of construction (the ratio of the density of the material to its design resistance) for the main structural materials is: for fiberglass -  $1.7 \times 10^{-4}$  1 / m, for wood -  $3.1 \times 10^{-4}$  1 / m, for low-carbon steel -  $3,7 \times 10^{-4}$  1/m, for concrete -  $18.5 \times 10^{-4}$  1/m. The lower the value, the relatively lighter the structure, which is very important when designing and building large span structures. The fibrous structure is better resistant to variable loading than crystalline structures. The endurance of wood is higher than that of steel and reinforced concrete.

Wooden structures also have disadvantages that limit their use. To neutralize these shortcomings, special measures are needed. The danger of decay and fire, shrinkage, swelling, heterogeneity of the structure and the presence of natural defects can be eliminated by creating a drying mode of operation, using antiseptics and fire

retardants, and gluing boards with cut out defects.

Wood combustion occurs at a temperature of 350 °C. Under the action of fire, wood is slowly charred, and elements from it retain their bearing capacity for some time under fire conditions. Therefore, the fire resistance of wooden load-bearing elements of massive section is much higher than metal elements and somewhat lower than reinforced concrete ones.

In recent years, housing decoration with this material has found great application. Entering a room finished with wood, we usually feel good, because wood is a “warm” and environmentally friendly natural building material [3]. The natural color of the wood also gives us a pleasant feeling, its yellowish and brownish coloring we again tend to define as warm.

The main condition for the profitability of logging is the maximum completeness of the use of raw materials, including roots, branches, and even barks and needles, which are used in the manufacture of pressed board materials. All lumber is expedient to be dried on site using solar energy, rather than transporting water around the country. Lumber that has passed the final hot drying ( $> 80\text{ }^{\circ}\text{C}$ ) is sterilized; during transportation, they can be packed tightly without gaps, which allow full use of the internal volumes of freight cars. When stored in a warehouse, one does not have to be afraid of either cracking or decay, the quality of sawn timber even increases due to the relaxation of internal shrinkage stresses.

The advantage of glued timber is that the house built with its help does not shrink and is immediately suitable for living in it.

Glued laminated timber is made from lamellas - small do-juice. Their thickness and length can be absolutely any (manufacturer decides). Glulam has a number of advantages, among which the main thing is the complete and uniform drying of the lamellas.

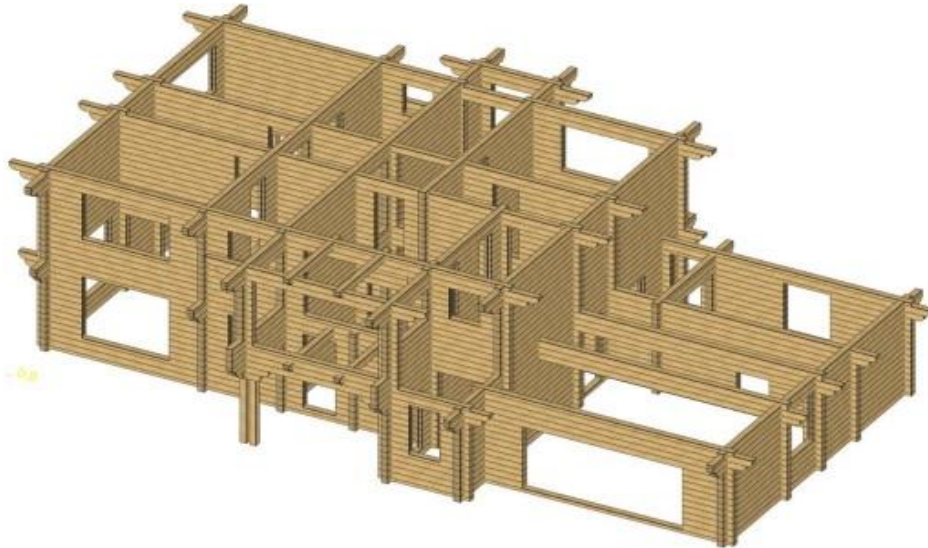
Glued profiled timber is shown in Fig.1.



*Figure 1 - Glued profiled timber*

Having decided to build a country house from glued beams, you need to imagine what you get in the end.

An example of the assembly of structural elements of a timber building is shown in Fig. 2.



*Figure 2 - An example of the assembly of structural elements of a timber building*

Houses made of glued beams are characterized by excellent heat and air exchange, reducing the ventilation requirements for the premises. Houses built from glued beams warm up very quickly and retain heat inside. To get the most out of this, heating needs:

- warming up the entire structure in depth (the effect of the Russian stove);
- the fastest heating rate;
- impact on the air mass in the room should be minimized;
- economy.

Only infrared heating, which has become widespread in the last two decades in the Scandinavian countries as the most environmentally friendly and most economical, can boast of similar characteristics.

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### **Анализ древесины как конструкционного строительного материала и его использование в малоэтажном домостроении**

**О. А. Корчагина, О. М. Шелестий\*, Ю. И. Кузнецова**

ФГБОУ ВО «Тамбовский государственный технический университет», Тамбов, Россия

*\*e-mail: Olga-Shelestiy@yandex.ru*

**Аннотация.** Произведен анализ древесины как конструкционного строительного материала, описаны ряд преимуществ, конструктивных и теплотехнических характеристик использования бруса в малоэтажном строительстве.

**Ключевые слова:** древесина, клееный брус, конструкция, деревянные конструкции, пиломатериалы.

## Features of Connection of Wall Elements and Development of Measures to Increase the Durability of a Beam Building

O. A. Korchagina, D. V. Vlasova\*, Yu. I. Kuznetsova

Tambov State Technical University, Tambov, Russia

\*e-mail: dashavlasova1@yandex.ru

### Abstract

The process of assembling the elements of a timber building, the correct installation and the necessary tools are given. Measures have been developed to increase the durability of the building, storage and transportation of parts of a timber structure according to the schemes of «TAMAK»

**Keywords:** timber house, installation, parts, studs, wall structure.

### Introduction

Low-rise housing construction is considered as a key tool for improving the living conditions of the population, solving the problems of dilapidated housing, and overcoming crowding in large cities. The very idea of developing low-rise construction is very important for society - it is the strengthening of family values, the formation of a new way of life, and the opportunity for a person to become an owner.

The process of assembling a log house is similar to assembling a log house from an ordinary log. On the foundation, waterproofing is laid in 3-4 layers. On top of the waterproofing, a mortgage board and an overlay crown are installed.

An important point that determines the quality of the entire subsequent assembly is the installation of the entire crown exactly on the same level. Even with the exact execution of the foundation, differences in height can occur, sometimes very significant. These differences can be eliminated by placing shims and checking their position with a level. Another way to adjust the base is to cut the base board in order to obtain a horizontal surface.

When assembling a timber building, regardless of the profile used, you will need the minimum necessary set of tools: a saw, a drill, a hydraulic or laser level, a construction stapler, a sledgehammer, as well as interventional insulation, wooden dowels, metal studs.

The technology of screeding glued laminated timber with studs is shown in Fig. 1.



Figure 1 - The technology of screeding glued laminated timber with studs

When erecting a log house from profiled timber, a ready-made house kit is produced at the manufacturing plant. The output is actually a set-designer, where each part is numbered.

Installation of studs, dowels and log shrinkage compensators is carried out on installation according to the drawings.

Diagrams of wall structures, a general view and a plan with the designation of elements are presented in Fig. 2.

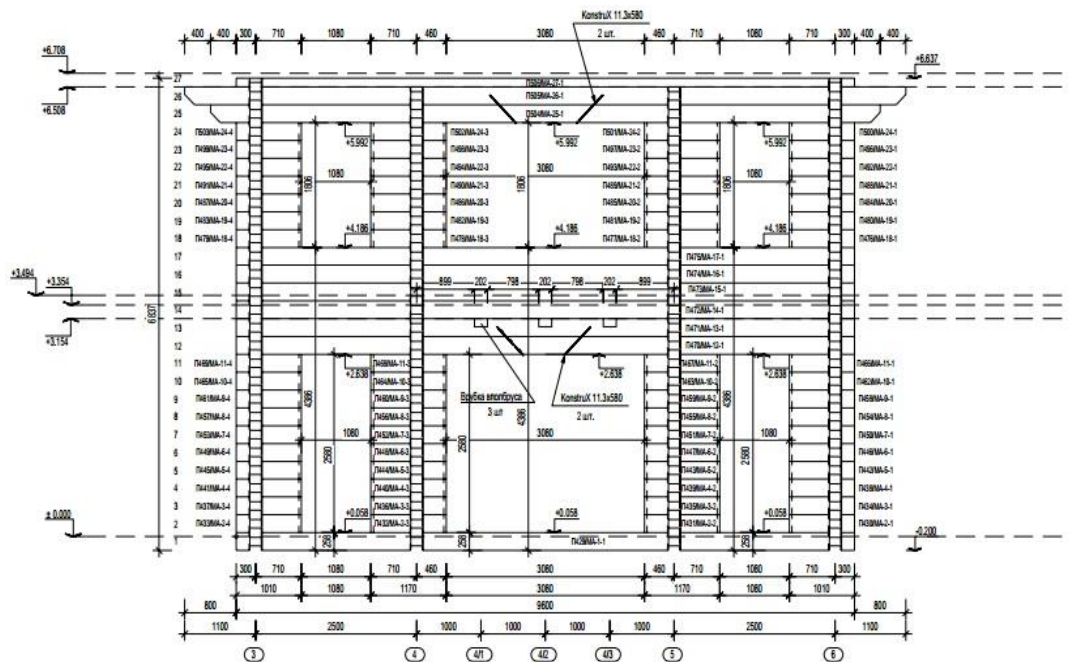


Figure 2 - A-axis wall

It is recommended to impregnate the wooden elements of the building with the Poly-fluid composition to protect against waterlogging. The rafter system is recommended to be treated with an antiperine composition. Coat steel fasteners: bolts, screws, plates, nuts, washers, etc. with anti-corrosion compounds.

Installation of building structures is carried out after checking the design dimensions of the foundations both in the horizontal plane and checking the height marks of the basement.

Initially, the installation of the lower rims of the building is carried out. In the future, the installation of timber walls is carried out. At the junction of the beam, lay interventional insulation.

Installation of structural parts must be carried out strictly in accordance with the design documentation. Installation of unpacked parts should be carried out within 1-2 days. Every day, wall parts are tightened with studs until gaps in the gear connection are not more than 2-3 mm, which is controlled at the ends of the parts and clamped with nuts through oversized washers.

The assembled parts at night must be covered from atmospheric precipitation and night dew to prevent moisture in the structures, which can lead to a change in geometric dimensions and the formation of mold. Periodically check the height marks

of the timber walls and the diagonal.

In the process of joining, assembling, prevent deformation of products, their installation in the working position. Parts and products made of sawn timber should be stored stacked in time sheets on gaskets in conditions that do not allow them to get wet.

When packing, loading, transporting, unloading and storing parts, it is necessary to take measures to prevent their moistening and contamination with a plastic film.

Wall profiled timber must be manufactured in strict accordance with the technical specifications.

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## Особенности соединения стеновых элементов и разработка мероприятий по увеличению долговечности брусового здания

О. А. Корчагина, Д. В. Власова\*, Ю. И. Кузнецова

ФГБОУ ВО «Тамбовский государственный технический университет», Тамбов, Россия

\*e-mail: dashavlasova1@yandex.ru

**Аннотация.** Приведен процесс сборки элементов брусового здания, правильность монтажа и необходимые инструменты. Разработаны мероприятия по увеличению долговечности здания, хранению и транспортированию деталей брусового сооружения по схемам АО «ТАМАК».

**Ключевые слова:** брусый дом, монтаж, детали, шпильки, стеновая конструкция.



## **Analysis of Emergencies and Hazards Affecting Humans and Environment in the City of Tambov**

**K. V. Krayushkina\*, T. F. Yelchischeva**

Tambov State Technical University, Tambov, Russia

\*e-mail: *KKV.2000@mail.ru*

### **Abstract**

The purpose of the study is to analyze emergency situations, harmful and dangerous factors affecting the life and health of people, as well as the environment in the city of Tambov. In the course of the study, emergency situations and harmful, dangerous factors were identified and examples of their consequences were given. The relevance of the study is the wide spread of dangerous situations, as a result of which it is necessary to analyze their consequences and develop measures to prevent them.

**Keywords:** harmful factors; danger; consequences of the emergency; emergencies.

In the city of Tambov there are a number of economic facilities, during the operation of which various emergencies can occur. These are a television and radio tower (121 Michurinskaya St.), Donskoye– Airport (Donskoy village, Aeroportmicrodistrict, 3), a military airport and an airbase, a railway station (1 Privokzalnaya Square St., 1), JSC Pigment (Montazhnikov str., 1), JSC Tambovnefteprodukt (Pionerskaya str., 9a), Production unit Tambov CHPP, which supplies electricity to the entire city and (Pr. Energetikov str., 7), city dump, etc. Each object can contribute to emergencies.

Transport is also a big risk. Accidents with chemical hazardous substances in road, rail and air transport can cause the spread of contaminated air up to 20 km or more from the place of release, soil pollution.

The location of objects within the city exposes the entire city to the risk of air pollution due to accidents. On August 7, 2019 in Tambov, a freight train with gasoline tanks derailed; traffic in the south of the city was paralyzed in the area of the oil depot [1]. At a distance of 7–8 km from the city center there is a Pigment JSC plant, where dyes, pigments, paints and varnishes are stored, used, transported, and produced, and most of the enterprise's workshops are classified as hazardous production workshops [2]. On November 19, 2015 at Pigment JSC there was a major technological accident, with depressurization of a tank with hydrochloric acid, 50 tons of HCL spilled, the affected area was 73.5 thousand m<sup>2</sup>. The territory of the plant, the area and the population were in the affected area [3]

A characteristic danger for the territory of the city of Tambov is smoke from natural and man-made fires. Due to the proximity of crop fields, forest land in hot weather. On September 27, 2020 in a forest area 6 km southeast of the village. Tulinovka there was a serious fire. 10 acres of forest caught fire and smoke formed [4]. On September 5, 2022 in the city of Tambov, haze from forest fires in the Ryazan region was recorded.

There may be short circuits, power surges or other electrical problems in or near the TV/radio tower, which could result in a fire. On April 14, 2021 on the territory of

the CHPP, an administrative building partially collapsed, the roof of the building of the Main control panel of the station collapsed, and two workers were pulled out from under the rubble.

There are no emergencies associated with biological and social hazards. The epidemiological and epizootic situation in the city remains relatively favorable, the likelihood of epidemics in seasonal diseases such as influenza, COVID-19, SARS, dysentery, hepatitis remains in December 2022. Less than 10 people a day become infected.

Heavy precipitation and its long duration can be dangerous for residents, tourists, objects and the environment. They may initiate other types of emergencies:

- Intense snowfalls paralyze transport, cause damage to trees and buildings due to snow load, due to snow sticking, communication lines can break, snow falling from the roof is dangerous for people and objects. On November 14–15, 2022 in the Tambov region, 141 accidents were registered due to bad weather conditions caused by snowfall.

One of the serious incidents that happened in the conditions of snowfall was recorded in the Tambov region. the driver of a passenger car in snowfall conditions was not convinced of the safety of the maneuver and went to overtake. The foreign car skidded into the oncoming lane, where it collided with a KamAZ in the trailer. As a result of an accident, the driver of the car and his passenger died on the spot before the arrival of the ambulance.

- intense downpours cause flooding and flooding of territories and objects, soil erosion. On June 10, 2021 due to heavy rain, the roads were flooded, and the roofs could not withstand the onslaught of water: in house No. 24G on the street. Bastion flooded dozens of apartments.

- extremely low amounts of precipitation lead to drought, danger of forest fires, shallowing of rivers, difficulties in water supply. On August 1, 2010 in the Tambov region, a forest fire of anomalous heat broke out.

- Ice and freezing of ice on roofs lead to injuries to pedestrians, accidents on the roads, damage to the soil from the formed icicles. On December 24, 2018 ice that fell from the roof of the house injured a 9-year-old child.

Waste at organized and unorganized landfills, spontaneous dumps pose an epidemiological hazard due to the processes of decomposition of anaerobic bacteria in the depths of the garbage heap, and the release of toxic biological gas, one of the components of which is methane. There is a deep contamination of the soil, the stinking air is carried by the wind over long distances, groundwater is infected.

The analysis of sources allows us to conclude that the possibility of emergency situations in the city of Tambov is very extensive, therefore, further research will be devoted to the development of urban planning measures to minimize emergency situations and their consequences.

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## **Анализ чрезвычайных ситуаций и вредных опасных факторов, влияющих на человека и окружающую среду в городе Тамбове**

**К. В. Краюшкина\*, Т. Ф. Ельчищева**

ФГБОУ ВО «Тамбовский государственный технический университет», Тамбов, Россия

*\*e-mail: KKV.2000@mail.ru*

**Аннотация.** Целью исследования является анализ чрезвычайных ситуаций, вредных и опасных факторов, влияющих на жизнь и здоровье людей, а также окружающую среду в городе Тамбове. В ходе исследования выявлены чрезвычайные ситуации и вредные, опасные факторы и приведены примеры их последствий. Актуальностью исследования является широкое распространение опасных и вредных ситуаций, в результате чего необходим их анализ последствий и разработка мероприятий для предупреждения их.

**Ключевые слова:** вредные факторы; опасность; последствия ЧС; чрезвычайные ситуации.

## Steel Frames of Variable Section in Modern Construction

**I. A. Markin**

Tambov State Technical University, Tambov, Russia  
*e-mail: igormarkin09@gmail.com*

### **Abstract**

The article discusses the area of use of steel frames of variable section, advantages and disadvantages, the main parameters, shows typical series and some examples of implementation.

**Keywords:** frame of variable section, municipal buildings, industrial building.

### **Introduction**

Steel frames of variable section are single or multi-span frames of U-shaped or polygonal shape with sections of crossbars or racks that vary along the length. This article discusses the scope of these structures, characteristics and implementation examples.

### **Application area**

Frameworks made of steel frames with variable stiffness are widely used in one-floor public and industrial buildings. Most often, such frames are used for spans from 12 m to 36 m, and if necessary, the span can reach 100 m, for example, in aircraft hangars. It is possible to use such frames in industrial buildings with crane equipment. In addition, this type of frame is used for storage buildings as roof structures.

The advantages of steel frames of variable cross section include: relatively small dimensions compared to lattice structures, high bending rigidity, the ability to place an enlarged joint anywhere in the structure, which makes it possible to more effectively divide structural elements into shipping marks.

The disadvantages of these structures include the following. At the early stages of the introduction of these designs, the disadvantage was the laboriousness of manufacturing. With the development of welding technology, this disadvantage has become insignificant. Another disadvantage is the complexity of the calculation of these structures.

### **Main parameters and characteristics**

Variable section frames have a number of parameters [2]. These include: the span value, the number of spans, the slope of the upper chord, the number of hinge nodes, the type of the support node on the foundation, the type of the junction of the crossbar and the rack, the dimensions and type of the cross section, steel. In a more detailed examination of the frame elements, the following characteristics are distinguished: element length, wall height, shelf width, shelf thickness, wall thickness, flange thickness, base plate thickness, support rib thickness, stiffener thickness, angles of inclination of the belt and ends of the elements, legs of welds.

In accordance with the above parameters, the frames can be divided into the following types.

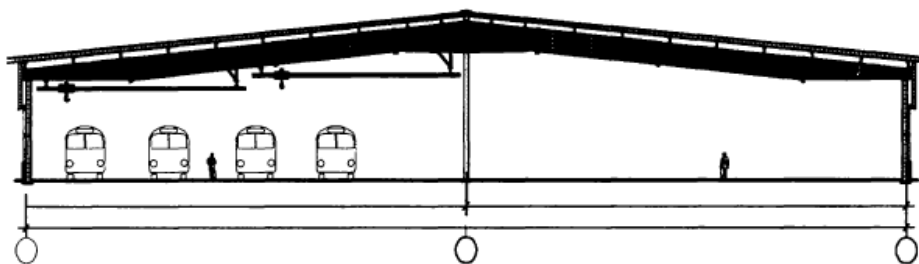
1. According to the principle of operation of the frame: frames made of flat or spatial frames, spatial frames made of flat frames with a system of special spatial connections.
2. By the number of spans: single-span and multi-span.
3. According to the span: small (15 m - 18 m), medium (18 m - 36 m), long-span (36 m - 120 m).
4. By configuration: U-shaped, with a slope of racks and crossbars, with a polygonal outline.
5. According to the static scheme of a single-span frame: two-hinged, three-hinged, frames with rigid junctions of a rack with a foundation and a rack with a crossbar, frames with a rigid junction of a rack with a foundation and a hinged junction of a crossbar with a rack.
6. According to the static scheme of a multi-span frame: frames with hinged junctions of racks with foundations and with hinged mates of all racks except for the outer ones with a crossbar, frames with split and continuous crossbars and with rigidly clamped posts, frames with developed middle posts, mixed frames.
7. By type of section: frames with a section of welded I-beams with flat walls, from rolled I-beams of constant and variable section, from welded I-beams with a corrugated wall, frames with a box section.

#### **Implementation examples**

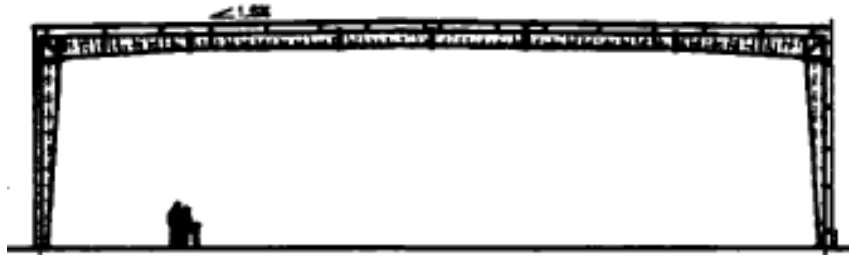
There are certain series of frames of variable section, which can be divided into domestic and foreign. Among the domestic ones, UNIKON is the most used [3]. Among the foreign ones are BUTLER, Robertson System, CONDOR.

Let's consider some examples of the implementation of buildings and structures with a supporting frame of frames of variable section. The first example is the trolleybus plant in Kyiv. Figure 1 shows a building with a continuous crossbar of variable cross section. The building has 2 spans of 36 m each. The height of the crossbar varies along the length and has a value of 600 mm on the support and 1500 mm above the middle post. Frame pitch - 12 m. Steel consumption for the production of those frames amounted to 14.7 kg per 1 sq. m. of the building. The building is equipped with an overhead crane.

Figure 2 shows the building of a sports complex in Yekaterinburg. A frame with a variable section is used as a supporting frame. In this case, the span is 42 m. The use of frames of variable section in this case made it possible to obtain the maximum value of the usable volume of the building. Therefore, these frames are often used in sports buildings.

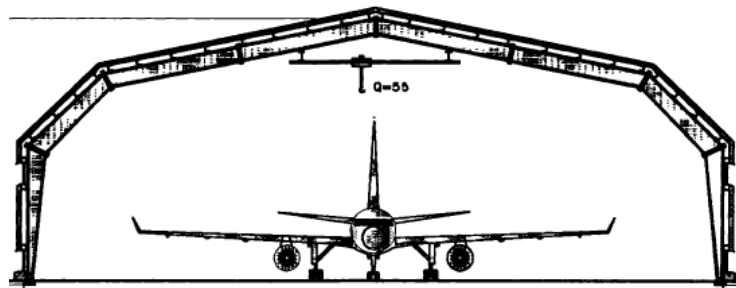


*Figure 1 - Trolleybus plant in Kyiv*



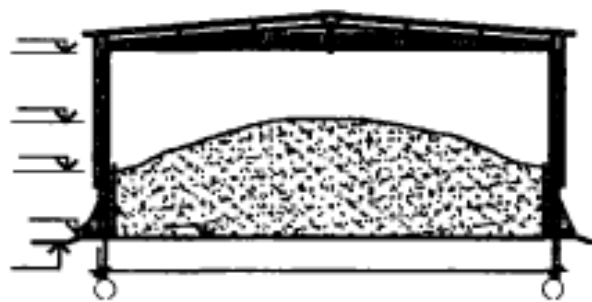
*Figure 2 – The building of the sports complex*

Figure 3 shows a hangar for Tu-204 and Il-76 aircraft. The span of the frame is 60 m. This building is equipped with an overhead crane. In this case, the frame has a polygonal outline. Frame bends are implemented by means of flange connections at the bends. The polygon outline allows you to get the building of the required height, which allows you to place airplanes inside.



*Figure 3 – Hangar for Tu-204 and Il-76 aircraft*

Figure 4 shows a cross-section of a warehouse-type building made using variable-section frames. In this case, the frame itself is used to a greater extent for the construction of coating structures. Massive reinforced concrete foundations are used to hold the stored material.



*Figure 4 – Warehouse building for anti-icing materials*

## **Conclusion**

This article discusses the main areas of application of steel frames of variable section, advantages and disadvantages, main characteristics and some examples of implementation. These structures are used in public and industrial buildings. Moreover, spans of frames can reach 100 m. Also, the design of frames allows you to create buildings with an effective ratio of useful and total volumes of the building with

a more rational use of the bearing capacity of structures in compliance with the requirements [1].

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## Стальные рамы переменного сечения в современном строительстве

**И. А. Маркин**

ФГБОУ ВО «Тамбовский государственный технический университет», Тамбов, Россия  
*e-mail: igormarkin09@gmail.com*

**Аннотация.** В статье рассмотрены область использования стальных рам переменного сечения, достоинства и недостатки, основные параметры, показаны типовые серии и некоторые примеры реализации.

**Ключевые слова:** рамы переменного сечения, общественные здания, промышленные здания.

## The Influence of Noise Barriers on the Formation of the Urban Environment

O. A. Medvedeva, O. A. Zhogoleva\*, I. V. Matveeva

Tambov State Technical University, Tambov, Russia

*e-mail: zhogoleva.olga@rambler.ru*

### Abstract

When designing noise barriers separating existing urban development from traffic arteries, it is necessary to assess their impact on the urban environment. This article discusses aspects of the influence of noise barriers on the processes of formation of the urban environment. It is shown that the design of noise barriers is a complex multifactorial process that requires the participation of acousticians, engineers, architects and other specialists in various fields of science and practice.

**Keywords:** noise barriers, urban environment, traffic noise, noise shielding.

Due to the increase in the number of cars in modern cities, noise pollution from highways is increasing. One of the most effective means of combating acoustic pollution in these cases is considered to be free-standing soundproof structures - noise barriers [1]. There are different types of noise barriers, which take into account the specific features of the environment where their use is necessary. Having become a part of modern urban development, noise barriers fit into the urban fabric quite difficult, so their integration with the environment is necessary [2,3].

Integration (translated from Latin - association) is the process of establishing optimal links between relatively independent, loosely connected objects and their further transformation into a single, integral environment in which all its parts are coordinated and interdependent [4]. Such an environment should provide the necessary functional links between the components of the "man-object-space" system. Therefore, it is necessary to take into account various factors influencing the formation of space. The shaping of the environment is divided into three types.

### *1. Multifactorial shaping with a dominant factor*

It involves the use of versatile means of architectural shaping and natural factors. Here the main attention is paid to the organization of various forms of life. An example would be a residential environment. When integrating noise barriers in such an environment, it is necessary to take into account a number of criteria related to emotional calmness and psychological comfort, the smooth functioning of life processes, a sense of spaciousness, lightness and light.

Such developments should take into account the special mood of dynamism and openness of the modern way of life, without which it is impossible to maintain the functional comfort and originality of the artistic content of the environment.

Harmonization of the environment is a search for a solution through the subordination of the main and secondary components of the designed system. Harmony is realized while observing such features of the object of the environment as

the repetition of the properties of the whole in its parts, subordination, proportionality of parts, balance. These features constitute the main set of criteria for the harmonious organization of the environment.

### *2. Shaping with dominant functional and technological factors*

In this case, the technological requirements for the organization of processes, which create spatial structures and favorable conditions for activity, are decisive. Such an approach is feasible with a careful analysis of specific activities and the creation of a satisfactory environment for people. An example would be the industrial districts of the city. In such an environment, a noise barrier can become a dominant characterizing its architectural and artistic properties.

### *3. Formation with dominant information-emotional (socio-cultural) factors*

It is characterized by bringing to the fore the consideration of the processes of perception of the environment. In this case, an environment with active emotional influences on a person is organized (historical parts of the city, parks, etc.). The spatial organization of such objects is formed under the influence of the image that forms the basis of its artistic solution.

To integrate noise barriers, it is necessary to create an optimal nomenclature of environments that takes into account the peculiarities of the lifestyle of society and their socio-cultural needs, as well as the problems of oppositional placement of elements of a noise barrier. The complexity of organizing such an environment characterizes the concept of "spirit of place". It denotes a form of perception of a particular object, a unique sense of originality, individuality of the environment, its involvement in the worldview of a person. The "spirit of the place" is formed in the viewer's mind by a combination of landscape landscapes, object-spatial constructions, color solutions, characteristic details of the environment, and the strengthening of cultural historical associations associated with this place. To understand the "spirit of the place" means to feel the uniqueness of the emotional and artistic content of the environment, to be imbued with respect for the elements of its components. The "spirit of the place" is the most important factor in the formation and enrichment of the individual figurative characteristics of an environmental object or system. It greatly facilitates the solution of artistic and utilitarian tasks of designing noise barriers. An important indicator of the environment is the duration of the processes of its formation and development. It leads to the appearance at each new round of life of the environment of various kinds of adaptation measures that are inconvenient for its perception and use

Linear formations inherent in noise barriers create a complex form of urban space. There is a need to connect separate visually isolated structures into a single whole. It is required to ensure that individual fragments of the environment belong to a common system. At the same time, monotony and repetition should be avoided.

When designing, it is necessary to comprehensively consider the system of elements of noise barriers in the general space of the environment. In this case, special

attention should be paid to the functionality and expediency of the barriers.

The design process for soundproofing structures should be planned and developed with regard to the situation of the residents living nearby. Since the inhabitants will be near the barriers for many years, this circumstance can significantly change their living conditions. Privacy implies a degree of protection against visual and physical intrusion. Noise barriers can intentionally prevent this. Participation of local residents can be achieved in the form of testing, information meetings, organization of working groups, etc.

Communicating with residents should use models, drawings or photographs, show models of various alternatives and indicate their impact on the urban environment. In the process of communication, it is necessary to involve state institutions and organizations on which decision-making depends. For example, these may include organizations that do not ensure road safety, design organizations, etc. They may have different requirements regarding the construction and design of noise protection structures.

Thus, the design of a noise barrier is a complex multifactorial process. The best results can be achieved through the coordinated actions of bushes, design engineers, landscape architects. This may require the assistance of geotechnicians, ecologists, gardeners and other specialists in the design of complex objects. When chosen with the right design solution to meet all requirements, noise barriers can contribute to the creation of visually appealing urban spaces.

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## **Учёт влияния шумозащитных барьеров на формирование городской среды**

**О. А. Медведева, О. А. Жоголева\*, И. В. Матвеева**

ФГБОУ ВО «Тамбовский государственный технический университет», Тамбов, Россия  
*e-mail: zhogoleva.olga@rambler.ru*

**Аннотация.** При проектировании шумозащитных барьеров, отделяющих существующую городскую застройку от транспортных магистралей необходимо производить оценку их влияния на среду города. В данной статье рассматриваются аспекты влияния шумозащитных барьеров на процессы формирования городской среды. Показано, что проектирование шумозащитных барьеров сложный многофакторный процесс, требующий при его выполнении участие акустиков, инженеров, архитекторов и других специалистов в различных областях науки и практики.

**Ключевые слова:** шумозащитные барьеры, городская среда, транспортный шум, экранирование шума.

## Design Solutions of the Administrative and Laboratory Building of the Plant

**D. A. Merzlyakova, M. Yu. Zagorodneva**

Tambov State Technical University, Tambov, Russia  
*e-mail: dashme2605@gmail.com*

### Abstract

The article describes the architectural and constructive solutions of the administrative and laboratory building of the plant. The characteristics of the main load-bearing structures of the building are given. Brief information about the technology of construction, timing and cost of construction of the projected object is presented.

**Keywords:** frame, organization of construction, foundation, structural scheme, calculation of structures, reinforced concrete.

The manufacture of paint and varnish materials allows you to make a substantial profit. But it is very important to ensure the high quality of the manufactured materials, and then you can guarantee a stable demand in the market. This requires a laboratory, with its help it is possible to carry out the entire complex of studies, monitor individual parameters and eliminate all shortcomings in a timely manner.

Therefore, the construction of laboratories that fully comply with modern international standards is an urgent task. Continuous improvement of production technologies and equipment level requires adjustment of norms and rules, which often lags behind the growing quality of the manufactured material. This creates certain difficulties in conducting such construction. The design and construction of laboratory complexes is a complex engineering task, with the implementation of which you need to know not only the building codes, but also the specifics of the premises.

The site of the projected building is located in Tambov, Oktyabrsky district, Montazhnikov str.

It is planned to build an existing plant on the projected territory. There are existing buildings in the neighborhood of the projected building.

The construction site has a regular shape, with dimensions in plan – 15.3 x 51 m. Adjacent streets have a small density (intensity) of traffic. Landscaping of the territory is made of deciduous and coniferous high-growing trees, shrubs, flowers and grass. Trees and a flower garden are planted in front of the main entrance.

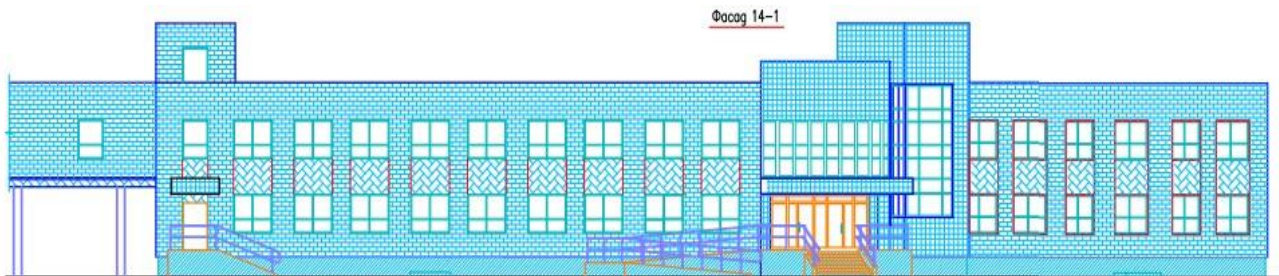
The exterior design of the building is selected in a complex, the color solutions are selected taking into account the best visual perception of the building as a whole and the functional purpose of the building. Advanced materials with the best physical and operational indicators, as well as taking into account their cost indicators, are used in the decoration of the building.

The building has a frontal asymmetrical composition, which is in good agreement with the requirements of the technological process. The main accent of this facade is

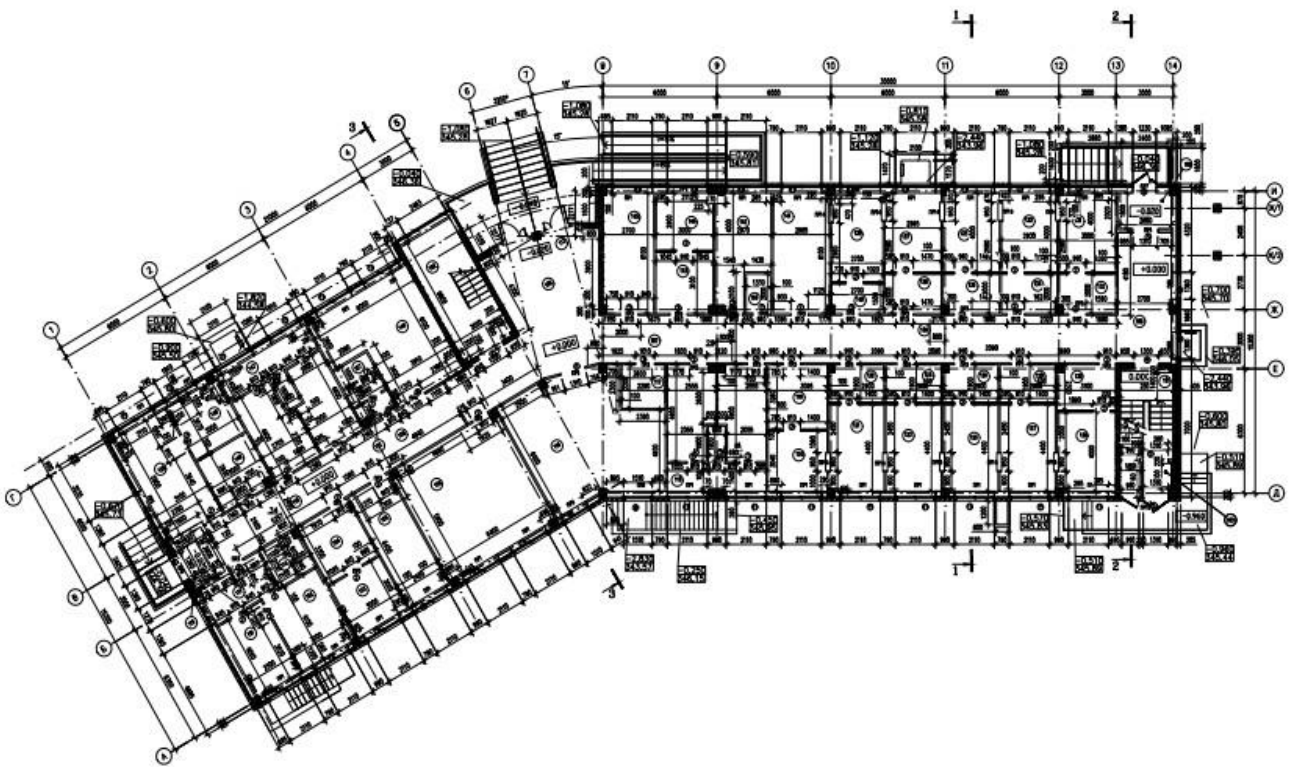
the volumes of the stairwell highlighted in color and the curved part of the building. The central location and color selection are supported by the stained glass glazing of these elements.

The facade of the projected building is shown in Figure 1.

The structural scheme of the projected building is a reinforced concrete frame with reinforced concrete columns, crossbars, floor slabs, stairs.



*Figure 1 – Facade of the projected building*



*Figure 2 – Ground floor plan*

The spatial rigidity of the building is ensured by the joint work of reinforced concrete columns, crossbars and floor slabs

A reinforced concrete crossbar of concrete class B30 with a length of 6.0 m was designed. The strength of longitudinal and normal sections was calculated, as well as the calculation of cantilever overhangs. The transverse and longitudinal fittings are selected. The floor slab PK-60.15-8 is also designed. In the process of calculation,

transverse and longitudinal fittings are selected.

The calculation of a columnar foundation of shallow laying, with a depth of 3.9 m, which is based on solid loam, has been performed. During the calculation, a foundation was selected with a sole size equal to 2.7x1.8 m. for external columns, and for internal columns – 1.8x1.8 m., due to the complex shape of the building, monolithic sections were not without, they had to be designed at the bend of the building. The calculation was performed using a software package.

In the technological part, the specification of all structures is given. A technological map has been developed for the installation of the aboveground part of the building, in particular the installation of floor slabs, crossbars and columns. The selection of the MKT-6-45 pneumatic wheeled crane was carried out, a network schedule and a schedule for the movement of labor were designed, temporary and warehouse premises were calculated, a construction plan was designed, the duration of the construction of the building was 179 days.

A local estimate was also developed for the construction of the building, including finishing and landscaping works. The estimate is calculated in the base prices of 2001 and is recalculated for 2022 with the help of indices. A general summary estimate has also been made. The cost per square meter was 43 thousand rubles.

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### **Проектные решения административно-лабораторного корпуса завода**

**Д.А. Мерзлякова, М.Ю. Загороднева**

ФГБОУ ВО «Тамбовский государственный технический университет», Тамбов, Россия  
*e-mail: dashme2605@gmail.com*

**Аннотация.** В статье описаны архитектурно-конструктивные решения административно-лабораторного корпуса завода. Даны характеристики основных несущих конструкций здания. Представлена краткая информация о технологии строительства, сроках и стоимости возведения проектируемого объекта.

**Ключевые слова:** каркас, организация строительства, фундамент, конструктивная схема, расчет конструкций, железобетон.

## Green Construction

**D. P. Nechaev**

Tambov State Technical University, Tambov, Russia

*e-mail: NDP.2000@mail.ru*

### Abstract

The purpose of my article is to draw attention to the problem of ecology and explain such a phenomenon as green construction. Green buildings meet all the necessary requirements of comfort for life and work, as well as efficiency in operation and consumption of resources such as water, energy, etc. But the main thing is that green construction is much less harmful to the environment and human health.

**Keywords:** BRE Environmental Assessment Method (BREEAM); green construction; green house; The Leadership in Energy & Environmental Design (LEED).

### Introduction

Currently, the problem of ecology is more urgent than ever, especially in such a voluminous sphere of life as construction. And, indeed, the active development of the industry necessary for the construction of buildings causes irreparable harm to the environment. Until recently, people were striving only for comfort, but now an important factor is already taken into account – environmental friendliness. Therefore, the construction of houses according to environmental standards is becoming a trend in the American and European markets. And even though eco-housing is not so popular in Russia yet, many experts believe that "green houses" are the future.

### Green construction principles

Green construction is the practice of building construction and operation, the goals of which are to reduce the level of consumption of energy and material resources throughout the life cycle of a building, to preserve and improve the quality of buildings and the comfort of their internal environment at the same time, as well as to reduce the overall impact of development on the environment and human health.

This is achieved by taking into account the efficient use of energy and other resources, as well as reducing environmental impacts, such as waste or emissions. It is also important to use local natural materials for the construction of buildings.

Green construction is primarily subject to environmental principles:

1. Reduction of the cumulative harmful impact of construction activities on human health and the environment, which is achieved through the use of new technologies and approaches;
2. Creation of new industrial products that meet the requirements of environmental friendliness;
3. Reducing the load on regional energy networks and increasing the reliability of their operation;
4. Creation of new jobs in the intellectual sphere of production;
5. Reducing the cost of maintaining new construction buildings.

What should a "Green House" have?

The construction of a "green house" requires the active use of materials with

minimal heat transfer. It is their use that significantly reduces energy losses during the operation of housing.

Special double-glazed windows contribute to the heating of the room due to the use of solar energy. Moreover, they can work even in the coldest period of the year - in winter. This is a very significant point, because if standard single-chamber double-glazed windows are used, the loss of energy spent on heating can reach 35%.

For the interior decoration of the interiors of the "green house", as many natural materials as possible should be used. It can be bamboo, cork wood, various types of wood, etc.

The heating system of the "green house" is usually designed on the basis of solar installations that convert solar energy into heat, directing it to heat rooms or to heat water. Excess energy is accumulated in special batteries and used in cloudy weather. The heating system can also include a heat pump running on the deep energy of the earth.

### **LEED**

LEED (The Leadership in Energy & Environmental Design) — Guidelines in Energy and Environmental Design" is a rating certification system for so-called Green Buildings. This system was developed in 1993 as a Green Building Standard for measuring energy efficiency and environmental friendliness of projects and buildings. The LEED system was developed by the American Green Building Council — United States Green Building Council (USGBC) as a standard for measuring projects of energy-efficient, environmentally friendly and sustainable buildings for the implementation of the transition of the construction industry to the design, construction and operation of such buildings.

### **BREEAM**

The first system of international Green certification was the BREEAM (BRE Environmental Assessment Method), developed in 1990 by the British organization BRE Global. The BREEAM system is an example of a successful concept that effectively implements the protection of the environment from human activity by satisfying the interests of all market participants without involving international or local law as a punitive tool.

### **Economic benefits**

The operation of Green buildings in comparison with traditional structures is economically more profitable.

1. Energy consumption is reduced by 25%, and accordingly, a reduction in energy costs is achieved;
2. Reducing water consumption by 30% naturally leads to a significant reduction in water supply costs;
3. Reduction of building maintenance costs is achieved due to higher quality of modern management tools, effective control and optimization of all systems;
4. Increased current net revenue (for example, a 3% premium on the average rental rate) and the value of property assets (for example, a 10% premium on commercial value) may lead to lower financial and insurance costs;

5. Reducing the number of refusals from rent and property, increasing tenant satisfaction can also lead to lower costs;

6. The introduction of the principles of Green construction is perfect for attracting public attention, contributes to the speedy payback of rental space and greater loyalty of tenants;

7. Buildings constructed using Green technologies contribute to the preservation of the health of people working in them, which can reduce losses from health insurance payments;

8. The principles of the construction of Green buildings are already in line with the expected tightening of environmental legislation related to the limitation of carbon emissions;

9. Constant cost reduction. Most Green Buildings are no more than 4% more expensive than conventional ones, and in the near future the use of Green Technologies will become the most effective means to reduce the cost of construction. At the moment, the additional cost can be amortized during maintenance of the building, and are usually compensated during the first 3 or 5 years by reducing operating costs.

### **Conclusion**

The concept of "green construction" carries a broader meaning than just the construction of buildings. "Green construction" is the development of the space surrounding the building. These are eco-friendly materials, and a reduction in the amount of garbage produced and emissions into the atmosphere. "Green construction" implies energy efficiency in the operation of buildings and a reduction in the intensity of its impact on the environment. That is, in order to be considered "green", the house must not only be made of eco-friendly materials, but also be more resource-independent in operation, as well as minimize the amount of waste.

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## **Зелёное строительство**

**Д. П. Нечаев**

ФГБОУ ВО «Тамбовский государственный технический университет», Тамбов, Россия  
*e-mail: NDP.2000@mail.ru*

**Аннотация.** Цель моей статьи - привлечь внимание к проблеме экологии и объяснить такое явление, как зеленое строительство. Зеленые здания отвечают всем необходимым требованиям комфорта для жизни и работы, а также экономичности в эксплуатации и потреблении таких ресурсов, как вода, энергия и т.д. Но главное то, что зеленое строительство гораздо менее вредно для окружающей среды и здоровья человека.

**Ключевые слова:** BRE Метод Экологической Оценки (BREEAM); зелёное строительство; зелёный дом; Лидерство в Области Энергетического и Экологического Дизайна (LEED).

## Large-Span Reinforced Concrete Coating Structures of Hall-Type Buildings

V. A. Ovsyannikova

Tambov State Technical University, Tambov, Russia

*e-mail: leraoao@gmail.com*

### Abstract

The purpose of this study is to explore information on the topic of long-span thin-walled coating structures, in particular, the analysis of shells with positive Gaussian curvature. The relevance of the paper lies in the fact that such a coating device is often developed for modern sports complexes. In this regard, it is necessary to find information about the device data of coatings, the subtleties of calculation, the positive and negative aspects of the device similar to coatings.

**Keywords:** constructive solution; cover; dome; hyperbolic paraboloid; positive Gaussian curvature; shell; support.

### Introduction

The desire of architects at all times to cover large spans can be traced from ancient times to the present. The development of technical progress, the use of modern materials and technologies makes it possible to cover significant spans without internal, intermediate supports for buildings of various purposes, such as civil, industrial and agricultural purposes. Structural systems and schemes of buildings are being improved. A breakthrough in the use of large-span structures gave rise to reinforced concrete structures. Unlike a flat plate, which also has a small thickness, the surface of the shell has a curvature in one or two directions, due to which forces of predominantly one sign appear in the shells. Bending moments in most cases appear only in limited areas (for example, near the contour of the shell), as a result of which their value for the selection of shell sections is significantly less than in flat structures. The shape of the shell surface is chosen so as to ensure its operation mainly in compression, while the concrete of the shell is used most efficiently.

Methods for calculating structures, deepening knowledge of the properties of various materials, and the technology for erecting such structures have received significant development.

New designs are emerging that combine efficient operation and various building materials.

### Shells of positive Gaussian curvature

The two most commonly used are shells with a transfer surface and shells with a torus surface (Fig. 1).

The shell with the transfer surface is formed by moving one curve along the other, both curves are curved upwards and lie in mutually perpendicular planes.

The shell with the surface of the torus is formed by the rotation of another circle around the axis of the circle. This is a special case of a shell with a transfer surface.



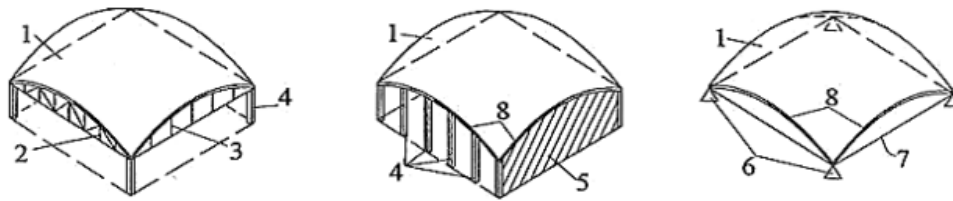


Figure 1 - Shell of positive Gaussian curvature, supported on the sides by various contour structures:

1 - shell; 2 - farm; 3 - arch; 4 - column; 5 - wall; 6 - support; 7 - tightening; 8 - curved beam

Typical reinforced concrete shells of positive Gaussian curvature are designed for covering buildings with column grids of  $18 \times 24$ ,  $18 \times 30$  and  $24 \times 24$  m without skylights, with skylights or with light-aeration lamps, without elevation changes, without cranes or with overhead cranes with a lifting capacity of up to 5 tons, with overhead cranes with a lifting capacity of up to 50 tons, with non-aggressive, slightly and medium aggressive gas environments. The shells are a prefabricated monolithic structure, assembled from plates with a nominal size of  $3 \times 6$  m with a cylindrical surface, contour diaphragms in the form of trusses and belts (Fig. 2).

