

# THE WORLD OF SCIENCE WITHOUT BORDERS

PROCEEDINGS  
OF THE 11<sup>th</sup> ALL-RUSSIAN SCIENTIFIC AND PRACTICAL  
CONFERENCE FOR YOUNG RESEARCHERS  
(WITH INTERNATIONAL PARTICIPATION)

April 26, 2024  
Tambov

# МИР НАУКИ БЕЗ ГРАНИЦ МАТЕРИАЛЫ

МАТЕРИАЛЫ  
11-й ВСЕРОССИЙСКОЙ НАУЧНО-ПРАКТИЧЕСКОЙ  
КОНФЕРЕНЦИИ МОЛОДЫХ УЧЕНЫХ  
(С МЕЖДУНАРОДНЫМ УЧАСТИЕМ)

26 апреля 2024 года  
Тамбов



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«Тамбовский государственный технический университет»**

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## FOREWORD

The 11th International Conference of Young Researchers - “The World of Science without Borders” – was held at Tambov State Technical University on April 26, 2024. The event brought together a diverse group of bright young researchers from various fields, all sharing a common passion for advancing science. The mission of the conference was to remove the barriers on the way of disseminating innovative projects among young researchers.

As we explore the abundance of knowledge and groundbreaking ideas found within these pages, it is evident that young researchers are at the forefront of driving scientific progress and shaping the future of innovation. The power of science lies not only in its ability to uncover truths about the world around us, but also in its capacity to inspire and drive progress. Young researchers bring fresh perspectives, innovative ideas, and boundless enthusiasm to their work, propelling the frontiers of knowledge ever forward.

International conferences like “The World of Science without Borders” serve as platforms for collaboration, exchange of ideas and expertise. By bringing together young researchers from different disciplines, this event fosters innovation that enriches our collective understanding of the world. The contributions of these talented individuals are a true testament to the transformative power of science and the boundless potential of young minds. Together, we are building a brighter future through the promotion of science and the nurturing of young talent.

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.

These proceedings are a celebration of the importance of science, the invaluable contributions of young researchers, and the profound impact of international conferences on the advancement of knowledge.

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ББК (Ж/О)31.15

## IMPROVING THE RELIABILITY OF WORK HEAT SUPPLY SYSTEMS

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### Abstract

The scientific article addresses the pressing issue of shortage of thermal energy from the boiler house in conditions of increased demand for heating in the area. It examines the mismatch between the heat requirements and the boiler's capabilities during periods of escalated water consumption in hot water supply systems (HWS). The article proposes an analysis aimed at optimizing heat consumption in the heating system, enabling the efficient management of thermal energy during periods of heightened demand by employing a storage tank accumulator. This study holds significant importance in addressing current challenges associated with the sustainable and effective fulfillment of thermal energy needs in the face of evolving consumption patterns and heightened energy demands.

**Keywords:** battery tank, hot water supply, heating.

Insufficient thermal energy from the boiler to meet increased demand for heating from the facility results in an inadequate provision of heat at the required consumption level.

Based on the boiler's inherent capacity, a specific amount of thermal energy is expected to be allocated to meet the facility's heating needs. However, during periods of maximum water usage in the hot water supply system (HWS), the facility requires more heat than the boiler can provide. This situation leads to a shortfall in heat to meet the facility's requirements and creates an imbalance between the supply and demand for thermal energy.

There are various ways to improve the reliability of heat supply to subscribers [1-3].

The article considers a way to solve the problem of lack of thermal energy for heating needs by using a storage tank-accumulator of a hot water supply system [4].

The storage tank accumulator is a device capable of accumulating and retaining thermal energy provided by the boiler during periods of low demand. During peak loads or periods of heightened demand for heating at the facility, the accumulated thermal energy within the storage tank accumulator can be utilized to compensate for the shortfall in heat from the boiler.

This approach enables a more efficient utilization of allocated thermal energy, balancing fluctuations in heating demand and supply. Various types of storage tank accumulators, including buffer tanks with heat exchangers or heat storage systems, can be adapted and integrated into the HWS in accordance with the facility's requirements and the characteristics of the heating system.

Benefits of using storage tank accumulator:

– *Thermal Energy Storage*: the storage tank accumulator is designed to store

excess thermal energy provided by the boiler during periods of low heat demand. It acts as a reservoir where heat is retained for subsequent use during periods of increased demand.

– *Smoothing Peak Loads*: the storage tank accumulator helps to smooth out peak loads on the boiler by temporarily storing excess thermal energy and subsequently utilizing it during periods when more heat is required than the boiler can supply.

– *Compensating for Heat Deficiency*: during peak periods of heat demand, when the boiler is unable to provide an adequate amount of thermal energy, the storage tank accumulator serves as an additional heat source, compensating for the deficiency.

The subject of the heating supply is a 25-story office building, which has thermal loads for:

- heating: 1.1292 gcal/h;
- ventilation: 2.8866 gcal/h;
- hot water supply zone 1: 0.778734 gcal/h;
- hot water supply zone 2: 0.326807 gcal/h.

The total thermal load amounts to 5.121341 gcal/h. However, the boiler's capacity is 4.8 gcal/h, resulting in a deficit of 0.321341 gcal/h to adequately heat the building. To rectify this imbalance, a storage tank accumulator is proposed for HWS Zone 1 to supply the required heat during the peak hour of water consumption.

Our task is to determine the volume of the storage tank accumulator to ensure an uninterrupted hour of operation during the peak load.

Considering the boiler's capability of producing 4.8 gcal/hour of thermal energy, and a deficit of 0.321341 gcal/h for building heating, it's proposed to use a storage tank accumulator to compensate for this shortage. The tank should provide sufficient heat during the maximum hour of water consumption for HWS Zone 1.

The required flow rate would be 12.98 m<sup>3</sup>/h. However, considering the actual power output during the thermal load imbalance, the effective flow rate is calculated to be 7.62 m<sup>3</sup>/h.

To rectify the imbalance, a storage tank accumulator with a volume of 5.36 m<sup>3</sup>/h is needed. A tank of this capacity will cover the peak hourly load for HWS.

Insufficient thermal energy from the boiler results in a shortfall to meet the heightened heating demand of the facility, particularly during peak water consumption periods. To address this, employing a storage tank accumulator within the hot water supply system proves beneficial. This device stores excess thermal energy during low-demand times and compensates for the deficit during high-demand intervals, ensuring a balanced supply of heat to the facility. For the 25-story office building, experiencing deficit of 0.321341 gcal/h with a boiler capacity of 4.8 gcal/h, installing a 5.36 m<sup>3</sup>/h storage tank accumulator for HWS would effectively cover peak hourly loads.

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## **ПОВЫШЕНИЕ НАДЕЖНОСТИ РАБОТЫ СИСТЕМЫ ТЕПЛОСНАБЖЕНИЯ**

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**Аннотация:** Рассмотрена актуальная проблема дефицита тепловой энергии от котельной в условиях увеличенного спроса на отопление в данной местности. Исследуется несоответствие между потребностью в тепле и возможностями котельной в периоды повышенного потребления воды в системах горячего водоснабжения (ГВС). Проведен анализ оптимизации потребления тепла в системе отопления, что позволяет эффективно управлять тепловой энергией в периоды повышенного спроса с использованием накопительного бака. Исследование имеет значение для решения текущих проблем устойчивого и эффективного удовлетворения потребностей в тепловой энергии в условиях изменяющихся моделей потребления и повышенного спроса на энергию.

**Ключевые слова:** бак-аккумулятор, горячее водоснабжение, отопление.

## THERMONUCLEAR FUSION AS A SOURCE OF CLEAN AND SAFE ENERGY

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### Abstract

The article considers the potential of fusion as a source of energy. The principle of tokamak operation and the history of research development in this field are described in detail. The two largest projects in the field of fusion - ITER and SPARC - are described, and the Kazakhstani project is also mentioned. ITER is an international project aimed at creating an experimental tokamak-type fusion reactor, which should prove the possibility of using fusion for commercial energy production. SPARC is a new tokamak that could be a breakthrough in fusion research being built by Commonwealth Fusion Systems (CFS) together with the Center for Plasma Science and Fusion (PSFC) at the Massachusetts Institute of Technology (MIT). Kazakhstan's contribution to fusion reactor research, in particular the construction of its reactor, based at the National Center for Fusion Research (Kurchatov Institute) is also considered. The article emphasizes that fusion can become a real source of clean and safe energy that can change the world.

**Keywords:** fusion, tokamak, ITER, SPARC, KTM, clean energy, future of energy.

With the development of electricity and the construction of the first nuclear power plant, the question of creating a new, cheaper and more economically viable energy arose. All existing energy sources are very costly in terms of fuel and construction or cause great harm to the ecological system. The creation of an ideal energy source is one of the main problems of the energy industry.

The formation of two medium-sized nuclei through a heavy nucleus fission reaction brings the release of energy. This method of energy generation is used in nuclear power plants. An even greater energy release occurs when light nuclei are combined. In 1931, H.A. Bethe discovered that the source of energy in stars is thermonuclear fusion. In the early 50s, the possibility of obtaining energy through nuclear fusion was demonstrated by testing thermonuclear weapons. Since then, the main focus has been on developing the scientific basis and devices that could realize fusion [1]. Just one of the ideas of mankind that has wanted to recreate for more than 70 years is to create its sun, or more scientifically, to create controlled thermonuclear fusion.

A light nuclear fusion reaction can be achieved by accelerating nuclei of one type in a gas pedal and directing them to a target consisting of an isotope of the same or another element. However, this method is inefficient on an industrial scale for several reasons. The cross-sections of nuclear reactions, even under optimal conditions, are much smaller than those of atomic collisions, by about  $10^6$  to  $10^8$  orders of magnitude. Therefore, the kinetic energy of accelerated nuclei is mainly spent on ionization and excitation of atoms in the target. The remaining energy of the accelerated nuclei is insufficient for the nuclear fusion reaction, which makes its realization unlikely. As a result, the energy expenditure for accelerating the nuclei

significantly exceeds the energy obtained from the nuclear reaction [2].

Controlled thermonuclear fusion (CFC) is a method of energy generation based on the fusion of light atomic nuclei under controlled conditions. Unlike unguided fusion used in thermonuclear weapons, CFC allows for safe and efficient energy generation. STS research began shortly after the development of thermonuclear bombs, stimulated by the prospect of access to the vast stores of energy contained in deuterium, tritium, lithium, and other elements. Currently, STS research is approaching an important milestone: demonstrating the feasibility of its realization in research facilities. This will make STS a real source of energy for the future [2].

The first thermonuclear installation – the tokamak T-10 is a facility in which controlled thermonuclear fusion takes place. Tokamak stands for toroidal chamber with magnetic coils. The principle of tokamak is as follows: in the center of the tokamak is a core with a primary winding for high-frequency current, the second winding is a secondary toroidal chamber, it creates a vacuum and is fed gaseous deuterium and tritium as a result of tokamak work in consequence of high temperatures there is a fusion of heavy hydrogen nuclei and plasma, it is held by the field created by magnetic coils. As a result of the fusion of deuterium and tritium, helium is created, thus due to the fusion of heavy hydrogen nuclei (deuterium and tritium) a huge amount of energy is released. The T-10 is mainly used for fusion research and is not designed to power the electrical grid. This was the starting point for the development of full fusion reactors.

Today, there are many projects to create a source of energy based on controlled fusion, but the largest of them is still ITER. It is an international project aimed at creating an experimental tokamak-type fusion reactor. The aim of the project is to prove the possibility of using fusion for commercial energy production and to solve the problems associated with it. Project development began in the 1980s and construction began in 2010. Reactor assembly started in 2020 and construction is scheduled to be completed in 2025. ITER is located in France, on an area of 180 hectares in the commune of Saint-Paul-le-Durans, next to the CEA nuclear center. The ITER project is an important step towards a clean and secure energy future and can demonstrate the potential of fusion as a long-term solution to energy security.

The heart of the ITER project is the tokamak, a massive structure that will be the key to unlocking fusion. Construction of ITER, which began in 2010, is well underway. Under the direction of France's ITER agency, researchers from around the world are erecting the 60-meter tall behemoth, which will weigh approximately 23,000 tons.

The scale of ITER is staggering: it will be taller than the Spasskaya Tower, and inside it, plasma of 40 m<sup>3</sup> will be created at a temperature of 150 million °C. This will require a magnetic field 200,000 times larger than the Earth's. The superconducting magnets will be cooled to a record-low temperature of -269 °C [3].

ITER is not just a science project, but a step into the future. If it is successful, fusion will become a real source of clean and safe energy that can change the world. ITER project as we said above is the largest in the study of controlled thermonuclear fusion, but fortunately, it is not the only one. Now there are such projects as KSTAR and SPARC and we will talk about the latter in more detail.

SPARC is a new tokamak being built by Commonwealth Fusion Systems (CFS) in conjunction with MIT's Plasma Science and Fusion Center (PSFC). The SPARC project was announced in 2018 with a planned completion date of 2022 and is scheduled to begin operation by 2025. SPARC will be much more powerful and technologically advanced than its predecessors, as well as will produce about 10 times more energy than it consumes.

One advantage of SPARC over ITER is that the magnets in SPARC will confine the plasma better and more precisely. SPARC will use what are called high-temperature superconducting magnets, which can create powerful magnetic fields. These new magnets can create much stronger magnetic fields - up to 21 tesla at SPARC compared to 12 tesla at ITER. By comparison, the strength of Earth's magnetic field ranges from 30 to 60 millionths of a tesla. SPARC is the most promising tokamak among all the others because it uses completely new components for construction, and if the project is successful, mankind can forget about nuclear power plants, hydroelectric power plants, hydroelectric power stations, etc. The efficiency is record-breaking: a glass of water will be enough to provide all the energy needs of one person for a lifetime. The appearance of SPARC means the end of "fossil" energy and the rapid reduction of nuclear power capacity. Researchers at the Massachusetts Institute of Technology and a subsidiary of Commonwealth Fusion Systems began designing a new reactor that is more compact than its predecessors back in early 2018, with construction set to begin in the first half of next year. According to researchers and company officials, if their schedule goes as planned, the reactor, called Sparc, will be able to produce electricity for the grid by 2030. That would be much faster than the existing large fusion power initiatives [4].

The existing reactor designs are too large and expensive to generate electricity for consumers. Using cutting-edge super strong magnets, the MIT and Commonwealth Fusion team hopes to create a compact, efficient and scalable tokamak reactor. "What we've done is combine existing science with a new material to open up tremendous new possibilities," Greenwald said. After demonstrating that the SPARC device can theoretically produce more energy than it takes to operate, in research papers published in September, the next step is to build the reactor and then pilot a plant that will generate electricity on the grid [4].

Kazakhstan also keeps up with everyone and is not going to lag in anything, which is why Kazakhstan is building its fusion reactor. It took 7 billion tenge from the country's budget invested in the construction and 6 years of forced downtime in search of funding sources. The project of Kazakhstan material science tokamak was on the verge of closure. However, the situation changed radically due to new directions of international cooperation.

If the SPARC project is successful, humanity will have taken a significant step forward. The thermonuclear reactor uses hydrogen as fuel, which can be obtained from natural gas or water. At the same time, its efficiency reaches record levels: one glass of water is enough to provide all the energy needs of one person for a lifetime. The advent of SPARC will lead to the end of the era of "fossil" energy sources and accelerate the reduction of nuclear power capacity, which is already under pressure from green energy [4].

The Kazakhstani facility was built in 2010 at a specially designated site in the administrative zone of the former Semipalatinsk test site - the city of Kurchatov. The project was developed in Russia at the National Center for Thermonuclear Research (Kurchatov Institute). The project was rebooted on the eve of EXPO 2017 in Astana. It was a perfect fit with the concept of the world exhibition dedicated to the energy of the future. On June 9, the plant was re-launched in the presence of a large number of journalists. As it was stated during the solemn event, the purpose of the first stage of the physical start-up was to debug and check the standard systems of the KTM. On June 10, a memorandum on joint research between ITER and KTM was concluded. The scientific supervisor is Baurzhan Chektybaev.

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## ТЕРМОЯДЕРНЫЙ СИНТЕЗ - ИСТОЧНИК ЧИСТОЙ И БЕЗОПАСНОЙ ЭНЕРГИИ

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**Аннотация:** В статье рассматривается потенциал термоядерного синтеза как источника энергии. Подробно описан принцип работы токамака и история развития исследований в этой области. Описываются два крупнейших проекта в области термоядерного синтеза - ITER и SPARC, а также упоминается казахстанский проект. ITER - это международный проект по созданию экспериментального термоядерного реактора типа токамак, который должен доказать возможность использования термоядерного синтеза для коммерческого производства энергии. SPARC - новый токамак, который может стать прорывом в термоядерных исследованиях, создаваемый Commonwealth Fusion Systems (CFS) совместно с Центром науки о плазме и термоядерного синтеза (PSFC) Массачусетского технологического института (MIT). Рассмотрен вклад Казахстана в исследование термоядерных реакторов, в частности строительство собственного реактора, на базе Национального центра термоядерных исследований (Курчатовский институт). Отмечается, что термоядерный синтез может стать реальным источником чистой и безопасной энергии, способным изменить мир.

**Ключевые слова:** термоядерный синтез, токамак, ITER, SPARC, KTM, чистая энергия, будущее энергетики.

## MODERN PROBLEMS OF MIXING BULK MATERIALS IN GRAVITY MIXERS

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### Abstract

The well-known models of gravitational mixers of bulk materials, which are widely used in various sectors of the economy, are considered. To improve the mixing process, additional impact on the bulk material is necessary during its movement along the mixer body, as shown by a study of gravity-type mixer designs. When developing more advanced designs of gravity mixers, special attention is paid to ensuring turbulence of the flow of bulk material on the working parts of the mixer.

**Keywords:** gravity mixers; increasing mixing efficiency; mixing bulk materials.

### Introduction

Bulk material mixing by gravity is a common practice in the chemical industry and related sectors. This technique is used in mixers where the ingredients are constantly circulated, moved along the body due to gravity, and disseminated throughout the full volume of the mixture. Gravity mixers provide the following benefits: no moving parts, low specific energy costs, and easy design and operation. Additional effects on the bulk material, such as spraying, stacking of mixed particles, uneven particle movement, impact of a jet of bulk material on the mixer's working body, etc., are also used in gravity mixers to accelerate the mixing process. At the moment, tray, hopper, and impact-spray gravity mixers are the most used types. [1]. The design of gravity mixers and techniques to improve the effectiveness of mixing bulk materials in both of them are covered in this article.

### Cascade gravity mixers without mixing element

The ease of use and design of tray mixers is its defining feature. The body 1 of a traditional gravity tray mixer (Fig. 1, a) has a rectangular cross-section, and inside are inclined trays 2 arranged one above the other [1].

Fittings 3 and 4 are used to link the dispenser and mixer. In the working mixing area, the bulk material is spread out in a thin layer along the tray. The angle at which the tray slopes towards the horizon needs to be larger than the angle at which the bulk material on the tray's surface frictionally acts. The mixture is stirred as the layers drain from the first two trays and migrate unevenly across the subsequent trays.

Due to the bulk material sliding over the trays' surface with essentially no particle mixing, this device's low mixing efficiency is a drawback.

The traditional gravity hopper mixer architecture is depicted in Figure 1, b [1]. A dispenser feeds the ingredients to be combined into the mixer via connections 2 and 3. Five or six conical bottoms 4 with holes 5 are fixed one above the other along the height of the cylindrical body 1. In this instance, the cylindrical body and each conical bottom combine to form a hopper. In order to guarantee a specific supply of material in the bins, the size of the outlet holes 5 in the bottoms must be chosen.

Because of the irregular movement of particles in bunkers, components are mixed together and must travel through the hopper many times to achieve homogeneity. For this purpose, hopper mixers with three or more conical bottoms are frequently utilized; they work well with materials that flow freely but not with sticky ones. It's crucial to keep arches from growing over bins' outlets that hold mixed materials.

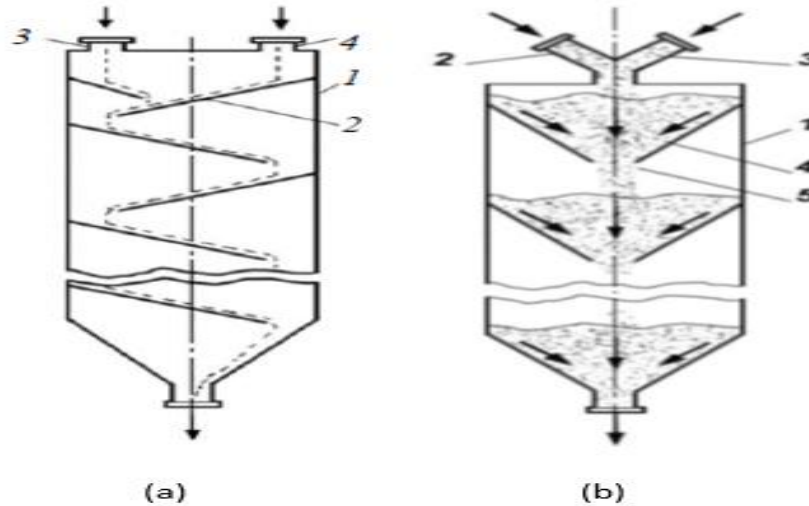


Figure 1 - Designs of traditional gravity mixers Tray mixer (a) and hopper mixer (b).

### Gravity mixers with mixing body

A bulk materials mixer operates as shown in Fig. 2 [2]. Initially, the plate 12 receives the bulk material via the loading nozzle 4 and the transfer funnels 3. This process is continued until all of the internal space in the transfer funnel cascade is filled. Under each of the spill funnels, therefore, heaps of material with natural angles of repose form. The material passes via blades 7—which are situated in the material heaps beneath the funnels—after the transfer funnels are filled. Under the influence of the blades, some of the material travels in parallel, loosening flows of falling particles between the body and the transfer funnels. Particles of falling parallel flows come into touch with brackets 6, which are formed like inclined plates. Particles in free fall are mixed and undergo trajectory changes upon coming into touch with the brackets.

The particles then enter the guide funnels 10 through the gap created by the transfer funnels 3 and the housing 1. They further mix the bulk material that falls in the gap between the housing and the transfer funnels with the assistance of the curved blades 11. The combined material is then once more injected into the transfer funnels 3 through the bottom base of the guiding funnels. The bulk material's particles are further mixed by the way the substance moves along the mixer body 1 in the transfer funnel due to gravity.

Conical pouring funnels facilitate both radial and longitudinal mixing due to the irregular flow of particles, which improves the overall mixing of bulk materials. The material is mixed both longitudinally and transversely before being moved to the next funnel and going through the same procedure again. Bulk materials are mixed to a high standard thanks to this progressive mixing in succeeding funnels. Pipe 5 is used

in the 2 conical bottoms of the apparatus to discharge the finished mixture.

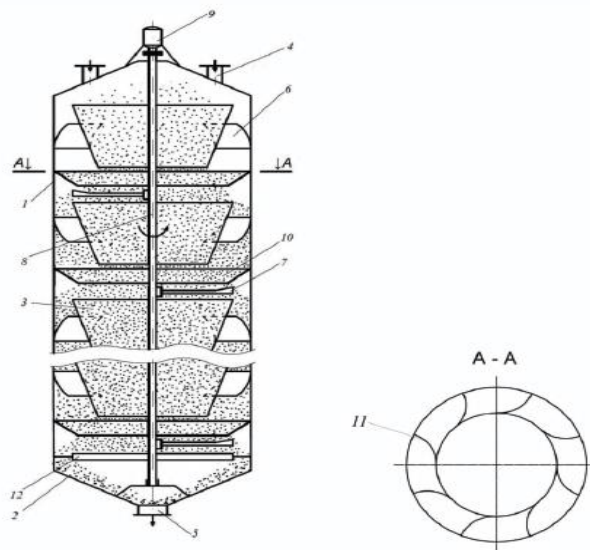


Figure 2 -A bulk materials mixer diagram.

Two techniques are used in another mixer [3] (Fig. 3) with a conical body 1 and a cylindrical working chamber 2 to mix bulk materials that enter this chamber through loading pipelines 3.

Moving working parts 4 on a shaft 5 with elastic brushes completes the first case's mixing process; in the second one, extra mixing is accomplished by rocking trays fitted with dampers 6. This device is characterized as a tray mixer with an elastic working body because the trays can revolve around their fastening axis. This device's benefits include a straightforward design, excellent mixing quality and productivity, and the elastic working element's capacity to get beyond the drawbacks of stiff mixing elements. Moreover, gravity equipment differs from mixers on a moving belt in that it uses two mixing techniques. [3, 4, 5].

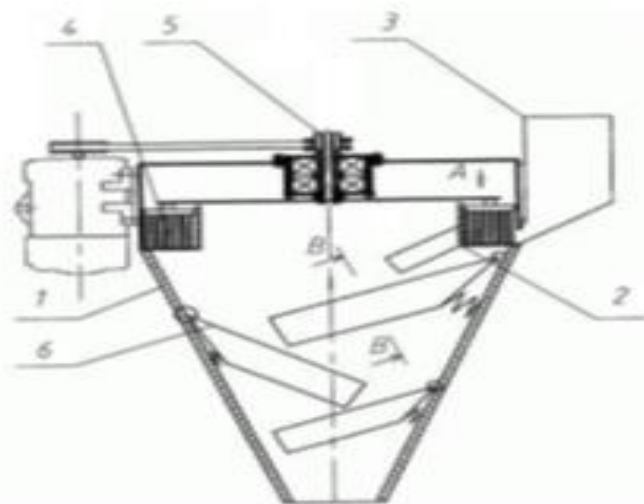


Figure 3 - Tray mixers with movable, elastic mixing parts that are gravity-type.



## Conclusion

It should be mentioned that although gravity mixers are simple to assemble and operate, they are not very effective for combining materials that separate easily. A review of the literature reveals that most industrial gravity mixer designs from the past are out of date. They also don't provide the chance to get a high-quality combination with a consistent composition. The primary drawback of the mixer designs used today is their poor operational reliability and low mixing process efficiency. In order to speed up the mixing process, we think that techniques and strategies that raise turbulence and circulation of flows of mixed bulk materials are promising.

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## СОВРЕМЕННЫЕ ПРОБЛЕМЫ СМЕШИВАНИЯ СЫПУЧИХ МАТЕРИАЛОВ В ГРАВИТАЦИОННЫХ СМЕСИТЕЛЯХ

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**Аннотация:** рассматриваются известные модели гравитационных смесителей сыпучих материалов, которые широко используются в различных секторах экономики. Чтобы улучшить процесс смешивания, необходимо дополнительное воздействие на сыпучий материал во время его движения вдоль корпуса смесителя, как показало исследование конструкций смесителей гравитационного типа. При разработке более совершенных конструкций гравитационных смесителей особое внимание уделяется обеспечению турбулизации потока сыпучего материала на рабочих органах смесителя.

**Ключевые слова:** гравитационные смесители; повышение эффективности смешивания; смешивание сыпучих материалов.

## RESEARCH INTO POWER INSTALLATIONS BASED ON RENEWABLE ENERGY SOURCES

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### **Abstract**

This paper examines the necessity and importance of green energy around the world and gives recommendations to the energy consumer on its development through the use of renewable energy sources.

**Key words:** green energy, renewable energy sources, development, research, energy consumer.

### **Introduction**

The availability, acceptability and affordability of energy play a crucial role in the comprehensive economic development of regions and countries. However, with the increasing global demand for fossil fuels, energy markets are under significant pressure. In addition, the use of fossil fuels is a major source of greenhouse gas emissions, and scientists around the world are warning that countries need to reduce emissions or face the potentially catastrophic effects of climate change. According to most scientists, switching to green energy is an effective way to address this problem. Green energy is electricity generated from renewable energy sources such as solar panels, biomass, geothermal projects and wind farms. The introduction of green energy can lead to zero pollution and can be effectively utilized in industry and daily life. Therefore, there is a global call for the widespread use of clean and renewable energy to combat global warming and climate deterioration.

This article first analyzes the relevance of “green energy” at the global level and offers recommendations for energy consumers to improve the use of renewable energy sources.

Research in this area can be divided into two phases: before and after 2010. Before 2010, research was relatively limited. However, since 2010, green energy has become an actively researched topic and the number of published research papers on the topic has been increasing rapidly. One of the main reasons for this increase is the universal concern about climate and environmental change caused by energy consumption in recent years.

In recent years, significant progress has been made in the development of Renewable energy sources technologies, especially solar and wind energy. From 2000 to 2013, global renewable energy sources production grew at an average annual rate of 3%. By the end of 2013, a total of 36 GW of solar panels had been installed globally, exceeding the total increase in capacity over the previous decades. The leading countries in renewable energy technologies at the moment are the US, China and Brazil. For example, Wal-Mart in the USA has already reached the maximum volume of its own generated "green" energy of more than 182 million kWh [1].

Table 1

The US companies using the maximum amount of their own generated renewable energy

Company	Consumption volume own generated energy, кВт⋅ч/year	Share in total volume consumption of the company, %	Used Renewable energy sources for own generation	Optional purchased amount of "green" energy, kWh/year
Wal-Mart	182 297 795	1	The sun, the wind	644 045 931
Apple Inc.	156 513 800	15	Biogas, solar	865 093 200
General Motors	53 260 800	43	Biogas,	0
Coca-Cola Refreshments	51 827 856	6	Biogas, solar	0
BMW Manufacturing Co	51 534 262	21	Biogas, solar	0

*Source. [1].*

Unfortunately, renewable energy-based installations are not widely developed in Russia, but several large companies are already committed to developing green energy in the country. Lukoil has been investing in Renewable energy sources for years, while “Enel Russia” sold all of its coal-fired capacity in 2019 and is currently building wind farms with a total capacity of 362 MW. Russia plans to significantly increase the share of renewables in the country's energy mix, from the current 1% to 10% by 2040. To achieve this goal, the government is extending the program of state support for RES, for which about 400 billion rubles will be allocated over 10 years (2025-2035) [2].

In addition to energy producers, consumers can also have a significant impact on the development of renewable energy sources. According to experts of the American energy company Just Energy, potential opportunities for consumers include the following:

- Conservation of fossil fuels;
- Minimizing dependence on fossil fuel imports.
- Slow and reversible climate change. [3]

### **Conclusion**

Thus, the development of green energy is a key factor in addressing the global challenges of climate change and pollution. Renewable energy installations have the potential for stable and sustainable development. It is important to continue research and develop new technologies to maximize the efficiency of renewable energy

sources.

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## АНАЛИЗ ИССЛЕДОВАНИЙ ЭНЕРГОУСТАНОВОК НА ОСНОВЕ ВИЭ

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**Аннотация:** В данной работе рассматривается необходимость и значимость «зеленой» энергии во всем мире, даны рекомендации потребителям энергии по ее развитию путем использования ВИЭ.

**Ключевые слова:** ветроэнергетика, энергия ветра, исследование, зеленая энергетика, потребитель энергии.

## PROSPECTS FOR THE DEVELOPMENT OF THE WIND ENERGY SYSTEM IN RUSSIA

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### Abstract

Given the global situation where demand for fossil fuels is inevitably declining, Russia is taking steps in the right direction by creating a wind energy market and starting to use its huge wind energy potential. It is extremely important that the wind energy sector in Russia continues to develop sustainably and that Russia uses its promising innovative prospects to create its own wind energy industry and create thousands of jobs throughout the industry chain. In addition to the market for grid-connected wind turbines, Russia has the potential to develop off-grid wind turbines and may even become a global market leader in this previously under-developed segment. Another important aspect of renewable energy development is the production of "green" hydrogen from wind energy and other renewable sources. Current consumers of Russian natural gas will sooner or later have to decide whether to produce hydrogen independently or import it from other countries. Given the existing infrastructure, Russia can take a leading position in this race for the place of the future leader of the world market in the supply of "green" hydrogen.

**Keywords:** wind energy, wind power plants, wind energy industry.

Russia has the largest wind energy potential in the world, estimated at more than 100 TWh/year [1]. In the long term, Russia can leverage these vast resources to export energy from wind farms, including to neighboring countries. According to estimates from the REMap-21 project, the total wind energy capacity in Russia could reach 24.3 gigawatts by 2030 [2]. This figure is based on the replacement of existing capacities as they are phased out of the energy balance for the wholesale market. In several regions within the wholesale market, there's an excess of generating capacities, making it quite challenging to justify wind energy in their energy balances. Such a volume of wind power would suffice to cover approximately 10% of Russia's energy supply and create about 50,000 jobs (as estimated by WWEA) in the wind sector.

The installed capacity of energy sources in autonomous zones, part of the retail market, is only 6 gigawatts. However, with successful Arctic development and improvements in the legislative framework within retail market zones, the total wind energy capacity in isolated regions could reach between 1 to 5 gigawatts by 2030, according to various estimates.

Various opportunities exist for different companies aiming to enter the Russian market to achieve the set localization targets.

1. For foreign companies intending to enter the Russian wind energy market, options include: selling their own licenses, establishing their production facilities in the country, and participating in competitive selections with their wind energy systems. Examples of companies selling licenses include Vensys; companies planning to establish their own production facilities include Siemens, General Electric, Lagerwey, and others. It's important to understand that the absence of

innovation growth in the Russian wind energy market segment within society could be perceived negatively.

2. For Russian companies, possibilities include: purchasing licenses from foreign companies. In this case, the design process doesn't start from scratch. OAO "Kirovsky Plant" has shown interest in wind turbine production. However, drawbacks include the limited ability for the license-selling company to introduce changes, primarily retaining space for innovations; self-development. This is a more complex approach as manufacturing certain components (such as blades) requires high competence. The production of megawatt-class wind energy units is technologically complex and demands a longer period for localizing production (General Electric's experience suggests at least 4 years on average). It requires significant restructuring of relevant industrial sectors, logistics development, a new system for training and education, including international knowledge exchange. Such developments and innovation implementations are typical for RUSNANO, which invests in the development of promising technologies, including for export [3].

Russia holds significant prospects in Arctic region development, and the creation of its own northern-specific wind energy units could enable the country to be competitive globally. Seeking technological partners is another strategy. For instance, Rosatom, in collaboration with the Danish company Lagerwey, is preparing to launch its assembly production of wind energy units with a capacity of 2.5–3 megawatts [4]. The production facilities will be located at the manufacturing base of OAO "Atomenergomash." Further growth of wind energy capacities will result in the emergence of new jobs in Russia, opening production sites in regions, attracting additional investments into Russian regions.

In the future, given the sustained industry growth, many problematic issues should be resolved, using the experience of countries with developed wind energy markets, as these nations also encountered similar problems and found solutions. Currently, several issues are being addressed within the regulatory field, such as amendments related to equipment localization, procedures for new capacity introduction deferrals, and the establishment of an extended regulatory framework in the retail market for electricity [4]. Additionally, trends indicate improvements in theoretical training and qualification of specialists in this sector.

The interval between project selections and the introduction of initial capacities in the wholesale market should be used to refine regulatory documentation in the retail market, improve existing standards, and pay attention to regions with isolated energy supply. To enhance the investment attractiveness of wind energy projects in Russia, the government needs to establish a clear long-term development position for the industry. Moreover, beneficial measures might include training programs for navigating the Russian market and open platforms for discussions, allowing the attraction of foreign partners. Furthermore, deeper partnerships among the Market Council, RUSNANO, the Global Wind Energy Council, Russian and international universities, wind energy research institutes, Russian, and foreign companies can unite efforts to accelerate the development of the wind energy market in Russia.

Within the project's framework, the following has already been accomplished:

1. An in-depth examination of the regulatory framework governing state support for renewable energy sources' facilities in Russia's wholesale and retail markets.
2. Identification of three barrier categories (financial, infrastructural, regulatory), separately addressing barriers in isolated zones.
3. Recommendations for possible measures to overcome barriers and the description of wind energy market development prospects in Russia for both Russian and foreign companies.

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## ПЕРСПЕКТИВЫ ВОЗМОЖНОСТИ ВЕТРОЭНЕРГЕТИЧЕСКОЙ ОТРАСЛИ В РОССИИ

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**Аннотация:** Учитывая глобальную ситуацию, когда спрос на ископаемые виды неизбежно сокращается, Россия делает шаги в правильном направлении, создавая ветроэнергетический рынок и начиная использовать свой огромный ветроэнергетический потенциал. Крайне важно, чтобы ветроэнергетический сектор в России продолжал устойчиво развиваться, и чтобы Россия использовала свои многообещающие инновационные перспективы для создания собственной ветроэнергетической отрасли и создавала тысячи рабочих мест на всей цепочке индустрии. Помимо рынка ветроэнергетических установок с сетевым подключением, Россия обладает потенциалом для развития внесетевых ветроэнергетических установок и даже может стать лидером мирового рынка в этом ранее недостаточно освоенном сегменте. Еще одним важным аспектом развития ВИЭ является производство «зеленого» водорода из энергии ветра и других возобновляемых источников. Нынешним потребителям российского природного газа рано или поздно придется решать, производить ли водород самостоятельно или импортировать его из других стран. Учитывая существующую инфраструктуру, Россия в этой гонке за место будущего лидера мирового рынка по поставкам «зеленого» водорода может занять ведущие позиции.

**Ключевые слова:** ветроэнергетика, ВЭС, ветроэнергетическая отрасль.

## METHODS OF INCREASING HEAT TRANSFER IN SHELL-AND-TUBE HEAT EXCHANGERS

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### Abstract

The purpose of this article is to critically evaluate various methods used to increase the heat transfer rate in shell-and-tube heat exchangers. Improvements in heat transfer in heat exchangers can be achieved through the use of several methods, which can be divided into active and passive. With active methods, the system requires an external power supply, whereas passive methods include surface modification or the inclusion of vortex devices in the flow field. Active methods are significantly complicated due to the need for an external power supply; however, they have significant potential and provide thermoregulation. On the other hand, passive methods are more common than active ones, since they can be easily implemented in existing heat exchangers.

**Keywords:** active method, efficiency improvement, passive method, shell-and-Tube heat exchanger

### Introduction

The development of the chemical and petrochemical industry is a crucial aspect of the Russian economy, and the country's strategy for the industry's development until 2030 involves both modernizing existing chemical plants and constructing new ones[1].