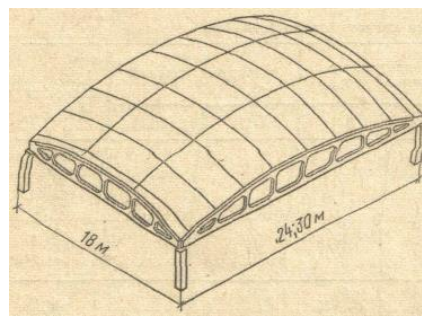


Figure 2 -Shell of positive Gaussian curvature

#### Advantages:

- 1) The most efficient in terms of static work.
- 2) Profitability (in terms of material consumption, it is 25... ..30% more economical than cylindrical shells).
- 3) Rare placement of supports (due to which exceptionally favorable conditions are created for the operation of many industrial and public premises).

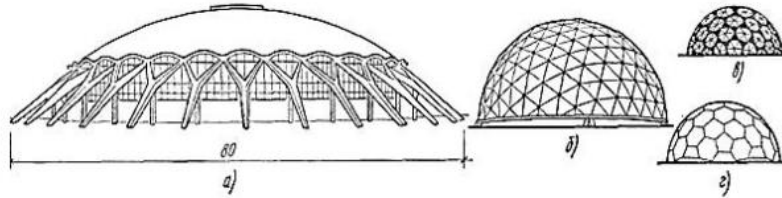
#### Disadvantages:

The disadvantages of this design include relatively small dimensions of prefabricated elements, expensive and time-consuming installation on complex conductors, a large number of seams and welded joints.

#### Domes

The dome is one of the most effective forms of thin-walled spatial structures. Its diverse design solutions have architectural expressiveness and allow covering spans up to 150 m. Dome coatings are used for round, elliptical or polygonal buildings and structures for various purposes. When choosing the outline of the dome cover, architectural and technological requirements, as well as technical and economic ones, are taken into account, including: minimum consumption of material for the construction of the dome; simplicity,

ease of manufacture and installation of elements; durability, the ability to care for the structure; conformity of the constructive solution of the dome to the nature of the acting loads. Reinforced concrete thin-walled domes are characterized by smooth or wavy (folded) shapes, which are generally described by a surface of revolution. The area of effective spans of such coatings is from 25 to 120 m (Fig. 3).



*Figure 3 - Dome-shells:*

*a - ribbed dome shell on inclined supports; b - mesh dome according to the system of eng. Fuller; c - a dome of triangular plates according to the system of eng. Tupolev; g - honeycomb dome of flat six- and pentagons*

#### *Advantages:*

The dome allows you to use space efficiently: you get the maximum amount of usable space, when compared with a rectangular room. Dome structures can meet a variety of needs and are used in industrial and civil construction. The geometry of the dome shell determines the high efficiency and cost-effectiveness of the structure, the construction of which requires a minimum amount of material and the shortest construction time.

#### *Disadvantages:*

The complexity of the calculation and installation.

#### **Hyperbolic paraboloid**

A hyperbolic paraboloid (gipar) is obtained when a series of identical downward-convex parabolas is suspended from two upwardly convex parabolas.

The resulting saddle surface is a surface of double curvature with opposite signs. Vertical sections of the hypar give parabolic outlines, while horizontal sections give hyperbolas. Gipari are often used both as an architectural form as a whole and as separate elements - clippings and combinations of these clippings (Fig. 5)

These coatings operate under a uniform load, mainly according to a momentless scheme and are distinguished by an expressive architectural appearance, therefore they are used for covering buildings for various purposes.

Reinforced concrete shells of this type were used to cover industrial buildings in Chernogorsk, Abakan and Krasnoyarsk. The dimensions of the shells are 6×18 m.

#### *Advantages:*

They have wider architectural possibilities, a smaller volume occupied by the shell in relation to the overlapped area, a straight line - generatrix, since the shell belongs to ruled surfaces, shape stability under the action of a uniform vertical load.

#### *Disadvantages:*

High labor costs arising in the manufacture of plates and during installation of the shell; since prefabricated elements having the shape of a hyperbolic paraboloid do not allow to fully mechanize the process of their manufacture, their transportation is difficult, after the

installation of the plates, it becomes necessary to monolithic a large number of seams.

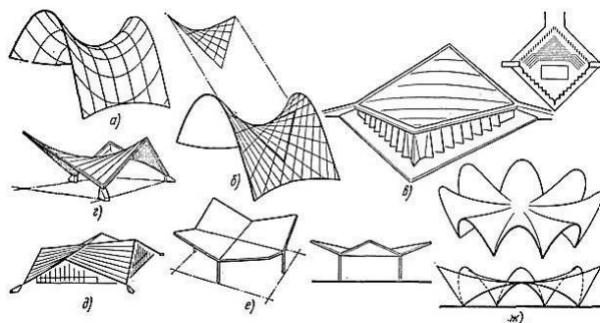


Figure 4 - Hyperbolic paraboloids (hypars):

*a - a row of identical parabolas suspended between two vertical parabolas, form a saddle-shaped surface of the hypar; b - a cut from the surface of the hypar, limited by four straight lines; c - a cut from the middle of the saddle-shaped part of the hypar, used as a covering of a separate building; g - a combination of 8 guipar clippings*

## Conclusion

Considering different types of reinforced concrete structures of the hall type coating, it is necessary to understand that there is a variety of such coatings, each of which has certain architectural features, and most importantly, calculation features. The most effective coating designs should be chosen.

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## Большепролетные железобетонные конструкции покрытия зданий зального типа

**В. А. Овсянникова**

ФГБОУ ВО «Тамбовский государственный технический университет», Тамбов, Россия  
*e-mail: leraoao@gmail.com*

**Аннотация.** Целью данного исследования является изучение информации по теме большепролетных тонкостенных конструкций покрытий, в частности, анализ оболочек с положительной гауссовой кривизной. Актуальность исследования заключается в том, что такое устройство покрытия зачастую разрабатывается для современных спортивных комплексов. В связи с этим необходимо изучить информацию об устройстве данных покрытий, тонкостях расчета, положительных и отрицательных сторонах устройства подобных покрытий.

**Ключевые слова:** гиперболический параболоид, конструктивное решение, купол, покрытие, положительная гауссова кривизна, оболочка, опора.

## Assessment of the Reliability of Building Envelopes

**A.S. Pchelintsev**

Tambov State Technical University, Tambov, Russia

*e-mail: i\_pan\_i@mail.ru*

### Abstract

Increasing the reliability of building envelopes is one of the priority tasks in construction. The main problems in this area are the correct assessment of the performance characteristics of the building. Identification of defects in structures will prevent similar errors in the design of new structures. The correct approach in maintenance will increase the longevity of the building.

**Keywords:** envelope structures, performance characteristics, reliability.

### Introduction

One of the most acute topics in the field of construction is the problem of aging housing stock.

According to Rosstat at the end of 2021 the volume of the housing stock of the Russian Federation is 4 043 974.8 thousand m<sup>2</sup>, while the total area of the housing stock in a state of disrepair is increasing every year. At the moment it amounts to 22,059,000 m<sup>2</sup>.

Most of the fund does not meet modern concepts of comfort and elementary sanitary requirements.

Today in Russia about 40 million people live in uncomfortable apartments, which is 27% of the country's population. More than 20% of the housing fund is in acute need of major repairs and reconstruction.[2]

The issue of maintaining the building stock at the proper level creates tasks aimed at improving the reliability of buildings, including improving the reliability of building envelopes.

### Indicators characterizing the reliability of building envelopes

According to GOST 27751-2014 Reliability of building structures and foundations:

Reliability of a building structure: The ability of a building structure to perform the required functions during the design life of the structure.

From this definition we can conclude that the construction objects, in our case the walls of buildings, must withstand loads without loss of their performance during the life of the entire building. It would be a mistake to consider each element separately, because a decrease in the reliability of a single element will certainly affect the reliability of the other elements of the structure. The complex inspection of such system allows to prevent the defects which appear during the incorrect exploitation in time and to choose the set of measures on the increase of the building exploitation characteristics.

Errors that can lead to a loss of reliability arise both in the design of the building

and in its unscrupulous maintenance.

The main characteristic for the evaluation of reliability is durability - the preservation of the performance of the building until the limit state under the established maintenance system [3].

In order to ensure the required durability of a building object in its design it is necessary to take into account:

- operating conditions as intended;
- design influence of the environment;
- the properties of the materials used, the possible means of their protection from the negative effects of the environment, as well as the possibility of degradation of their properties.

The parameters of the durability of building structures are affected not only by weather and man-made effects, but also by the quality of building materials used, quality of installation work, as well as operating conditions associated with the timeliness of elimination of emerging defects, as well as the implementation of scheduled maintenance activities. Most operating errors could have been prevented by reacting in a timely manner to adverse effects on the design.

As operational parameters that characterize the reliability, we can use the parameter that characterizes the safe operation of the wall - strength, and the parameter that provides an appropriate level of comfort in the room - the resistance to heat transfer.

When designing construction projects, it is necessary to take into account the possible impact on them of aggressive environment and other negative operating conditions (alternate freezing and thawing, the presence of anti-icing agents, the impact of sea water, industrial emissions, etc.).

At the moment, construction standards are based mainly on calculations for two limit states, taking into account an extensive list of factors affecting strength and durability.

Building structures must meet the requirements (criteria) corresponding to the following limit states:

- the first group of limit states - the states of construction objects, the excess of which leads to the loss of bearing capacity of building structures and the emergence of an emergency design situation;
- the second group of limit states - conditions, in excess of which the normal operation of the building structures is broken, the resource of their durability is exhausted or the conditions of comfort are violated;
- special limiting states - conditions arising under special influences and situations and the excess of which leads to the destruction of structures with catastrophic consequences.

Without taking into account any environmental factor, structural elements of buildings are tested for strength, which may adversely affect its characteristics.

## **Reliability assessment methods**

A preliminary survey of a building is one of the simplest evaluation methods.

The main task of the preliminary survey of the building is to determine the general condition of the building structures and the operating environment, to determine the composition of the planned work and to collect the initial data necessary to draw up a technical specification for a detailed instrumental survey to establish the cost of the planned work and conclude a contract with the customer. [3]

The results of the survey identify the need for repair and overhaul of the building, based on the information gathered, determine a set of works for a more accurate instrumental examination. The categories of the technical condition of the structure are determined according to the defects and damages present.

If possible, recommendations are given on the need for emergency measures to prevent emergency situations in the event of a critical condition of the structure.

The damages in the structure are divided into two groups depending on the reasons of their occurrence: from force actions and from external environment actions. The latter group of damages not only reduces the strength of the structure, but also reduces its durability.

The condition of the building envelopes can be assessed according to GOST R 53778 (clause 5.1.5) according to the following categories:

- in normative technical condition;
- in serviceable condition;
- in moderate serviceable condition;
- in an emergency condition.

Determination of the category of technical condition of enclosing structures allows to specify their serviceability, as well as to choose rational ways of carrying out repair and restoration work. [3]

Detailed inspection in selective order should be carried out when it is necessary to assess individual structures, as well as in potentially dangerous places, where due to the inaccessibility of the structures it is impossible to conduct a full examination.

## **Conclusion**

Reliability assessment of building envelopes will allow to characterize correctly the condition of structural elements and assign timely work to improve performance characteristics, allowing to reduce the rate of aging of the structure.

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## Оценка надежности ограждающих конструкций зданий

А.С. Пчелинцев

ФГБОУ ВО «Тамбовский государственный технический университет», Тамбов, Россия  
*e-mail: i\_pan\_i@mail.ru*

**Аннотация.** Повышение надежности ограждающих конструкций зданий является одной из приоритетных задач в строительстве. Основными проблемами в этой области является правильная оценка эксплуатационных характеристик здания. Выявление дефектов конструкций позволит предотвратить подобные ошибки при проектировании новых сооружений. Правильный подход при содержании позволит повысить долговечность здания.

**Ключевые слова:** надежность, ограждающие конструкции, эксплуатационные характеристики.

## Life Cycle Management of a Capital Construction Facility

O. N.Redina\*, A. N. Nikolyukin

Tambov State Technical University, Tambov, Russia

\*e-mail: bojedolka@mail.ru

### Abstract

The article deals with the concept of managing the "life cycle" of a product and discusses the most important difficulties that arise in the process of implementing information modeling technology (TIM) in the construction sector based on the results of recent research. The main problems include the lack of regulatory literature regulating the process of developing a digital twin of a building, the lack of a universal software package for optimizing the construction of digital models and the lack of qualified personnel.

**Keywords:** buildings, capital construction object, design, digital twin of a building, information modeling technology (TIM).

Currently, there is a rapid development of digital technologies for computer-aided design and decision-making, and, accordingly, the introduction of technologies in the industrial sectors of the Russian Federation (RF). The phased introduction of digital technologies forms the basis for the management of the life cycle of a capital construction facility.

The life cycle of a building or structure is the period during which engineering surveys are carried out, justification of the financial feasibility of the project, design, construction, operation (including ongoing repairs), reconstruction, major repairs, repurposing of the structure, demolition (Fig. 1).

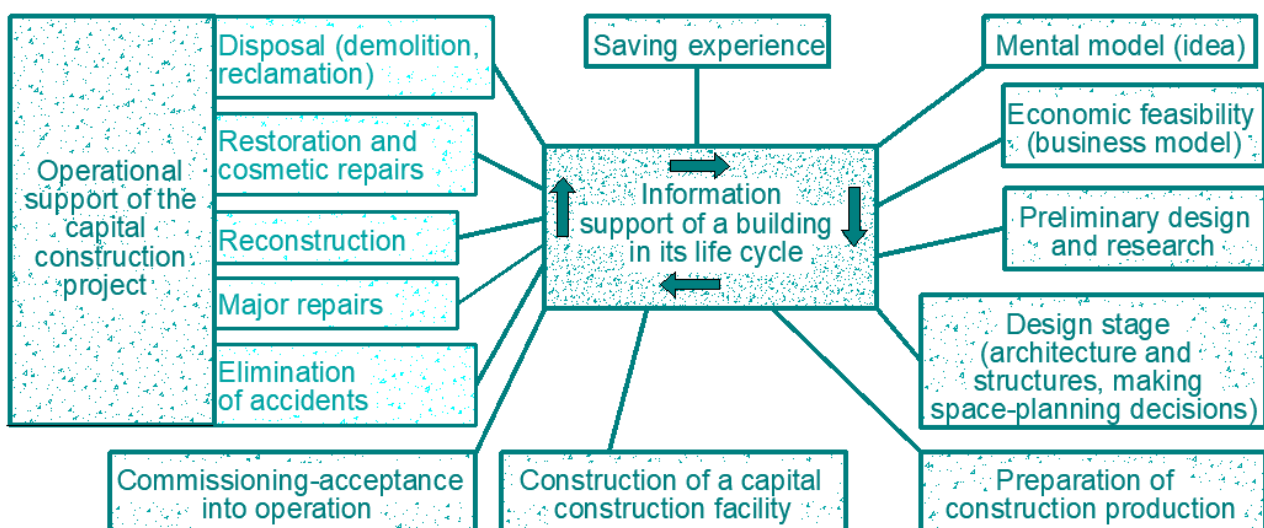


Figure 1 – Stages of the life cycle of a capital construction object.

Life cycle management of a capital construction facility using a "digital twin" is a concept aimed at managing all information about the facility and related processes

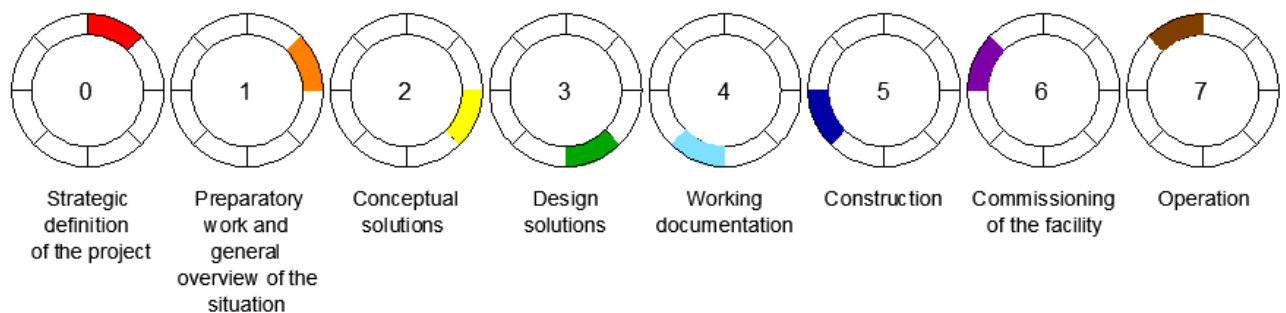


throughout its entire life cycle, starting with the justification of the expediency of investments ending with capital reconstruction or demolition [4]. To be able to manage the "life cycle" of an object, it is necessary to create an information environment in which, at all stages, the participants of the process closely interact with each other: financiers, designers, builders, operating company and others

At the stages of design and construction, there is its own specificity, therefore, adaptation and development of a digital twin of the object is required for industry-specific features, it is necessary to create technologies that take into account the nuances of the construction stages. The technology of building information modeling allows you to take into account these nuances.

To ensure the management of the life cycle of an object, it is necessary to create a common integrated database, which will contain information about the object, the processes of its development and creation, as well as the resources necessary for this. It is the creation of a digital model of a building or structure that makes it possible to establish and improve the relationship between the main stages of design, construction of an object, its operation and demolition. Also, the use of technology allows you to manage the operation of the facility and the costs of operation, to model the justifications for investments [4].

As a successful example of the introduction of information modeling technology, it is worth considering the experience of the UK. Back in 1963, the Royal Institute of British Architects (RIBA) was working on the issue of the life cycle of the building in order to further identify the main goals, objectives and problems that appear at all stages of the life cycle of the capital construction object and identify ways to solve them (Figure 2).



*Figure 2 – Life cycle of capital construction projects according to the "Work Plan" of the RIBA*

The catalyst for the introduction of BIM in the UK was the decision to hold the 2012 Olympics in London and the economic unwillingness of the state to do so. Testing of information modeling technology allowed solving problems related to the life cycle of the facility and showed a significant reduction in construction costs. In the UK, in order to successfully implement BIM, an organization was created that engaged in the development and implementation of national standards in this area, National BIM Standards (NBS). Description of the stages of the life cycle of a capital

construction object, according to RIBA, is the creation of funds that make it possible to effectively use resources during capital construction. It is the competent policy of the state regarding the application and promotion of BIM in the UK that makes her experience fundamental.

In Russia, today, the state provides great support for the promotion of TIM, at the legislative level. Thus, according to the decree of the Government of the Russian Federation dated March 05, 2021, from January 1, 2022, when preparing project documentation for the construction or reconstruction of a capital construction facility with the involvement of funds from the state budget, an information model of the building should be created. The documents of the Ministry of Construction and Housing and Communal Services of the Russian Federation present a generalized scheme showing the stages of the life cycle of a capital construction object and detailing the stages of the introduction of information modeling technologies. It follows from the scheme that the successful implementation of information modeling technology in Russia is impossible without standardization at all stages of the object's life cycle: when designing, creating a digital model and quality control of the work performed.

In 2022, the National Research Moscow State University of Civil Engineering (MGSU) published a report with research results regarding difficulties with the promotion and adaptation of TIM in projects of Russian investment and construction companies. According to the report, the main problem at the moment is the shortage of trained personnel, as well as the unwillingness of investors, customers, contractors and other participants involved in the construction process to interact with the use of TIM [1-3].

As with any innovation, the process of implementing information modeling in the construction industry has its own difficulties, such as: the development of new regulatory documentation or the adaptation of existing regulations; the development of software systems and packages that allow all participants in the life cycle of a building to work in them; the training of qualified personnel who can work in these software complexes using regulatory documentation.

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## **Управление жизненным циклом объекта капитального строительства**

**О. Н. Редина\*, А. Н. Николюкин**

ФГБОУ ВО «Тамбовский государственный технический университет», Тамбов, Россия

*\*e-mail: bojedolka@mail.ru*

**Аннотация.** В статье ведется речь о концепции управления «жизненным циклом» изделия и рассматриваются наиболее важные трудности, возникающие в процессе реализации технологии информационного моделирования (ТИМ) в строительной сфере на основе результатов последних исследований. К основным проблемам стоит отнести отсутствие нормативной литературы, регламентирующей процесс разработки цифрового двойника здания, отсутствие универсального программного комплекса для оптимизации построения цифровых моделей и недостаток квалифицированных кадров.

**Ключевые слова:** здания, объект капитального строительства, проектирование, технология информационного моделирования (ТИМ), цифровой двойник здания.

## Types and Causes of Shrinkage Deformations

**A.I. Reshetnikov**

Tambov State Technical University, Tambov, Russia

*e-mail: reshetnikov2000@yandex.ru*

**Abstract:** This article deals with the types of shrinkage deformations such as contraction, carbonization and moisture, and their impact on cement-based building materials. The analysis reveals that the most dangerous type of shrinkage is moisture shrinkage, since it has biggest probability of crack occurrence.

**Keywords:** concrete, cracks, deformations, shrinkage.

Shrinkage deformations are decrease in linear size and volume of consolidated concrete because of it losing moisture, hydration and carbonization. All types of cement-based building materials are affected by shrinkage deformations during the hardening and maintenance processes. The value of deformations is determined by the combination of three structural types of modification of material, which are classified depending on arrangement of physical and chemical processes of structure formation:

1. **Moisture** is the type of shrinkage that occurs as a result of physical and chemical processes that take place when water is removed from material structure. It appears since material is placed in air environment;

2. **Contraction** is a type of shrinkage that occurs because of a decreasing volume of concrete mixture compared to initial total volume of cement minerals and water before the hydration process;

3. **Carbonization** is a type of shrinkage that occurs in process of chemical reaction, when products of cement hydration interact with component from external environment – carbon dioxide  $\text{CO}_2$ . All of the aspects of shrinkage in details presented in beneath.

### *Contraction shrinkage*

When cement grout is grabbed and consolidated, forming cement rock, observation of contraction shrinkage becomes possible. It happens in that moment, when the volume of consolidated concrete becomes less than the volume of cement mixture by about 3%. This type of shrinkage happens in the period when intense chemical reactions between cement and water occur. Contraction shrinkage proceeds with the appearance of contraction pores – spherical formations, that appears inside of hydrating cement rock, and contraction shrinkage itself characterized by external hydrating cement rock volume loss. The authors in [5] specify total value of contraction, as 3-5 ml on 100g of cement. Depending on the cement type, there are different values between contraction shrinkage and volume increase because of contraction pores. Development of this type of shrinkage happens in the period of concrete mixture consolidation, when it still has enough of plasticity, so concrete does not acquire visible cracking. It is most intensity achieved in the first 4-5 days. Today there is no common opinion about the contraction shrinkage influence, relative to the

structure and properties formations of material, and relative to the shrinkage deformation values. Such contradictory opinions are explained by the dependency between contraction shrinkage value and water-cement ratio. In [3] special attention was given to the fact that in condition of decreased water-cement ratio (lower than 0.3) the relative value of contraction shrinkage swiftly increases. Scientists, exploring normal concrete with medium water-concrete ratio (more than 0.45) consider this shrinkage deformation insignificant. The main part in cracking is the time factor of structure formation. The maximum value of cracking achieved in post-plasticity stage, it characterized by cement grout plasticity loss and conversion into resilient condition.

Decreasing contractor shrinkage in concrete mixture can be achieved by decreasing astringent volume, but in this case it's necessary to increase aggregate volume. Decreasing contraction shrinkage of foam concrete possible by increasing sand volume, but it's important to know, that it will lead to serious durability loss.

*Carbonization shrinkage* happens in result of chemical reaction, which flows in interaction of cement rock components with carbon dioxide, forming calcium carbonate  $\text{CaCO}_3$ . Calcium hydroxide  $\text{Ca}(\text{OH})_2$  is mostly affected by the shrinkage deformations, it can be explained by equation:  $\text{Ca}(\text{OH})_2 + \text{CO}_2 = \text{CaCO}_3 + \text{H}_2\text{O}$  [6]. As a result of chemical reaction foam concrete volume loss occurs because of calcite (calcium carbonate), structure collapses and durability loss. Pretty constant value of carbon dioxide in atmosphere is 0.03% [4], which is different from the results in industrial placements – 0.04%, and sometimes it even reaches 0.1%. It is proven that intensive carbonization appears in following range of related humidity – 30...100%. The velocity of carbonization shrinkage deformation swiftly declining in water-saturated concrete, it is explained by diffusion coefficient of carbon dioxide, which is about 10000 lower than in gaseous medium. Scientists analyzed influence of water-cement ratio of foam concrete mixture on carbonization speed, and proved that it declined with rising of alite volume in used cement. With the 0.4 water-cement ratio, the sinking value is minimal, namely carbonization is almost absent [4].

To fight carbonization shrinkage, it is recommended to protect foam concrete products from an atmospheric air, which means creating circumstances in which there will be no contact of material with oxygen dioxide. In [5] it is claimed that creating of hydrophobization in case of bricklaying walls or plastering of monolith foam concrete helps to decrease not only carbonization, but moisture shrinkage too. It should be noted that the influence of this type of shrinkage can be neglected because it takes place only in the early age.

*Drying (moisture) shrinkage* is a volume change that takes place because of drying of concrete, and it happens immediately when concrete is placed in air environment. Drying shrinkage is inevitably, and it value is controlled by decreasing astringent volume in mixture. Drying shrinkage can last for several years, and depends on concrete properties. Moisture shrinkage takes place as a result of consolidation and drying of concrete mixture in the process of concrete conversion from viscous-plastic to elastic state. Physical and chemical reactions that are happening provide water removal from the named mixture. Researchers consider the main causes of this

shrinkage: capillary forces; vaporization and adsorption of bounded water from helium constituent of cement rock; removal intercrystalline water in process of molecular interaction.

According to Z.N. Cylosani, changing of shrinkage mechanism depends on the type of vaporized water. Mechanically bounded water from large size pores is vaporized without shrinkage deformations. The beginning of development of shrinkage considers formation of meniscus in capillaries with related humidity of air value is about 40-98%. A.E. Sheikin [5] pointed out that at 60% relative humidity from the initial state, the adsorption removal of bound water. When related humidity values are lower than 45%, the interplanar water removal occurs, i.e. the water located between layers of crystal structure of calcium hydrosilicates, resulting in shrinkage. The determination of the shrinkage value will be carried out relative to the parameters of the pore structure, the dependence of which consists of the water-cement ratio and the moisture content of the cement rock.

Many scientists and research teams paid attention to the mechanism of moisture shrinkage, in their opinion, the idea is based on the idea of a change in the state of materials, that is, under tension, when they are hydrated or dried due to internal forces. The initial stage of drying is characterized by a change in the balance of capillary forces and surface tension forces during the evaporation of capillary, free and absorbed water from the pores. Further drying, which occurs with the evaporation of intergranular and interplanar water, is accompanied by the participation of the following forces: the interaction of cohesive and cohesive forces and the forces of internal crystal bonds. The final stage of drying at a material moisture content of about 0 is characterized by the fact that the forces of elastic resistance to deformation of the solid phase act.

It can be concluded that the function of the resultant force determines the amount of moisture deformation. The composition and structure of the material will upset the balance of internal forces at some point of dehydration. By adjusting the structure of the material, there will be changes in the nature and strength of the bonds, which will help control moisture shrinkage.

All types of shrinkage deformations are interconnected and follow one from the other. The formation of a structure at the stage of compaction of a cement mixture with a porous structure will manifest itself at the stage of operation, during shrinkage of moisture from drying of the material or during operation.

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## **Виды и причины возникновения усадочных деформаций**

**А. И. Решетников**

ФГБОУ ВО «Тамбовский государственный технический университет», Тамбов, Россия  
*e-mail: reshetnikov2000@yandex.ru*

**Аннотация.** В статье рассмотрены такие виды усадочных деформаций, как: контракционная, карбонизационная и влажностная; указано их влияние на строительные материалы, содержащие в своем составе цемент. Проведен анализ работ исследователей, занимающихся данным вопросом; выявлено, что наибольшую опасность в образовании трещин материала представляет влажностная усадка.

**Ключевые слова:** бетон, деформации, трещины, усадка.

## Reconstruction of Cinema Buildings for Modern Use

**K. A. Rogova, O. N. Kozhukhina**

Tambov State Technical University, Tambov, Russia  
*e-mail:alpatovakira@yandex.ru*

### **Abstract**

This article discusses the problem of adapting closed cinemas to the modern needs of the population. The problem is urgent due to the fact that, thanks to the reconstruction and changes in the functional purpose, it is possible to create conditions for leisure, education and family recreation near home for the population. According to research, each district has its own needs, which will be reflected by architects in individual projects for the reconstruction of cinemas.

**Keywords:** reconstruction, cinema, functional purpose, redevelopment, leisure, community centers.

During the Soviet period of the last century, cinemas were built in every residential area of the city of our country, including the provincial one. The cinema became a cultural center for young people, and in general for the population of the entire district. The type and capacity of the cinema were set by the design assignment depending on the number of the population served. The norms were to provide 20...30 seats and in the future 30...50 seats per 1000 inhabitants, while smaller limits were accepted for large cities, and for small cities that do not have theaters, concert halls, circuses and other entertainment institutions larger limits. The halls were designed for 600, 800 and 1200 seats. Today, cinema buildings are mostly not used for their intended purpose, and many of them are closed, due to the fact that only a few people could come to the session, and the planning structure inside the cinemas cannot be used for other functional purposes without reconstruction.

Let us consider the situation in our city of Tambov. Now there are four cinemas in the city, and in the twentieth century there were nine, some with a rich history [1]. The cinema "Modern" ("Zvezda") on Komsomolskaya Str., 25/81 is one of the oldest in Russia showing films since 1909. The building of the Komsomolets cinema was built in the 19th century as a church at the city almshouse, later it housed a nursing home, a hospital and a pharmacy. In the 40s of the twentieth century, a children's cinema started operating in the building, and a restaurant opened in the 80s. Currently, the building has gone to the Tambov Diocese and the Church of St. Lazarus is located in it, so everything has returned to normal.

The building of the Rodina cinema also has a rich past. In its place, in 1908, a profitable house of a wealthy citizen of the city of Matveev was built, which after the revolution was used for proletkult purposes. But in the late 20s, the building burned down and construction of the largest cinema in the region, which was opened in 1941, began in its place. It became the third cinema in the city after Modern and Komsomolets. In the mid-fifties of the last century, the building underwent reconstruction in the style of Stalinist classicism designed by architect V. Samorodov.



For a long time the cinema was very popular, but in 2014 it was closed for reconstruction, which has not begun until now. According to the Department of Culture, there have been no appeals regarding the redevelopment and adaptation of the building for other purposes. The building is located in the central part, and its improper appearance spoils the impression of the city.

The Mir cinema (65A/1 Gastello Street) has expanded its functional purpose and has been transformed into a cultural and leisure center of the Sovetsky district, where numerous creative collectives, interest clubs and amateur associations of various orientations are engaged. The building of the Sputnik cinema (2A Astrakhan Street) was transferred to the Tambov Youth Theater after the reconstruction.

The buildings of the Zvezda and Yunost cinemas have also been reconstructed, and now they have become shopping centers, but due to creating the necessary conditions for a comfortable life, bringing services and goods closer to the pedestrian accessibility zone, residents of these areas began to experience a shortage of high-quality leisure offers.

In the past, cinemas played the role of venues for meetings, communication and interesting pastime near home. But even now, for a significant part of the country's population, cinemas remain the only centers of cultural development and a place for family leisure, therefore, it is necessary to develop the social, cultural and educational functions of cinemas in the future.

In modern conditions, it is the residents of the microdistrict who should suggest to the architects a new concept in the purpose of the reconstructed cinema building. Such studies were conducted among Muscovites, which showed that there are not enough places for residents of the district to communicate. Based on the wishes of the citizens and on the results of a comprehensive study, an individual project can be developed for each cinema building, which will reflect the needs of the citizens of this area. The designers propose to turn the cinema buildings into "community centers" with the preservation of cinema halls and ensuring attendance of the center throughout the day. Such a center should offer a wide range of children's educational and entertainment formats, a large assortment of shops with everyday goods, as well as restaurants and cafes. The tendency to build multifunctional community centers and complexes is due to sociological, economic, urban planning, artistic, aesthetic and functional factors.

The type of reconstruction of each object depends on the condition in which the building is currently located. Most cinemas in Moscow will be rebuilt, as their physical condition does not allow them to adapt to modern needs. ADG Group acquired 39 cinemas in one package and announced that it would turn the buildings into community centers while preserving cultural, leisure and film distribution activities. The implementation of the project will require 57 billion rubles. Currently, seven cinemas have been reconstructed. They have become public centers within walking distance while maintaining the function of a film screening, and construction work has already begun on twenty-two objects [2].

During the reconstruction of the Moscow cinema, the design concept of the famous British architect Amanda Leavitt, winner of the prestigious Sterling Prize award and

founder of the Amanda Levet Architects bureau is used [2]. Distinctive features of district centers are transparent entrance groups that remove the boundary between the street and the interior. The space inside the centers is organized with a minimum number of partitions and with wide galleries, i.e., according to the principle of a barrier-free environment with the effect of “openness”. It is planned to hold regional holidays, festivals, open-air fairs in the adjacent territory.

The experience of reconstruction of Moscow cinema buildings can be useful for other Russian cities, as the reconstruction creates conditions and opportunities for leisure, education, family recreation near home.

The fate of the further development of the cinema network and cinemas cannot but be considered in relation with other cultural institutions, with the system of organizing leisure activities of the population. Out-of-home communication, change of scenery and collective perception of the film, recreation, related activities and entertainment – stage, exhibitions, discussion of the film – these are the functions that, together with the incomparably better quality of the film demonstration, remain the advantages of the cinema.

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## Реконструкция зданий кинотеатров для современного использования

К. А. Рогова, О. Н. Кожухина

ФГБОУ ВО «Тамбовский государственный технический университет», Тамбов, Россия  
*e-mail: alpatovakira@yandex.ru*

**Аннотация.** В данной статье рассматривается проблема адаптации закрытых кинотеатров под современные нужды населения. Проблема является актуальной в связи с тем, что, благодаря реконструкции и изменения функционального назначения, можно создать условия для досуга, образования и семейного отдыха рядом с домом для населения. Как показывают исследования, у каждого района существует свои потребности, которые будут отражены архитекторами в индивидуальных проектах по реконструкции кинотеатров.

**Ключевые слова:** реконструкция, кинотеатр, функциональное назначение, перепланировка, досуг, общественные центры.

## Modern Methods of Increasing Thermal Protection of Buildings

**S. S. Saveleva**

Tambov State Technical University, Tambov, Russia  
*e-mail: saveleva.ss99@mail.ru*

### **Abstract**

This article provides an overview of the main methods of improving energy efficiency in construction of new buildings. Options for solving the issues of reducing the energy consumption of new facilities through their rational use are presented. The ways of solving the problem of implementing energy-efficient technologies in the construction of residential buildings are present.

**Keywords:** energy saving, energy efficiency, life support systems.

One of the serious problems of construction is reduction of energy resources for building maintenance and structures while providing comfortable conditions for living, working and being in them. Energy efficiency is a set of organizational, economic and technological measures aimed at increasing the importance of the rational use of energy resources in the industrial, household and scientific-technical fields.

First of all, it is a concern for the environment and the planet. Houses of a high energy efficiency class cause less damage to the environment by optimizing resource consumption. Currently, even high-energy-efficient buildings are not equipped with everything necessary for obtaining maximum resource conservation, but for now this is more of a possibility than reality. However, the benefits of highly energy-efficient buildings are not limited to conservation. The comfort of living and being in it directly depends on the class of the building.

The results of numerous studies dedicated to the research of energy saving problems show that the largest amount of energy is spent on heating, hot water supply, covering losses during energy transportation, air cooling in air conditioning systems, and artificial lighting.

The reduction of heat consumption in the process of building's usage can be achieved by improving building design standards, by improving quality of construction and operation of buildings, by a set of design, planning and engineering solutions that guarantee the creation of a favorable and comfortable inner environment of residential and industrial premises. Improvement of the thermal and air conditions of buildings is bound to the need of the heat-shielding qualities of building envelopes improvement.

An increase in the resistance to heat transfer of non-translucent fences is achieved by choosing a more efficient heater and applying technical solutions to improve the thermal uniformity of the structure by reducing the influence of heat-conducting inclusions. Thermal insulation is the creation of the most comfortable microclimate in buildings, the flow of excess heat from the outside and the reduction of heat losses inside. Even at the stage of construction work, the insulation makes it possible to significantly reduce the cost of aerated concrete, brick, mortar, and already during the

operation of the finished facility - for heating a building or structure. In construction, heat-insulating materials are used to insulate floors, exterior walls, attics, and roofs.

Recently, there has been a very sharp tightening of the requirements for the thermal characteristics of fences. The topic of building houses with energy-saving materials is becoming more and more relevant. To ensure the required regulatory indicators, the external walls of residential buildings are erected in multilayer, consisting of a bearing and heat-insulating layers. The technology of external wall insulation provides maximum protection of the building from heat loss through the walls, due to the fact that it takes on the cold effect of the environment. External insulation systems allow you to reduce the thickness of the walls and use lighter materials in their construction without losing thermal insulation properties. In addition, multilayer external insulation systems can reduce the load on the foundation, reducing the cost of its construction.

A significant part of the heat loss through the building envelope (more than 33%) occurs through leaky windows and doors. In connection with this circumstance, it is necessary to improve the thermal insulation qualities of windows. Currently, the following main methods are used in Russia to improve the energy efficiency of translucent structures:

- use of thermal film (heat-absorbing glazing);
- transition from one- and two-chamber double-glazed windows to three- and more-chamber ones;
- filling double-glazed windows with inert gases.

The thermal conductivity of glazing depends on the angle of incidence of sunlight and the thickness of the glass. The reduction of heat loss through windows is achieved in the following ways: glass is covered with metal or polymer films with one-sided transmission of short- and long-wave radiation (the long-wave part of the spectrum is infrared rays coming from heating devices, they are delayed, and the short-wave part - ultraviolet rays - is passed through). As a result, in winter the sunlight enters the room, but the heat does not leave the room, in the summer the opposite effect occurs. The heat transmission coefficient of such glasses is  $0.2 \div 0.6$ . The use of windows with heat-reflecting glass can reduce heat loss through them by up to 40%.

Experience shows that an increase in the thickness of the air gap between the panes in a double sash does not lead to an increase in the thermal efficiency of the entire window. It is more efficient to make several layers (chambers), increasing the number of glasses. The greatest effect (thermal insulation, sound insulation) can be achieved with triple glazing. The optimal thickness of the air gap between the panes is 16 mm.

The task of an energy-efficient ventilation system is to provide thermal comfort for living in conditions of increased tightness of buildings, as well as to reduce heat consumption for heating infiltrating air. Most residential buildings have a ventilation system with natural air circulation, which operates due to natural draft resulting from pressure and temperature differences. In winter, when the ventilation system is operating, the temperature inside the building decreases, and the cost of heating the home increases significantly. With ventilation air, from 30 to 75% of heat leaves the

room, which is a lack of natural ventilation and does not meet modern energy saving requirements.

To date, the situation is such that energy-efficient solutions that are incorporated in the design, in the process of building a building, most often, are not implemented. This is due to the fact that the Customer does not have an incentive to invest in energy efficient technologies. The main factor hindering the introduction of energy efficient technologies in construction is the increased cost of an energy efficient house. To solve this issue, it is necessary to build energy-efficient houses within the framework of the federal program, with partial financing of innovative technologies by the state. Thus, we can conclude that for the widespread introduction of energy-efficient technologies, a legislative framework and real government programs are needed that would stimulate energy-efficient construction in our country.

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## Современные методы повышения тепловой защиты зданий

С. С. Савельева

ФГБОУ ВО «Тамбовский государственный технический университет», Тамбов, Россия  
*e-mail: saveleva.ss99@mail.ru*

**Аннотация.** В статье представлен обзор основных методов повышения энергоэффективности в новом строительстве. Представлены варианты уменьшения энергопотребления новых объектов за счет их рационального использования. Предложены пути решения проблемы внедрения энергоэффективных технологий в строительстве жилых домов.

**Ключевые слова:** энергосбережение, энергоэффективность, системы жизнеобеспечения.

## Applications of Epoxy and Epoxy-Diane Resins

A.V. Sevost'yanov\*, K.O. Suchkov

Tambov State Technical University, Tambov, Russia

\*e-mail: sevo-andrey@yandex.ru

### Abstract

Epoxy resins are a universal, self-adhesive material used for the manufacture of compounds, composites, as well as for pouring various surfaces and applying glue, sealant, etc. The article discusses the areas of application of epoxy and epoxy-diane resins in various industries.

**Keywords:** epoxy-diane resin, epoxy resin, epoxy resin application.

### Introduction

Epoxy resin is oligomers containing epoxy groups and capable of forming cross-linked polymers under the action of hardeners (polyamines, etc.). The most common epoxy resins are the products of polycondensation of epichlorohydrin with phenols, most often with bisphenol A. Bisphenol A-based resins are often called epoxy-dian in honor of the Russian chemist A.P. Dianin, who first obtained bisphenol A. The structure of the epoxy resin is shown in Fig. 1.

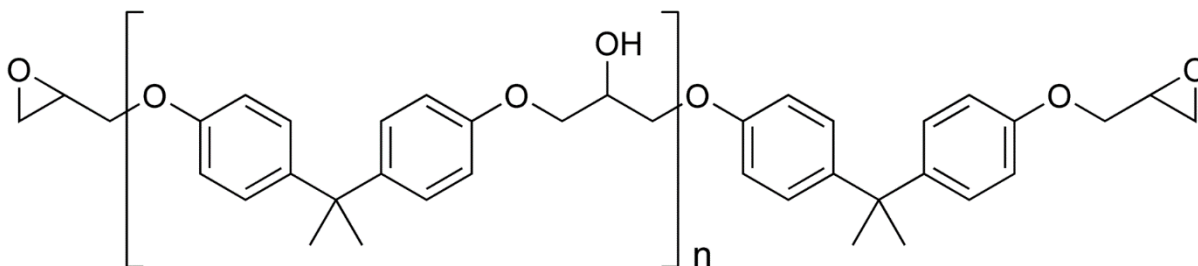


Fig. 1 - The structure of the epoxy resin - the condensation product of epichlorohydrin with bisphenol A,  $n = 0-25$

Epoxy resins are a universal, self-adhesive material used for the manufacture of compounds, composites, as well as for pouring various surfaces and applying adhesives and sealants. Epoxy resin is a kind of epoxy resins, it is a transparent, viscous liquid of yellow, brown color, without mechanical impurities. It is a fusible reactive product based on diphenylolpropane and epichlorohydrin [1].

Depending on the physicochemical properties, the following grades of epoxy-diane resins are established: ED-22, ED-20, ED-16, ED-14, ED-10, ED-8 [2].

The designation of resin grades consists of the following letters: E - epoxy; D - diphenylolpropane; figures indicating the limit of the norm of the content of epoxy groups [2].

Due to their unique properties, epoxy resins are widely used in various industries. The most characteristic areas of application are their use as:

- adhesives for the manufacture of parts of aircraft structures, in the manufacture of paint brushes and finishing coatings for concrete;
- individual elements and as a seal in the repair of plastic and metal boats, cars,

etc.;

- components for the production of small batches of castings, experimental castings, dies, templates and tools;
- stuffing and hermetic masses in construction and on roads;
- molds and seals for trains, as well as impregnating compounds for resins and varnishes in the electrical and electronic industries;
- laminates used for the construction of aircraft and aircraft bodies, for wound products and clamping fixtures.

Coatings applied from solutions are used as protective and finishing works:

- for finishing ships, coatings for steel, tank shells, aircraft;
- ground coatings in the tool and automotive industries;
- lining of cans and drums;
- finishes of furniture and coverings in the form of a tubular structure.

They are also used as paints for concrete floors and for gyms, hallways, floor varnishes, etc. [3].

Epoxy resins are also used as:

- decorative coatings in the production of printing inks;
- in the textile industry;
- in the prosthetic and prosthetic industry;
- in the petrochemical industry;
- electrical industry;
- radio-electronic industry;
- aviation, shipbuilding and mechanical engineering.

Epoxy resins are widely used in the production of building polymer composite materials (PCM) - polymer solutions, polymer concrete, adhesives, protective coatings, etc. [3] Due to the unique combination of a set of operational properties, such as:

- high strength characteristics;
- good adhesion to various materials;
- high resistance to aggressive media, etc.

Composites based on epoxy resins are used in the manufacture of:

- load-bearing structural elements of buildings and structures;
- protective and structural;
- waterproofing and decorative coatings;
- arrangement of floors;
- the device of plaster coverings with special properties;
- repair of pavement coatings, etc.

Their high efficiency of application was also noted for:

- reconstruction and repair of buildings;
- restoration and strengthening of building structures;
- arrangement of joints of prefabricated elements;
- when protecting structures from the action of the environment, etc. [4].

## Conclusion

Epoxy resins, due to the unique combination of performance properties, are widely used in various industries. The article gives a definition of epoxy resin, representing the grades of epoxy-diane resins, the scope of epoxy and epoxy-diane resins in various industries.

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## Области применения эпоксидных и эпоксидно-диановых смол

**А.В. Севостьянов\*, К.О. Сучков**

ФГБОУ ВО «Тамбовский государственный технический университет», Тамбов, Россия  
*e-mail: sevo-andrey@yandex.ru*

**Аннотация.** Эпоксидные смолы – это универсальный, самоклеящийся материал, используемый для изготовления компаундов, композитов, а также для заливки различных поверхностей и нанесения клея, герметика и т. п. В статье рассмотрены области применения эпоксидных и эпоксидно-диановых смол в различных областях промышленности.

**Ключевые слова:** применение эпоксидной смолы, эпоксидно-диановая смола, эпоксидная смола.



## The Project of Gymnastics School in Tambov

**A. V. Suzyumov, D. S.\* Kobzev**

Tambov State Technical University, Tambov, Russia  
*e-mail: kobzev.danila97@yandex.ru\**

### Abstract

The project of the gymnastics school building in Tambov is given. The main characteristics of this project from an architectural point of view are considered.

**Keywords:** architecture, building, design.

The construction of a gymnastics school in Tambov is very relevant due to the shortage of buildings of this type in the city and the policy pursued by the government of the Russian Federation aimed at the development of physical education and sports (Fig. 1).



*Figure 1 – The project of gymnastics school*

The building is planned to be built on Astrakhanskaya Street. This location is relevant because of shortage of buildings of such type in this area, a large number of potential visitors and availability of land for construction of the school. Additionally, a planned construction of a massive residential area also shows the need for the gymnastics school here.

The planned building is an object having a complex shape, consisting of a several squares. It is designed to be six-storey with dimensions in the plan in the axes “1-9”, “A-L”, 31,2x37,8m. The height of first floor is 4,2m, the height of second and

subsequent floors are 4,2m; the grid of columns is 6x7.2; 3x7.2; 5.4x7.2; 3.6x3; 12x7.2; 12x3; 2.4x3.3; 3.0x3.3 m.

The floor line of the 1st floor is 0.000, corresponds to the absolute mark of 121.92 m.

The building has a 2.7 m high basement [1].

The structural system of the building is frame. The structural scheme of the building is cellular.

The rigidity and stability of the building is ensured by the rigid coupling of columns with foundations, a hard disk of coating plates and a hard disk of floor slabs connected to each other by anchors in the direction of the seams; stiffening diaphragms installed on the walls of the stairwell and elevator shafts. The outer walls are planned to be five-layered:

- 1 – plaster made of cement-sand mortar 2 cm thick;
- 2 – a layer of silicate brick with a density of 1800 kg/m<sup>3</sup> and a thickness of 51 cm;
- 3 – a layer of insulation made of mineral wool slabs ISOROC Isovent with a density of 80 kg/m<sup>3</sup> and a thickness of 13 cm;
- 4 – an air layer, thickness of 4 cm;
- 5 – granite slabs, thickness of 1 cm.

Overlappings and coverings are hollow slabs 220 and 300 mm thick, 1000; 1200; 1500 mm long 3,0; 3,3; 4,8; 6,3; 6,9; 8,1; 11,7 m, supported by crossbars of the T-section. The tie plates are connected to each other using anchors for mounting loops. The concrete class of the floor slabs is B20, the coating slabs are B45. The class of stressed reinforcement of floor slabs and coatings is A600, the class of non-stressed reinforcement is A400, B500 [3].

The columns are precast reinforced concrete, 400x400 mm in cross section, made of heavy concrete of class B20. The column reinforcement class is A400.

The crossbars are prefabricated T-section, have a height of 450 mm. At the level of the roof and the coating, the crossbars are supported on the consoles of the columns and are fixed by welding the fasteners. Concrete of strength class B30. The class of strained rebar crossbars is A600, the class of non-strained rebar is A400, B500.

Stairwells are located in a grid cell of columns 3.0x7.2 m. Marches with half-platforms are supported in the plane of the floor-to-floor ceilings on the shelves of additional crossbars of the frame and on the consoles of the stiffening diaphragms. The slope of the staircase-landing is 1:2.

In the structural section, a reinforced concrete floor slab and a reinforced concrete march with a half-platform were calculated. The selection of fittings in the elements was made. The tensioned armature is installed in the lower part of the crossbar.