Improving and optimizing heat transfer within systems is essential to identify thermodynamic Pinch Points and maximize overall energy efficiency. Although the shell-and-tube heat exchanger is widely used in the industry for heat transfer, it suffers from inefficiency, low compactness of heat transfer area, non-ideal fluid flow arrangement, and fluid flow maldistribution, which results in fouling and reduced overall heat transfer coefficient. Enhanced heat transfer techniques, such as providing additional heat transfer surface or inducing more turbulence in the flow can intensify the operation while simultaneously reducing fouling and mechanical vibrations experienced by the equipment [2]. This leads to lower maintenance costs. The primary objective of this research is to enhance the heat transfer rate in shell and tube heat exchangers, as they are a key means of reducing energy waste. The focus is on the significant role played by Heat Transfer Enhancement (HTE). The combination of HTE with Heat Integration retrofit has shown promising results, increasing heat recovery by an additional 10% compared to retrofit without HTE.

### Heat Exchanger Design and Technology Improvement

Heat transfer intensification has been the subject of extensive research for several decades, encompassing various types of heat exchangers. However, the majority of studies have focused on the shell-and-tube heat exchanger (STHX) due to its prominence in the industrial sector. STHXs possess the flexibility to be adapted to a wide range of scenarios and fluid conditions, including pressure, temperature, and



viscosity. Consequently, considerable attention has been devoted to augmenting the heat transfer coefficients (HTC) in order to enhance the overall cost-effectiveness of a heat exchanger.

### Heat Transfer Enhancement (HTE)

Heat transfer enhancement (HTE) is a fundamental tenet that entails the implementation of alterations to equipment, which augment the rate of heat transfer for a specified surface area. This is done in order to attain greater workloads within the confines of the identical equipment unit, thereby amplifying energy preservation and productivity [3]. It is important to note that HTE can be categorized into two primary classifications: active and passive.

As previously mentioned, the implementation of active methods necessitates additional energy to enhance the rate of convective heat transfer. The application of active methods is constrained by the limitations of practical implementation and the challenges associated with external power supply, as illustrated in Figure 1.

Passive heat transfer enhancement (HTE) is commonly employed through the process of redesigning the structure and incorporating additional inserts into preexisting heat exchangers. The fundamental concept behind passive HTE is to generate a robust disturbance within the boundary layer while simultaneously minimizing the uneven distribution of the internal fluid flow [4]. There exist two distinct categories of passive HTE: tube-side enhancement and shell-side enhancement. The components associated with the passive method are visually depicted in Fig. 1. These two categories encompass tube-side enhancement and shell-side enhancement.

For the purpose of enhancing the heat transfer on the tube side, alternative heat transfer tubes and tube inserts are introduced as substitutes or improvements to the conventional smooth circular tubes. The enhancement of the tube side can be applied to both the inner and outer walls of the tube, with a focus on the geometrical design and heat transfer coefficient. The objective is to enhance the flow turbulence, elevate the Nusselt number, and enhance the heat transfer coefficient by optimizing the surface structure or the shape of the inserts.

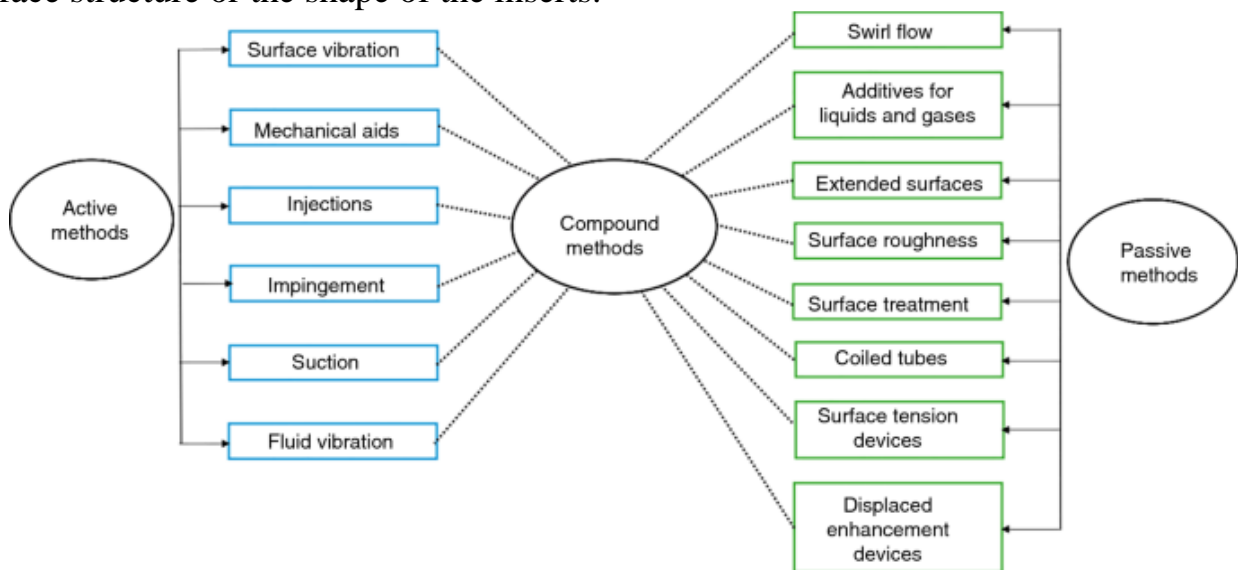


Figure 1 -The components of active and passive methods to HTE in shell and tube heat exchanger

The shell-side of STHX accounts for the majority of thermal resistance. Within shell-side HTE, the focus of research lies on the baffles. The application of STHX with segmental baffles has been proven to possess several advantages, including structural simplicity, high adaptability, and the potential for upgrades. Helical baffles aim to address fluid stagnation zones, thereby minimizing fouling and hydraulic resistance. Furthermore, the distribution of velocity in the bulk fluid becomes more uniform, which can also positively impact HTC.

### **Conclusion**

An endeavor has been undertaken to analyze the recent advancements in the realm of heat transfer enhancement techniques. These techniques have been categorized as active and passive methodologies. The investigation has revealed that active methods exhibit considerable potential in augmenting heat transfer, albeit they possess a high level of intricacy. On the other hand, passive methods enjoy widespread popularity and find extensive utilization in industrial applications, with their efficacy being contingent upon the specific needs of the system.

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## **СПОСОБЫ ПОВЫШЕНИЯ ТЕПЛООТДАЧИ В КОЖУХОТРУБЧАТЫХ ТЕПЛООБМЕННИКА**

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**Аннотация:** Целью данной статьи является оценка различных методов, используемых для увеличения скорости теплопередачи в кожухотрубных теплообменных устройствах. Улучшения теплопередачи в теплообменниках могут быть достигнуты за счет использования нескольких методов, которые можно разделить на активные и пассивные. При активных методах системе требуется внешний источник питания, тогда как пассивные методы включают модификацию поверхности или включение вихревых устройств в поле потока.

**Ключевые слова:** активный метод, кожухотрубный теплообменник, пассивный метод, повышение эффективности.

## RESEARCH ON THE POTENTIAL OF SOLAR ENERGY

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### **Abstract**

Combating climate change and further improving the quality of life around the world will require enormous amounts of renewable energy. In 2014, the world consumed 15 TW of energy, of which 8% came from renewable sources. If we could keep our carbon emissions down and improve our quality of life, by 2030 renewable sources would consume approximately 15 TW of energy. Solar energy has the greatest potential of all renewable energy sources to meet this need. Every hour, enough energy falls on the Earth's surface to meet the entire world's energy demand for a year.

**Keywords:** renewable sources, solar energy, photovoltaic cell, photovoltaics.

Solar energy, radiation from the sun that can produce heat, cause chemical reactions, or generate electricity. The total amount of solar energy reaching the Earth greatly exceeds the world's current and expected energy needs. If used properly, this highly dissipative source is capable of meeting all future energy needs. In the 21st century, solar energy is expected to become increasingly attractive as a renewable energy source due to its inexhaustible supply and environmentally friendly nature, which stands in stark contrast to the finite resources of fossil fuels coal, oil and natural gas.

The sun is an extremely powerful source of energy, and sunlight is by far the largest source of energy received by the Earth, but its intensity at the Earth's surface is actually quite low. Essentially, this is due to the enormous radial spread of radiation from the distant Sun. Relatively little additional loss comes from Earth's atmosphere and clouds, which absorb or scatter up to 54 percent of incoming sunlight. Sunlight that reaches the earth consists of nearly 50 percent visible light, 45 percent infrared radiation, and smaller amounts of ultraviolet and other forms of electromagnetic radiation.

The potential of solar energy is enormous, as the Earth receives approximately 200,000 times the world's electricity generating capacity in the form of solar energy every day. Unfortunately, although solar energy itself is free, the high cost of collecting, converting and storing it still limits its use in many places. Solar radiation can be converted into either thermal energy (heat) or electrical energy, although the former is easier to accomplish.

Among the most common devices used to capture solar energy and convert it into heat are flat plate collectors, which are used for solar heating. Since the intensity of solar radiation on the Earth's surface is very low, these collectors must be of large area. For example, even in sunny parts of temperate regions of the world, the collector area must be about 40 square meters (430 square feet) to collect enough energy to meet the energy needs of one person.

The most widely used flat plate collectors consist of a blackened metal plate

covered with one or two sheets of glass, which is heated by sunlight falling on it. This heat is then transferred to air or water, called carrier fluids, which flows past the back of the plate. The heat can be used directly or can be transferred to another storage medium. Flat plate collectors are commonly used for solar water heaters and home heating. Heat storage for use at night or on cloudy days is usually achieved by using insulated tanks to store water heated during sunny periods. Such a system can supply the home with hot water drawn from a storage tank, or, when heated water flows through pipes in the floors and ceilings, it can provide room heating. Flat plate collectors typically heat carrier fluids to temperatures ranging from 66 to 93 °C (150 to 200 F). The efficiency of such collectors (i.e. the proportion of captured energy that they convert into useful energy) ranges from 20 to 80 percent, depending on the design of the collector.

Another method of converting thermal energy can be found in solar ponds, which are bodies of salt water designed to collect and store solar energy. The heat extracted from such ponds allows the production of chemicals, food greenhouses, swimming pools and livestock buildings, etc. Solar ponds are sometimes used to generate electricity using an organic Rankine cycle engine, a relatively efficient and economical means of converting solar energy, which is particularly useful in remote areas. Solar ponds are quite expensive to install and maintain and are generally limited to warm, rural areas.

Solar radiation can be converted directly into electricity using solar cells (photovoltaic cells). Such cells generate a small electrical voltage when light hits a junction between a metal and a semiconductor (such as silicon) or a junction between two different semiconductors.

The power produced by a single photovoltaic cell is typically only about 2 Watts. However, by connecting large numbers of individual cells together, as in solar panel arrays, a solar power plant or large home array can generate hundreds or even thousands of kilowatts of electricity. The energy efficiency of most modern photovoltaic cells is only about 15-20 percent, and because solar radiation intensity is low to begin with, large and expensive assemblies of such cells are required to generate even moderate amounts of power.

Small photovoltaic cells, powered by solar or artificial light, have found widespread use in low-power applications - for example, as power sources for calculators and watches. Larger installations have been used to power water pumps and communications systems in remote areas, as well as weather and communications satellites. Classic crystalline silicon panels and the latest technologies using thin-film solar cells, including building-integrated photovoltaics, can be installed by homeowners and businesses on their rooftops to replace or augment traditional electricity supplies.

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## ИССЛЕДОВАНИЕ ПОТЕНЦИАЛА СОЛНЕЧНОЙ ЭНЕРГИИ

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**Аннотация:** Для борьбы с изменением климата и дальнейшего повышения качества жизни во всем мире потребуется огромное количество возобновляемой энергии. В 2014 году в мире потреблялось 15 ТВт энергии, из которых 8% приходилось на возобновляемые источники. Если бы удалось сохранить уровень выбросов углерода и повысить качество нашей жизни, то к 2030 году возобновляемые источники потребляли бы примерно 15 ТВт энергии. Солнечная энергия обладает наибольшим потенциалом из всех возобновляемых источников энергии для удовлетворения этой потребности. Каждый час на поверхность Земли падает достаточно энергии, чтобы удовлетворить весь мировой спрос на энергию в течение года.

**Ключевые слова:** возобновляемые источники, солнечная энергия, фотоэлектрический элемент, фотовольтаика.

## NEURAL NETWORKS IN ENERGY SYSTEM OPTIMIZATION

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### **Abstract**

In the article the possibilities of application of neural networks in optimization of modes of energy systems (ES) are considered. It is shown that neural networks have a number of advantages over traditional methods of optimization of ES modes, such as versatility, flexibility and high speed of calculations. However, neural networks also have a number of disadvantages, such as the need for large amounts of data, sensitivity to choose of parameters, and the need for regular retraining. Further development of methods of application of neural networks in ES optimization can be expected. In particular, it is expected to develop techniques for training neural networks on small volumes of data, methods for increasing the resistance of neural networks to degradation and methods for improving the efficiency of neural networks. The application of neural networks in the optimization of ES modes can lead to increased efficiency and reliability of ES. This can contribute to such goals as improving energy efficiency, reducing harmful emissions and ensuring the reliability of electricity supply.

**Keywords:** emissions of harmful substances, energy efficiency, neural networks, optimization of ES modes, reliability of power supply.

### **Introduction**

Energy systems (ES) are complex dynamic systems that must provide reliable and efficient energy services. Optimization of ES modes is an important task, which is to find a mode of operation of ES that, under given conditions, minimizes the relevant target functions, such as electricity losses, emissions of harmful substances or the cost of electricity.

In recent years, in the field of ES mode optimization, there has been a growing interest in machine learning methods, particularly neural networks. Neural networks are universal models that can approximate arbitrary functions. [2] This makes them attractive for optimization tasks for which traditional methods are not applicable or are not effective enough.

Energy systems (ES) should provide reliable and efficient electricity services. Optimization of ES modes is an important task, which is to find a mode of operation of ES that, under given conditions, minimizes the relevant target functions, such as electricity losses, emissions of harmful substances or the cost of electricity. [1] Traditional methods for optimizing ES modes have a number of disadvantages, such as implementation complexity and high computational complexity, especially for large and complex ES.

Various types of neural networks are used for ES assessment, including convoluted neural networks, gradient boosting trees and random forests. This diversity of approaches makes it possible to model complex relationships and non-linear dependencies in data effectively, which is particularly important for accurate estimation and prediction of ES state parameters. [3]

In the modern context of management of electric power systems (ES), the

problem of calculation of parameters and optimization of their modes plays a key role. This issue becomes even more relevant with the increasing complexity and dynamism of modern energy networks. One of the promising approaches to this task is the use of neural networks, providing unique opportunities for adaptation to a variety of scenarios and conditions of ES operation.

The effective management of system control effects, such as power flow and frequency control, is critical to the stability and optimal functioning of the ES. Neural networks demonstrate outstanding versatility in approximating complex functions, making them promising tools for accurately calculating control impacts and thereby ensuring reliable operational control. [2]

First, neural networks can be used to calculate control impacts such as power flow and frequency regulation. This allows for more accurate and adaptive management of various parameters of ES operation, which is essential for operational control.

Second, neural networks are used effectively to solve problems of ES mode optimization. This may include minimizing electricity losses, reducing harmful emissions and optimizing the cost of electricity generation. The application of various types of neural networks, such as recurrent, convoluted and gradient boosting trees, allows a more efficient adaptation to various aspects of the ES mode parameter calculation.

Improving the efficiency and reliability of the electric power system (ES) gives us the important task of optimizing the mode of its operation. In this context, the application of neural networks provides solutions for various optimization tasks.

First of all, neural networks can be involved in minimizing electricity losses within ES. This approach can effectively reduce the cost of electricity generation, leading to an overall increase in system performance.

Further, the application of neural networks can focus on reducing emissions of harmful substances within ES. [3] This work area contributes significantly to improving the environmental resilience of the system, which is becoming an integral part of regime optimization.

All these ES mode optimization tasks are successfully performed using a variety of neural network types, including recurrent neural networks, convoluted neural networks, and gradient boosting trees. [1]

At the moment, the application of neural networks in optimization of modes of electric power systems (ES) is in the initial stage of development. However, recent years have seen an increase in interest in this area, due to a number of advantages provided by neural networks.

In the future, the application of neural networks in the optimization of ES modes can be expected to expand further. Particular emphasis will be placed on developing techniques for training neural networks on small amounts of data, increasing the resilience of networks to degradation and increasing their effectiveness.

Further development of methods of application of neural networks in ES optimization can be expected. In particular, it is expected to develop techniques for training neural networks on small volumes of data, methods for increasing the resistance of neural networks to degradation and methods for improving the

efficiency of neural networks. [2]

However, the utilization of neural networks is not devoid of challenges. A substantial drawback lies in their demand for voluminous datasets during the training phase, posing potential difficulties in scenarios characterized by data scarcity. Furthermore, the efficiency of neural networks is intricately linked to the judicious selection of parameters, with an erroneous choice potentially exerting adverse impacts on their overall performance. A temporal facet adds another layer of complexity, as the periodic retraining of neural networks becomes imperative to forestall the encroachment of degradation over time.

### **Conclusion**

In navigating the nuanced interplay between advantages and challenges, the application of neural networks in ES mode parameter calculation necessitates a discerning and vigilant approach. Such an approach, cognizant of the potential intricacies involved, seeks to harness the immense potential of neural networks while mitigating the associated challenges. This confluence of analytical rigor and pragmatic consideration is indispensable for advancing the efficacy and applicability of neural networks in the dynamic landscape of ES research and management.

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## **НЕЙРОННЫЕ СЕТИ В ОПТИМИЗАЦИИ ЭНЕРГОСИСТЕМ**

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**Аннотация:** В статье рассмотрены возможности применения нейронных сетей в оптимизации режимов энергетических систем (ЭС). Показано, что нейронные сети обладают рядом преимуществ по сравнению с традиционными методами оптимизации режимов ЭС, такими как универсальность, гибкость и высокая скорость вычислений. Однако нейронные сети также имеют ряд недостатков, таких как необходимость больших объемов данных, чувствительность к выбору параметров и необходимость регулярного переобучения. В дальнейшем можно ожидать дальнейшего развития методов применения нейронных сетей в оптимизации режимов ЭС. В частности, ожидается развитие методов обучения нейронных сетей на малых объемах данных, методов повышения устойчивости нейронных сетей к деградации и методов повышения эффективности нейронных сетей. Применение нейронных сетей в оптимизации режимов ЭС может привести к повышению эффективности и надежности ЭС. Это может способствовать решению таких задач, как повышение энергоэффективности, снижение выбросов вредных веществ и обеспечение надежности электроснабжения.

**Ключевые слова:** выбросы вредных веществ, надежность электроснабжения нейронные сети, оптимизация режимов, энергоэффективность, ЭС.



## EXPLORING CUTTING-EDGE MPPT INNOVATIONS FOR ENHANCED SOLAR EFFICIENCY

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### Abstract

This article explores the latest advancements in Maximum Power Point Tracking (MPPT) technologies and their impact on enhancing solar system efficiency. These innovations are crucial for maximizing energy harvesting from solar panels, even in dynamic environmental conditions.

**Keywords:** algorithms, artificial Intelligence, MPPT, maximum Power Point Tracking, renewable Energy, solar energy.

### Introduction

The transition towards renewable energy sources, particularly solar power, is crucial for addressing global energy challenges and mitigating climate change.

Solar energy offers a clean, abundant, and sustainable alternative to fossil fuels, but maximizing its efficiency remains a paramount goal. In this context, the optimization of Maximum Power Point Tracking (MPPT) technologies plays a pivotal role in enhancing the performance and viability of solar energy systems.

This article explores the forefront of MPPT innovations, highlighting the latest advances leading to greater efficiency and reliability in solar power generation.

### The standard methods of MPPT

In the realm of Maximum Power Point Tracking (MPPT) for solar energy systems, several standard methods are employed to optimize energy harvesting. These methods include Perturbation and Observation (P&O), Incremental Conductance (INC), and the Slope Intercept method, among others. P&O and/or hill climbing and incremental conductance (INC) are popular MPPT techniques [1].

P&O, a widely utilized technique, involves perturbing the operating point of the solar panel and observing changes in power output to determine the direction that maximizes power. Similarly, the INC method utilizes the derivative of the power-voltage curve to adjust the panel's voltage for maximum power output.

Additionally, the Slope Intercept method analyzes the slope of the power-voltage curve to pinpoint the point where the slope is maximum, corresponding to the maximum power point.

These standard methods provide fundamental approaches to MPPT, each with its unique advantages and limitations, contributing to the ongoing efforts to enhance the efficiency and reliability of solar energy systems.

### Advanced MPPT Algorithms

Advanced Maximum Power Point Tracking (MPPT) algorithms in solar systems represent a convergence of sophisticated research aimed at improving energy efficiency.

Genetic Algorithms (GA), inspired by the natural selection process, employ evolutionary techniques to generate and select optimal solutions.

Particle Swarm Optimization (PSO) is a meta-heuristic global search method which is based on the common and self-organizational activity of particles of the same group [2,3].

Artificial Neural Networks (ANN) provide a machine learning-based approach, where complex models are trained to predict and optimize the maximum power point based on various inputs.

Additionally, Artificial techniques like the fuzzy logic controller (FLC) have gained popularity [4]. It is a method to make decisions while accounting for uncertainty and variability in environmental data. The FL approach comes from the decomposition of a range of variation of a real variable in the form of linguistic variables and the attribution of the membership function for each variable [5,6].

By integrating these advanced methods, MPPT systems can not only accurately and swiftly track variations in the maximum power point but also dynamically adapt to changing conditions to continuously maximize solar energy production.

This multidisciplinary approach paves the way for more efficient and resilient solar systems, thus contributing to progress towards a sustainable energy transition.

### **Integration of artificial intelligence**

Integrating artificial intelligence (AI) into Maximum Power Point Tracking (MPPT) systems represents a significant advancement in the field of solar energy optimization.

AI algorithms, such as machine learning and neural networks, are capable of analyzing vast amounts of data, including environmental conditions, solar panel characteristics, and historical performance data. By processing this information, AI-driven MPPT systems can predict variations in the maximum power point with a high degree of accuracy, even in complex and dynamic operating conditions. This predictive capability enables the system to proactively adjust parameters in real-time, optimizing energy harvesting and maximizing overall system efficiency.

Moreover, AI-based MPPT systems can continuously learn and adapt to changing environmental conditions, ensuring optimal performance over time. With the integration of artificial intelligence, MPPT systems can achieve unprecedented levels of efficiency, reliability, and adaptability, ultimately contributing to the widespread adoption of solar energy as a clean and sustainable power source.

### **Conclusion**

In conclusion, the integration of advanced innovations in Maximum Power Point Tracking (MPPT), including the use of artificial intelligence, represents a crucial step in optimizing solar energy systems.

These advancements enable dynamic adaptation to changing environmental conditions, precise prediction of maximum power point variations, and continuous optimization of energy harvesting. By combining traditional methods with cutting-edge technologies, MPPT systems can achieve unprecedented levels of efficiency and reliability, thereby contributing to accelerating the transition towards clean and sustainable energy. As we continue to explore new possibilities and push the boundaries of innovation, it is evident that the future of solar energy is promising, with prospects for increased performance, cost reduction, and enhanced sustainability.

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## ИССЛЕДОВАНИЕ ПЕРЕДОВЫХ ИННОВАЦИЙ В ОБЛАСТИ МРРТ ДЛЯ ПОВЫШЕНИЯ ЭФФЕКТИВНОСТИ СИСТЕМ СОЛНЕЧНОЙ ЭНЕРГЕТИКИ

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**Аннотация:** В данной статье рассматриваются последние достижения в технологиях отслеживания точки максимальной мощности (МРРТ) и их влияние на повышение эффективности систем солнечной энергетики. Эти инновации играют важную роль в оптимизации извлечения энергии из солнечных панелей, даже в изменяющихся природных условиях.

**Ключевые слова:** алгоритмы, возобновляемая энергия, искусственный интеллект, отслеживание точки максимальной мощности, солнечная энергия.

## DEVELOPMENT OF MICROGENERATION USING RENEWABLE ENERGY SOURCES IN RUSSIA

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### Abstract

The article discusses the situation in which the renewable energy industry in Russia is located, and in particular, considers the impact exerted by microgeneration facilities on the development of energy using renewable energy sources (RES).

**Keywords:** renewable energy, microgeneration, energy of the Russian Federation.

### Introduction

In a country with so many depleted natural resources as the Russian Federation, the prerequisites for the active development of renewable energy did not manifest themselves to the same extent as in the countries of the European Union, renewable energy developed through the creation of hydro and solar power plants (as of July 1, 2016 amounted to a total of 60.2 MW), but the main generating link in the electric power industry of Russia is still thermal power plants (TPP), however, at a meeting of the State Council in 2016, a goal was adopted on the need to develop a strategy for stimulating microgeneration at renewable energy sources in order to increase the overall generation of electricity, as well as reduce hydrocarbons in the energy balance.

Objects of microgeneration can be both individuals and organizations that have their own electric generating equipment, with an installed capacity of up to 15 kW, who have concluded an agreement with the guaranteeing supplier on the supply of this electricity, if it meets its requirements, to the network, which is not classified as entrepreneurial activity.

### Benefits of microgeneration

The experience of countries that have developed microgeneration at a fairly high level shows the positive impact exerted both on the energy industry due to the emergence on the electric energy (EE) market of more generating capacities capable of maintaining the stability of the energy system, at least at the local level and on the economy, due to the development of small and medium-sized businesses serving the operation of microgeneration facilities and supplying EE.

Thus, a private consumer of electricity, becoming also its producer, will be able to reduce their own consumption from the power grid, using the power produced by them during the hours of the most favorable environmental conditions for the activity of the generating plant.

### Measures taken to stimulate the development of microgeneration

Previously, renewable energy in Russia was based primarily on large, solar, wind or hydroelectric power plants, a gap in legislation on connecting small power producers based on renewable energy to power grids was eliminated on behalf of the

Chairman of the Government of the Russian Federation (No. AD-P9-776 of 11.02.2017), the main provisions of which are [1]:

- RES microgeneration is performed by generating objects with installed power up to 15 kW;

- apartment buildings are excluded from consideration;

- installation of double-sided electricity metering devices providing hourly accounting and automation at the expense of the applicant is required;

- if there is no need to change the existing technological connection to the electric network, a notification procedure for putting the equipment into operation is used with the need to register a reversing metering device in accordance with the established procedure. For other cases of issuing (supplying) excess electric energy produced for the own needs of their household, a simplified procedure for technological connection to electric networks and commissioning of the facility is established;

- mandatory purchase of energy generated by RES microgeneration by the guaranteeing supplier is established;

- the purchase and sale price is equal to the weighted average unregulated price for electricity in the wholesale market;

- the income of an individual obtained as a result of the sale of surplus electricity produced for the own needs of his household is not taxable.

### **Development of microgeneration in Russia: challenges and prospects**

In December 2019, Russia adopted Federal Law No. 471-FZ "On Amendments to the Federal Law" On Electric Power Industry "in terms of the development of microgeneration." In March 2021, Decree of the Government of the Russian Federation No. 299 made some changes to the NPA in terms of microgeneration. Now, in accordance with these documents, any individual or legal entity can generate electricity using a power generation device, join common networks and give/sell electricity to it. This means that every Russian can now use a generator on any type of fuel and any power, including a wind generator, a solar power plant or a diesel or gas plant, but the law establishes a restriction - the plant must supply no more than 15 kW to the network. [2]

It is important to note that now the sales organization is obliged to conclude an agreement on the purchase of electricity from a private trader. Accounting of consumption volumes from the network and delivery to the network will take place every hour, and at the end of the month, hourly volumes will be settled. The price of "surplus" depends on the region. In the price zones of the wholesale energy market (the European part of the Russian Federation, the Urals and Siberia), the guaranteeing electricity supplier is obliged to buy these volumes at the wholesale price of the region. In non-price zones - Arkhangelsk and Kaliningrad regions, Komi and the Far East - at a regulated tariff, and in isolated systems - at a minimum production price. At the same time, the sale of energy is not considered entrepreneurial activity and will not be subject to personal income tax until 2029.

So far, microgeneration in Russia is not a way to earn money, but a way to increase the reliability of energy supply and minimize future payments for electricity.

So, in some regions it is more profitable to use solar panels than to spend money

on electricity, buying it from sales companies. The most obvious difference is obtained in the Nizhny Novgorod region: there, an individual will have to pay about 7 rubles for kW/h, and the same amount of energy generated by solar panels will cost 4.7 rubles. In total, there are 33 regions in Russia where solar energy can benefit in money. With legal entities, everything is much simpler: in Russia there is only one region where the tariff for them is lower than the cost of energy from solar panels - Irkutsk region. In all other regions, generating your own energy is more profitable.

The introduction of microgeneration in Russia is also hindered by a stable myth about the inexpediency of installing solar panels due to lack of sun. They refute his data from the Global Solar Atlas of the World Bank project and the International Finance Corporation, which show that the differences between the Sahara desert and the Russian Trans-Baikal Territory in the volume of potential solar electricity generation are not so large.

According to the atlas, the Trans-Baikal Territory is the leader in terms of insolation in the Russian Federation, but the Krasnodar Territory is located only at 16 meter.<sup>2</sup> In general, insolation in  $\frac{2}{3}$  territory of Russia is excellent for the development of solar energy - these are not only southern regions, but also most of central Russia, the Urals, Siberia and the Far East. So, for example, in Moscow with 1 m<sup>2</sup> per year you can get an average of 1120 kW/h, which is more promising than Berlin, which has this figure of 1004 kW/h, and our Buryatia in terms of the amount of sun (1613 kW/h/m<sup>2</sup>) overtakes Rome (1549 kW/h/m<sup>2</sup>). In Russia there are examples of enterprises and budgetary organizations that receive electricity from photovoltaic modules, while having access to grid electricity.

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## РАЗВИТИЕ МИКРОГЕНЕРАЦИИ С ИСПОЛЬЗОВАНИЕМ ВОЗОБНОВЛЯЕМЫХ ИСТОЧНИКОВ ЭНЕРГИИ В РОССИИ

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**Аннотация:** Проанализировано текущее состояние отрасли возобновляемой энергетики в России; а именно - воздействие объектов микрогенерации на развитие энергетики, основанной на использовании возобновляемых источников энергии (ВИЭ).

**Ключевые слова:** возобновляемая энергетика, микрогенерация, энергетика Российской Федерации.

## THE DEVELOPMENT OF SOFTWARE FOR INFORMATION- MEASURING SYSTEMS OF ELECTRIC POWER COMPLEXES

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### Abstract

The article deals with the problem of assessing the quality of information-measuring systems in the electric power industry. The methodology of forecasting changes in metrological characteristics of IMS nodes using an information system is proposed. It allows promptly monitoring and analyzing the quality of operation of the investigated objects, increasing the efficiency of the electric power system and improving the quality of customer service.

**Keywords:** information-measuring systems, mathematical models, metrological reliability, prediction methods.

### Introduction

In today's world, the electric power industry is one of the main and important components of any state's economy. It provides energy for industrial enterprises, infrastructure facilities, and household appliances. The efficiency of the electric power system largely depends on the quality and reliability of the information-measuring systems (IMS) used [1]. Such systems ensure the collection, analysis, and transmission of information about the energy system parameters, which allows making correct decisions on managing and monitoring its operation.

However, in order to use IMS most effectively, it is necessary to develop a methodology for assessing their quality. Such methodology should take into account many parameters, such as measurement accuracy, speed, reliability, cost, and others. The constructive, structural, and algorithmic complexity of modern IMS makes the task of ensuring their high level of metrological reliability particularly relevant.

### Theoretical basis of the research

The forecasting task in the implementation of analytical and probabilistic methods is reduced to determining the probabilistic characteristics of the studied random processes in the forecasting area, taking into account the designated factors of the OS  $\vec{\varphi} = \{T, F, P, E\}$  [4].

Taking into account the above, the forecasting task is set as follows. For known values of parameters  $\vec{\eta}(t) = \{\eta_1(t_1), \eta_2(t_2), \eta_i(t_i), \dots, \eta_r(t_r)\}$  at times  $t_i$ , provided that  $\{T_i, F_i, P_i, E_i\} = \text{const}$ , and  $i = 1 \dots k$ ,  $k$  - the number of temporary sections, as well as the probability of an  $F_i(\vec{\eta})$  object maintaining operability is calculated according to the known type of object distribution function:

$$F_{k+j}(\vec{\eta}^*) = P\{\vec{\eta}(t_{k+j}) < \vec{\eta}^*\} = \int_{-\infty}^{\vec{\eta}^*} f_{t_{k+j}}(\vec{\eta}) d\vec{\eta}$$

In this expression,  $\vec{\eta}^*$  is the permissible value of the function  $\eta(t)$ ,  $f_{t_{k+j}}(\vec{\eta})$  is the density of distribution of values  $\vec{\eta} = \{\eta_1(t_p), \eta_2(t_2), \eta_i(t_i), \dots, \eta_r(t_r)\}$  for times  $t_{k+j}$ ,

and  $j = 1, \dots, m$  with mathematical expectation  $m_{\bar{\eta}^*}$  and variance  $\sigma_{\bar{\eta}^*}^2$ .

### **The research methodology**

To predict changes in the metrological characteristics of the studied IIS units, an information system will be used. This information system (IS) assesses the quality of operation of a power engineering facility with minimal operator involvement. The IS independently constructs a mathematical model of the operation of the test measuring unit by loading the structural, functional, and schematic diagrams of the designed unit into the database. Constructs mathematical models of changes in time of metrological characteristics of the test unit on the basis of this determines the quality of functioning of the information-measuring system of the electric power complex. It increases the efficiency of the electric power system, improve the quality of consumer service, and ensure the safety of the electric power complex operation.

### **The description of the research method**

One of the advanced methods for processing data from random processes for forecasting is the Monte Carlo statistical simulation method [3], which is a numerical approach to solving various professional problems by mathematically simulating randomness to conduct a statistical test [3].

The forecasting process includes the following steps:

- 1) determining the requirements for the metrological characteristics of blocks of the information and measuring system;
- 2) developing a measurement model that includes a description of the measurement process, noise sources, and uncertainties;
- 3) generating random numbers corresponding to the probabilistic distribution of input signals and noise;
- 4) performing a series of measurements using the model and the generated random numbers;
- 5) statistical processing of measurement results to obtain an assessment of metrological characteristics;
- 6) assessing the metrological reliability based on the obtained results;
- 7) comparing the obtained results with the requirements and adjusting the model if necessary;
- 8) repeating the process until satisfactory results are obtained.

### **Conclusion**

The information system under development will allow you to quickly monitor and analyze the performance of the blocks of information-measuring systems that are part of the electric power complex, as a result of which the efficiency of operation of the object under study will increase. In addition, the quality of customer service is being improved, the information system will ensure the stability and reliability of power supply. Due to the improvement in the stability of power supply, the risk of emergency situations is reduced and the level of stable operation of the electric power complex is increased.

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## **РАЗРАБОТКА ПРОГРАММНОГО ОБЕСПЕЧЕНИЯ ФУНКЦИОНИРОВАНИЯ ИИС ЭЛЕКТРОЭНЕРГЕТИЧЕСКИХ КОМПЛЕКСОВ**

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**Аннотация:** В данной статье рассматривается проблема оценки качества информационно-измерительных систем в электроэнергетике. Предложена методика прогнозирования изменения метрологических характеристик блоков ИИС с использованием информационной системы. Это позволяет оперативно отслеживать и анализировать качество работы исследуемых объектов, повышать эффективность работы электроэнергетической системы и улучшать качество обслуживания потребителей.

**Ключевые слова:** информационно-измерительные системы, математические модели, методы прогнозирования, метрологическая надежность.

УДК 681.518  
ББК 39.571-52

### ANALYSIS OF EXISTING INFORMATION MEASUREMENT SYSTEMS OF AIR TRAFFIC CONTROL AND INFORMATION PROCESSING ALGORITHMS

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#### **Abstract**

This article analyzes the existing information and measurement systems to identify their advantages and disadvantages, to ensure high throughput of dispatching radar stations at a given level of security. The relevance of the work is determined by the need to increase the accuracy of estimating the angle of the seat between the flight control point and a highly maneuverable aircraft.

**Keywords:** ATC systems; UDPRLS; aircraft.

The estimating method of the trajectory parameters of radio emission sources in an angle-measuring two-position passive radar system refers to radar detection systems and is used to estimate the trajectory parameters of mobile radio emission sources. The achieved technical result is the possibility of estimating the parameters of the movement of the radio emission sources with a given level of estimation errors and the independence of these errors from the position of the radio emission sources in relation to the receiving positions. When forming generalized measurements, the angular coordinates of the radio emission sources and the coordinates of the PP are measured; the coordinates of the radio emission sources are calculated in a rectangular coordinate system. Adaptive algorithms of  $\alpha$ - $\beta$  filtering of the results of generalized measurements are used to estimate the coordinates and projections of the velocity vector of the radio emission sources on the axis of this coordinate system. The adaptation consists in choosing the values of the gain coefficients in the filtering algorithms that depend on the values of the current errors of generalized measurements due to the mutual displacement of receiving positions and radio emission sources.

Generalized measurements in the literature on multi-position radar systems are understood as measured or calculated coordinates of the spatial position of the radio emission sources without taking into account previous measurements. [3]

The two-position radar system includes the first and second receiving positions, which can be stationary or mobile. The first receiving position contains: navigation system, goniometer, data reception and transmission equipment. The second receiving position contains: a goniometer, data reception and transmission equipment, a navigation system, and a computer system. [1]

The advantages are as follows:

– filters are easily implemented since their restructuring is achieved by changing

only two gain coefficients;

– when implementing the method, it is not necessary to perform an operation to form generalized measurements, which introduces additional errors in the measurement results.

The disadvantage is that the implementation of the method requires the use of linear filtering devices and computers. [2]

*The method of controlling aircraft along the course in an angle-measuring two-position radar system*

The invention relates to the technique of controlling aircraft and can be used to guide aircraft to aerial targets using angle-measuring two-position radar systems.

Monitoring of targets on which radio emission sources are located can be carried out on the basis of receiving signals emitted by their radio-electronic means using angle-measuring two-position radar systems.