The concrete class of the slab is B45. The class of stressed plate reinforcement is A600, the class of non-stressed reinforcement is A400, B500. The tensioned reinforcement serves to increase the rigidity and crack resistance of the plate. The design scheme of the plate is a beam on two supports loaded with a uniformly distributed load. The plate works on bending. The estimated span of the crossbar is 11.540 m. The dimensions of the plate are accepted according to the 1.241-1 series.

The calculation of a monolithic columnar free-standing foundation for the extreme and middle columns on a natural base and under the rigidity diaphragm was carried out. The base of the foundation is solid loam. The foundation was checked for 2 groups of limit states. The selection of the dimensions of the foundation sole, the calculation of precipitation, (calculations for the 2nd group of limit states), calculation for depth shift and calculation by material (calculations for the 1st group of limit states) were carried out.

The concrete class of the foundation is B15. The reinforcement class of the foundation is A400 [2].

In the organizational section, a network schedule was compiled and calculated, and schedules for the movement of labor were built. The duration of construction is 558 days. The network schedule was optimized due to the availability of time reserves for certain types of work that lie outside the critical path. The critical path is shown on the graph in the form of a double line (the critical path is the path that has the longest duration in terms of work completion time without time reserves on it). Optimization was carried out by reducing the number of workers at a certain type of work by increasing the duration of work due to the time reserve.

Additionally, in the section of organization of construction, an object construction plan was developed for the construction of the aboveground part of the building. For the safe and compact placement of temporary buildings and structures on the construction site, their location was chosen outside the hazardous area of the crane operation. The location of temporary buildings, storage sites for structures and temporary communications is shown. The dangerous zone of the crane operation is shown (circles with flags). The dangerous zone of the crane operation is the space where it is possible for the load to fall during movement, taking into account the likely dispersion during the fall [4].

In the construction economics section, local and object estimates were compiled based on the work statement. The estimated cost of work in the prices of 2021 is amounted to 336 million rubles; the cost of 1 m square building was 59 thousand rubles.

To conclude, the building meets all modern requirements applied in the construction and operation of buildings.

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## **Проект школы гимнастики в городе Тамбов**

**А. В. Сузюмов, Д. С. Кобзев\***

ФГБОУ ВО «Тамбовский государственный технический университет», Тамбов, Россия

*e-mail: kobzev.danila97@yandex.ru\**

**Аннотация.** Рассмотрен проект здания школы гимнастики в Тамбове. Рассмотрены основные характеристики проекта с архитектурной точки зрения.

**Ключевые слова:** архитектура, строительство, проектирование.

УДК 81`37  
ББК 81.1

## Some Cognitive Features of Terminological System Emergence (Viewed through COVID-19)

**A. S. Antipova**

Lomonosov Moscow State University, Moscow, Russia  
Kursk State University, Kursk, Russia  
*e-mail: alineant@yandex.ru*

### **Abstract**

The purpose of this study is to consider some cognitive features of terminological system at the stage of its emergence. COVID-19 pandemic sets up new realms for terminology research being a unique historical period coined by the burst of novel terminology in all types of discourse. The corpus research based on selected textual materials from official media sources in Russian and English is aimed at investigating structural and systemic unity of COVID-19 semantic field components due to the introduction of conventionally fixed designation (COVID-19) into the language system.

**Keywords:** COVID-19, terminology, terminological system, definition frame, tropes, individual lexicon, conceptual sphere

Terminology is extremely versatile and extensive in terms of its subject matter explication. The scope of theoretical interest of terminologists includes elements of industry-specific subsystems belonging to the natural language in the interconnectedness of "their logical content determined by the features of a special concept denoted by a term, and terminological essence, which includes conceptual, functional and formal structure represented by the term-elements". [Leichik 1989: 6].

One of the main directions that studies the functional features of terminological units is cognitive approach in linguistics. Cognitive science analyzes peculiarities of perception and further information processing both at the level of an individual and at the level of the society as a whole. Cognitive linguists consider language in the aspect of its categorizing potential through naming the reality: the process aimed at particular objects relevant for human "here-and-now" activity. As a result, the link between a linguistic unit and extra-linguistic reality is provided. In the process of naming activity-significant phenomena, things, tools and characteristics specialized terminological systems are developed. They are directed at effective interaction in specific socially predetermined conditions.

From the point of view of cognitive approach representatives, terminological systems are the reflection of the leading pragmatic motives of domain-specific interaction and are formed logically within professional communication, which greatly extends traditional understanding of the systemic nature of terminological elements and terminology-based structures. Previously, the researcher's attention has already been focused on the arranging function of terminological systems. K. Y. Averbukh

points out that any terminological system is a set of terminology in which its actual systemic properties are revealed. A. N. Baranov believes that within one scientific theory, the terms of a particular discipline set up its terminological system. According to V. Leychik, a terminological system is a set of terms formed on the basis of a particular theory or concept reflecting the connections of all concepts of a particular field of knowledge. It is also important to note that "a terminological system may not necessarily be based on a scientific theory; a concept or even a simple generalizing idea that describes the field in a consistent and complete way is sufficient for a number of special areas" [Leichik 2009: 104].

Significant for our study is the conclusion that "the inversibility of scientific discourse is based on the permanent incorporation of terms and concepts from naive, fictional and other types of discourse. At the same time, terms and concepts used in new contexts become a metaphorical basis for the formation of special terms, providing conceptual fund restructuring of a particular scientific field. This process is accompanied by the establishment of new associations between objects and phenomena, resulting in the positive development of terminological apparatus of a scientific paradigm". [Zubkova 2008: 128] Our empirical observations have shown that it is also true for the phenomenon under investigation. It is due to the complex transformations of COVID-19 semantic gestalt being under the influence of "pulsating" intrusions into connotative semantic field that the emerging COVID-19 terminological system adapts and incorporates communication-relevant, axiological and discursive elements quite naturally.

In March, 2020, the world faced a new systemic social reality: COVID-19 coronavirus pandemic. While this is not the first case of a viral disease mass spread, the related infodemic – the emergence of excessive information including false or misleading that distorts its perception – resulted in creating a universal, ambiguous and largely contradictory information field. Novel vital circumstances were reflected in all natural languages with the occurrence of new words and word combinations in the language systems, first of all, due to the manifestation of a special class of lexical units – terminology of specialized fields, particularly, medicine. At the same time, the overwhelming coverage, heterogeneity and diffusion of the developing semantic space are not comparable with the characteristics of traditionally formed terminological systems, that underlie linguistic representation of any previously known disease and its overall knowledgeable basis. The process of naming, i.e., term designation related to a certain illness further systemic representation in language, normally takes a long way to develop into a terminological system. With COVID-19 this process is fundamentally different. Short-term dynamics of terminological elements systemic functioning and their social predeterminance play a decisive role. It is important to note that the paradox and uniqueness of COVID-19 terminological system lies in simultaneous representation of many signifying potencies of semiotic elements that it comprises. "On the one hand, tropic lexicon acts as a semantic exciton in professionally saturated space, and on the other hand, as a means of communication, manifested as a sign that verbalizes the metaphorical image of the professional

phenomenon and captures in oral or written form the correlation of cognitive, cultural, linguistic and professionally conditioned phenomena". [Zubkova 2016: 16]. Thus, unlike seemingly isolating potential of a single term, COVID-19 terminological system manifests its otherness through sign convergence of its constituent elements, forming connotative background for condensed denotative semantic capacity.

Due to the uniqueness of the historical period and in terms of its impact on the development of global lexical system, we analyzed relevant information sources to describe the features of new coronavirus infection representation longitudinally, reflecting the first three waves of COVID-19. Official news reports in Russian and English in total amount of 4060 text units were selected by the keyword COVID-19 for the ongoing analysis of semantic field structure presupposed by the key COVID-19 categorizing component. The term COVID-19 is the cornerstone of the whole structure, as it was conventionally introduced into the public sphere becoming its primary and main constituent element. In the official sources of the initial pandemic period, within the framework of frequency analysis of lexical cooccurrences, COVID-19 demonstrates about 1500 manifestations. Along with the less frequent *coronavirus* (about 1000 uses) it enters the core structure of the COVID-19 semantic field at the initial stage of pandemic representation. In predominant number of sources in March-June, 2020, the term COVID-19 is given descriptively and tends to be accompanied by a definition. The definition, in its turn, reflects a kind of categorical scheme or its terminological framework that is provided through the inseparable unity of the defined part and the defining component. As the research has shown, the definition frame of COVID-19 during the first pandemic wave represents such key concepts as *a new type of disease* and *the virus that causes it* at the same time. At the pandemic onset, the term *SARS-COV-2*, introduced by virologists to denote a new type of coronavirus, was artificially ousted from the public agenda due to the presence of a negative emotional semantic component - *acute respiratory syndrome*. Together with that, the frame-forming elements of COVID-19, stripped of their emotional connotations, incorporated *the virus* slot and COVID-19 definition thus acquired a two-component structure.

Subsequent analysis of textual data demonstrates definition frame transformation in the temporal perspective of pandemic waves. Between May and July 2020, for instance, COVID-19 is defined in terms of its main symptoms. *Preventive measures*, *social limitations* and *health threat* arising from non-adherence gain significance. The definition frame of this period represents the concepts of *respiratory disease (pneumonia)*, *asymptomatic development*, *lethality*, *complications (risk factors)*, *protectionism*, *personal protective measures*, *social isolation*, and *distancing*. In comparison, COVID-19 definition frame of the third wave is characterized by gradual displacement of symptomatic slots with the elements that nominate ways to deal with coronavirus infection: *prevention*, *vaccine* and *immunity*. Subjective components of the definition frame: *life-threatening* and *lethally dangerous* are replaced by *situation control*, *collective responsibility* and *overcoming the fear of death*.

The involvement of several subfields in shaping pandemic representation leads to terminological conglomeration. Thus, COVID-19 thematic frame may be viewed as

cumulative knowledge of a new disease, its symptoms, causes, effects, outcome and social impact. COVID-19 terminological system emergence illustrates gradual and step-by-step short-term development. The dramatic change of social attitudes leads to the occurrence of new terminological units together with observable shifts of irrelevant lexical units, significant at subsequent stages, to semantic periphery. Thus, throughout pandemic waves, an updated COVID-19 conceptual framework is being created and updated. Due to the fact that described components are selected on the basis of frequency analysis of cooccurrences and collocational shifts in comparative corpora-based research of English and Russian media sources with further data clustering, the categories under study represent socially significant trends of COVID-19 pandemic based on axiological paradigms. These include vital life-and-death issues, indicating the significant role of extralinguistic factors both in structuring COVID-19 terminological system and in developing global conceptual field of the pandemic that predetermines subsequent perception of its elements by all socio-cultural, age and professional groups.

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## Некоторые когнитивные особенности появления терминосистемы (на примере COVID-19)

**А. С. Антипова**

Московский государственный университет имени М.В. Ломоносова, Москва, Россия

Курский государственный университет, Курск, Россия

*e-mail: alineant@yandex.ru*

**Аннотация.** Целью данного исследования является рассмотрение некоторых когнитивных особенностей терминосистемы на этапе ее зарождения. Пандемия COVID-19 открывает новые возможности для исследований в области терминоведения, являясь уникальным историческим событием. Этот период характеризуется манифестацией новых терминологических единиц во всех типах дискурса. Проведенное корпусное исследование на материале официальных новостных источников на русском и английском языках направлено на изучение структурного и системного единства компонентов семантического поля COVID-19, обусловленного внедрением в языковую систему конвенционально обусловленной номинации.

**Ключевые слова:** COVID-19, терминосистема, дефиниционный фрейм, тропы, индивидуальный лексикон, концептосфера.



## Metaphores au Discours Medical en Ligne

L. G. Barasheva\*, A. V. Barashev

Université d'Etat de Tambov G.R. Derjavine, Tambov, Russie

\*e-mail: lidia1913@mail.ru

### Résumé

L'article est consacré à l'analyse des métaphores contenues dans les commentaires et avis sur les établissements de santé et le personnel médical sur les sites officiels des établissements médicaux correspondants de la France. Les possibilités communicatives de la métaphore dans l'espace Internet sont étudiées selon leur appartenance à tel ou tel groupe sémantique. En particulier, la fonction de la métaphore comme moyen pour un patient d'évaluer de manière productive une consultation passée / un établissement médical / un spécialiste médical dans le discours médical en ligne moderne est analysée. L'échantillon étudié d'exemples de métaphores est structuré en groupes selon la caractéristique sémantique. La base de l'analyse est le principe de classer le transfert de sens de la sphère-source d'origine de la métaphore à la sphère-cible à travers un trait sémantique commun. Sur la base des résultats de l'analyse des métaphores, on fait une conclusion sur le rôle évaluatif des métaphores dans l'espace Internet médical.

**Mots clés :** discours médical en ligne, langue française, métaphores.

Dans la linguistique contemporaine, les problèmes de la relation entre le langage et la pensée sont activement étudiés. En particulier, les moyens d'expression linguistiques sont considérés du point de vue de leur capacité à transmettre des sentiments, des émotions, des appréciations subjectives du locuteur. L'un de ces moyens d'expression est une métaphore, dont l'étude a reçu une importance particulière depuis l'Antiquité. À l'heure actuelle, avec l'avènement de nouveaux moyens et types de communication, y compris les forums, les sites officiels, les publicités, les réseaux sociaux et d'autres modes d'échange d'informations dans la sphère des réseaux, les questions de la place et des fonctions de la métaphore dans les types de discours contemporains nécessitent un développement spécial. À cet égard, la recherche présentée est actuelle, car elle s'inscrit dans le paradigme scientifique moderne, en raison de la numérisation de toutes les sphères de l'activité humaine. Cette recherche analyse le fonctionnement de la métaphore dans le discours médical en ligne.

Comprendre la métaphore uniquement comme un moyen d'expression littéraire élégant ne révèle pas son vaste potentiel. Les chercheurs modernes sont unanimes à dire que la métaphore remplit des fonctions cognitives, qu'elle contribue à la connaissance du monde environnant par la comparaison d'un phénomène connu avec un nouveau phénomène inconnu. La propriété de la pensée humaine de connaître ou d'adapter de nouvelles informations pour réfléchir par comparaison avec un fait déjà connu explique la popularité, et parfois le caractère indispensable de l'utilisation de la métaphore dans des domaines de la vie humaine tels que la politique, l'économie, la médecine, l'informatique, etc.

Les linguistes s'intéressent particulièrement au discours médical, qui est compris

comme un type particulier de discours institutionnel. Il se caractérise par deux caractéristiques de système : le but de la communication et les participants de la communication. Dans le cadre de notre recherche, le but de la communication est d'obtenir des soins médicaux ou des informations sur un problème médical d'intérêt, ou une description d'un établissement médical ou d'un médecin, et les participants à la communication sont des patients et des médecins.

La question de l'utilisation de la métaphore dans le discours médical est activement analysée dans les recherches contemporaines, d'après lesquelles la métaphore a un potentiel créatif dans le domaine de la formation de nouveaux termes, en raison des associations comparatives émergentes entre le nouveau phénomène et l'objet de comparaison.

La partie prédominante du système terminologique médical est représentée par des termes métaphoriques. Les termes des sciences médicales fondamentales : anatomie, physiologie, histologie, fixés dans l'esprit d'un spécialiste médical, servent de déclencheur à la formation de termes dans les domaines privés de la science médicale : symptômes, traitements, pratiques médicales, maladies, etc. La pensée d'un médecin spécialiste devient orientée à la création métaphorique. Le médecin décrit de nouveaux symptômes, syndromes, maladies afin de permettre de comprendre un nouveau phénomène, fait, basé sur de telles réalités qui pourraient être comprises par un étudiant, un collègue ou un patient. Dans ce contexte, la fonction d'une métaphore est de réduire le temps de compréhension, de rester en mémoire, de simplifier la compréhension d'une nouvelle information à celui à qui cette information s'adresse.

En plus de la formation de termes, les métaphores du discours médical peuvent remplir d'autres fonctions. La question de l'utilisation de métaphores dans la communication quotidienne entre un médecin et un patient est activement étudiée. L'une des fonctions principales de la métaphore est ici la fonction d'explication d'informations compliquée pour le patient. La métaphore joue également le rôle de moyen d'absorption verbale des émotions dans une situation stressante, contribue au développement d'un microclimat favorable dans l'équipe et améliore le processus de communication professionnelle. Évidemment, la métaphore remplit une fonction émotive dans le cadre de la communication orale dans les dyades médecin/patient, médecin/médecin.

Une question distincte de la linguistique contemporaine est l'étude du discours médical sur Internet. La numérisation mondiale de diverses sphères de la vie humaine, la pénétration des technologies informatiques dans la vie quotidienne contribuent à l'émergence de types de communication qualitativement nouveaux dans les paradigmes des relations médecin-patient, médecin-médecin, patient-patient. Parmi eux, des consultations médicales en ligne pour les patients, des forums médicaux dédiés à un sujet précis : une maladie, ou une situation dans laquelle une explication du problème par un médecin spécialiste est nécessaire.

Pour un type particulier de communication médicale, les linguistes contemporains incluent des avis de patients sur les médecins, les hôpitaux, les autres établissements médicaux sur des sites officiels, ainsi que des avis sur les sites des administrations

d'État ou municipales d'établissements médicaux ou de médecins.

La communication de réseau, y compris médicale, étant un type spécifique de la communication, a les caractéristiques suivantes :

- médiation (à l'aide de dispositifs techniques de communication) : un mode de communication similaire est effectué via un ordinateur personnel, un smartphone, une tablette ;

- nature distante de la communication (distance spatio-temporelle) : la demande du patient et la réaction du médecin spécialiste sont généralement séparées dans le temps ;

- négligence grammaticale, de ponctuation et d'orthographe des sujets de communication par rapport à la formation du message ;

- émoticônes, argot informatique, utilisation du verrouillage des majuscules pour concevoir des messages aux couleurs émotionnelles.

Dans la sphère Internet, les concepts d'avis et de commentaire sont populaires. Les avis sur les sites officiels des établissements médicaux publics, ainsi que sur les sites officiels des cabinets privés de thérapeutes familiaux, sont des avis de patients qui, en règle générale, sont accompagnés de la rétroaction de l'administration de l'établissement médical. Dans le cas d'un avis positif du patient, la rétroaction s'accompagne d'une gratitude clichée, avec un avis négatif, un commentaire-regret est noté, ou bien un commentaire-explication de la situation controversée. Dans les commentaires de l'appareil administratif, la motivation du patient à redemander à l'organisation est régulièrement observée.

La communication dans les forums médicaux est présentée d'une manière différente. Un patient indique un problème qui est commenté par les visiteurs du forum expérimentés dans ce domaine, des discussions peuvent avoir lieu sur le sujet spécifié. Souvent, la communication prend une forme amicale. De ce fait, le patient reçoit ou non un conseil/une solution au problème, selon que son message est commenté ou non.

Le style de communication dans les premier et deuxième cas est proche du style de discours familier, caractérisé par l'émotivité des messages, la présence de phrases incomplètes, interrogatives et exclamatives, d'expressions tronquées. La présence de divers moyens d'expression, y compris des phrases sarcastiques, est notée. La métaphore est présente dans les deux types de discours médicaux en ligne.

Présentons une classification d'exemples de métaphores. Elle repose sur le principe du transfert de sens de la zone source de la métaphore vers la zone cible à travers une caractéristique commune identifiée au cours de l'analyse sémantique. Les groupes de métaphores suivants sont distingués.

**Métaphores morales** : *commentaires blessants (ci-après traduits par l'auteur de l'article - LB)*. Dans cet exemple, le sens de l'action physique est transféré à l'état mental. Le processus d'écoute par le patient de déclarations qui sont désagréables pour lui est associé dans son esprit à des sensations physiques douloureuses.

**Métaphores animalistes** : *cette allergie me bouffera (ci-après, l'orthographe de la source est conservée)*. L'allergie est associée par l'utilisateur à une créature prédatrice qui peut lui nuire, jusqu'à sa destruction complète. Le patient, en revanche, s'assimile à la victime de cette créature hostile, dont il utilise un vocabulaire familier.

**Métaphores corporelles :** *si vous cherchez une oreille attentive.* La réactivité et la sympathie du médecin, notées par le patient lors de la consultation médicale, s'accompagnent d'une comparaison de la capacité du médecin à percevoir attentivement à travers la partie perceptive de son corps – l'oreille. Il y a une expression d'un phénomène mental à travers le physique, le corporel. Lors de la caractérisation d'un médecin, sa qualité professionnelle, qui est particulièrement importante pour le patient - l'attention - vient au premier plan.

**Métaphores nature-morphiques :** *attitude glaciale.* Selon un principe similaire, il y a un transfert de sens d'un concept physique à un processus mental dans l'exemple ci-dessus. Le patient rencontre le comportement indifférent du médecin et l'identifie dans sa pensée avec le concept physique de la glace, ce qui signifie pour lui un environnement de communication inacceptable.

**Métaphores militaires :** *C'est un vrai parcours du combattant !* De nombreux obstacles auxquels le patient a dû faire face pour atteindre le médecin, la difficulté de leur passage, le traitement sévère des patients par le personnel médical - tout cela conduit à associer dans l'esprit du patient cet établissement médical au lieu de l'entraînement des militaires.

**Métaphores religieuses :** *Depuis ce jour là l'enfer a commencé...* La douleur, le tourment, la souffrance ressentis par le patient lorsqu'il s'adresse à un établissement médical permettent de le comparer à un lieu de souffrance extrêmement intense - l'enfer.

**Métaphores du domaine de la mythologie :** *La douleur ne doit pas être uniquement le fil d'Ariane des consultations.* Dans la mythologie grecque, la fille du roi crétois Ariane a aidé son bien-aimé Thésée en lui donnant une pelote de fil. Le héros a utilisé ce fil pour sortir du labyrinthe, attachant une extrémité au début du labyrinthe, sauvant ainsi lui-même et les jeunes hommes et jeunes filles envoyés pour être dévorés par le Minotaure. En français moderne, l'expression Fil d'Ariane signifie " ce qui sert de guide et permet de se tirer d'une situation difficile " ( Larousse ). Dans le cadre de l'avis, le patient identifie la douleur à l'une des façons de trouver la cause de la maladie, c'est-à-dire à un certain point de référence pour le médecin, et il croit que cela ne suffit pas pour poser un vrai diagnostic ou choisir un méthode de traitement convenable.

Ainsi, la métaphore est un moyen linguistique d'expressivité, qui aide de manière vivante et figurative à transmettre des informations sur les expériences sensorielles, l'état émotionnel, sur l'expérience acquise au destinataire. A l'aide d'une métaphore, un internaute attire l'attention des futurs patients, médecins d'un établissement médical, ainsi que des visiteurs du site sur les problèmes qu'il a rencontrés en contactant l'établissement médical. La capacité d'une métaphore à influencer la sphère émotionnelle de la conscience de l'utilisateur permet d'atteindre relativement rapidement et de manière productive l'objectif de la communication – l'échange d'expériences.

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## Метафоры в медицинском онлайн дискурсе

Л. Г. Барашева\*, А. В. Барашев

ФГБОУ ВО «Тамбовский государственный университет им. Г.Р. Державина, Тамбов,  
Россия

\*e-mail: [lidia1913@mail.ru](mailto:lidia1913@mail.ru)

**Аннотация.** Статья посвящена анализу метафор, содержащихся в комментариях и отзывах о лечебных учреждениях и о медицинских работниках на официальных сайтах соответствующих лечебных учреждениях Франции. Изучаются коммуникативные возможности метафоры в интернет-пространстве согласно их принадлежности к той или иной семантической группе. В частности, исследуется функция метафоры как способа продуктивного оценивания пациентом прошедшей консультации/лечебного учреждения/медицинского работника в современном сетевом медицинском дискурсе. Исследуемая выборка примеров метафор структурируется по группам согласно семантическому признаку. За основу взят принцип классификации переноса значения от сферы-источника происхождения метафоры на сферу-цель через общий семантический признак. По результатам анализа метафор делается вывод об оценочной роли метафоры в медицинском интернет-пространстве.

**Ключевые слова:** медицинский онлайн-дискурс, метафора, французский язык.

## Dictionnaire Covidien et Évolution de la Langue Française

**N. Yu. Borodulina, M. N. Makeeva**

Université technique d'état de Tambov

*e-mail: nat-borodulina@yandex.ru; marnikma@inbox.ru*

### Résumé

L'objectif principal de cet article est de mettre l'accent sur les différentes associations lexicales qui sont des indicateurs de la créativité linguistique prometteuse inspirée par la pandémie de Covid-19, et qui offrent des pistes de recherche à la fois riches et fertiles dont il serait difficile de déterminer les principaux aspects dans un seul travail. Ces unités lexicales néologiques se présentent sous les formes différentes, mais ils proviennent toujours d'un ensemble d'usages lexicaux et discursifs, propres à une sphère de l'activité humaine. Ainsi, les productions écrites et orales, englobant la terminologie savante, les textes de haute scientificité, mais aussi le vocabulaire banalisé et la terminologie populaire viendront se ranger dans le technoclecte. Il s'agit de l'emploi de la langue de spécialité qui reste pertinent dans les études philologiques.

**Mots-clefs:** langue de spécialité, lexique, néologie, terminologie.

Le lexique du moment de la pandémie et aussi celui du jour d'après permettent d'apprécier l'évolution de la langue française en général, puisque les mots comme «COVID», «déconfinement», «écouvillon», etc appartiennent non seulement à un moment donné mais comptent parmi les nombreux mots, combinaisons et concepts dans la plupart de la terminologie médicale, biologique et sociologique qui ont grandement renouvelés et enrichis le vocabulaire en quelques jours [1, 2, 3]. L'accélération de la créativité lexicale de la période de coronavirus est considérée comme un ensemble d'usages lexicaux et discursifs, spécifique à la pandémie qui a fait changer brusquement les perceptions des individus vis-à-vis de leurs activités, leurs comportements et leurs attitudes.

Tout d'abord, les caractéristiques sémantico-pragmatiques du vocabulaire covidien de la langue française témoignent des potentialités et de la spécificité de la création des nouveaux mots et des significations français, y compris non seulement les néologismes, mais aussi les mots qui, en élargissant la sémantique, ont commencé à être corrélés aux réalités du nouveau temps. Les nouveaux mots incluent également les anglicismes, les noms propres et les abréviations. Citons quelques exemples:

BALCONNER - applaudir sur son balcon.

BARRIGÈSTE - l'abréviation plus courte que «geste barrière».

CORONIALS - terme, en vogue sur les réseaux sociaux qui fait référence à la génération qui naîtra dans les mois à venir du fait de la distanciation sociale et, dans certains pays, du confinement.

DÉCONFINEMENT - dérivé de confinement avec le préfixe *dé*. Le terme définit la fin de l'isolement, la période que nous vivrons une fois la pandémie terminée.

FFP2 (filtering facepiece, littéralement «pièce faciale filtrante») - le masque FFP2, en forme de bec de canard, il est plus élaboré que le masque chirurgical, car il est capable de filtrer l'air. Il est également étanche, pour éviter les projections. Il s'agit du

modèle recommandé par les autorités pour éviter de propager le virus.

**GESTEBARRIÈRE QU'UN** - repousser un individu qui tente la bise ou le serrage de main.

**PATIENT ZÉRO** - initialement, le patient zéro est la première personne à avoir été contaminée par un virus. Le terme est aussi utilisé pour désigner celle à l'origine de l'arrivée du virus sur un territoire (un pays, une région, une commune...).

**QUATORZAINE** - à l'ère de la COVID-19, ce néologisme, dévié du mot «quarantaine », exprime la période d'isolement de 14 jours à laquelle certaines personnes doivent se soumettre. Établie à partir du terme de quarantaine, qui désigne la mise en place de mesures de confinement, peu importe leur durée, la quatorzaine est un processus identique, qui dure quatorze jours. Ce délai équivaut, selon la communauté scientifique, à la période d'incubation (temps entre la contamination et le développement des symptômes) du coronavirus.

**SLOWPHISTICATION** - anglicisme composé de *slow*, et *phistic* et le suffixe *-ation* qui signifie le processus visant à organiser l'administration du vaccin contre le Covid.

**SUPER CONTAMINATEUR** – ce composé désigne un malade qui contamine un grand nombre d'autres personnes.

**TOUX-SHAMER** - regarder mal quelqu'un qui tousse en période de pandémie mondiale.

Il y a une quantité considérable de termes médicaux formés par la voie métaphorique et par les symboles des couleurs, par exemple:

**CELLULE HÔTE** – mot signifiant une cellule envahie par un agent infectueux.

**PLATEAU ÉPIDÉMIQUE** – les représentations graphiques le plateau épidémique correspond au plateau de la courbe épidémique.

**SEUIL ÉPIDÉMIQUE** - incidence critique déterminée a priori qui, en cas de dépassement, donne lieu à la déclaration d'une épidémie ou à la mise en place de mesures sanitaires prévues.

**ZONE ROUGE** - zone d'un établissement de soins de santé où sont traités les patients atteints de la maladie infectieuse en cause dans une épidémie.

**ZONE VERTE** - zone d'un établissement de soins de santé où sont traités les patients qui ne sont pas atteints de la maladie infectieuse en cause dans une épidémie.

**ZONE JAUNE** - zone d'un établissement de soins de santé où sont traités les cas suspects ou probables de la maladie infectieuse en cause dans une épidémie.

Il y a également beaucoup de mots désignant de nouveaux types des relations entre les gens, surtout la manière de se saluer qui permet d'éviter la poignée de main: *coude-à-coude, poing-à-poing, salut du pied*.

Une grande part des néologismes sont des mots-valises dont la structure et la signification sont déterminées par la compréhension des composants ayant une orientation pragmatique, reflétant les réalités de l'ère du coronavirus, y compris celles générées par le développement des technologies numériques:

**APÉROVISIO** - concept inventé pendant le confinement en prenant l'apéro en se réunissant par écrans interposés pour garder le lien social.

**ATTESTARDER** - remplir son attestation alors qu'on est déjà dans la rue. Certaines personnes contaminées par le coronavirus n'en présentent pas les symptômes, qui se rapprochent de ceux de la grippe (forte fièvre, difficulté à respirer). Elles sont asymptomatiques. Si aucun effet de la maladie n'est visible sur elles, elles sont en revanche capable de transmettre le virus à leur tour, ce qui complique les mesures de prévention.

**BALCONAZI** - contraction de *balcon* et *nazi* désigne les personnes qui font la police depuis leur étage, insultant les passants sans même savoir s'ils sont autorisés à circuler.

**CONFIGNORANT(E)** - se dit de quelqu'un qui n'a pas suivi les plus récentes évolutions des règles sanitaires, et contrevient à ces dernières par ignorance.

**COVIDIOTIE** - mot-valise fusionnant les mots *covid* et *idiotie*. Comportement de covidiotie.

**PARANOVIRUS** - terme composé de *parano* et *virus*, qui désigne l'effet de la peur qui se propage plus rapidement dans la population que le virus lui-même en période de pandémie. Grâce notamment au développement des réseaux sociaux, le paranovirus pousse les gens à se ruer dans les supermarchés, à se croire malade alors qu'ils sont en pleine forme, à vénérer les dictatures, et à rejeter les marginaux en masse.

**SKYPÉRO (WHATSPÉRO, E-PÉRO)** - faire un apéritif à distance afin de garder un contact avec les proches.

**VACCINGLINGLIN** - composé de *vaccin* et de *glinglin*, le terme désigne la projection dans un avenir incertain lorsque la perspective d'un vaccin contre le coronavirus apparaissait encore très lointaine.

**ZOOMBOMBING** - le terme est associé au nom du logiciel de vidéoconférence Zoom en est dérivé, mais il a également été utilisé pour désigner le phénomène sur d'autres plateformes de vidéoconférence. C'est une intrusion non désirée et perturbatrice, généralement effectuée par des trolls ou des pirates informatiques pirates, dans une vidéoconférence.

**ZOÛTER** - faire un zoom à l'heure du goûter.

Le potentiel du nouveau vocabulaire de la langue française est corrélé avec la création des mots spontanés et l'humour, ce qui se manifestent dans l'utilisation des techniques du jeu de la langue, révélant les intentions culturelles des locuteurs natifs.

Ainsi, on pourrait conclure que les néologismes nés à l'époque de COVID-19 restent les indicateurs de la créativité linguistique du français.

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## **Ковидный словарь и эволюция французского языка**

**Н. Ю. Бородулина, М. Н. Макеева**

ФГБОУ ВО «Тамбовский государственный технический университет», Тамбов, Россия

*e-mail: nat-borodulina@yandex.ru; marnikma@inbox.ru*

**Аннотация.** Цель данной статьи - сосредоточить внимание на различных лексических ассоциациях, которые являются индикаторами многообещающего лингвистического творчества, вдохновленного пандемией Covid-19, и предлагают плодотворные направления исследований, основные аспекты которых было бы трудно определить в одной работе. Описываемые в статье неологические лексические единицы бывают разных форм, но они всегда происходят из набора лексических и дискурсивных употреблений, характерных для определенной сферы человеческой деятельности. Таким образом, письменные и устные произведения, включающие научную терминологию, тексты высокой научности, а также разговорную лексику и популярную терминологию, могут быть включены в технолект. Речь идет, прежде всего, о профессиональном языке, что остается актуальным в филологических исследованиях.

**Ключевые слова:** профессиональный язык, лексика, неология, терминология.

## Le Français Moderne Dans la Communication Virtuelle

N. Yu. Borodulina\*, V. I. Kopelnik, G.N. Tchebotareva

Université technique d'état de Tambov  
\*e-mail: nat-borodulina@yandex.ru;

### Résumé

Le but de cet article est de démontrer la spécificité du contenu linguistique de la communication électronique. L'article examine les particularités de la langue française de la communication virtuelle en tenant compte du principe: vitesse maximale de transmission du message avec un minimum de caractères sans perte de contenu. Sont analysées les techniques linguistiques de base pour obtenir un effet de communication positif. Il est à noter que la spécificité du contenu linguistique de la communication électronique francophone est liée à la tendance à la représentation non linéaire, à la démocratisation de la communication Internet et au format des pratiques discursives utilisées. Les transformations lexicales se manifestent dans l'invention de nouveaux mots, l'utilisation des anglicismes et des abréviations, ainsi que dans les tendances envers des formes linguistiques non standard qui rapprochent l'écriture de l'écran à l'écriture phonétique.

**Mots-clés:** abréviations, anglicismes, écriture phonétique. néologismes, rebus.

Le développement rapide des technologies de l'information et de l'Internet au cours des dernières décennies a abouti à l'émergence d'un espace globale de la communication. La communication virtuelle occupe une place particulière dans la structure de cette nouvelle forme de la communication. Aujourd'hui, le côté technique de la communication virtuelle est bien étudié, alors que le phénomène linguistique reste parfois ignoré face au développement quasi quotitien du corpus lexique [1, 2, 3].

Tenant compte du fait que la réalité virtuelle est devenue la plus grande réalisation, disons "une sorte de carte de visite" de la société de l'information, un des principaux facteurs des prospérités des domaines scientifiques, techniques, sociaux, économiques, culturels et autres du mode de la vie social, il est impossible d'imaginer la communication moderne sans connaître et maîtriser de nouveaux signes, symboles et abréviations nés au sein des réseaux sociaux.

La communication virtuelle a également conduit au développement actif en France d'une langue artificielle "parallèle" au langage commun, mais transféré dans l'espace de l'Internet - la ciberlangue.

En français moderne on voit aujourd'hui se former un groupe thématique du vocabulaire des internautes: *toile*, *télécharger*, *cibertexte*, *ciberlecture*, *cybercafé*, *ciberespace*, *cyberamitié*, *arobase*, etc.

En plus, cette communication dans le réseau nécessite la vitesse de la transmission de l'information, le minimum de temps avec le maximum de contenu. En conséquence on assiste à la situation linguistique caractérisée par la disparition des

éléments grammaticaux, orthographiques et syntaxiques de la langue, dont la perte ne déforme pas le sens du message, l'élimination des signes de ponctuation, des prépositions, des unions et des articles, ce qui emmène à la formation des "chaînes" des noms. Les formules courtoises propres à la langue française ne sont plus utilisées dans la communication virtuelle.

Bien sûr, il y a un appauvrissement, une normalisation, une unification de la langue à mesure que les versions orale et écrite se rapprochent rapidement. On ne peut que constater ce fait, car des millions de personnes utilisent l'Internet et les phénomènes dont nous parlons semblent être universels. Le cyberlangage vit, évolue, s'enrichit au fur et à mesure que l'imagination de ses utilisateurs se développe, en conformité avec de nouvelles tendances, mais sans se détacher du français moderne.

Les caractéristiques de la "nouvelle" langue sont: franglais (anglais francisé), écriture phonétique, le plus proche du discours familier (on écrit comme cela est entendu), abréviation, emploi des morphèmes spécifiques, onomatopée, spécificités stylistiques lors de la création de textes.

L'influence de l'anglais sur le vocabulaire français a commencé au XVII<sup>e</sup> siècle et a atteint les plus grandes échelles au XVIII<sup>e</sup> et XIX<sup>e</sup> siècle. Ce phénomène était initialement dû à des raisons politiques, ainsi qu'à l'intérêt des gens pour la philosophie et la littérature anglaises. Après le renforcement des relations commerciales entre l'Angleterre et la France au XIX<sup>e</sup> siècle, puis l'influence de la popularité mondiale des jeux de sport inventés par les britanniques, les anglicismes associés à ces thèmes sont fermement ancrés dans la langue française. Il à noter que les français s'intéressaient non seulement aux anglicismes, mais aussi aux américanismes. De nos jours, le processus d'emprunt de mots de la langue anglaise se poursuit, ce qui peut être démontré par la présence des mots suivants en français: *cool, shopping, hashtag, surfer (sur Internet)*, etc.

Citons quelques exemples des anglicismes utilisés dans le cyberlangue:

*CUL8R – See you later*

*F2F – Face to face - face à face, tête à tête, rendez-vous, B4 – Before – avant*

Les anglicismes peuvent être remplacés par des équivalents français sans perte de temps de communication et d'espace de texte: *F2F = RV (rendez-vous) Before-avant (avt) IMO-in My Opinion-AMA( à mon avis)*.

Dans certains cas, la traduction peut ralentir la transmission du message ou prendre plus de place en raison de la longueur du mot.

*IC (I see) – Je vois; TIA (Thanks in advance) – Merci d'avance*

Un certain nombre de linguistes voient traditionnellement dans cette utilisation des anglicismes une source de "destruction" de la langue française.

Un autre marqueur du vocabulaire familier sont les abréviations. Par exemple: *dac = d'accord, à toute = à tout à l'heure, à plus = à plus tard, sympa = sympathique, un déca = un décaféiné*, etc. Ces abréviations sont souvent utilisées dans la vie quotidienne dans les messages SMS et dans la communication de l'Internet.

L'abréviation en tant que moyen de combler le fossé entre les fonctions

nominatives et communicatives d'une langue, et le reflet du principe de l'économie linguistique, devient l'un des phénomènes dominants dans les langues modernes en général.

Ainsi, dans un seul numéro du quotidien français les ECHOS, on peut trouver plus de 200 abréviations: noms des entreprises, des administrations, des projets et des programmes, des institutions, etc.

Les chercheurs réfèrent l'apparition massive de l'abréviation en français à la fin du XIX et au début du XXe siècle. Les abréviations qui sont apparues d'abord dans le vocabulaire sportif, sont ensuite entrées dans le jargon des écoliers et ont pénétré dans le vocabulaire commercial et militaire.

La classification généralement acceptée des abréviations repose principalement sur la méthode d'éducation et l'on pose la question: quelle partie d'un mot ou d'une phrase est perdue. Dans le cadre de cette systématisation, on distingue: tronçation, abréviations initiales, contractures, acronymes, formes hybrides. En conservant les méthodes traditionnelles d'abréviation, le cyberlangue préfère ce dernier type, démontrant une approche créative originale qui transforme le codage et l'interprétation du message en "démêlant" les énigmes et les charades des communicateurs. Les deux méthodes dans la version française sont combinées par le nom commun "rebus", malgré la différence dans les définitions.

On comprend le rébus dans le sens classique: présentation d'un texte sous la forme de dessins en combinaison avec des lettres et des symboles. Les rébus sont créés grâce à l'utilisation maximale de toutes les possibilités du clavier – lettres, chiffres, signes et leur disposition mutuelle.

Donnons les xemples d'acronymes traditionnels du cyberlangue:

1. Truncation: *apt* – *appartement*, *sem* – *semaine*;
2. Initiales: *ASV* – *Age Sex Ville* (*âge, sexe, lieu de résidence*); *IMO-in My Opinion* (*à mon avis*);
3. Contractures: *BJR* – *Bonjour* (*bonjour*), *PR* – *Pour*;
4. Acronymes: *MOTOS* – *member of theopposite sex* (représentant du sexe opposé);
5. Hybrides: *B4* – *BE FORE*; *F2F* – *face to face*. Ce dernier groupe d'abréviations présente le plus grand intérêt, correspondant à la définition classique du rébus et étant également l'exemple du franglais.

Un autre type d'abréviations a acquis de la popularité dans la communication virtuelle en français, celle qui implique l'utilisation des noms numériques ou alphabétiques de lettres. Ces abréviations sont basées sur l'homophonie du mot abrégé ou de sa partie avec les éléments ci-dessus. L'utilisation de chiffres en français pour l'abréviation a été empruntée à l'anglais. Par exemple, le chiffre **1** est capable de remplacer la combinaison de lettres avec **un** dans le mot *chacun* ou le mot *quelqu'un*: *chak1 le sait!*, *klk1 est là?* Parfois, pour rendre le mot encore plus court, deux chiffres peuvent être utilisés à la fois pour remplacer ses parties: le mot *demain* peut être transmis comme *2m1*. Le chiffre **9** dans la phrase *quoi de 9?* (quoi de neuf?) remplace le mot entier. Le remplacement de certaines parties par des noms alphabétiques est

également courant. Par exemple, la lettre **C** remplace *c'est*: *C mon ami*; la lettre **t** - *t'es*: *t revnu kan?* (*t'es revenue quand?*); la lettre **m** est capable de remplacer le mot entier *aime*: *J tm* (*Je t'aimes*).

Dans les abréviations de ce type, leur prononciation dans le discours oral revêt une grande importance, c'est le problème inhérent de toutes les abréviations, quelle que soit la langue, il s'agit de l'orthoépie. La lecture des abréviations peut être soit alphabétique, c'est-à-dire suivant le nom des lettres de l'alphabet français, soit syllabique. Pour les abréviations composées uniquement de consonnes, la lecture littérale est caractéristique. Pour les abréviations à deux lettres, quelle que soit leur composition, le même principe est utilisé. La lecture syllabique est typique, en règle générale, uniquement pour les abréviations de la composition *consonne – voyelle – consonne*. La prononciation des abréviations ayant quatre lettres ou plus, peut être littérale ou syllabique et parfois mixte. La nature de leur lecture est déterminée par la composition sonore et obéit aux lois phonétiques de la langue française.

Les abréviations dans lesquelles il ya deux syllabes ou plus ont une lecture syllabique. Citons dessous des exemples typiques des messages qui deviennent compréhensibles lors de la lecture des lettres majuscules suivant leur nom dans l'alphabet, et des lettres numériques et majuscules suivant des règles de lecture traditionnelles. Les espaces entre les mots sont respectés:

*GT entr1 2 penC a twa J'étais en train de penser à toi.*

*T la + BL T'es la plus belle.*

Citons également des exemples de la lecture qui permet de se débarrasser de la correspondance classique du participe passé dans les temps complexes et de raccourcir la longueur du message. Dans tous les exemples, les terminaisons des participes sont remplacées par des lettres majuscules, qui sont lues suivant leur nom dans l'alphabet:

*Où étiez -vous passés - Où étiez-vous paC;*

*Tes prepas, tu les as toutes finies - Tes prepas, tu les as toutes finI;*

*Il me l'a pretée - Il me l'a prêT;*

*J'ai déjà mangé - J'ai déjà manG.*

De nouvelles abréviations utilisant les éléments ci-dessus apparaissent aujourd'hui au sein de la communication virtuelle. Ainsi pour montrer la composante émotionnelle on utilise des répétitions des voyelles à la fin du mot:

*Ouiiiiiiiii; Merciiiiiiii; Je taiiiiiiiiiimeeeee.*

Le composant non verbal largement répandu dans l'Internet c'est celui des émoticônes. Le cyberlangue a les possibilités de créer de nouveaux graphiques similaires à ceux-ci à l'aide des capacités du clavier.

Cependant, la base du cyberlangue est sans aucun doute la langue française classique qui reste officiellement le patrimoine national, ce qui est extrêmement important pour ses locuteurs. Les chercheurs du nouveau langage artificiel notent qu'il est vieux comme ce monde, mais ils tiennent en compte sa propagation rapide dans l'environnement des jeunes et suggèrent la possibilité de réformer l'orthographe afin de la simplifier.

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## Современный французский язык в виртуальном общении

Н.Ю. Бородулина\*, В.И. Копельник, Г.Н. Чеботарёва

Тамбовский государственный технический университет, Тамбов, Россия

\*e-mail: [nat-borodulina@yandex.ru](mailto:nat-borodulina@yandex.ru)

**Аннотация.** Цель данной статьи - продемонстрировать специфику языкового наполнения электронной коммуникации. В статье рассматриваются особенности языка французского виртуальной коммуникации с учетом принципа: максимальная скорость передачи сообщения при минимальном объеме знаков без утраты содержания. Анализируются основные языковые приемы для достижения положительного коммуникационного эффекта. Отмечается, что специфика языкового наполнения франкоязычной электронной коммуникации связана с тенденцией к нелинейному представлению, демократизацией интернет-коммуникации и форматом используемых дискурсивных практик. Лексические трансформации проявляются в изобретении новых слов, использовании англицизмов и сокращений, а также тенденциях к нестандартным языковым формам, приближающих экранное письмо к фонетическому.

**Ключевые слова:** аббревиация, англицизмы, неологизмы, ребусы, фонетическое письмо

## **Unambiguity/Ambiguity of Comprehension In Correlation with the Parameters of a Literary Text**

**E.V. Evenko\*, O.A. Glivenkova, O.E. Shmyryova**

Tambov State Technical University, Tambov, Russia

*e-mail: nazarova33-1975@mail.ru*

### **Abstract**

The problem of unambiguity / ambiguity of comprehension is one of the main issues both in teaching the methodology of interpretation and in substantiating each individual interpretation. To solve this problem it is advisable to identify criteria that contribute to the unambiguity / ambiguity of comprehension. It is necessary to investigate, on the one hand, the process of comprehension as an active mental activity characterized by reflection and, on the other hand, the parameters of a literary text that lead to unambiguous/ambiguous comprehension.

**Keywords:** ambiguity, unambiguity, comprehension, hermeneutics, interpretation, recipient, reflection.

The problem of comprehension of a literary text is one of the main problems in philological hermeneutics. The term “comprehension” in philological hermeneutics can be viewed as “to comprehend means to understand the content of a literary text” (content is the totality of the content and meanings of a literary text) on the one hand, and “to understand something means to make it the subject of our thought” (Rogovin, 1981) on the other hand.

The tonality of meaning is defined by the authors as emotional text tuning characterized by the specific lexical unit arrangement creating the tone sounding.

The investigation of text comprehension and interpretation allows presenting specifics of the text structure both from its content sound (phonosemantic) organization.

Nowadays there are a lot of theories and methods analyzing the text comprehension, but only a few researches are dedicated sound (phonosemantic) organization which contributes to text comprehension. Comprehension is defined in this work as a thinking activity, the result of which is meaning construction by the reader. The result of comprehension is meaning as a sort of knowledge, meaningful formation which is included into existing knowledge system or corresponds to it, that's why “meaning” as ideal meaningful model created by the reader in the process of text comprehension.

The process of text-construction and the tonality of meaning is directly associated with psychology of such cognitive processes as sensation, perception, thinking and categorization.

The process of perception is a sort of recognition and transmission of signals to the recipient's brain cortex. With the help of sensory signals human brain gets the sound information primarily of sensory origin.

Perception is always connected with thinking, memory, attention; directed by motivation and emotionally colored.

Thinking activity in the perception of the text sound organization represents the reflection of such phonosemantic means which are perceived as unusual, devoid of automatism and thus attracting reader's attention. This leads to construction of tonality of meaning, which in its turn assists the reader in the construction of contextual meaning.

Comprehension is a complex thought process characterized by reflection. To comprehend means to construct meanings objectified by the means of text construction during reflection. "Reflection is a volitional appeal to one's own way of categorizing the activated elements of experience in the process of their integration in situations of active thinking" (Kolodina, 2000). Reflection contributes to the enrichment and reorganization of the activated elements of the recipient's experience.

The process of comprehension is directly related to the amount of knowledge with the elements of cultural and life experience that the recipient has. During the reception of a literary text, it is extralinguistic knowledge that contributes to its deeper understanding, which includes the ability of an intuitive assumption and represents the sum of knowledge and taking into account any factors of reality.

The success of constructing meanings in a literary text depends on the recipient himself, his extralinguistic knowledge and the text as a whole and its parameters. There are many texts requiring different types of comprehension.

Texts that involve two types of comprehension, semantizing and cognitive, i.e. understood due to the "external" context are interpreted extremely unambiguously and belong to a certain type - "non-strong" texts. Texts requiring deobjective understanding, i.e. revealing the "internal" context in addition to the "external", imply an extremely high number of various interpretations. Such texts are understood ambiguously and are referred to as "strong" texts. The main difference between literary texts of the "strong/non-strong" type runs along the line of "fiction/non-fiction" text.

"Strong" texts are literary and artistic texts that create a maximum of reflection fixation points and subsequent repeated appeal to the recipient's basic experience during reception. The construction of meanings occurs when referring to the experience of the recipient in the text comprehension process during the reception of texts of a "strong" type.

The parameters of a literary and artistic text that determine the degree of unambiguity / ambiguity of comprehension include: the artistry of the text; the content of the text; polyphony i.e. "polyphony" in the text; genre and stylistic features of the text; belonging of the text to a certain genre; the quantity and density of information transmitted by the text; intertextuality, i.e. inclusion in the text of the cultural space of other works.

Literary and artistic text is a combination of text construction tools and text formation tools. Within a text, it is possible to distinguish between text-construction tools and text-formation tools. Outside the text, there is no clear distinction between them; both those and others work for the embodiment of the author's intention. The



correlation of text construction tools with text formation tools can be a measure of the adequacy of what is understood to be written. This approach is especially relevant in considering the plurality of interpretations, as well as in determining the measure of unambiguity/ambiguity of comprehension.

Examining the process of text comprehension, we distinguish the cognitive algorithm of text comprehension.

Text comprehension is expressed through the following algorithm:

- 1) text perception;
- 2) reflection of perceived text construction means;
- 3) categorization of perceived text construction means;
- 4) association revealing based on reflected text construction means;
- 5) categorization;
- 6) construction of meaning.

Thus, comprehension is a complex process, a huge internal work in terms of using life and cultural experience with an inwardly directed beam of reflection, where text construction tools are markers that contribute to the activation of the understanding process, and their correlation with text formation tools acts as a measure that determines unambiguity / ambiguity of comprehension.

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## **Однозначность/неоднозначность понимания в корреляции с параметрами художественного текста**

**Е. В. Евенко\*, О. А. Гливенкова, О. Е. Шмырёва**

ФГБОУ ВО «Тамбовский государственный технический университет», Тамбов, Россия  
*e-mail: nazarova33-1975@mail.ru*

**Аннотация.** Проблема однозначности/неоднозначности понимания является одной из главных как в вопросах обучения методики интерпретации, так и в вопросах обоснования каждой индивидуальной интерпретации. Для решения данной проблемы целесообразно выявить критерии, способствующие однозначности/неоднозначности понимания. Необходимо исследовать с одной стороны процесс понимания как активную мыследеятельность, характеризующуюся рефлексией, и с другой стороны, параметры художественного текста, которые приводят к однозначности/неоднозначности понимания.

**Ключевые слова:** герменевтика, интерпретация, неоднозначность, однозначность, понимание, реципиент, рефлексия.

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## Argumentation im kognitiven Aspekt

V.S. Grigoriowa

Tambov State Technical University, Tambov, Russland

*\*e-mail: grigoriowa@mail.ru*

### Zusammenfassung

In diesem Artikel wird der Versuch unternommen, das Argument als Gegenstand der Linguistik, unter Berücksichtigung der positiven Erfahrungen beim Studium dieses Phänomens in verwandten Fachgebieten zu untersuchen. Eine solch umfassende Analyse der Argumentologie wurde mit dem Aufkommen der Kognitionsforschung in der Linguistik und anderen Wissenschaften möglich. Das Studium und die Berücksichtigung aller Arten von Wissen, die in den Argumentationsprozess involviert sind, führten zu der Schlussfolgerung über die kognitive Natur des Arguments. Es werden die Wissenstypen des integrativen Formats des argumentativen Diskurses aufgezeigt, die neben thematischem Wissen auch soziokulturelles, personales, ethnokulturelles und sprachliches Wissen umfassen. Mit Informationen dieser Art argumentiert der Sprecher mit Hilfe kognitiver Mechanismen, von denen einer die analoge Ähnlichkeit ist.

**Schlüsselwörter:** Argumentation, Integrativität, persönliche Beziehungen, soziokultureller Faktor, Wissen, kognitive Linguistik.

### Einführung

Argumentation als Studienrichtung, angesiedelt in einer interdisziplinären Zone und gekennzeichnet als hybride Ausbildung, war ursprünglich das Studienfach von solchen Wissenschaften wie Logik, Philosophie, Rhetorik und Neo-Rhetorik, Psychologie. Die vorrangige Position beim Studium des Phänomens der Argumentation wurde zweifellos von der Logik eingenommen, daher wurden die Hauptparadigmen dieses Phänomens und des konzeptionellen Apparats im Rahmen des logischen Ansatzes und der Logik entwickelt. Im Mittelpunkt des logischen Ansatzes steht die Untersuchung des argumentativen Prozesses als Produkt der Sprachinteraktion. Gleichzeitig wird das Hauptaugenmerk auf die Bedeutung der Argumente gelegt, die Schlussfolgerungen, die sich aus einer oder mehreren Prämissen ergeben (siehe: A.P. Alekseev; G.A. Brutyan; V.I. Kurbatov; G.I. Ruzavin; A.A. Ivin; F.H. Yemeran, R. Grootendorst). Im Zusammenhang mit der Entwicklung einer globalen und interdisziplinären Theorie des Spracheinflusses wurde ein linguistischer Argumentationsansatz skizziert. Unter argumentativer Kommunikation wird im Rahmen dieser Theorie die Kommunikation zwischen Individuen bzw. zwischen einem Individuum und einem Publikum mit ausgeprägtem Fokus auf die Beeinflussung und Kontrolle des Bewusstseins derjenigen verstanden, die Sprache von der Seite des Sprechers wahrnehmen, um das Weltbild des Zuhörers zu verändern. In diesem Artikel versuchen wir, eine umfassende Analyse des Argumentationsphänomens durchzuführen und seinen kognitiven Status zu

bestimmen. Eine solche Möglichkeit bietet unseres Erachtens die Methode der kognitiv-diskursiven und der diskursiven Matrixanalyse. Das Vorhandensein von drei Hauptfunktionen der Sprache – kognitiven, kommunikativen und interpretativen – bestimmt die Integrativität ihres Studiums. Aus Sicht des kognitiven Ansatzes basiert die Integrativität der Sprachinteraktion auf der konzeptionellen Interaktion verschiedener Ebenen. Integrität manifestiert sich auf unterschiedliche Weise in den Diskursen argumentativer, informativer und anderer Arten der sprachlichen Interaktion. Bei jedem dieser Typen wird der eine oder andere Wissenstyp als kognitiv dominant profiliert. Die Integration wird durch das System der verbalen Kommunikation selbst festgelegt und findet statt, während sich der Dialog entfaltet. Die Integration des Wissens von dem Sprecher und dem Zuhörer aller Ebenen bestimmt die Zusammenarbeit in der Kommunikation. Eine Verletzung der Integrativität der Kommunikation führt zu kommunikativem Scheitern. Integration offenbart die Interdependenz des Wissens der Kommunikanten und demonstriert damit die Beziehung zwischen den kognitiven, kommunikativen und interpretativen Funktionen der Sprache.

### **Hauptteil**

Effektiver Dialog in einem öffentlichen Kommunikationsraum erfordert nicht nur die Kenntnis der Argumentationslogik, sondern auch die Kenntnis der Organisation des kommunikativen Prozesses, der nach bestimmten Regeln und Mustern aufgebaut wird. Die Verwendung logischer Postulate in der argumentativen diskursiven Praxis kann nicht immer eine Grundlage für eine qualitativ sinnvolle, wahre argumentative Aussage liefern. So zum Beispiel in Argumenten wie „Alle Menschen sind sterblich. Ivan ist ein Mann. Ivan ist also sterblich“, ist die Schlussfolgerung definitiv richtig. In Argumenten wie „In den letzten Jahren hat es im Juni immer wenig geregnet. Es wird also auch im Juni dieses Jahres keinen Regen geben.“ Eine formal logische Herangehensweise an die Argumentation und die Anwendung des Logikgesetzes garantiert nicht die Angemessenheit der Schlussfolgerung. Offensichtlich funktionieren die Inferenzmechanismen unseres Gehirns anders als die Regeln der Logik. Während die Logik strikt versucht, uns daran zu hindern, von wahren Prämissen zu falschen Schlussfolgerungen zu gelangen, hat die Evolution unser Gehirn so ausgestattet, dass wir aus Erfahrungen lernen und einigermaßen wahrscheinlichkeitstheoretische Hypothesen wahrnehmen und relativ angemessen reagieren können. Ein Mensch, dessen Gehirn auch in kritischen Situationen sorgfältig und akribisch versucht, die vermeintlich verlässliche Wahrheit zu berechnen, könnte nicht überleben, weil man Alltagssituationen oft durch schnelle Entscheidungen bewältigen muss und nicht durch langwieriges Nachdenken. Mit anderen Worten, es gibt eine enge Beziehung zwischen erlernten und angeborenen Verhaltensmustern, die für unser Denken von großer Bedeutung ist und eine gewisse Verlässlichkeit und ein bewusstes Verständnis von Anreizmechanismen und regulatorischen Handlungen bietet. Die Erstellung einer perfekten Theorie der Argumentation erfordert einen integrierten Ansatz, der alle Arten von Wissen einbezieht, die Kommunikanten bei der Implementierung von Sprachinteraktion verwenden, einschließlich des sprachlichen

(zu den Ursprüngen der sprachlichen Argumentologie (siehe: [1]). Eine solche Gelegenheit ergab sich mit dem Aufkommen eines solchen Zweigs der Linguistik wie der kognitiven Linguistik. Laut N.N. Boldyrev ist die kognitive Linguistik einer der Hauptakteure in der multidisziplinären Untersuchung der menschlichen Kognition. Diese Schlussfolgerung wird geleitet von „dem Bewusstsein der dringenden Notwendigkeit einer systematischen Untersuchung der Mechanismen des menschlichen Bewusstseins und dem Verständnis, dass der einzige zuverlässige Zugang zum Bewusstsein nur durch die Sprache bereitgestellt wird“ [2].

Die kognitiven Prozesse, die im Mittelpunkt des Studiums der kognitiven Linguistik stehen, befinden sich in direktem Zusammenhang mit den Prozessen der Beschaffung, Verarbeitung, Fixierung und Speicherung von Informationen, was neue Perspektiven für das Studium der Semantik des argumentativen Diskurses eröffnet. Der Kommunikationsprozess kann nicht angemessen beschrieben werden, ohne die kognitiven Prozesse zu verstehen, die in den Köpfen der Kommunikationsteilnehmer während der Generierung und Wahrnehmung von Sprache ablaufen. Noch Ende des letzten Jahrhunderts konzentrierten sich Linguisten auf das Vorhandensein eines gemeinsamen semantischen Feldes unter Kommunikanten, das eine „Region konventioneller, d.h. auf einen gemeinsamen Nenner gebracht, das Wissen des Sprechers und des Zuhörers als Mitglieder einer bestimmten Sprachgemeinschaft darstellt“ [3].

Dennoch kann man beim Studium und Unterrichten des Aufbaus argumentativer Texte sowohl die Logik als auch die logische Analyse nicht ignorieren. Im Wesentlichen ist die Anwendung der Gesetze der Logik auf die Analyse argumentativer Texte nichts anderes als die Operation unseres Wissens bei der Konstruktion von Schlussfolgerungen. Mit anderen Worten, es ist wahr, dass Erkenntnis die Grundlage der logischen Analyse ist. Daher sollte die Argumentologie unserer Meinung nach die relevanten Ergebnisse der Logik und Rhetorik nicht ausschließen, die ebenso unberücksichtigt bleiben wie die Ergebnisse der modernen Stilistik. Syntax und Wortwahl, Bildsprache und Ironie, Text- und Dialogstruktur, Prosodie und viele andere Faktoren beeinflussen die Effektivität und Angemessenheit der Argumentationsformulierung. Es scheint, dass die logische Analyse der Ausgangspunkt und die notwendige Grundlage für die weitere pragmatisch-rhetorische Analyse ist. Dabei ist die Logik nicht auf bestimmte, sogenannte deduktive Argumente beschränkt. Logik im weiteren Sinne ist als Maßstab für die Beurteilung empirisch beobachteten argumentativen Verhaltens in argumentativen Dialogen (Stil, Interaktion, Gesprächsorganisation, Monolog, Dialogismus, psychologische Prozesse, Moral, Rationalität, Politik, Täuschung, Kooperation, Strategie etc.) notwendig.

Vieles von dem, was wir glauben, basiert auf Annahmen, nicht auf direkten Beweisen oder direkter Kommunikation mit anderen. Wenn uns jemand sagt, dass seine Frau krank ist, dann schließen wir daraus, dass er verheiratet ist. Wenn wir hören, dass Herr Wang Chinese ist, schließen wir daraus, dass er Chinesisch spricht. Wenn wir eine Katze sehen, dann schließen wir aus unserem allgemeinen Katzenwissen, dass diese Katze auch miauen und auf Bäume klettern kann. Wenn wir

dunkle Wolken aufziehen sehen, schließen wir daraus, dass es regnen wird. Wenn wir lesen, dass regelmäßiges Zähneputzen unsere Zähne gesund hält, schließen wir daraus, dass wir unsere Zähne putzen sollten. Die Abhängigkeit unseres Denkens und Erkennens von solchen Schlussfolgerungen zeigt sich, wenn wir unser Allgemeinwissen auf einen konkreten Fall anwenden, wenn wir von Einzelbeobachtungen zu Verallgemeinerungen übergehen, wenn wir etwas vorhersagen oder erklären wollen, wenn wir das Verhalten unserer eigenen verstehen wollen Gesprächspartner oder wenn wir Schlussfolgerungen ziehen und bestimmte Entscheidungen treffen wollen. In den meisten Fällen tun wir dies automatisch. Etwas ganz anderes ist es, wenn wir unsere Schlussfolgerungen in Worte fassen und anderen mitteilen, um Aussagen zu untermauern oder zu widerlegen, etwas zu erklären oder vorherzusagen, uns zu rechtfertigen oder die Regeln des gesellschaftlichen Zusammenlebens festzulegen. Wenn wir den Übergang vom Vertrauten zum Neuen verbal formulieren, dann wird die Argumentation zu einem individuellen, oft vagen und noch vorsprachlichen Gedankenbündel, bestehend aus mehreren Sätzen, einer Schlussfolgerung, die wir begründen wollen, und einer oder mehreren beabsichtigten Prämissen zur Schlussfolgerungsunterstützung in der Argumentation. Argumente sind also sprachliche Handlungen, um Aussagen zu rechtfertigen oder Entscheidungen zu rechtfertigen. So zum Beispiel in dem Text „Essen Sie keinen Schnee in Moskau! Mama hat immer geschrien. „Es enthält Salze von Schwermetallen!“ Die Forderung der Mutter wird durch neue Informationen für das Kind über das Vorhandensein von Metallsalzen im Moskauer Schnee untermauert.

Argumente haben neben ihrer kognitiven Funktion immer eine Vielzahl weiterer sozialer und psychologischer Merkmale. Die Absicht eines argumentativen Diskurses kann beispielsweise der Wunsch einer Person sein, den Gesprächspartner zu beruhigen, sich selbst zu überzeugen oder andere zu überzeugen; Stärkung der Position Ihrer Partei oder Gruppe usw. Verschiedene Arten von Auseinandersetzungen und Diskussionen werfen auch erkenntnistheoretische Fragen auf: Können wir mit Hilfe von Argumenten wirklich zu bestimmten Schlussfolgerungen kommen? Selbst wenn die Argumente in den meisten Fällen einen sicheren Übergang von Prämissen zu Schlussfolgerungen garantierten, wie zuverlässig und vollständig sind unsere Prämissen? Wenn wir mehr wüssten und dieses Wissen in unsere Argumentation einbeziehen würden, würden wir dann nicht zu ganz anderen Schlussfolgerungen kommen? Und schließlich hängt die Frage nach der Berechtigung und dem Nutzen des Streits nicht von der Kultur ab, in der sie gestellt wird. Thema tabuisierter Argumentation sind in den meisten Fällen vor allem religiöse und politische Dogmen. Zudem ist das Recht, zentrale Behauptungen argumentativ zu prüfen und zu begründen, meist auf bestimmte Personen wie Priester, Richter, Lehrer, Wissenschaftler oder Politiker beschränkt. Darüber hinaus wird nur der argumentieren, wer nach entsprechender Erziehung und Bildung in der Lage und motiviert ist, Aussagen und Normen zu begründen oder zu widerlegen. Wer hingegen gelernt hat, seinen Vorteil im Glauben, im Gehorsam oder im Schweigen zu suchen, wird ebenso wenig argumentieren wollen wie derjenige, der sein Leben den Werbebotschaften und

Moden der Konsumgesellschaft und ihrer Medien anpasst.

Unsere Essgewohnheiten sind zum Beispiel kulturell geprägt. In vielen Fällen ist unser Verhalten intuitiv. Gleichzeitig muss bedacht werden, dass die Mechanismen unseres Gehirns im Laufe unserer evolutionären Entwicklung zu einer Zeit entstanden sind, als sich die Bedingungen des menschlichen Lebens wesentlich von den heutigen unterscheiden. Während man sich bei einfachen Handlungen wie Laufen und Springen durchaus auf Körperempfindungen und Intuition verlassen kann, reichen solche unbewussten Mechanismen am Steuer eines modernen Autos nicht mehr aus. Die enge Verbindung zwischen erlernten und angeborenen Verhaltensmustern ist für unser Denken von großer Bedeutung. Einerseits vermittelt es eine gewisse Verlässlichkeit und Nützlichkeit alltäglicher Verhaltensmechanismen. Andererseits werden diese Mechanismen oft eher von unseren Impulsen als von unserer Erfahrung und unserem bewussten Verständnis angetrieben. Alltägliche Argumente erfordern manchmal eine gründliche Prüfung. Wie oben erwähnt, können wir uns irren, wenn wir uns von einfachen Analogien leiten lassen oder wenn wir Argumente nur akzeptieren, weil sie ästhetisch formuliert sind. Die Gefahr von Maximen wie „Wer A sagt, muss auch B sagen“ liegt auf der Hand.

Schließlich sollte bedacht werden, dass unsere Schlussfolgerungen nicht nur von Lust und Angst, sondern auch von persönlichen Beziehungen beeinflusst werden. Wenn die Menschen, die uns wichtig sind, bestimmte Überzeugungen haben, neigen wir dazu, unsere Schlussfolgerungen unbewusst zu verzerren, um diese Überzeugungen zu unterstützen. Umgekehrt könnten wir versuchen, den Schlussfolgerungen von Menschen, die wir nicht mögen, nicht zu folgen, selbst wenn sie die vernünftigsten sind. Diese Eigenschaft der argumentativen Funktion muss beispielsweise bei der Diskussion von Ergebnissen wissenschaftlicher Arbeiten, die auf Seminaren und Dissertationsräten präsentiert werden, in Lehrer-Schüler-Beziehungen, befreundeten Personen und umgekehrt in einem Streit sein. Nur die Bewertung und Kritik unabhängiger Persönlichkeiten kann objektiv sein. Als Beispiel könnte man Tschitschikovs Dialoge in N.V. Gogol "Tote Seelen" anführen. Bevor Tschitschikov ein Gespräch über den Kauf toter Seelen begann, sammelte er jedes Mal Informationen über ihre Besitzer und baute mit jedem von ihnen einen Dialog auf, der ihrem Charakter und ihrer Weltanschauung entspricht. Bemerkenswert ist, dass sich die lexikalische Zusammensetzung des Dialogs in ähnlicher Weise verändert hat. Im Fall von Manilov äußert er seine Absicht, tote Seelen zu kaufen, als „Bitte“, er spricht Sobakevitsch mit einem „Angebot“ an, mit einer keulenköpfigen Korobotschka spricht er von einem „Zugeständnis“ (siehe ausführlicher: [4, 5]).

Die Betrachtung des Verhältnisses von Konklusion und Argument weist darauf hin, dass Argumentation eine der Möglichkeiten der Erkenntnisgewinnung ist. Menschliche Verhaltensfähigkeiten hängen weitgehend von bewusster Argumentation und ihrer Kontrolle durch Analyse und Kritik ab. Versuchen wir zu beweisen, dass die Argumente wirklich dazu dienen können, unsere Schlussfolgerungen zu korrigieren. Können sie dabei auch unser Wissen erweitern? Wenn wir uns von bekannten Prämissen zu etwas Neuem bewegen, wie sicher können wir uns dieser Neuheit sein?

Gibt es Anhaltspunkte, von denen aus wir zu bestimmten Erkenntnissen gelangen könnten? Wir gehen davon aus, dass diese Überlegungen hilfreich sind, um die Rolle der Argumentation im Kontext menschlichen Wissens zu verstehen.

Der Mensch zeichnet sich dadurch aus, dass er sein Handeln auf das „innere Modell seiner Außenwelt“, das sogenannte „Weltbild“, abstimmt. Die Tatsache, dass Lebewesen interne Modelle der Außenwelt entwickeln, scheint nicht ganz offensichtlich zu sein. Wir neigen dazu, unsere Sicht der Welt für bare Münze zu nehmen und glauben, dass unsere Umgebung tatsächlich so ist, wie wir sehen, hören, berühren, atmen und fühlen. In Wirklichkeit sind Innen und Außen streng voneinander getrennt. Die Außenwelt dringt nicht in unser Gehirn, den Sitz unserer Weltanschauung, ein. Das Gehirn ist in der Entwicklung unseres Weltbildes völlig abhängig von seiner eigenen, hauptsächlich genetisch bedingten Struktur und von den Informationen, die ihm unsere Sinnesorgane liefern. Ob etwas gesehen, gehört oder gefühlt wurde, erkennt das Gehirn nur daran, dass die entsprechenden Impulse durch ein bestimmtes Nervenbündel zu einer bestimmten Stelle kommen (siehe [6]). Die bunte, bewegte, fühlbare Welt, durchdrungen von Gerüchen und Geräuschen, ist nichts anderes als ein Produkt unseres Gehirns, der Art und Weise, wie wir sie wahrnehmen. Unser internes Modell der Außenwelt ist in der Tat nur eine modellhafte Rekonstruktion und höchst unzureichende Repräsentation dieser Außenwelt, keineswegs aber dieser Außenwelt selbst. N.N. Boldyrev schreibt auch darüber: "Sprache repräsentiert nicht die Welt selbst, sondern wie eine Person sie repräsentiert." Die wahre Struktur der Außenwelt ist für kein Lebewesen und damit für den Menschen unzugänglich. Folglich gibt es keine verlässlichen Bezugspunkte, von denen unsere Erkenntnisse ausgehen könnten. Am wichtigsten im Zusammenhang mit unserer Argumentation ist, dass Schlussfolgerungen eine zentrale Rolle bei der Konstruktion eines Weltbildes spielen: Selbst das einfache Nervensystem eines Tieres zieht unbewusst und automatisch Schlussfolgerungen. Ebenso schließen Menschen aus einer Kombination bestimmter Reize auf die Anwesenheit eines Objekts, beispielsweise aus grünen Punkten und braungrauen Flächen auf die Anwesenheit eines Baums und daraus wiederum auf die Möglichkeit, Schutz vor der Sonne zu suchen oder Regen. Unser Gehirn verarbeitet jene Gegenstände, die wir im Alltag für selbstverständlich halten. Tatsächlich werden diese Objekte durch intensive Verarbeitung der Informationen, die in unser Gehirn gelangen, selbst konstruiert.

Im Laufe der Evolution unserer Gehirne, Kulturen und Sprachen haben Menschen es als nützlich empfunden, andere Menschen, Bäume, Häuser, Vögel und viele andere Dinge als Objekte zu identifizieren. Unsere internen Modelle sind darauf ausgelegt, möglichst wirtschaftlich genau die für unser Leben und Überleben wichtigen Merkmale der Außenwelt abzubilden. Unser Nervensystem schließt die Anwendbarkeit bestimmter Muster aus dem Eintreffen mehrdeutiger Sinnesreize. Wir konstruieren Objekte, indem wir sie wahrnehmen. Gleichzeitig ist die Einheit von Theorie- und Alltagswissen der Begriff. Im Konzept gibt es ein Verständnis und eine Darstellung der Erfahrung der menschlichen Interaktion mit der Welt. „Dadurch wird das menschliche kognitive System zu einem komplexen, mehrstufigen Gebilde, das die

Mechanismen und Ergebnisse verschiedener Arten kognitiver Aktivität in Form zahlreicher Arten von Wissen umfasst.“ [7].

Unsere Weltbilder bestehen jedoch keineswegs aus einer einfachen Aufzählung von Gegenständen. Vielmehr kombinieren wir akzeptierte Objekte zu offenen Klassen und registrieren Beziehungen zwischen Objekten und Objektklassen. Wir verbinden auch bestimmte Objektklassen mit bestimmten Handlungsmustern, indem wir zum Beispiel darauf hinweisen, dass wir auf keinen Fall Fliegenpilze und Ackertaucher essen sollten. Noch bevor wir diese Verbindung herstellen, mussten wir eine Verallgemeinerung vornehmen. Aus der Beobachtung, dass frühere Exemplare der erwähnten Pilze immer giftig waren, schließen wir, dass alle Exemplare giftig sind. Aus der Beobachtung einzelner Kletterkatzen schließen wir, dass alle Katzen klettern können. Verallgemeinerungen dieser Art machen unser Weltbild wirksam. Sie dienen in erster Linie dazu, unser Handeln zu leiten, unser Wissen über die Welt zu erweitern, sie mit einer wichtigen Information zu ergänzen, die für unser zukünftiges Handeln von großer Bedeutung ist. Gleichzeitig erlauben sie uns nicht nur, vorherzusagen, was in der Zukunft passieren wird; sie erlauben auch Erklärungen vergangener Ereignisse (siehe: [8, 9]). Gerade wenn wir unsere Erfahrungen verallgemeinern und in Zukunft nutzen wollen, müssen wir im Nachhinein verstehen, warum bestimmte Dinge so und nicht anders passiert sind. Erklärungen bestehen in der Regel aus einem Schluss oder Argument, mit dem wir das Ereignis erklären. Erklärungen sind eine Art nachträglicher Vorhersage vergangener Ereignisse. Zunächst ist es wichtig, Ereignisse mit unserem Weltbild in Einklang zu bringen und sie später vorherzusagen. Unerklärliche Ereignisse stellen unser Weltbild in Frage. Sie zeigen uns, dass das interne Modell der Außenwelt, auf das wir in jedem Moment dringend reagieren müssen, unvollständig ist oder Fehler enthält.

Aus der präsentierten Beschreibung kann der falsche Eindruck entstehen, dass Erkenntnis ausschließlich die Aktivität eines Individuums ist, das völlig unabhängig von anderen Menschen wahrnimmt, Hypothesen aufstellt, Schlussfolgerungen zieht und sein Weltbild aufbaut. Menschliches Wissen ist sozial. Ohne verbale Kommunikation und erst recht ohne den Austausch von Argumenten ließe sich Wissen nicht ausleihen. Die verbalen Äußerungen von Eltern und anderen Bezugspersonen lenken die Aufmerksamkeit der Kinder darauf, die richtigen Sinnesreize zu Objekten zu gruppieren, stabile Muster von Objekten zu bilden und diese Objekte in Kategorien zu gruppieren. Ebenso entwickelt sich die Aktivität der Kinder bei der Bildung von Schlussfolgerungen nicht nur aufgrund angeborener Mechanismen, sondern auch aufgrund zugehörter Argumente.

Im argumentativen Diskurs werden für die Bildung und Repräsentation von Bedeutung verschiedene kognitive Mechanismen verwendet, die als die eine oder andere Weise verstanden werden, die spezifischen Eigenschaften des Begriffs hervorzuheben und darzustellen. Einer der für Argumentation charakteristischen kognitiven Mechanismen ist die analoge Ähnlichkeit. Ohne Berücksichtigung soziokultureller, persönlicher, thematischer Kenntnisse kann die Schlussfolgerung jedoch falsch sein. Wenn wir also wissen, dass der Buddhismus in China, einem



asiatischen Land, weit verbreitet ist, können wir daraus schließen, dass er auch in Japan, einem ebenfalls asiatischen Land, weit verbreitet ist. Da China und Japan in einer Hinsicht ähnlich sind, nämlich in ihrer geografischen Lage, schließen wir daraus, dass sie auch in einer anderen Hinsicht ähnlich sind, nämlich in ihrer Religion. In diesem Fall führt eine solche Analogie zu einer völlig akzeptablen Schlussfolgerung. Gleichzeitig wird die assoziative Inferenz weniger erfolgreich sein und uns zu der falschen Schlussfolgerung führen, dass schwarz-gelb gestreifte Käfer genauso stechen wie schwarz-gelb gestreifte Wespen.

Analogieschluss ist besonders wichtig, wenn wir versuchen, andere Menschen zu verstehen. Wir können nicht umhin, aus den äußerlichen Ähnlichkeiten in der Struktur des menschlichen Körpers und Verhaltens zu folgern, dass andere folglich so denken und fühlen müssen wie wir. Umgekehrt neigen wir dazu, psychologische Unterschiede aus Unterschieden in der Hautfarbe oder Sprache abzuleiten. Und hier werden die Errungenschaften und Grenzen solcher Schlussfolgerungen deutlich. Einerseits ist es unvermeidlich und durchaus vernünftig, dass wir uns andere so vorstellen, wie wir sind. Andererseits müssen wir immer wieder sehen, wie falsch diese Vorstellung sein kann.

### **Schlussfolgerung**

Zusammenfassend ist festzuhalten, dass Argumentation nicht nur zu einer größeren Verlässlichkeit unserer Weltanschauungen führen kann, sondern auch zu neuen Hypothesen, zu einer begründeten Kritik unseres Wissens, zu einer kritischen Suche nach Widersprüchen und zu neuen Beobachtungen, die unser bisheriges Wissen und unsere Schlussfolgerungen in Frage stellen könnten. Argumentation als sprachliche Repräsentation des Übergangs von Prämissen zu Schlussfolgerungen erweist sich als nützlich und sogar notwendig – nicht als Weg zur endgültigen Gewissheit, sondern als eine der Methoden, das Falsche auszulesen. Argumente spielen eine zentrale Rolle bei der Konstruktion und Verwendung unserer Weltbilder, vor allem bei Erklärungen und Vorhersagen sowie bei der Widerlegung von Hypothesen, die für die Erweiterung unseres Wissens entscheidend ist. Argumentative Kritik bietet eine gewisse, wenn auch oft sehr kleine Chance, hartnäckige Missverständnisse und Vorurteile abzubauen.

Die Daten unserer Studie belegen die Integrativität des argumentativen Diskursformats. Argumentation kann nicht effektiv sein, ohne alle Arten von Wissen zu berücksichtigen, die für die Sprachinteraktion charakteristisch sind, was zu einem integrierten Ansatz für ihre Untersuchung führt. Neben thematischem Wissen muss die argumentierende Person über Kenntnisse sozialer, persönlicher, ethnokultureller Art sowie über sprachliche Kenntnisse verfügen. Das Fehlen jeglicher Aspekte des Wissensformats kann zu kommunikativen Misserfolgen und Konflikten führen.

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### **Аргументация в когнитивном аспекте**

**В.С. Григорьева**

ФГОБУ ВО «Тамбовский государственный технический университет», Тамбов, Россия

*\*e-mail: grigorieva@mail.ru*

**Аннотация.** В данной статье предпринята попытка рассмотреть аргумент как предмет языкознания с учетом положительного опыта изучения этого явления в смежных дисциплинах. Такой комплексный анализ аргументологии стал возможен с появлением когнитивных исследований в языкознании и других науках. Изучение и рассмотрение всех видов знаний, задействованных в процессе аргументации, привело к выводу о когнитивной природе аргументации. Показаны виды знаний интегративного формата аргументативного дискурса, к которым, помимо тематических знаний, относятся также социокультурные, личностные, этнокультурные и лингвистические знания. С информацией такого рода говорящий аргументирует, используя когнитивные механизмы, одним из которых является аналоговое сходство.

**Ключевые слова:** аргументация, интегративность, личностные отношения, социокультурный фактор, знание, когнитивная лингвистика.

## Teaching to Use Cohesive Devices in Academic Writing in English to Graduate and Postgraduate Students

**N.A. Gunina**

Tambov State Technical University, Tambov, Russia  
*e-mail: natalya\_gunina@mail.ru*

**Abstract:** The paper discusses the importance of using cohesive devices in academic writing. Some of the problems that students face when writing academic texts have been identified. Exercises to improve students' writing skills and confidence in using cohesive devices have been proposed.

**Keywords:** cohesive devices, academic writing; teaching.

### Introduction

Linkers and cohesive devices are essential tools for creating coherent and cohesive texts. Therefore, it is important to teach students how to use them effectively to improve their writing skills.

The problem of using cohesive devices and teaching students to use them appropriately has been previously discussed in scientific literature. For example, in [1] the authors investigated Iranian graduate non-English majors' use of cohesive devices in argumentative essays, and also the relationship between the number of cohesive devices and writing quality. It was found that there was no significant relationship between the number of cohesive devices used and quality of writing. Another study found that undergraduate students give preference to using lexical devices although they can use a variety of cohesive devices in their writing. Interestingly, the quality of writing significantly co-varies with the number of lexical devices and the total number of cohesive devices used [2]. The quasi- experimental study examined the effects of explicit discourse marker instruction on ESL learners' academic writing performance. It was revealed that explicit teaching of discourse markers is beneficial for writing academic essays [3].

### Statement of the problem

Challenges that students might have to deal with when mastering cohesive devices and ways of improving them include:

1. Limited vocabulary and knowledge of cohesive devices: Teachers can provide explicit instruction and model examples of how to use cohesive devices effectively.
2. Difficulty in recognizing and using appropriate cohesive devices: Teachers can provide feedback and correction to help students recognize and use appropriate cohesive devices.
3. Lack of practice: Teachers can provide ample opportunities for students to practice using cohesive devices in various contexts.

The best way to teach students to use linkers effectively is through explicit instruction and ample practice opportunities. Teachers can provide model examples of

how to use linkers appropriately and give feedback on students' writing to help them recognize and correct any errors. Group discussions and collaborative writing activities can also be used to encourage students to use linkers in their writing and develop their skills further. Additionally, teachers can provide a variety of writing prompts that require the use of linkers to help students practice using them in different contexts.

### **Activities for the classroom to practice linkers**

There is a wide range of classroom activities that can help students to deal with writing challenges more effectively. They include:

- sentence completion exercises where students have to use linkers to connect two ideas;
- group discussions where students have to use linkers to express their opinions and support their arguments;
- writing prompts where students have to use linkers to organize their ideas and create a coherent text.

### **Examples of exercises to reinforce students' skills in using cohesive devices in academic writing**

#### Exercise 1: Error Correction

Identify and correct the errors in the following sentences by adding appropriate linkers.

1. The research paper was well-written, moreover, it lacked coherence.
2. The experiment was conducted twice, first in the morning and then in the afternoon, therefore, the results were compared.
3. The author presented a compelling argument, although it failed to convince the readers.
4. The study found a significant correlation between smoking and lung cancer, because, further research is needed.

#### Exercise 2: Gap Fill

Fill in the blanks with appropriate linkers in the following sentences.

1. \_\_\_\_\_ the findings of previous studies, our research suggests a different conclusion.
2. The data showed a clear trend \_\_\_\_\_ time.
3. The professor explained the concept \_\_\_\_\_ using real-life examples.
4. The article discusses various theories \_\_\_\_\_ the origins of language.
5. The study found no significant difference \_\_\_\_\_ the two groups.

#### Exercise 3: Multiple Choice

Choose the appropriate linker to complete the following sentences.

1. The study found a strong correlation \_\_\_\_\_ smoking and lung cancer.  
a) despite  
b) between  
c) however  
d) furthermore
2. \_\_\_\_\_ the limitations of the study, the findings are still significant.  
a) Despite

- b) Although
- c) Furthermore
- d) In addition

3. The professor discussed several theories \_\_\_\_\_ the causes of climate change.

- a) in contrast
- b) in addition
- c) consequently
- d) nevertheless

4. The author presented a compelling argument; \_\_\_\_\_, it failed to convince the readers.

- a) therefore
- b) however
- c) moreover
- d) despite

### **Conclusion**

The appropriate use of linkers in academic writing is crucial as it helps to create a logical flow of ideas and improve the coherence of the text. Linkers also help to show the relationship between different ideas and arguments, which is essential in academic writing.

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## **Обучение использованию средств логической связи магистрантов и аспирантов при написании академических текстов на английском языке**

**Н. А. Гунина**

ФГБОУ ВО «Тамбовский государственный технический университет», Тамбов, Россия  
*e-mail: natalya\_gunina@mail.ru*

**Аннотация.** Обсуждается важность использования средств логической связи в академическом письме. Выявлены некоторые проблемы, с которыми сталкиваются студенты при написании академических текстов. Были предложены упражнения для улучшения навыков письма учащихся и уверенности в использовании связных устройств.

**Ключевые слова:** средства логической связи, академическое письмо, обучение.

## **Cognitive Non-Verbalism in the Framework of Intercultural Communication**

**I. E. Ilyina\*, E. Yu. Voyakina, O. E. Shmyryova**

Tambov State Technical University, Tambov, Russia

*\*e-mail: ser\_il@mail.ru*

### **Abstract**

The article deals with the problems of non-verbal communication from the standpoint of intercultural communication. It has been established that skillful possession of natural language implies not only the ability to use language nominations as elements of a verbal semiotic code, but also the ability to recognize gestures characteristic of the specific culture behind them through linguistic manifestations. The analysis made it possible to state that even generally recognized elements of non-verbal communication can easily change meaning or acquire additional meanings.

**Keywords:** body language, intercultural communication, cognitive non-verbalism, culture, semiotic code.

The communicative nature of speech activity predetermines its bilateral character. Human speech activity is designed to transfer some specific amount of information to another person who is supposed to respond by receiving this information. Thus, a mutual speech process arises where co-operation, assistance and complicity are viewed as important components.

Speech communication involves a complex set of personal funds, including non-linguistic funds, which plays an important role in the communication process. Being historically the first form of human communication, non-verbal communication is a type of interaction between people without verbal means which allows not only to diversify and complement verbal communication, but also to replace it in some situations. The necessary information can be obtained not only through linguistic, i.e. verbal, means of communication, but also using non-verbal tools which sometimes become the only possible means of communication [1, 2, 4, 6, 7].

Non-verbal communication is determined by the social norms of society. Excessive and friendly gestures are unlikely to be appropriate in the official circumstances; rather, communicants will use special non-verbal means. And only thanks to involuntary gestures we can determine the real intention of the sender and the recipient, as well as their true emotional state.

Nonverbal means have ethnocultural specifics which can be one of the serious obstacles in communication between multilingual and multicultural communicants. The difference in the organization, functions and methods of mediating communication processes is inherent in representatives of different linguistic and cultural communities and depend on the following factors:

- factors related to cultural tradition;
- factors related to the social situation and social functions of communication;

- factors related to ethnopsychology in the narrow sense, i.e. with the features of the course and mediation of various mental processes and activities;
- factors associated with the presence in the thesaurus of a given community of certain special reactions, concepts, etc., i.e. with specifics of denotation;
- factors determined by the specifics of the language of a given community [3].

Non-verbal communication is determined by the social norms of society. Excessive and friendly gestures are unlikely to be appropriate in the official circumstances; rather, communicants will use special non-verbal means. And only thanks to involuntary gestures we can determine the real intention of the sender and the recipient, as well as their true emotional state [5, 8].

The presence of an association with a certain social stereotype, which is established due to non-verbal means of communication and in written speech due to the language manifestation of non-verbal behavior, is noted, e.g. the military have a special dressing and gait like raising their legs high when walking while sailors waddle, etc.

The norms of interaction also have a socially-determined character. This includes all the specific behaviors that accompany speech, e.g. a speech utterance in a given situation cannot be interrupted and communicants resort to non-verbal means of communication or, on the contrary, we can interrupt as much as we like to speak only in a whisper (e.g. during the church ceremony).

Some of the listed speech components are somewhat heterogeneous: there are components that are social in nature (e.g. participants in a speech act and the relationship between them) and components that acquire social significance only in the context of such social determinants of speech behavior as a social situation, social status, circumstances, role relationships, etc. The importance of all these speech aspects in the analysis of the social determination of verbal and non-verbal behavior seems doubtless.

A number of gestures coincide in different cultures. This includes various components of the main typical communicative situations such as: greeting, meeting, farewell, surprise, gratitude, joy, sadness, etc. For example, when greeting, people usually shake hands in both Russia and Germany.

Some gestures do not match in execution with the same meanings. So, the German gesture “threaten someone with a finger” has a discrepancy with the Russian gesture: the hand is bent at the elbow, the palm is turned toward the addressee, the index finger is extended, the rest are bent, the hand makes short jerky movements from left to right, while in the Russian version the palm is turned edge to to the addressee and the hand moves back and forth.

Some gestures with the same execution do not coincide in the meanings. The German gesture of “clicking fingers” is associated with attracting attention which is sometimes used at school by students in order to attract the attention of a teacher. In the Russian tradition this gesture has the meaning of annoyance, error or difficulty in finding the right word or answer.

Ethnocultural features of non-verbal communication affect the communication process. There are a number of kinemas that have a fixed socio-cultural significance

and are characteristic of a particular ethnic system of non-verbal means. It is precisely this kind of non-verbal means that are used in dialogical discourse to emphasize the nationality of the communicants.

Non-verbal manifestations of some emotional state can also have both general elements similar to different cultures and a special character. Tears are an almost universal sign of sadness, however, cultural norms pay attention to these forms of reactions determining when, how and for how long you should cry. Laughter is a fairly common sign of joy and satisfaction. However, contempt and a mocking attitude are often also expressed with the help of laughter.

Everything related to relations between people, as a rule, presupposes clear norms that are binding on all members of a given culture, therefore emotions directed at others to a greater extent than self-centered emotions are influenced by culture. Emotions directed at others are characterized by more significant intercultural differences. Self-centered emotions, as they serve as a means of transmitting information about personal relationships, are also subject to the regulatory influence of culture. Thus, the usual reaction in a state of sadness is crying, but special rules establish under what circumstances, to what extent and for how long a person can cry.

Adequate knowledge of non-verbal language includes not only the ability to use its gestures as elements of a non-verbal semiotic code, but also knowledge of the language manifestations of each of the gestures. A good command of the natural language as one of the components implies not only the ability to use language nominations as elements of a verbal semiotic code, but also the ability to recognize the gestures behind them by language manifestations.

Thus, a good command of the natural language implies not only the ability to use language nominations as elements of a verbal semiotic code, but also the ability to recognize the gestures behind them by language manifestations. The conducted analysis allowed us to state that even generally recognized gestures can easily change their meaning or acquire additional meanings. In this regard it is also important to note that different gestures can be compatible, e.g. the use of concomitant gestures, which can significantly affect the whole communication process.

Depending on how differentiated, complicated or simple a language is structured, this has concrete effects on the non-verbal part. With a stereotypical, little differentiating language, the importance of the body language increases. This is particularly evident in the extravagant gestures – similar to secret codes – that young gangs use to be able to communicate between stereotypes such as “cool” and “old age”. In contrast, the non-verbal part is low in everyday Japanese life, because in addition to the traditionally required restraint, the highly nuanced vocabulary requires a maximum of concentration.

There are also national differences. For example, Americans often sit with their legs superimposed on each other, with the lower leg lying crosswise above the knee of the other. Americans are more likely to find the sitting posture of Central Europeans with closed thighs unusual.

In addition, there are differences between men and women, adults and children,



differences that are explained by the status and role of a person. For example, men take up more space in their sitting posture and their overall gestures than women. Furthermore, each culture has developed its own body language rules. A clear example of this is the (reversed) nodding / shaking of the head to the negation / affirmation in Bulgaria, which regularly causes guests of the country to doubt the veracity of verbal statements of the inhabitants.

Various body language elements have become internationally established through their dissemination. The best example is the “Victory” sign (the index and middle fingers of the hand, which is otherwise closed forward, stretched upwards to the “V”): this symbol should be known even to members of the Inuit or Maasai.

Due to their genetic and cultural roots, non-verbal communication is far less subject to conscious control than verbal communication. It is usually used to underline the selected words, or it offers an alternative if the spoken words do not seem expressive or differentiated enough. In some cases, the body language is also deliberately used.

To date, there is no reliable standard lexicon of the body language, it is always perceived in its complexity, because every person has innate and learned interpretation skills. However, it is rarely possible to assign a concrete meaning to a single signal. When analyzing individual reactions and individual behaviors, one turns to the individual parts of the body: eyes, head, mouth, nose, eyebrows, shoulder area and upper body, the posture of legs and feet when sitting, the posture of the hand and fingers.

However, understanding the body language is not just about a few basic rules, but about the interaction of many details. The topic of the body language covers various psychological areas: personality, communication, instinctive behavior, aggressiveness, and affectivity. Only by carefully observing the situational environment can the danger of gross misinterpretations be countered. It may be that the body language is very clear, but it is certainly not clear to interpret. There are simply too few details for this in every situation. Different people do not necessarily behave the same. Both in personal life and at work, it depends not only on what someone says, but on the unconscious signals of the body. These are often more honest and believed much more, again unconsciously. It is important to interpret such signals correctly.

Using the body language consciously is certainly an advantage. But it only works if it is done perfectly. A superimposed smile or contradictory signals are easily recognizable. Anyone who demonstrates openness while deliberately lying creates a contradiction, which is reflected in opposing signals. The more a person is “himself”, the less likely you will register signals with him that are incongruous with this person.

For those who want to understand the body language, the following always applies: someone who cannot become aware of his own body language signals will never be able to register the signals of others very accurately and the more empathy a person has in his own emotional world, the more he will also be able to develop for those of others.

The way a person sets his feet can also have a signalling effect. A person, who

pulls the knee in front of the first point of the body, demonstrates caution, or rather still uncertainty. On the contrary, you can also walk in such a way that the toes always proceed. A toe gait, on the other hand, is usually a powerful, space-occupying gait. This is how someone who is not afraid runs, maybe someone who has a clear goal in mind or someone in a hurry. Here again, attention should be paid to whether the body weight is in front of, above or behind the pelvis.

Thus, a good command of the natural language implies not only the ability to use language nominations as elements of a verbal semiotic code, but also the ability to recognize the gestures behind them by language manifestations. The conducted analysis allowed us to state that even generally recognized elements of non-verbal communication can easily change the meaning or acquire additional meanings.

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## Когнитивная невербалика в аспекте межкультурной коммуникации

**И. Е. Ильина\*, Е. Ю. Воякина, О. Е. Шмырёва**

ФГБОУ ВО «Тамбовский государственный технический университет», Тамбов, Россия

\*e-mail: ser\_il@mail.ru

**Аннотация.** В статье рассматриваются проблемы невербальной коммуникации с позиций межкультурной коммуникации. Установлено, что умелое владение владение естественным языком предполагает не только умение использовать языковые номинации как элементы вербального семиотического кода, но и умение узнавать за ними жесты, характерные для определенной культуры, по языковым проявлениям. Проведенный анализ позволил констатировать, что даже общепризнанные элементы невербальной коммуникации могут легко менять значение или приобретать дополнительные значения.

**Ключевые слова:** язык тела, межкультурная коммуникация, когнитивная невербалика, культура, семиотический код.

## Comparison as a Tool for Creating an Artistic Image

**A. A. Karachevtseva**

Kursk State University, Kursk, Russia  
*e-mail: KN9038761111@yandex.ru*

### **Abstract**

The article analyzes the stylistic potential of comparison by which the authors of artistic works create vivid unique images of characters; and of particular interest are those images that require the involvement of a broad context. The implementation of figurative comparison demonstrating the partial identity of objects belonging to different semantic classes is aimed at achieving an aesthetic effect from the individual interpretation of the associations introduced by the writer.

**Keywords:** image, comparison, language game, comparative image

The artistic text serves as a plan for expressing the figurative structure of a literary work. The image is always an aesthetically organized structural element where the forms of verbal construction and the principles of its compositional development characterize the method to transfer and transform reality through the writer's eyes. The expressive potential of the linguistic units of the image is formed through stylistic figures designed to enhance the expressiveness and metaphoricity of the fictional reality "based on the verbal projection of socio-cultural experience" [Zubkova 2008: 135]. It is important to emphasize that it is the technique of comparison in the literature that gives the effect of associative imagery of objects from different semantic classes.

The main carriers of the author's ideals, thoughts and feelings are the protagonists of literary works. The lexical artistic technique "comparison" plays an important role in creating an evaluative characterization of characters through diversity of analogies and similarities between two semantically heterogeneous objects preserving, in turn, their own originality and independence. So, the comparison can be presented as a linguistic phenomenon that serves to explain the comparable features or qualities in the unfolding of the image "which is determined by the national characteristic (sensual imagery and marked expressiveness)" [Zubkova, Logvina 2022: 41].

The modern Russian linguist V.P. Moskvin divides comparisons into two categories: figurative and logical (expressing a quality equally inherent in both the subject and the object); comparisons, according to the scientist, express the explanatory and descriptive functions of the resulting semantic relationships between two pairs of objects [Moskvin 2004: 23]. Thus, the comparison for the recipient acts as a logical means to perceive the expressed thought.

Figurative comparisons are characterized by explicit presentation of information where language game is realized due to an extraordinary context or unexpected logical-semantic connections. This trope refers to the varieties of language game aimed at setting the achievement of a pragmatic effect along with the formation of new

semantic accents and a different level of perception through the implementation of a semantic complex focused on the comparison standard's features. The less similarity the compared objects have, the brighter and more aesthetically the created image is. This principle of language game can be traced in the fiction novel for teenagers by Susan Hinton "The Outsiders".