The effectiveness of the use of UDPRLS largely depends on the method of controlling the aircraft (AC) on which the receiving positions of this system are placed, since the mutual position of the aircraft and the radio emission sources change during the control process, which significantly affects the accuracy of determining the location of radio-emitting targets.

When using angle-measuring two-position radar systems, as a rule, it is necessary to simultaneously solve two tasks, namely: the task of pointing aircraft at an airborne radio-emitting target and the task of trajectory control of aircraft to create the most favorable conditions for high-quality radar surveillance of a radio-emitting target. In this regard, methods are being developed that provide for solving the problem of controlling the observation process with simultaneous targeting of the radio emission sources. At the same time, the most time-consuming is the organization of aircraft control in the horizontal plane. [3]

One of the advantages is an increased efficiency of the use of angle-measuring two-position radar systems. The disadvantages include the high complexity of aircraft information and computing systems with direction finders, a large amount of information that aircraft must exchange, as well as the presence of restrictions on the conditions of use. [2]

When analyzing scientific and technical information, the existing methods of measuring the angular coordinates of AIS ATC were studied, the conditions for using AIS ATC angle measurement channels were analyzed, which showed that the angle, angular velocity and angular acceleration change in accordance with a nonlinear law that complicates the assessment of these coordinates by traditional methods.

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## **АНАЛИЗ СУЩЕСТВУЮЩИХ ИНФОРМАЦИОННО ИЗМЕРИТЕЛЬНЫХ СИСТЕМ УПРАВЛЕНИЯ ВОЗДУШНЫМ ДВИЖЕНИЕМ И АЛГОРИТМОВ ОБРАБОТКИ ИНФОРМАЦИИ**

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**Аннотация:** В статье проанализированы существующие информационно-измерительные системы с целью выявления их преимуществ и недостатков, а также для обеспечения высокой пропускной способности диспетчерских радиолокационных станций при заданном уровне безопасности. Актуальность работы определяется необходимостью увеличения точности оценивания угла места, между пунктом управления полётами и высокоманевренным воздушным судном.

**Ключевые слова:** системы УВД; УДПРЛС, летательные аппараты.

## PARAMETRIC 3D MODEL OF THE DECOMPRESSION DEVICE

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### Abstract

The developed parametric 3D model of a decompression device designed to collect data on parameters that can be changed in accordance with technical requirements landscaping. The defining parameters of the model are the diameter and thickness of the shell.

**Keywords:** 3D model, parameterization, shell, sparse space

### Introduction

The purpose of this work is to develop a parametric 3D model of a decompression device designed for assembling cylindrical shells of technological equipment. Cylindrical shells are the main element of technological equipment (capacitive apparatuses, evaporators, heat exchangers, column apparatuses, etc.). Shells are made on sheet bending machines with subsequent edge welding. After bending, defects are formed that do not allow welding. If the edges to be welded overlap after bending, then release rings are used to ensure the possibility of welding. The parameters of the release ring depend on the diameter and thickness of the shell.

### Methodology

Modern graphic editors allow you to develop parametric 3D models of technical devices using only the user interface. This is achieved by superimposing functional relationships between the dimensions of the elements. As a result, regardless of the obvious measurements, all measured values are recalculated and the 3D model is revised. For the release ring, the main dimensions on which all other dimensions depend are the diameter and thickness of the shell.

### Results

After obtaining the required dimensions, you can work on the drawings. Figure 1 shows the assembly drawing of the release ring.

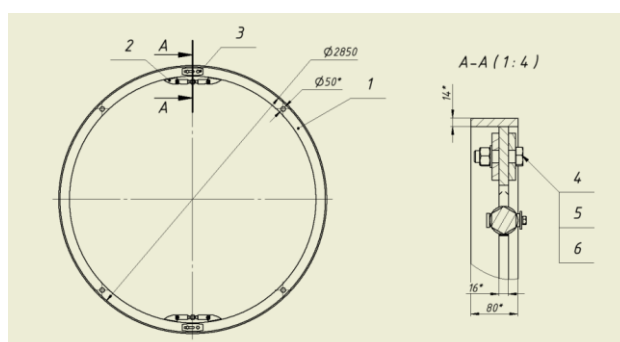


Figure 1 - Assembly drawing of the release ring

Main elements: 1- release ring, 2-release device, 3-bar, 4-screw, 5-nut, 6-washer. The assembly drawing of the release device is shown in Figure 2.

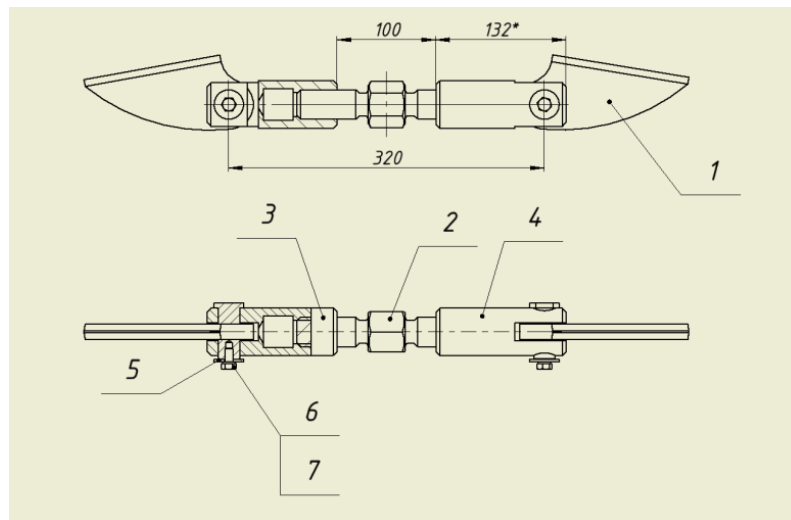


Figure 2 - Assembly drawing of the release device

Main elements: 1-bar, 2- screw, 3,4-sleeve, 5- axis, 6-screw, 7-washer. The players of the 3D model of the release wheel are shown in Figure 3.

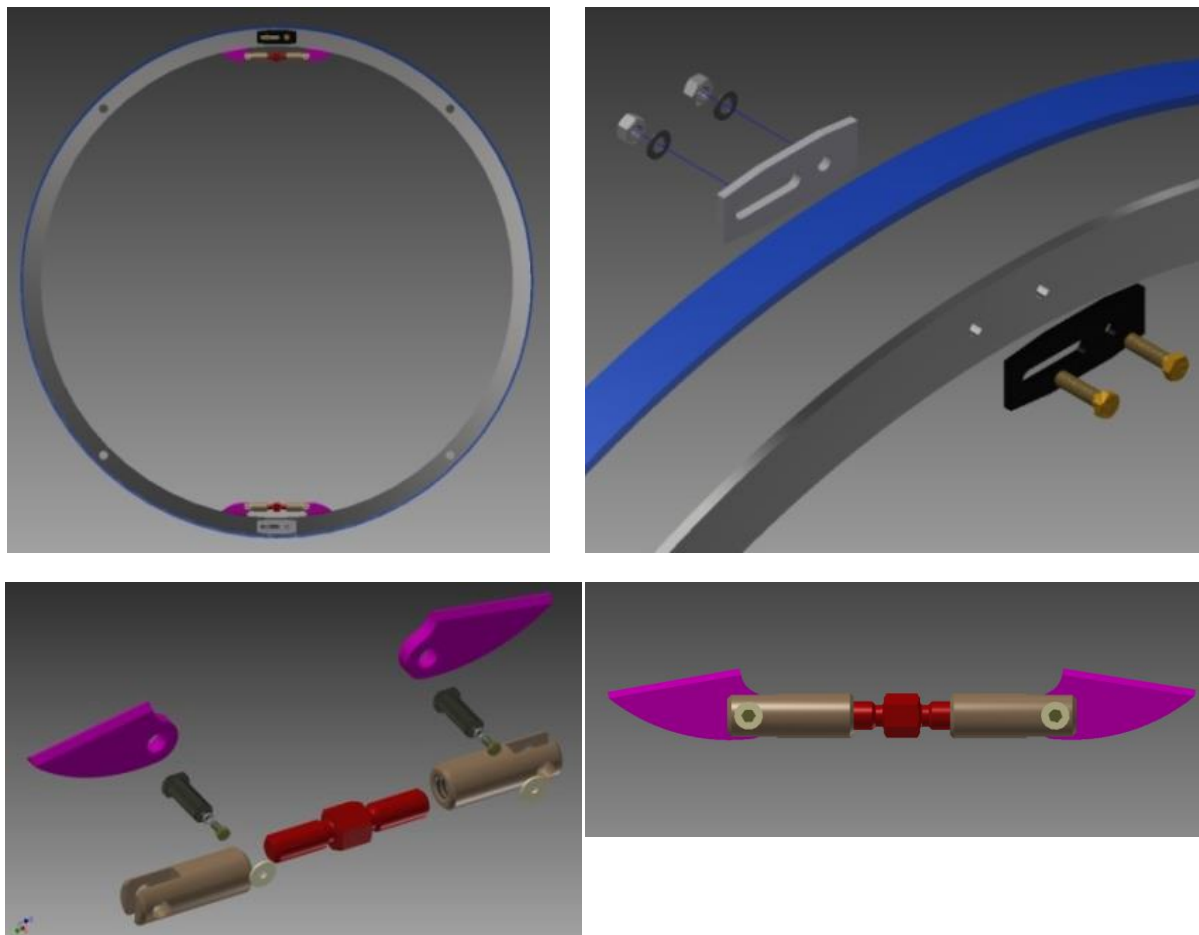


Figure 3 - Elements of the 3D model of the decompression device

## Conclusion

The developed parametric 3D model of the decompression device, which is rebuilt depending on the size and thickness of the shell. The model is an element of the computer-aided design system of technological equipment developed by the authors [1-4].

## Acknowledgements

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## ПАРАМЕТРИЧЕСКАЯ 3D-МОДЕЛЬ РАЗЖИМНОГО УСТРОЙСТВА

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**Аннотация:** Разработана параметрическая 3D-модель разжимного устройства, предназначенного для сборки цилиндрических обечаек технологического оборудования. Определяющими параметрами модели являются диаметр и толщина обечайки.

**Ключевые слова:** 3D-модель, обечайка, разжимное устройство, параметризация

## PROCESS NETWORK FOR PLANNED WORK ON INSTRUMENTATION AND CONTROL EQUIPMENT AT PIGMENT JSC

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### Abstract

The purpose of this article is to show the procedure for conducting preventive maintenance activities, using the example of a network of processes. Preventive maintenance of equipment is a set of planned organizational and technical measures for the care, supervision of equipment, its maintenance and repair. The purpose of these measures is to prevent progressively increasing wear, prevent accidents and maintain equipment in constant readiness for operation.

**Keywords:** design documentation, instrumentation and automation equipment, maintenance, planning and technological department, scheduled maintenance.

The process of performing preventive maintenance activities at PIGMENT JSC is carried out in accordance with the current design documentation, technical specifications and technological processes. Figure 1 shows the network of subprocesses performed in the workshop of Pigment JSC, and also shows control points K1, K2,..., K10 points for carrying out scheduled maintenance and maintenance of instrumentation and automation equipment.

The Planning and Technological department draws up a monthly production plan for all workshops. Each workshop submits a maintenance plan for timely repair and maintenance of equipment and tools necessary for the stable operation of the enterprise.

The initial step is to prepare a monthly preventative maintenance plan. Next, preparations for carrying out this work begin; at this stage, the preparation of the tools necessary to perform the work may occur. Preparatory work is being carried out for safe work at the work site; maintenance work can be carried out by the personnel of the enterprise and contractors. Individual operations can be carried out by operational (technical) personnel.

Technical activities carried out by the enterprise, in addition to work related to the introduction of new and replacement of obsolete instrumentation and automation equipment, are divided into unscheduled and scheduled maintenance work.

Unscheduled work mainly comes down to operational repairs or replacement of failed measuring and automation equipment.

Scheduled maintenance work consists of technical maintenance, current repairs, major repairs, and verification/calibration of measuring instruments.

Technical service includes the following types of work:

1. Functionality check, checking by control points (set to “zero”), identification and elimination of minor defects that arose during operation;



2. Checking the automation equipment operation in the event that a discrepancy is detected during the process mode and the readings of measuring instruments;

3. Removal of measuring and automation equipment for repairs and timely submission of them for inspection;

4. Checking power supplies, indicating and recording units of measuring instruments for analyzing the composition and properties of substances and materials.

Current repairs may include part of the maintenance work and additional work, namely:

a) Replacement of elements of measuring and automation equipment that have expired, elimination of minor breakdowns;

b) Checking the quality of insulation and condition of measurement and power supply circuits of measuring and automation equipment;

c) Partial disassembly and reassembly of measuring systems with the replacement of individual unsuitable parts (rings, screws, arrows) (Fig. 1).

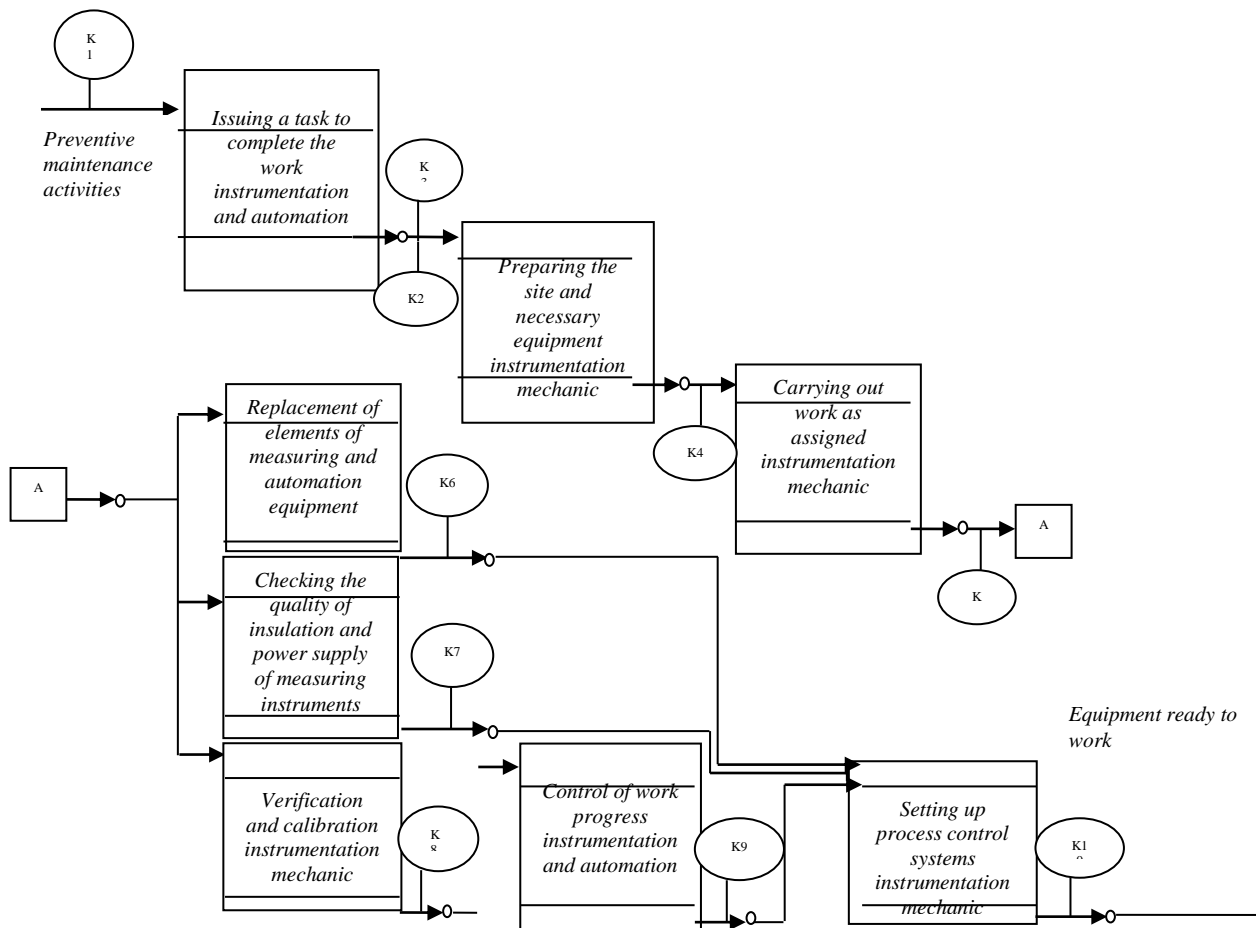


Figure 1 - Processes for performing pre-production work on instrumentation and control equipment

During routine repairs of the measuring part of measuring instruments, they must be verified.

Repair of measuring and automation equipment is carried out, as a rule, when the equipment is shutdown. Stopping of technological equipment can be emergency

or planned. During an emergency stop, they perform work that cannot be performed during operation of the equipment. In this case, those components of automation equipment whose serviceability was in doubt during the operation of process equipment are subject to maintenance and repair.

During a planned shutdown, those measuring and automation equipment, cable and pipe lines that are located near the process equipment and may be damaged during its repair are dismantled.

Repairs are carried out by specialized units of the enterprise or organizations that have: a registration certificate for the right to repair measuring instruments, issued by Gosstandart authorities; verification means (model and auxiliary measuring instruments, fixtures, devices, etc.); personnel trained and authorized to carry out repairs and verification; necessary regulatory and technical documentation, verification diagrams; premises that ensure proper repair and verification in accordance with regulatory requirements.

The approach outlined above, based on the recommendations of [3], makes it possible to visually represent the network (chain) of subprocesses and operations performed within the workshop business process, using a graphical model.

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## ПРИМЕНЕНИЕ СЕТИ ПРОЦЕССОВ ПРИ ПРОВЕДЕНИИ ПЛАНОВО-ПРЕДУПРЕДИТЕЛЬНЫХ РАБОТ СРЕДСТВ КИПиА НА АО «ПИГМЕНТ»

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**Аннотация:** Цель данной статьи – продемонстрировать процесс проведения планово-предупредительных работ на примере сети мероприятий. Мероприятия планово-предупредительного ремонта оборудования – это совокупность запланированных организационных и технических мероприятий по уходу, надзору за оборудованием, его обслуживанию и ремонту. Цель этих мероприятий – предотвращение прогрессивно нарастающего износа, предупреждение аварий и поддержание оборудования в постоянной готовности к работе.

**Ключевые слова:** конструкторская документация, планово-предупредительные работы, средства КИПиА, планово-технологический отдел, техническое обслуживание.

## USING EXTREMELY HIGH FREQUENCY RADAR TO MONITOR VITAL SIGNS

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### Abstract

This study investigates the possibility of using extremely high-frequency radar operating in the millimeter wave band to localize a person in space and determine the indicators of a person's breathing rate and heart rate in a contactless manner at home. By detecting oscillatory movements in space, caused by a person's breathing and heartbeat, through the application of the Fast Fourier Transform, extraction of the phase of the target range, unwrapping, and finding the phase difference with subsequent application of bandpass filters and spectral estimation methods (estimation based on inter-peak distances), it is possible to estimate the heart rate and breathing rate of a person in a sitting position with a Root Mean Square Error (RMSE) of approximately 8.27. Measurements were conducted at home, and the heart rate was compared with measurements from the pulse oximeter.

**Keywords:** breath rate frequency monitoring, EHF-radar, FMCW-radar, heart rate frequency monitoring

### Introduction

The aim of the study is to develop a solution that allows for contactless determination of person's breath rate and heart rate. Contactless monitoring in home conditions using of radio frequency monitoring technologies in the extremely high frequency range. This will make vital signs monitoring research more accessible while ensuring clinically significant measurements.

### Vital signs determination algorithm

Of the two cycles (respiratory and cardiac), breathing is simpler to detect (from the perspective of human body movement). The breathing cycle consists of inhalation and exhalation. During inhalation, the chest expands, causing a measurable displacement ranging from a few millimeters to a few centimeters, depending on the individual's characteristics and the angle of the body relative to the measuring device. A typical respiratory cycle consists of inhalation  $t_1$  and exhalation  $t_2$ . In addition, the total breathing period usually ranges from 2 to 10 seconds, leading to a breathing frequency in the range of 0.1-0.5 Hz (6–30 breaths/min). It should be noted that although the movement of the chest may seem sinusoidal, but it is not a perfect sinusoid. This leads to the appearance of harmonics. Respiratory cycle, measured by radar placed in front of a person, contains the following parameters:  $R$  - static distance to the radar,  $T$  - inhalation period, and  $\Delta R$  - magnitude of chest expansion.

The signal shape in the case of heart contractions is slightly different. Due to the presence of double beats, the signal shape becomes bimodal. The first peak at time  $t_1$  corresponds to atrial systole. The aforementioned contraction causes vibration in the chest area, the phase of which can be measured using a measuring device. The second and largest vibration at time  $t_2$  is caused by ventricular systole, occurring after the R-peak. The displacement caused by this vibration can be measured in the chest area,

but is not associated with it. In fact, when blood is transmitted through the aorta and pulmonary arteries and further into arteries throughout the body, it generates vibration of the entire body, only with a smaller amplitude. Such displacements as a result of vibrations usually amount to 0.1-1.0 mm. In addition, the typical frequency of heart contractions in humans is in the range of 0.8-3.0 Hz, which alternatively is 48-180 beats per minute.

Cardiac cycle is detected by the vibrations generated by the systole of the atria and ventricles.  $T$  is the period of cardiac contractions, and  $\Delta R$  is the peak amplitude of chest expansion. The  $QRS$  complex, which can be seen on the ECG, is shown for reference: atrial systole occurs after the  $P$  wave, and ventricular systole after the  $R$  peak.

To measure the displacements of the human chest, we record the phase change of the signal in the time bin of the target range:

$$\Delta\phi_b = \frac{4\pi}{\lambda} \Delta R,$$

where  $\Delta\phi_b$  is the phase change when the object moves a distance  $\Delta R$ .

It is clear that a shorter wavelength  $\lambda$  gives better sensitivity to displacement. With the help of radar, measurements of chest displacement were made when it was directed at the chest of a person standing in front of it. An embedded programmable data processing core is used to filter the signals of breathing and heart rate by chest displacements and subsequent assessment of breathing and heart rate. The graphical interface of the developed software displays the value of chest displacement, visualizes waveforms, and displays calculated indicators of breathing and heartbeat.

For measurements, radar with frequency-modulated continuous wave (FMCW) was used. The radar transmits a signal consisting of periodic high-intensity pulses with linear frequency modulation (Compressed High-Intensity Radiated Pulse, CHIRP, hereinafter referred to as chirp/chirps), towards the object (Figure 1).

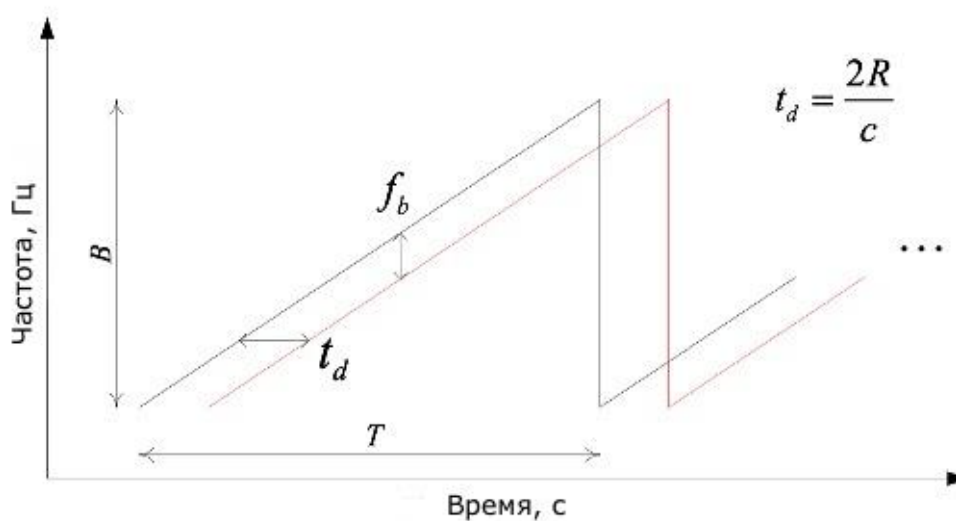


Figure 1 - Transmitted and received sawtooth chirp signal

The signal transmitted by the FMCW radar is defined by the expression:

$$s(t) = e^{j(2\pi f_c t + \pi \frac{B}{T} t^2)}.$$

The signal at the receiver is a version of the transmitted signal with a delay  $t_d$ :

$$s(t) = e^{j(2\pi f_c(t-t_d) + \pi \frac{B}{T}(t-t_d)^2)}$$

The transmitted and received signals are continuously compared by a mixer, which generates an intermediate frequency signal. The beat signal  $b(t)$  from an object at a distance  $R$ , after passing through the mixer and filtering procedures, is defined by the expression:

$$b(t) = s'(t)r(t) \approx e^{j(2\pi \frac{BR}{cT}t + \frac{4\pi}{\lambda}R)} = e^{j(f_b t + \phi_b)}$$

It should be noted that for a single object under study, the beat signal  $b(t)$  is sinusoidal and has a frequency  $f_b$  and phase  $\phi_b$ .

The phase is measured using a Fast Fourier Transform (FFT) of the beat signal  $b(t)$  and calculation of the phase in the range bin of the object.

Suppose the object is in the range bin  $m$ , then the vibration signal  $x(t)$  is extracted by measuring the phase in the range bin  $m$  at time indices  $nT_s$ , where  $n$  is the chirp index, and  $T_s$  is the time between successive measurements:

$$x(m, nT_s) = \frac{\lambda}{4\pi} \phi_b(m, nT_s).$$

We assume that the vibrations  $x(t)$  are small, so the object remains in the same range bin throughout the measurement time. The general scheme of signal extraction from chirps is shown in Figure 2.

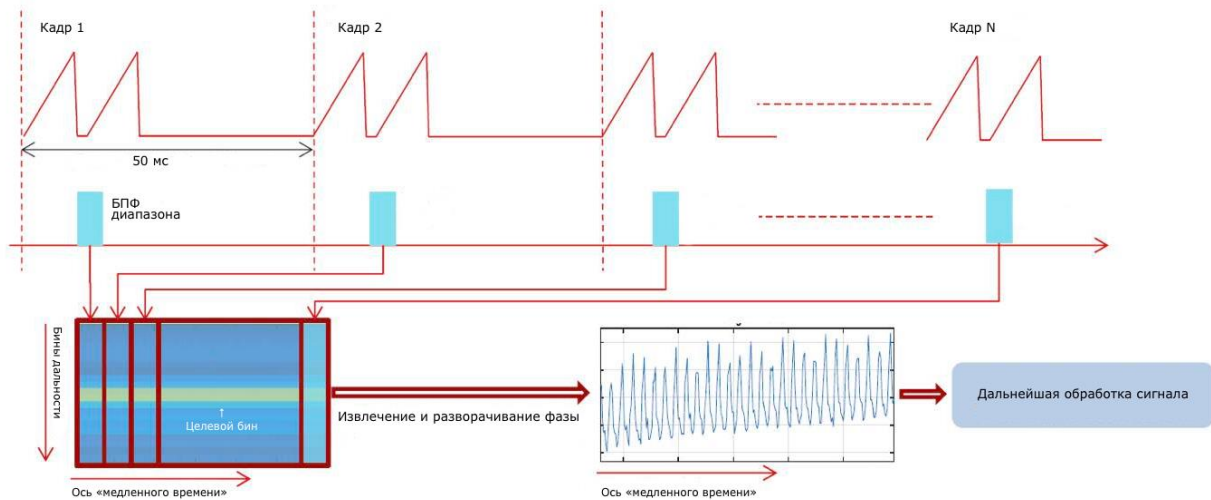


Figure 2 - General scheme of signal extraction from chirps

## Conclusion

During the study, an algorithm was developed to determine the breath rate and heart rate of a human. This algorithm leverages the technology of extremely high-frequency radar for non-contact monitoring of vital signs.

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# ИСПОЛЬЗОВАНИЕ КРАЙНЕ ВЫСОКОЧАСТОТНОГО РАДАРА ДЛЯ МОНИТОРИНГА ЖИЗНЕННО ВАЖНЫХ ПОКАЗАТЕЛЕЙ ЗДОРОВЬЯ

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**Аннотация:** Целью исследования является анализ возможности применения алгоритма бесконтактного определения частоты дыхания и частоты пульса человека, используя крайне высокочастотный радар. В работе рассмотрен реализованный алгоритм. Изучение алгоритмов бесконтактного определения основных жизненных показателей человека сделает процесс их мониторинга более доступным и в то же время обеспечат клинически значимые измерения.

**Ключевые слова:** КВЧ-радар, мониторинг частоты дыхания, мониторинг частоты пульса, радар непрерывного излучения с частотной модуляцией

## DETERMINATION OF ANOMALOUS MEASUREMENTS OF SATELLITE TRACKING COORDINATES

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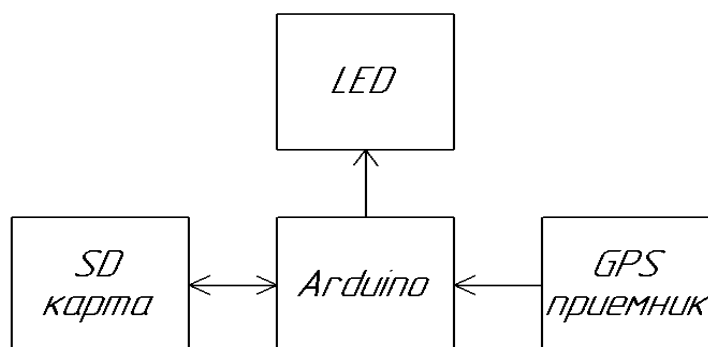
### Abstract

Satellite radio navigation system provides high accuracy of positioning coordinates in navigation systems. But it has a big disadvantage - the occurrence of anomalous coordinate measurements, which leads to inaccurate location determination. The purpose of this study is to develop a device for recording data from the GPS receiver on an SD card and the subsequent study to determine the coordinates of the location of the object by GLONASS/GPS signals to confirm the presence of anomalous measurements at the output of the receiving equipment.

**Keywords:** anomalous coordinate measurements, GLONASS/GPS, satellite radio navigation system.

### Introduction

One of the methods to control the reliability of navigation data is to identify anomalies in the obtained coordinate values that occur when the signal-to-noise ratio is low. [1]. In order to determine the accuracy of coordinate measurement and registration of navigation information anomalies, a device was developed, the block diagram of which is shown in Figure 1.



*Figure 1 - Electrical structural circuit of the device*

The designed device includes the following parts: the u-blox NEO-6M GPS receiver module; the Arduino Nano V3.0 platform based on the ATmega328 microcontroller; a module for connecting an SD card with an SPI interface, a 16 GB card; an LED with a current-limiting resistor for signaling the end of data recording.

To conduct the study, a fixed coordinate device was recorded for an hour, with a data acquisition frequency of 5 Hz at two points in the area that are 3 km apart. Satellite data was received indoors, but in close proximity to the window.

As a result of the recording, about 17,000 coordinate values were obtained for each location. Next, a small preprocessing of the collected data was performed, for next import into Microsoft Office Excel software through the built-in data import

function. The next step was to find the boundary values for each of the coordinates, the exits beyond which are considered anomalous measurements.

We give an example of a study of the obtained latitude data of the first point of the terrain.

First, using the AVERAGE() function built into Microsoft Excel, we find the average value of the latitude of the first point:

$$M_1(L) = 52,40829237^\circ \text{ N},$$

where  $M_1(L)$  is the mathematical expectation of latitude at the first point of the terrain.

For anomalous measurements, we will take values beyond the boundaries of the  $M_1(L)$  range plus or minus  $3\sigma$ .

We find  $3\sigma$  using the following formula

$$3\sigma = 3*\sqrt{D}, \tag{1}$$

where  $\sigma$  is the standard deviation, D is the sample variance.

We find the variance using the built-in Excel function VAR.S(), which returns the variance of the sample values.

Next, we obtain the values of  $3\sigma$  according to the formula (1) at the first point:

$$3\sigma_1(L) = 0,000494602^\circ \text{ N}.$$

From the obtained data we calculate the boundaries of anomalous values for the first point:

$$M_1(L) + 3\sigma_1(L) = 52,40878697^\circ \text{ N},$$

$$M_1(L) - 3\sigma_1(L) = 52,40779777^\circ \text{ N}.$$

For clarity, Figure 2 shows a graph of the obtained latitude coordinates of the first terrain point.

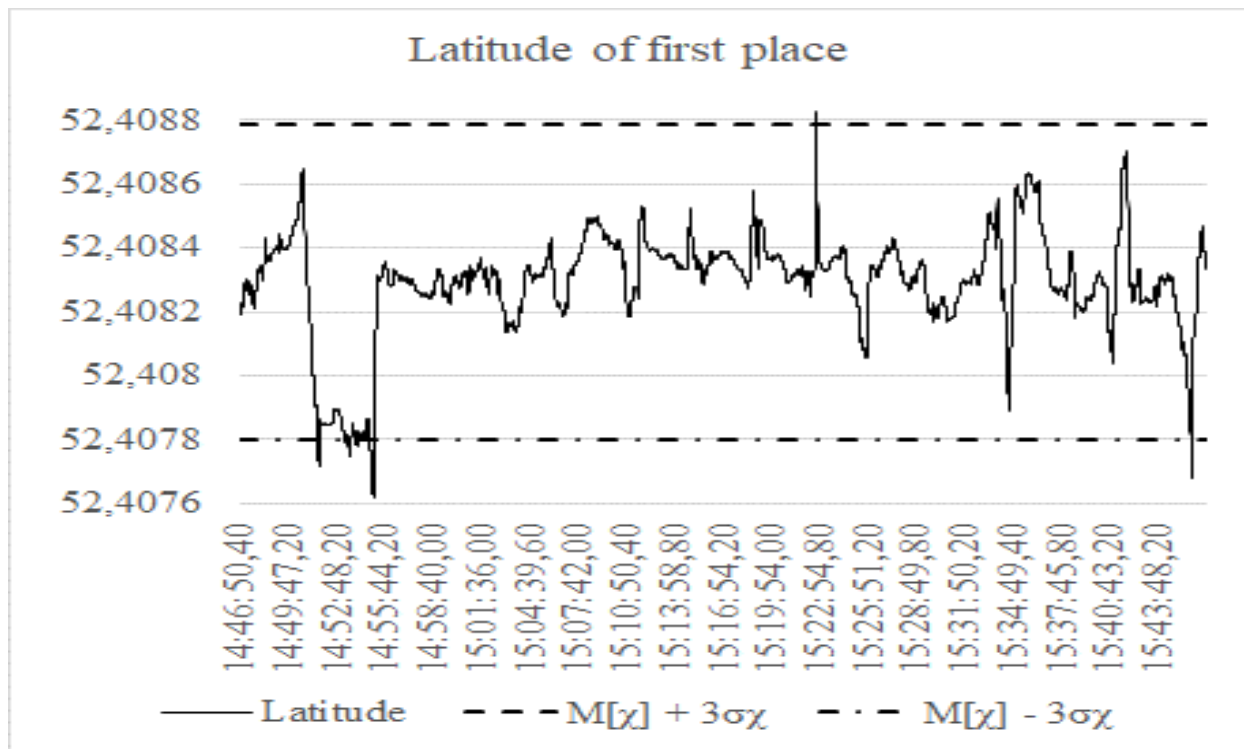


Figure 2 - Graph of latitude of the first point of the terrain

In Fig. 2, the solid line indicates the change in latitude value, the dashed line



marks the upper limit of valid measurements, and the dashed-dotted line marks the lower limit. Values that fall outside these limits are anomalous coordinate measurements.

### **Conclusion**

During satellite positioning, anomalous measurements associated with a short-term decrease in signal-to-noise ratio appear with some probability, which are unacceptable in most situations. [2].

### **Acknowledgements**

We gratefully acknowledge our supervisor, Candidate of Technical Sciences, Associate Professor Sergei Petrovich Moskvitin for his great help in selecting the material and writing this article.

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## **ОПРЕДЕЛЕНИЕ АНОМАЛЬНЫХ ИЗМЕРЕНИЙ СПУТНИКОВОГО ОТСЛЕЖИВАНИЯ КООРДИНАТ**

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**Аннотация:** Высокую точность определения координат местоположения в навигационных системах обеспечивает спутниковая радионавигационная система. Но у данной системы есть большой недостаток – появление аномальных измерений координат, что приводит к неточному определению местоположения. Целью данного исследования является разработка устройства для записи данных с GPS приемника на SD карту и последующее исследование по определению координат местоположения объекта по сигналам ГЛОНАСС/GPS с целью подтверждения наличия аномальных измерений на выходе аппаратуры приема.

**Ключевые слова:** аномальные измерения координат, спутниковая радионавигационная система, ГЛОНАСС/GPS.

## ANALYSIS OF INFORMATION AND MEASUREMENT SYSTEMS OF AIRCRAFT CONTROL

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### **Abstract**

The simultaneous presence of air vehicles in the sky is rapidly increasing. This trend requires high precision tracking of their position to improve flight safety. The task of processing such a large amount of data is solved by information measurement systems. Information-measuring systems are combinations of various measuring instruments and devices that are interconnected by communication channels. Such connections are intended to automate the process of obtaining measurement information from various sources. Thus, the purpose of this article is to consider information-measuring systems as systems for tracking aircraft and their safety, since various factors pose a danger, such as terrain, interference in obtaining information, and more.

**Keywords:** aircraft, adaptive filters, aircraft position, information-measuring systems, interference, terrain.

Information-measuring systems are a complex measuring complex that includes not only measuring transducers, but also computer technology - electronic computers of various capacities.

Depending on the method of organizing the transfer of information between functional blocks, a distinction is made between chain, radial and backbone structures of the IIS. The information is subsequently processed and transmitted. Any radar system during operation is exposed to various factors. The difficulty of obtaining information is created by interference conditions, different terrain, flight dynamics of highly maneuverable aircraft, as well as weather conditions outside the aircraft.

The interference environment is a set of physical fields, processes and phenomena that change in space, time, frequency range and other dimensions that impede the functioning of electronic equipment. The interference environment can be presented in the form of intentional active and passive interference, as well as in the form of unintentional passive interference. They may cause messages received to be garbled. To combat such impacts, it is necessary to use a variety of operating modes and certain technical solutions.