The novel's story is set in a small town in Oklahoma in the 60s and is narrated by Ponyboy Curtis, a fourteen-year-old teenager who is a junior member of "Grizzers" (from the term "greaser"), a gang of teenagers from poor families on the east side of the town. Ponyboy tells about the events of the eternal confrontation between gangs of teenagers: Grizzers and Socs (the abbreviation for the Socials), – "gilded youth". The story attracts the reader's attention not only with its dynamic description of the conflict but also with clearly, expressively written characters acting as subjects of comparison. Let's illustrate with examples the figurative comparisons from the perspective of an unusual language context.

1) "He's got *eyes that are like two pieces of pale blue-green ice*. They've got a determined set to them, like the rest of him" [Hinton 1995: 7] – the imagery of comparing the eyes of Pony Boy's older brother, Darry, is created by an extremely specific description of the sign of comparison; which confirms the truthfulness of the expression "eyes are the mirror of the soul". The writer reminds us with the help of them what a young man had to face in his early years: the death of parents, custody of his younger brothers, the end of childhood, getting a job. Ponyboy describing the attractive sides of Darry still comes to the following conclusion: "He would be real handsome *if his eyes weren't so cold*." Thus, comparison, as the basis of an artistic metaphor, "appears as a "new" formal artistic practice, the art of telling stories to an audience manifesting the peculiarities of individual style or linguistic patterns entrenched to a representative of a particular culture" [Zubkova 2021: 95].

2) "Soda is *handsomer than anyone else I know*. Not like Darry – Soda's *movie-star kind of handsome*, the kind that people stop on the street to watch go by" [Hinton 1995: 8] – in this example the comparison's imagery is divided into several parts and is arranged in a logical chain which indicates a high degree of admiration for Ponyboy's second older brother – Soda. In addition, the hero doesn't miss the opportunity to once again mention his personal attitude and manifestation of feelings for his brothers. But because of the endless stream of reflections accompanied by doubts and contradictions, who is better and closer to him, Ponyboy cannot uncompromisingly put either of the brothers on a pedestal in his head. At the sight of Darry he reflects: "I turned my head to look at him and in the moonlight *he looked like some Greek god came to earth*. I wondered how he could stand being so handsome". The presented variety of interpretation of the brothers' appearance testifies to the complex multifaceted inner world of the narrator.

3) "Whether that was because Steve was so good with cars or because Soda attracted girls *like honey draws flies*, I couldn't tell you" [Hinton 1995: 9] – the presented comparison once again emphasizes Ponyboy's adoration of the brother: he considers Soda's pleasant appearance to be his dignity. Moreover, the young man

introduces numerous descriptive fragments of Grizzers' appearance into the context in order to prove to both the reader and himself that they are no worse than Socs and they also have something to be proud of.

4) "He had an *elfish face*, with high cheekbones and a pointed chin, *small, sharp animal teeth*, and *ears like a lynx*...He was *as wild as the boys in the downtown outfits, like Tim Shepard's gang*" [Hinton 1995: 10] – the comparison's feature of Dally, one of Grizzers, with a predator is easily inferred from the context where the second part of the character's description determines the circumstance of the embedded details. The analyzed example is interesting because the multipolar imagery of Dally's appearance and character is created due to the interaction of such related tropes as metaphor (*he had an elfish face*), on the one hand, and comparisons (*sharp animal teeth, and ears like a lynx*), on the other hand.

5) "If you can picture *a little dark puppy* that has been kicked too many times and is lost in a crowd of strangers, you'll have Johnny. He was *the gang's pet*, everyone's kid brother" [Hinton 1995: 11] – in the analyzed example the object of comparison is the image of a puppy which is associated with a defenseless, innocent creature. His owners, in this case, his parents, don't notice him at all and if they do pay attention, they only leave marks on his body: "His father was always beating him up, and his mother ignored him..." The parallel drawn and the wide contextual environment of the context of Johnny Cade's description confirms the idea that he, like any pet, needs care and love, the only source of which could be his friends from the gang.

Having analyzed the factual material of the work, we can conclude that the presented artistic technique "comparison" plays an important role not only in the embodiment of memorable images but also in revealing heroes' feelings, thoughts and character. In the mechanism of creating a comparative image the dependence between the degree of similarity of the compared objects and the aesthetics of the created image comes to the fore, namely: the more expressively the image is outlined, the more piercing it is for the recipient [Mironova 2020: 12].

Note that the words in the above examples denoting the compared objects are connected by the conjunctions *as* and *like* while some comparative constructions are built on a direct analogy without the introduction of referents – structural parts of speech. It should be emphasized that comparison always serves as one of the main and effective methods of verbal painting regardless of its form in which it appears in the text. Thus, the depicted is concretized, becomes more expressive in context and for readers – more understandable as a result of the comparison of the described persons in the artistic work.

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## **Сравнение как инструмент создания художественного образа**

**А. А. Карачевцева**

Курский государственный университет, Курск, Россия

*e-mail: KN9038761111@yandex.ru*

**Аннотация.** В статье анализируется стилистический потенциал сравнения, с помощью которого авторы художественных произведений создают яркие неповторимые образы действующих персонажей; а особый интерес вызывают те образы, которые требуют вовлечения широкого контекста. Реализация образного сопоставления, демонстрирующего частичную идентичность объектов разных семантических классов, направлена на достижение эстетического эффекта от индивидуальной интерпретации введённых писателем ассоциаций.

**Ключевые слова:** образ, сравнение, языковая игра, сравнительный образ

## Diversité littéraire des sons et étude comparée de la figurativité de l'intonation

**V. I. Kopelnik, O. N. Morozova**

Université technique d'état de Tambov

*e-mail: kopelnik99@mail.ru*

### Résumé

*L'article discute et analyse la combinaison d'intonation des sons dans un mot. Le symbole de l'imitation des sons est une imitation de la réalité. L'article décrit comment une personne perçoit la diversité du monde qui l'entoure. Ce qui sonne dans un mot reçoit une désignation spéciale dans la langue et dans la traduction dans une autre langue. Le système et l'analyse d'innombrables matériaux développent la sémantique de base des langues.*

**Mots-clefs:** *intonation sonore, imitation sonore, sémantique*

La généralisation, la systématisation et l'analyse d'une énorme quantité de matériel factuel ont contribué au développement de la science de la sémantique d'arrière-plan et de ses divers aspects. Cela est dû à l'étude d'une des questions les plus difficiles de la théorie du langage, concernant le phénomène de l'intonation sonore, dans lequel il existe un lien direct entre le son d'un mot et sa signification. L'étude des intonations sonores a commencé dans les temps anciens. Au Moyen Âge, saint Augustin et Thomas d'Aquin ont traité de cette question. De nombreux scientifiques, tels que Herder et Paul, ont fondé leurs conclusions sur l'intonation sonore à partir de laquelle le langage a émergé.

Les linguistes utilisent diverses méthodes d'intonation sonore picturale et mènent de nombreuses analyses linguistiques étymologiques pour prouver un lien réel entre le son, l'intonation et le sens d'un mot. Ces études ont été poursuivies par A. M. Gaz-Ginzberg, A. M. Shakhnarovich au XXe siècle. Cependant, il n'y a toujours pas de confirmation de signes de systèmes de vision et de signes de motivation dans tous les sons des mots de la langue moderne. Les expériences des linguistes européens ont prouvé l'existence du symbolisme sonore. L'intonation sonore prouve la validité de l'existence de la sémantique d'arrière-plan en tant que discipline linguistique distincte, mais indique également les perspectives d'utilisation de ses capacités uniques dans des recherches ultérieures.

L'intonation sonore contribue à la construction de la tonalité sémantique, puisque c'est sa figurativité qui constitue la forme sonore d'un texte artistique et est le matériau premier dans le processus de pensée exprimé par le texte.

Grâce à l'intonation du son, à savoir son imitation et son symbolisme, des associations vives apparaissent qui provoquent un certain agencement du texte.

L'intonation du son dans le texte devient un élément clé dans la transmission non seulement du segment sonore du texte, mais aussi du sens principal du texte, car en raison des caractéristiques acoustiques et articulatoires des sons sous-jacents à la dénotation, il est décrit succinctement et utilise le minimum de construction dans le texte, et les lignes sémantiques profondes du texte déterminent avec précision le sens et l'intonation du travail de l'auteur.

Le sous-système onomatopéique est formé de mots onomatopéiques. La nomination onomatopéique d'un mot est basée sur le son, c'est-à-dire sur la désignation acoustique. Onomatopéie peut également être définie comme une imitation verbale conditionnelle des sons de la réalité environnante au moyen d'un langage donné. L'articulation du mot racine qui forme le son, d'un point de vue physique, reproduit presque le processus naturel qui produit le son. La classification objective des mots onomatopéiques est basée sur les paramètres psychoacoustiques des sons de différents types de dénotations.

Ces paramètres sont : 1) pitch (sons graves et aigus) ; 2) volume (intensité) (sons forts et faibles / sons intenses et non intenses) ; 3) temps (tact et non-tact, bref non-tact); 4) régularité (fréquence) des oscillations (tonalité et bruit); 5) dissonance (dissonance et non-dissonance). Structurellement et sémantiquement, le système onomatopéique est divisé en trois classes (instantanée, continue et fréquentielle) et deux hyperclasses (instantanée-continue et fréquentielle-quasi-instantanée-continue). A titre d'exemple de moments onomatopéiques (signal ou bruit instantané), on peut citer les suivants: tuk-tuk (robinet), bulle (gargouillement, bulle), clack-clack( cluck so); continuants (signal ou son continu, bruit): aussi (klaxons, bourdonnement), squeak (bip), sifflet (sifflement), bourdonnement (élevé), frekatifs (sons aigus fusionnés en une série de sons): cherk (chirp), birr (bruit fort vent), boucles (sifflement lors de la friture). Les classes et les hyperclasses de mots onomatopéiques anglais couvrent 18 types de combinaisons sonores, ainsi 18 types de dénotations sont reflétés dans le sous-système onomatopéique de la langue anglaise. Sur la base de la compatibilité de divers paramètres, neuf types de sons sont également distingués : 1) apparence ; 2) ton neutre ; 3) bruit neudar pur ; 4) bruit tonal neudar ; 5) quasi-choc ; 6) dissonance « pure » ; 7) ton quasi-percussif ; 8) quasi-absorbeur de bruit pur ; 9) tonalité de bruit de quasi-choc. Les chercheurs ont construit des modèles canoniques qui reflètent tous les sons d'intonation et d'imitation courants. Connaissant la structure acoustique de la dénotation, on peut prédire avec précision la structure phonétique de l'intonation du son dans un mot. L'intonation du son est également formée par le symbolisme du mot, par exemple dans "Ignited with a red cry" de Blok. Ici, on peut dire, il y a un symbole du mot, sur les traits duquel l'objet est basé. L'homme le perçoit par la vue, l'odorat et le goût.

La base de l'intonation du son en un mot est le phénomène du cinéma-cinéma, ce sont divers mouvements gestuels et mimiques, qui sont des mouvements réflexes et expressifs qui accompagnent le processus mental dans la sphère de la conscience humaine, ainsi que des mouvements intéressants qui servent d'imitations mimiques d'objets extérieurs, dans la forme, la taille et le mouvement. Tout cela permet de



comprendre, d'analyser et de traduire les stimuli d'une modalité sensorielle dans une autre. Grâce à l'action de l'intonation sonore, une personne peut, à l'aide de l'appareil articulatoire, transmettre les signes d'objets perçus par la vue, le toucher et le goût. De plus, le cinéma-cinéma couvre la sphère des émotions, qui jouent également un rôle dans l'intonation du son. Les chercheurs linguistes ont identifié une nouvelle branche de la sémantique de fond, qui comprend non seulement les enjeux les plus importants de la sphère du langage, mais aussi des aspects de la physiologie, de la psychologie, de la sémiotique et de la philosophie qui lui sont inextricablement liées.

Comme vous le savez, la phonétique et la phonologie concernent l'étude du langage, la sémantique l'étude du sens sémantique d'un mot, la sémantique d'arrière-plan traite de ce qu'on appelle traditionnellement la relation entre l'organisation sonore et le sens. Le sujet de la nouvelle science linguistique est l'intonation du son dans le système linguistique. Deux sous-systèmes - l'imitation sonore et le symbolisme sonore - forment la base de l'intonation visuelle du son dans une langue. Un rôle particulier dans la théorie de la sémantique d'arrière-plan est joué par la théorie de la connaissance, qui décrit les concepts de base de la maîtrise de la réalité et la primauté de la perception sensorielle et le principe de refléter l'intonation des sons dans un mot.

La théorie de l'imitation est directement liée à l'ingéniosité du son comme signe linguistique. Initialement, l'imitation s'appelait la recreation de mouvements humains en danse, plus tard, toute reproduction d'objets. Selon Aristote, l'homme « se distingue des autres êtres vivants en ce qu'il est le plus enclin à l'imitation » ; la première connaissance s'acquiert par imitation, dont les résultats "chacun jouit"

L'imitation de sons est une connexion phonétique imprononçable entre les phonèmes d'un mot et la base émotionnelle d'un son. L'imitation sonore a été définie comme une imitation verbale des sons de la réalité environnante à l'aide d'un langage donné (plop, chut, miaou). Dans les années 80 du XXe siècle, une classification universelle des mots onomatopéiques de la langue anglaise a été développée en fonction de leur relation avec l'intonation. Par exemple : Bum, bang, thrash, thrash - bang, bang, bang, dodu, Bash (frapper fort) - bang, bang, Whit-whit (chirp, sifflet) - chirp-chirp, Whang, thump (fouet avec un sifflet) ) - whip, whip, Thramp (difficile à marcher) - top-top, stomp, Clank (tir.), crink, chink (gazouillement, tintement) - cliquetis, cliquetis, Strum, brnnnnng (imitation d'un très long son aigu son, sirène de feu) - trille - strum, strum, strum, Dong (frappe d'une grosse cloche) - dong-dong, Ring (sonnerie d'une cloche), ding (sonnerie d'une cloche gênante), ting (aigu, doux, sonnerie) ding-ding, longueur-longueur, Tinkle - sonnerie (à propos du téléphone), Clam - sonnerie en frappant toutes les cloches), Piff (le son d'une balle volante) - Bang-bang, Zonk (l'argot britannique est un coup court, sonore et sifflant), Zip (le son d'une fermeture éclair) - Zhik, vzhik et bien d'autres exemples différents peuvent être cités. [1]

Un exemple frappant de l'imitation des sons dans la langue sont les interjections. Le motif de l'intonation des sons des interjections est évident. Les interjections sont souvent perçues comme des phénomènes de réalité. Dans n'importe

quelle langue, vous pouvez facilement faire le bruit d'un oiseau, l'alarme, le son d'une sirène, le silence.

Les moyens sonores de la langue comprennent la mélodie de la parole avec ses modulations, l'intensité et le tempo de la parole, les nuances dans l'articulation des sons individuels et leurs combinaisons. Tous ces différents moyens permettent en tout cas d'influencer quantitativement et qualitativement le sens émotionnel et sonore du mot. De plus, je voudrais noter que l'imitation et l'intonation des sons sont les types les plus élémentaires de symboles sonores. Les onomatopées peuvent être transmises non seulement à l'aide de mots onomatopéiques représentant l'étymon onomatopéique original sous une forme morphologisée (sous forme de noms ou de verbes) (bang - bang, puff - puff, etc.), mais aussi à l'aide de son répétition de l'imitatif. L'existence de divers complexes sonores pour désigner des phénomènes sonores similaires s'explique par l'existence d'une synonymie au niveau des imitatifs. Dans les enregistrements sonores de ce type, les caractéristiques articulatoires et acoustiques des sons qui forment un complexe onomatopéique sont importantes. Par exemple, les consonnes fricatives sont plus souvent utilisées pour reproduire des "sifflements", des "sifflements", des "bruits" et des bruits similaires. [1]

Dans la terminologie traditionnelle, les lexèmes désignant divers sons sont appelés onomatopées. Ce sont des lexèmes tels que couinement, miaou, bourdonnement, coassement, etc. Le paramètre principal de la caractéristique sémantique de l'onomatopée est la possibilité de sa corrélation avec une certaine "source sonore" et un certain signifiant onomatopéique. Un signifiant est une caractéristique sonore choisie dans une langue comme base de nomination.

Une caractéristique du système onomatopéique est la motivation (extralinguistique) de ses unités, c'est-à-dire la présence d'un lien nécessaire, essentiel et répétitif entre les phonèmes du mot et le trait dénotatif (motif), qui est à la base de la nomination. .

Divers sons sont liés à leurs désignations spécifiques dans la langue à travers un système de modèles onomatopéiques. Un modèle en tant qu'outil de recherche est compris comme une sorte de construction qui reflète toutes les imitations communes à un certain groupe.

Dans le système onomatopéique, par rapport à la source sonore, toutes les unités sont divisées en deux grands groupes : polyvalent et monovalent. Cette division est due au fait que certaines sources sont pertinentes pour une large gamme de tons, tandis que d'autres sont considérablement réduites. La polyvalence est associée aux caractéristiques cognitives de l'intonation : la plupart des sources polyvalentes (par exemple, les voix des corbeaux, des poulets, des oies, des pigeons, etc.) sont suffisamment significatives pour les locuteurs natifs ; leurs voix ont des caractéristiques acoustiques spécifiques (nettement différentes des autres sons) et peuvent être reflétées par le système phonologique d'une langue donnée. Deux types peuvent être attribués aux sources monovalentes : celles qui ont leurs propres modèles onomatopéiques (pew - le cri d'un cerf-volant, jug - le chant d'un rossignol), et celles qui sont monovalentes en raison du caractère exotique de ces sources et d'une

connaissance minimale. de leurs voix (crake - un cri d'un râle des genêts, cawk - le cri d'un huard). Ceci explique la représentation de différentes voix dans différentes langues. Par exemple, le système phonologique spécifique de la langue anglaise contribue à mieux refléter le cri d'un hibou qu'en russe (whoo, whoop, whoot, tu-whoo, tu-whit - uuu, uuu, uuu - le cri d'un hibou).

Ainsi, l'onomatopée, étant une imitation verbale conditionnelle de la réalité qui nous entoure, nous permet de refléter graphiquement les sons que nous percevons dans la langue. Les mots onomatopéiques, essayant de reproduire toute la diversité du monde sonore qui nous entoure, réalisent cette connexion dans la langue, provoquant des associations correspondant à l'une ou l'autre source sonore. Dans le processus de construction de la tonalité sémantique, l'onomatopée fait référence aux moyens phonosémantiques sonores-figuratifs qui organisent la tonalité sémantique, et agit comme l'un des principaux critères de sa détermination, en raison des caractéristiques acoustiques-articulatoires du son, qui constituent la base de l'onomatopée.

Dans les onomatopées, les éléments phonogènes du son sont directement transmis par des éléments, des phonèmes appartenant aux mêmes types psychoacoustiques que les éléments sonores eux-mêmes. La fonction des onomatopées dans la construction du sens-tonalité-réflexion, désignation d'un son ou d'une combinaison de sons ; les phonèmes d'un mot onomatopéique constituent un ensemble harmonieux d'éléments dans l'intonation des sons.

Il existe également un système tout aussi important de symbolisme sonore. À l'époque hellénistique, s'appuyant sur la théorie de l'imitation et de l'imitation, un nouveau concept du début cognitif de l'art a été désigné, et au milieu du siècle, un nouveau concept du début cognitif de l'art a été fermement établi: l'art était compris non seulement comme représentation d'objets individuels, mais aussi comme essence universelle et comme sens existentiel. Ce concept a été précédé par Platon, qui parlait de l'imitation de l'harmonie cosmique en musique. Son centre est la doctrine du symbole, qui agit principalement comme une catégorie religieuse et philosophique. Transformant la théorie de l'imitation, les philosophes médiévaux parlaient du symbole comme d'une ressemblance inappropriée, y voyant notamment le fondement et le noyau des œuvres d'art. Une importance décisive a été attachée à la parabole symbolique-allégorique, qui est si significative dans les textes chrétiens canoniques. De nos jours, linguistes et chercheurs considèrent la créativité artistique comme un symbole éternel de la parole. Comprendre l'art du mot et de la langue puis traduire ou traduire dans une autre langue le sens figuratif et non figuratif du mot et de l'intonation reste un point important pour les linguistes chercheurs.

Il existe des approches pour l'étude d'un symbole sonore et de son imitation. Le symbole du son est initial par rapport à la compréhension du sens du son, puis du mot, et il est né sous l'influence de la nature sonore de la langue. Les chercheurs en linguistique ont identifié l'existence du premier ou symbole initial du son et ont trouvé une dépendance aux caractéristiques acoustiques du son. La phonétique et les règles de cette langue nous aident à comprendre et à analyser correctement les sons et leur intonation. La théorie des symboles sonores est l'un des sujets les plus

intéressants et les plus controversés pour les linguistes. Beaucoup contribue à la préservation et à l'émergence de ce thème ; l'une des raisons les plus convaincantes est l'impression créée par l'articulation de divers phénomènes sonores. Les sons des symboles dans les langues du monde sont très productifs. Se démarquant sémantiquement et structurellement, de nombreux symboles sonores et imitations sonores dans un mot forment des catégories spéciales dans le verbe et d'autres parties du discours. Dans les langues modernes, le symbole sonore est de nature statistique. Comme exemples les plus frappants de l'intonation des sons dans un mot, on peut donner des descriptions de sa taille, du volume des sons graves comme des sons larges et épais, et des sons aigus comme des sons petits et fins. Cette correspondance est généralement basée sur la taille réelle des objets qui produisent le son. Actuellement, les chercheurs en linguistique travaillent dans différentes langues et montrent que tous les concepts symboliques n'étaient pas déterminés par les propriétés articulatoires des sons. Le symbole d'un mot, l'imitation d'un son et l'intonation d'un son dans un mot sont analysés et discutés lors de conférences et de divers forums sur des thèmes linguistiques.

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### **Сравнительное изобразительное исследование и литературное разнообразие звуков и интонации**

**В.И. Копельник, О.Н. Морозова**

ФГБОУ ВО «Тамбовский государственный технический университет», Тамбов, Россия  
*e-mail: kopelnik99@mail.ru*

**Аннотация.** Цель данной статьи рассмотреть и проанализировать сочетание интонации звуков в слове. В статье написано, как человек воспринимает многообразие окружающего его мира. Символ имитации звуков является подражанием действительности. Какие звуки в слове получают специальное обозначение в языке и в переводе на другой язык. Система и анализ бесчисленного материала развивают фоновую семантику языков.

**Ключевые слова:** интонация звука, имитация звука, семантика.

## Teaching Phrasal Verbs Using Multiple-Choice Tests

**P.I. Lobeeva**

*Bauman Moscow State Technical University, Moscow  
e-mail: guninap@gmail.com*

**Abstract:** Multiple-choice questions are traditionally used to test students' knowledge and measure their progress in many subjects. In this paper, the possibility of using multiple choice tests for teaching English phrasal verbs is investigated. The examples of test assignments that can be turned into a teaching tool are given.

**Keywords:** automated multiple choice tests, validity, standardized questions.

### Introduction

Automated multiple-choice questions have become a popular tool for testing students' knowledge and understanding of various subjects. For example, Foos and Fischer (1997) assessed the value of test-taking as a means of increasing learning, rather than simply monitoring. They conducted a study that showed that scores on the final test were higher for those students who did the initial test, which indicated the potential value of tests as learning experiences.

There is a debate about the validity of these tests as a reliable measure of student learning. It is assumed that tests are a valid measure of student learning, but only when they are well-designed and aligned with the curriculum.

Automated multiple-choice tests offer several benefits, including quick scoring, standardized questions, and the ability to test a large number of students at once. These tests can also be easily adapted to different subjects and levels of difficulty. However, they have some disadvantages. One limitation of automated multiple-choice tests is that they may not accurately measure higher-order thinking skills, such as analysis and synthesis. Additionally, these tests may be susceptible to guessing and may not accurately reflect a student's true understanding of the material.

The benefits and potential issues with using multiple-choice questions including concerns about cheating, ways to detect and deter cheating, and testing issues and strategies unique to online formats have been summarized by Xu et al. (2016). The authors argue that assessment of deeper-level thinking is a common concern with multiple-choice question use. However, with appropriate formatting of multiple-choice testing it is possible to assess deeper-level thinking. Student understanding and learning can also be increased by utilizing appropriate feedback in terms of content and timing.

### Multiple-choice tests as a teaching tool

Multiple choice tests can be used not only as a testing tool, but also for teaching purposes. The methodology of using multiple-choice tests for teaching phrasal verbs involves the following important points:

- while reading, do not look at the answer options, but try to understand the meaning of the sentence and, analyzing the words and phrases in this sentence;
- try to come up your own correct answer, and then compare it with the proposed options and fill in the gap with one of them.

The exercise presented below is aimed at developing problem-solving skills. In addition, it develops grammatical and sociolinguistic competencies.

Students are given a test assignment:

*“All men over 18 will be called \_\_\_\_\_ to fight in the war”*

*A in B over C back D none of them correct*

The assignment has 3 options, each of which is incorrect. Students read the text, look at the incorrect options A, B, C, discuss, analyze the difference in the lexical meaning of phrasal verbs, provide the appropriate context for them and choose option D and write the correct one.

This assignment has obvious advantages: firstly, it teaches learners to think about the answer, to analyze the semantic features of distractors, and secondly, it develops grammatical competence through vocabulary expansion, and sociolinguistic competence through the use distractors in appropriate situations.

Another type of multiple-choice assignments could be gap-filling in a sentence with no answer options, followed by a comparison and discussion of the options with illustrated examples.

A slightly different procedure is also acceptable. Before looking at the assignment, students write their own sentences with different answers, discussed their examples, and then chose the correct options for specific sentences.

The use of various types of multiple-choice assignments in the lessons, which require more than filling in the gap with a word from the answer options, contributes to the development of language competence, in particular, to the expansion of the vocabulary, replenishing it with phrasal verbs, and expanding the scope of meanings.

The proposed assignments are aimed at developing ideas about the authentic use of the language. A deeper understanding of how some lexical units differ from other units enriches learners’ vocabulary with phrasal verbs, which are an integral part of colloquial style and everyday language. These assignments also explain the nature of distractors and focus on being able to come up with your own answers instead of using suggested alternatives.

After the test stage, in order to consolidate the material, the students are asked to personalize the elements. For example, a test sentence could read “She is looking for a job in consulting” or “He always gets round me by buying me presents. In personalized sentences, it is allowed to replace either the subject or the object with the names of friends, classmates, family members, and famous people. Thus, constructions are better remembered due to their originality and humor.

### **Apps to create multiple-choice tests**

There are several apps available for creating multiple choice tests, including Quizlet, Quizziz, QuizMe, MyQuiz and many others. These apps allow teachers to

create customized quizzes and track student progress over time. Below are some examples of multiple choice tasks to test phrasal verbs:

1. Choose the correct phrasal verb to complete the sentence: "I need to \_\_\_\_\_ my computer before I can install the new software."

a) back up b) set up c) turn off d) log out

2. Which phrasal verb means "to make a copy of data on a separate device"?

a) back up b) set up c) turn off d) log out

3. What is the correct phrasal verb to complete the sentence: "I always \_\_\_\_\_ my computer when I'm finished using it."

a) back up b) set up c) turn off d) log out

### **Conclusion**

Summing up, multiple-choice tests enable to take into account different meanings and different shades of meaning thanks to their contextualized form; they are relatively simple, fast and easy to process. The use of multiple tests is a very effective way of teaching phrasal verbs at the initial stage of learning, where much attention is paid to mastering language means. This type of tests contributes to a more complete and deeper understanding of linguistic phenomena, meaningful assimilation of linguistic material, memorization / consolidation / automation of lexical and grammatical material.

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## **Обучение фразовым глаголам с использованием вопросов с множественным выбором**

**П.И. Лобеева**

НИУ «Московский государственный технический университет им. Н.Э. Баумана», г. Москва  
*e-mail: guninap@gmail.com*

**Аннотация.** Задания с множественным выбором традиционно используются для проверки знаний учащихся и оценивания по многим дисциплинам. В данной работе рассмотрена возможность использования тестов с множественным выбором ответа для обучения английским фразовым глаголам. Приведены примеры тестовых заданий, которые можно использовать в обучающих целях.

**Ключевые слова:** автоматизированные тесты с множественным выбором, валидность, стандартизированные вопросы.

## Features of the Concept HOME/HOUSE Verbalization in the English-Speaking Environment

**M. N. Makeeva, N. Yu. Borodulina**

Tambov State Technical University, Tambov, Russia  
e-mail: marnikma@inbox.ru; nat-borodulina@yandex.ru

### **Abstract**

The aim of the article is to describe the content and characteristics of the concept HOME/HOUSE in the English-speaking environment. The concept of HOME/HOUSE is defined as a universal, archetypal concept with a high axiological intention, cultural status and national specifics, reflected in the lexical and phraseological system of the English language. Proverbs, including the concept HOME/HOUSE, emphasize the importance of creating comfort, homesickness, they also include the cognitive components "private life", "house as a fortress", "family hearth" and represent the house as part of a person's emotional or intellectual experience. In the minds of native English speakers, the home is identified first of all with the homeland, and then with housing, it opposes the openness, unlimitedness, uncertainty and chaos of alien space.

**Keywords:** concept; culture; lexis; paremia.

*There is no place more delightful than home.*  
(Cicero)

In English culture, the concept HOME/HOUSE can be referred to as universal concepts, which are defined as "archetypal concepts" [1, 2]. The first folklore ideas about the organization of the space of the "home" model in the English language reveal that the linguistic realization of folklore meanings in the mythopoetic model of the world directly depends on the scope of national and universal sociocultural factors that endow each language unit with a rich coloring of ethnic and national meanings. The value component of this concept establishes its cultural status and is characterized by incorporation into traditional semiotic oppositions. The national specificity of the concept HOME/HOUSE is reflected in the lexical and phraseological system of the language, is associated with philosophical and ethnocultural ideas about the house. The individual component is revealed through the characters; author's - through the speech of the narrator; national is revealed through proverbs, sayings, dictionaries of 19<sup>th</sup> century, as well as text; universal - is defined through the text, historical and etymological dictionaries.

An important aspect of the HOME/HOUSE concept for English writers is its connection with tradition and continuity. The building of the house itself bears the imprints of all previous cultural layers, bygone times, and therefore is subject to careful storage. Being verbally organized and embodied in many linguistic units, the HOME/HOUSE concept has an imprint of the cultural consciousness of native speakers and is one of the most important cultural, mental, linguistic spatial constants that make up the national picture of the world. This concept incorporates, along with universal human characteristics, a complex of ethnic, mythological, religious, socio-



cultural, philosophical, figurative elements in their historical dynamics and is complemented within the framework of a novel by the features of the individual author's sphere of concepts.

Linguists distinguish the following structural components of the HOME/HOUSE concept: firstly, "private life", "homeland", "family", which form the core of the concept, and secondly, smaller components, such as "neighborhood", "wealth", "children", "happiness", "guests", "labor", etc. located on the periphery. The British associate their country with their homeland and often say "home" instead of the word "homeland". For the British, a home is a refuge, a fortress, a clear confirmation of which is found in English proverbs and sayings: "A house is not a home", "Be it ever so humble, there's no place like home", "The wider we roam, the welcomer home" (<https://lingvister.ru/blog/a-house-is-not-a-home-angliyskie-poslovitsy-pro-dom>), as well as in a large number of words derived from "home": "home-coming", "homesickness", "homey", "homeliness", "home-keeping", "home-ward", etc. Thus, for representatives of the English linguoculture, a home is, first of all, a refuge, a fortress, which in any, even in the most difficult moment of life, should not let its owner down.

The etymological analysis of the concept HOME/HOUSE testifies to the two most famous English nominations - "home" and "house". They came from Germanic to Old English before 900 AD. The Old English word "hus" (future "house") originally meant "buildings, shelters, houses". The word "home" is derived from the Old English word "hām", which, in addition to "building" and "house", also meant "state" and "village" ("dwelling, house, estate, village"), therefore it has the meaning of "homeland". The archetype of the house has a rich associative complex in the human mind. At the same time, in the English concept of HOME/HOUSE, more emphasis is placed on the functional purpose of the house and its role in relations between people.

According to the Longman English Dictionary, in vocabulary units that verbalize the concept under study, it is possible to identify the following cognitive layers:

**home:** 1) place where you live;

2) family;

3) where you came from/belong (the place where you usually live, especially when this is the place where you feel happy and comfortable);

4) your country;

5) property.

**house:** 1) where someone lives (a building that someone lives in especially one that has more than one level and is intended to be used by one family);

2) building (a large public building for a particular purpose)

3) government, company.

(<https://www.ldoceonline.com/>)

Thus, the difference between "house" and "home" is that "house" is used only in the meaning of a separate building, while "home" has the meaning "permanent place of residence of the family." The English also use the word "home" when talking about family members: "comes from a good home" / "be from a good family"; about the

homeland of any person or his family, ancestors; about institutions that take care of the needy (hospice, etc.); about the origin of something. A significant cognitive feature of "home" in English linguoculture is the concept of privacy/private life and the associated opposition "one's own – alien's".

Paremiias are an excellent material for the study of the concept. Proverbs and sayings make up the most stable layer of the language. In general, all proverbs related to the studied HOME/HOUSE concept in English can be divided into five large groups:

1) *Paremiias, which talk about the importance of creating comfort, and not excessive attention to the appearance of the house:*

Owner should bring honor to the house, not the house to the owner;

Grace your house, and not let that grace you;

The house is a fine house when good folks are within;

A house is not a home;

Men make houses, women make homes;

2) *Paremiias associated with homesickness:*

The wider we roam, the welcomer home;

Be it ever so humble, there's no place like home;

3) *Paremiias with the cognitive sign "private life":*

Curiosity is illmanners in another's house;

Those who live in glass houses should not throw stones;

4) *Paremiias with the meaning of a house as a fortress:*

For a man's house is his castle/ An Englishman's home is his castle;

There is no place like home;

He that would be well needs not go from his own house;

Far from home is near the harm;

When the house is open, the honest man sins;

5) *Paremiias related to the semantic group "Family hearth, home comfort, ensuring safety and comfort":*

East or West, home is the best;

The furthestest way about is the nearest way home;

6) *Paremiias, where the house is as part of a person's emotional or intellectual experience:*

Home is where the heart is;

Go where he will, a wise man is always at home

(<https://reallanguage.club/angliyskie-poslovitsyi-o-dome/>;

<https://aforisma.ru/anglijskie-poslovicy>).

English house, dwelling as a concept has a symbolic meaning in English culture. The images of the names of the elements of the dwelling, which are realized in linguistic units (idioms, phraseological units, proverbs), are embodied in the linguistic consciousness of the individual, thereby forming a linguocultural subcode. Historically, the possession of land, a castle, an estate was the pinnacle of social status; hence the desire of the inhabitants of Great Britain to have a country house. Hence the

English idiom (to build) castles in the air – (to have) plans or dreams that are not likely to happen or come true. Even in cities, two-three-story houses with a small front garden in front of the window prevail over multi-apartment buildings. Country estates are the privilege of high society in Great Britain. For a resident of the United Kingdom, a house, a dwelling, is an image of the homeland; he loves his land as his own home, with this place he associates the joys of leisure, and not everyday chores. The image of the motherland is associated with a well-groomed front garden under the window.

It is no coincidence that government institutions and the main legislative body of Great Britain once got their names: The Houses of Parliament – the building in which the British parliament sits, or parliament itself: We bring you a report on today's debate in the Houses of Parliament, the Home Office – the British government department that deals with the law, the police and prisons and about who can enter the country. The functional properties of various types of dwellings also form the basis of the imagery of the house. For example, a castle (English castle) symbolizes security - My house [home] is my castle; house (English - cottage) - modesty, moderation; palace (English – palace) - luxury. Acting in a symbolic role, the names of the elements of the dwelling have a great communicative significance.

It is noted that as a result of a long struggle for independence, separation from the continent in the formation of the English essence, its "quintessence", the trend "Self contra Total" can be traced, for the British a natural craving for a separate life.

A feature of the concept under consideration is the internal deployment from the concept of HOME to the concept of FAMILY, as a result of which HOME and FAMILY become conceptually synonymous. For English writers, the inner experience of the hero associated with the home has always been important.

Thus, the study of the representation of the concept HOME/HOUSE at various levels made it possible to establish that the “home” in the minds of English speakers is identified primarily with the homeland, and then with housing, “permanent place of residence of the family”, which is an independent closed space, limited from the outside and controlled by man. The house resists the openness, unlimitedness, uncertainty and chaos of alien space and is a kind of means of protecting a person, a place where he is comfortable.

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## Особенности вербализации концепта ДОМ в англоязычной среде

**М. Н. Макеева, Н. Ю. Бородулина**

ФГБОУ ВО «Тамбовский государственный технический университет», Тамбов, Россия

*e-mail: ; marnikma@inbox.ru, nat-borodulina@yandex.ru*

**Аннотация.** В задачи статьи входит описать концептуальное содержание и характеристики концепта ДОМ в англоязычной среде. Концепт ДОМ определяется как универсальный, архетипический концепты, обладающий высокой аксиологической интенцией, культурным статусом и национальной спецификой, отраженной в лексико-фразеологической системе английского языка. Паремии, включающие концепт ДОМ, акцентируют важность создания уюта, тоску по дому, они также включают когнитивные компоненты «частная жизнь», «дом как крепость», «семейный очаг» и представляют дом как часть эмоционального или интеллектуального переживания человека. В сознании носителей английского языка дом отождествляется в первую очередь с родиной, а затем с жильем, противопоставит открытости, неограниченности, неопределенности и хаосу чужого пространства.

**Ключевые слова** концепт, культура, лексика, паремия.

## Features of Digital Educational Milieu to Persons with Disabilities

O. N. Morozova <sup>1</sup>, I. S. Razuvaeva <sup>2</sup>

<sup>1</sup>Tambov State Technical University, Tambov, Russia

<sup>2</sup>Municipal Autonomous Educational Institution School №30, Tambov, Russia

*e-mail: <sup>1</sup>morozova-on@mail.ru, <sup>2</sup>razuvaevainna@rambler.ru*

### Abstract

The article deals with the problem of increasing the educational potential of students with disabilities. The emphasis is on creating a digital educational milieu for learning a foreign language, contributing to the effective social adaptation of students with disabilities to the medium of university. The system of principles to ensure the optimal inclusion of such students in the milieu of universities is determined. The components forming the digital educational milieu when learning foreign language are described.

**Keywords:** adaptation, digital educational environment, digital society, foreign language, persons with disabilities.

According to the Federal State Statistics Service, the total share of people with disabilities in Russia is more than 11 million people. High rates of disability are also observed among children and adolescents.

In this situation, the question of the day is to increase the educational potential of young people with disabilities with the aim of further employment. At the same time, one of the most powerful adaptation tools is the learning process at a higher education institution, because, in addition to acquiring a specialty, students with disabilities get the opportunity to communicate with peers, and, consequently, the opportunity to enrich their social, communicative experience that contributes to the active inclusion of this category in social relationship.

In combination with the specifics of disability, features of social status, this problem becomes quite significant and affects the success of the individual's social functioning.

Currently, there is a real contradiction between the special needs of students with disabilities in creating optimal learning conditions and the presence of these conditions in universities, which makes it particularly relevant to create a digital educational milieu that promotes effective social adaptation of students with disabilities to the university conditions.

It is also necessary to develop a system of principles designed to ensure the optimal inclusion of students with disabilities in the medium of universities. An educational organization is obliged to create in its collective a professional and social tolerant medium necessary for the formation of a civil, legal and professional position of complicity, the readiness of all members of the collective to communicate and cooperate, and the ability to tolerate social, personal and cultural differences.

The developing digital educational milieu is designed to provide wider access for

students with disabilities to the educational resources of the department of foreign languages, a friendly interface for interactive communication with the teacher and inclusion in the social life of students. It is necessary to combine on-line and off-line technologies, as well as individual and collective forms of work in educational process.

The training of students with disabilities should be implemented as an integral pedagogical process, which is a decisive factor in the professional training of a disabled person to work in the modern information environment.

The digital educational milieu is understood as the specially organized information medium of the university, aimed at achieving the ultimate goals of teaching people with disabilities, which has an active influence on the educational process through the use of communication and information technologies.

The process of organizing such a medium involves the state, managerial and academic staff and a teacher. The state determines the social order for the system of higher education for specialist training. Managerial and academic staff defines the general requirements for students with disabilities, taking into account the traditions of professional training of a particular educational institution. A teacher determines the content of the course program, the choice of educational and methodical literature, technology and teaching methods.

Digital educational milieu, organized in the process of learning a foreign language, has its own characteristics, components and characteristics that contribute to the formation of the readiness of students with disabilities to professional educational activity in modern information environment [1].

The introduction of specialized adaptation disciplines (modules) into the main educational programs is intended for additional individualized correction of educational and communication skills violations, professional and social adaptation at the stage of higher education.

The main components forming the learning and information digital educational milieu in the foreign language classes include: teacher, student, study group, teaching aids, computer equipment, necessary software, didactic materials. The logistical support of the educational and informational environment is represented by computer tools and using software products. Informational and methodological support includes software, teaching aids, didactical materials, and a teacher. Communicational support consists of a teacher, a student, and a study group.

The teacher's role should be reduced to defining and putting into practice the program and methods of teaching a foreign language course, the content of this course and specific educational topics, taking into account the individual characteristics of people with disabilities. In the absence of a standard program, it is the teacher and his professional qualification ensures the success of the training.

The teacher develops, if necessary, an individual curricula and individual training schedules for people with disabilities.

Students with disabilities, like all other students, can be studied on an individual curriculum in a timely manner, taking into account the characteristics and educational

needs of a particular student.

The choice of teaching methods is determined by the content of training, the level of teacher professional training, methodological and material and technical support, and also the peculiarities of perception of educational information of disabled students and students with disabilities. In the educational process, it is recommended to use socially-active and reflexive teaching methods, technologies of social and cultural rehabilitation in order to assist in establishing full-fledged interpersonal relations with other students, creating a comfortable psychological climate in the student group.

An equally important component of the learning and information environment is the study group in which a student with disabilities is trained.

An educational organization is obliged to create in its collective a professional and social tolerant environment necessary for the formation of a civil, legal and professional position of complicity, the readiness of all members of the collective to communicate and cooperate, and the ability to tolerate social, personal and cultural differences.

For the implementation of personal, individualized social support for students with disabilities, it is advisable to introduce such a form of support as a volunteer movement among students. The volunteer movement not only contributes to the socialization of persons with disabilities, but also promotes the rest of the students towards them, develops integration processes among the youth, which will necessarily manifest from the positive side in the future in public life.

Taking into account the main trends of humanization, it is assumed that the student, his personal development and professional development should be in the center of the educational process. Special attention is paid to the autonomy of students, which refers to their ability to learn more productively, to take responsibility for the effectiveness of their studies during their time at the university, to acquire skills and abilities that allow for self-education and self-improvement after graduation. The independence of the student, his autonomy, manifested in the fact that a person is to a large extent his own teacher and is responsible for his teaching, is in itself a very important goal in teaching a foreign language.

The educational information digital educational milieu is an integral component of the information environment of the university, and is considered by us at the same time both as a means of learning and as a means of solving professionally oriented tasks.

It also includes global and local networks that provide students with access to important professional information. The use of computer telecommunications in the process of teaching technical translation allows students to provide authentic information materials reflecting the current state of foreign science and technology, as well as features of a foreign language at the current time.

One of the defining components that form the digital educational milieu is software. It is the software that determines which information technology can be used in solving educational problems [2].

In the classroom, one should use the software that is considered to be the most

relevant and accessible at the present time, since the main task of training is to form the student's readiness for professional activity in the modern information environment.

Training materials are also constituent elements of digital educational milieu in the foreign language classes. These include video films, videos, audio recordings, television, as well as various textbooks, lecture notes.

Students with disabilities, unlike other students, have their own specific features of perception, material processing. In this regard, the choice and development of training materials should be made taking into account the provision of this material in various forms so that people with hearing disabilities receive information visually, with visual impairments - audially (for example, using speech synthesizer programs) or using typhoid information devices.

In order to implement the procedures for monitoring performance and intermediate certification of students, the educational organization should create funds of assessment tools adapted for people with disabilities and allowing them to evaluate the achievement of the learning outcomes planned in the main educational program and the level of development of all competencies stated in the educational program.

Studies show that the system-holistic and communicative approaches in the formation of the professional readiness of persons with disabilities will be provided precisely in a digital educational milieu of teaching a foreign language, if a number of requirements are taken into account in the process of its creation [3].

The specifics of training people with disabilities in higher education should be combined with special, information-computer, as well as language training, taking into account the individual characteristics of students.

The professional orientation of the training will be ensured by the adequacy of the digital educational milieu of learning a foreign language to the professional environment of a specialist.

It is necessary to take into account a flexible response to changes in the social order of society for the preparation of a modern specialist, as well as the traditions of the professional training of a particular technical university.

Created on the basis of the implementation of these requirements a multimedia learning environment for teaching foreign languages to students with disabilities is able to ensure at a sufficient level of their professional readiness formation in the process of mastering a foreign language.

Analyzing the current state of vocational training of students with disabilities, we understood that there is practically no methodological system that ensures the formation of the professional readiness of students with disabilities in a digital educational milieu for teaching a foreign language. In such milieu organization, as a rule, there is no target component aimed at resolving issues related to the peculiarities of the formation of persons with disabilities readiness to professional activities in the modern information environment.

Our research and practice in a technical university showed that the effectiveness of vocational training for people with disabilities in the process of mastering technical



translation skills will be achieved if the system-holistic and communicative approach is implemented with its organization. The didactic tool for the formation of the professional readiness of technical universities graduates is the new information technologies [4].

The stable functioning of the educational structure is determined by the creation of a multi-level system of didactic conditions, each level of which determines the interaction of its components.

For the formation of specialist readiness to people with disabilities, it is necessary to create conditions for the effective organization of its training and cognitive activity in the process of learning a foreign language [4].

The system-holistic approach should provide professional orientation of the educational process through modeling and targeted organization of the process of forming foreign language knowledge of the student, professional adaptation in the context of educational and information professional-oriented learning environment, systematization of the selection of the content of teaching foreign language.

The organization of a digital educational milieu for teaching a foreign language, implementing a target component aimed at resolving issues related to the peculiarities of preparing people with disabilities for professional activities in the modern information environment, involves:

- systematic development of methodological principles for the organization of classes using information and computer technologies;
- environment focusing on the activation of educational activity of students with disabilities through the use of information technology tools.

The choice of the foreign language learning content should be based on the principles of scientific, professional orientation and systematic.

In the process of technical translation teaching, it is necessary to apply new organizational forms and methods using computer technologies, which contributes to the formation of skills for searching and processing professionally important information in the modern information environment.

Educational, methodical and programmed didactic support of the process of teaching a foreign language should include:

- creation a software corresponding to the content of teaching foreign language to people with disabilities and meeting psychological and pedagogical requirements, focused on solving pedagogical problems, as well as the availability of guidelines for their use in the educational process of a technical university;
- representing of modern software and hardware for the development of didactic materials and documents on the organization of the educational process, training management, the creation of training and monitoring programs;
- software flexibility and its adaptability to the individual characteristics of students with disabilities;
- compliance of the foreign language teaching methodology with the general strategy of the educational process.

Created on the implementation of these requirements, a digital educational milieu

for teaching foreign languages to people with disabilities is able to provide a high level of adaptability and professional readiness for such students.

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## Особенности цифровой образовательной среды обучения лиц с ОВЗ

О. Н. Морозова<sup>1</sup>, И. С. Разуваева<sup>2</sup>

<sup>1</sup>ФГБОУ ВО «Тамбовский государственный технический университет», Тамбов, Россия

<sup>2</sup>Муниципальное автономное общеобразовательное учреждение «СОШ №30»

*e-mail: <sup>1</sup>morozova-on@mail.ru, <sup>2</sup>razuvaevainna@rambler.ru*

**Аннотация.** В статье рассматривается проблема повышения образовательного потенциала студентов с ограниченными возможностями здоровья. Акцент делается на создание цифровой образовательной среды обучения, способствующей эффективной социальной адаптации студентов с инвалидностью к условиям вуза. Определяется система принципов, призванных обеспечить оптимальное включение таких студентов в среду вуза. Описываются компоненты, формирующие цифровую образовательную среду на занятиях по иностранному языку.

**Ключевые слова:** адаптация, иностранный язык, лица с ограниченными возможностями здоровья, цифровая образовательная среда, цифровой социум.

## Reflection as a Means of Forming Pre-Service Teachers' Professional Identity

A. A. Palina<sup>1</sup>, G. K. Tleuzhanova<sup>1</sup>, T. V. Mordovina<sup>2</sup>

<sup>1</sup>Buketov Karaganda University, Karaganda, Kazakhstan

<sup>2</sup>Tambov State Technical University, Tambov, Russia

*e-mail: <sup>1</sup>antossik\_anna@mail.ru*

### Abstract

The purpose of the article is to substantiate the effectiveness of reflection as a means of forming professional identity of pre-service teachers. The relevance of the study is reasoned by the contradiction between the society need for highly qualified teachers with achieved professional identity and reflective skills and the lack of methodological manuals. The authors of the article show the positive impact of reflective tasks and active discussions on the formation of students' professional identity.

**Keywords:** education, pre-service teacher, professional identity, reflection.

### Introduction

A teacher, likewise any other specialist, who does not have clear boundaries of his professional identity, will have to face problems in the process of entering the professional community that are caused by his inability to establish effective relationships, competently resolve conflicts, solve professional tasks, which thereby would cause intrapersonal conflicts that accumulate dissatisfaction with his social position [1]. Therefore, it is so important to have an achieved identity for successful self-realization.