The terrain contributes to the creation of different occlusion angles and “blind” zones, where stations located on the ground will not be able to detect the aircraft, and therefore obtain information about its location. In rangefinder radars there is the concept of “blind” range zones. If an object is located in these zones, a signal from it is not received. For example, in radar with correlation processing of signals having a large base, then the range to the object is determined by the received code, and due to the presence of “blind” zones, the signal from it will disappear when the target moves.

At the same time, there is a possibility of receiving echo signals reflected from the terrain at a short distance from the radar station, which will cause illumination of

the indicator screen.

The dynamism of an aircraft flight lies in the fact that the aircraft moves within the specified limits of the air zone through which the flight is carried out. The effectiveness of the information-measuring system is affected by frequent changes in aircraft parameters, such as speed, acceleration, position of the aircraft in space, altitude and others.

The weather conditions create various difficulties for the operation of IIS. Hydrometeors contribute to the appearance of passive interference on the screens of radar systems. Constant changes in humidity, pressure and temperature cause additional requirements for the characteristics and parameters of individual components and elements of radar stations. You can increase the accuracy of information measurement systems using filtering. In my work I will look at adaptive filtering.

Adaptive filtering is a signal processing technique that is used to remove unwanted interference and noise from a signal. Unlike conventional filtering, adaptive filtering is based on algorithms that can automatically adapt to changing signal conditions.

One of the most common applications of adapted filtering is signal cleaning in communication systems. For example, when transmitting a signal over an RF channel, there is a lot of interference, such as multipath propagation, noise from other sources, etc. Adaptive filtering allows you to automatically adjust filter parameters in real time to reduce the impact of this interference. The analysis of scientific and technical information on measurement systems revealed the existing difficulties of obtaining information. To overcome this obstacle a filtering method was proposed which helped to improve the signal quality.

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## АНАЛИЗ ИНФОРМАЦИОННО-ИЗМЕРИТЕЛЬНЫХ СИСТЕМ УПРАВЛЕНИЯ ВОЗДУШНЫМ СУДНОМ

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**Аннотация:** Одновременное нахождение воздушных транспортных средств в небе стремительно увеличивается. Такая тенденция требует высокой точности слежения за их положением для повышения уровня безопасности полетов. Задачу обработки такого большого количества данных решают информационно-измерительные системы.

Информационно-измерительные системы это – объединения различных средств измерений и устройств, которые соединены между собой каналами связи. Такие связи предназначены для автоматизирования процесса получения измерительной информации от всевозможных источников. Таким образом, целью данной статьи является рассмотрение информационно-измерительных систем, как систем, слежения за летательными аппаратами и их безопасностью, так как опасность представляют различные факторы, такое как рельеф местности, помехи при получении информации и другое.

**Ключевые слова:** адаптивные фильтры, информационно-измерительные системы, летательные аппараты, положение воздушных судов, помехи, рельеф,

## METHODOLOGY FOR CALCULATING SERVICE AREAS FOR BASE STATIONS WHEN PLANNING CELLULAR COMMUNICATION NETWORKS

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### **Abstract**

The development of mobile communications requires the use of effective methods for increasing capacity. Organizing an LTE network is an important aspect of cellular communications; difficulties arise when planning a network, primarily due to the vastness of the territory; in order to cover the entire territory, a large number of base stations will have to be built, which is economical. is not profitable, so you should resort to various algorithms and methods that help implement network coverage plans.

**Keywords:** Network coverage plan, LTE network organization, optimization of cellular network planning, data transmission system, coverage radius, calculation of service areas.

Cellular communications networks are a vital tool for communication, information and communication in the modern world. Planning cellular communication networks requires careful calculation of service areas for base stations (BSS) to ensure reliable and high-quality coverage of the territory. We consider a methodology for calculating service areas for a BS in order to ensure optimal use of resources and coverage of the territory; with wireless access, load distortions occur due to the stochastic movement of subscribers.[1]

When calculating service areas for a BS, several basic parameters should be taken into account:

- Coverage Radius: this is the distance that the signal from the BS can reach. Typically this parameter is determined based on the characteristics of the antenna and transmitting device.

- Signal level: the minimum signal level that is required to ensure communication. This setting depends on the type of equipment used and the data transmission standard.

- Noise Level: this is the signal level that is considered unacceptable for communication. Noise levels will vary depending on the environment and interference that may occur from other cellular networks or radio frequency sources.

- Type of equipment used: antennas, transmitting and receiving devices may have different characteristics, which affects the calculation of service areas.

- Load Balancing: Load balancing is the ability of a network to handle a large number of requests and transfer data. The service area must be divided in such a way

as to ensure an even load distribution between the base stations.

- **Bandwidth Frequency:** Bandwidth frequency is the amount of data that can be transmitted through a network at a certain time. The service area must be divided in such a way as to provide sufficient bandwidth for each user [2].

To calculate service areas, the following methodology should be used:

1. Determine the geographic area for which you need coverage.
2. Select the type of equipment you are using and the antenna specifications.
3. Determine the signal level needed for communication, as well as the noise level.
4. Calculation of service areas:
  - Determine the coverage radius for the BS based on the characteristics of the antenna and transmitting system.
  - Determine the signal level at the boundary of the service area, taking into account the noise level and equipment characteristics.
  - Determine the boundaries of the service area using the signal strength at the edge of the area and the noise level.
5. Check the coverage of service areas for the BS using geographic information systems (GIS) or specialized software.
6. Use the obtained data to optimize the planning of cellular communication networks and BS placement.[3]

The methodology for calculating service areas for BSs when planning cellular communication networks allows for optimal use of resources and coverage of the territory. Determining the geographic area, type of equipment, signal and noise levels, and calculating the boundaries of service areas allows you to create an effective communication network that will meet the needs of users. The proposed methods and algorithms will help determine the high efficiency of network coverage areas with subsequent adjustments to the network coverage plan of LTE standards, the use of artificial intelligence will assess the uniform distribution of LTE network resources

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# МЕТОДИКА РАСЧЕТА ЗОН ОБСЛУЖИВАНИЯ ДЛЯ БАЗОВЫХ СТАНЦИЙ ПРИ ПЛАНИРОВАНИИ СОТОВЫХ СЕТОК СВЯЗИ

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**Аннотация:** Развитие мобильной связи требует использования эффективных методов увеличения пропускной способности. Организация сети стандарта LTE является важным аспектом сотовой связи; при планировании сети возникают трудности, в первую очередь, по причине обширности территории. Чтобы покрыть всю территорию придется строить большое количество базовых станций, что экономически не выгодно, поэтому следует прибегнуть к различным алгоритмам и методам, способствующим реализации планов покрытия сети.

**Ключевые слова:** план покрытия сети, организация сети стандарта LTE, оптимизации планирования сотовых сетей связи, система передачи данных, радиус покрытия, расчет зон обслуживания.

## EDDY CURRENT METHOD OF THICKNESS CONTROL OF MULTILAYER MATERIALS IN ELECTRONIC ENGINEERING

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### **Abstract**

The article presents an analysis of the physical processes occurring in multilayer materials in order to determine the characteristics by the vortex method, and then the results of further analysis are used to control the determination of the layer thickness. It is necessary to carefully control the thickness of the layers of multilayer materials and the ratio of the thicknesses of the layers of each component, on which the physical and mechanical properties and operational characteristics depend to a large extent. Reference quality control of finished products requires the use of newer, more productive and accurate methods and means of quality control in the manufacturing process of components, such as, for example, printed circuit boards. To do this, it is desirable to use non-contact methods of continuous non-destructive testing (NDT) of the geometric values of the studied components.

**Keywords:** non-destructive testing (NDT); ultimate strength; the vortex method.

The intensive development of modern technologies has always required the creation and widespread use of structural materials with special properties. In this regard, multilayer metallic, non-metallic and composite layered compositions have great prospects for application in various industries. These materials are not only a substitute for rare metals, but also an independent group of industrial materials that make it possible to create new machines, devices and a wide range of products.

The technical and economic efficiency of using layered compositions is due, firstly, to the fact that a specific combination of various metals or alloys and non-metals in a layered composition allows you to combine the desired working properties of their components, and in some cases obtain certain properties inaccessible to materials taken separately [3, p. 46]. This is because they can be combined. Secondly, the use of multilayer composites in the national economy makes it possible to significantly save on expensive and rare metals and alloys, while increasing the strength and reducing the weight of products and structures.

Multilayer composite materials are used in the manufacture of parts and equipment at chemical, petroleum, agricultural, transport, energy and other machine-building enterprises. Consumers of such materials are also the instrument-making and radio-electronic industries, the tool industry, enterprises producing household and daily necessities.

Currently produced multilayer compositions for their intended purpose can be divided into the following types: anticorrosive, wear-resistant (including instrumental), antifriction, electrical (conductive, contact), thermo bimetallic, building compositions and household. To assess the quality of production of multilayer materials, there are many methods of continuous monitoring. Currently, it is impossible to introduce new products without testing [1, p. 38].

Based on the analysis of the existing methods and devices for thickness control of



multilayer materials of electronic technology, it was found that the methods and devices are insufficiently effective in terms of performance and accuracy of thickness control. To improve the efficiency of thickness control in production conditions, it is necessary to develop high-speed, accurate and easy-to-use control methods and devices.

The most common is the eddy current method. The eddy current method is based on the analysis of the interaction of the electromagnetic field of an eddy current converter with the electromagnetic field of eddy currents induced in a controlled object [2, p. 126]. The method uses the effect of eddy currents induced in a conductive sample using a converter in the form of an inductor fed by alternating or pulsed current. It is used only for testing products made of conductive materials. An excitation coil or another coil (measuring) is used as a signal converter.

The main advantages of the eddy current method are its versatility and a wide range of functions that are not yet fully used. Disadvantages include testing the thickness of only the conductive layer or the dielectric layer on the conductive base. The change in the gap between the measuring transducer and the object of control strongly affects the results of the testing.

The existing methods and equipment for thickness control of multilayer materials in electronic devices are analyzed. The shortcomings and limitations of all relevant methods are revealed. To improve the efficiency and accuracy of thickness control of multilayer materials, it is necessary to develop a new method of continuous monitoring, such as the eddy current method.

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## ВИХРЕТОКОВЫЙ МЕТОД КОНТРОЛЯ ТОЛЩИНЫ МНОГОСЛОЙНЫХ МАТЕРИАЛОВ В ЭЛЕКТРОННОЙ ТЕХНИКЕ

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**Аннотация:** В статье представлен анализ физических процессов, происходящих в многослойных материалах, с целью определения характеристик вихревым методом, а затем результаты дальнейшего анализа используются для контроля определения толщины слоя. Необходимо тщательно контролировать толщину слоев многослойных материалов и соотношение толщин слоев каждого компонента, от которых в значительной степени зависят механические свойства и эксплуатационные характеристики. Эталонный контроль качества готовой продукции требует использования новых, более производительных и точных методов и средств контроля качества в процессе производства компонентов, таких как, например, печатные платы. Для этого желательно использовать бесконтактные методы непрерывного неразрушающего контроля (НК) геометрических значений исследуемых компонентов.

**Ключевые слова:** неразрушающий контроль (НК); предел прочности; вихревой метод.

## DEVELOPMENT OF AN ABSOLUTE OPTICAL ENCODER

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### Abstract

The purpose of the study is to develop an absolute optical encoder, which is easy to manufacture and configure, implemented on the principle of changing the luminous flux during rotation of a disk containing optically transparent and opaque areas.

**Keywords:** absolute encoder, light flow, photodiodes.

### Introduction

Encoders are required in many applications that require linear or angular position feedback. There are a large number of encoders that differ in the principle of operation – magnetic, resistive, capacitive, inductive, with mechanical contacts. This article will consider the device of an absolute optical encoder, which does not require high-precision equipment and complex technological processes in the manufacture.

### Methods and materials

The optical principle was chosen because of the relative simplicity of converting signals from optical sensors, unlike capacitive and inductive encoders, the absence of the need for permanent magnets, and the absence of restrictions due to their geometric dimensions. This encoder consists of several components: an optical disk, a group of LEDs and a group of photodiodes, which are located on different sides of the disk. When the disk rotates, the luminous flux incident on the photodiodes changes, as a result of which it is possible to determine the absolute angular position from the signals from the photodiodes. The schematic image is presented in Figure 1.

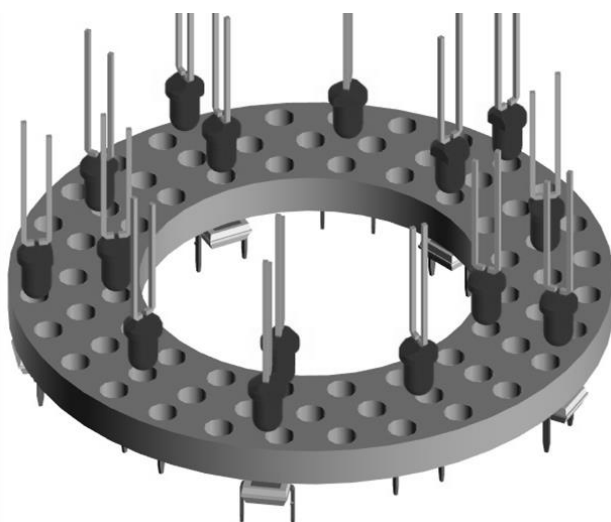


Figure 1 - The concept of an absolute optical encoder

## Results and discussion

An encoder of this design contains several optical tracks, from two or more. Each optical track contains a certain number of optically transparent areas (slots). There are several photodiodes for each track, from two or more. A larger number of photodiodes allows for greater accuracy. When the optical disc rotates, each photodiode belonging to one optical track will have a signal similar to a sine wave (Figure 2). These signals are shifted relative to each other in phase, where the value of the phase shift is determined by the number of photodiodes, with their uniform distribution in a circle. Using the signals from the photodiodes, the quasi-absolute position can be calculated using the arctangent function. To do this, the phase shift of the signals should be equal to 90 degrees, and the signals should be as similar as possible to a sine wave. If the number of photodiodes per optical track is more than two, then to obtain a quasi-absolute position, it is necessary to first calculate the sine and cosine signals, this can be done using the following formula:

$$S = \sum_{i=1}^N \sin \omega_i * \theta_i$$

Where S is the value of the desired sine wave

$\omega_i$  is the angle of rotation of the sensor, relative to the axis of the desired sine wave, Rad.

$\theta_i$  is the signal from the sensor

N is the number of sensors

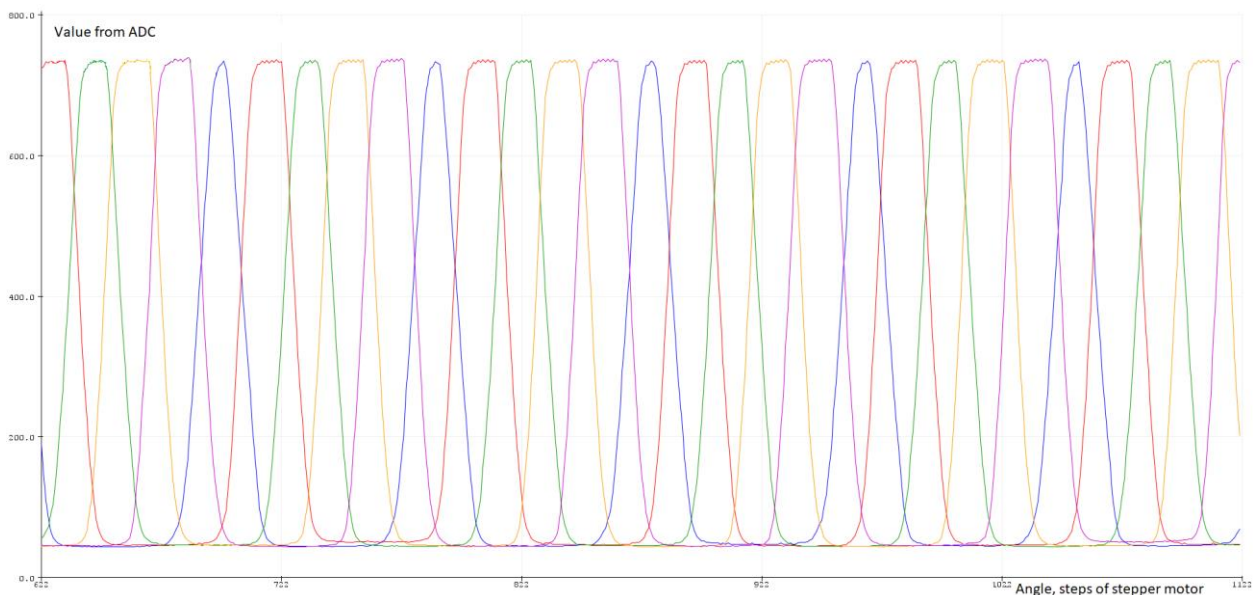


Figure 2 - Signals from five photodiodes

The cosine signal is calculated similarly, only instead of the sine function, the cosine function must be used.

Having several optical tracks, it is possible to calculate a quasi-absolute position for each track, and based on these quasi-absolute values, calculate the absolute value. A necessary condition is that the number of periods of quasi-absolute signals per full revolution of the disk should be mutually prime numbers. Figure 3 shows graphs of quasi-absolute and absolute angular positions.

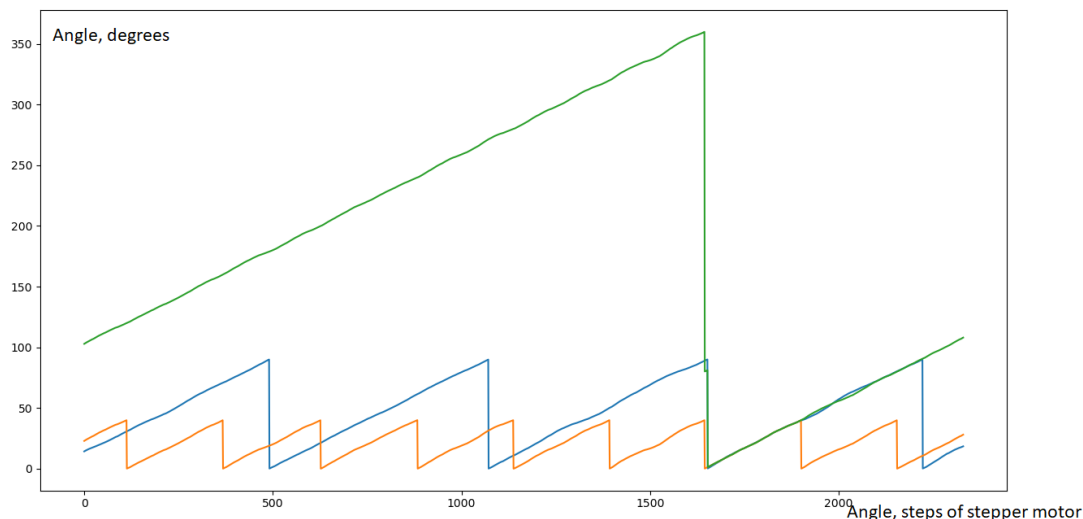


Figure 3 – Graphs of angular positions

## Conclusions

The possibility of creating a simple and cheap optical encoder that can be used in applications that are undemanding in accuracy and reliability is shown. The idea of combining several quasi-absolute encoders to obtain an absolute one can also be applied to a magnetic or other principle, and allows you to create encoders with a wide range of characteristics, and 3D printing technology can be used to manufacture the components.

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## РАЗРАБОТКА АБСОЛЮТНОГО ОПТИЧЕСКОГО ЭНКОДЕРА

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**Аннотация:** Цель исследования – разработка простого в изготовлении и настройке абсолютного оптического энкодера, реализованного на принципе изменения светового потока при вращении диска, содержащего оптически прозрачные и непрозрачные области.

**Ключевые слова:** абсолютный энкодер, оптический поток, фотодиоды.

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**ASSESSMENT OF THE NEGATIVE IMPACT OF TRANSPORT ON  
ENVIRONMENTAL ECOLOGY**

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**Abstract**

This paper describes the main urban environmental problems - air pollution, soil pollution, and other types of pollution caused by the nature of motor vehicles. Studies of chemical processes in the atmosphere, according to environmental monitoring data, show that one of the reasons for exceeding the concentration of harmful substances is emissions from motor vehicles.

**Keywords:** transport; pollution; noise; environmental problems.

Transport has a huge impact on the environment. It helps people to move everywhere and at any time and transfer their goods to any location. This affects economic situation in society. The manufacture and service of various types of transport, the creation of the highways contribute to the economic growth of all countries. A huge number of vacancies appear due to the development of transport systems. It has a huge impact on different spheres of social life including politics, culture and mass market. The transport system of a city imprints on the urban landscape as transport routes are made to facilitate the access to the major sites of a city. The citizens can enjoy a better life quality owing to the latest models of vehicles. The usage of cars, planes, trains, etc. is rising all over the world. It reflects on the amount of goods and people transported annually.

According to experts' estimates, more than 1.47 billion [1] cars are currently in use worldwide. In recent decades the European and Asian car fleets have been growing rapidly. According to the experts' forecasts, the growth in the number of vehicles is expected at the beginning of the current century.

The Asian region of Russia is considered to take the most advantage of private transportation. Among the cities where the pedestrians are much less frequent than the drivers, we can name the following: Vladivostok, Irkutsk and Khabarovsk. As a comparison in the capital of the country only around 30% of population owns a car whereas in the Far East city almost half of citizens drive. The fact that Siberian and Far Eastern cities have the largest number of car owners says not so much about the fact that people earn more there, but about the availability of almost new and quite used cars from Japan.

Despite the above-mentioned advantages of developed transport system, we can certainly detect some drawbacks related to that. One of them is the negative impact on the environment.

In the early 1970s, the share of pollution from transport was 15%; nowadays this

value has reached 70%. In large Russian cities the share of emissions from motor transport is commensurate with emissions from industrial enterprises (Moscow and the Moscow region, St. Petersburg, Krasnodar, Yekaterinburg, Ufa, Omsk, etc.). In the small Russian cities, the damage to the environment caused by exhaust fumes is around 85%. Such cities include for example Makhachkala, Norilsk and Gorno-Altai.

Road transport emits more than 190 poisonous chemicals polluted into the air. The substances emitted in carburetor engines are carbon monoxide, hydrocarbons and nitrogen oxides and in diesel engines is nitrogen oxides and soot.

Numerous ailments occur due to polluted air which people breathe such as asthma, lung cancer and many others. Apart from that, it shortens the life span of people affected in general.

It is especially difficult for children: bronchitis, bronchial asthma, coughing, neonatal disorders of the body's genes and incurable diseases develop, as a result, the infant mortality rate increases by 10% per year.

The main reason for the adverse impact of motor transport on the environment is the low technical level of the rolling stock and the lack of exhaust gas neutralization systems.

Based on the analysis of statistical data [2] it is possible to assess the quality of atmospheric air on the territory of cities and regions of the Russian Federation taking into account the impact of pollutants. For example, for the Central Black Earth Economic Region the most polluted is the territory of the central and north-eastern part, as these areas are industrial zones of Lipetsk, Voronezh, and Stary Oskol. The level of carbon oxide, which makes the maximum contribution to air pollution, for the Tambov region is about 100 thousand tons that indicates a relatively prosperous condition of the air of our region.

Effective preventative measures include widening of streets, creation of filters as walls of green plants between the roadway and apartment buildings.

Improvement of the structure of the car fleet, development of energy-saving modes of transport (metro, high-speed tram, railways, monorails, bus service), improvement of road infrastructure, its beautification, traffic arrangement and of course improvement of maintenance, repairs and organization of control over the technical condition of vehicles – these are the main ways to protect the environment from the motor transport.

Nowadays the problem of noise control is no less important than the problem of chemical pollution of urban environment. Noise is commonly called a chaotic set of sounds that are different in their frequency and strength of impact. That is, it is an unpleasant combination of sounds that disturbs our calmness, irritate our hearing and even destroy the organism.

Transport noise has much more negative consequences for the population than industrial or household noise, as its sphere of action is much wider and physical options characterizing the impact of noise on the human body are incomparably higher.

Noise has a harmful effect on the human body. This harmful effect is manifested in specific damage to the hearing and non-specific changes in other human organs

and systems of human body.

The level, nature, spectral composition, duration of action and individuality of sensitivity are important when person is exposed to noise. Prolonged intense noise exposure can cause significant disorders of the nervous and endocrine systems, vascular tone, gastrointestinal tract and progressive hearing loss.

The main method of noise control is an improvement of vehicle constructions and stricter technological requirements, especially:

- reduction of rotor unbalance;
- installation of silencer;
- transition to electric traction;
- improvement of the rail junction (for rail transport), installation of cushioning pads, etc.

It is very important to reduce the power of noise sources through optimal placement of enterprises, creation of detours, interchanges based on noise maps.

Urban planning measures are no less important; along transport routes it is necessary to reduce the glazing of houses, use painted windows and increase the density of natural screens. Two rows of medium-sized trees planted at a distance of 50 meters from a building reduce noise by about 29 dB. It has been established that forest plantations along the railway reduce noise by 0,1-0,2 dB per metre of plants width (and for dense green hedges even by 0,5 dB per metre). The screens in the form of warehouses and similar buildings are practiced along the railways.

Recently in houses located near the powerful noise resources if it is impossible to evict the citizens, triple glazing of windows with separate window sash is used. Noise is reduced by 2,5 times when the windows are closed.

Only through a set of organizational and legal, architectural and planning, design and technical, operational and technological measures it will be possible to reduce the negative effects on the environment from the functioning of urban infrastructure facilities including transport highways.

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## ОЦЕНКА НЕГАТИВНОГО ВЛИЯНИЯ ТРАНСПОРТА НА ЭКОЛОГИЮ ОКРУЖАЮЩЕЙ СРЕДЫ

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**Аннотация:** Рассмотрены основные экологические проблемы городов - загрязнение атмосферного воздуха, почв и т.п., обусловленные воздействием автотранспортных средств. Исследования химических процессов в атмосфере, по данным мониторинга окружающей среды показывают, что одной из причин превышения концентрации вредных веществ являются выбросы автотранспорта.

**Ключевые слова:** транспорт, загрязнения, шум, экологические проблемы.

## THE IMPACT OF DOCUMENTATION MANAGEMENT ON LABOR PRODUCTIVITY AND PRODUCT QUALITY

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### Abstract

This article focuses on the problem of documentation management at enterprises operating in the field of mechanical engineering. This study is intended to diagnose the effectiveness of the joint use of analog and digital technical documents. An algorithm of actions is being formed that identifies vulnerabilities in the production cycle that entail defective products.

**Keywords:** documentation, digital documentation, printed documentation.

### Introduction

Document management is very important for the production of high-quality products, and also affects labor productivity. Currently, it is quite common for industrial enterprises to switch to electronic document management. This transition is associated with a number of problems. During the transition period, as practice shows, both electronic documents and paper documents are often used in the production process. We consider them through the example of a machine-building enterprise.

The first problem is the lack of an electronic version of the documentation developed before the introduction of digitalization at the enterprise, and its availability only on paper, whereas new information is available both in digital and printed form. Thus, when the task of manufacturing parts based on documentation that has not been digitized appears, it will be necessary to lift this documentation from the archive on paper. Practice shows that in some cases, documentation is damaged or lost. At the same time, the technology has undergone changes during this time, new equipment has appeared at the enterprise. All this leads to a significant loss of time for searching, processing, possible improvements or even a complete change, due to the irrelevance of technological processes, replacement of used equipment, tools, etc., digitization, entry into the database and commissioning. All this significantly increases the work of the technologist and the time for manufacturing the part as a whole. And as a result, it affects labor productivity.

The second problem is to maintain the relevance of printed documentation throughout the entire life cycle [1]. For example, when concluding contracts, the customer can make changes to the design documentation up to the moment when the parts have already been sent for manufacture. At the same time, changes made to the drawings by the customer or the designer must be entered into a common database, and this information must be communicated to all those involved in the manufacture. In practice, it is not uncommon for workers to receive paper documentation in the workshop, printed out before making changes, and in this form it is accepted for



work. At the same time, when any changes are made, they are made only in electronic form, they are entered into a common database, which shop workers do not have access to. In turn, the production continues according to the drawings printed earlier. In conditions of large-scale production, with a small assortment of manufactured products per unit of time, it is not difficult to track printed drawings and update them, as well as notify all participants in the process of changes. However, in small-scale productions with a wide range of products, it is possible to make changes to hundreds of items. At the same time, it is almost impossible to identify the location of all printed drawings and replace them with actual ones without a dedicated special person and a well-established connection between the workshop and the design department. This affects the quality of the products.

The third problem is related to the updating of regulatory documentation. In the course of their work, technologists, designers and operators of CNC machines constantly refer to various GOST standards, standards and norms. Due to constant progress, the identification of errors and other reasons, regulatory documents are undergoing changes. In machine-building industries, different types of storage and accounting of such documents are used:

*The 1st option:* The documentation is in hard copy. Such documentation, if properly stored, is quickly accessible and easy to use. The problem is that it is constantly necessary to monitor the relevance and, if it appears, it should be immediately replaced [2]. Quite often, given that enterprises most often have a large number of copies with this form of information storage, some of them may remain unaccounted for and continue to be used in work, which can significantly lower the quality of products, since it is based on non-updated regulatory documentation. This leads to the need to check the relevance of the document and, as a result, additional time and reduced productivity. The use of an outdated version of the documents leads to errors and the release of defective products.

*The 2nd option:* Documentation in a digital version in the format of a common database. This is the most convenient option, because you only need to control the relevance in one place [3]. However, with this method, it is necessary to provide protection against unauthorized changes, and it is also necessary to ensure that information is available to users.

*The 3rd option:* The lack of a single database and free access to documentation search. This option is used in enterprises where the common database and archives are poorly organized or do not exist at all. In this case, employees search for documentation on the Internet, which creates many problems: inaccuracy of the search results, difficulty in finding the latest relevant version, some regulatory documents are not publicly available. With this approach, the technological documentation can be obtained with many inaccuracies, which in turn will lead to poor product quality.

The fourth problem is the maintenance of paper magazines. Enterprises constantly need to register various actions [2]. In large enterprises, where each tool is clearly controlled by technology and, if a replacement is required, it is immediately changed, the entire tool base is easily controlled and, most often, even if paper logs are present, data from there is immediately entered into the database [3]. In small

enterprises, where the right to replace a tool with another lies with the workers of the workshop, the workers themselves take the tool from the warehouse and record it in a printed journal (there is no database). In these conditions, it is very difficult to control its condition and time to complete wear, requirements for the purchase of a new one, also such logs are not convenient to use, data to it cannot be obtained quickly, which complicates the work of technologists and programmers. This problem leads to a lack of the right tool, as a result of which it is necessary to make changes to the technology or even suspend production. This also affects the reduction of product quality and reduces labor productivity.

### **Conclusion**

From all of the above, we can conclude about the importance of the issue of documentation management and the impact on the quality of products and labor productivity at the enterprise. In the course of this work, the main problems of sharing paper and electronic documentation were shown. It was shown the importance of complete simultaneous digitalization of documentation, the presence of a single database containing general information about movements, changes and adjustments related to the object.

### **Acknowledgements**

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## **ВЛИЯНИЕ УПРАВЛЕНИЯ ДОКУМЕНТАЦИЕЙ НА ПРОИЗВОДИТЕЛЬНОСТЬ ТРУДА И КАЧЕСТВО ПРОДУКЦИИ**

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**Аннотация:** Статья посвящена проблеме управления документацией на предприятиях, работающих в области машиностроения. Данная работа предназначена для диагностики эффективности совместного использования аналоговой и цифровой технической документации. Формируется алгоритм действий, который выявляет уязвимые места в производственном цикле, приводящий к браку продукции.

**Ключевые слова:** документация, цифровая документация, печатная документация.

## COMPUTER PROGRAM FOR CALCULATING INDICATORS OF THE AGE STRUCTURE OF THE VEHICLE PARK

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### Abstract

Aging of rolling stock negatively affects the efficiency of its use. Managing the age structure of the park is one of the organizational tasks of management. The choice of a rational strategy for updating the fleet of cars is possible based on the use of existing methods. To eliminate errors in their application and speed up calculations, a computer program was developed that implements existing fleet renewal strategies.

**Keywords:** age structure of the car fleet, motor transport enterprise, computer application.

### Introduction

With an increase in the life of the car, the cost of its maintenance and repair increases. This leads to a decrease in the profitability of the enterprise. Premature decommissioning of vehicles also negatively affects. In order to find a rational service life, methods of calculating indicators of rolling stock decommissioning will be used. There are discrete (simple and complex) and random write-off methods. These methods are quite laborious, which reduces the efficiency of calculations. To eliminate this drawback, a special computer application was developed that implements these methods and allows you to choose a rational strategy.

This application allows you to calculate the input data manually entered or, for training purposes, the input data options presented in the tutorial [2]. The initial data for discrete write-off are: the distribution of rolling stock by age group, the size of supplies indicating the age of purchased, and for complex write-off and the number of cars sold, as well as the percentage of income received from cars of the corresponding age groups. After you select the source data source, you define the calculation method. For example, we choose manual data entry.

**Initial data for calculation**

Number of vehicles in the age group, pcs.					Percentage of income from vehicles of age groups, %					Number of purchased vehicles in the group, pcs.		Number of vehicles sold from the group, pcs.
1 (0 - 1)	2 (1 - 2)	3 (2 - 3)	4 (3 - 4)	5 (4 - 5)	1 (0 - 1)	2 (1 - 2)	3 (2 - 3)	4 (3 - 4)	5 (4 - 5)	1	3	4
6	8	14	12	5	100	97	85	70	52	4	10	1

Parameter	The initial state	Simple write-off	Complex write-off
Size of deliveries of new cars, pcs.	0	4	0
Age group of cars (age from and to)			
1 (0 - 1)	6	4	0
2 (1 - 2)	8	6	6
3 (2 - 3)	14	8	18
4 (3 - 4)	12	14	13
5 (4 - 5)	5	12	12
Write-off amount, pcs.	0	5	6
Fleet size after write-off, pcs.	45	44	49
Change in fleet size, %		-2.22	8.89
Average age of a car in the fleet, years.	2.54	3.05	3.49
Relative park income, %	81.47	74.23	74.41
Change in quality indicator for average car income, %		-7.24	-7.06
Relative income of the park, units of account	3666.00	3266.00	3646.00
Change in park income relative to the initial state, %		-10.91	-0.55

Figure 1 - Calculation results for discrete write-off

Initial data and calculation results for discrete write-off are given in Fig. 1. Based on the calculation results, the selection of the write-off method and parameters is evaluated. With the entered data, with a simple update, the income of the park is reduced by 10.91% compared to the initial state, while the size of the park is reduced by 2.22% (with an average age of 3.05 years). With a complex write-off, the fleet's income decreases by 0.55% compared to its original state, while the fleet's size increases by 8.89% and the average age of the fleet's cars is 3.49 years. In this case, you should select a complex write-off or change the conditions for updating the fleet. It is also necessary to know the further strategy for updating the fleet and the tasks facing the rolling stock for the current year.

For random write-off, the number of cars in the fleet is a constant value and must be maintained at a given level. Initial data and calculation results for random write-off are given in Fig. 2. For greater clarity, you can open the write-off schedule (Fig. 3).

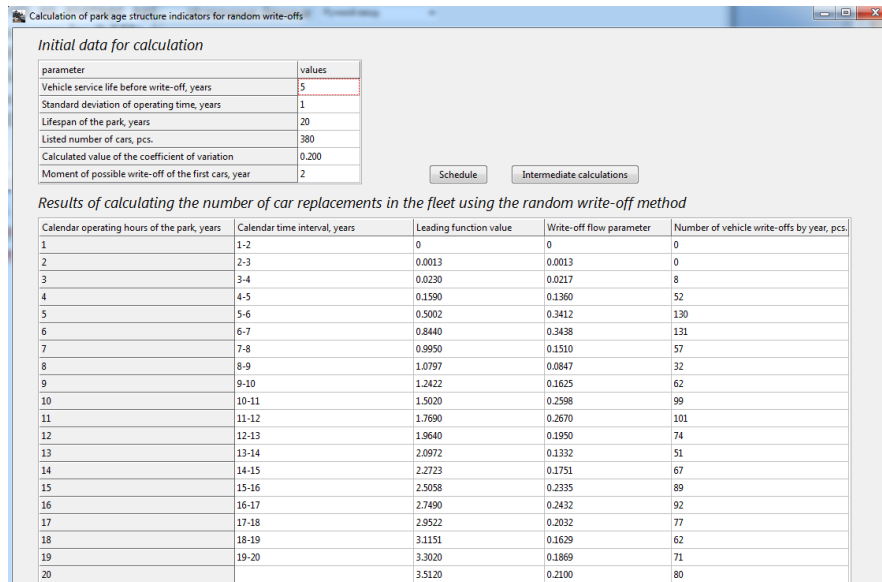


Figure 2 - Calculation results for random write-off

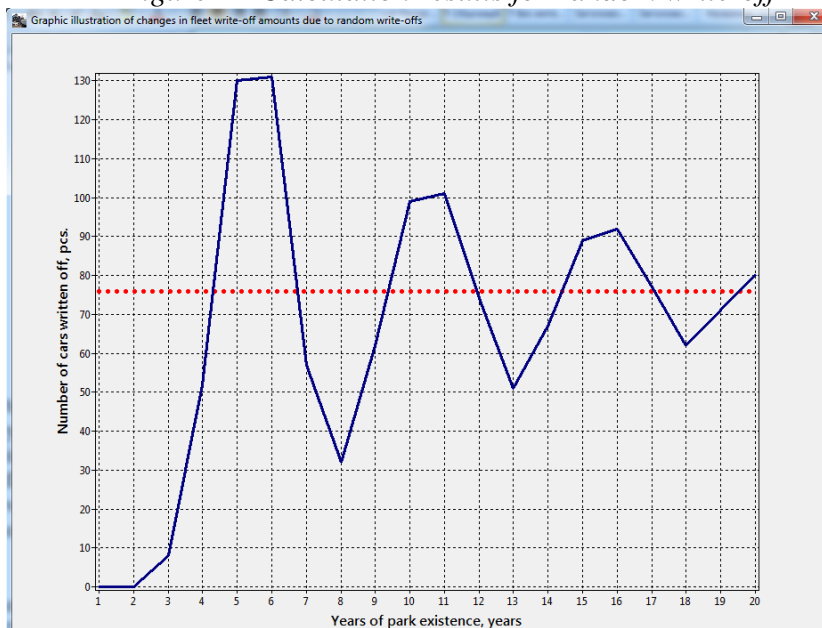


Figure 3 - Write-off curve

For the calculation conditions chosen for the example, the size of write-offs tends to stabilize at the level of 76 cars per year. There are no write-offs during the first two years of the park's existence. Maximum replacement needs (131 units per year) arise in the zone of average operating time for the first replacements in 6 years of the fleet's existence. For second replacements, the number of write-offs per year is 101 vehicles, and for third replacements, 92 vehicles. For greater information, you can obtain the calculation results in tabular form by clicking the corresponding button.