The development of professional identity is facilitated by the acts of reflection about oneself, about one's professional behavior in the process of professional communication and professional activities, about one's professional values, beliefs and the ways to correct them, about one's professional goals and the ways to achieve them, about one's personal and professional qualities, perceiving oneself as if from the outside [2].

The ability of a person to critically comprehend his own Self and exercise control over his thoughts, feelings, and actions is reflective thinking which indicates the height of his mental activity.

The higher the level of reflection skills, the more objective a person's self-esteem and self-perception are. A high level of reflective thinking allows a person to improve in professional life, to achieve success, and to receive satisfaction from these. A low level of reflexive processes leads to choosing ineffective professional actions and communication strategies, to intrapersonal and interpersonal conflicts, dissatisfaction with oneself, environment and life, and, as a result, to nervous breakdowns.

For teachers the reflective skills are essential because in the process of educating personalities who are growing up and forming, a teacher needs to be able to set

professional goals, plan and organize the process of achieving these goals, critically think about problem situations, find a creative approach to solving them, adapt to changes, reconsider his own values and beliefs, find a way to transmit them to children, teach children all the mentioned above by personal example. And these skills indicate the achieved professional identity of a teacher.

### **Materials and methods**

In the course of the study, we used theoretical analysis of literary sources, generalization of existing scientific provisions, derivation and systematization of new knowledge, survey method, observation, experiment, and statistical analysis of the data obtained.

The statuses of students' professional identity were determined by means of a set of diagnostic tools:

- 1) the author's questionnaire for studying professional identity;
- 2) the methods for studying professional identity statuses (A.A. Azbel).

### **Research Results and Discussion**

The experimental base of our study was the language education research laboratory at the Faculty of Foreign Languages in Karaganda Buketov University (Karaganda, Kazakhstan). The experimental work was carried out with the 3<sup>rd</sup>- and 4<sup>th</sup>-year students getting Bachelor's degree in "Foreign Language: Two Foreign Languages", its purpose was to construct the professional identity of pre-service foreign language teachers. This work consisted of 4 stages and included the solution of many tasks which reflect the complexity and versatility of the mental phenomenon being formed and which require students' reflection skills:

1. *The stage of self-cognition:* developing reflection skills, developing students' awareness of their own abilities, skills, inclinations, needs, personality traits, professional goals, values, beliefs, claims, creating an ideal professional self-image, comparing other people's professional images with their own, developing a sense of identification with the profession;

2. *The stage of preparation:* creating a positive professional image, identifying and forming effective professional attitudes, acquiring professional theoretical and practical knowledge and skills, developing necessary personality traits, designing a professional self-development plan and searching for perspectives, creating a real professional self-image;

3. *The stage of research:* acquiring first professional experience, getting involved into professional activities, making students aware of themselves as prospective professionals, communicating with masters on professional topics, forming a range of professional contacts, searching for effective methods of carrying out activities, assimilating professional norms and complying with requirements, structuring the self-image as a professional;

4. *The stage of self-organization:* forming students' awareness of their professional self-sufficiency and effectiveness, developing a sense of responsibility,

developing a sense of identification with representatives of the profession, developing creative thinking for conducting professional activities, improving their pedagogical skills, developing an individual style of conducting professional activity, clarifying a professional career model, developing desire to share their experience with others.

To accomplish these tasks, students were offered lectures on professional identity and reflection, as well as a set of tasks we designed, which contributed not only to the formation of professional identity in its three components (cognitive, emotional and behavioral), but also to the development of three types of reflective skills (reflection on personality in the profession, reflection on professional activities, reflection on communication strategies) [2]. The experimental work was based on the discussion method. The teacher's role was to encourage students to actively participate both in acts of reflection and discussions [3].

This experimental work contributed to the increase in the share of students with the status of professional identity achievement by 2.3 times. Statistical analysis of the results using the paired Student t-test and the Wilcoxon signed rank test revealed the statistically significant changes in the professional identity statuses, and the indicators after the experiment exceed the values of the indicators before this work.

### **Conclusion**

Teacher's professional identity is the higher, the more thoroughly it is reflected by the teacher himself, since the depth and degree of awareness of his professional goals, values and beliefs, professionally important qualities, needs, abilities, etc. contribute to the creation of a more holistic professional self-image, increase of professional self-esteem, reduction of anxiety, development of greater thinking flexibility, awakening of creative freedom in implementing professional tasks, as well as to professional self-development. Thus, well-developed reflective skills provide the achievement of professional identity.

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## **Рефлексия как средство формирования профессиональной идентичности будущих учителей**

**А. А. Палина<sup>1</sup>, Г. К. Тлеужанова<sup>1</sup>, Т. В. Мордовина<sup>2</sup>**

<sup>1</sup>Карагандинский университет им. Е.А.Букетова, Караганда, Республика Казахстан

<sup>2</sup>Тамбовский государственный технический университет, Тамбов, Россия

*e-mail: <sup>1</sup>antossik\_anna@mail.ru*

**Аннотация:** Целью статьи является обоснование эффективности рефлексии как средства формирования профессиональной идентичности студентов. Актуальность исследования обосновывается противоречием между потребностью общества в высококвалифицированных педагогах, владеющих сформированной профессиональной идентичностью и рефлексивными навыками и дефицитом методических разработок. Авторами статьи показано позитивное влияние выполнения студентами рефлексивных заданий и активных дискуссий на формирование их профессиональной идентичности.

**Ключевые слова:** образование, педагог, профессиональная идентичность, рефлексия.

## Interpretation of Cultural Codes through Analysis of Internet Meme Paremias

**E. Yu. Voyakina**

Tambov State Technical University, Tambov, Russia  
*e-mail: voyackina.elena@yandex.ru*

### **Abstract**

The article analyzes Internet meme paremias from the point of their cultural specificity. Internet memes are considered as a form of thinking, a way of comprehending national identity and transmitting cultural knowledge from generation to generation. The study of Internet meme paremias allows expanding knowledge about the national and universal in linguistic cultures, the system of ethno-specific and general cultural values, as well as the pragmatic impact on the recipient in the framework of the formation of public opinion. The paper describes some cases confirming that for an adequate interpretation of the Internet meme, it is necessary to have a sufficient level of background knowledge about the source on which the meme is based. It has been established that on the basis of Internet meme paremias, the change in the value priorities of society can be traced.

**Keywords:** cultural code, evaluation, Internet meme paremia, interpretation, national specificity.

Knowledge about the surrounding reality, formed by representatives of different cultural communities, is reflected in the linguistic and linguocultural pictures of the world and contains ideas about stereotypes of human behavior, social structure, and value orientations of society. The centuries-old experience of mankind in the field of cognition and interpretation of the world is vividly reflected in the languages in the form of folk art, which includes a special layer of the language system consisting of stable phraseological units with a didactic orientation, namely, paremias.

The problems of paremiology have been the topics of numerous linguistic studies, however, in connection with the constant updating of the language, new questions arise and require scientific analysis and interpretation [1–6]. Since the language is a dynamic system, all its elements are subject to change. Adjusting to these changes, paremiological units are also transformed through acquiring new forms to describe and evaluate events and phenomena of the modern reality. At present, the folk word has moved to the world of the Internet, which gives rise to new forms of communication.

The similarity of an Internet meme with paremia is due to their ability to transmit cultural information from person to person, from generation to generation reflecting and evaluating typical life situations. The semantics of proverbs based on folk wisdom is a kind of repository of a person's ideas about the world and their relationships. According to Z.D. Popova and I.A. Sternin, the national picture of the world is found in the stereotypical behavior of the people in typical situations, in their general ideas about reality, general opinion, proverbs, sayings and aphorisms [5].

The same can be said about Internet memes that form a stereotypical idea of modern reality. With the help of Internet memes, a person conceptualizes his

knowledge about the surrounding reality and systematizes it in accordance with cultural characteristics, the national system of values and the linguistic consciousness of the nation. The system of images, entrenched in Internet memes, serves as the basis for accumulation of collective experience by representatives of a certain linguistic culture, while interpretation of memes allows expanding a person's knowledge about the world and forming a personal attitude to the described phenomena.

National mentality and national culture are unique. The high potential of Internet memes as a means of intercultural interaction is expressed in the fact that memes reflect both national and global cultural and information content. On the one hand, they embody the national specificity inherent in this particular culture; on the other hand, they contain universal elements based on the general cultural knowledge of generations in the field of religion, mythology, or folklore observed in any linguistic culture.

Ethno-specific realities may be misinterpreted or incomprehensible to speakers of other linguistic cultures. So, in Internet meme paremias based on contamination (or combining) of several proverbs, there is an additional cognitive load associated with deciphering the meme. In the following Russian meme paremias, one can trace the contamination of such proverbs as 'love is evil, love the goat' and 'to play a dirty trick on smb' (Fig. 1).



*Figure 1 - Internet meme based on contamination*

In order to adequately interpret an Internet meme, it is often necessary to have a sufficient level of erudition, background knowledge about the source on which the meme is based. For example, in the modern Runet, a popular meme is the Diogenes in a barrel meme. This meme is based on the knowledge of ancient philosophy, namely the name of the philosopher Diogenes, who preached asceticism, calling to get rid of everything superfluous. Diogenes built a dwelling for himself in a huge barrel – a pithos, used by the Greeks to store wine, olive oil, etc. The philosopher's desire for marginal behavior, refusal to follow dogmas created a kind of reputation for him for centuries. In modern psychiatry, there is even Diogenes syndrome defined as a mental disorder associated with self-neglect, social isolation, lack of shame, apathy, pathological hoarding, etc.



Based on the image of Diogenes, such proverbs as “hide like Diogenes in a pithos”, which means ‘hide from the world’, ‘isolate from society’, ‘be a sociopath’, are based. Internet users picked up this theme and developed it in a comical direction emphasizing the phenomenon of isolation in various areas of human activity (Fig. 2).



Figure 2 - Internet memes “Diogenes in a pithos”

Thus, in order to correctly decipher these Internet memes, it is necessary to have background knowledge about ancient philosophy, the philosopher Diogenes himself and his views on life.

Internet memes as translators of the cultural code, of course, contain an evaluative component that allows the authors of memes to influence their value orientations. Moreover, the axiological component of the meme, which is almost always presented implicitly, makes it possible to enhance the pragmatic effect, exercising a hidden influence on the views and opinions of the recipient in relation to the described situation.

Memes trace the change of value orientations which take place right now. In connection with the change of the informational occasion, new values are updated, and the old ones go through the stage of reassessment. Today, in the context of the political and economic conditions that have changed in 2022, the attitude to the old problems is also changing. Moreover, personal and collective experience plays an important role in the choice of signs of comparison, figurative or literal. The selection of signs of comparison is based on the anthropocentric principle, in which all phenomena of reality are viewed through the prism of human consciousness, being refracted and modified depending on cultural affiliation and value systems that dominate society in a certain period of historical development. Thus, the recent events on the political and economic arena in the world are constantly compared, and the attitude of users to the events taking place is revealed in Internet memes (Fig. 3).



*Figure 3 - Evaluation of the reality through comparison in Internet meme paremias*

Thus, Internet memes act as modern translators of the cultural code, since they contain a person's ideas about the world and relationships with it in the reflection of national culture. They embody both the national specificity inherent in a given culture and universal elements based on the general cultural knowledge in the field of religion, mythology, folklore observed in any linguistic culture. To correctly decipher an Internet meme, the recipient must have a sufficient level of erudition, background knowledge about the source on which the meme is based. Internet memes always contain an axiological component that allows expressing attitude towards the described situation, thereby forming value orientations and exercising an implicit pragmatic impact on the recipient. On the basis of Internet memes, the change in the value priorities of society can be traced, when new values are updated with a change in the informational occasion, and the old ones go through the stage of reassessment. Thus, Internet memes can be considered as a form of thinking, a way of comprehending national identity and transmitting cultural knowledge from generation to generation.

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## **Интерпретация культурных кодов посредством анализа интернет мемов-паремий**

**Е. Ю. Воякина**

ФГБОУ ВО «Тамбовский государственный технический университет», Тамбов, Россия  
*\*e-mail: voyackina.elena@yandex.ru*

**Аннотация.** В статье анализируются интернет мемы-паремии с точки зрения их культурной специфики. Интернет-мем рассматривается как форма мышления, способ постижения национальной идентичности и передачи культурных знаний из поколения в поколение. Изучение интернет мемов-паремий позволяет расширить знания о национальном и общечеловеческом в лингвокультурах, системе этноспецифических и общекультурных ценностей, а также прагматическом воздействии на реципиента в рамках формирования общественного мнения. Проанализированы случаи, подтверждающие, что для адекватной интерпретации интернет-мема необходимо иметь достаточный уровень фоновых знаний об источнике, на котором основан мем. Установлено, что на основе интернет мемов-паремий прослеживается изменение ценностных приоритетов общества.

**Ключевые слова:** культурный код, оценка, интернет мем-паремия, интерпретация, национальная специфика.

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## **Problems of Reforming the International Institute of Industrial Property Using the Example of an Invention**

**K. R. Amadanyan**

Tambov State Technical University, Tambov, Russia e-mail:  
*e-mail: Karen2000110@gmail.com*

### **Abstract**

Patent law is firmly entrenched in our life and is an integral part of it. The exaltation of something new into the world is certainly an indicator that a person as a species does not stand still. However, this is not the only advantage of innovation. Now the economy of the state, more than ever, depends on inventions. And in the international arena, where technology is developing so rapidly, patent law is an inseparable component of it. Does everything work as it should? Is the legislation in this area ideal? Of course, over the centuries of the existence of this institution, a lot has been corrected, however, with the change of time, there are more gaps in legislation that need to be eliminated.

**Keywords:** invention, innovation, Paris Convention of 1883, patent law, industrial property.

### **Introduction**

Modern society cannot do without such an important mechanism for protecting its inventions, industrial designs and rights to them, as patent law, which includes the object of our research – industrial property, in turn, part of which is the invention. Therefore, in the modern world, it is important to avoid gaps, collisions, inaccuracies, omissions that can negatively affect the competent and fair resolution of cases related to the protection of an invention as an object of industrial property. This is important both for domestic legislation and for the international legal arena. All these factors determine the relevance of the topic under study.

The purpose of this article is to study the institute of industrial property, define its basic concepts and identify problems related to the international legal protection of an invention as an object of industrial property for their solutions in the future.

Initially, in order to deal with the problems of the institute of industrial property, it is necessary to understand what is industrial property? To look at the question from the point of view of time. To look at the stages of the formation of this institution, which provoked its appearance. And only then to define industrial property and to understand the problems posed.

Science, education, industry the development of these areas has always been accompanied by theft. It's easier for people to steal something ready-made than to invent something new themselves. Of course, in order to prevent such cases and secure the rights to what a person consciously owns, the institute of patents was developed.

The entire development of the institute of patent law can be divided into three stages:

1) Privileges. This is the stage of the 15th-18th centuries. The characteristic of the

period was that the supreme ruler gave special rights to individuals.

2) National patents. This is the stage of 1790-1883. It is characterized by the fact that now any person who invented something could apply for a patent, but its issuance depended on various factors. Also characteristic of this period is that the patent that was made in the country was not distributed abroad.

3) Internationalization. This is the stage from 1883 to the present day. This period has become a key one in the development of patent law at the international level. In 1883, the Paris Convention for the Protection of Industrial Property was adopted. Over the years of its existence, it has been revised and supplemented more than once.

Consider the definition of "industrial property". The broad meaning of this concept is enshrined in Article 1 of the Paris Convention of 1883 and includes industry, all products of industrial or natural origin, agricultural production, as well as trade. However, if we consider the domestic definition, it is somewhat different. National legislation defines industrial property as subjective rights to innovations that have been created as a result of intellectual creative activity, mostly in the technical field (inventions, industrial design, and trademarks). Industrial property rights do not restrict the legal exchange of technologies. They stimulate scientific and technological progress, supporting the state's economy at the proper level.

Having dealt with the definition of "industrial property", it's time to move on to the definition of one of its objects, namely "inventions". The invention is a technical solution in any field that relates to a product or method (the process of performing actions on a material object with the help of material means — Article 1350 of the Civil Code of the Russian Federation). The invention is immaterial, however, it is perceived by society as an object of the material world, since they see it after its embodiment into reality.

The invention must comply with a number of mandatory features that are prescribed in the Civil Code of the Russian Federation. Namely:

- novelty;
- inventive level;
- industrial applicability.

Only if all three features are present, the invention can be such and be patentable.

But what can be done if some objects in the international arena are recognized as non-patentable? As an example, one can cite computer programs that are non-patentable. Writing a program is the same creative process as writing a picture or poetry. However, there is no guarantee that after you have written a program, it will not be duplicated by someone else. In this situation, the difficulty arises precisely with the evidence base. Sometimes the original and the copy are identical and it is impossible or very difficult to distinguish them, and the attacker who stole the code of our program will simply say that he wrote it himself, and your identity with his program is an accident. Consequently, there are many unnecessary difficulties. Yes, of course the situation is not hopeless. However, to prove to the court that we had the code earlier than the thief, it may be problematic. What to do? Are there really no better protection options? Yes, of course there is. You can patent the algorithm of the

program, because it is already an invention, you can patent the hardware and software complex or interface design. That is, there is always a way out, of course, but for a more reliable and quick solution to this problem, it would be much easier to amend the legislation and, at least as an exception, include in the list of things that can be patented programs. Programs are far from the only problem that people face in life. There are a lot of things in the 21st century that are subject to adjustment. Legislation should keep up with the times and reflect reality, since reality itself requires the normative consolidation of all innovations in life.

### **Conclusion**

Thus, we can conclude that the institute of patent law went through several stages of formation before we saw it as it is now. For the period of 2022, technologies do not stand still, as always, so we believe that in order to improve the protection of inventions, legislation should be updated more often so that it meets modern trends.

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## **Проблемы реформирования международного института промышленной собственности на примере изобретения**

**К. Р. Амаданян**

ФГБОУ ВО «Тамбовский государственный технический университет», Тамбов, Россия  
*e-mail: Karen2000110@gmail.com*

**Аннотация.** Патентное право прочно закрепилось в нашей жизни и является неотъемлемой её частью. Превознесение в мир, чего-то нового, безусловно является показателем того, что человек как вид не стоит на месте. Однако это не единственный плюс новшеств. Сейчас экономика государства, как-никогда зависит от изобретений. И на международной арене, где так бурно развиваются технологии, патентное право является её неразрывной составляющей. Всё ли работает так как надо? Идеально ли законодательство в этой сфере? Безусловно, за века существования, данного института, было исправлено многое, однако, с изменением времени, появляется и больше пробелов в законодательстве, которые подлежат устранению.

**Ключевые слова:** изобретение, новшество, Парижская конвенция 1883 г., патентное право, промышленная собственность.

## **Liberales und repressives Strategien zur Bekämpfung des Drogenhandels**

**S. A. Jurin**

Tambow Staatliche Technische Universität, Tambow, Russland

*e-mail: yurin-stas00@mail.ru*

### **Zusammenfassung**

Der Artikel ist der Analyse der Umsetzung der liberalen und repressiven Strategie zur Bekämpfung des Drogenhandels gewidmet. In diesem Artikel diskutiert man die Ursachen der Entstehung und Ausbreitung der Drogenabhängigkeit als Phänomen, man untersucht die Erfahrungen des Auslands bei der Anwendung liberaler und repressiver Strategien.

**Schlüsselwörter:** die Drogenabhängigkeit, die Süchtigkeit, der Drogenhandel, die liberale Strategie, die repressive Strategie, die Kriminalität, der biologische Faktor, der psychologische Faktor, der soziale Faktor.

Die Zahl der Menschen, die Betäubungsmittel und Psychopharmaka konsumieren, wächst täglich. Auch im Drogenhandel ist ein weltweiter Aufwärtstrend zu verzeichnen. Das Ausmaß und die Geschwindigkeit der Ausbreitung der Drogenabhängigkeit sind erstaunlich und bedrohen die Gesundheit und das Wohlergehen der jüngeren Generation. Sie tragen zur Zunahme der Kriminalität bei und destabilisieren die Gesellschaft. In der juristischen Literatur wird zu Recht darauf hingewiesen, dass eines der wesentlichen Probleme, von dessen Lösung die Zukunft der Menschheit abhängt, die Bekämpfung des Drogenhandels ist [1].

Die Faktoren, die die Entstehung und Ausbreitung von Drogenabhängigkeit beeinflussen, werden üblicherweise in biologische, psychologische und soziale Faktoren unterteilt.

Es ist wissenschaftlich erwiesen, dass das Risiko, eine Drogen- oder Alkoholabhängigkeit zu entwickeln, bei Menschen, deren Eltern an einer dieser Abhängigkeiten leiden oder litten, um ein Vielfaches höher ist als bei Menschen, deren Eltern keine solchen schädlichen Abhängigkeiten hatten. Dies ist eine Demonstration des Einflusses des biologischen Faktors.

Der psychologische Faktor bei der Entstehung und Ausbreitung von Drogenabhängigkeit umfasst individuelle Charakter- und Persönlichkeitsmerkmale, die zum Beginn und Fortbestehen des Drogenkonsums beitragen, sowie eine Reihe von psychiatrischen Erkrankungen und psychopathologischen Zuständen.

Die Gruppe von Gründen, die mit Charakter- und Persönlichkeitsmerkmalen verbunden sind, umfasst:

geringes Selbstwertgefühl, mangelnde Fähigkeit, seine Aggressionen gut auszudrücken, Gefühl sozialer Unsicherheit, geringe emotionale Intelligenz, Unfähigkeit, angemessene, ausgewogene Entscheidungen zu treffen und Verantwortung dafür zu tragen, mangelnde innere Unterstützung, schlecht entwickelte Kommunikationsfähigkeiten, Fehlen oder Fehlen neuer Interessen und Hobbys,

lebendige Eindrücke.

Das Vorliegen psychiatrischer Erkrankungen und psychopathologischer Zustände hat einen erheblichen Einfluss auf das abweichende Verhalten von Kindern und Jugendlichen, begleitet vom Konsum von Betäubungsmitteln und psychotropen Substanzen. Sie sollten nicht denken, dass die Anzahl der Menschen, die an solchen Krankheiten leiden, gering ist und die Rolle dieser Krankheiten bei der Einnahme von Medikamenten unbedeutend ist. Im Jahr 2019 litt laut Statistik jeder achte Mensch auf der Erde an einer psychischen Störung [2]. Im Jahr 2020, inmitten der COVID-19-Pandemie, hat die Zahl der Menschen, die an Angstzuständen und depressiven Störungen leiden, deutlich zugenommen. Nach vorläufigen Schätzungen stieg die Prävalenz von Angstzuständen und schweren depressiven Störungen in nur einem Jahr um 26 % bzw. 28 % [3].

Die Rolle sozialer Faktoren sollte nicht unterschätzt werden, wenn es um die Ursachen der Entstehung und Ausbreitung von Drogenabhängigkeit geht. Der Rückgang des Lebensstandards der Mehrheit der Bevölkerung, Arbeitslosigkeit, ungünstige Atmosphäre in der Familie und anderen kleinen sozialen Gruppen, Missachtung der Standards von Ethik und Moral.

Es ist erwähnenswert, dass sich die instabile wirtschaftliche und politische Situation, die sich derzeit auf der Weltbühne entwickelt, negativ auf das Wohlbefinden der Bürger, das Gefühl der sozialen Sicherheit und die psychische Gesundheit der Menschen auswirkt. Es ist wahrscheinlich, dass dies einige Konsequenzen haben und möglicherweise das Ausmaß der Verbreitung schädlicher Abhängigkeiten wie Drogenabhängigkeit und Alkoholismus erhöhen wird.

Die Ursachen für die Entstehung und Verbreitung von Drogenabhängigkeit sind in den meisten Ländern recht ähnlich. Die Strategien zur Bekämpfung des illegalen Drogenhandels weisen jedoch eine Reihe deutlicher Unterschiede auf.

Alle Strategien, die von verschiedenen Staaten verfolgt werden, können einigermmaßen konventionell in liberale und repressive unterteilt werden.

Libérale Strategien zur Bekämpfung des Drogenhandels und der Zunahme der Drogenkriminalität basieren auf den Ideen der Menschenrechte und der individuellen Freiheit. In Ländern, die eine liberale Strategie verfolgen, gibt es eine Politik der teilweisen Legalisierung oder Entkriminalisierung bestimmter Drogen. Solche Maßnahmen werden häufig mit Programmen zur „Schadensminderung“ für den Konsum illegaler Drogen zusammen mit der Anwendung von Substitutionstherapien kombiniert. Das liberale System zur Bekämpfung des Drogenhandels sieht eine Zwangs- oder Alternativbehandlung für Drogenabhängige sowie strenge verwaltungs- und strafrechtliche Sanktionen gegen Täter vor.

Ein bekanntes und markantes Beispiel für die Anwendung einer liberalen Strategie sind die Niederlande. In den Niederlanden wird ein aktiver Kampf gegen starke Betäubungsmittel und psychotrope Substanzen geführt, und die sogenannten „weichen“ Drogen auf Cannabisbasis wurden legalisiert. Auch Länder wie die Schweiz, Australien und einige US-Bundesstaaten haben tatsächlich den Weg der Drogenentkriminalisierung eingeschlagen.



Die liberale Strategie zur Bekämpfung des Drogenhandels hat den Auftrag, die drogenbedingte Sterblichkeit und Morbidität zu verringern und die Nachfrage nach Behandlungen der Drogenabhängigkeit zu erhöhen. Das ist definitiv ein positives Ergebnis. Zu den Nachteilen der liberalen Strategie gehört jedoch gleichzeitig die Zunahme der Zahl der drogenabhängigen Minderjährigen, und nach Ansicht einiger Wissenschaftler trägt die liberale Strategie nicht nur zur Bildung einer toleranten Einstellung in der Gesellschaft bei Drogenabhängige, sondern auch zum Thema Drogen im Allgemeinen.

Das Gegenteil einer liberalen Strategie ist eine repressive Strategie. Die Repressionsstrategie ist durch eine Reihe von Methoden gekennzeichnet, die hauptsächlich den Verkauf, Besitz und Gebrauch von Betäubungsmitteln und Psychopharmaka strafrechtlich verfolgen. Ziel der repressiven Strategie ist es, den Drogenhandel und das Ausmaß des Drogenmissbrauchs im Land durch den Einsatz strafrechtlicher Maßnahmen sowie die Herausbildung einer stark negativen Einstellung der Gesellschaft gegenüber Suchtstoffen und damit verbundenen Straftaten deutlich zu reduzieren. Der ideologische Teil der repressiven Strategie ist die Vorstellung, dass Personen, die Betäubungsmittel und Psychopharmaka konsumieren, eine Gefahr für die Gesellschaft darstellen und dass der Einsatz medizinischer Maßnahmen gegen sie, selbst wenn sie Zwangscharakter haben, völlig wirkungslos und ungerechtfertigt ist.

Die repressive Strategie wird in China aktiv eingesetzt.

In der Mitte des 20. Jahrhunderts konsumierten mehr als 5 % der Bevölkerung Opium in China. Nach der Gründung der VR China ergriff die Regierung eine Reihe repressiver Maßnahmen, darunter Zwangsarbeit und die Todesstrafe. Gleichzeitig wurde eine vollständige und strenge Kontrolle über die Herstellung und Verwendung von Opium eingeführt. So begann die Ära des Einsatzes repressiver Strategien in China, und es ist erwähnenswert, dass sie bis heute andauert. Zum jetzigen Zeitpunkt bleibt die Position der chinesischen Behörden streng. Sie stehen für die Härte und Unausweichlichkeit der Bestrafung für diejenigen, die gegen das Gesetz verstoßen und ihr Leben auf die eine oder andere Weise mit Betäubungsmitteln in Verbindung gebracht haben. Es ist erwähnenswert, dass in der Volksrepublik China die Todesstrafe in diesem historischen Stadium häufiger verhängt wird als in jedem anderen Land. Nach Ansicht einiger Wissenschaftler ist eine solche Strategie nicht ganz gerechtfertigt, da Kriminologen seit langem bewiesen haben, dass die Verschärfung der strafrechtlichen Bestrafung nicht zu einem Rückgang der Kriminalität beiträgt [4].

Aus den Erfahrungen mit der Anwendung einer repressiven Strategie zur Bekämpfung des Drogenhandels kann geschlossen werden, dass eine solche Strategie wirksam ist, wenn die Zunahme der Drogenabhängigkeit in einer Gesellschaft stark ansteigt. Zum Beispiel ereignete sich in Japan nach dem Zweiten Weltkrieg ein ähnlicher Sprung. Es gab einen Ausbruch der Amphetaminsucht, der das Land zehn Jahre lang heimsuchte. Um die sich abzeichnende Katastrophe zu verhindern, verschärfte die japanische Regierung die Drogengesetze, wodurch laut Experten die Mehrheit der Drogenkonsumenten den Konsum von Amphetamin einstellte, weil sie die Unvermeidbarkeit einer strafrechtlichen Bestrafung befürchteten.

Trotz der Effektivität dieser Strategie in bestimmten Krisensituationen weist sie jedoch auch eine Reihe erheblicher Nachteile auf.

Dazu gehört die Wahrnehmung des Süchtigen ausschließlich als Krimineller. Die Tatsache, dass es sich um eine kranke Person handelt, die Behandlung und Resozialisierung benötigt, scheint aus dem Blickfeld der Öffentlichkeit und der Regierung zu verschwinden. Ein weiterer Nachteil ist die Verlagerung der Aufmerksamkeit von den Ursachen der Entstehung und Ausbreitung der Drogenabhängigkeit hin zu den Folgen, also den Straftaten im Bereich des illegalen Handels mit Suchtstoffen und psychotropen Stoffen.

Nachdem wir die Erfahrungen anderer Länder bei der Anwendung sowohl liberaler als auch repressiver Strategien studiert haben, können wir zu dem Schluss kommen, dass jede dieser Strategien ihre Vor- und Nachteile hat. Dieser Artikel listet nur einige davon auf. Abschließend möchte ich sagen, dass zuallererst tiefgreifende wirtschaftliche und soziale Probleme angegangen werden müssen, die in der Gesellschaft gedeihen und einen fruchtbaren Boden für die Entstehung und Ausbreitung der Drogenabhängigkeit darstellen.

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### **Либеральная и репрессивная стратегии по борьбе с незаконным оборотом наркотиков**

**С. А. Юрин**

ФГБОУ ВО «Тамбовский государственный технический университет», Тамбов, Россия  
*e-mail: yurin-stas00@mail.ru*

**Аннотация.** Статья посвящена анализу реализации либеральной и репрессивной стратегии противодействия незаконному обороту наркотиков. В настоящей статье рассмотрены причины возникновения и распространения наркомании как явления, изучен опыт зарубежных стран по применению либеральной и репрессивной стратегии.

**Ключевые слова:** наркомания, наркозависимость, незаконный оборот наркотиков, либеральная стратегия, репрессивная стратегия, преступность, биологический фактор, психологический фактор, социальный фактор.

## **Assessment of Economic Risks in the IT Services Market through the Example of the Computer Club “Skill”**

**D.I. Konyakhin, R.V. Zharikov**

Tambov State Technical University, Tambov, Russia  
*konyakhindenis4@gmail.com*

### **Abstract**

Nowadays, many people use IT services to one degree or another. In this regard, there are plenty of economic risks associated with the imperfections of this technology. This article focuses on some economic risks and proposes methods for their solution. The relevance of this article is explained by the fact that all people using computers or other means of communication (phones, tablets, etc.) can be exposed to data. It is worth noting the increasing cases of fraud on the Internet. However, in a computer club, these risks increase as people leave their data on different computers. Investment risks will also be studied.

**Keywords:** IT-services; economic risks; fraud; computers; investment risks.

### **Introduction**

A common area of study is the IT services market. Information technology is a wide class of disciplines and fields of activity related to technologies for managing and processing data, including the use of information technology.

Currently, information technology is most often understood as computer technology. In particular, IT deals with the use of computers and software to store, transform, protect, process, transmit and receive information. IT covers various areas of activity of both business and ordinary citizens. One such area is Internet cafes.

The first online cafe appeared in Seoul in 1988 and consisted of only two 16-bit computers connected to the network. Today, there are Internet clubs of various formats all over the world; and if earlier they were places where you could check your email or print a document, now they are the centers of the multi-million dollar sports industry. In this article, IT services will be studied through the example of the Internet cafe "Skill".

A number of researchers studied key IT risks facing the technology as a whole, estimated the operating costs of IT services, and also announced the volume of the computer clubs market in money and audience [1,2,3]. Although much attention has been given to cybercrime [4], the problem of data breach in Internet cafes remains unsolved. Data breach is an incident where information is stolen or taken from a system without the knowledge or permission of the system owner. A small company or a large organization can suffer from data breach. The stolen data may include sensitive, proprietary, or confidential information such as credit card numbers, customer data, trade secrets, or national security issues.

The majority of data breach crimes are due to hacker attacks or malware attacks. Other frequently observed hacking methods include the following:

*Insider Leak:* A trusted person or authorized person with access rights steals data.  
*Payment card fraud:* payment card data is stolen using physical skimming devices.  
*Lost or Theft:* Portable drives, laptops, office computers, files, and other physical assets are lost or stolen.  
*Unintentional Disclosure:* Due to error or negligence, sensitive data is disclosed.  
*Unknown:* In a small number of cases, the actual hacking method is unknown or not disclosed [3, 4].

Data breach laws vary by country or region. Many countries still do not require organizations to notify the authorities in the event of a data breach. In countries such as the United States, Canada, and France, organizations are required to notify affected individuals of a data breach under certain conditions.

The purpose of this research is to study what risks a visitor to an Internet cafe may face and how to prevent or eliminate those risks.

The study was conducted using the following methods: communication with clients and employees of the computer club "Skill", the analysis of their opinions and personal study of the security system of this club.

### **Materials and methods**

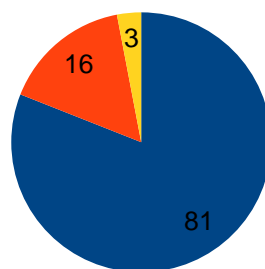
The research was based on a survey of 32 visitors to the computer club, who were interviewed on the following questions:

1. How much do you trust the security system of this institution?
2. Have you ever left your data on the computer?
3. Have you ever faced fraud in this club? If yes, please specify.
4. What is the best way to prevent fraud and theft of personal data?

Customer portfolio. It should be noted that the average age of the respondents is approximately 25 years. They go to this Internet cafe about 4 times a week throughout the year.

### **Results and discussion**

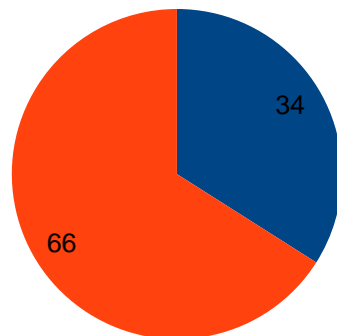
Overall, the survey participants are quite happy with the security system the company is currently using. As can be seen from Fig.1, the majority of the respondents (81%) believe that the security system is quite reliable, while the rest have little or no confidence in it (16% and 3%, respectively). Obviously, this shows that visitors generally trust this computer club.



*Figure 1 – Visitors' attitude to the security system (%)*

- average of reliable;
- average of quite reliable;
- average of unreliable;

Most users admitted forgetting to log out of the personal accounts on completion of the session (95%). Thus their personal data remained on computers and was available to other visitors. However, only 3% experienced any data security problems. In other cases, the administrators of this Internet cafe manually exited the personal accounts of visitors, preventing possible cases of data fraud.



*Figure 2 - Number of people who have been scammed (%)*

Visitors mentioned different types of fraud. Someone left their account details, after which the attackers deducted money from their cards. Someone left data from their social networks, after which other visitors could write to their friends or relatives, laugh at them or ask to transfer money to a specific account owned by the attackers. As can be seen from Fig. 2, 66% of those surveyed have never experienced cases of fraud in the club, even if they forgot to log out of their personal accounts.

As far as ways of preventing data breach are concerned, users' proposals varied:

- introducing two-factor authentication for every action that requires the input of personal data;
- complete blocking of all actions that require the input of personal data;
- creating an application that monitors suspicious activity from your accounts and informs you about it.

Summing up the results of the survey, the vast majority of the respondents have never experienced fraud or other illegal actions against them when using the services of this Internet cafe.

### **Conclusion**

To sum up, IT security is an important problem of modern society. The research showed that the security system of the Internet café under study is quite reliable. Less than a half of the respondents experienced fraud or other problems in this Internet club.

Based on the results of the survey, a solution to the problem of personal data leakage and fraud was proposed.

### **Acknowledgements**

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## **Оценка экономических рисков в ИТ-сфере на примере компьютерного клуба «Skill»**

**Д.И. Коняхин, Р.В. Жариков**

ФГБОУ ВО «Тамбовский государственный технический университет», Тамбов, Россия  
*konyakhindenis4@gmail.com*

**Аннотация.** В настоящее время много людей пользуется ИТ услугами в той или иной степени. В связи с этим возникает большое количество экономических рисков, связанных с несовершенствами технологий. В данной статье будут изучены некоторые экономические риски и предложены методы их решения. Актуальность данной статьи объясняется тем, что данным могут подвергнуться все люди, использующие компьютеры или другие средства коммуникации (телефоны, планшеты и т. д.). Стоит отметить участвовавшие случаи мошенничества в интернете. Однако в компьютерном клубе эти риски увеличиваются, так как люди оставляют свои данные на разных компьютерах. Также будут изучены инвестиционные риски.

**Ключевые слова:** ИТ-услуги; экономические риски; мошенничество; компьютеры; инвестиционные риски.

## **Kommunikationsunterstützung für einen russischen Agrarproduzenten auf dem Markt**

**M. D. Kudrina**

Tambow Staatliche Technische Universität, Tambow, Russland  
*e-mail: lady.cudrina@yandex.ru*

### **Zusammenfassung**

Es sind die Rolle und der Platz des agroindustriellen Komplexes unter modernen Marktbedingungen betrachtet. Es ist die Bedeutung der Kommunikationstechnologien für die Förderung von Organisationen und Produkten des Agrarsektors, die Bildung und Verbesserung ihres Images aufgezeigt, die untrennbar mit ihrer Erlangung einer positiven Reputation und damit einer stabilen Position im Wettbewerbsumfeld verbunden sind.

**Schlüsselwörter:** Image, Landwirtschaft, Kommunikationstechnologien, Promotion.

### **Einleitung**

Gegenwärtig entwickelt sich der russische agroindustrielle Komplex zu einem Schlüsselsektor der Volkswirtschaft, von dem die wirtschaftliche Sicherheit des Landes angesichts wirtschaftlicher und politischer Risiken abhängt.

Die Relevanz des Themas dieser Studie wird durch die Rolle des agroindustriellen Sektors bei der Entwicklung der heimischen Wirtschaft insgesamt und dementsprechend durch seinen Beitrag zum Wachstum des Wohlstands des Landes und seiner Bevölkerung bestimmt. Die russische Landwirtschaft ist eine der größten der Welt. Die russischen Exporte von Agrarprodukten im Jahr 2020 stellten einen Rekord in der modernen Geschichte auf. Damals belieferte Russland andere Länder mit 79 Millionen Tonnen Agrarprodukten und Lebensmitteln im Wert von 30,7 Milliarden US-Dollar, was sowohl monetär als auch physisch 20% mehr ist als in den Vorjahren. Exportorientiert, vor allem in befreundete Länder, wick die heimische Landwirtschaft auf dem heimischen Markt in vielerlei Hinsicht einem ausländischen Anbieter. Importiert werden nicht nur "exotische" Produkte, die unter russischen Bedingungen nicht angebaut werden können, sondern auch vieles, was wir selbst im Überfluss haben.

Die Verkomplizierung der Beziehungen zwischen der Russischen Föderation und den EU-Ländern, die Einführung von Wirtschaftssanktionen, die Abwertung des Rubels und das Wachstum des Wechselkurses führten zu einem starken Rückgang der Einfuhr von Agrarprodukten aus den EU-Mitgliedstaaten. In diesem Zusammenhang ist die Notwendigkeit gestiegen, um das Land mit eigenen Nahrungsmitteln zu versorgen. Es stellte sich heraus, dass bei aller Redundanz russischer Ressourcen die Gesamtentwicklung der Agrarindustrie eine ernsthafte Umstrukturierung erfordert, und dies betrifft in erster Linie ihr Image in den Augen des russischen Verbrauchers, der seit vielen Jahren an importierte Waren gewöhnt ist. Um das Vertrauen in heimische Agrarprodukte zu stärken, die meist qualitativ wirklich besser sind als importierte, bedarf es der kompetenten Arbeit von Spezialisten auf dem Gebiet der

Kommunikationstechnologien. Es ist auch notwendig, dass Organisationen unmittelbare Probleme lösen: dem Wettbewerb standhalten, den Grundstein für die weitere Entwicklung legen.

Unter modernen Bedingungen wird der Wettbewerb zwischen landwirtschaftlichen Erzeugern vor allem auf der Ebene ihres Images ausgetragen. Das Image erhält einen besonderen Wert und gilt als eines der wichtigsten strategischen Assets, das es uns ermöglicht, die Krise mit den geringsten Verlusten zu überstehen. Eine wichtige Rolle spielt auch die Reputation, die eine organische Verbindung zum Image eingeht. Leider haben landwirtschaftliche Betriebe Besonderheiten, die ihre Beliebtheit bei Kommunikationsspezialisten erschweren. In der Informationsgesellschaft hat sich ein Klischee entwickelt, der Agrarsektor sei gegenüber dem Dienstleistungssektor oder gar der Industrie zweitrangig, als eine Art Symbol eines „früheren Lebens“. Daher bleibt es trotz des hohen Wettbewerbs auf dem Agrarmarkt, der auf die Bedeutung von Image und Reputation für jedes Unternehmen in der Branche hinweist, problematisch, qualifizierte Fachkräfte für das Dorf zu gewinnen. Es gibt andere Risiken: Arbeiten mit lebenden Organismen, direkte Abhängigkeit von klimatischen Bedingungen usw.

Das schwierige wirtschaftliche Umfeld zwingt viele Organisationen, den Gürtel enger zu schnallen, und nicht jeder ist bereit, Geld für so ein immaterielles Gut wie Reputation und Image auszugeben. Nicht jedem ist klar, dass in einer Krise als erstes das Image verteidigt werden muss, denn die Wiederherstellung eines beschädigten Rufs ist viel schwieriger als materielle Ressourcen. Es ist bezeichnend, dass das Wort "Krise" im Chinesischen selbst aus zwei Hieroglyphen besteht, von denen eine "Gefahr" bedeutet, die andere - "Chancen". Eine dieser Möglichkeiten ist die Stärkung des Ansehens der Organisation, was durch eine kompetente Formung und Förderung ihrer Position in verschiedenen Zielgruppen möglich wird. Das geförderte Image der Organisation muss die Unterstützung von Menschen in einer schwierigen wirtschaftlichen Situation demonstrieren, die oft in den Hintergrund tritt.

Natürlich können nur Organisationen, die mit ihren eigenen Endprodukten auf den Markt gehen und die Möglichkeit haben, alle Werbeinstrumente zu nutzen, ein effektives Image aufzubauen. Die Entwicklung der Zusammenarbeit und der agroindustriellen Integration wird dazu beitragen, die Liste dieser Produzenten erheblich zu erweitern.

Unter den Unternehmen, die im heimischen Bereich der Agrarindustrie tätig sind, sind heute die führenden Unternehmen in der Imagebildung (die sich direkt auf ihren Markterfolg auswirken): die Sodruzhestvo-Unternehmensgruppe (Gebiet Kaliningrad), die ölhaltige Pflanzen verarbeitet; EFKO-Unternehmensgruppe (Region Woronesch), die sich auf die Herstellung von pflanzlichen raffinierten Ölen und Fetten, Eiprodukten und Lebensmittelzutaten spezialisiert; GC "Rusagro" (Moskau) - Produktion von Zucker, Schweinefleisch, Öl- und Fettprodukten, Anbau von landwirtschaftlichen Kulturen; der Moskauer landwirtschaftliche Betrieb „Miratorg“ mit breitem Profil, spezialisiert auf Viehzucht, Pflanzenbau, Verarbeitung, Einzelhandel und Futtermittelproduktion. Ihnen folgt eine Vielzahl anderer Unternehmen; Marktleistungsbewertungen werden periodisch auf verschiedenen



Plattformen veröffentlicht und sind öffentlich zugänglich, Änderungen werden darin aufgezeichnet, was den Schluss zulässt, dass sich dieses Umfeld in ständiger Entwicklung befindet. Ein wesentlicher Erfolgsfaktor führender Unternehmen ist neben ihren Produktions- und Marketingaktivitäten die Kommunikationspolitik, die darauf abzielt, den Zielgruppen der Öffentlichkeit ein ganzheitliches Bild von Organisationen zu vermitteln.

Kommunikation ist ein notwendiges Werkzeug für den Aufbau eines erfolgreichen Geschäfts in jedem Markt, einschließlich des agroindustriellen Komplexes. Für Landwirte ist es von entscheidender Bedeutung, mit vielen Behörden gleichzeitig ein hohes Maß an Kommunikation aufrechtzuerhalten. Gleichzeitig weiß nicht jeder, wie man mit Informationen umgeht – nicht nur reden, sondern auch vorhersagen, analysieren, formatieren, überwachen und auch Informationen produzieren. Wer also glaubt, bei der Gewinnung von Fachkräften im Bereich Werbung und Öffentlichkeitsarbeit Geld sparen zu können, der ist kurzsichtig. Denn auch hier ist die Kommunikation mit Vermietern (Aktionären), mit Geschäftspartnern, mit Wettbewerbern, mit Investoren und mit Regierungsvertretern wichtig. Dementsprechend sollten auch tägliche Nachrichten über die Aktivitäten des Unternehmens in unterschiedlichen „Tonarten“ präsentiert werden, wobei die Eigenschaften des jeweiligen Empfängers berücksichtigt werden.

In der Landwirtschaft sind Ausstellungen und Messen ein umfassendes Kommunikationsinstrument, das sich sowohl an Verbraucher als auch an Wiederverkäufer und Geschäftspartner richtet und alle Formen der Verkaufsförderung (Werbung, Verkaufsförderung, persönlicher Verkauf und Öffentlichkeitsarbeit) umfasst. Sie ermöglichen es Ihnen, der Zielgruppe das „Produktgesicht“ direkt zu zeigen. Ausstellungen finden in der Regel gleichzeitig statt, Messen - regelmäßig, aber beide Arten von Veranstaltungen haben viel gemeinsam und ein Ziel - den Verkauf von Produkten anzukurbeln und das Image des Herstellers zu optimieren.

Der moderne Agrarbetrieb zeichnet sich vor allem durch zwei Merkmale aus: Saisonalität (Sommer- und Winter- sowie Ganzjahresrichtungen) und eine sehr große Produktvielfalt. Werbung für alle Dienstleistungen ist ein ziemlich kostspieliges Geschäft, daher ist es erwähnenswert, dass es sinnvoll ist, ganzjährige Reiseziele durch SEO zu bewerben, relativ hohe Kosten nur zu Beginn der Arbeit. Ganzjahresprodukte sind stabil, mit dem Saisonwechsel ändern sich in der Regel nur die Preise. Daher ist SEO als Promotion mit „langfristiger“ Wirkung großartig für sie.

In den letzten Jahren ist mit der Zunahme der Verbindungsgeschwindigkeit und der Popularität von Videoplattformen ein neues Werbeformat entstanden – Videowerbung. Youtube ist der größte Video-Werbedienst im Internet, er hostet den Großteil der Werbung von landwirtschaftlichen Erzeugern.

Bis heute gibt es mehrere Arten von Online-Werbung auf der Website.

- 1) Werbung vor Videos (Pre-Roll).
- 2) Werbung über Videos (Teaser).
- 3) Werbung im Fenster vor dem Start des Videos.
- 4) Werbung im Fenster nach den Videos.

So werden verschiedene Videos von echten Menschen und Fans von Bloggern angesehen. Dadurch ist es möglich, die Meinung über die beworbene Dienstleistung psychologisch zu beeinflussen und das im Geschäftsleben wichtige Vertrauen zu steigern.

SMM (Social Media Marketing) ist Werbung in sozialen Medien, die darauf abzielt, ein breites Publikum über soziale Netzwerke anzuziehen. Das Publikum sozialer Netzwerke hat Millionen von Nutzern auf der ganzen Welt, was es ermöglicht, direkt mit dem Publikum zu kommunizieren. Die Registrierung in allen sozialen Netzwerken ist sowohl zeitlich als auch finanziell eine ziemlich kostspielige Angelegenheit, insbesondere wenn ein Unternehmen einen Spezialisten einstellt, der nicht nur ein Fachmann auf dem Gebiet der Kommunikationstechnologien sein muss, sondern auch die Besonderheiten der Arbeit der Organisation kennen muss. Vor der Entscheidung, wo eine Unternehmensseite registriert werden soll, müssen die Zielgruppe, die Merkmale und die Zusammensetzung der Zielgruppe bestimmter sozialer Netzwerke bestimmt werden - das Durchschnittsalter, der Wohnort, die Interessen und die berufliche Zugehörigkeit ihrer Benutzer: Das ist bekannt Das Publikum ist in verschiedenen sozialen Netzwerken unterschiedlich. Ein wichtiges Merkmal der Nutzung des Netzwerks ist seine Vielseitigkeit, die ein wirksames Instrument zur Förderung landwirtschaftlicher Unternehmen darstellt.