### **Conclusion**

The use of digital technologies is one of the components of the effective operation of modern motor transport enterprises [1, 3]. A current trend in their use is the development of “digital twins”. The developed application can be considered a simplified “digital twin” of the process of managing the age structure of the car fleet. It has shown its efficiency and effectiveness. The application allows you to quickly calculate indicators of the age structure of the fleet based on options or arbitrary data, adjusting the write-off strategy. This program can be used for educational purposes, as well as by specialists of motor transport enterprises.

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## **КОМПЬЮТЕРНАЯ ПРОГРАММА ДЛЯ РАСЧЕТА ПОКАЗАТЕЛЕЙ ВОЗРАСТНОЙ СТРУКТУРЫ АВТОМОБИЛЬНОГО ПАРКА**

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**Аннотация:** Старение подвижного состава негативно сказывается на эффективности его использования. Управление возрастной структурой парка является одной из организационных задач руководства. Выбор рациональной стратегии обновления парка автомобилей возможен на основании применения существующих методик. Для исключения ошибок их применения и ускорения расчетов была разработана компьютерная программа, реализующая существующие стратегии обновления парка.

**Ключевые слова:** автотранспортное предприятие, возрастная структура автомобильного парка, компьютерное приложение.

## MULTIFUNCTIONAL ROAD SERVICE AREA IN THE TAMBOV REGION ON THE R-22 HIGHWAY

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### Abstract

This study examines the necessity and significance of multifunctional road service areas. In particular, research has been conducted along the R-22 highway in the Tambov region. Recommendations have been provided regarding the development and potential placement of a multifunctional zone within the studied area.

**Keywords:** multifunctional road service areas, MFSA, intensity, freight transportation, logistics center, road safety.

Currently, there is a significant growth in motorization. As of the end of 2022, the traffic police registered 60.45 million motor vehicles. Compared to 2021, there was an increase of +0.5%, or +312 thousand units. Against this backdrop, there is a need for MFSA (multifunctional road service areas) on high-intensity intercity highways.

MFSA contribute to safety, efficiency, improvement of working conditions for drivers, and reduction of negative impact on the environment. They are an important component of infrastructure for freight transportation and contribute to the development of the logistics industry.

The R-22 highway has high traffic intensity. The intensity in both directions is presented in Table 1. Measurements were taken in the morning at 10:00 [4].

Table 1 The intensity of traffic on R-22 highway

Direction of movement	Traffic intensity, vehicles/15 minutes			Presented intensity, vehicles/hour
	Passengers	Trucks	Buses	
Towards the city of Tambov	81	63	-	333
Towards the city of Moscow	88	42	-	718
Total				1051

A large number of freight trucks is due to the presence of a logistics center in the direction of the city of Tambov, in the settlement of Streltsy. Due to the high intensity and the presence of a logistics center, there is a need for a multifunctional road service area (MFSA) in this area. The creation of MFSA has the following positive aspects:

- Safety provision: with high intensity of freight transport on the roads, the risk of accidents and other incidents increases. Multifunctional road service areas allow for the creation of safe places for parking, resting, and servicing freight trucks. This may

include parking with convenient access to technical service facilities, gas stations, restaurants, hotels, and other facilities where drivers and carriers can rest and provide proper technical support for their vehicles.

- Efficiency and logistics optimization: Multifunctional road service areas allow for the optimization of logistics processes and improvement of freight transport efficiency. Drivers can plan their stops in advance in known and equipped locations, which helps reduce downtime and increase productivity. Additionally, the availability of diverse services in multifunctional areas saves time and resources, as drivers can access all necessary services in one place.

- Improvement of working conditions for drivers: High intensity of freight transport may be associated with long working periods for drivers and stressful conditions. Multifunctional road service areas provide drivers with the opportunity to rest, replenish supplies, get food, and regain strength before continuing their journey. This contributes to improving working conditions for drivers and increasing their productivity [2].

- Reduction of negative environmental impact: Multifunctional road service areas should be organized taking into account environmental aspects. MFSA must provide opportunities for charging electric vehicles or using alternative fuels. This contributes to the development and operation of electrically powered vehicles, helping to reduce emissions of harmful substances and negative environmental impact. According to the recommendation of "Russian Highways" (Avtodor), MFSA is arranged at a distance of 30 kilometers. It is suggested to set up a multifunctional road service area at a distance of 41 kilometers.

In accordance with GOST 33062, MFSA should include the following facilities:

- parking lot
- multi-fuel gas station
- dining facility (cafe, restaurant, etc.)
- trading point (mini-market, etc.), placed separately or as part of the dining facility
- rest area
- self-service area with mandatory provision of a tire pressure checking and inflating station
- restrooms
- trash bins
- ATM(s)
- telecommunication services (phone(s), Wi-Fi, etc.) [3]

### **Conclusion**

Overall, multifunctional road service areas (MFSA) on intercity highways are of great importance due to the increasing motorization. They ensure road traffic safety, driver comfort, support logistics, and contribute to the regional economy. To also support alternative fuel types, MFSA should be equipped for charging electric vehicles or using alternative fuels such as gas or hydrogen. This helps reduce emissions of harmful substances such as carbon dioxide, nitrogen oxides, and particulate matter, which are the main causes of air pollution from motor vehicles.

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## МНОГОФУНКЦИОНАЛЬНАЯ ЗОНА ДОРОЖНОГО СЕРВИСА В ТАМБОВСКОЙ ОБЛАСТИ НА УЧАСТКЕ ТРАССЫ Р-22

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**Аннотация:** Рассматривается необходимость и значимость многофункциональных зон дорожного сервиса. В частности, проведено исследование на участке трассы Р-22 в Тамбовской области. Были даны рекомендации о разработке и возможном размещении на исследуемом участке МФЗ.

**Ключевые слова:** многофункциональные зоны дорожного сервиса, МФЗ, интенсивность, грузоперевозки, логистический центр, безопасность дорожного движения.



## **ARBEITSSCHUTZ, BRANDSCHUTZ UND UMWELTSICHERHEIT**

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### **Zusammenfassung:**

Der Artikel behandelt Fragen der Bedeutung des Arbeitsschutzes, der Feuer- und Umweltsicherheit. Diese Bereiche sind ein wichtiger Komplex von Aktivitäten, der die Erhaltung des Lebens und der Gesundheit der Menschen und die Sicherheit der Umwelt gewährleistet. Der Artikel beleuchtet die Information, dass diese Richtungen Unterschiede aufweisen, aber dennoch untrennbar miteinander verbunden sind.

**Schlüsselwörter:** die Sicherheit, das Leben und die Gesundheit, die Umwelt, der Arbeitsschutz, der Brandschutz, die Ökologie, ökologische Sicherheit

### **Inhalt**

Heute sind die Fragen des Arbeitsschutzes, des Brandschutzes und der Umweltsicherheit für jedes Unternehmen wichtig und relevant. Die richtige Organisation dieser Bereiche hängt sowohl von der Sicherheit des Lebens und der menschlichen Gesundheit, der Sicherheit der Umwelt als auch von der wirtschaftlichen Komponente jedes Unternehmens ab [1]. Diese Bereiche sind eine Reihe von Aktivitäten, die richtig organisiert werden müssen. Sie haben eine gemeinsame Grundlage, unterscheiden sich jedoch voneinander.

Die Grundlage der menschlichen Existenz ist die Verwirklichung des Menschen in der Arbeit, aber damit die Mitarbeiter ihre Arbeit effizient erledigen, ist es notwendig, einen kompetenten Arbeitsschutz zu organisieren. Das Leben und die Gesundheit eines Menschen sind von höchster Bedeutung [2]. Die Höhe des Gewinns, das Rentabilitätsniveau oder der Wert des Produktionsprodukts sollten nicht priorisiert werden. Der Arbeitsschutz ist ein System zur Erhaltung des Lebens und der Gesundheit von Arbeitnehmern während der Arbeit, das rechtliche, soziale, wirtschaftliche, organisatorische, hygienische, therapeutische, vorbeugende, rehabilitative und andere Maßnahmen umfasst. Der Arbeitsschutz umfasst vor allem rechtliche Fragen – die Rechte und Pflichten von Arbeitnehmern und Arbeitgebern, die die Einhaltung des Arbeitsgesetzbuches gewährleisten.

Ökologische Sicherheit ist ein Zustand des Schutzes der natürlichen Umwelt und der lebenswichtigen Interessen des Menschen vor möglichen negativen Auswirkungen wirtschaftlicher und anderer Aktivitäten, natur- und technogener Notsituationen und deren Folgen. Die Gewährleistung der ökologischen Sicherheit sollte der führende Entwicklungstrend des modernen Russland sein [3].

Brandschutz ist ein Zustand des Schutzes der Person, des Eigentums, der Gesellschaft und des Staates vor Bränden. Es handelt sich um eine Reihe praktischer Maßnahmen und Regeln, die darauf abzielen, einen versehentlichen oder vorsätzlichen Brand zu verhindern, seine Ausbreitung im Falle eines Brandes zu begrenzen und die Folgen, einschließlich möglicher Verluste, auf ein akzeptables

Niveau zu minimieren. Der Brandschutz umfasst eine Reihe von öffentlichen Beziehungen, um die Sicherheit des Einzelnen und der Gesellschaft vor Bränden und ihren Folgen zu gewährleisten. Dieser Zustand des gesellschaftlichen Lebens wird vom Staat durch ein System von Vorschriften und Vorschriften, die die Anforderungen des Brandschutzes enthalten, gewährleistet [4].

Basierend auf diesen Definitionen hat jede dieser Richtungen ihre eigenen Besonderheiten. Die Tatsache, dass die Verletzung von Arbeitsschutz-, Feuer- und Umweltschutzanforderungen negative Auswirkungen sowohl auf Arbeitnehmer als auch auf die Umwelt haben kann, sollte jedoch nicht ignoriert werden. Die Beziehung dieser Bereiche (Arbeitsschutz, Brandschutz und Umweltsicherheit) ist nach großen gefährlichen Betriebsunfällen am besten nachvollziehbar. Kleine systematische Fehler und Zufälle führen dazu, dass Menschen, Tiere und die Natur insgesamt unter verschiedenen negativen Faktoren leiden.

Sie können die Beziehung der Richtungen im folgenden Beispiel betrachten. Zu den Umweltschutzfunktionen, die das russische Katastrophenschutzministerium in der Praxis durchführt, gehören Maßnahmen zur Verhütung und Beseitigung von Bränden, da sie von Umweltverschmutzung begleitet werden. Die Deponie für Hausmüll ist ein Objekt, auf dem große Mengen brennbarer Materialien konzentriert sind: Papier, Polyethylen, Kunststoff (letzteres gibt beim Verbrennen eine große Menge an Karzinogenen frei, die für die menschliche Aktivität besonders gefährlich sind). Gorenje ist ein Objekt, auf dem große Mengen brennbarer Materialien konzentriert sind. Jahr für Jahr werden Probleme bei der Entsorgung von Hausmüll zu Bränden. Die Entstehung von Bränden auf Deponien und Deponien von festen Hausmüll stellt eine enorme Bedrohung für die Umweltsicherheit und die Sicherheit der Menschen im Allgemeinen dar. Brände haben einen negativen Einfluss auf den Zustand der natürlichen Umwelt und die menschliche Gesundheit, verändern die Lebensbedingungen lebender Organismen. Das Ausmaß der negativen Folgen von Bränden kann jedoch unterschiedlich sein. Brände in der Technosphäre können auf lokaler und sogar regionaler Ebene zu erheblichen Umweltverschmutzungen führen und zum Tod von Mitarbeitern von Produktionsunternehmen führen.

Besonders wichtig sind die Fragen des Arbeitsschutzes und der industriellen Ökologie vor dem Hintergrund von Arbeitsunfällen und Berufskrankheiten. Die schwierige Situation in Unternehmen verschiedener Eigentumsformen hängt weitgehend von der Einführung wirtschaftlicher Mechanismen und Arbeitsbeziehungen ab, die Arbeitgeber dazu ermutigen sollten, sich an die gesetzlichen Anforderungen zu halten.

Die Vielfalt der technologischen und industriellen Prozesse erfordert wiederum die Berücksichtigung der Besonderheiten der Produktion bei der Ausbildung von Spezialisten, da die Gültigkeit der Wahl der Methoden und Mittel zur Kontrolle und Verwaltung der menschlichen Sicherheit davon abhängt. Diese Aufgabe ist Multifaktor, und von der Fähigkeit, bei der Analyse von Faktoren, die die Gesundheit des Personals beeinflussen, Akzente zu setzen, hängt die richtige Wahl von Managern, organisatorischen oder technischen Lösungen ab, die darauf abzielen, Verletzungen und Berufskrankheiten zu reduzieren oder zu vermeiden.

Die Einhaltung von Arbeitsschutz-, Feuer- und Umweltschutzanforderungen im

Unternehmen bringt viele Vorteile mit sich. Erstens reduziert es das Risiko von Arbeitsunfällen, was sich positiv auf die Gesundheit und das Wohlbefinden der Arbeitnehmer auswirkt. Zweitens minimiert dies die öffentliche Unzufriedenheit und verringert die Möglichkeit von Strafen durch den Staat. Drittens zeigt dies ein hohes Maß an sozialer Verantwortung des Unternehmens.

So müssen Unternehmen die Besonderheiten der Branche und das Vorhandensein gefährlicher Faktoren in der Produktion berücksichtigen, den Fragen des Umwelt- und Brandschutzes sowie des Arbeitsschutzes höchste Aufmerksamkeit widmen. Die Lösung dieser Aufgaben sollte in die Hauptbereiche der Aktivitäten des Unternehmens einfließen, eine angemessene Arbeitsqualität sicherstellen und einen der wichtigsten Indikatoren für die Produktionseffizienz darstellen, was sich zweifellos auf das finanzielle Ergebnis des Unternehmens auswirken wird.

### **Schlusswort**

Arbeitsschutz, Brandschutz und Umweltsicherheit sind wichtige Aspekte in jeder Organisation. Sie zielen darauf ab, Arbeitnehmer vor möglichen Risiken und Gefahren zu schützen und die Umwelt zu schützen.

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## **ОХРАНА ТРУДА, ПОЖАРНАЯ И ЭКОЛОГИЧЕСКАЯ БЕЗОПАСНОСТЬ**

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**Аннотация:** Охрана труда, пожарная и экологическая безопасность являются важным комплексом мероприятий, который обеспечивает сохранение здоровья людей и безопасность окружающей среды. Обязанность соблюдать требования охраны труда, пожарной и экологической безопасности является важным аспектом в любой организации. В статье освещается информация о том, что эти направления имеют различия, но, тем не менее, неразрывно связаны между собой.

**Ключевые слова:** безопасность жизнедеятельности, жизнь и здоровье, окружающая среда, охрана труда, пожарная безопасность, экология, экологическая безопасность.

## MANAGEMENT OF GREENHOUSE GAS EMISSION QUOTAS IN REGIONAL ECONOMY

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### **Abstract**

The study considers the solution to one of the main global problems – climate change caused by emission of greenhouse gases. It addresses the issues of interaction between the participants of the emission quota markets on the level of regional economy. The relevance of the study is explained by current deregulation of the quota market and a lack of information support of stakeholders who are willing to sell or buy the quotas for greenhouse gases emission. As a result, the scheme of interaction between the participants of the quotas market was proposed in order to facilitate the process of redistributing the quotas, thus, reducing the impact on the environment and moving towards green economy.

**Keywords:** greenhouse gases emission management, quotas for greenhouse gases emission, regional economy, green economy

### **Introduction**

Extensive economic activity unfortunately has resulted in climate change, which became one of the main global problems, and its solution requires an integrated approach at all levels of the economic system. One of the methods currently used to level out the negative impact of economic entities on the environment is the market of quotas for greenhouse gas (GHG) emissions.

Business entities can meet the established standards for GHG emissions either through investments in technologies for processing harmful substances contained in GHGs or through the acquisition of permits to emit GHGs from those producers who have achieved a significant reduction in emissions compared to the initially allocated quotas. However, the enterprises willing to purchase or sell quotas are faced with a lack of up-to-date information on the state of the regional quota market, namely:

- volume of quotas available for purchase, their cost, as well as the validity period of these quotas;
- demand for the purchase of quotas, their volume, the price offered for them;
- up-to-date scheme of interaction for quotas exchange taking into account local and federal regulations;
- list of quota market participants, regulatory bodies, as well as contact details of specialists in these areas [1, 2].

The above factors have led us to the necessity of developing a regional system that will facilitate interaction between economic entities, as well as simplify the supervision of this area for environmental regulatory authorities. The proposed diagram of interaction using a system of accounting and exchange of quotas is presented in Fig. 1.

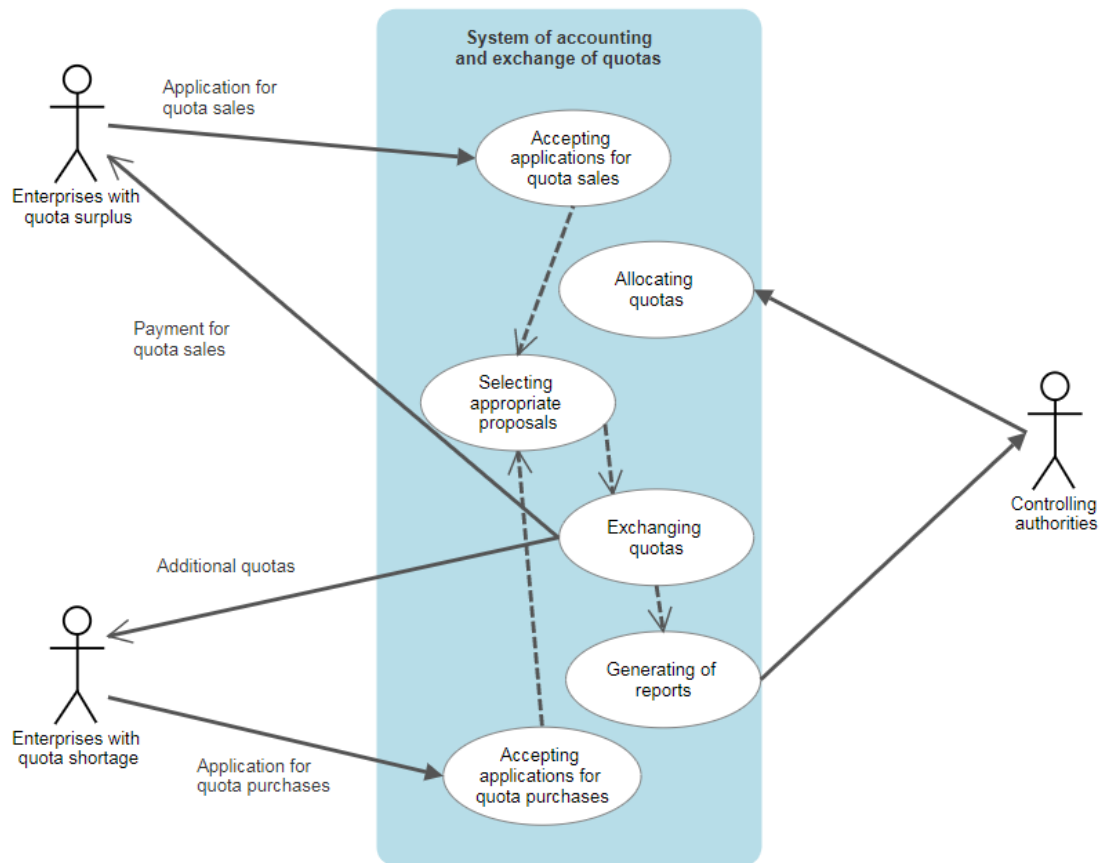


Figure 1 - The block diagram of information flows for managing GHG quotas

The above diagram demonstrates the interaction between the participants in the system of GHG quotas exchange at the regional level. It displays the main stakeholders (business entities that have a surplus of quotas and want to sell them in order to make a profit; business entities that want to reduce costs by purchasing additional quotas; regulatory bodies - regional departments (city committees) for environmental protection and environmental management) and the system that allows interaction and consolidation of reporting on quota exchange operations, as well as the cases (scenarios) reflecting the main actions of the participants [3].

The system of accounting and exchange of quotas, as noted earlier, optimizes the interaction between the stakeholders of the quota market. In order to develop such a system, it seems logical to determine its key characteristics. Taking into account the described specifics of the area under consideration, they include:

- openness of quota market for business entities: enterprises should be able to register in the system by providing the minimum required amount of paperwork;
- safety of identifying the business entity and regulatory authorities, as well as confirming the fact of transfer of quotas: it is necessary to use an enhanced qualified electronic signature in accordance with current legislation;
- relevance of data: at any time, information about supply and demand on the quota market, completed transactions, as well as related paperwork must be up-to-date;
- ease of use and support: the system should be a tool aimed at facilitating the

interaction of participants.

### **Conclusion**

By applying the system built on the principles listed above, it is possible not only to achieve positive economic result for a business entity by obtaining additional profits from the sale of quotas or reducing costs by purchasing additional quotas, but also transparency of the regional quota market, which will lead to simplification of its control and analysis.

### **Acknowledgements**

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## **УПРАВЛЕНИЕ КВОТАМИ НА ВЫБРОСЫ ПАРНИКОВЫХ ГАЗОВ В РЕГИОНАЛЬНОЙ ЭКОНОМИКЕ**

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**Аннотация:** Рассмотрено решение одной из главных глобальных проблем – изменения климата из-за выбросов парниковых газов. Исследуются вопросы взаимодействия участников рынков квот на выбросы на уровне региональной экономики. Актуальность исследования объясняется существующей дерегуляцией рынка квот и отсутствием информационной поддержки заинтересованных сторон, готовых продать или купить квоты на выбросы парниковых газов. Предложена схема взаимодействия участников рынка квот, позволяющая облегчить процесс перераспределения квот, тем самым снизить воздействие на окружающую среду и перейти к зеленой экономике.

**Ключевые слова:** управление выбросами парниковых газов, квоты на выбросы парниковых газов, региональная экономика, зеленая экономика.

### THE ANALYSIS OF THE EFFICIENCY OF SCREW ROOT AND TUBER CROPS GRINDERS FOR CATTLE

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#### Abstract

Screw grinders are widely used in agriculture. This type of grinders has its advantages and disadvantages. Despite the variety of screw grinders' designs, currently there are no machines that fully meet the zootechnical requirements. This article describes the classification of root and tuberous grinders thanks to which grinders can be divided according to classification criteria. A review and analysis of existing structures was also carried out and relevant conclusions were drawn.

**Keywords:** agricultural industry, cattle breeding, preparation of feed, root crop, screw grinders.

In agricultural production, root and tuber crops grinders have been in use since 1952[1]. The designs of agricultural screw grinders are borrowed from the food industry. Although industrial-type grinders are used for grinding raw materials whose mechanical properties differ dramatically from those of succulent feed, the types of working bodies of agricultural grinders are basically similar to those of industrial grinders. In the food industry, there is extensive experience in the use and operation of screw grinders (for example, in the meat industry, screw grinders are called tops or meat grinders). In principle, the working bodies of a screw grinder are not a new word in technology and are widely used in other similar types of devices not only when working together (tops), but also as independent machines (screw presses) [2,3]. Their advantages include: versatility, high productivity – when grinding root crops, it is in the range from 2 to 15 t / h, low specific energy consumption, low metal consumption [1], and disadvantages – abrasion of the transported cargo and wear of the casing and screw surfaces [1].

To determine the direction of search for a rational design and technological design of the grinding device that provides low specific energy costs for the cutting process while meeting the obtained crushed root tubers with modern zootechnical requirements based on the known classifications [1,2], we developed and updated classification root tubers, according to which, this category of grinders can be divided according to the following classification features:

- a) the type of crushed product-slices and pulp (or paste);
- b) the method of grinding – cutting, chipping and combined;
- c) designs of grinding bodies – knives, incisors, punches, milling cutters, hammers, pins and combined;
- d) the shape of the knife – plate, comb, curved, scoop-shaped, L-shaped, spiral, ring and U-shaped;
- e) the shape and location of the grinding machine – ring, rotary, drum, disk, screw (or screw), conveyor-knife and combined;

- f) the method of support – mechanical, gravitational, inertial and combined;
- g) the number of grinding stages – single-stage, two-stage and multi-stage.

Theoretical studies of the parameters of root and tuberous grinders for large and small livestock farms show that despite such a variety of designs of their working bodies, the shape of the knife blade, the principle of their control, methods of support and others, as well as in general machines, the problem of high-quality cutting at low specific energy costs has not yet been solved. The wide variety of these devices is explained by the zonal features of the feed used, the conditions of use, the search for the most efficient and rational machine designs, as well as the fact that the industry currently does not produce machines that fully meet the zootechnical requirements for the quality of the product obtained, specific energy consumption and nutrient losses [2,3,4].

A review and analysis of literature and scientific sources has shown that two types of screw grinders – horizontal and vertical - are used for grinding the root and tuber of fruits. There are practically no studies on the process of grinding root and tuberous with screw grinders for feeding cattle [2,4], and a number of works are devoted to their preparation for pigs or poultry in the form of paste [1]. Therefore, we consider it appropriate to use this experience in the design of agricultural grinders for cattle.

Based on the review and analysis of existing designs of root and tuber grinders for cattle feed, the following conclusions can be drawn:

- machines for processing root and tuber are produced by industry either in the form of separate specialized machines that perform only one operation (grinding), or in the form of an integral part of the unit that provides two or more processing operations (washing, grinding, dosing, etc.);
- the developed classification and analysis make it possible to determine the direction in the development and improvement of grinding devices, as well as to evaluate existing designs used for the process of grinding the tuberous;
- the most promising design and technological scheme of the shredder is a single-stage vertical screw-type shredding device with knives installed at a certain distance from each other in accordance with zootechnical requirements.
- from the analysis of grinders, it is clear that the problem of increasing their technical and economic indicators can be solved by finding the possibility of reducing the energy intensity of screw grinders while maintaining high-quality indicators.

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## **АНАЛИЗ ЭФФЕКТИВНОСТИ ПРИМЕНЕНИЯ ШНЕКОВЫХ ИЗМЕЛЬЧИТЕЛЕЙ КОРНЕКЛУБНЕПЛОДОВ ДЛЯ КРУПНОГО РОГАТОГО СКОТА**

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**Аннотация:** В сельском хозяйстве широко применяются шнековые измельчители. Данный тип измельчителей имеет свои преимущества и недостатки. Несмотря на разнообразие конструкций шнековых измельчителей, в настоящее время не существует машин, полностью удовлетворяющих зоотехническим требованиям. В данной статье описана разработанная нами классификация измельчителей корнеклубнеплодов, благодаря которой измельчители можно разделять по классификационным признакам. Также был проведен обзор и анализ существующих конструкций и сделаны соответствующие заключения.

**Ключевые слова:** животноводство, корнеклубнеплод, приготовление кормов, сельское хозяйство, шнековый измельчитель.

## APPLICATION OF MACHINE LEARNING IN AGRICULTURE

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### Abstract

In the modern world, technology plays a key role in all spheres of life, including agriculture. The application of machine learning is one of the most promising areas in this field. The purpose of this article is to consider the main tasks and goals that can be achieved using machine learning in the agricultural industry. Machine learning tasks in agriculture are aimed at increasing efficiency and productivity, improving product quality, and reducing production costs. Machine learning can be used to solve many problems in agriculture and allows for significant success in improving productivity and product quality. However, for the successful implementation of these technologies, many factors must be taken into account, such as regional characteristics, weather conditions, cultural diversity, and others. In the following sections of this article, we will look in more detail at the main areas of application of machine learning in the agricultural sector and their results.

**Keywords:** diagnostics, forecasting, implementation problem, machine learning.

### Introduction

The relevance of this topic is that in the modern world, with the rapid development of machine learning technologies, its application in agriculture can significantly increase its efficiency and improve production results. Data analysis and forecasting of results allow agricultural enterprises to make informed decisions and optimize their activities. This contributes to improving product quality and reducing costs, which in turn has a positive effect on the economy and the well-being of society as a whole, which is the main task and goal of further development of machine learning.

### Discussion

Machine learning can be applied in various fields of agriculture. For example, machine learning algorithms can be used to determine the optimal time for sowing, fertilizing and watering. The analysis of data obtained using sensors and observations allows us to determine the optimal conditions for growing various crops. Machine learning can also be used in crop forecasting. This allows agricultural enterprises to plan their activities and optimize costs. In addition, machine learning can help in the fight against diseases and pests. Machine learning algorithms can process data from sensors and cameras to detect diseases and pests early. This allows you to take measures to localize them and prevent their spread.

#### *Forecasting*

Forecasting yields using machine learning is based on the analysis of various factors affecting plant growth and development. For example, using data on weather, soil conditions, light levels, and other parameters, machine learning models can predict the yield of a particular field or crop. To create a yield prediction model using machine learning, it is necessary to collect and prepare data. This may include collecting information about the weather, agronomic characteristics of plants, the

effectiveness of fertilizer use, and other factors affecting yields. This data is then used to train machine learning models, which can then be applied to predict yields in real time.

Forecasting yields using machine learning has many advantages. First, it allows agricultural enterprises to make more informed decisions in production planning and resource use. Second, crop forecasting can help in determining the optimal conditions for growing plants, such as light levels, temperature, and soil moisture levels.

However, for the successful application of machine learning in agriculture, some factors must be taken into account. First, machine learning models need constant updating and adaptation, as plant growing conditions can change over time. Second, it is necessary to provide high-quality and reliable information for training models, which can be difficult in the agricultural sector, where data may be heterogeneous and incomplete [1].

Weather plays an important role in agriculture because it can significantly affect yields and agricultural operations. Machine learning algorithms can help farmers better understand and predict weather conditions and trends. This can optimize farming strategies. For example, machine learning models can analyze data from weather stations, satellites, and other sources. It can predict the likelihood of extreme weather events such as droughts, floods, or frosts. By understanding the potential impact of weather on their operations, farmers can take steps to reduce risks and protect their crops [2].

In general, forecasting yields using machine learning opens up new opportunities for agricultural enterprises. Accurate yield forecasts make it possible to effectively plan production, optimize resource use and increase profitability. In addition, machine learning can be used to optimize the irrigation schedule, determine the optimal dose of fertilizers, as well as to predict risks associated with weather conditions or plant diseases.

### *Diagnostics*

Machine learning allows you to create models that process large amounts of data about plants and their diseases, analyze them and identify patterns, which help in the diagnosis and prevention of various diseases. One of the main advantages of using machine learning in the diagnosis of plant diseases is the ability to automatically recognize and classify diseases.

Special machine learning algorithms can be trained based on a large amount of data on plant diseases and learn how to automatically determine the type of disease and its degree of development by external signs. This makes it possible to detect diseases at an early stage of development, which increases the effectiveness of combating them.

One of the most common tasks in the diagnosis of plant diseases using machine learning is the detection and classification of pests and diseases from plant photographs. Machine learning algorithms can be trained on a large set of photos of plants that contain information about diseases and pests. After training, the model can independently determine the presence of a disease or pest in a photo, which allows monitoring and taking the necessary measures to protect plants. In addition, machine learning can also be used to prevent plant diseases.

Machine learning algorithms can analyze data on weather, soil, plant varieties and other factors affecting the development of diseases to predict the likelihood of disease occurrence. Based on these predictions, effective plant protection methods can be developed and disease prevention measures can be taken, which helps agricultural producers save money and increase yields. Thus, the use of machine learning methods in agriculture makes it possible to improve the diagnosis and prevention of plant diseases. This helps to increase the efficiency of agricultural producers and ensures the stability of production in a changing environment [1].

#### *Implementation problem*

Although there are many advantages of using machine learning in agriculture, it also has some problems that are difficult to solve. Some of the most serious problems include the following [2]:

1. *Data access.* Data availability is one of the biggest challenges in implementing machine learning in agriculture. In many cases, most of the data we know is limited. Examples include data on weather conditions, soil conditions, and crop growth. Therefore, it is difficult to accurately train machine learning algorithms.

2. *Infrastructure.* Another problem is the need for additional infrastructure and resources in many rural areas, which makes it difficult to implement machine learning solutions. It includes electricity and internet connection, as well as the cost and availability of hardware and software.

3. *Cultural and legal issues.* There are many issues to consider when implementing machine learning in agriculture. First, you should consider cultural and legal issues. In some cases, farmers may be concerned about the impact of new technologies on traditional farming methods. Therefore, they may not be in a hurry to introduce new technologies. There may also be legal issues related to the use of data and ownership of intellectual property.

#### **Conclusion**

Agriculture is an important branch of the economy in which product quality plays an important role. One of the problems faced by agricultural enterprises is the need to conduct multiple tests and inspections of products to ensure their safety and compliance with specified quality standards. This process requires significant time and resource costs. Modern machine learning and artificial intelligence technologies provide new opportunities to solve this problem. Also, the use of machine learning methods in agriculture allows not only to improve product quality control, but also to optimize production processes. For example, using machine learning algorithms, it is possible to determine the optimal time and quantitative parameters for irrigation, fertilization and other processes that affect the quality and yield of products.

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# ПРИМЕНЕНИЕ ТЕХНОЛОГИЙ МАШИННОГО ОБУЧЕНИЯ В СЕЛЬСКОМ ХОЗЯЙСТВЕ

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**Аннотация.** Сельское хозяйство является одной из ключевых отраслей экономики, и оно играет важную роль в обеспечении пищей для населения. Однако перед ним стоят серьезные вызовы, такие как изменение климата, деградация почвы и неэффективное использование ресурсов. В этой ситуации машинное обучение может внести значительный вклад в сельское хозяйство, предлагая инновационные решения и помогая оптимизировать процессы. Еще одним примером применения машинного обучения в сельском хозяйстве является предсказание заболеваний растений. Алгоритмы машинного обучения могут анализировать данные о состоянии почвы, погоде и других факторах, чтобы выявить связь между определенными показателями и появлением заболеваний растений. Это позволяет заранее предупреждать возможное возникновение заболеваний и принимать соответствующие меры.

**Ключевые слова:** диагностика, машинное обучение, проблемы внедрения, прогнозирование,

## CLEANING TRACTOR ENGINES FROM CONTAMINATION

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### **Abstract**

The paper examines how the oxidation process that occurs in motor oils affects the engine performance. The primary cause of high-temperature in engines is oxidation processes in the fluid size and on the metallic exterior that have a detrimental impact on the engine's performance, dependability, and endurance. Various qualities are used to determine the quality of grease. These include essential antioxidant characteristics. The study recommends adding washing chemicals to internal combustion engine oil. Additives are used to dissolve and clean out sediments that is found on the exterior of components. Additionally, they can convert compounds that not dissolve into suspension. The results of laboratory analyses on industrial oil types and novel additive samples are provided, along with suggestions for their application.

**Keywords:** analysis; composition; engine; flushing oil; oxidation; pollution; properties; purifier used engine oil.

### **Introduction**

Engines, even those of the same brand, operate under unique conditions and experience varying rates of wear and tear. In order to ensure optimum operating conditions, modern internal combustion engines require high quality lubricating.

The quality of the lubricants is used to determine the reliability and durability. In this regard, all lubricants without exception must meet the standard quality requirements. Even when they contain a small amount of mechanical impurities, oils of highest quality will not ensure the operation of machines without wear. The amount of mechanical impurities must be strictly limited in engine oils.

When oil is pumping through the cylinder-piston friction units, oil oxidation occurs either in the entire volume or in a thick layer, or in a thin layer. In the latter case, the oil hydrocarbons are in particularly difficult conditions of temperature and in contact with atmospheric oxygen and metal [1].

### **Research methodology**

The oil temperature of the engine rises to between 75 and 80 °C. Through the filler neck, added ammonium hydroxide with carbamide and added to the oil. This oil composition is used by the engine for a period of ten minutes at idle and 30 to 40 minutes at full load. To measure oil pollution and discolouration, a dipstick sample is obtained every ten minutes and placed on "white ribbon" filter paper. When the engine stops working, a centrifuge is cleansed of contaminants, and diesel fuel (3% by weight to oil volume) is injected to the internal crankcase through the filler neck. This process is repeated until yellow oil shows on of the filter paper [2]. After starting, the engine idles for sixty minutes. A 100 cc sample is drawn from the crankcase each twenty minutes to gauge oil pollution and evaluate cleaning efficiency. Both prior to and following the testing, the pressure inside cylinders and the physical-chemical features of the modifications in the oil attributes under

laboratory settings were ascertained using an appropriate approach. Research has demonstrated that the wasted motor compared with sinks where crucial oils applied to it, oils offer multiple benefits. Trash oils, for example, have an acceptable viscosity and include 20–30% not working detergents that disperse and prevent degradation.

The expense of cleaning with physical and chemical procedures is higher. Cleaning prevention is important since it uses high-tech equipment that is not available to the general public in agricultural operations [2]. Research on streamlining the cleaning procedure to produce a cleaning agent has been done. It satisfies the specifications for the initial ingestion of important oil chemical and physical characteristics. A novel engine is developed using M-10 g 2 kg engine oil. After the wasted engine oil had been heated to 100°C, it was put into a heat-insulating container fitted with electrical heating components. Two percent of the oil's weight was added to each of the monoethanolamine and isopropanol. Later, the oil temperature increased to 130 °C and is still warming up [3].

### Conclusion

In this study, it was discovered that adding physical or chemical substances to the oils used before discharging them from the engine will prolong the engines' life.

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## ОЧИСТКА ДВИГАТЕЛЕЙ ТРАКТОРОВ ОТ ЗАГРЯЗНЕНИЙ

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**Аннотация:** Рассмотрен процесс окисления, происходящий с моторными маслами, и его влияние на работу двигателя. Основной причиной накопления высокой температуры в двигателях являются процессы окисления в жидкости и на металлическом корпусе, которые оказывают пагубное влияние на производительность, надежность и долговечность двигателя. Для определения качества смазки используются различные характеристики. К ним относятся важные антиоксидантные свойства. Рекомендуется добавлять моющие средства в масло для двигателей внутреннего сгорания. Присадки используются для растворения и очистки от отложений, которые находятся на внешней поверхности компонентов. Кроме того, они могут превращать соединения, которые не растворяются, в суспензию. Приведены результаты лабораторных анализов типов промышленных масел и образцов новых присадок, а также рекомендации по их применению.

**Ключевые слова:** анализ; состав; двигатель; промывочное масло; окисление; загрязнение, свойства; очиститель отработанного моторного масла.

## CHANGING THE APPROACH IN THE CONSTRUCTION OF A MOUNTED MACHINE FOR AGRO-TECHNICAL WORKS

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### Abstract

To perform a large volume of work in rural areas, cities, and construction sites, tractors with front loaders of various types and types are used. To combine all these types and types into one, I developed a universal front loader platform mounted on the MTZ-82 wheeled tractor. The purpose of this development was to produce a budget multifunctional front loader with the ability to increase the range of work performed using additional quick-release units, and to reduce the area for storing units. This development is relevant in the context of import substitution since not a single foreign component is used.

**Key words:** front loader, analysis of technological solutions, attachments, quick-release units.

### Introduction

At the moment, the line of front loaders includes a number of foreign products intended for certain types of work, with the corresponding characteristics.

But in all this variety, what is missing is one that would cover most of the functions of these prisoner models in one practical, multi-functional unit.

An analysis of the studied publications [1-7] showed that each manufacturer tries to produce equipment for a specific type of activity.

We offer a universal front loader platform that, with the help of additional quick-release units, will be able to perform a wide range of work used in both urban and rural conditions.

The main design criteria were the production of a universal quick-release unit that could be disconnected from the tractor by the operator without outside help if necessary. Another important aspect of the development was the length of the boom; it will allow loading to a greater height and loading the trailer from one side without moving.

An important element of this design is the developed quick-detachable units, designed to perform various types of work, which can be effortlessly installed on a specialized mount, which makes this machine multifunctional.

This is a bucket for bulk materials, a grip for Euro pallets, a boom with a hook for lifting loads, a drill, a bulldozer blade, a specialized grip with a set of attachments for fixing various shapes of objects, a front rotary mower, a cradle for collecting fruit crops.

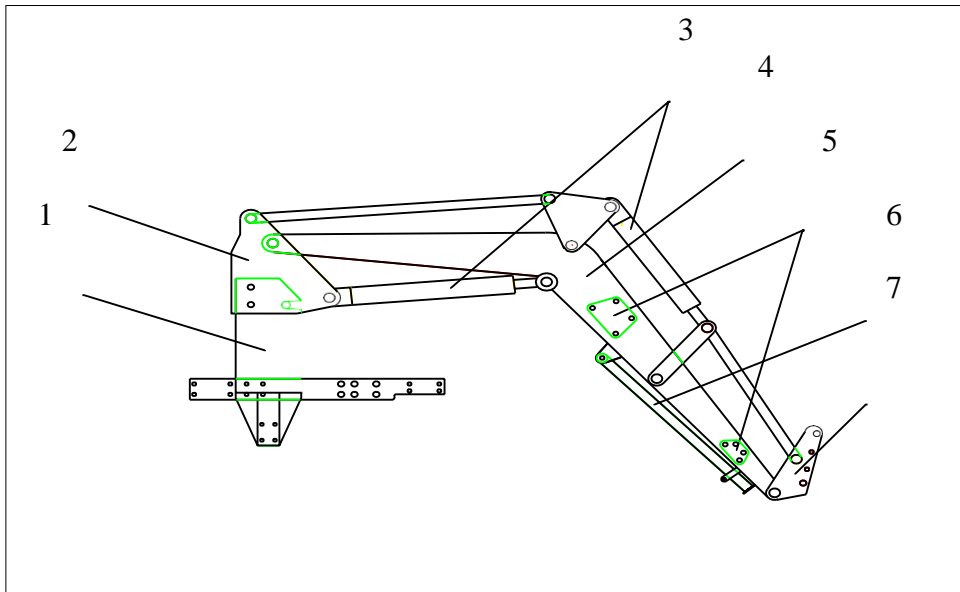
### Experimental studies

New technological solutions for the production of a universal platform were implemented on PU machines, the main elements of the mounting brackets were cut on a waterjet cutting machine, and the boom elements were cut on a laser cutting machine. Lathes and a bending machine with PU were also used.

For ease of assembly and transportation, this platform is designed and



manufactured from several basic elements, this will allow two specialists to assemble and install the loader elements on the tractor without any visible effort. All elements and mechanisms are welded using semi-automatic welding in a carbon dioxide environment.



*Figure 1 - Main elements of a mounted machine*

**The mounted machine consists of:** a mounting bracket to the tractor frame (item 1); quick-release mechanism for securing the machine (item 2); hydraulic cylinders (item 3); twin boom (item 4); transverse struts (item 5); support posts (item 6); quick-release mechanism for mounted units (item 7).

**Research results, their analysis and discussion**

The assembly and installation of the prototype was carried out in two stages: first, installation of brackets and spacers on the tractor frame, and then installation of the boom and connection of hydraulics.

After completing the assembly, tests were carried out on the universal front loader platform, all structural elements confirmed the desired result, everything worked as planned (Fig. 2).



*Figure 2 (a, b) – Installation of a mounted machine*

At the moment, the prototype has been regularly performing its functions in the peasant farm for more than three years, undergoing various tests and strength tests.

## Conclusion

As a result of the research, the following conclusions were made:

- 1) An analysis of the types and functional purposes of mounted machines for wheeled tractors was carried out;
- 2) The main indicators and characteristics of the desired equipment have been calculated;
- 3) The optimal method for manufacturing a universal front loader platform has been found;
- 4) The problem of optimal transportation and the method of assembling a universal front loader platform with its installation on the MTZ-82 tractor has been solved.

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## ИЗМЕНЕНИЕ ПОДХОДА ПРИ ИЗГОТОВЛЕНИИ НАВЕСНОЙ МАШИНЫ ДЛЯ АГРОТЕХНИЧЕСКИХ РАБОТ

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**Аннотация:** Для выполнения большого объема работ в сельской местности, в городах, на стройплощадках, используются трактора с фронтальными погрузчиками разных типов и видов. Для объединения всех этих видов и типов во едино мною была разработана универсальная платформа фронтального погрузчика, устанавливаемая на колесный трактор МТЗ-82. Целью данной разработки стало изготовление бюджетного многофункционального фронтального погрузчика с возможностью увеличения спектра выполняемых работ при помощи дополнительных быстросъемных агрегатов, уменьшение территории для хранения агрегатов. Данная разработка является актуальной в условиях импортозамещения так как не используется не одного иностранного компонента.

**Ключевые слова:** фронтальный погрузчик, анализ технологических решений, навесное оборудование, быстросъемные агрегаты.

## IT SUPPORT FOR SUGAR BEET QUALITY DETERMINING SYSTEM IN A BEET HARVESTER BUNKER

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### **Abstract**

The purpose of this study is to discuss a method for determining the quality characteristics of sugar beet root crops using machine vision based on neural networks and its implementation in the production process. The relevance of the study is that employees tend to set when working at heights. This as a result, it is necessary to develop a set of measures to ensure safety when working at heights by upgrading old technologies and the developing of new ones.

**Keywords:** kagat, machine vision, storage, sugar beet, sugar beet root crop size.

### **Introduction**

One of the sugar industry problems has always been the high losses of sugar beet during storage. The main need for the use of machine vision arises at the stage of harvesting sugar beet and laying it in field kagats. There may be dozens of field cahats in one field, however, indicators such as size, contamination, littering, and the percentage of beet tops in individual cahats may vary greatly. The safety of sugar beet largely depends on these indicators. However, these indicators are currently being evaluated for the field as a whole, but not for individual kagats. The use of machine vision at the stage of harvesting sugar beet gives an answer to the question: in what order to carry out the shipment of field kagats for processing to reduce the risks of loss of weight and quality of sugar beet.

Currently, many enterprises use machine vision complexes to determine the quality characteristics of vegetables and fruits, let's look at some of them.

### **Discussion**

Specialists of the agroholding "STEPPE" have developed machine vision that evaluates sunflower crops. The technology is able to calculate the number of plants on the field from aerial photographs, and the system also ranks fields by the number of seedlings, the presence of weed vegetation [1].

Nord Clan's project in the field of agriculture determines the condition of crops using machine vision. Drones fly around the plantations along the specified routes and take pictures. The algorithm recognizes fruits, determines their ripeness and counts the number, determines the presence of damage from diseases [2].

Another of these complexes is VISCONTE.Beet. This is a system for assessing the quality of sugar beet in the open body of a truck in the visible wavelength range. With the help of neural networks, the localization of the contents of the body and the detection of dirt, tops, chips, snow is performed. According to the data obtained, the classification of raw materials by quality categories is carried out [3]. This complex differs from our proposed method in that it is located at the receiving points of processing plants and does not determine the size.

With a decrease in the mass of the root crop, the parameter of its specific surface area

increases. Small root crops are more susceptible to temperature changes and relative humidity of the environment, which leads to a change in the partial pressure of water vapor between the surface of sugar beet and the surrounding air. During storage in the inter-root space of the sugar beet mound, the relative humidity of the air reaches from 90 to 95% due to the removal of moisture from the surface of root crops, which, in turn, is a source of beet mass losses and subsequently intensifies respiration processes.

When determining the requirements for sugar beet entering storage, it is necessary to take into account, in addition to physical and chemical parameters, the value of the specific surface area of the root crop. Therefore, it is recommended to send large root crops, weighing from 570 g, to kagats to reduce the risk of loss of quality of root crops during storage [4]. Thus, by forming field kagats using machine vision in beet harvesters, it will become known where mainly large and small sugar beets lie, and by shipping field kagats with small root crops in the first place, the risks of losing the mass and quality of sugar beet will be minimized.

### **Conclusion**

Having the coordinate of the area where the harvesting took place, the time and the quality characteristics of the root crops, it is possible to say in which field the sugar beet lies in order to ship it sooner or later. Thus, the risk of loss of raw material quality will be significantly reduced.

The system has a number of advantageous features:

- the system allows you to detect beet tops, which allows the operator of the beet harvester to understand whether the tool is configured correctly;
- the system allows you to detect coordinates and quality characteristics, which allows the agronomist to understand which area lacks fertilizers, moisture, etc.

The vision system functions according to the following algorithm: detecting the appearance of root crops in the hopper of a beet harvester using a laser rangefinder, turning on the illumination of the embankment surface using an LED spotlight, shooting the embankment surface, turning off the lighting, image processing using a neural network and filters, determining the area of sugar beet root crops and beet tops, creating a folder and writing to it data, sending a folder with data to cloud storage, deleting a folder with all data from a microcomputer, recording GPS coordinates and making a conclusion about whether the beet is big or not, the beginning of the program cycle first when there is a difference between the values from the laser rangefinder.

The change in the number of root crops in the hopper occurs by determining the difference in readings from the laser rangefinder. If the value decreased, comparing with the previous one, then there were fewer root crops, if it increased, then vice versa.

Since the beet harvester can work from the very morning until the very night, the presence of lighting gives the vision system the necessary level of illumination at any time of the day and in any weather. Thus, it is impossible to get a completely dark image due to lack of light.

Due to the extremely diverse weather and time conditions, namely from morning to night, fog, snow, rain, bright sun, cloudy weather, it is impractical to use a threshold color transformation for detecting individual sugar beet root crops and will

give a large error, therefore it is better to use neural networks.

To recognize root crops, the convolutional neural network SSD ResNet 50 was selected, which stands for "Single-shot detector Deep residual network". This neural network assumes more than 150 layers. Many modern studies show that this model is most effective for detecting objects in images in the presence of small data sets. The advantage of ResNet can also serve as a "softening" of the effect of the problem of vanishing gradients and improving accuracy (because when a deep network collapses, the depth of the network increases and the accuracy deteriorates).

The neural network is trained on 150 photos in 1000 steps. This number of steps is justified by the same vast variety of conditions when shooting the embankment surface, so instead of very accurate recognition of several root crops, we need to recognize as many as possible, even taking into account the resulting errors.

As a result of processing images by a trained neural network, it turns out that some root crops are classified into two classes (beetroot on top and beetroot on the side). This greatly interferes with the adequate operation of the vision system. In addition, two, three or more objects are detected at once as one. To improve the recognition of root crops by the neural network, additional filters were made. Therefore, now we take from the neural network only the obtained coordinates of the rectangle bounding the area containing the root crop, the class (beetroot on the side, beetroot on top, beet tops) and the probability of belonging to this class.

Filters work according to the following algorithm: removing elements from arrays that belong to a class of less than 5%, determining the coordinates of two opposite vertices of a rectangle bounding the area containing the root crop, filtering out elements whose coordinates coincide, filtering out elements with an area of 500 thousand pixels or an aspect ratio greater than 5 or less than 0.2.

In order to exclude the overlap of two classes on one object, one of them is eliminated by comparing the probability of belonging to the class: the lower probability is deleted along with all the data. The remaining array is considered correct, since the probability of belonging is greater.

In order to exclude the identification of two or more objects in one, objects with too large an area are screened out by comparing the area in pixels with a fixed value of 500 thousand pixels. Even a very large root crop cannot be higher than this value. In addition, the ratio of length to width is also compared. If the ratio is greater than 5 or less than 0.2, then this object is eliminated.

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## **ПРОГРАММНО-АЛГОРИТМИЧЕСКОЕ ОБЕСПЕЧЕНИЕ СИСТЕМЫ ОПРЕДЕЛЕНИЯ ХАРАКТЕРИСТИК КАЧЕСТВА САХАРНОЙ СВЁКЛЫ В БУНКЕРЕ СВЕКЛОУБОРОЧНОГО КОМБАЙНА**

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**Аннотация:** Рассмотрены способ определения характеристик качества корнеплодов сахарной свеклы с использованием машинного зрения на основе нейронных сетей и его внедрение в производственный процесс.

**Ключевые слова:** кагат, машинное зрение, сахарная свекла, размер корнеплода сахарной свеклы, хранение.

## EINFLUSS ORGANISCHER DÜNGEMITTEL AUF DIE ÖKOLOGIE

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### **Zusammenfassung**

Der Einsatz von organischen Düngemitteln wird mit einer Steigerung der Bodenfruchtbarkeit in Verbindung gebracht. Allerdings ist es nicht immer möglich, eine positive Wirkung zu erzielen, sondern mit den Problemen der Umweltverschmutzung und der Verschlechterung der chemischen Zusammensetzung des Bodens konfrontiert. Der Artikel befasst sich mit den Gründen für die negativen Auswirkungen von organischen Düngemitteln auf die Umwelt. Es werden Ansätze zur Verbesserung der Umweltsicherheit bei der Verwendung organischer Düngemittel vorgeschlagen.  
**Schlüsselwörter:** agrotechnische Maßnahmen, organische Abfälle, organische Düngemittel, Bodenfruchtbarkeit

### **Einführung**

Fast alle industriellen und kommunalen organischen Abfälle enthalten die wichtigsten Makro- und Mikroelemente, die für die Pflanzenernährung notwendig sind. Je mehr dieser Makronährstoffe in den Abfällen enthalten sind, desto höher ist der Wert der daraus hergestellten Düngemittel. Die Verwendung von Abfällen, die erhebliche Mengen an Spurenelementen, insbesondere Schwermetallen, enthalten, wird jedoch durch eine Reihe von Anforderungen eingeschränkt. So gehören beispielsweise Schwermetalle wie Kobalt, Chrom, Kupfer, Nickel und Zink zu den Spurenelementen, die für das Wachstum und die Entwicklung der Pflanzen notwendig sind. Sie wirken sich nur dann negativ aus, wenn sie in zu großen Mengen auf den Boden aufgebracht werden [1].

Kadmium, Blei und Quecksilber, die sich allmählich im menschlichen und tierischen Organismus anreichern können, sind schon bei geringen Konzentrationen im Boden gefährlich. Die negative Wirkung von Schwermetallen zeigt sich in stärkerem Maße auf sandigen, sandig-lehmigen und leicht lehmigen Böden. Bei der Düngung von humusreicheren schweren Lehm- und mittleren Lehmböden mit hoher Aufnahmekapazität werden Schwermetalle weitgehend im Absorptionskomplex des Bodens fixiert, durch organische Substanz unter Bildung von metallorganischen Verbindungen (Chelaten) gebunden und sind weniger pflanzenverfügbar [1].

Um die Umwelt und die Wasserressourcen bei der Verwendung von einstreufreiem Dünger vor Verschmutzung zu schützen, ist ein ganzer Komplex von agrotechnischen Maßnahmen durchgeführt, die in erster Linie darauf abzielen, Nährstoffverluste zu verhindern. Die wichtigste Maßnahme ist die Verwendung wissenschaftlich begründeter Ausbringungsmengen von einstreufreiem Dünger, die nach dem Bedarf der angebauten Pflanzen an Nährstoffen berechnet werden. Dadurch wird die Anhäufung überschüssiger Nitrate in den Pflanzen verhindert und ihr Eindringen in das Grundwasser begrenzt [1, 2].

Die Autoren schlagen einen Ansatz vor, der die Möglichkeit bietet, die Auswirkungen von organischen Düngemitteln auf die Bodenfruchtbarkeit und die Ökologie zu verringern.

Es ist bekannt, dass die Verschmutzung von Wasserquellen durch Oberflächenabfluss durch die rasche Einarbeitung von einstreulosem Dung, der auf die Bodenoberfläche aufgebracht wird, verhindert wird. Daher war bei der Ausbringung von Dung im Herbst eine Erosionsschutzbehandlung (tiefes Pflügen, Auflockerung der Unterbodenschicht, Eggen u. a.) durchgeführt, um die Wasserdurchlässigkeit des Bodens zu erhöhen.

Um den Oberflächenabfluss und die Versickerung zu begrenzen und damit die Gefahr der Verschmutzung des Oberflächen- und Grundwassers zu vermeiden, ist es ratsam, die Felder nach Möglichkeit nicht kulturfrei zu lassen und nach der Ernte der Hauptkultur Zwischenfrüchte anzusäen.

Um die Verluste von überschüssigem Stickstoff zu verringern, wird empfohlen, einstreulosen Dung in Kombination mit gehäckseltem Stroh auszubringen, das nach der Getreideernte auf dem Feld verbleibt. Diese Technik gewährleistet die Fixierung von Stickstoff in organischen Verbindungen durch die Bodenmikroflora. Auch die Stoppelaussaat von Nicht-Leguminosen (Raps, Terpentin und andere), die wie das Stroh ein günstiges Kohlenstoff-Stickstoff-Verhältnis aufweisen, ist nicht weniger wirksam.

### **Schlussfolgerung**

Die Einführung einer Buchführung und Berichterstattung über den Einsatz organischer Düngemittel ermöglicht es, den Einsatz organischer Düngemittel erheblich zu steigern, ihre negativen Auswirkungen auf die Umwelt zu verringern und die Bodenfruchtbarkeit zu verbessern. Die ordnungsgemäße Anwendung und Nutzung von agrotechnischen Maßnahmen ist der wichtigste Ansatz zur Lösung dieses Umweltproblems.

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## **ВЛИЯНИЕ ОРГАНИЧЕСКИХ УДОБРЕНИЙ НА ЭКОЛОГИЮ**

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**Аннотация:** Применение органических удобрений связано с повышением плодородия почвы. Однако, не всегда возможно достичь положительного эффекта, так как могут возникнуть проблемы с загрязнением окружающей среды и ухудшением химического состава почвы. В статье рассмотрены причины негативного влияния органических удобрений на экологию. Предложены подходы, повышающие экологическую безопасность при применении органических удобрений.

**Ключевые слова:** агротехнические мероприятия, органические отходы, органические удобрения, почвенное плодородие.



## THE HISTORY OF TRACTOR TRACTION DEVICES DEVELOPMENT

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### **Abstract**

The article examines the history of tractor traction devices development, possible options for their modernization and the main directions of design improvement.

**Keywords:** traction coupling device; tractor.

Traction devices are an integral part of modern tractors, providing them with a reliable connection to various working tools and trailers. However, few people think about how these devices appeared and developed over the years.

The history of tractor traction devices development begins at the end of the 19th century, when the first steam and gas-powered tractors appeared in American fields. At that time, simple chains or ropes were used to connect the tractor to other machines. However, such connections were ineffective and often broke down under heavy load.

In the 1920s, manufacturers began to realize the importance of developing special devices for more reliable connection of the tractor with other machines. This is how the first models of traction loops and hinges appeared, which significantly increased the efficiency of tractors. In the following decades, engineers continued to refine these devices, adding new features and improving their durability.

Today, tractor hitches are complex mechanisms capable of withstanding enormous loads and providing a reliable connection with various working tools. They play an important role in agriculture, construction and other industries, allowing tractors to perform a wide variety of tasks. In this article, we will look at the main stages of the development of tractor hitches and their impact on modern agricultural machinery [1].

The first traction devices for tractors appeared at the beginning of the 20th century. At a time when tractors were just beginning to be used in agriculture, the need for an effective coupling between a tractor and a trailer became obvious.

One of the first developers of such devices was Henry Ford. He introduced the "Fordson F" model, which had a special socket for connecting a trailer. This made it possible to transport goods over long distances more reliably and safely.

The next significant step in the development of traction devices was the appearance of the "fifth wheel" system. This system consisted of a platform mounted on the back of the tractor, on which a trailer could be fixed. This design provided a more uniform load distribution between the axles and increased the stability of the entire bundle.

In the future, with the development of industry and new technologies, traction devices have become more and more advanced. Systems with hydraulic and

pneumatic drives were developed, which made it possible to more accurately control the movement of the trailer.

The history of tractor traction devices development is associated with the constant desire of engineers to improve the efficiency and reliability of machinery. The evolution of the design of traction devices went through several stages.

The first simplest traction devices were presented in the form of chains or ropes, which were attached to the front of the tractor and used for towing loads. However, such solutions were ineffective and did not provide sufficient strength to perform complex tasks.

With the development of mechanization in agriculture, the first mechanical traction devices appeared. They consisted of special clamps that allowed the tractor to be connected to trailers or other working tools. Such systems significantly increased work efficiency and provided a more reliable connection [4].

In the following decades, engineers continued to work on improving the design of traction devices. New types of joints were developed, such as hinge and finger mechanisms, which provided smoother movement and maneuverability.

In recent decades, technologies in agriculture have undergone revolutionary changes, and tractor hitches are no exception. New technologies and innovations in this field have significantly increased the work efficiency and improved the productivity of agricultural machinery.

One of the most significant innovations is the use of electronics in traction devices. Electronic control systems allow precise control of power and transmission speed, which contributes to optimal machine operation in various conditions [2]. Thanks to this, farmers can achieve higher productivity with minimal fuel consumption.

Also, a new technology is the use of automatic control systems in traction devices.

Today's models of traction devices have high reliability and durability, which allows them to be used in the most difficult conditions of agriculture. They are capable of transmitting high traction forces and providing precise control of the working tool.

When working with trailer units, domestic tractors use, for the most part, a trailer bracket. Thus, guns that are not equipped with hydraulic cylinders on a trailer device are deprived of one of the main functions - copying the relief.

In the conditions of the relief of the fields of the Sampursky district of the Tambov region, poor-quality tillage and excessive wear of individual working bodies of agricultural implements occur. To improve the quality of field cultivation when working with trailed agricultural implements, there is a need to use an improved vehicle.

This solution will allow you to distribute the load on the working bodies of the tools, reduce the jerky load on the vehicle and ensure better soil cultivation.

That is, one of the promising ways to improve the vehicle can be identified by combining a three-point traction device and a technical solution implemented in the semi-automatic KAMAZ EURO vehicle. [3] This will ensure unification when aggregating domestic tractors with foreign agricultural implements.

Using the example of the Amazone Catros disc harrow of the old and new samples, it is possible to analyze the wear of the working organs.

The disc harrow of the 2012 model is aggregated with a tractor using a trailer earring. The 2022 disc harrow sample has been improved by a floating bracket, which is aggregated onto the longitudinal levers of the rear hitch. This solution implements terrain copying not only in the transverse profile, but also in the longitudinal one. In practice, with the same processing areas, the wear of the working discs of the 2022 harrow is 16% less than that of the 2012 harrow. At the same time, according to the on-board computers of tractors, the percentage of slippage also decreased when using a new type of harrow by 7%.

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## ИСТОРИЯ РАЗВИТИЯ ТЯГОВО-СЦЕПНЫХ УСТРОЙСТВ ТРАКТОРА

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**Аннотация:** Рассмотрена история развития тяговых устройств тракторов, возможные варианты их модернизации и основные направления совершенствования конструкции.

**Ключевые слова:** тягово-сцепное устройство; трактор.

## WAYS OF MODERNIZATION OF RUSSIAN-MADE DISC HARROWS

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### Abstract

This article deals with innovative methods for modernizing existing Russian-produced disc harrows. The main problem discussed in the article is the deflection of the working beam that holds the loosening discs, which negatively affects efficiency. The main goal is to find effective ways to improve the rigidity of the structure in order to optimize the functional dynamics of the harrow.

**Keywords:** disc harrow equipment, ecological sustainability, modernity, technological progress, precision agriculture, production optimization, agricultural methods.

Agriculture can only develop if there is improvement in the instrumental equipment necessary for modern farming methods. The key tool for soil cultivation and preparing arable land for growing the best crops is a disc harrow. Therefore, increasing the reliability of the disc harrow is of paramount importance, as like all mechanical systems, it faces difficulties in operation. This paper examines the design features that can serve as a prototype for a technical solution to improve the reliability of disc harrows manufactured in Russia [1-6].

Disc harrow [1] consists of a metal frame, disc gangs, C-shaped springs, supporting wheels, and a scraper system.

The metal frame, with longitudinal and transverse beams, structurally located securely, forms the foundation of the disc harrow. This foundation ensures critical stability when connecting various parts, guaranteeing stability during operations.

Disc assemblies, which are united in disk batteries, are functional components responsible for soil disruption and leveling. The strategic placement of disks is a key component of plow efficiency.

S-shaped springs: These new elements provide a balanced combination of strength and stability in the structure, reducing bending issues. They connect the disks to the cross beams of the frame.

Support wheels are installed on the cross beams of the metal frame and help maintain the overall stability of the cultivator. These wheels ensure uniform weight distribution, which improves performance on different types of soil.

The complex scraper system, integrated into the cultivator, has a well-designed scraper structure with curved blade-shaped plates. To maximize efficiency, this technology prevents disc blockage during operation.

Some of such elements are also described in the article of the invention of the utility model [6].

The lever axis and holder rotate at an angle of  $90^{\circ} \pm 1^{\circ}$  relative to each other, ensuring optimal performance of the scraper system.

The blade plates bend at an angle of  $45^{\circ} \pm 1^{\circ}$ , which enhances the efficiency of the scraper when processing soil.

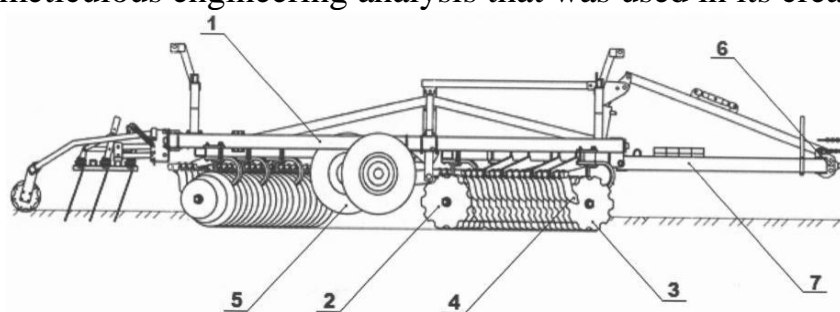
The blade ends have a curved cut: This design element aims to improve efficiency by utilizing the curved cut of the blade ends.

Material specifications: The scraper is made of 60C2A steel, known for its strength and reliability in various operating conditions.

Scraper thickness: The 6mm thickness of the scraper indicates its sturdy construction and long service life. It also meets strict requirements.

The scraper holder, made of a square tube, is a well-designed component that enhances the overall strength and rigidity of the cultivator during operation.

The technical solution is positioned as a comprehensive solution to overcome operational issues inherent in Russian-made disc harrows, and its description highlights the meticulous engineering analysis that was used in its creation (Fig.1).



1 - metal frame in the form of a frame; 2 - disk; 3 - disc batteries; 4 - cleaner;  
5 - wheels; 6 - hitch for connecting to a tractor; 7 - skid

*Figure 1 - General view of a disc harrow*

The advantages of the discussed technical solutions are as follows:

They have increased reliability, achieved by implementing the proposed technical solution, significantly improving soil processing through changes in the structural frame and the addition of C-shaped springs. The working equilibrium is maintained thanks to a carefully designed metal frame and supporting wheels, which reduce unwanted deviations when using the cultivator. Such balance is necessary to maintain stability and efficiency in soil processing.

Efficient soil processing is achieved through the use of a special scraper system, which prevents disk blockages and improves the soil processing process.

Further examination of the advantages makes it evident that this technical solution has significant potential to address issues related to the operation of Russian-made disk cultivators and will enhance reliability and efficiency in farming conditions.

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## **СПОСОБЫ МОДЕРНИЗАЦИИ ДИСКОВОЙ БOROНЫ РОССИЙСКОГО ПРОИЗВОДСТВА**

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**Аннотация:** Рассмотрены инновационные методы модернизации существующих дисковых борон российского производства. Выявлена основная проблема – прогиб рабочей балки, удерживающей рыхлящие диски, что негативно сказывается на эффективности работы. Основная цель – найти эффективные способы повышения жесткости конструкции, чтобы оптимизировать функциональную динамику бороны.

**Ключевые слова:** оборудование для дисковых борон, экологическая устойчивость, современность, технологический прогресс, точное земледелие, оптимизация производства, аграрные методы.

## SELECTION PARAMETERS OF MIXER SHREDDER FOR PRIVATE FARMS AND PRIVATE FARMS

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### Abstract

The article describes the parameters of selection of chopper-mixers for private subsidiary farms and peasant farms. The principles that guide the selection of shredder-mixers for different crops are explained. This study examines the various parameters that should be relied on when selecting equipment for a particular farm, and also describes and clarifies the zootechnical requirements for the crops used.

**Keywords:** forage chopper, zootechnical requirements, succulent fodder, coarse fodder, private subsidiary farms (PSF), peasant farms (PF).

### Introduction

This article deals with the selection parameters of a chopper-mixer for private farms and private farms. Parameters of selection of the shredder-mixer considered in this article are the fundamental bases on which it is necessary to rely when choosing a shredder-mixer if you are categorized as private subsidiary farms (PSF) or peasant-farming farms (PF).

First of all, the material is aimed at small businesses that do not have a large financial fund as having a large amount of free funds, then you are open to the doors of large agricultural centers that provide services for the selection and supply of equipment of interest to you than PSF or PF which due to limited budget, have to make a choice among the numerous mass of solutions both domestic and foreign presented in the Russian market.

### *Physical and mechanical properties of forages*

Feed chopping is an important step in the production of livestock and poultry feed, which is crucial for efficient utilization of feed resources and ensuring high levels of animal productivity. Selecting the right feed chopper is a key aspect in ensuring optimum productivity and efficiency in livestock production. Before selecting a chopper, the physical and mechanical properties of the selected feed materials must be carefully examined.

As a rule, the forage base is feed that the farm can obtain without excessive financial and human costs. Such fodder includes: succulent fodder in the form of potatoes, beets and melons; rough fodder in the form of hay, straw, etc., as well as grains if the enterprise grows for sale.

Each of the described feed types has parameters such as moisture, texture, particle size, viscosity, etc., e.g. feeds with high moisture content or fibrous materials may require choppers with specific characteristics capable of efficient chopping and mixing.

The recommendations described in the practical guide to feed preparation on

farms of the State Budgetary Institution of Non-Commercial Organizations INK AIC describe the parameters to be followed when preparing feed.

Chopped straw should not be too fine so that animals do not swallow it without chewing. Unchewed small particles are poorly digested, cause cattle cessation of cudging, rumen atony. Therefore, straw should be chopped to particles of 10-50 mm with obligatory splitting. If a cow eats an average of 2-3 kg of unchopped straw per day, then chopped straw - 1.5 times more, and as part of the feed mixture - up to 5 kg.

Potatoes are fed to cattle raw in shredded form, and to pigs - boiled in the form of a mixture with concentrates and grass meal. Boiled potatoes are crushed, and the size of the unbroken particles should not exceed 10 mm, and their number is allowed not more than 5% of the total mass [1].

Cereals are usually milled as it is the easiest, most accessible and obligatory way to prepare the grain for feeding. This destroys the hard surface shell of the grain, significantly increases the area of contact between the milled grain and digestive juices, nutrients become more accessible, which contributes to their fuller utilization.

### ***Performance***

One of the most important criteria when selecting a feed chopper is its capacity. This is defined as the amount of feed that can be processed per unit of time. The capacity of the chopper should be matched to the amount of forage production on the farm or production facility to ensure continuous and efficient operation [2].

### ***Energy consumption and efficiency***

The energy consumption of the shredder is an important aspect. Utilizing energy efficient technology can reduce the cost of feed production and improve the economic efficiency of the process. Shredding efficiency also plays a role in ensuring uniformity in feed particle size, which in turn affects animal digestibility and productivity.

### ***Type of chopper***

There are several types of feed choppers, each with its own advantages and disadvantages. For example, disc shredders provide good shredding for low moisture materials, while hammer shredders are more effective for fibrous and wet materials. The selection of the appropriate type of shredder depends on the specific production conditions and shredding quality requirements [3].

### ***Reliability and durability***

Reliability and durability of the shredder are key aspects, especially in intensive forage production. The shredder must be able to withstand high loads and provide stable operation for long periods of time without major breakdowns or failures.

### ***Safety requirements***

When selecting a shredder, safety requirements must be taken into account. This includes the presence of safety devices to prevent personnel from accessing the working parts of the machine during operation, as well as emergency shutdown devices and safety monitoring systems.

### ***Cost and maintenance***

Obviously, the cost of purchasing and maintaining a shredder also plays an important role in your decision. Both initial costs and operating costs such as maintenance, spare parts and energy consumption must be considered.



### ***Technological innovations***

Modern technology is constantly improving, which opens up new opportunities in the field of feed pulverization. For example, the use of computerized control systems can improve the accuracy and efficiency of the chopping process, and automated monitoring systems can help in the early detection of problems and prevention of accidents.

### ***Environmental aspects***

Environmental aspects should also be taken into account when selecting a forage chopper. This includes not only energy consumption and emissions, but also the recyclability of production waste. The use of environmentally friendly technologies and materials can help to reduce the negative impact on the environment [4].

### ***Adaptation to changing conditions***

It is important to choose a shredder that is able to adapt to changing production conditions. This may include the ability to handle different types of feed materials, change settings for optimal shredding, or even the ability to upgrade and expand functionality in the future.

### ***Individual needs***

Each production facility has unique needs and characteristics that can influence the selection of a feed chopper. For example, a compact and mobile shredder may be sufficient for a small-scale farm, while larger production facilities may require more powerful and productive equipment.

### **Conclusion**

Choosing the right feed chopper is an important step to ensure efficient feed production and maintain high levels of animal productivity. This article has reviewed the main criteria to be considered when selecting a shredder and discussed current trends and technological innovations in this area. Understanding these aspects will help private farms to make an informed choice that suits their specific needs and production conditions.

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## **ПАРАМЕТРЫ ПОДБОРА ИЗМЕЛЬЧИТЕЛЯ СМЕСИТЕЛЯ ДЛЯ ЛПХ И КФХ**

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**Аннотация:** В статье описаны параметры подбора измельчитель – смесителя для ЛПХ и

КФХ. Разъясняются принципы, которыми руководствуются при выборе измельчитель-смесителей для различных сельскохозяйственных культур. В этом исследовании рассматриваются различные параметры, на которые стоит опираться при выборе оборудования для определённого хозяйства, а также описываются и уточняются зоотехнические требования, предъявляемые к используемым культурам.

**Ключевые слова:** измельчитель кормов, зоотехнические требования, сочные корма, грубые корма, личные подсобные хозяйства (лпх), крестьянско фермерские хозяйства (кфх).

AI BASED SYSTEM OF AUTOMATED DIAGNOSTICS OF MEDICAL IMAGES

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Abstract

This article discusses the issue of machine learning of diagnostic systems based on neural networks. The article presents a method for creating a diagnostic system that performs the tasks of classification and detection of medical images.

**Keywords:** CDSS, medical visualization, machine learning, neural network, pathological patterns.

Introduction

Medical visualization systems hold a significant place in modern diagnostics. Advancements in neural networks and machine learning methods in recent decades have allowed for a substantial acceleration in the analysis of medical visualization data and their utilization within Clinical Decision Support Systems (CDSS).

The generalized scheme of the proposed automated diagnostic system utilizing the Yolo v8 algorithm is presented in Figure 1. The system tackles three tasks: classifying the uploaded image, highlighting pathological patterns, and providing a preliminary medical conclusion.