### **Schlussfolgerung**

Zusammenfassend ist festzuhalten, dass die aktuelle Situation sowohl auf dem Inlands- als auch auf dem Auslandsmarkt den russischen Agrarorganisationen die Möglichkeit bietet, mit den erwogenen Kommunikationsinstrumenten ein Image aufzubauen und zu fördern, das Vertrauen und Verlässlichkeit schafft unter Kontaktpublikum. Mit der Verschärfung des Wettbewerbs im Marktumfeld wächst nicht nur die Rolle der Imageförderung, sondern auch die Wirksamkeit von Werbekampagnen, für die eine Bewertung dieser Wirksamkeit durchgeführt wird, die es ermöglicht, Informationen über die Machbarkeit von Kommunikationsförderung zu erhalten.

Kommunikationsförderung ist somit ein universeller Kanal, der Agribusiness-Organisationen eine stabile Position auf dem Markt und eine Entwicklungsperspektive für die Zukunft bietet.

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# **Коммуникационное сопровождение российского сельскохозяйственного производителя на рынке в условиях импортозамещения**

**М. Д. Кудрина**

ФГБОУ ВО «Тамбовский государственный технический университет», Тамбов, Россия

*e-mail: lady.cudrina@yandex.ru*

**Аннотация.** Рассмотрены роль и место агропромышленного комплекса в современных рыночных условиях. Выявлено значение коммуникационных технологий в продвижении организаций и продукции агросектора, формирования и повышения их имиджа, что неразрывно связано с завоеванием ими позитивной репутации и, как следствие, устойчивым положением в конкурентной среде.

**Ключевые слова:** имидж, коммуникационные технологии, продвижение, сельское хозяйство.

## **Artificial Intelligence: Prospects and Risks**

**I. S. Kulaeva**

*Tambov State Technical University, Tambov, Russia*

### **Abstract**

The article presents the results of a survey conducted among 70 respondents aged 18 to 55 in order to identify their attitude to the prospects for the introduction and development of AI in various fields of activity. Based on the results of the study, the main risks associated with the use of AI technologies, as well as the positive aspects of this phenomenon, were identified. It is noted that the development of AI is considered as a promising direction that allows solving a number of problems in the industrial and domestic spheres. At the same time, problems associated with the active introduction of AI, such as the possibility of reducing jobs, as well as errors and failures in the operation of automated systems were also identified.

**Keywords:** artificial intelligence; development; implementation; prospects; application; pros and cons.

### **Introduction**

In the last decade, there has been a rapid development of artificial intelligence technologies. Artificial intelligence involves the use of computers to study human intelligence, but it does not always end with biologically truthful methods.

The history of artificial intelligence as the latest scientific trend began in the first half of the 20th century. By this period, many prerequisites for its emergence had already been created: philosophers held discussions about the nature of man and the process of knowing the world, neurophysiologists and psychologists created several concepts regarding the work of the human brain and thinking, economists and mathematicians solved the issues of optimal calculations and the concept of knowledge about society in formalized version; eventually, the basis of the mathematical theory of computation – the theory of algorithms – was developed and the first computer was invented.

Due to the fact that the development of AI implies a radical breakdown of systems and, accordingly, the need to train personnel to work in the field of AI, it seems interesting to find out the attitude to AI technologies in the modern Russian society. The goal of this study is to determine which aspects of the development and implementation of AI are characterized as positive, and which ones pose risks or even a threat.

Artificial intelligence is used in medicine, finance and commerce, industry and law and security - wherever you need to process large amounts of data, systematize and predict.

### **Materials and methods**

From December 5 to December 12, 70 people were interviewed. Of those, 46% were men, and 54% were women. The distribution by age was as follows: 23% fell into the 18-30 age group, 35% fell into the 31-45 age group, 21% fell into the 46-55

age group and 21% of the respondents were over 55 years of age.

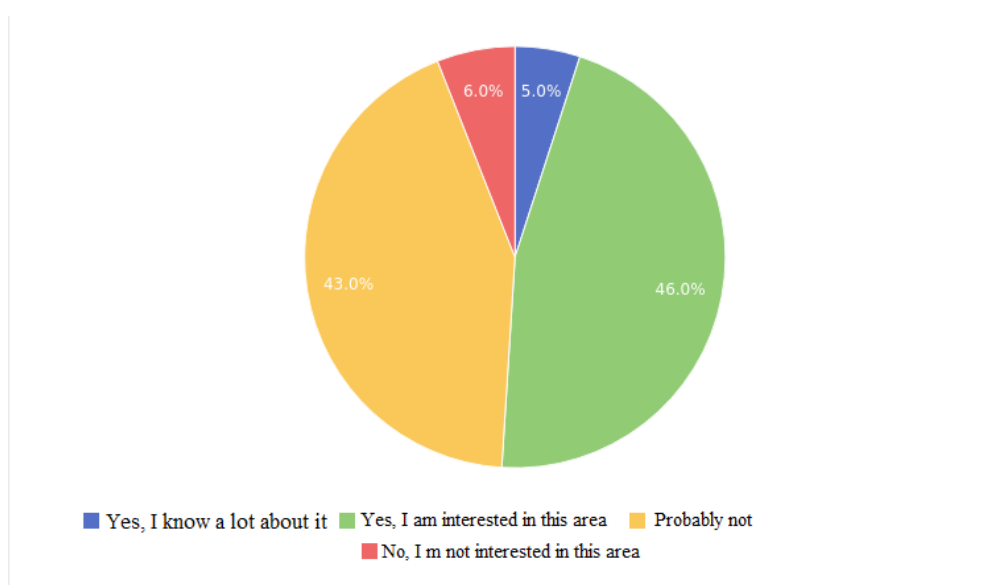
The respondents had to answer the following questions:

1. Are you interested in anything related to artificial intelligence?
2. Do you think it is possible for artificial intelligence to surpass human intelligence in the future?
3. Do you think a computer can acquire the ability to think and be aware of itself (in the future, theoretically)?
4. Do you think the development of artificial intelligence is good or bad?
5. Do you believe that in the future artificial intelligence and robotic mechanisms will replace humans in the following areas?
6. What positive things in the development of artificial intelligence do you see?
7. What disadvantages do you see in the development of artificial intelligence?
8. Do you think the widespread introduction of artificial intelligence will lead to mass unemployment?
9. What areas is artificial intelligence do you think is inferior to human, and in what areas it is superior?
10. In what areas do you think the use of artificial intelligence is most effective at the moment?

The survey findings have been analyzed and relevant conclusions have been made.

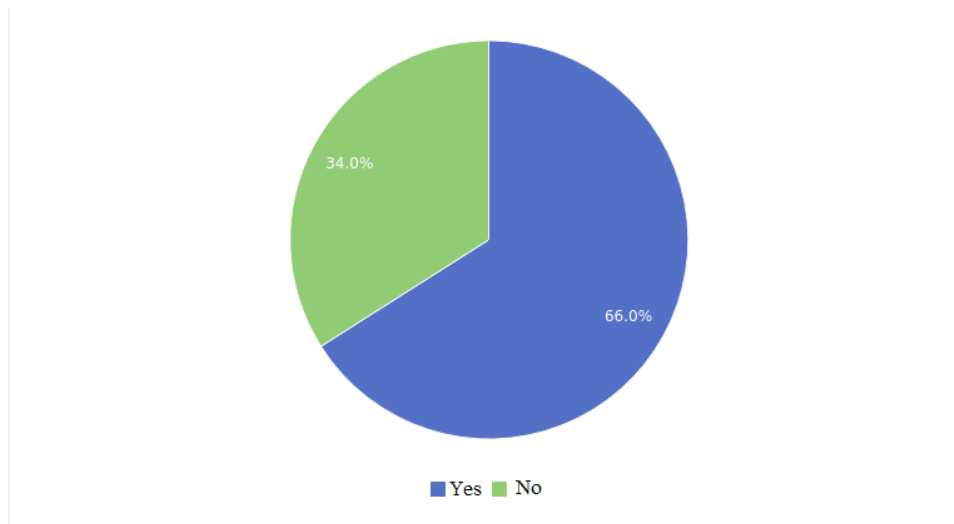
### Results and discussion

Nearly half of the respondents (46%) demonstrated an interest in artificial intelligence. However, only 5% of respondents admitted that they were well versed in this issue. Another 6% said they were not interested in this topic at all (Fig. 1).



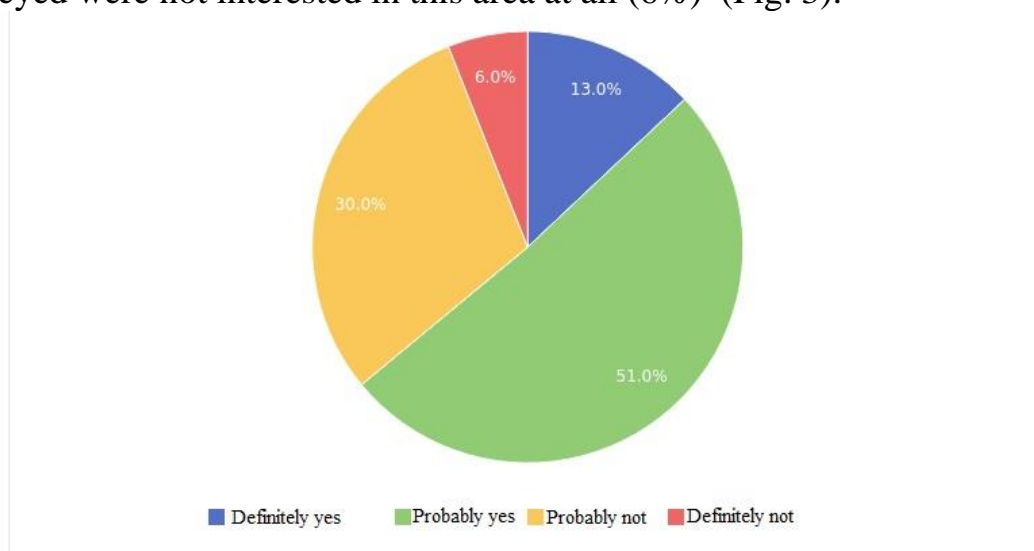
*Figure 1 – The attitude of the respondents to AI*

Two-thirds of respondents (66%) are sure that in the future AI will be compared with human intelligence, while 34% of the respondents do not believe in AI surpassing the human intelligence. (Fig. 2).



*Figure 2 – The prospects of AI surpassing the human intelligence*

Quite a lot of the respondents (64%) think that in the future the AI will be able to develop cognitive abilities on itself, while the third think the opposite. Very few of those surveyed were not interested in this area at all (6%) (Fig. 3).



*Figure -3 The attitude to cognitive abilities of AI*

The majority of respondents (72%) positively assess the introduction of artificial intelligence into human life. It is noteworthy that positive assessment of AI improves with an increase in the level of education of the respondents. Thus, 44% of the respondents with a secondary education, 25% with a higher education, and 22% with several higher educations or an academic degree have a bad or rather bad attitude towards its development (Fig. 4).

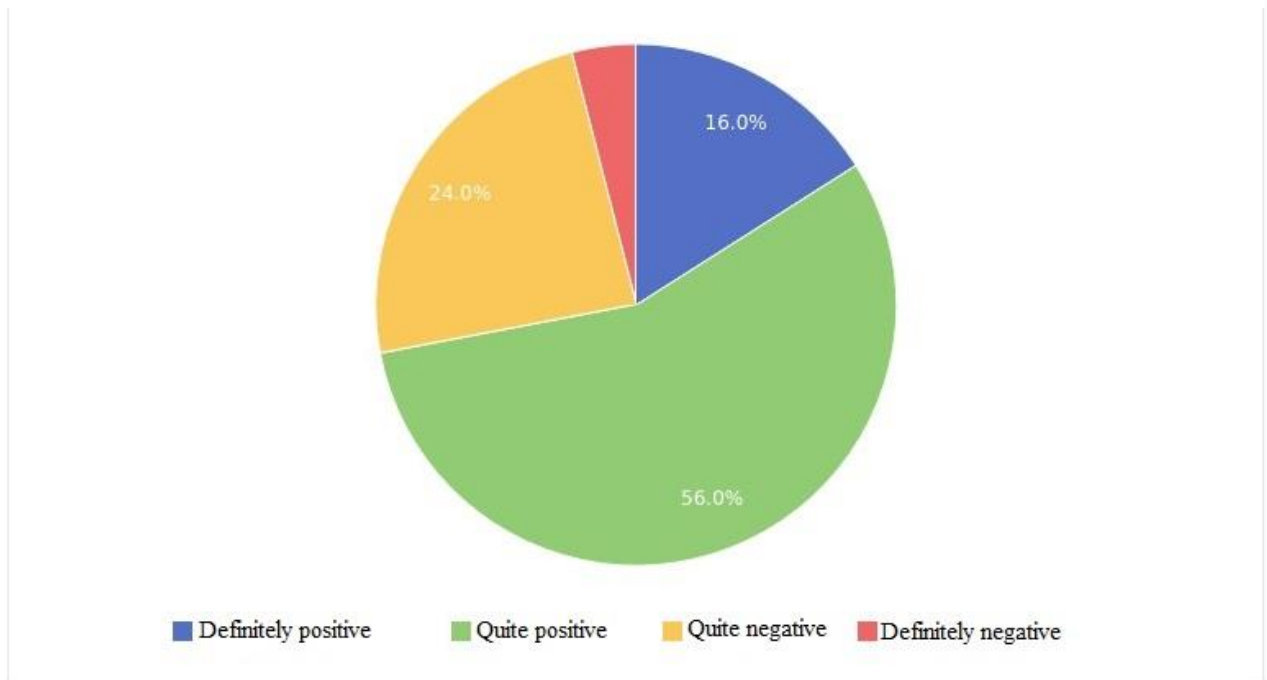
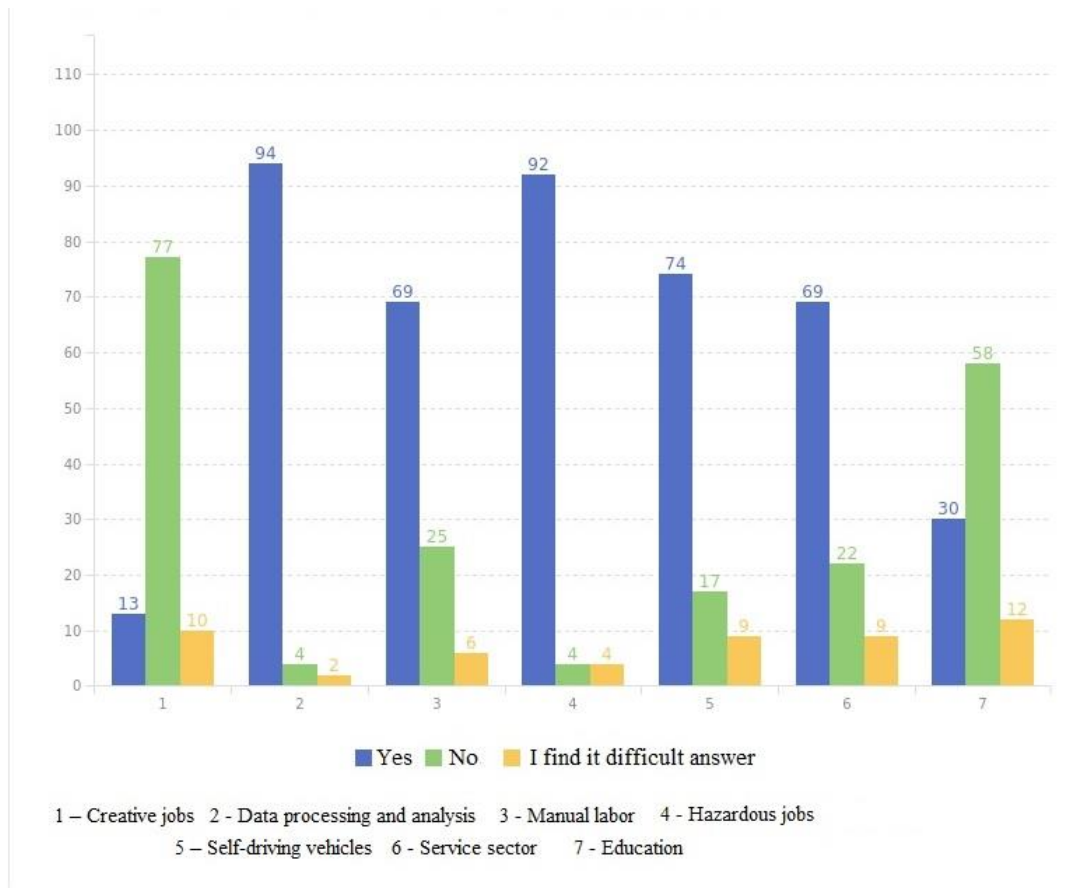


Figure 4 – The overall attitude to the development of AI

Table – The attitude of the respondents to AI development

Do you think the development of artificial intelligence is good or bad?	Leve of education:				
	Secondary education	Secondary specialized education	Incomplete higher education	Higher education	Graduate / postgraduate degree
Definitely positive	9%	13%	16%	16%	24%
Quite positive	48%	58%	47%	59%	54%
Quite negative	41%	27%	30%	21%	20%
Definitely negative	3%	3%	7%	4%	2%

The respondents had little doubt that AI and robotic mechanisms will replace humans in the field of data processing and analysis, with 94% of respondents confirming this. In the near future, 92% are confident that AI will replace human labour in jobs that are hazardous to health, 74% believe that that AI will replace drivers as self-driving vehicles will become more affordable and available, and 69% believe the AI will have its place in the service sector and manual labor. The majority of respondents named creative jobs and education as areas where AI will not replace humans (Fig. 5).



*Figure 5 – Prospect of AI and robotics in replacing humans (by industry)*

According to the survey, the main advantages in the development of artificial intelligence are the ability to free a person from harmful or dangerous production (85%), increase the speed and quality of data processing (77%), to release from monotonous work and the exclusion of the human factor from production processes (65% each) (Fig.6).

Among the main disadvantages of AI, the respondents named the possibility of using this intelligence against a person (66%), the possibility of errors and failures (67%) and job cuts (71%). In general, 74% of the respondents believe that the widespread introduction of AI will lead to mass unemployment, and only 2% are sure that this will not happen (Fig.7).

Most of the respondents are sure that the widespread development of artificial intelligence will lead to mass unemployment, but they still have a positive attitude to this technology (Fig. 8).

At the moment, respondents note the absolute superiority of AI in areas such as storing and searching for information – 92% and 85% of the survey participants think so. The superiority of AI in the efficiency of information analysis is noted by 73% of respondents, building logical connections - by 46%. However, in some areas of activity, the majority of respondents give superiority to the person, for example, in the ability to learn (57%), setting and achieving goals (74%), generating ideas (83%) and creativity (90%) (Fig. 9).



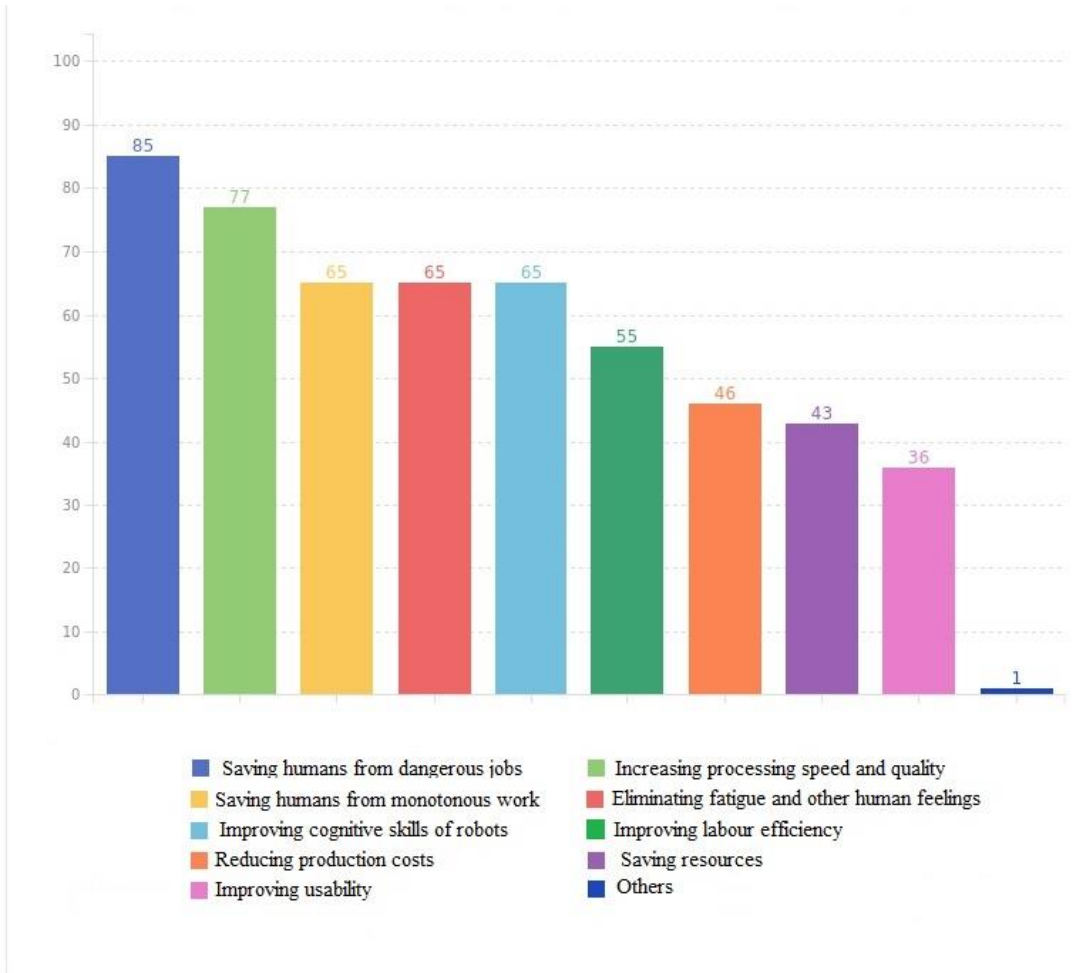


Figure 6 – Positive impact of AI

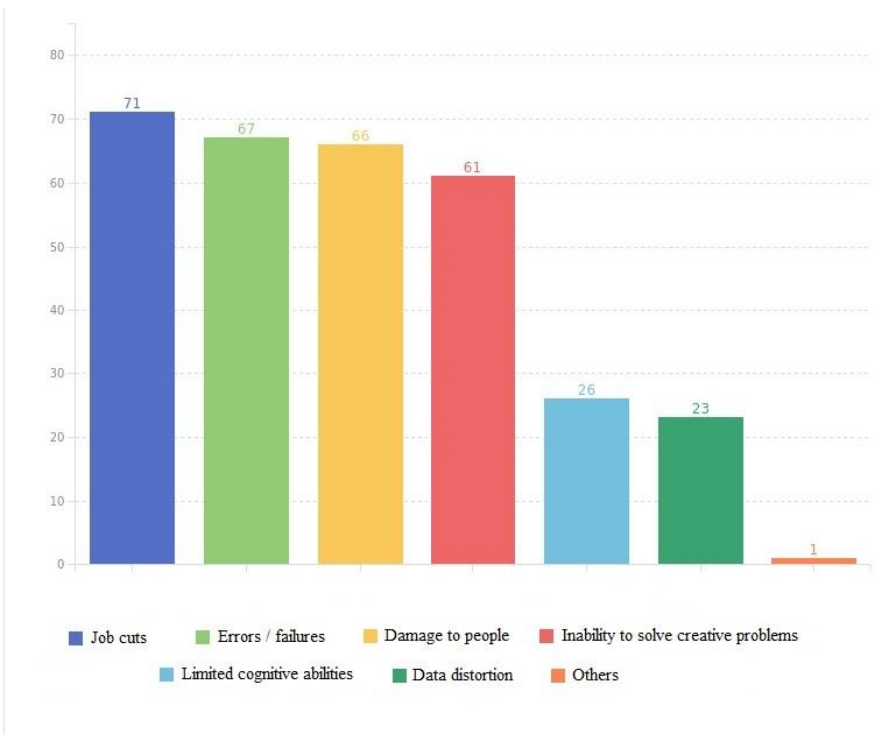
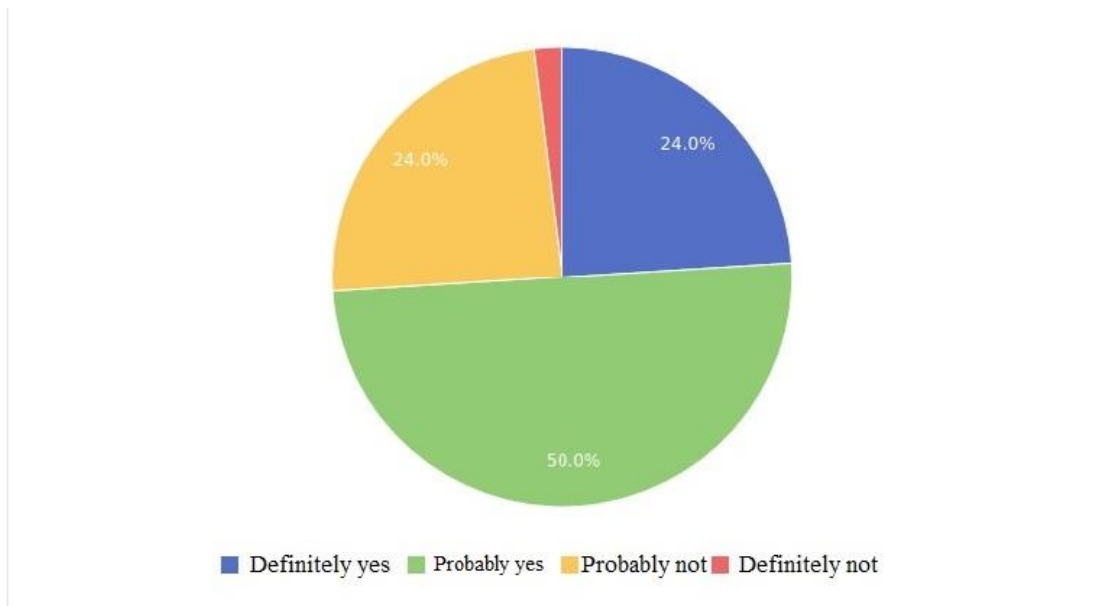


Figure 7 – The negative impact of AI



*Figure 8 – The impact of AI on unemployment*

**Table 2 – The attitude of the respondents to the AI impact on unemployment**

Do you think that the widespread introduction of artificial intelligence will lead to mass unemployment?	Age group:			
	18-30	31-45	46-55	Over 55
Definitely yes	28%	24%	25%	17%
Probably yes	54%	48%	53%	47%
Probably not	17%	25%	20%	32%
Definitely not	1%	2%	2%	5%

The respondents see the most justified and effective use of artificial intelligence in industry (76%), customer support services (47%) and transport industry (46%). Significantly fewer respondents believe in the effectiveness of AI in finance and medicine — 38% and 23%, respectively (Fig.10).

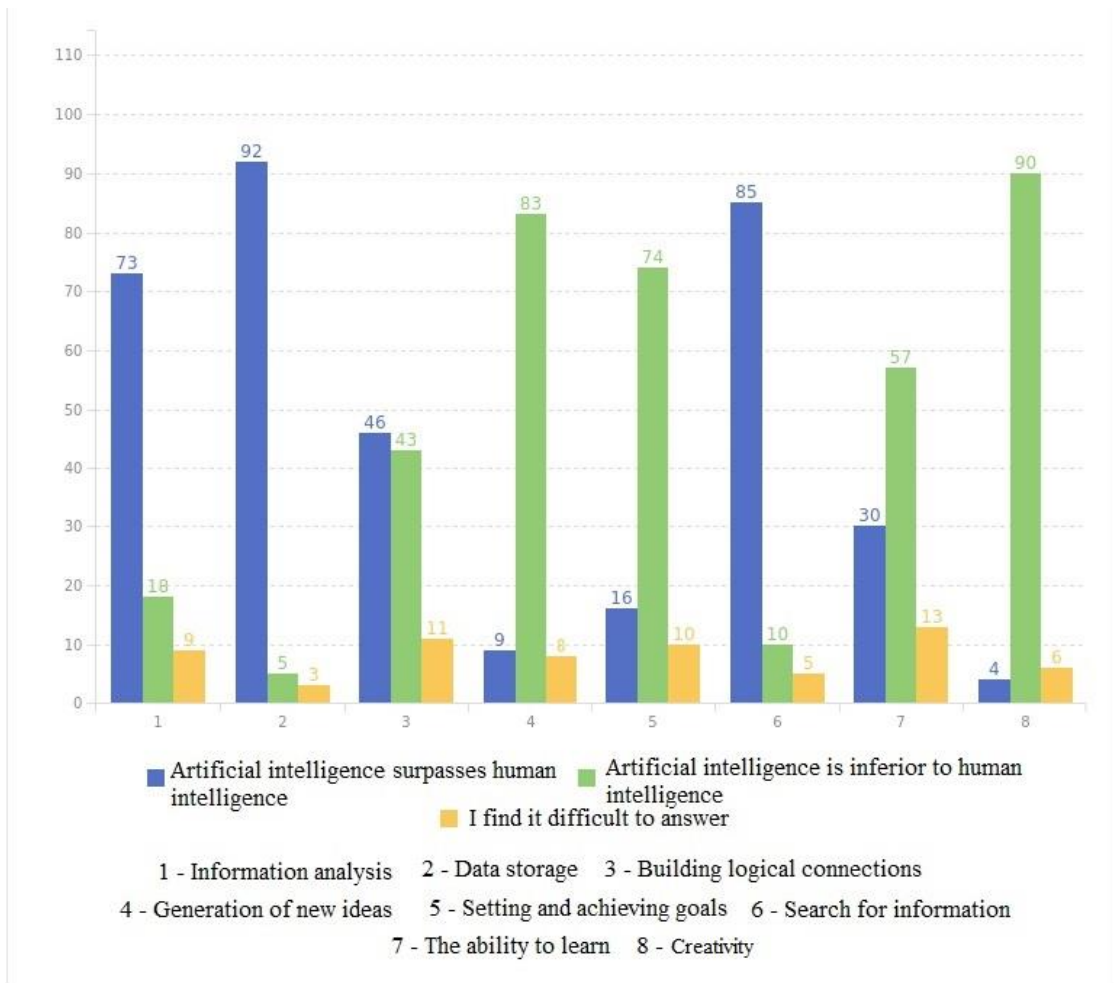


Figure 9 – AI inferiority and superiority (by areas of knowledge)

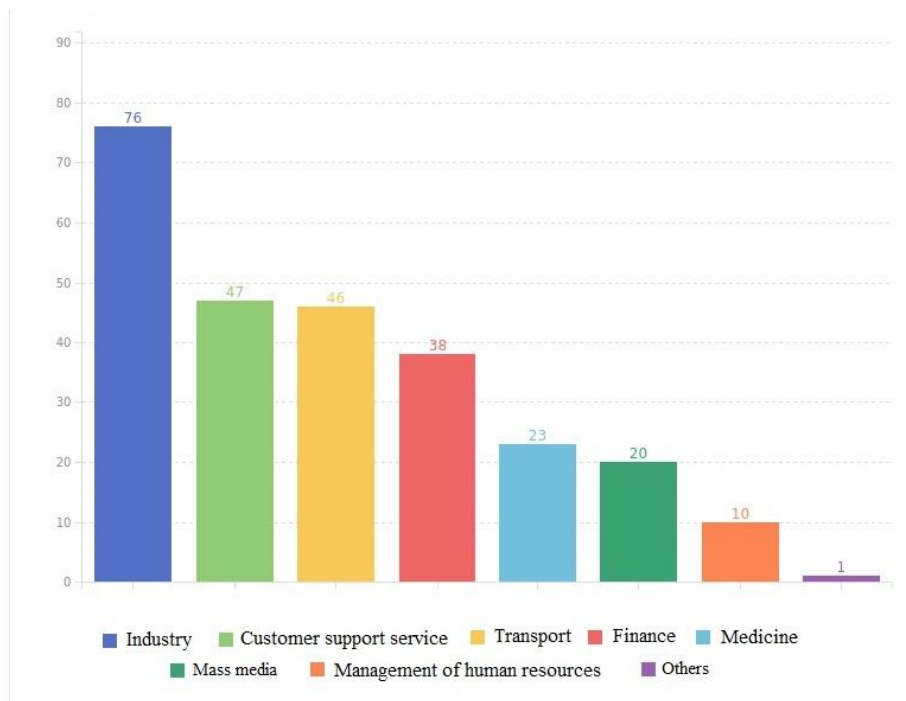


Figure 10 – The efficiency of AI (by industry)

## Conclusion

Replacing a human specialist with artificial intelligence systems can significantly speed up and reduce the cost of the production process. Artificial intelligence systems are always objective and the results of their work do not depend on the momentary mood and a number of other subjective factors that are inherent in a person. But, despite all of the above, one should not build dubious illusions and hope that in the near future human labor will be replaced by the work of artificial intelligence. Experience shows that today artificial intelligence systems achieve the best results when they operate in conjunction with a person. After all, it is a person, unlike artificial intelligence, who can think outside the box and creatively, which allowed him to develop and move forward throughout his era. The main task of any technological breakthrough should be sustainable and harmonious development, an increase in the quality of life and new opportunities for people.

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## Искусственный интеллект: перспективы и недостатки

**И. С. Кулаева**

ФГБОУ ВО «Тамбовский государственный технический университет», Тамбов, Россия

**Аннотация.** В статье представлены результаты опроса, проведенного среди 70 респондентов в возрасте от 18 до 55 лет, с целью выявления их отношения к перспективам внедрения и развития ИИ в различные сферы деятельности. По результатам проведенного исследования были выявлены основные риски, связанные с использованием технологий ИИ, а также положительные стороны данного явления. Отмечается, что развитие ИИ рассматривается как перспективное направление, позволяющее решить ряд задач в производственной и бытовой сфере. Вместе с тем, были выделены и проблемы, связанные с активным внедрением ИИ, в частности, возможность сокращения рабочих мест, а также ошибок и сбоев в работе автоматизированных систем.

**Ключевые слова:** искусственный интеллект, развитие, внедрение, перспективы, применение, плюсы, минусы.

## PR-Technologies in the Digital Sphere

**Z. I. Larionova, A. S. Chalova**

Tambov State Technical University, Tambov, Russia

*e-mail: Nechalik@yandex.ru*

### Abstract

Currently the advertising services market is developing rapidly: the demand for services is increasing and the number of market participants is growing at a significant rate. Trends in business and economic development at the moment are mostly related to the Internet space which encourages companies to turn to advertising agencies specializing in Internet marketing to promote their business and find new customers. Public relations can be considered as an integral element of the marketing activity of the enterprise which belongs to the system of integrated marketing communications. Promotion is designed to ensure the relationship between the supply of the product and the demand for it through two-way communication between the enterprise-producer (enterprise-trader) and the target consumer audience. Public relations are one of the ways of marketing communication. The importance of PR-technologies in the sphere of commerce is due to the rapid development of competition among Russian entrepreneurs. Advertising as the most important part of marketing is not able to completely solve its main task - to ensure the promotion of goods to the consumer. The activity on selection of means of influence on mind and feelings of potential buyer in interests of firm expands possibilities of marketing and today represents a special discipline within its limits - Public Relations.

**Keywords:** public relations, marketing communications, advertising, target audience.

Digital PR is an online marketing strategy used by companies to increase their online presence. Digital PR agencies work with journalists, bloggers, dignitaries and improve search engine optimization.

Digital PR gives you the opportunity to get high quality backlinks from websites and online publications and honest customer reviews. Digital PR helps you reach your target customers by showcasing your business on websites they read, podcasts they listen to, and social media accounts. Digital PR positively affects a website's reach and search engine rankings. Digital technology increases the speed of communication and engages more participants. New media combines the scale of mass communication with the richness of interpersonal communication. All this makes interaction more complex and its results less predictable.

Internet-PR provides companies with the following opportunities:

1. Audience awareness. This opportunity can be realized by publishing materials on the website and placing articles in online media to draw attention to the product/product or brand.
2. Trust building. On the Internet, buyers do not come into direct contact with merchants, so it is more difficult to ensure a relationship of trust between them. You can help to establish them by placing information on the site and constantly updating it, by applying interactive tools of interaction with the company, by publishing articles on various Internet resources.

3. Sales stimulation. With the help of measures on public relations it is possible to improve indicators of sales, to stimulate work of intermediaries, to raise enthusiasm of dealers of the company.

4. Reducing the cost of sales promotion. Costs on the Internet-PR is usually lower in comparison with the cost of organizing advertising and PR in traditional media.

5. Provision of feedback. For this criterion, companies create special forms for registering visitors to the site, finding out their interests, preferences, asking questions. There are sites that contain a special appeal to visitors, in which users are invited to ask questions to site developers or to express their wishes, as well as to leave their main coordinates. With their help it is realistic to monitor public opinion, to determine the need and demand for information, to provide feedback.

6. Conducting online conferences, including press conferences. Conferences on given topics are conducted by moderators (organizers or specially involved persons).

All PR activities on the Internet can be divided into three types. First, it is mass communication through branding, product or website promotion. Website promotion is the most important in terms of attracting the attention of the target audience and creating an active community of regular visitors, considered to be the company's immediate business environment. Secondly, it is interaction with mass media. Using the possibilities of the Internet, one can send press releases to users, create a special section "For press" on the website, post relevant articles and videos. Third is building group relationships. It is necessary to organize interaction via the Internet with the target market segment of the company, i.e. with its immediate environment, which needs to receive different information about it. It can be useful for a company to segment its business environment into a number of homogeneous groups in order to conduct separate activities for each of them. For example, regular customers can be sent information relating to changes in prices, new services of the company. You can resort to a weekly mailing of industry statistics, invite people to presentations, send greetings on holidays.

In conclusion it can be said about the effectiveness of using digital channels as part of strategies to increase sales and communication with the potential client to increase awareness of the brand. Thus, a positive image among the target audience is formed.

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## **PR-технологии по связям с общественностью в digital-сфере**

**З. И. Ларионова, А. С. Чалова**

ФГБОУ ВО «Тамбовский государственный технический университет», Тамбов, Россия

*e-mail: Nechalik@yandex.ru*

**Аннотация.** В настоящее время рынок рекламных услуг быстро развивается: спрос на услуги возрастает, а количество участников рынка увеличивается значительными темпами. Тенденции развития бизнеса и экономики на данный момент связаны, в большей степени, с интернет-пространством, что побуждает компании обращаться в специализированные рекламные агентства, профилем которых является интернет-маркетинг, для продвижения бизнеса и поиска новых клиентов. Связи с общественностью можно рассматривать в качестве неотъемлемого элемента маркетинговой деятельности предприятия, которые относятся к системе интегрированных маркетинговых коммуникаций. Promotion призван обеспечивать взаимосвязь между предложением продукта и спросом на него посредством двусторонней коммуникации между предприятием-производителем (предприятием-торговцем) и целевой потребительской аудиторией. Связи с общественностью представляют собой один из способов маркетинговой коммуникации. Важность PR-технологий в сфере коммерции обусловлена быстрым развитием конкуренции среди российских предпринимателей. Реклама как важнейшая составная часть маркетинга не способна полностью решить свою главную задачу - обеспечить продвижение товаров к потребителю. Деятельность по подбору средств воздействия на ум и чувства потенциального покупателя в интересах фирмы расширяет возможности маркетинга и представляет сегодня специальную дисциплину в его рамках – Public Relations.

**Ключевые слова:** связи с общественностью, маркетинговые коммуникации, реклама, целевая аудитория.

## **Modern Electoral Processes in Russia: Communication and Political Technology Aspects**

**Yu.I. Mikhailova**

Tambov State Technical University, Tambov, Russia

*email: yulia\_apk@mail.ru*

### **Abstract**

The article studies modern Russian political system development. It is stressed that the observed changes have a significant impact on the Russian electoral process and, above all, on the mechanism for organizing and holding elections to representative bodies of political power. On the one hand, the elites need elections to legitimize their stay in power. On the other hand, elections are becoming almost the only real opportunity for the citizens of the state to participate in political decision-making both regarding the path along which the state moves in general, and regarding the personalities of the political elite, in particular. That is why every campaign must have a well-thought-out and tightly integrated plan for using various communication means so that its main message can reach each individual voter.

**Keywords:** communication channels, elections, electoral processes, optimal communication systems, politics.

### **Introduction**

The analysis of Russian reforms' practice shows a great dependence on many factors related to the state structure, political system, economic and social institutions, as well as mentality. A special feature is the constant modernization that modern political processes are experiencing in our time, which are very complex in the field of integration into civil society. A variety of electoral processes are acquiring special significance today. It is no secret that these processes are not autonomous, but depend on society, which is changing in the sphere of socio-political conjuncture. In the same way, previously important factors are in the background, but at the same time they become the basis for the traditions of modern political activity. Often giving way to new trends or phenomena, they nevertheless have a tangible impact on the electorate. It is obvious that the current problems in the electoral processes require close attention.

Diverse studies of electoral processes often show the dynamics of the development of the Russian society in a very generalized way, focusing on the difference in rates and their nature, show the identified features of the formation of values in the newest social system.

Despite the availability of extensive material on the problems of political communication and their impact on public opinion, the basic principles and technological approaches, united under the concept of "information and communication impact", theoretically remain poorly developed, which determines the relevance of this article. The problem of studying the course of socio-political events in electoral processes remains open and very topical.

### **Discussion**



It should be noted that in many studies devoted to the analysis of electoral processes, only the final result or procedure is shown, but in fundamental political theory this is considered its methodological foundation. Its structure, consciousness and the properties determined by them often turn out to be insufficiently explicated. At present, the focus of research is on tasks that are mainly related to the conceptualization of the issue, are used in a deep understanding of practical experience, becoming the history of socio-political development, and this is represented in the monitoring of electoral processes and events.

It is the study of this area of electoral processes that interests all sociologists [1], and it is this area that is focused on practical use in the field of activity of political scientists [2].

Electoral processes and their models in modern Russia are undergoing a noticeable transformation, which most often leads to updating the models themselves with the participation of modern citizens, as well as the mode of civic behavior that is fixed when studying various stages. There are several markers of interest in this problem, and they are explained by different circumstances.

On the one hand, this is the activation of the behavior of citizens, which is becoming an important part of the democratization process. Most often, this manifests itself in the mobilization of groups of various directions that take an active part in elections - the most important tool of democracy. In our time, everyone is oriented towards a positive attitude towards democratic processes, towards active participation in elections and interest in their results.

There is another side - these are electoral processes in our world in general and in our country, in particular. Here and there, there is a deterioration in the positive dynamics of the electoral process and the transformations taking place in connection with this. There are negative and untested forms in processes and consequences. They can lead to global problems and provoke incorrect forecasts. The consequence of such reasons is the deterioration of the quality of political elections and the unstable political situation in individual countries.

Current socio-political studies show that the modern part of Russians is characterized by political alienation, which most often manifests itself as apathy, fatigue in the field of politics, and all this in general leads to the fact that the population ceases to take an active part in the election processes.

In this regard, optimal communication systems are of particular importance (it is at this stage of optimizing the socio-political system that modern Russia is now). It is communication that makes it possible to adequately reflect reality and influence the implementation of the social behavior of the whole society as a whole.

As observations of this process show, in modern Russia there are a large number of communication channels, including the will of the voters; interviews with the media; - teleconferences of heads of state; messages of the President of the Russian Federation; sociological surveys; round tables and forums; work of reception political parties and "hot lines" of politicians.

All this can be supplemented by issues of specialized literature, politically oriented

websites and blogs. Many politicians promote their blog or website through Internet channels in order to reach large groups of the population.

### **Conclusion**

All this determines the specifics in the field of political Internet communication. In the modern world, in society, spontaneous processes of self-organization take place, which differ from the authoritative hierarchical model of behavior, they are built solely on dialogue and equal communication between participants and act as a neutral public opinion.

All this means that participants in elections and Internet communications in the field of politics can not only be passive witnesses of the election results and the decisions of statesmen, but also actively participate in elections at various levels, in the development and discussion of some decisions. This is the essence of "electronic government", the essence of which is to widely involve the socially active part of the country's population in active participation in the processes of political life and making urgent government decisions. They have been actively participating and discussing this problem lately.

Improving communication and political technologies can make a significant contribution to solving this problem through modern electoral processes.

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## **Современные электоральные процессы России: коммуникативные и полит-технологические аспекты**

**Ю.И. Михайлова**

ФГБОУ ВО «Тамбовский государственный технический университет», Тамбов, Россия  
*e-mail: yulia\_apk@mail.ru*

**Аннотация.** В современной России происходит развитие политической системы. Наблюдаемые изменения оказывают существенное влияние на российский электоральный процесс и, прежде всего, на механизм организации и проведения выборов в представительные органы политической власти.

С одной стороны, выборы необходимы элитам, чтобы легитимировать свое пребывание у власти. С другой, выборы становятся едва ли не единственной реальной возможностью для граждан государства участвовать в принятии политических решений как относительно пути, по которому оно движется в целом, так и относительно персоналий политической элиты, в частности. Именно поэтому каждая кампания должна иметь хорошо продуманный и строго интегрированный план по использованию различных средств коммуникаций так, чтобы её главный посыл дошёл до каждого отдельного избирателя.

**Ключевые слова:** российские реформы, выборы, электоральные процессы, оптимальные системы коммуникации, каналы коммуникации, политика.

## New PR Trends: 2020-2022

**M. V. Morozova**

Tambov State Technical University, Tambov, Russia

*e-mail: Morozova\_mv@bk.ru*

**Abstract.** The article considers the latest changes in the infocommunication market, which are the result of new geopolitical and economic realities. The most significant trends in the development of advertising and public relations technologies have been identified.

**Key words:** information, communications, advertising, public relations

The world of public relations is more dynamic than ever. A huge massiv of information - the so-called infonoise - significantly affects consumer behavior and transforms the tools that brands use to interact with the audience.

Undoubtedly, the unprecedented and unexpected events of 2021 related to COVID-19 and the events of 2022 in the international geopolitical arena have affected the advertising market both in the world and within our country.

At this time, we are in a zone of turbulence and are experiencing these metamorphoses. A deeper analysis of all aspects of the transformation of the communications market is possible after a few years, during a period of stability, however, at the moment, the main trends in the advertising and PR market for 2020-2022 can be identified.

1. «Human-centric movements». At the forefront are not just individual events, but the person as the primary source. This transformation focuses on human experiences (be it in the digital world or the real world). It allows PR to have a tangible impact on the target audience.

2. Authenticity is a key metric for a brand's success and a key industry trend. PR specialists must ensure that brands have an authentic voice and genuinely believe in what they stand for. Fake is not a trend no more.

3. Thought leadership. With the B2B sales environment getting increasingly more competitive, and decision-makers seeing little or no differentiation between competitors, there is a clever tactic that marketers should pay more attention to – thought leadership. It is necessary to strive to possess some new "authentic" knowledge and constantly develop in this direction.

4. Inclusion, diversity & awareness. Businesses should integrate inclusion, diversity and awareness in their PR strategies in 2022. Social, gender, environmental, political and cultural awareness are at the height of sensitivity today. This means one must do research, know your audience and be cognizant of how to pitch and build relationships with the editorial community.

5. A crucial change in the audience. Focusing on Gen Z is the new trend of 2022 that can't be overlooked. The average representative of the new generation will use their smartphone for at least 5 hours daily. (98% have it already). The average representative of the new generation cannot go more than 30 minutes without checking their phone. PR experts must focus on Gen Z - the next generation of consumers. They break the record for openness on the Internet, dominated by digital PR and digital marketing.

6. Working from home and its consequences. We are all aware of the impact of the pandemic on our daily lives. The trends here also apply to the work ethic, which has been changed. People are now mixing two spaces - office and living room, as a result of which they lose clear boundaries of their day, in connection with which labor relations are undergoing changes.

7. The prevalence of multimedia content. PR strategies are becoming increasingly mobile and dynamic as it is possible to embed a client's brand, product or service in various audio and video formats and customize them in such a way as to reach the target audience, taking into account their interests. For example, you can work with different podcasts, YouTube vloggers, or other media outlets to squeeze your client's brand into the relevant form of entertainment that the specific viewer and potential customer is enjoying. Podcasts and short vertical videos are in trend: VK clips and Reels.

8. Expansion of digital channels. To evaluate your online presence efforts, you need to pay attention to SEO tactics. Link building, keywords, search engine rankings are all ways to track the effectiveness of a digital PR campaign. It is now much easier to monitor the performance of a communication campaign in real time. With the many tools and software available, collecting information is much easier than before.

Over the past couple of years there have been a lot of changes in the world of communications. The main driving element of these transformations is a person and his interests. Companies and brands have begun to work to help humanity protect values, eradicate the roots of problems and move forward. New trends in PR and media relations are examples of the changing world we live in. It's important to keep a close eye on the latest trends in order to have a real impact. The use of digital media is shaping the world, and new trends in public relations are showing that more can be done, but it has to be done right.

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## **Новые тенденции в PR: анализ 2020-2022 г.г.**

**М. В. Морозова**

ФГБОУ ВО «Тамбовский Государственный Технический Университет

*e-mail: Morozova\_mv@bk.ru*

**Аннотация.** В статье рассмотрены последние изменения на инфокоммуникационном рынке, ставшие следствием новых геополитических и экономических реалий. Выявлены наиболее значимые тенденции развития технологий рекламы и связей с общественностью.

**Ключевые слова:** информация, коммуникации, реклама, связи с общественностью

## **Development of New Technologies of Artificial Intelligence and Big Data Analysis as a Factor of Increasing the Competitiveness of Russian Commercial Banks**

**A.A. Mutalimov**

Tambov State Technical University, Tambov Russia  
*e-mai: artem2000585@gmail.com*

**Abstract.** The article discusses the development of new artificial intelligence technologies and big data analysis as a factor in increasing the competitiveness of Russian commercial banks. The influence of artificial intelligence on the process of work and interaction of commercial banks is touched upon.