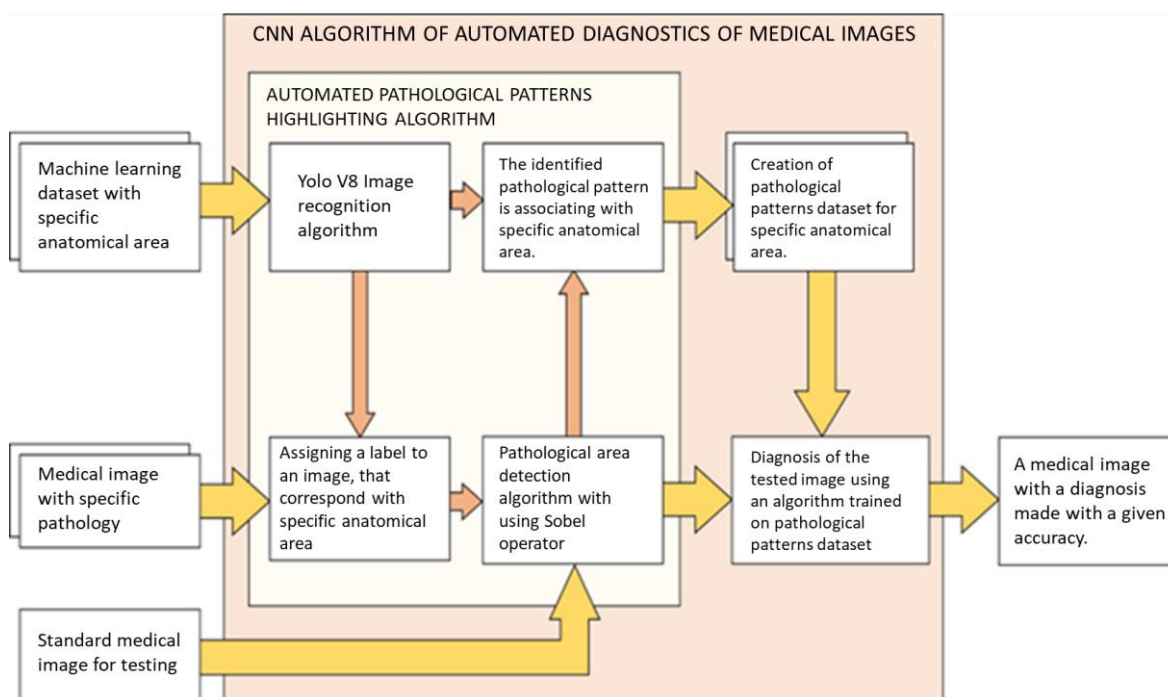


Figure 1 - Diagram of the medical image diagnostic system; the results can be utilized within a CDSS to reduce physician's routine workload

At the outset, a prepared set of images corresponding to a specific anatomical area in the normal state is loaded into the system, labeled accordingly (e.g., 'brain' for

a dataset of brain images). The trained classification algorithm confidently determines whether the studied image belongs to the 'brain' group. The training process is depicted in Figure 2. A red bounding box is attached to the object labeled as 'brain.' As the number of epochs increases (a single cycle of training the neural network with all the data), the algorithm's confidence in classifying the depicted object rises

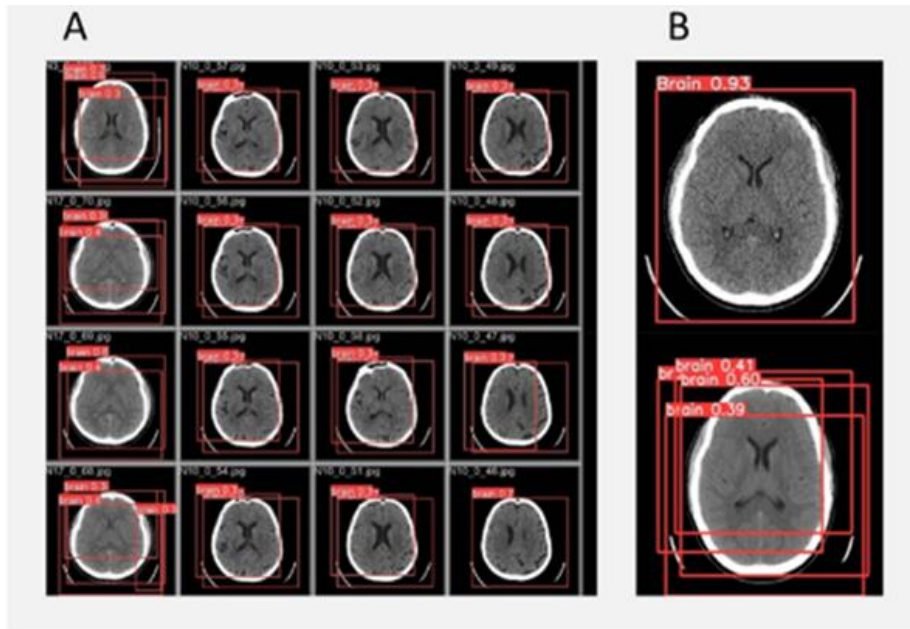


Figure 2 - Left: evolution of the bounding box attachment indicating the confidence level as epochs progress. Right: assessment results of an image not included in the dataset for 60 epochs (bottom) and for 300 epochs (top)

Subsequently, a dataset of brain images with a specific pathology, such as astrocytoma, undergoes processing using an algorithm for isolating the pathological area within the image. This algorithm relies on threshold filtering and the Sobel edge detection method. The isolation process is illustrated in Figure 3 – after threshold processing and edge removal, the pattern corresponding to the astrocytoma is prepared for further utilization in training the diagnostic system directly. The pattern accurately represents the tumor-affected area; the specificity of detection can be enhanced by isolating individual zones within the original image. As a result of image processing, we obtain a dataset of pathological patterns categorized by two labels: the brain image class and the tumor\_astrocytoma pathology class.

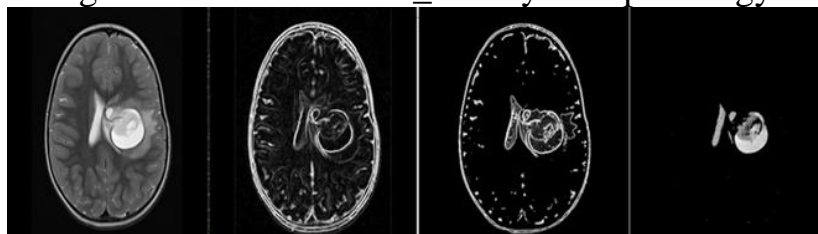


Figure 3 - Stages of segmenting MRI axial brain slice with astrocytoma; the segmented result is determined by the brain area and the tumor pathology

After training the system on the obtained dataset of pathological patterns, an

image can be loaded for which a medical conclusion is required. The accuracy of the conclusion depends on the volume of the pattern dataset and the specificity of the images. The result can be used as part of a Clinical Decision Support System (CDSS).

### **Conclusion**

An advantage of this system, implemented in Python, is its high versatility. Creating a training dataset for each required pathology is the primary requirement. Weight files for the Yolo v8 algorithm are placed within the program folder. Training the model is possible using images obtained from ultrasound, CT, MRI, allowing for cross-analysis of the same pathology (particularly relevant for brain lesions).

However, a drawback of this approach is the substantial size of the program files, which can affect the performance on relatively low-powered computer systems. Additionally, the diagnostic accuracy heavily depends on the volume and quality of the pattern dataset: with a small number of images and variations in parameters (resolution, gamma correction, etc.), the weight coefficients may lack specificity (for instance, the program may struggle to precisely identify a specific tumor type).

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## **СИСТЕМА АВТОМАТИЗИРОВАННОЙ ДИАГНОСТИКИ МЕДИЦИНСКИХ ИЗОБРАЖЕНИЙ НА ОСНОВЕ НЕЙРОННЫХ СЕТЕЙ**

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**Аннотация:** Рассмотрен вопрос машинного обучения диагностических систем на основе нейронных сетей. Представлен способ создания диагностической системы, выполняющей задачи классификации и детекции медицинских изображений.

**Ключевые слова:** СППВР, медицинская визуализация, машинное обучение, нейронная сеть, патологические паттерны.

## PROBLEMS OF CHOOSING A BIOCHEMICAL ANALYZER

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### Abstract

In this paper, the analysis of the problems of choosing medical equipment for a medical center is carried out. The main characteristics of a biochemical analyzer are considered, and a solution to the problem of choosing a biochemical analyzer is proposed.

**Keywords:** biochemical analyzer, decision support system, medical center, medical equipment.

### Introduction

Medical equipment plays a key role in providing high-quality and effective medical care. Equipping medical centers with modern medical equipment is a key aspect of providing high-quality and effective medical care. However, problems often arise due to the insufficient equipment of medical institutions with the necessary equipment. The purpose of this work is to analyze and find solutions to problems with the technical equipment of the medical center.

The technical support of a medical institution is a complex process involving large economic and time expenditures. When choosing a particular type of medical equipment, it is necessary to take into account various factors:

1. The amount required for the purchase of this equipment;
2. The tasks that will be solved with the help of this equipment;
3. Issues of qualified maintenance and repair of medical equipment.

One of the types of medical equipment, the choice of which requires an integrated approach, is a biochemical analyzer.

Biochemical analyses are the most important studies in the examination of patients in medical institutions. A biochemical analyzer is a specialized equipment for the production of laboratory tests for the content of substances (electrolytes, enzymes, hormones, etc.) in a patient's blood sample. The result of the work is to determine the presence and concentration of the above substances in the studied sample of biological material. The biochemical analyzer, while conducting research, is able to carry out both standard tests to determine the biochemical composition of the sample, and to take on board the so-called urgent studies.

When choosing a biochemical analyzer, it is necessary to pay attention to the following:

1. Type of analyzer: automatic and semi-automatic.
2. Analysis methods: biochemical analyzers can use various methods to measure the concentration of various biochemical substances, such as enzymatic methods, colorimetric methods, enzyme immunoassay methods, etc.
3. Measurement range: each biochemical analyzer has its own unique measurement range for each indicator, which determines the sensitivity and accuracy of the analyzer.

4. Biochemical analyzer system: the choice between an open and a closed system depends on the reagents used and the cost of their costs. The closed-type analyzer will work only with the manufacturer's proprietary reagents. In turn, open-type analyzing devices have a device of light filters that facilitate the implementation of the most relevant techniques, which allows the use of those reagents that are currently available in the laboratory or can be found in the public domain.

5. Frequency of analyses: an important parameter is the speed of sample processing and the output of analysis results, which allows you to optimize the diagnostic process.

6. Indicator of the biochemical blood analyzer: Batch access, in which the analyzer determines first one parameter, then the next, and so on for all samples. A significant disadvantage of the system, especially for laboratories that serve hospitals, is the inability to quickly obtain research results for each patient. Free Random Access, in which it is possible to set the mode "determination of all parameters for one sample", or, like Batch mode, the mode "determination of the same parameter in all samples". A Random Access system has all the advantages of a Batch system, but is devoid of its disadvantages. It allows you to urgently determine any parameter, but requires the correct assignment of the sequence of tests performed, careful specific flushing between certain types of analyzes.

7. Availability of automated functions: automatic sample feeding, reagent mixing, incubation, reading of results and reporting - all this can be adjusted depending on the manufacturer and model of the analyzer.

8. Calibration and quality control: the analyzer must be able to calibrate to accurately determine the concentration of substances in the sample, as well as built-in analysis quality control functions.

9. The ability to connect to an information system: an optional parameter that allows you to transfer test results in digital format and integrate them into electronic medical records.

10. Size and weight: It is also important to take into account the size and weight of the biochemical analyzer, especially when organizing space in the laboratory or when mobile work is necessary.

11. Maintenance and support: it is necessary to make sure that the selected analyzer is easy to maintain, and has access to technical support if necessary.

To solve the problem of choosing a biochemical analyzer, it is proposed to develop a decision support system (DSS) [1, 2].

DSS is a set of methods, tools and technologies designed to help in decision-making in complex and unstructured situations. It provides support in the process of analysis, evaluation and selection of solutions in order to achieve optimal results. The software implementing the DSS allows you to automate decision-making processes, improving their quality, minimizing risks and reducing the time spent on analysis and selection of optimal solutions.

The proposed decision support system for choosing the optimal model of a biochemical analyzer will solve the following tasks:

- 1) the content of the general database of medical equipment on the market;
- 2) choosing the optimal model of medical equipment for the individual

requirements of each medical center;

3) choosing the optimal models of medical equipment for a limited budget of the institution with a set of necessary options;

4) selection of a biochemical analyzer, the suppliers of which provide training for medical personnel and guarantee after-sales maintenance.

### **Conclusion**

As a result of this study, the main problems of the technical equipment of the medical center were identified, which primarily affect the quality of medical services provided. It is also proposed to solve these problems by creating a DSS for optimal technical equipment of the medical center.

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## **ПРОБЛЕМЫ ВЫБОРА БИОХИМИЧЕСКОГО АНАЛИЗАТОРА**

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**Аннотация:** В данной работе проведен анализ проблем выбора медицинского оборудования для медицинского центра, рассмотрены основные характеристики биохимического анализатора, предложено решение проблемы выбора биохимического анализатора.

**Ключевые слова:** биохимический анализатор, медицинская техника, медицинский центр, система поддержки принятия решений.



## APPLICATION OF VR-TECHNOLOGIES IN THE CORRECTION OF MYOPIA AND AMBLYOPIA

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### **Abstract**

This article describes an approach to correcting amblyopia and myopia that replaces traditional visual exercises with adaptive training in virtual reality. The methods for standard trainings on their VR analogs with adaptive functionality are described.

**Keywords:** VR, adaptive train, restoring visual function.

### **Introduction**

In today's world, where technology plays an increasingly important role in the field of medicine and rehabilitation, virtual reality (VR) is entering a range of tools that offer new perspectives in the correction of visual disorders [1]. This article discusses an approach to the correction of amblyopia and myopia in which traditional visual exercises are replaced by adaptive training in virtual reality, with a greater degree of engagement.

Amblyopia, also known as "lazy eye", is a condition in which the vision of one eye is less developed compared to the other. One of the treatment methods is visual exercises aimed at strengthening the muscles and improving the visual function of the weakened eye [2].

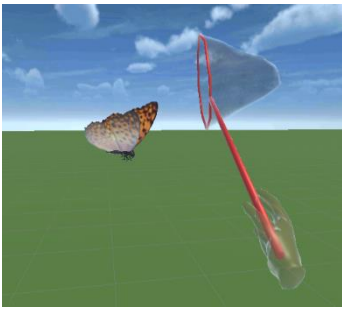
Myopia is a condition of the eye in which the image is focused in front of the retina inside the eye instead of on it. This causes distant objects to be seen fuzzy, while close objects are seen more clearly. In this case, visual training using light stimuli can be used to improve accommodation [3].

Adaptive training in VR provides unique opportunities to stimulate the eyes and promote recovery of visual function. Aimed at correcting amblyopia and myopia, these techniques can adapt to each patient's individual needs, providing a personalized and effective treatment approach. Let us consider at how these adaptive virtual reality techniques can transform the approach to eye training and help patients achieve optimal results in correcting and restoring visual function.

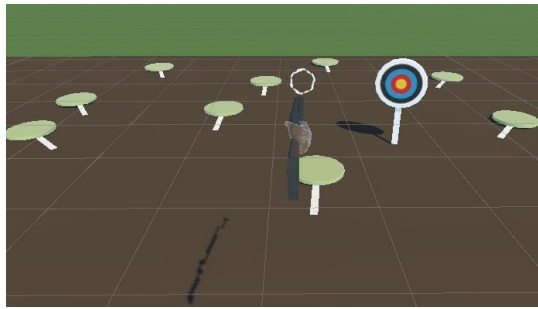
### **Methods and Materials**

To fulfill the objective of the paper, let's look at standard exercises and how to implement them in VR:

**Eye focus training:** VR can provide scenarios where the user must focus their attention on objects at different distances, which helps improve eye accommodation (Figure 1).



a. Butterfly fishing



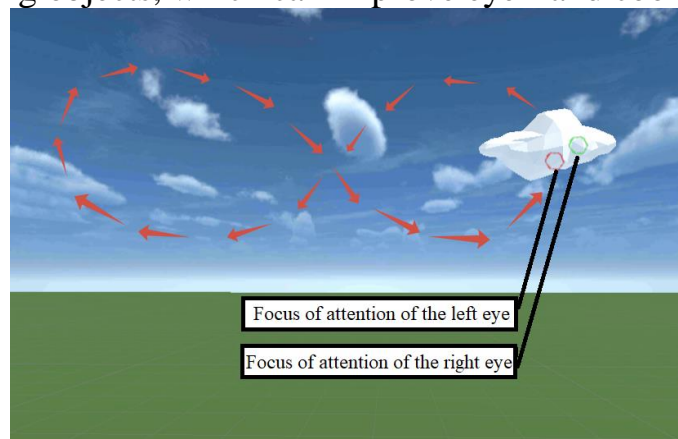
b. Target shooting

*Figure 1 - Eye focus training*

In the scenario shown in Figure 1(a), a butterfly appears in front of the user and starts moving periodically towards and away from the person. The user needs to catch the butterfly with a net, after which it will appear at a random location in front of the person, changing its size depending on how quickly the user was able to catch it.

In the scenario shown in Figure 1(b), the user needs to shoot at targets that are at different distances from him. The disk of the target may decrease or increase with frequent hits, and the disk of the target may increase with frequent misses.

**Item tracking training:** VR applications can include exercises that require the user to follow moving objects, which can improve eye-hand coordination.



*Figure 2 - Item tracking training*

In tracking training, the user must focus attention on an object with each eye at one point. When eye coordination is successful, the person's attention should be moved to another point. For example, in Figure 2, the subject needs to track a cloud. If the user successfully combines the attention focuses of the left and right eyes, the cloud starts moving along the trajectory shown by the red arrows. The adaptive part is to change the trajectory, speed and size of the cloud.

**Training to develop binocular vision:** VR can create environments in which the user must use both eyes to solve problems and perceive space.

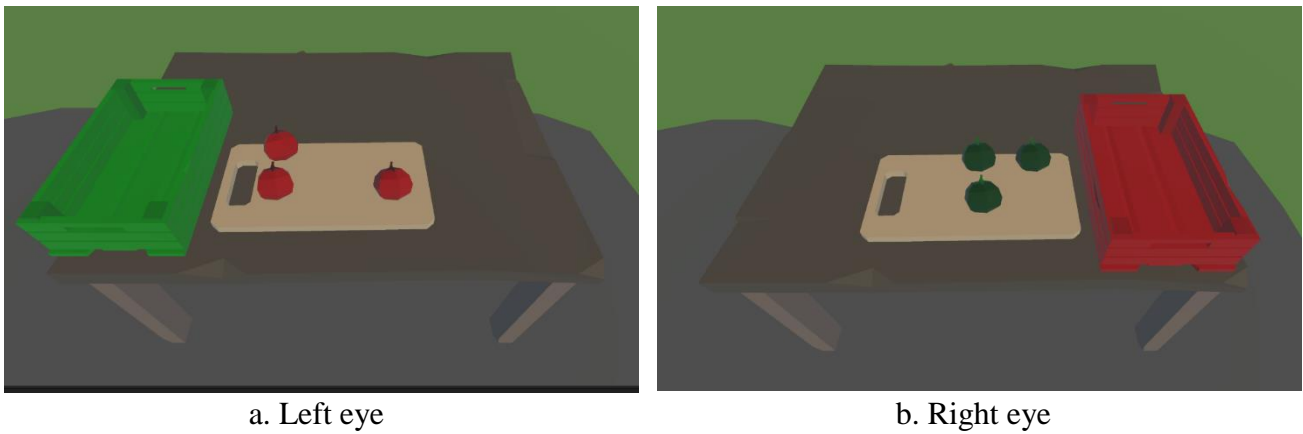


Figure 3 - Training on object matching

In training for the development of binocular vision, it is necessary to divide the objects to be combined into layers, and each layer outputs only to a specific eye. For example, in Figure 3, the user needs to sort green apples into a green basket and red apples into a red basket, in turn, the red apples and green basket are visible in the left eye, and the green apples and red basket in the right eye. You can also change the size and shape of the basket to adapt the difficulty of the exercise.

**Light stimulation:** Light stimulation in VR is an approach in which a bright, monochromatic image appears in the user's entire field of view at an appropriate frequency during training (Figure 4). Stimuli play a key role in restoring or improving visual skills.

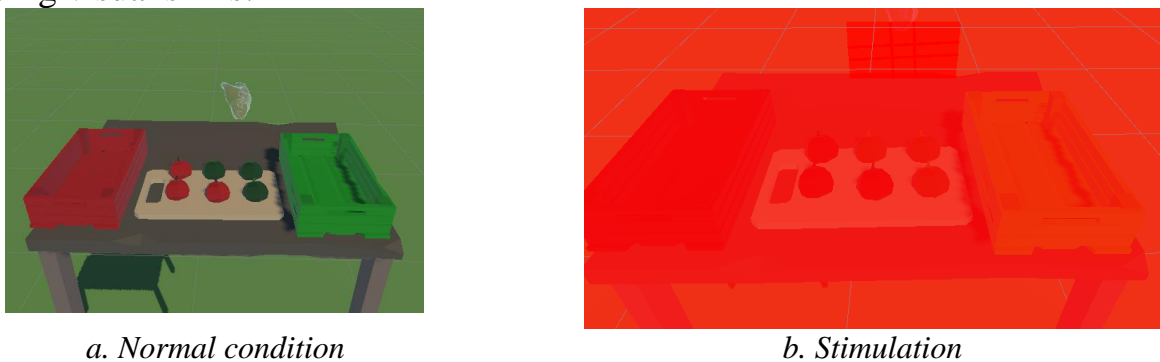


Figure 4 - Stimulation by light

## Conclusion

The paper considers the task of correcting visual impairments such as myopia and amblyopia using VR technologies. VR technologies open new perspectives for innovative approaches to training the visual system. The adaptability of the training can keep the individual engaged and increase the effectiveness of the training.

Future clinical trials are planned in collaboration with ophthalmologists to validate the effectiveness of this approach.

## Acknowledgements

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## ПРИМЕНЕНИЕ VR-ТЕХНОЛОГИЙ В КОРРЕКЦИИ МИОПИИ И АМБЛИОПИИ

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**Аннотация:** Описан подход к коррекции амблиопии и миопии, при котором традиционные зрительные упражнения заменяются адаптивными тренировками в виртуальной реальности. Проанализированы методики проведения стандартных тренировок на их VR-аналогах с адаптивным функционалом.

**Ключевые слова:** VR, адаптивные тренировки, восстановление зрительных функций.

## DEVELOPMENT OF MATHEMATICAL MODEL OF THE RESPIRATORY SYSTEM

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### Abstract

The paper focuses on the analysis and development of a mathematical model of the respiratory system. It provides the description of the different physical characteristics and the methods of calculating them. The author suggests dividing the respiratory system into three main components: anatomical dead space, the mixing space, and the alveolar space. The main physical parameters of lung function are determined by the elasticity and resistance of the lungs. Mathematical formulas have been developed for using the digital twins of the respiratory system. The relevance of the study is in developing system of supporting decision-making for doctors working in intensive care units. For this purpose, it is necessary to study and apply additional parameters of the respiratory system in order to improve the accuracy of the digital twin.

**Keywords:** alveolar space, anatomical dead space, digital twin, mixing space, respiratory system, system of supporting decision-making.

### Introduction

The COVID-19 pandemic has become a real test for medical institutions, and to a greater extent for intensive care units. Against the background of sharply increased morbidity, a huge number of cases of severe disease, as well as the increased morbidity of the medical staff themselves, the burden on hospital staff was enormous. Assistance in assessing the state of the respiratory and circulatory systems is intended to be a serious help both in the period of infectious diseases and in the treatment of chronic and acute diseases.

In order to develop a hardware and software complex for the intensive care unit, based on a digital twin of the circulatory and respiratory systems, we decided to select the optimal model for the respiratory system. The purpose of this research is to study the human respiratory system, its basic physical properties, a mathematical description of the processes that occur during breathing, and to construct a mathematical model of the lungs.

The lungs are divided into several reservoirs. The first reservoir is the anatomical dead space (D), the second is the mixing space (S), and the third is the alveolar space. This last reservoir is further divided into ventilated alveoli and perfused (A), non-ventilated alveoli and perfused (ASH) and ventilated alveoli and non-perfused (AD).

The process of gas exchange is shown in Figure 1. The movement of gases between the outside environment, the dead space (D), and the mixing space (S) occurs due to convection. At the same time, gas exchange between S and A occurs mainly through diffusion. Diffusion gas exchange - perfusion - also occurs between the ventilated alveolar reservoir A and the pulmonary capillary reservoir PC.

Based on Lighthill's research, we believe that the first 10 branches of the bronchial tree account for majority of airway resistance [1]. Given that the length of

reservoir A is approximately 3 mm, space S is approximately 4 mm, space D is 280 mm, and the cross-sectional areas are 10,000 cm<sup>2</sup>, 3,700 cm<sup>2</sup> and 7 cm<sup>2</sup>, respectively. It is reasonable to assume that the main obstacle to gas flow lies in the region between the external environment (I) and the dead space (D). Let's estimate the resistance of each reservoir using formula 1.

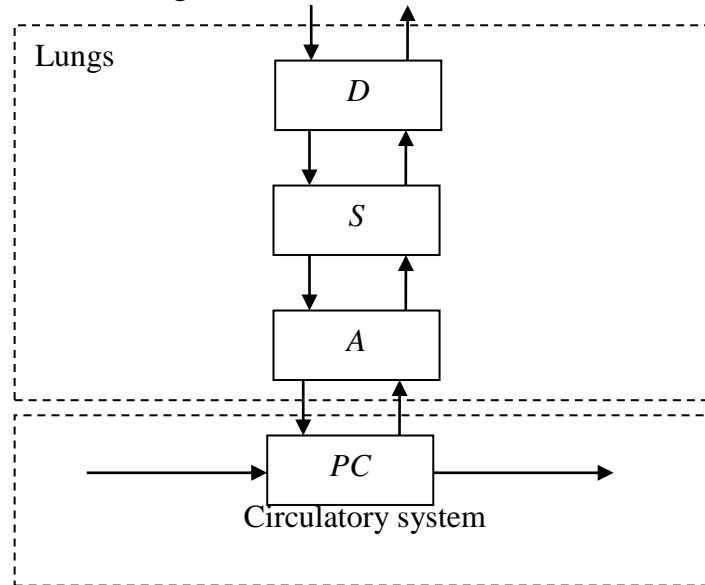


Figure 1 - The process of gas exchange

$$R_i = \frac{k_i l_i}{S_i}, \quad (1)$$

$R_i$  is the resistance of the reservoir  $i$ ,  $k_i$  is the coefficient, and  $l_i$  is the total length of that reservoir.  $S_i$  is its total area, and the coefficients are  $K_{ID}$ ,  $K_{DS}$ , and  $K_{SA}$ , according to the data we have studied, follow the pattern  $K_{ID} > K_{DS} > K_{SA}$ . Using these values, we can calculate the resistance of each reservoir.

$$R_{ID} = K_{ID} \frac{280}{7}, \quad (2)$$

$$R_{DS} = K_{DS} \frac{4}{3700} \quad (3)$$

$$R_{SA} = K_{SA} \frac{3}{10000}, \quad (4)$$

Based on the above calculations, it can be concluded that the resistances of  $R_{DS}$  and  $R_{SA}$  are so low that they can be neglected when calculating the total resistance in the respiratory tract. We find that it is approximately equal to the resistance of space D. When calculating the total resistance, we only take into account the diffusion flow between space D and the outside environment I. The total resistance of the respiratory system is expressed by the formula (5).

$$R_L = \int_T \frac{P_I - P_L(t)}{Q_{ID}(t)} dt, \quad (5)$$

$P_L(t)$  represents the pressure in the lung reservoir at time  $t$ .  $Q_{ID}(t)$  denotes the total diffusion flux between the lung and the external environment at time  $t$ .

The total elasticity of the lungs can be calculated using the following formula (6).

$$C_L = \frac{V_L(t_I) - U_L}{P_I - P_{PL}(t_I)}, \quad (6)$$

$V_L(t_i)$  is the total volume of the lung reservoirs at the end of inspiration.  $U_L$  is the volume of the reservoirs at the end of exhalation.  $P_I$  is the pressure inside the lung reservoir at the end of inspiration and  $P_{PL}(t_i)$  is the pressure in the pleural cavity at that time.

At this stage of the research, system analysis and mathematical modeling techniques were employed. Based on the research conducted, it has become possible to understand the essence of this issue further. It is necessary to describe the process of gas exchange during blood circulation, describe the small consumption of oxygen and carbon dioxide in order to identify the parameters of a patient's bodily metabolism and assess their vital signs. Additionally, it is necessary to perform trial calculations based on experimental data.

### **Conclusion**

The conducted research has demonstrated the significance of addressing to this issue. Addressing the challenge of creating a digital twin of the circulatory and respiratory systems would be an essential step in enhancing the intensive care units.

At the stage of mathematical modeling of the respiratory system, a mathematical model of the lungs was developed, which is based on the idea of separate gas reservoirs. This model describes the process of gas exchange between the lungs and the outside environment, as well as the behavior of the lung tissue over time.

The results of this modeling are expressed in mathematical formulas that describe physical characteristics such as elasticity and resistance in the respiratory tract. These formulas can be used to predict the effects of various conditions on the functioning of the lungs, such as changes in lung volume or pressure.

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## **РАЗРАБОТКА МАТЕМАТИЧЕСКОЙ МОДЕЛИ ДЫХАТЕЛЬНОЙ СИСТЕМЫ**

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**Аннотация:** Исследование посвящено анализу и разработке математической модели дыхательной системы. В нем приводится описание различных физических характеристик системы дыхания и методов их расчета. Дыхательная система условно делится на три

основных компонента: анатомическое мертвое пространство, резервуар смешивания и альвеолярный резервуар. Основные физические параметры функции легких определяются эластичностью и сопротивлением легких. Получены математические формулы для использования в цифровом двойнике дыхательной системы. Актуальность исследования заключается в разработке системы поддержки принятия решений для врачей, работающих в отделениях интенсивной терапии. В результате необходимо изучить и применить дополнительные параметры дыхательной системы, чтобы повысить точность цифрового двойника.

**Ключевые слова:** альвеолярный резервуар, анатомическое мертвое пространство, резервуар смешивания, система дыхания, система поддержки принятия решений, цифровой двойник.



УДК 66.081.3  
ББК (Ж/О) 35.10

## SYNTHESIS AND SORPTION PROPERTIES OF ACTIVATED BIO-CARBONS BASED ON GRASS MEAL

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### Abstract

The study implements the synthesis of new sorption carbon materials based on vegetable raw materials – granulated grass meal. The materials were obtained by hydrothermal carbonization, followed by carbonization in a muffle furnace and activation by alkali. Sorption studies on the extraction of methylene blue dye have been carried out. Studies proved that alkaline activation is a promising option for increasing the porosity and the surface area of hydrothermal carbon, and, accordingly, increasing the sorption capacity of the material synthesized from grass meal.

**Keywords:** activation, adsorbent, carbonation, methylene blue, grass meal.

### Introduction

Modern agricultural production generates a huge amount of waste of plant origin. These materials can potentially be used as raw materials for the production of new high-tech products. Currently, the processing of cake or meal of agricultural crops into active carbon materials is actively used, which can be used in various industries. For example, one of the promising areas for the use of waste from the agro–industrial complex is the production of new functional materials. This approach minimizes the environmental impact and saves natural resources [1-3].

In this work, a sorption material based on granulated grass meal (GM) was obtained by hydrothermal carbonization (HTK). For this purpose, stainless steel autoclaves with a volume of 100 ml were used, in which crushed biomass and distilled water were placed, heated to 180 °C and kept for 12 hours. The contents were then filtered on a water jet pump through a fabric filter to remove reaction byproducts. Then the resulting material was dried at 110 °C to a constant weight (GM/HTK sample).

The resulting HTK mass was carbonized in a muffle furnace with a constant supply of argon (flow rate 1 l/min) in 3 stages – by heating and holding the sample at 150, 500 and 750°C stepwise for 1 hour at each temperature (sample GM/HTK/ K).

The final stage was the alkaline activation of the carbonized sample. For activation, potassium hydroxide is added to the precursor material in a ratio of 1 to 6, after which it is loaded into the reactor and placed in a muffle furnace. Activation is carried out in an inert environment with a constant supply of argon (flow rate 1 l/min) in 2 stages by heating and holding the sample at 400 and 750°C stepwise for an hour at each temperature. After activation, the resulting material was washed with distilled water, the alkali residues were neutralized with hydrochloric acid, after which the material was re-washed with distilled water and dried at 100°C to a constant weight

(sample GM/HTK/K/KOH).

Fig. 1 shows SEM images of the structure of hydrothermal carbon before and after alkaline activation.

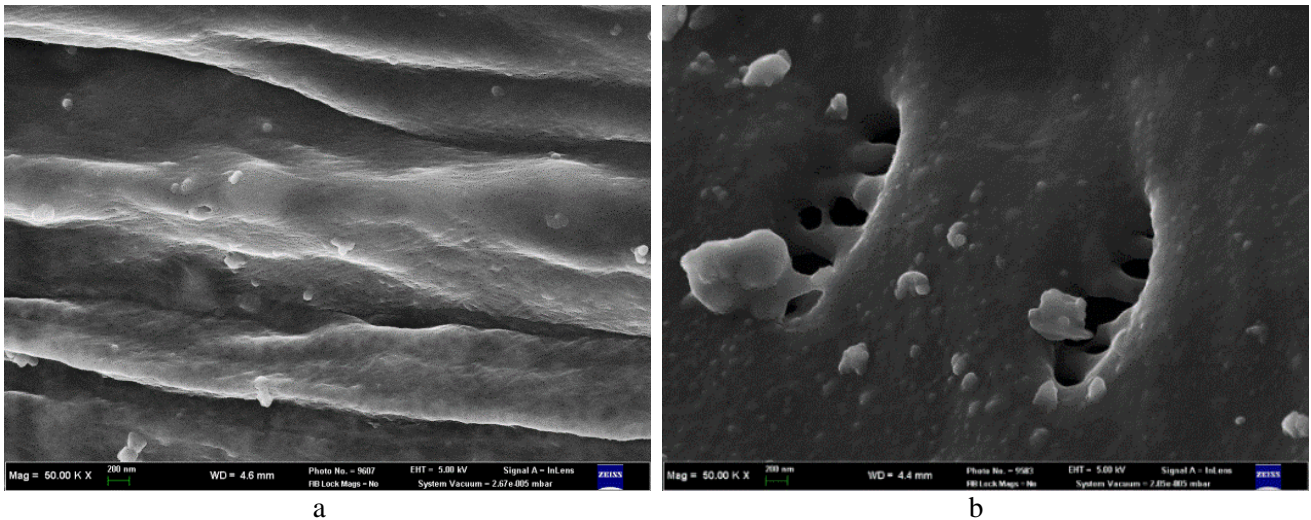


Figure 1 – SEM images of the obtained samples: a – GM/HTK, b – GM/HTK/K/KOH

The sorption properties of the obtained samples in the processes of liquid-phase adsorption of methylene blue dye were studied. During kinetic sorption studies, 0.01 g of the synthesized material was placed in a test tube with a model solution of methylene blue (initial concentration 1500 mg/l) with a volume of 30 ml. The contact time was 5, 10, 15, 30 and 60 minutes. The results of the conducted research are presented in Fig. 2.

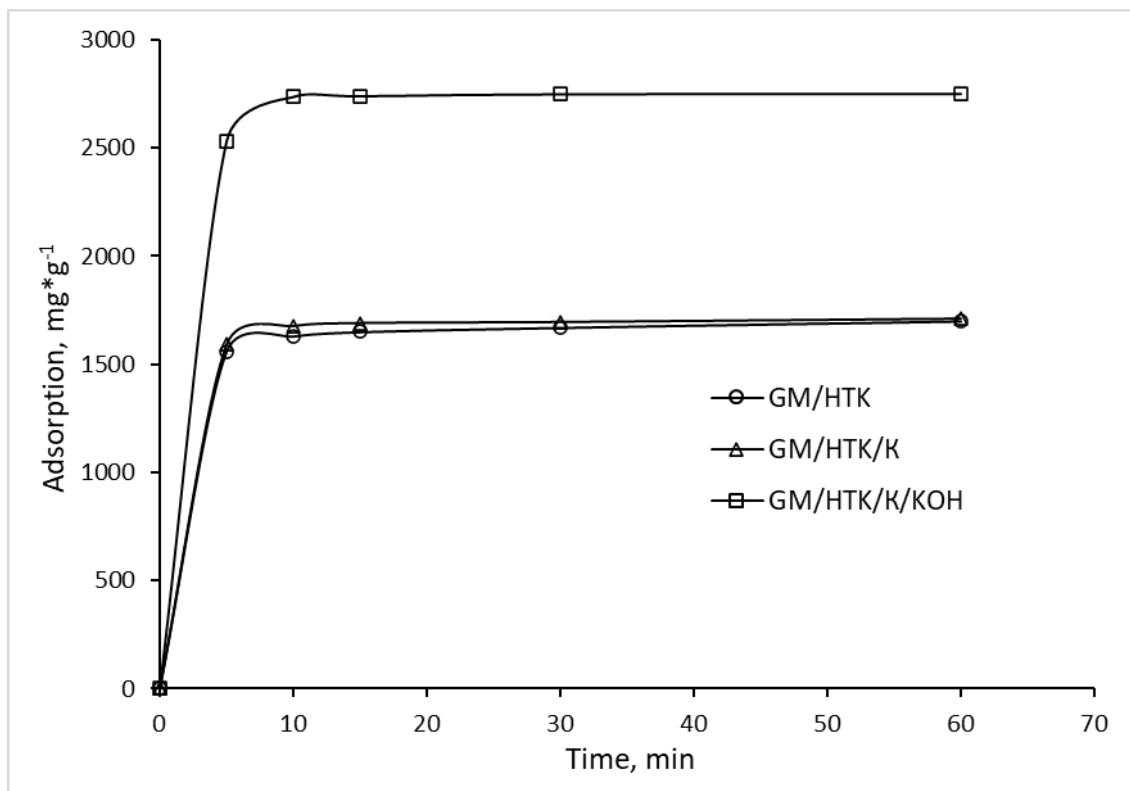


Figure 2 – The adsorption capacity of the MB dye on GM/HTK, GM/HTK/K, GM/HTK/K/KOH materials

Dependence analysis shows that activated GTK materials, along with non-activated ones, show high activity and sorption capacity – 1700 mg/g (sample GM/HTK), 1710 mg/g (sample GM/HTK/K), 2750 mg/g (sample GM/HTK/K/KOH) according to MB.

#### **Conclusion**

Thus, alkaline activation is the optimal option for increasing the porosity and surface area of hydrothermal carbon, which accordingly increases the sorption capacity of the material synthesized from grass meal.