**Keywords:** technologies, commercial banks, Big Data.

This report considers the use of artificial intelligence in the banking sector, namely, as a factor in increasing the competitiveness of Russian commercial banks.

Artificial intelligence is used by banks to provide services to customers and improve business processes. But the heyday of this technology may still be ahead. According to the study by the Fintech Association and Accenture, which conducted a survey of banks, AI will be used for next-generation financial services. The survey participants noted that they need to develop competencies in the field of AI and other related technologies (machine learning, big data collection and processing, open APIs, etc.) [1].

AI in Fintech is in the period of large-scale piloting and testing. According to Alexey Sidoryuk, Director of Artificial Intelligence, Director of Development of ANO Digital Economy, we are mainly dealing with Narrow AI technology (“narrow” artificial intelligence), focused mainly on highly specialized applied tasks. For example, in chatbots and voice assistants, AI helps to close large blocks of communication with customers, but solutions are not always optimally trained and configured [2]. On the other hand, in some areas artificial intelligence shows itself as a mature technology: in scoring clients, biometrics, computer vision, and anti-fraud activities.

### **Reasons and examples of using AI in banks**

AI in banking accelerated access to products for many customers and automated some stages of internal processes, which also affected the speed of service.

Another reason is cost optimization. For example, in 2020, the introduction of AI brought Sberbank a financial effect of 100 billion rubles — this is both earned and saved money. In 2021, this figure amounted to 200 billion rubles [3].

*Customer scoring:* AI is used for automatic decision-making on customer requests for credit products. Previously, an application for a loan from a large business was considered for two to three weeks, and this took the time and effort of many different specialists. Now, when these applications are considered by AI, no more than

seven minutes pass from the client's request to receiving money. Everything happens remotely, without the use of paper documents, and the share of delay has decreased to almost zero.

*Voice assistants and chatbots:* AI is used when a customer contacts a call center or a bank chat to reduce service time and optimize the work of employees. Thanks to the use of Oleg's voice robot in the Tinkoff Bank call center, customers on average began to receive consultations 40 seconds faster, and the bank saves over 30 million rubles a month. As for the chatbot, it processes over 40% of client requests and saves the bank more than 200 million rubles per month [4].

*Anti-fraud and financial monitoring:* AI is used to counter financial fraud by analyzing atypical behavior of individuals and legal entities.

*ATM maintenance:* AI predicts the loading of ATMs and reduces the cost of collection.

*Document processing:* Rosbank uses AI to automatically process and enter customer data when opening accounts and performing banking transactions where identity verification is required. Artificial intelligence recognizes more than 70 details from scans and photos of documents for each client in 2 seconds and performs about 15 automatic data checks [5].

### **Conclusion**

Thus, it can be concluded that the introduction of the latest technologies related to artificial intelligence contributes to improving customer comfort, increasing the quality of customer service and increasing the competitiveness of banks capable of providing these services.

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## **Развитие новых технологий искусственного интеллекта и анализа больших данных как фактор повышения конкурентоспособности российских коммерческих банков**

**А. А. Муталимов**

ФГБОУ ВО «Тамбовский государственный технический университет», Тамбов Россия

*e-mail: artem2000585@gmail.com*

**Аннотация.** В статье рассматривается развитие новых технологий искусственного интеллекта и анализа больших данных, как фактор повышения конкурентоспособности российских коммерческих банков. Затрагивается влияние искусственного интеллекта на процесс работы и взаимодействия коммерческих банков.

**Ключевые слова:** технологии, коммерческие банки, Big Data.

## Podcasts Capabilities as a Platform for Advertising and PR Communications

V. A. Neverova

Tambov State Technical University, Tambov, Russia  
*e-mail: vera\_neverova\_00@mail.ru*

### Abstract

The purpose of this article is to study the specifics of the manifestation of such a phenomenon as banner blindness in the field of Internet marketing. and ways to overcome it.

**Keywords:** Internet marketing, banner blindness, advertising, web page, user.

Digitalization has affected almost all spheres of society. She had a special impact on the advertising market in Russia and the world. The Internet has become the leading media segment in the advertising market, ahead of television and the press, which have held the lead over the past few decades. While advertising budgets for TV, press, radio and outdoor advertising are falling, the cost of advertising on the Internet is increasing every day.

This, in turn, influenced the emergence of a special interest in the field of Internet marketing and the use of new technologies in the field of advertising. For example, virtual reality systems and 3D visualization help to demonstrate all the consumer qualities of certain products and services, conduct virtual product testing or services, which is a relatively new and original way to attract potential customers and make it possible to stand out from competitors.

Also, the leading position in the advertising market, occupied by such a media segment as the Internet, has generated not only a significant increase in the number of PR agencies and creative groups using new technologies in their activities, but also a number of agencies specializing specifically in the field of Internet marketing. For example, iConText is one of the largest digital marketing agencies. The scope of iConTex is contextual and media advertising, search engine promotion, marketing and targeted advertising in social networks, analytics and optimization of advertising campaigns and improving the efficiency of Internet resources, digital.

However, despite the large advertising budgets allocated for the development of online advertising and the use of new technologies in this area, advertising effectiveness indicators leave much to be desired. One of the main reasons for the low performance of online advertising is banner blindness.

Banner blindness is a user's perception of information on the Internet, in which he does not pay attention to elements of the web interface that look like advertising [1].

Jen Benway and David Lane coined the term "banner blindness" back in 1998. Since then, as mentioned above, the types of advertisements and their visual component in the form of design have evolved significantly. It would seem that high-



quality advertising with an attractive design should interest the user, but the problem of banner blindness has only worsened over time. This is noticeable in terms of CTR - the ratio of the number of clicks on a banner to the number of impressions. For example, in 1994 the CTR of the first advertising banner was 44%, and now 0.5% is already considered a good result.

We live in a time of information noise. Our brain would not be able to function normally if it tried to process the endless stream of sounds, signals and images coming from outside. So from the point of view of the psychophysiology of perception, banner blindness is a manifestation of certain protective reactions of the body. Our attentional capacity is limited, which is why, as Internet users, we tend to pay attention only to elements that are useful to us, corresponding to our purpose, and ignore those elements that usually do not contain useful information. Advertising is one of the main elements of this category. Content elements that have features characteristic of advertising are ignored by the user. For example, users are used to seeing ads on the right side of a web page, which is why they pay much less attention to them than to the left.

Jakob Nielsen's web browsing research found that users spend 80% of their time at the top of a web page and only 20% of their time below the scrollbar. In addition, 69% of the time users browse the left half of a web page and 30% the right [2].

It is worth noting that the user's nationality, as well as linguistic and cultural characteristics, do not have a significant impact on the formation of the user's web browsing model. This was revealed in another study by the Nielsen Norman Group [3].

There are many ways to overcome banner blindness. These include: drawing up a clearer portrait of the target audience, competent choice of the location of the advertising banner, the absence of elements similar to banners in the development of a web interface, minimalism and functionality of the design, understanding and using the distinctive features of banners in social networks and search engines, etc.

A high-quality portrait of the target audience is one of the most important steps on the way to overcoming banner blindness. An advertising offer should be of interest to a specific user, it is possible to solve any of his tasks or problems.

When choosing the location of the ad unit, many experts recommend following certain rules. The main one is the placement of advertising banners in places that users pay special attention to when browsing a web page.

It should be noted that the absence of elements similar to banners in the development of a web interface is understood as native advertising. Native advertising corresponds to the functionality and visual component of the site on which it is placed. Such content does not cause a negative reaction from the user, but is perceived neutrally or with interest.

However, it is worth remembering that there is no single solution to combat banner blindness. Banner blindness, being a certain defensive reaction of the user, harms him to some extent. After all, he may miss important and relevant information for him. The task of web developers and web designers is to improve the quality of advertising and advertising delivery, test different approaches to overcome banner blindness and choose the most effective one at a given time.

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## Феномен баннерной слепоты в сфере интернет-маркетинга

**В. А. Неверова**

ФГБОУ ВО «Тамбовский государственный технический университет», Тамбов, Россия  
*e-mail: vera\_neverova\_00@mail.ru*

**Аннотация.** Целью настоящей статьи является изучение специфики проявления такого феномена как баннерная слепота в сфере интернет-маркетинга и путей её преодоления.

**Ключевые слова:** интернет-маркетинг, баннерная слепота, реклама, веб-страница, пользователь.

## Éducation Juridique Des Jeunes De L'après-Guerre

**A. O. Plotnikov, V. V. Krasnikov**

*Université technique d'état de Tambov*

*e-mail: artem03plo@mail.ru; viktor\_krasnikov@list.ru*

### Résumé

Le but de cet article est de concentrer l'attention sur l'éducation juridique des jeunes des années 1950 du XX-ème siècle. Sont montrées les réalisations et les erreurs de calcul dans les études politiques. Est analysée la participation des komsomols à l'application de la loi dans les lieux publics. Sont révélées les lacunes dans la politique de jeunesse du parti et du gouvernement indiquant l'inefficacité des méthodes de travail idéologique et éducatif dans les conditions de la faible formation théorique et pratique des départements éducatifs des organisations du komsomol sur le terrain, le manque de personnel formé et les conséquences irrésistibles du culte de la personnalité de Staline.

**Mots-clés:** cercles, éducation juridique des jeunes, études politiques, komsomol, politique de la jeunesse.

La politique de la jeunesse et l'éducation juridique en Union Soviétique attirent toujours de l'attention des chercheurs travaillant dans le domaine des sciences humaines, en particulier historiques et juridiques [1, 2].

Cet article met l'accent sur les réalisations et les erreurs dans la mise en œuvre de l'éducation juridique des jeunes de l'URSS dans les années 1950 du XX-ème siècle.

Après la fin de la Seconde guerre mondiale et la mort de Staline le processus de la démocratisation progressive commence dans la vie de la société soviétique. Les jeunes participent aux nombreux projets tels que la mise en valeur des terres vierges, la construction de la centrale hydroélectrique Fraternelle et BAM.

Dans l'après-guerre en URSS, il y avait plus de jeunes que d'adultes. Par conséquent, le pouvoir a cherché à gagner les esprits de la partie la plus active de la population. Dans les années 1950, le Komsomol a grandi à un rythme rapide. La priorité du Komsomol était de diriger le travail idéologique parmi les jeunes. Des brigades d'aide à la police ont été créées, des personnes de 18 ans y ont été admis. Les citoyens qui ont adhéré à l'organisation, ainsi que les policiers, ont assuré l'ordre lors des événements de masse, étaient en service dans les bureaux de police, etc. Dans les années 1950, cette idée a donné un nouvel élan. C'est à cette époque que la priorité a été donnée à l'application de la loi. La période de la construction du socialisme déployé a également commencé.

Dans la région de Tambov, les statistiques sur la criminalité parmi les jeunes étaient élevées. Pour améliorer la situation, les autorités ont décidé à l'aide du komsomol de les impliquer dans la protection de l'ordre public. Des groupes de brigadmils ont mené des raids. Il y avait 20-30 personnes et la ville était divisée en secteurs. En 1958, les forces de l'actif du komsomol ont participé à la sécurisation de l'ordre public et à la préparation en toute sécurité des élections au Soviet suprême de l'URSS. Ils étaient en service 24 heures sur 24 la veille et le jour du scrutin.

De tels groupes ont été créés dans de grandes entreprises: le service de patrouille a

été renforcé et des raids ont été effectués.

La décision du Comité central du Parti communiste et du conseil des Ministres de l'URSS «sur la participation des travailleurs à la protection de l'ordre public dans le pays» du 2 mars 1959 a réorganisé les brigades d'assistance à la police en brigades populaires volontaires. Cela a contribué à renforcer le rôle du komsomol dans la lutte contre le comportement antisocial des citoyens. Le but de cette décision était d'obliger les organisations syndicales et komsomol à prendre des mesures pour informer les jeunes de la discipline et des règles de la conduite dans les lieux publics.

Le Comité central du Parti communiste a demandé aux organisations du parti de prendre des mesures qui aideraient à obtenir d'abord une forte réduction de la criminalité, puis à s'en débarrasser complètement. Le moyen d'atteindre cet objectif était la prévention des crimes.

Les mesures visant à faire participer les jeunes aux activités de maintien de l'ordre ont donné des résultats positifs.

Au départ, l'éducation idéologique du parti était de bas niveau. On lisait les journaux sans leur discussion, les gens maîtrisaient mal le matériel. Les problèmes des études politiques étaient régulièrement discutés lors des plénums du parti, mais l'inefficacité des résultats était associée à des violations de la discipline.

Le travail du komsomol s'est considérablement intensifié après le XX-ème congrès du Comité central du Parti communiste. La mise en œuvre réussie des plans de la construction économique à grande échelle était directement liée au travail organisationnel et politique des organes du parti, des organes soviétiques et du komsomol. L'une de ses tâches, le komsomol a mis l'éducation des jeunes avec le programme des congrès du PCUS.

Le département de la propagande du Comité central a guidé les comités du komsomol dans leur aide aux jeunes hommes et jeunes filles à assimiler la théorie, à l'appliquer pour résoudre les problèmes pratiques de la construction du communisme.

L'éducation politique des jeunes pouvait en premier lieu aider à comprendre la politiques du parti, les problèmes de la politique intérieure et internationale.

Dans les années 1950, des cercles ont commencé à apparaître pour étudier l'histoire du komsomol et des domaines de l'économie nationale. Dans 16 organisations régionales et républicaines, 8637 cercles ont été créés. Dans ces cercles on étudiait aussi des documents sur l'histoire des organisations locales du komsomol.

Après le XX-ème congrès, dans les documents officiels des organes du parti, il y avait moins de dogmatisme, la plus grande attention était accordée à la pratique de la construction du communisme. En réalité, la politique était à un niveau bas. Souvent, les gens devaient être forcés d'assister à des cours. En outre, les listes incluses dans le réseau politique ont souvent été surestimées.

Dans la région de Tambov, il y avait des cercles d'histoire du Parti communiste, on organisait des séminaires d'étude de l'économie politique, il y avait un cercle d'étude du matérialisme dialectique et historique, des universités du marxisme-léninisme. Il y avait aussi ceux qui ont étudié la théorie marxiste-léniniste par eux-mêmes. Dans le même temps, le Comité régional du Parti communiste a reconnu que l'éducation

политике était mal dispensée dans plusieurs régions.

L'élargissement de la thématique des cercles a donné des résultats positifs, l'opinion des jeunes a été prise en compte, mais en même temps, il a été plus difficile de contrôler les activités. Les programmes étaient généralement de faible niveau et il y avait une pénurie de personnel. En raison du manque de personnel qualifié et du manque des manuels scolaires dans les années 1950, le nombre des écoles politiques diminuait chaque année. L'amélioration de la qualité des cours a suivi le perfectionnement de la qualification du personnel propagandiste. Des efforts ont été faits pour former les participants plus actifs et plus qualifiés. Mais cette mesure n'a pas beaucoup changé la situation, car ces personnes ne pourraient que présenter du matériel plus intéressant, il était interdit d'analyser la situation.

La principale raison pour laquelle le parti politique n'était pas efficace était que la formation était basée sur le cours officiel du parti, dont l'exactitude ne pouvait être mise en doute.

Donc, les études politiques et l'éducation juridique en URSS des années 50 du XX-ème ont révélé la prédominance des lacunes dans la politique des jeunes du parti et du gouvernement, ce qui témoigne de l'inefficacité des méthodes de travail idéologique et éducatif dans les conditions d'une faible formation théorique et pratique des départements éducatifs des organisations du komsomol sur le terrain, du manque de personnel formé et des conséquences insurmontables du culte de la personnalité de Staline.

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## Правовое просвещение молодёжи в послевоенный период

**А. О. Плотников, В. В. Красников**

*ФГБОУ ВО «Тамбовский государственный технический университет», Тамбов, Россия*

*e-mail: artem03plo@mail.ru; viktor\_krasnikov@list.ru*

**Аннотация.** Цель данной статьи - сосредоточить внимание на правовом просвещении молодёжи 1950-х годов прошлого века. Показаны достижения и просчёты в политучёбе. Анализируется участие комсомольцев в обеспечении правопорядка в общественных местах. Выявляются недочёты в молодежной политике партии и правительства, свидетельствующие о неэффективности методов идейно-воспитательной работы в условиях слабой теоретической и практической подготовки воспитательных отделов комсомольских организаций на местах, отсутствии обученных кадров и непреодоленных последствий культа личности Сталина.

**Ключевые слова:** кружки, правовое воспитание молодежи, политучеба, комсомол, молодежная политика.

## **Big Data and Artificial Intelligence in Credit Institutions: Foreign and Russian Experience**

**K.D. Pukhovets**

Tambov State Technical University, Tambov, Russia

*e-mail: 68.56.@bk.ru*

### **Abstract**

The paper studies the influence of artificial intelligence on the banking sector. In the conditions of new developing technologies, progressive banks are beginning to accumulate huge amounts of information about customer behavior. Thanks to artificial intelligence and cognitive computing, companies can more quickly process vast amounts of information, build more accurate models that allow them to anticipate customer needs, create personalized offers and automate their services. The article discusses the features of artificial intelligence technologies, the possibilities of their use and the impact on transformations in the banking sector.

**Keywords:** artificial intelligence, banking technology, computer, credit organizations, IT technologies.

### **Introduction**

The modern banking sector applies a lot of technological innovations. One of them is artificial intelligence, which is changing traditional methods of work in the banking industry.

Artificial intelligence (AI) is a human-like computer system. It finds rational solutions, completing working tasks better than people. The main goal of using AI is to create a helper not affected by feelings, and emotions, which would understand human commands and intentions [1]. AI's mental abilities are not limited, unlike human ones. The largest foreign companies like Apple, Google, Amazon, Facebook, and Alibaba are working on effective managerial AI systems due to their growing role.

Robotic systems used in many fields of human activity gradually replace humans. The financial sphere invests more resources in the research and development of artificial intelligence technologies. The reason for this interest is the profit that AI systems would bring: reducing production expenses, growing speed of work, decreasing influence of human factor, higher automatization and accuracy of internal working processes. Using AI in the banking sphere improves the quality of service. Artificial intelligence systems help to create personalized offers for customers. This leads to increased consumption of bank products per single person.

Artificial intelligence is going to be a driving force in developing of the financial sphere, compared to other fields of human activity [1]. Citibank, situated in the USA, made the first step in applying AI systems in its work. The company attempted applying a system that would make decisions automatically as well as an experienced specialist could do it, taking less time and making fewer efforts. The major banks of the USA started their own study of AI systems after the success of Citibank.

Applying AI systems allows working with big data which is highly important for

the banking field. Constantly developing artificial neural networks help to build another level of communicating with clients, and making managerial decisions [1]. There are several innovations successfully probated in many leading banks.

1. *Smart assistant*. This is a system helping customers to solve their problems, on the one side, and reducing appeals to the bank workers, on the other side. Usually, it is a chat-bot, integrated into the application or on the website. These can be seen on the websites. Example: smart assistant Max on the website “Gosuslugi”. As a rule, the system implies a ready-made set of simple questions and answers.

2. *Personal Virtual Assistant*. This system was developed to help people using the bank’s mobile application. People can ask it questions related to finance and banking services. Personal assistants help them save money, give advice, or connect with a call-centre operator. Example: voice assistant Oleg (Tinkoff Bank), working with the financial sphere only. Other analogues: Siri (USA) and Alice (Russian), working with a large amount of information.

3. *Algorithmic trading or roboadvising* is communication with an AI system acting like a real financial consultant. It can open and close bank accounts, estimate possible risks, and process several deals at the moment. In the USA and Western Europe robotized assistants are successfully used in the banking sphere.

Nowadays, bank customers often face the problem of financial fraud through the Internet. Special algorithms based on AI systems prevent the leak of personal information. Thus, new safety measures are invented to protect customer data. Many banks plan to go online and stop using paper documents for their work. Japanese breakthrough showed that artificial intelligence systems proved to be useful in work. The AI systems, developed for office workers, were launched in 2017. Their task was to make people’s work easier by processing big data. It reduced human work and expenses for people’s salaries.

Russian banks have followed the experience of their western colleagues, starting the research of artificial intelligence and involving leading experts. They are Sberbank with its robot Anna and Tinkoff Bank with its virtual assistant Oleg. The robots share relevant financial news that may interest the customers, help in saving money and study the financial habits of people [3]. Thus, it made it possible to solve client issues 50% faster than earlier.

Thanks to developing AI systems, customers of financial organizations are able to take loans online. They need to upload the images of their documents to the application and wait for the credit approval. For example, the American multinational financial company JPMorgan Chase has introduced a new smart contract Intelligence (COiN) platform, which works with people’s personal data and papers. This technology reduces the working hours of bank workers and saves customer time as they don’t need to go to the bank personally.

Rosbank also uses artificial intelligence in its work. It has introduced a product called Marketing Logic GIS Atlas. It is assumed that the users of this programme would purchase more bank products and services. This system collects big data of various types and conducts geo-analytics. Potential clients get information about bank

products that may interest them, as well as personalized offers [4].

In the future, artificial intelligence is going to play an important role in the banking field. More banks and financial organizations invest money and human resources in the study of AI and the development of original products. As the FinTech News research has shown, the largest market players choose a few innovation solutions instead of trying to catch everything, in order to focus on a specific task and achieve a better result. However, compared with the world-famous Google and Facebook, banks have fewer possibilities to compete with them.

### **Conclusion**

Developing artificial intelligence is worth the investment of financial and human resources since it can be applied in various types of markets, including domestic and external ones.

Using AI systems increases benefits and forms an individual approach for every customer. Information space is no longer a metaphor, but a real instrument for the banking sphere. Getting bank products and services requires less customer time nowadays. Artificial intelligence systems help to automate and optimize the processes taking place in the banks.

In this moment, we see that more banks, financial, and credit organizations apply artificial intelligence in their work since it brings noticeable benefits.

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## **Использование больших данных и искусственного интеллекта в кредитных организациях: зарубежный и российский опыт**

**К. Д. Пуховец**

ФГБОУ ВО «Тамбовский государственный технический университет», Тамбов, Россия  
*e-mail: 68.56.@bk.ru*

**Аннотация:** Целью работы является исследование влияния искусственного интеллекта на банковскую сферу. В условиях новых развивающихся технологий, прогрессивные банки начали накапливать огромные массивы информации о поведении клиентов. Благодаря искусственному интеллекту и когнитивным вычислениям, компании могут быстрее обрабатывать огромные массивы информации, выстраивать более точные модели, позволяющие предвосхищать потребности клиентов, формировать персональные предложения и автоматизировать их обслуживание. В статье рассмотрены особенности технологий искусственного интеллекта, возможности их использования и влияние на трансформации в банковской сфере.

**Ключевые слова:** банковские технологии, искусственный интеллект, компьютер, кредитные организации, IT-технологии.



## **International Legal Aspects of Cooperation between States to Combat the Illegal Transportation Of Migrants**

**A. B. Pyshkin**

Tambov State Technical University, Tambov, Russia  
*e-mail: Sasha888777sasha@mail.ru*

### **Abstract**

International illegal migration is one of the important problems of our time. The legal status of migrants moving from one country to another varies. They can be classified into two groups: legal migrants, i.e. persons who, with the permission of a foreign state and in accordance with its legislation and international treaties, are on its territory; illegal migrants — citizens of other states and stateless persons who have violated the rules of entry, exit, stay or transit through territories established by national legislation of a foreign state.

**Keywords:** migration, illegal migration, international legal acts, UN, CIS.

### **Introduction**

Universal social processes have various forms of manifestation. One of them is a large degree of population migration (hereinafter referred to as migration). Migration is understood as mass resettlement, displacement of people. Thus, "illegal migration" is a massive illegal relocation, the movement of people who cross the border without meeting the established requirements for legal entry. Almost all countries of the world believe that illegal migration causes a negative impact on the socio-economic situation in the host country of migrants. There is an increase in offenses and crimes, the burden on the social sphere increases, and other negative consequences arise.

The interstate group includes contracts and agreements concluded within the CIS. Considering the first group, it is necessary to highlight the international legal acts adopted within the framework of the United Nations. The main ones in the field of combating illegal migration are the UN Convention against Transnational Organized Crime (Palermo, November 15, 2000) and its complementary Protocol against the Smuggling of Migrants by Land, Sea and Air (New York, November 15, 2000).

In accordance with article 3 of the Protocol against the Smuggling of Migrants by Land, Sea and Air, against Transnational Organized Crime, "illegal import of migrants" is represented in the form of ensuring the illegal entry into any State Party of any person who is not its citizen or does not reside permanently on its territory. The main purpose of providing such transportation is to obtain financial or other material benefits.

The illegal transportation of migrants can also be qualified as an international crime, on the following grounds: 1) illegal transportation of migrants is most often carried out through private services of carriers outside the borders of one or more states by land, sea or air, which is an extremely profitable activity with relatively little risk to the transporters themselves, which, in turn, attracts criminals, and is extremely

dangerous to the life and safety of migrants themselves; 2) the organized activities of the migrant carrier are actions outside of the activities of the State in order to achieve illegal own goals; 3) the type of crime committed is transnational in nature and affects the interests of two or more States; 4) has a degree of public danger; 5) international legal norms on cooperation in combating the illegal transportation of migrants have been adopted.

Migration by sea has become widespread. According to practice, in recent years the volume of illegal migration has been growing due to illegal migrants who often use sea vessels, traveling on them without tickets or without proper documents. For example, surveys of captains of ships that sail under the flag of the Russian Federation and shipowners indicate an increase in the scale of this method of movement of illegal migrants. Migrant stowaways create difficulties both for the States themselves and for interstate relations. The presence of these migrants on board ships leads to significant expenses for ship crews and shipowners, which relate to unscheduled calls of ships to ports, the delay of ships in ports and court costs. In addition, difficulties arise in establishing the nationality of these persons, their detention, transfer to the port authorities and expulsion.

Illegal transportation of migrants can be considered as providing assistance, assistance or paid services in illegal crossing of the state border. If the consequence of illegal migration is a violation of the current legislation of one or more States, in particular an administrative offense, in turn, the illegal transportation of migrants (with the so-called "foreign element") can be qualified as an international criminal offense. The nature and scope of international legal regulation of cooperation in this area can be regarded as an indicator that such an independent branch as the law of international cooperation in the fight against crime has been formed in modern international law.

A distinctive feature of international crimes committed by States in the person of their top officials, leaders, or other responsible individuals is that a transnational crime (of an international nature) is committed by private individuals and without connection with the activities of the State to achieve any illegal goals. Crimes of an international nature are represented by ordinary criminal acts that are burdened with a foreign element and, as a result, affect the interests of several States. Another criterion for distinguishing between such varieties of international crimes and crimes of an international nature can determine the degree of their public danger.

### **Conclusion**

Thus, "illegal migration" is a massive illegal relocation, the movement of people who cross the border without meeting the established requirements for legal entry.

States are making great efforts to counter illegal migration. By virtue of sovereignty, they have an inalienable right to safeguard their national interests and not to allow foreigners to enter their territory, except in cases directly provided for by international law. This issue is also becoming relevant in the fight against international terrorism, when terrorists and other extremist forces infiltrate the territory of foreign States together with migrants.

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## Международно-правовые аспекты сотрудничества государств по борьбе с незаконной перевозкой мигрантов

**А. В. Пышкин**

ФГБОУ ВО «Тамбовский государственный технический университет», Тамбов, Россия  
*e-mail: Sasha888777sasha@mail.ru*

**Аннотация.** Международная незаконная миграция – одна из важных проблем современности. Правовой статус мигрантов, перемещающихся из одной страны в другую, различен. Их можно классифицировать на две группы: законные мигранты, т.е. лица, которые с разрешения иностранного государства и в соответствии с его законодательством и международными договорами находятся на его территории; незаконные мигранты — граждане других государств и лица без гражданства, нарушившие правила въезда, выезда, пребывания или транзитного проезда через территории, установленные национальным законодательством иностранного государства.

**Ключевые слова:** миграция, незаконная миграция, международные правовые акты, ООН, СНГ.

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## **Youth Policy in the Religious Sphere during the NEP Years**

**N. D. Sharapov**

Tambov State Technical University, Tambov, Russia

*e-mail: nik.sharapov.2020@inbox.ru*

### **Abstract**

The aim of this study is to analyze Soviet youth policy in the religious sphere during the NEP period. The relevance of this study stems from the particular importance of youth work. The unity and integrity of society and its stable positive dynamics depend on the success of this work. Studying the experience of such work in previous periods is of considerable interest. At present, one of the most important tasks facing Russian society is the implementation of a correct youth policy. The methodology of this paper is based on the historical-comparative and historical-systematic, as well as the inductive and deductive methods. In addition, the principle of historicism and the socio-psychological method are used. Methods from related humanities disciplines, such as political science and sociology, will be applied. This topic has been widely and extensively covered in the works of Soviet and contemporary Russian researchers. Many aspects have been touched upon, but it would be worthwhile to conduct the study from an interdisciplinary perspective. It is also necessary to summarize the findings of Soviet and Russian scientists. The results of this study can be used to propose materials for classes and textbooks in secondary and higher education. Also, conclusions can be drawn on the nature and methods of work with young people in the early years of Soviet power.

**Keywords:** NEP; religion policy; twentieth century; USSR; youth policy.

### **Introduction**

At the beginning of the twentieth century, major transformations took place on the territory of the Russian Empire. The vigorous activity of revolutionary movements led to a complete change in the social structure. The first socialist state in the history appeared on the world stage. New values and norms were proclaimed for human society. The new social order met opposition from other political forces and the Soviet government needed the support of the general population to protect their ideals.

As we know, youth is one of the most active and mobile social groups. Very often social transformations are carried out with the participation of this social group. Carrying out youth policy was one of the important activities of the Soviet state. In the spiritual sphere of public life, religion was the main opponent of the Communist Party ideology.

The Orthodox religion represented the fundamental ideological system for Russia before the events of the October Revolution. This system purported to explain the whole existing order of things, from elementary domestic issues, to basic aspects of existence. The state and law were also interpreted in this way, presented as the product of the divine will, which found its realisation on earth in them. The monarchical government and its domestic and foreign policies were explained to the average Russian from a religious standpoint, among others. It should not be forgotten that the spiritual sphere of life itself was under the full influence of religion, and that various social events, festivals and weddings were dictated by it.

That is why the Communist Party placed the main emphasis in the spiritual sphere of society on fighting religion as the main competitor to the new comprehensive ideological system - Marxism-Leninism. The main emphasis of the Communist Party was on combating religion as the main competitor to the new all-encompassing ideological system - Marxism-Leninism.

In the struggle for a place as the dominant social outlook, the Communist Party and its subordinate organisations used various methods and means. They can be roughly divided into violent and non-violent means. As to the violent means, we should note the Communist Party's use of political repression, with extensive involvement of the punitive organs. Let us take a closer look at the combination of non-violent means.

As mentioned above, young people play an active role in social transformation. The Communist Youth Union was created by the Communist Party on October 29, 1918, as a centralized public organization under the direct leadership of the RCP (b) in order to comprehensively influence its consciousness and to form a new identity in it. This union proclaimed as its main objectives the political education of youth in the spirit of communist ideas, ensuring the participation of youth in the state and economic construction, and their involvement in the protection of the new social order from external and internal infringements.

It is worth pointing out that although the Union of Communist Youth was set up as a voluntary organisation and positioned itself as a free association of young people, in fact the full control of its activities very soon fell into the hands of the Communist Party. The Union repeated the internal organizational structure of the RCP (b). The Union acted in strict accordance with Party orders, and showed little or no initiative. They were also sharply negative towards all possible alternatives to youth organizations, which they saw as a competitor in the struggle for the minds of the youth. The Union sought to monopolise its own influence in spiritual life.

The plan was to form an atheistic worldview among young people, striving to explain various phenomena only from a materialistic point of view. The members of this youth union were to carry out active propaganda work among the various strata of the population. It was also entrusted with the task of involving young people in the ranks of the organisation.

A number of new phenomena sought to build on the antagonism of the old orders. Innovations became not principally new, but 'not-so-old'. For example, so-called subbotniks and resurrection days were held, usually on major holidays. Such events for communist youth were not so much mundane examples of various festivals, but rather an ideological tool. They were characterized by the mockery and disrespect for religion in the course of these events, and by all sorts of "workouts" for young people who did not take part in the Sabbath or, conversely, took part in the religious festivities [3; 18,19].

Attention should be drawn to such phenomena as "Komsomol Easter" and "Komsomol Christmas". The value of the new festivals was to form worship, not of sacred forces, but of people who were directly involved in the building of communism. The old religious festivals were to be used for the purposes of anti-religious

propaganda. Such measures gradually led to a belief in the legal exclusivity of the Komsomol and communists and the disenfranchisement of clerics and believers, which later contributed to a psychology of permissiveness towards 'social strangers', who could easily be included on the basis of social background, as well as attitudes towards religious and anti-religious festivals. This would later play a role in the mass participation of Soviet citizens in the struggle against the 'enemies of the people'. [2; 83, 90]

In addition to the "Komsomol Easter" and "Komsomol Christmas", we should note the gradual emergence of such phenomena as "red christenings", "civil funerals" and "weddings without priests". Sokolova writes, "New rites were necessary in order to constitute not just a different status for humans but also to proclaim the creation of a new, hitherto unseen man - a man born of the revolution. In the 1920s, the idea of a new ritual and festive culture was part of the propaganda campaigns of the state for atheist propaganda and the movement for a new way of life. Holidays and social events were used by the propaganda apparatus as a dividing line between the old and the new world, which can be clearly seen in the publications of the 1920s". [4; 196-197]

The phenomenon was dictated largely by the need to literally replace church ceremonies with their secular counterparts; the Russian population of the 1920s could not imagine itself without a vast array of spiritual activities, in fact the church accompanied the average citizen throughout his or her life.

J. N. Lyutov notes that "at the end of the 1920s the Komsomol sought to strengthen the anti-religious sentiments of peasant youth. Their manifestation was seen in the fact that "in the villages the youth were the instigators in driving the popes out of the public flats. In premises from which clerics were expelled at the initiative of young people, hut-reading-houses were then set up. In some villages young people sought to avoid church marriages". [1; 132]

Also, L. N. Lyutov notes that young people who had lived in the Soviet state for more than a decade had a changing attitude towards church servants. Increasingly, the priest was not called "father-in-law" and was not treated "with the slavish politeness he had once shown". Youth anti-religiosity also found expression in 'Komsomol songs', taunts and jokes about the faithful. Note that although the number of believers was still considerable, there was already a growing disdain among them for the church people themselves. [1; 132]

Active struggle was also waged through the press, e.g. the magazine *Revolution and Church* was published. It aimed to justify in the eyes of the general public the various activities of the Soviet state aimed at separating church and state. [3; 23-24] The newspaper *Bezbozhnik* came out in 1922. There were several editions of *Bezbozhnik*: general, school, Red Army, and a number of regions.

Another organisation engaged in combating religion is the Union of Militant Godless. Its methods could be described as "moderate" in the mid-1920s. This was expressed in the official slogans of the organization itself: "Let us master natural science in order to have a strong weapon against religion. Natural scientific

materialistic knowledge and various every day and cultural innovations were opposed to religious practices and acted as an instrument of anti-religious propaganda.

We should note that despite the actually unfolding struggle with religion on the part of society, the legislative regulation was not so categorical. On January 20 (February 28) 1918, the Decree of the Council of People's Commissars of the RSFSR "On Freedom of Conscience, Church and Religious Societies" separated the Church from the State and the schools and granted the population the freedom of conscience: the right of every citizen to profess any religion or not to profess any; the equality of rights and obligations for believers of all faiths and unbelievers; and the impossibility for religious associations to use coercive or punitive measures against their members. The Decree provided for a material guarantee of the freedom of conscience: granting religious societies the use of religious buildings and properties free of charge. A categorical ban was imposed on the publication of "any local laws and regulations which would restrict or limit freedom of conscience".

However, at the same time the state was stepping on old orders, introducing a number of purely secular measures. By the end of 1917 and the beginning of 1918, for example, applying the possibilities of legal regulation, the Soviet state began a systematic rollback of outward signs of everyday religiosity. Decrees were issued by the VTsIK and SNK on the dissolution of marriage, on civil marriage, on children and on the keeping of civil status books. Pursuant to these legal acts, records of marriages, births and deaths were excluded from the jurisdiction of the church. A large number of religious ceremonies, previously very important for citizens, were being transformed by the state authorities into relics of the past. [3; 12]

### **Conclusion**

The following conclusions can be drawn. The Soviet state, including through youth organisations, waged an active struggle against religion as an ideological and economic opponent. It cannot be said that full success was achieved in this direction, as a significant part of the population remained religious in one way or another. A large number of Soviet citizens in one way or another tried to reconcile religious faith and communist ideology. Overall, however, due to active propaganda, especially among young people, a new identity with a greater orientation towards Marxism-Leninism was gradually constructed.

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## Молодежная политика в религиозной сфере в годы НЭП

**Н. Д. Шарапов**

ФГБОУ ВО «Тамбовский государственный технический университет», Тамбов, Россия  
*e-mail: nik.sharapov.2020@inbox.ru*

**Аннотация:** Целью данного исследования является анализ советской молодежной политики в религиозной сфере в период НЭП. Актуальность данного исследования обусловлена особой значимостью работы с молодежью. От успеха реализации данной работы зависит единство и целостность общества, его стабильная положительная динамика. Изучение опыта проведения такой работы в предыдущие эпохи представляет существенный интерес. В настоящее время, одной из важнейших задач, стоящих перед российским обществом, является осуществление грамотной молодежной политики. В основе методологии данной статьи лежат историко-сравнительный и историко-системный, а также индуктивный и дедуктивный метод. Кроме того, используются принцип историзма и социально-психологический метод. Будут применяться методы из смежных гуманитарных дисциплин, таких как политология и социология. Данная тема достаточно широко и полно представлена в трудах советских и современных российских исследователей. Были затронуты многие ее аспекты, однако представляется целесообразным проведение исследования с междисциплинарных позиций. Также, является необходимым обобщение выводов советских и российских ученых. По результатам данного исследования могут быть предложены материалы для проведения занятий и написания учебных пособий в средней и высшей школе. Также, могут быть сделаны выводы о характере и методах работы с молодежью в первые годы советской власти.

**Ключевые слова:** молодежная политика; новая экономическая политика; религиозная политика; СССР; XX век.



## Improving the quality of employee training

**P. A. Steblev, V. O. Nersesyan, A. I. Vasilenko**

Tambov State Technical University, Tambov, Russia

*e-mail: valera.nersesyan.00@mail.ru*

### Abstract

In the conditions of the economic crisis that has developed today from many factors, the issue of increasing the cost efficiency of companies in various sectors of the economy is of particular relevance. The budget of the largest Russian oil and gas companies aimed at training and staff development amounts to hundreds of millions of rubles annually. Various companies set themselves one of the goals to ensure maximum efficiency of the financial resources spent on staff training. The article defines the main tools for improving the quality of staff training at the stages of forming staff training plans and their implementation. And also their implementation is presented on the example of the company PJSC NK «Rosneft».

**Keywords:** improving competitiveness, mentoring, quality improvement tools.

Every year, all global companies, including Russian companies, incur enormous costs associated with training and advanced training of personnel. The expenses of the largest Russian oil and gas companies in this direction reach a colossal revenue of several hundred million rubles, while each company pays great attention to the effectiveness of the training and professional development process to improve the quality of services and products provided to increase the competitiveness of the enterprise. To this end, Russian oil and gas companies are developing and implementing a huge number of different tools to improve the quality of staff training. In the economic difficulties that have developed to date, the issue of increasing the cost efficiency of companies, including personnel training, is gaining a special degree of urgency.

Quality improvement tools can be implemented at various stages of the company's life, namely at the stages of planning and implementing staff training plans. At the stage of personnel training planning, an assessment of the company's need for personnel training can be attributed to the tools for improving the quality of training. Identifying weaknesses in the professional competencies of employees always allows you to better determine the required training programs for a particular employee, thereby optimizing future training costs.

For example, one of the methods at the stage of forming staff training plans in terms of choosing an educational service provider and its necessity, if training requires intervention by an external educational organization, should include the introduction of evaluation procedures for educational organizations. For example, PJSC NK «Rosneft» implements a whole complex aimed at improving the competencies of each employee in various areas of his professional activity.

At the stage of implementation of personnel training plans, the following tools can be used:

1. Development or approval of a training program (curriculum) for a specific employee. This tool will ensure that the content of the training program meets the identified training needs. Such a program can be developed by the company independently by a certain focus group or by competent employees whose goal is the development and training of personnel.

2. Development or coordination of educational and methodological support of training programs (lecture materials, textbooks, workshops). The company's participation in the development of educational and methodological support makes it possible to reflect the relevance of the non-competencies of employees and to form the necessary level and features of the technological process, machinery and equipment that will be used in the professional activities of the company's employees. For example, Rosneft has a unified corporate training system covering all business areas and categories of personnel.

Rosneft's corporate personnel training and development system is aimed at solving the following strategic tasks:

- to ensure the level of professional and technical competence of employees corresponding to the current and future needs of the Company's business;
- strengthen the Company's management competencies, including through the development of an internal personnel reserve;
- provide the Company's strategic projects with trained personnel;
- fulfill mandatory state requirements for the level of training of personnel of the fuel and energy complex, aimed at ensuring quality and safety in production;

3. Formation of the material and technical base of the educational organization. Any company, regardless of its field of activity, is interested in ensuring that the laboratory complex or training grounds of educational organizations are as close as possible to the real conditions and the direction of activity of a particular employee. In this regard, the company can finance the creation of laboratory complexes or training grounds. For example, Rosneft is continuously developing the capabilities of its internal training resource and its own training base. The volume and quality of professional training of production personnel of hazardous industries are provided by 63 corporate training centers, more than 2,000 people of expert teaching staff implementing professional training programs for workers, advanced training of specialists and managers, courses for the development of specialized competencies in the areas of activity. The training centers have a modern base equipped with professional training equipment, electronic and remote means of teaching and testing knowledge, training areas for practicing practical skills.

4. Any company should ensure the provision and competence of the training staff at the required level. Its purpose can be aimed at improving the level of qualification of a teacher employee using various learning tools from studying literature to various production practices using mentoring technologies. The development of an end-to-end mentoring system has been identified as one of the priority areas for the development of the personnel of PJSC NK Rosneft. Mentoring is an essential element of the accumulation and transfer of professional knowledge, skills and experience to young

workers – workers and specialists. The mentoring system includes:

- internship and on-the-job training for newly hired workers and young professionals;
- assessment of knowledge, skills and abilities, compulsory training, vocational training, working out practical skills on simulators;
- participation of mentors and mentees in corporate events;
- training and motivation of mentors.

5. Evaluation of the results of staff training under the program. Competent employees and teachers of educational institutions may be included in the examination commission to assess the results of training. This tool allows you to increase the objectivity of the evaluation of learning outcomes and timely assess the quality of the implementation of the training program. Rosneft experts take part in the state project on the development of industry professional standards, thereby helping each other, both their company and educational institutions. For example, since 2019, a new profile class has been opened at the SUNC MSU – natural science, or Rosneft-class, aimed at training in the field of natural sciences, ecology.

The application of the considered personnel training tools is aimed at improving its quality through a more effective process of planning training programs, if necessary, selecting educational organizations and supporting educational, methodological, logistical and personnel support of the educational process, as well as the introduction of a mechanism for evaluating learning outcomes. On the one hand, this tool requires significant financial investments, which may affect the financial results of the company, but on the other hand, training in such centers can ensure that the needs and requirements of the company are met. Thus, each employee of the organization of PJSC NK «Rosneft» consistently passes training for advanced training and exams to confirm a sufficient level of competence every period of time. The relevance of this topic will be high in any period of time. There is no unambiguous template solution to the problem of improving the quality of staff training, for the effectiveness of the company, but there are various methods, using which in a complex can solve the task set for any company.

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## Повышение качества обучения работников

**П. А. Стеблев, В. О. Нерсисян, А. И. Василенко**

ФГБОУ ВО «Тамбовский государственный технический университет», Тамбов, Россия

*e-mail: valera.nersesyan.00@mail.ru*

**Аннотация.** В условиях экономического кризиса, сложившегося на сегодняшний день от многих факторов, вопрос повышения эффективности затрат компаний различных отраслей экономики имеет особенную актуальность. Бюджет крупнейших российских нефтегазовых компаний, направленный на обучение и развитие персонала, ежегодно составляет сотни миллионов рублей. Различные компании ставят перед собой одну из целей обеспечить максимальную эффективность потраченных финансовых средств на обучение персонала. В статье определены основные инструменты повышения качества обучения персонала на этапах формирования планов обучения персонала и их реализации. А также представлена их реализация на примере компании ПАО НК «Роснефть».

**Ключевые слова:** инструменты повышения качества, наставничество, повышение конкурентоспособности.

## **Burden of proof in civil proceedings**

**I. S. Voropaev**

*Tambov State Technical University, Tambov, Russia  
e-mail: ilyavoropaev78@gmail.com*

### **Abstract**

The burden of proof is a procedural phenomenon expressed in a combination of the rights of the person participating in the case and the obligation to put forward and prove the grounds of their claims and objections. The distribution of evidentiary responsibilities remains controversial and is currently being discussed.

**Keywords:** burden of proof, civil procedure, civil dispute, procedural obligation, subject of law,

The principle of dispositivity is enshrined in civil law, that is, the opportunity for individuals and legal entities to exercise their civil rights at their discretion. In turn, this imposes on them responsibility for the commission or non-commission of actions in material legal relations.

By carrying out actions defined by civil legislation and properly registering them, a person forms prerequisites for the protection of their legitimate rights and interests in the event of a civil dispute. Thus, a person creates conditions for the proper performance of his/her evidentiary duty.

Legal science draws attention to the need to take into account pre - trial interests and actions when distributing the burden of proof . The definition of general and special evidentiary rules should be carried out taking into account the possibility of the party to record their actions, for example, the conclusion of a purchase and sale transaction by signing a contract. The main part of the special evidentiary rules imposes the obligation of proof on the subject who had real opportunities to provide his interests with the necessary evidence.

From the above, it follows that the civil process in general and the proof in particular begins with the distribution of evidentiary duties. First, the court treats the versions about the proof or unprovenness of these facts as equally probable. This relationship may exist indefinitely, in the case when any of the participants in the procedural relations did not have the need to take action to establish the circumstances of the subject of proof. The Institute of Proof just answers the question: which of the participants in legal relations, and what kind of actions should be taken to establish the subject of proof. In addition, the distribution of the burden of proof aims to eliminate the uncertainties that have arisen in legal relations when it is not possible to establish the circumstances relevant to the case.

If a sufficient amount of evidence has been received by the court that contributes to the reliable establishment of circumstances, then the consequences of non-fulfillment of the burden of proof do not occur. If it is impossible to reliably establish the circumstances of the case, the court has no right to take out with reference to the

insufficiency of evidence or the lack of certainty of the actual circumstances of the case. In order to eliminate uncertainty and limit the arbitrariness of the assessment of the existence of facts, there should be an institute for the distribution of the evidentiary burden.

If we compare the Civil Procedure Code of the Russian Federation and the Arbitration Procedure Code of the Russian Federation, there is a noticeable difference. So, 10 years ago, the defendant could win the case simply by not appearing in court or by telling the court: "the plaintiff did not prove the circumstances to which he refers, and I am not obliged to refute his arguments." Currently, the subject will be punished for such passive behavior in the arbitration process. However, in 2010, amendments were made to the Arbitration Procedural Code of the Russian Federation, paragraph 3.1 appeared, according to which: "the circumstances referred to by a party in support of its claims or objections are considered recognized by the other party if they are not directly challenged by it or disagreement with such circumstances does not follow from other evidence substantiating the objections submitted regarding the substance of the stated requirements." For information, there is no such clause in the Civil Procedure Code of the Russian Federation.

The distribution of the burden of proof means, among other things, to draw a conclusion about the presence or absence of legal facts in favor of one of the parties. If the party has not convinced the court of the unreliability of such a conclusion by statements and evidence, then the conclusion is transformed into a statement about the existence of the desired fact, which will be recorded in the reasoning part of the court decision.

It is necessary to distinguish between general and special rules for the distribution of evidentiary duties. The general rules for the distribution of evidentiary duties are fixed in Part 1 of Article 56 of the Civil Procedure Code of the Russian Federation, according to which each party must prove the circumstances to which it refers as the grounds for its claims and objections, unless otherwise provided by federal law. Understanding of the general rule of distribution of the evidentiary burden becomes more complicated when both parties point to the same fact, and one — to its presence, the other — to its absence. Special rules for the distribution of evidentiary duties apply to certain categories of civil cases or when solving a number of procedural issues.

Conclusion: the institution of the burden of proof is important in civil proceedings, contributing to the realization of the right and obligation of persons participating in the case to put forward and prove the grounds of their claims and objections.

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## **Бремя доказывания в гражданском процессе**

**Воропаев И.С.**

*ФГБОУ ВО «Тамбовский государственный технический университет», Тамбов, Россия  
e-mail: ilyavoropaev78@gmail.com*

**Аннотация.** Бремя доказывания представляет собой процессуальное явление, выраженное в сочетании прав лица, участвующего в деле, и обязанности выдвигать и доказывать основания своих требований и возражений. Вопросы распределения обязанностей по доказыванию остаются спорными и обсуждаются в настоящее время.

**Ключевые слова:** бремя доказывания, гражданский процесс, гражданско-правовой спор, процессуальная обязанность, субъект права.

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