#### **Acknowledgements**

The study was supported by the Russian Science Foundation Grant No. 22-13-20074, <https://rscf.ru/project/22-13-20074>

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## **СИНТЕЗ И СОРБЦИОННЫЕ СВОЙСТВА АКТИВИРОВАННЫХ БИОУГЛЕЙ НА ОСНОВЕ ТРАВЯНОЙ МУКИ**

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**Аннотация:** В работе реализован синтез новых сорбционных углеродных материалов на основе растительного сырья – гранулированной травяной муки. Материалы были получены путем гидротермальной карбонизации, с последующим прохождением карбонизации в муфельной печи и активации щелочью. Проведены сорбционные исследования по извлечению метиленового синего красителя. Исследования показали, что щелочная активация является перспективным вариантом увеличения пористости и площади поверхности гидротермального углерода, и, соответственно, повышения сорбционной емкости материала, синтезированного из травяной муки.

**Ключевые слова:** активация, адсорбент, карбонизация, метиленовый синий, травяная мука.

## HERSTELLUNG UND SORPTIONSEIGENSCHAFTEN VON KOHLENSTOFFMATERIAL AUF DER GRUNDLAGE VON LANDWIRTSCHAFTLICHEN ROHSTOFFEN

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### **Zusammenfassung**

In der Arbeit wurden Sorptionsstudien zu hochwirksamen Sorptionsmaterialien durchgeführt. Als Grundlage wurde ein organisches Material genommen – Raps. Das Material ist durch hydrothermale Karbonisierung von Raps / HTK, gefolgt von der Aktivierung von Raps / HTK / K und der Karbonisierung von Raps / HTK / K / KOH erhalten. Die Kinetik der Flüssigphasen-Adsorption ist auf den entwickelten Materialien eines organischen Farbstoffs, Methylenblau (MB), untersucht. Es ist festgestellt, dass die Adsorptionskapazität des resultierenden Materials in MB beträgt: Raps / HTK – 1500 mg / g, Raps / HTK / K – 1800 mg / g, Raps / HTK / K / KOH – 2900mg / g, die optimale Sorptionszeit beträgt 10 bis 60 Minuten.

**Schlüsselwörter:** Adsorbent, Aktivierung, Karbonisierung, Raps.

### **Einführung**

Es gibt eine Vielzahl von Unternehmen, die sich nachteilig auf die Umwelt auswirken. Ein solches Problem ist die Abwasserverschmutzung. Schadstoffe werden in organische und anorganische, organische Farbstoffe unterteilt. Eine hohe Konzentration von Farbstoffen im Abwasser verursacht schwere Schäden an der Umwelt und der menschlichen Gesundheit [1].

Heute gibt es viele Möglichkeiten, Abwasser zu reinigen. Häufiger ist die Adsorption. Viele organische Substanzen, wie Raps und Sonnenblumen, können als Ausgangsstoffe für die Adsorption verwendet werden. Diese Substanzen werden durch hydrothermale Karbonisierung hergestellt.

Hydrothermale Karbonisierung des Mahls.

Das Schrot wird für 50 Sekunden vorgemahlen und durch ein Sieb mit einer Größe von weniger als 2 mm gesiebt. In einen 100 ml-Autoklav werden das zerkleinerte Schrot und destilliertes Wasser gegeben. Der Autoklav wird in einen auf 180 ° C vorgeheizten Trockenschrank gestellt und für 12/24 Stunden aufbewahrt. Der Inhalt des Autoklavs wird an der Wasserstrahlpumpe durch einen Gewebefilter gefiltert, um die Reaktionsnebenprodukte zu entfernen. Als nächstes wird das resultierende Material bei 110 ° C zu einer konstanten Masse getrocknet.

Karbonisierung im Muffelofen.

Zur Karbonisierung wird das Vorläufermaterial in den Reaktor geladen und in einen Muffelofen gelegt. Die Karbonisierung erfolgt in einem inerten Medium bei einer konstanten Argonzufuhr (1 l / min) in 3 Stufen durch Erhitzen und Einhalten der Probe bei 150, 500 und 750 ° C schrittweise für eine Stunde bei jeder Temperatur.

Aktivierung im Muffelofen.

Zur Aktivierung wird Kaliumhydroxid im Verhältnis 1 zu 6 in das Vorläufermaterial gegeben, dann in den Reaktor geladen und in einen Muffelofen gelegt. Die Aktivierung erfolgt in einem inerten Medium bei einer konstanten Argonzufuhr (1 l /min) in 2 Stufen durch Erhitzen und Einhalten der Probe bei 400 und 750 ° C für jeweils eine Stunde schrittweise bei jeder Temperatur.

Nach der Aktivierung wird das erhaltene Material mit destilliertem Wasser gewaschen, anschließend werden die Alkalirückstände mit Salzsäure neutralisiert, danach wird das Material mit destilliertem Wasser gewaschen. Als nächstes wird das Material bei einer Temperatur von 100 ° C in einen Trockenschrank zum Trocknen geschickt.

Die Struktur der Materialien ist mit Hilfe der Rasterelektronenmikroskopie (SEM) untersucht (Abb.1). Auf den eingereichten SEM-Bildern der Oberfläche des Raps-HTK (Abb.1 (a)) es ist ersichtlich, dass das Material eine Oberfläche aufweist, bei der die unorganisierte Struktur der ursprünglichen Morphologie natürlichen Ursprungs erhalten bleibt. Während der Karbonisierung und Aktivierung war die Struktur nicht zerstört, jedoch erschienen Poren auf der Oberfläche. Auf Abb.1(b) Es kann angemerkt werden, dass die Materialstruktur durch Prozesse organisiert wird.

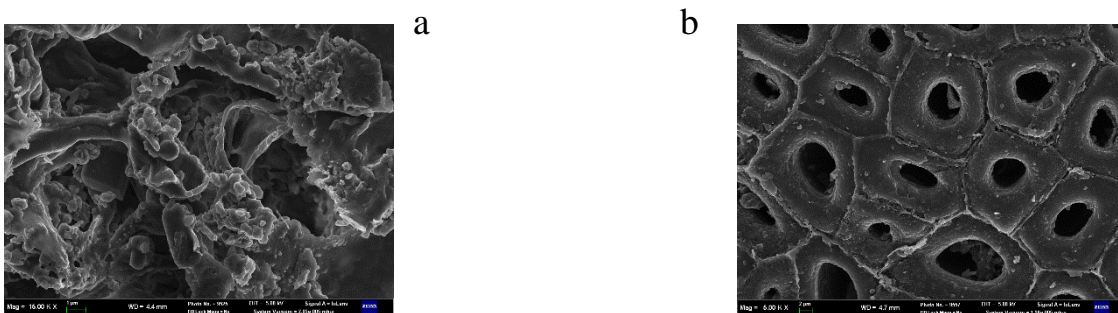


Abb.1. SEM-Bild der Materialstruktur: a - Raps / HTK, b - Raps / HTK/ K / KOH.

Während der Sorptionsstudien werden 0,01 g synthetisiertes Material in ein Röhrchen mit einer Modelllösung von MB [2] (Anfangskonzentration von 1500 mg / l) mit einem Volumen von 30 ml gegeben. Die Kontaktzeit beträgt 5, 10, 15,30 und 60 min. Als Ergebnis der durchgeführten Studien sind die kinetischen Abhängigkeiten des Flüssigphasenextraktionsprozesses von MB in Abb.2 vorgestellt.

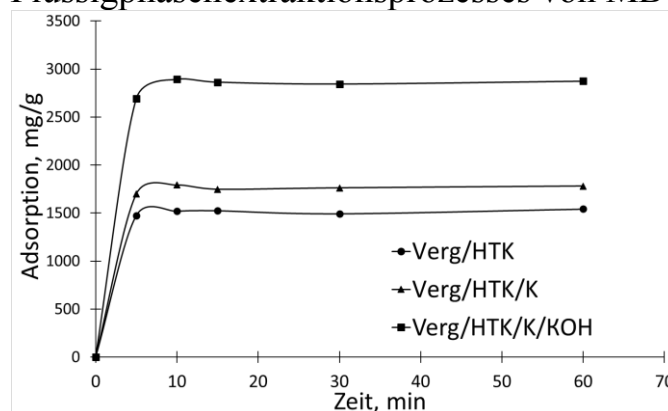


Abb. 2. Kinetische Abhängigkeiten der MB-Farbstoffadsorption auf den Materialien Raps / HTK, Raps / HTK / K, Raps / HTK/ K / KOH.

Bei der Analyse der erhaltenen Daten kann festgestellt werden, dass die Materialien eine hohe Adsorptionseigenschaften von MB-Molekülen aus wässrigen Lösungen aufweisen. Die Adsorptionskapazität erhöht sich, wenn sie der Karbonisierung und Aktivierung ausgesetzt ist und beträgt: Raps / HTK – 1500 mg / g, Raps / HTK / K – 1800 mg / g, Raps / HTK / K / KOH – 2900mg / g, die optimale Sorptionszeit beträgt 10 Minuten.

### **Schlussfolgerung**

Daraus kann man schließen, dass das entwickelte Material ein hohes Ergebnis von Sorptionseigenschaften zeigt.

### **Dankbarkeit**

Die Studie ist durch einen Zuschuss des Russischen Wissenschaftsfonds Nr. 22-13-20074 durchgeführt, <https://rscf.ru/project/22-13-20074>.

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## **ПОЛУЧЕНИЕ И СОРБЦИОННЫЕ СВОЙСТВА УГЛЕРОДНОГО МАТЕРИАЛА НА ОСНОВЕ СЕЛЬСКОХОЗЯЙСТВЕННОГО СЫРЬЯ**

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**Аннотация:** В работе проведены сорбционные исследования высокоэффективных сорбционных материалов. За основу был взят материал органического происхождения – Рапс. Материал был получен путем гидротермальной карбонизации Рапс/ГТК, с последующим прохождением активации Рапс/ГТК/К и карбонизации Рапс/ГТК/К/КОН. Была изучена кинетика жидкофазной адсорбции на разработанных материалах органического красителя – метиленового синего (МС). Выявлено, что адсорбционная емкость полученного материала по МС составляет: Рапс/ГТК – 1500 мг/г, Рапс/ГТК/К – 1800 мг/г, Рапс/ГТК/К/КОН – 2900мг/г, оптимальное время сорбции от 10 до 60 минут.

**Ключевые слова:** адсорбент, карбонизация, активация, рапс.

## THE INFLUENCE OF THE NUMBER OF LAYERS IN SMALL NANOGRAPHITE CLUSTERS ON THE SIZE OF THE ENERGY GAP

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### Abstract

The aim of this paper is to predict the number of graphene layers per value of the energy gap between the highest occupied molecule orbital and the lowest un-occupied molecular orbital. Nanographite clusters are taken as the object under study. Simulation of nanographite clusters was carried out at the level of the theory of tight-binding model (TB). Calculations were carried out in a solvent (octanol). Data were obtained on the value of the the highest occupied molecule orbital and the lowest un-occupied molecular orbital energy gap depending on the number of graphene layers. It is concluded that the value of the energy gap between the highest occupied molecule orbital and the lowest un-occupied molecular orbital differs by two orders of magnitude for an even and odd number of layers.

**Keywords:** nanographite, energy gap.

### Introduction

Nanographite consists of several graphene layers, a hexagonal network of atoms on the outside. Currently, an active object is the study of unusual properties that make it a promising extension for modification, for example, of paints and varnishes or the sorption of ions from solutions [1].

The energy difference between the highest occupied molecular orbital (HOMO) and the the lowest un-occupied molecular orbital (LUMO) is the HOMO-LUMO energy gap. Its value can be used to predict the strength and stability of chemical compounds, as well as the color they produce in solution. As a general rule, the larger the energy gap between the HOMO and LUMO compounds, the more stable the compound. Also, HOMO and LUMO values are often used to assess connections using indices of reactivity.

The purpose of this work is to study the influence of the number of graphene layers on the value of the HOMO-LUMO energy gap.

Nanographite clusters consisting of one, two, three and four graphene layers terminated at the edges with hydrogen atoms are taken as the object under study. The size of each layer is 10 by 10 cells.

Modeling of nanographite clusters was carried out at the level of the theory of tight-binding model (TB); the GFN2-xTB method [2] was adopted for calculations and geometry optimization since it has a low computational cost and is suitable for calculating large structures. Calculations were carried out in a solvent (octanol). Continuum ALPB [3] was used as a solvent model. All calculations were performed using the ORCA 5 software package [4].

The obtained results of calculating the HOMO-LUMO energy gap are presented in Table 1.

Table 1 - The results of calculating the HOMO-LUMO energy gap are presented in

Number of layers	1	2	3	4
Energy gap value, eV	0.00134	0.467	0.00146	0.363

Images for one and several layers of nanographite are presented in Figs 1 and 2.

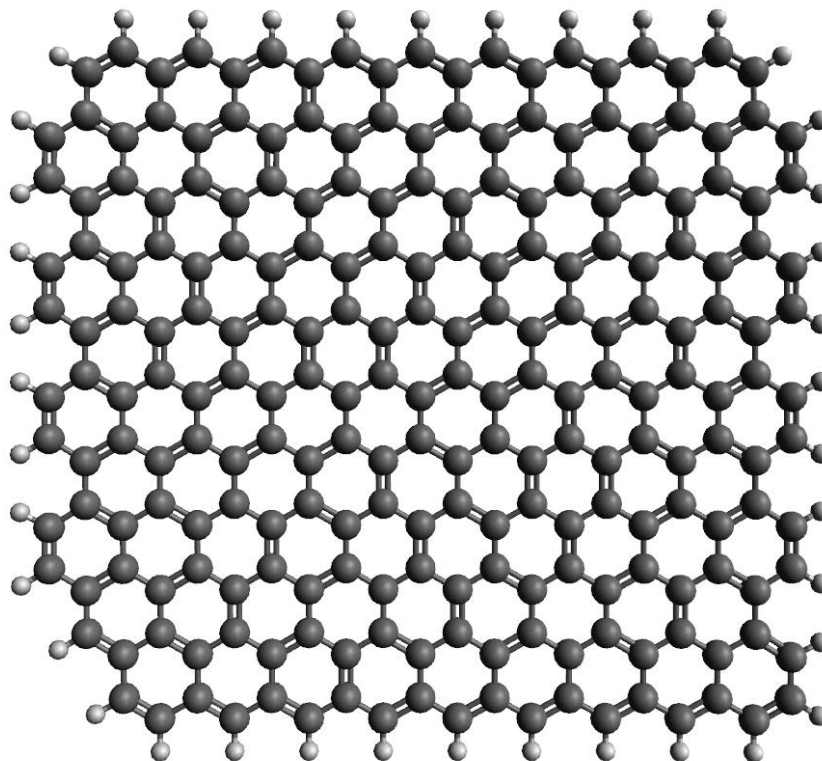


Figure 1 - Calculated geometry for one layer using the GFN2-xTB method. View from above.

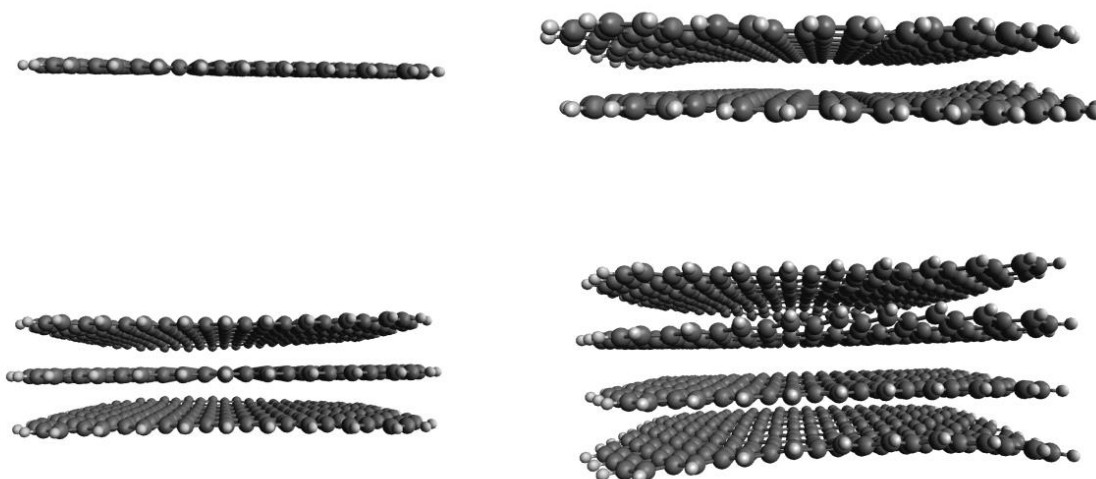


Figure 2 - Calculated geometry for nanographite clusters using the GFN2-xTB method. Side view.

## Conclusion

Summarizing the results, we say that the value of the HOMO-LUMO energy gap differs by two orders of magnitude for an even and odd number of layers.



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## ВЛИЯНИЕ КОЛИЧЕСТВА СЛОЕВ В МАЛЫХ КЛАСТЕРАХ НАНОГРАФИТА НА ВЕЛИЧИНУ ЭНЕРГЕТИЧЕСКОЙ ЩЕЛИ

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**Аннотация:** Целью данной работы является выявление влияния числа слоев графита на величину энергетической щели между высшей занятой молекулярной орбиталью и низшей вакантной молекулярной орбиталью. Исследуемым объектом являются нанографитовый кластеры. Моделирование проводилось на уровне теории сильно связанных электронов (ТВ). В качестве растворителя, в котором производились вычисления выступил октанол. В ходе работы были получены данные о значениях энергетической щели между высшей занятой молекулярной орбиталью и низшей вакантной молекулярной орбиталью в зависимости от числа графеновых слоев. После анализа полученных данных был сделан вывод, что величина энергетической щели между высшей занятой молекулярной орбиталью и низшей вакантной молекулярной орбиталью на два порядка больше для четного числа слоев нанографита.

**Ключевые слова:** нанографит, энергетическая щель

## RESEARCH WORK OF THE EXPEDITION "FLOTILLA OF FLOATING UNIVERSITIES" IN THE FIELD OF STUDYING THE ECOLOGICAL AND CHEMICAL COMPOSITION OF SURFACE WATERS AND SOIL OF THE RIGHT BANK OF THE VOLGA RIVER IN THE VICINITY OF VOLSK, SARATOV REGION (THE VILLAGE OF RYBNOYE - BELOGRODNYA TRACT-SEMENOVSKY TRACT)

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### Abstract

In July 2021, students of the Department of "Nature Management and Environmental Protection" completed a summer internship as part of the expedition "Flotilla of Floating Universities", whose task was to investigate for high-quality ecological and chemical indicators of surface waters and soil of the coastal territory of the Volga River.

**Keywords:** environmental monitoring, expedition, environmental safety, Flotilla of floating universities.



*Figure 1 - Sampling location*

The Volga River is one of the major water bodies of the Russian Federation. It has become a source of water resources for many industrial cities located on its coastal borders. Operating enterprises and people's everyday activities have caused the growth of pollution and, as a consequence, the deterioration of the ecological state of the Volga River water reserve. Additional contribution is made by the Central Military Chemical Warfare Range (CMWR; it was also known as Volsky Chemical Warfare Range - VCWR), which is located on the river bank, where chemical warfare agents are buried. This facility is located in the Saratov region on the bank of the Volga River near the village of Shikhany (station Prichernavskaya). The beginning of its combat activity dates back to the 1920s, when in 1924 on the territory of the estate of Count V.P. Orlov-Denisov, requisitioned after the revolution, a tank range was established. In 1928, the question arose of selecting a territory for work with a special group, i.e. for German-Soviet work on chemical weapons.

Taking into account the summation of negative objects that are potential sources

of pollution of the Volga River, the students were tasked to conduct initial studies of the ecological and chemical composition of the river surface water and the soil of the coastal zone of the reservoir. The studies were carried out by means of express-testing in accordance with the methods established by regulatory acts.

During the internship the students traveled 129 km along the Volga River. At a separate section of the river and riparian zone (lasting 10 km), water and soil samples were collected and subsequently analyzed for chemical and physical properties (Table 1).

Coordinates of surface water sampling (Figure 1):

1. 51.966880, 47.212075
2. 51.961827, 47.200490
3. 51.956339, 47.188946
4. 51.950028, 47.178389
5. 51.943712, 47.167355
6. 51.938089, 47.157012
7. 51.932508, 47.145334
8. 51.927096, 47.133533
9. 51.922267, 47.121602
10. 51.916363, 47.110725

Table 1.

Results of chemical analysis of the surface water layer:

Sample no.	Chloride ions (mg/dm ) <sup>3</sup>	Sulfates (mg/dm ) <sup>3</sup>	Iron (mg/dm ) <sup>3</sup>
1	1-10	10-100	1-2
2	1-10	10-100	< 0,05
3	1-10	10-100	< 0,05
4	10-50	10-100	< 0,05
5	10-50	10-100	< 0,05
6	10-50	10-100	< 0,05
7	10-50	10-100	< 0,05
8	10-50	10-100	< 0,05
9	10-50	10-100	< 0,05
10	10-50	10-100	< 0,05

The analysis on the level of radioactive contamination showed compliance of the radioactive background of the river surface water with the standardized permissible indicators.

Conclusion: no exceedances of MPC on analyzed ions were found, radioactive background and salt content does not exceed the established norms, therefore, the water is suitable for bathing and use in domestic needs.

Results of soil samples (4 samples):

Humus content in the soil (by Zakharov color triangle):

1 sample: black (humus 7-10%, humus fertile),

Sample 2: dark gray (4-7%, srendehumus medium fertile),

Sample 3: gray (2-4%, low-humus medium fertile),

Sample 4: light gray (1-2%, low humus, low fertility).

Determination of granulometric composition of soil by "wet" method:

1 sample: light loam (cord disintegrates when rolled),

Sample 2: heavy loam (cord solid, forming ring with cracks),

3 sample: clay (cord solid, ring solid),

4 sample: clay (cord solid, ring solid).

The results of rapid testing allow only initial conclusions to be drawn about the quality of water and land resources in the riparian zone of the river. Consequently, the question about the scale of pollution of the river remains open and raises the task to conduct more accurate laboratory studies.

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## **НАУЧНО-ИССЛЕДОВАТЕЛЬСКАЯ РАБОТА ЭКСПЕДИЦИОННОЙ ФЛОТИЛИИ ПЛАВУЧИХ УНИВЕРСИТЕТОВ» В ОБЛАСТИ ИЗУЧЕНИЯ ЭКОЛОГО-ХИМИЧЕСКОГО СОСТАВА ПОВЕРХНОСТНЫХ ВОД И ПОЧВЫ ПРАВОГО БЕРЕГА РЕКИ ВОЛГИ В РОК-ОНАХ ВОЛЬСКА САРАТОВСКОЙ ОБЛАСТИ (С. РЫБНОЕ - БЕЛОГРОДНЯНСКИЙ ТРАКТ- СЕМЕНОВСКИЙ ТРАКТ)**

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**Аннотация:** В июле 2021 года студенты кафедры «Природопользование и охрана окружающей среды» прошли летнюю стажировку в составе экспедиции «Флотилия плавучих университетов», задачей которой было исследование качественных эколого-химических показателей поверхностных вод и почв. прибрежной территории реки Волги.

**Ключевые слова:** экологический мониторинг, экспедиция, экологическая безопасность, флотилия плавучих университетов.

## A STUDY OF THE INFLUENCE OF MORPHOLOGICAL AND PHYSICO-CHEMICAL PROPERTIES OF THE SOIL OF THE VOLSKY CHALK QUARRY OF THE KRASNY OKTYABR PLANT: ON THE STATE OF ENVIRONMENTAL SAFETY OF THE SARATOV REGION

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### Abstract

As a result of the shutdown of the Saratov cement factories, chalk mining in some quarries was stopped. The Volsky chalk quarry ceased functioning in 2003. In the future, its reclamation was carried out. Within the framework of the Flotilla of Floating Universities project, which included the V.I. Vernadsky Floating Detachment, soil samples were taken from the quarry to analyze the samples taken for chemical composition, morphological and physical properties. The data obtained allowed us to draw conclusions about the level of self-healing of the soil of the Volsky quarry.

**Keywords:** chalk quarry, ecological and morphological analysis, ecological safety, envelope method, Flotilla of floating universities, Mansell scale, soils.

### Introduction

In geological terms, the Volsky District lands are of special interest in the whole Volga region. Massive layers of white chalk occur in many geological outcrops of natural and anthropogenic character. One of the anthropogenic outcrops is the Volsk chalk quarry of the plant "Red October", located on the southern outskirts of the town of Volsk, 7 km from the village of Rybnoye, Saratov region. According to the age of the rocks composing it belong to the Cretaceous period and are 65-100 million years old. This quarry is an example of negative anthropogenic impact on the relief structure of the surrounding area. Following the closure of the Krasny Ocityabr cement plant in 2003, mining of Cretaceous fossils in the quarry was discontinued. The quarry was subsequently rehabilitated in 2009.

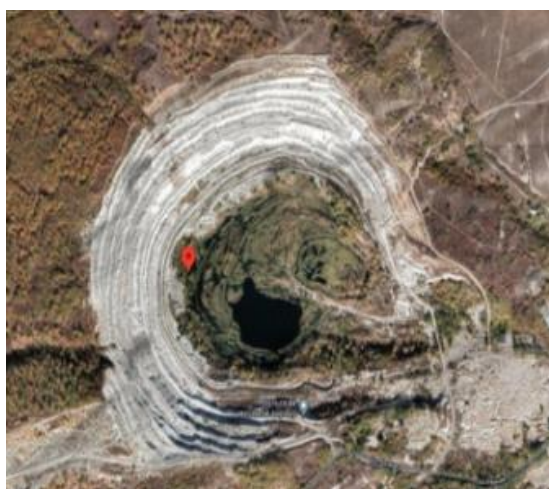
During reclamation of worked-out quarries there is always a process of soil formation as a consequence of anthropogenic impact. Soil formation in anthropogenic quarries is considered to be a "side" process that accompanies self-overgrowth of rocks [1]. Currently, a lake is located at the bottom of the quarry. This reservoir appeared as a result of the cessation of groundwater pumping with the stoppage of quarry development. Along the shores of the non-man-made lake in the anthropogenic quarry, calciphilic flora specific for Cretaceous soils began to appear, some representatives of which are listed in the Red Book. One of the scientific and educational tasks of the V.I. Vernadsky Floating University, which is part of the Floating University Flotilla project, was to study the geological, morphological and physico-chemical properties of the quarry soil. The obtained data will make it

possible to draw conclusions about the level of the conducted process of reclamation of the chalk mine.

### **Methodology of experiments**

Sampling point coordinates: 52.019709, 47.325073. The location of the works is presented in Figure 1.

Members of the research expedition of the "Vernadsky Floating University" as part of the "Floating University Flotilla" took soil samples by the envelope method (Fig. 2) according to the established methodology [2, 3, 4] to conduct morphological and physicochemical studies of the samples. Visual determination and color selection of the studied soil samples were carried out using the Mansell color scale and Zakharov color triangle (Fig. 2).



*Figure 1 -View of the inner dump of the Volsky open pit "Krasnaya Zvezda" and the place of soil sampling.*

Taken soil samples from the Volsky chalk quarry of the plant "Krasny Oktyabr", Saratov region were sent to the Federal State Budgetary Educational Institution of Higher Professional Education "Tambov State Technical University" for further study of ecological-morphological and chemical-physical properties of soil in laboratory conditions. Determination of morphological and physical and chemical properties of soil was carried out both in the laboratory and in the field in accordance with the established methods [2, 3, 4] with the use of express-testers and mobile minilaboratory.

Rapid analysis instruments (Fig. 3):

1. RADEX RD1505+ dosimeter;
2. TDS-3 salt meter;
3. PASCO wireless digital pH sensor with PASCO SPARKvue software;  
PASCO wireless digital temperature sensor with PASCO SPARKvue software.

Chemical analytical studies were aimed at determining the presence of ions by qualitative determination of:  $\text{Cl}^-$ ,  $\text{SO}_4^{2-}$ ,  $\text{NO}_3^-$ ,  $\text{Ca}^{2+}$ ,  $\text{Mg}^{2+}$ ,  $\text{Pb}^{2+}$  (Fig. 3).





Figure 2 - Soil sampling by the envelope method for geological and morphological chemical-analytical studies of the soil of the Volsky chalk quarry of the plant "Krasny Oktyabr", Saratov region

### Results and analysis of the research

As a result of the analysis of the combined soil sample, it was possible to obtain the following results on geological-morphological and physico-chemical properties, which are presented in Tables 1, 2, 3.

Table 1. Dependence of soil fertility on soil color

Sampling location	Color	Humus content, %	Category
Chalk quarry	Gray	2 - 4	Low-humus, medium fertility

The combined soil sample has dense lumpy structure, saturated gray color. By color content the percentage amount of humus and character of soil fertility were established (Table 1). The selected soil samples have some inclusions representing calcium neoplasms, the proof of this is the presence of active foaming when soil is treated with 10% HCl solution.

Table 2. Determination of granulometric composition of soil by "wet" method

Sampling location	Particle size distribution	Description
Chalk quarry	heavy loam	cord solid, forming ring with cracks

The presence of such inclusions in the studied soil can be explained by the presence of chalky minerals, leading to coring of the quarry soil. The results of determining the granulometric composition of the soil by the "wet" method are presented in Table 2.

The analysis of soil physicochemical properties allowed us to draw the following conclusions:

1. the pH is 8.5 units;
2. Radiation background - 0.12  $\mu\text{Sv}$  with the permissible value of 0.3  $\mu\text{Sv}$  [4];
3. The content of ions in aqueous extract  $\text{Cl}^-$ ,  $\text{SO}_4^{2-}$ ,  $\text{NO}_3^-$ ,  $\text{Ca}^{2+}$ ,  $\text{Mg}^{2+}$ ,  $\text{Pb}^{2+}$  at qualitative determination in the studied samples are presented in Table 3;

4. Values of total salt content in water extract are presented in Table 3.

Table 3. Qualitative composition of the aqueous extract

Location of soil sampling	Cl <sup>-</sup> , mg/dm <sup>3</sup>	SO <sub>4</sub> <sup>2-</sup> , mg/dm <sup>3</sup>	NO <sub>3</sub> <sup>-</sup> , mg/dm <sup>3</sup>	Ca <sup>2+</sup> , mg/dm <sup>3</sup>	Mg <sup>2+</sup> , mg/dm <sup>3</sup>	Pb <sup>2+</sup> , mg/dm <sup>3</sup>	Total salt content, ppm
Chalk quarry	1-10	<100	1,0	+	-	+	180

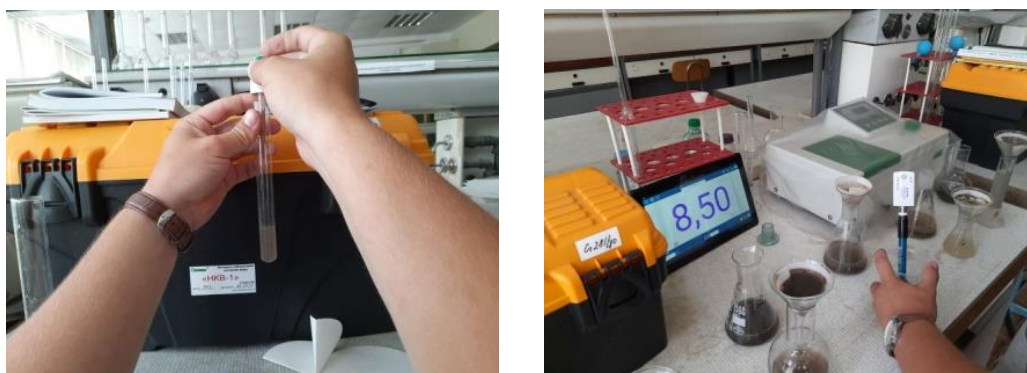


Figure 3 - Ecological-morphological and chemical-analytical studies of soil of Volsky chalk quarry of the plant "Red October", Saratov region.

The conducted ecological and morphological analysis of the soil of Volsky chalk quarry of the plant "Red October" of the Saratov region allows us to draw the following conclusions:

- 1) soil has an alkaline environment;
- 2) radiation background level corresponds to permissible values;
- 3) the content of defined ions in aqueous extract of soil does not exceed the permissible values [5];
- 4) fertility of the studied soil has average indicators.

The data obtained during the work of the research expedition of the "V.I. Vernadsky Floating University" as part of the "Flotilla of Floating Universities" can become the basis for the development of ways to improve the level of environmental safety of the Saratov region and rational nature management.

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## **ФИЗИКО-ХИМИЧЕСКИЕ СВОЙСТВА ПОЧВЫ ВОЛЬСКОГО МЕЛОВОГО КАРЬЕРА ЗАВОДА «КРАСНЫЙ ОКТЯБРЬ»: О СОСТОЯНИИ ЭКОЛОГИЧЕСКОЙ БЕЗОПАСНОСТИ САРАТОВСКОЙ ОБЛАСТИ**

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**Аннотация:** В результате остановки Саратовских цементных заводов была прекращена добыча мела на некоторых карьерах. Вольский меловой карьер прекратил работу в 2003 году. В дальнейшем проводилась его рекультивация. В рамках проекта «Флотилия плавучих университетов», в состав которого входил корабль В.И. Вернадского из карьера были взяты пробы грунта для анализа взятых проб на химический состав, морфологические и физические свойства. Полученные данные позволили сделать выводы об уровне самовосстановления почвы Вольского карьера.

**Ключевые слова:** меловой карьер, эколого-морфологический анализ, экологическая безопасность, метод конвертов, флотилия плавучих университетов, шкала Мэнселла, почвы.

## A MECHANISM OF SULFURATION OF BENZENE WITH SULFURILLIUM CATION

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### Abstract

Benzenesulfonic acid (C<sub>6</sub>H<sub>5</sub>SO<sub>3</sub>H) is an important product of the chemical industry and is used as a surfactant for the high-quality removal of contaminants, a catalyst in condensation and polymerization reactions, and in the production of plant protection products. The most common method for producing benzenesulfonic acid is the sulfonation reaction of benzene (C<sub>6</sub>H<sub>6</sub>). Several alternative mechanisms with different sulfonating species (H<sub>3</sub>SO<sub>4</sub><sup>+</sup>, SO<sub>3</sub>, H<sub>2</sub>S<sub>2</sub>O<sub>7</sub>) have been proposed for this process. According to the literature data, the most active sulfonating particle in oleum is the sulfurylium cation (HSO<sub>3</sub><sup>+</sup>), so the study of the mechanism of benzene sulfonation by oleum, assuming a true sulfonating agent of the sulfurylium cation particle, is an urgent task.

**Keywords:** sulfonation, benzene, sulfurylium cation, oleum.

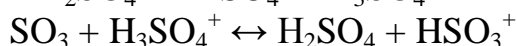
### Introduction

Sulfonation is the process of introducing a sulfonic group –SO<sub>3</sub>H into a molecule of an organic compound. In this case, the reaction products are sulfonic acids, usually called sulfonic acids.

For sulfonation processes occurring in concentrated sulfuric acid and oleum, true sulfonating agents can be sulfuric acid cation (H<sub>3</sub>SO<sub>4</sub><sup>+</sup>), mono-, di-, oxides of sulfur dioxide (SO<sub>3</sub>, S<sub>2</sub>O<sub>6</sub>, S<sub>3</sub>O<sub>9</sub>), sulfurylium cation (HSO<sub>3</sub><sup>+</sup>), oleum (H<sub>2</sub>S<sub>2</sub>O<sub>7</sub>). One of the most reactive sulfonating agents is the sulfurylium cation, which is formed in dilute solutions of oleum.

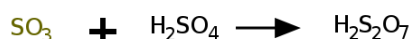
### Theoretical background

The sulfurylium cation in oleum is formed according to the mechanism [1-2]:



Based on the literature data, the most likely occurrence of the sulfonation process with the HSO<sub>3</sub><sup>+</sup> cation can be represented by the following mechanism.

1. Formation of pyrosulfuric acid by the reaction between sulfur trioxide and sulfuric acid:



2. Autoprotolysis of pyrosulfuric acid with the formation of anion and cation of pyrosulfuric acid:

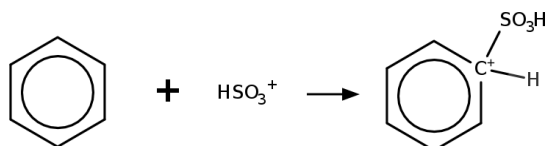


3. Dissociation of the pyrosulfuric acid cation into sulfurylium cation and sulfuric acid:

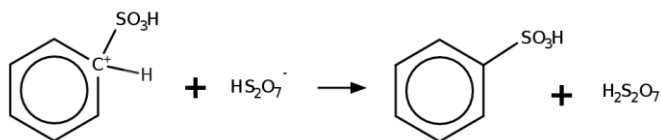


4. The reaction of benzene with sulfurylium cation, with the formation of

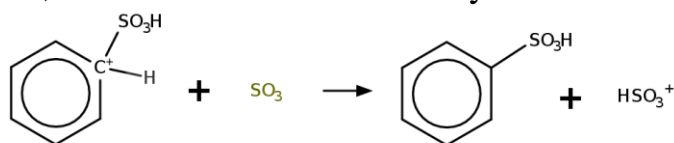
benzenesulfonic acid carbocation:



5. Ionic recombination of benzenesulfonic acid carbocation with pyrosulfuric acid anion:



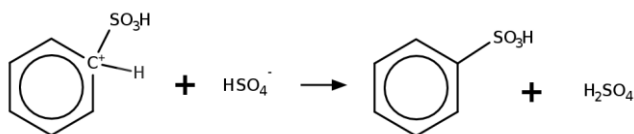
6. The reaction of the interaction of benzenesulfonic acid carbocation with sulfur trioxide, with the reduction of sulfurylium cation:



7. Autoprotolysis of sulfuric acid with the formation of anion and cation of sulfuric acid



8. Ionic recombination of benzenesulfonic acid carbocation with sulfuric acid anion:



### Discussion

Based on the above reactions, kinetic equations were compiled and the observed reaction rate was calculated depending on the initial concentration of  $\text{SO}_3$ , shown in Fig. 1.

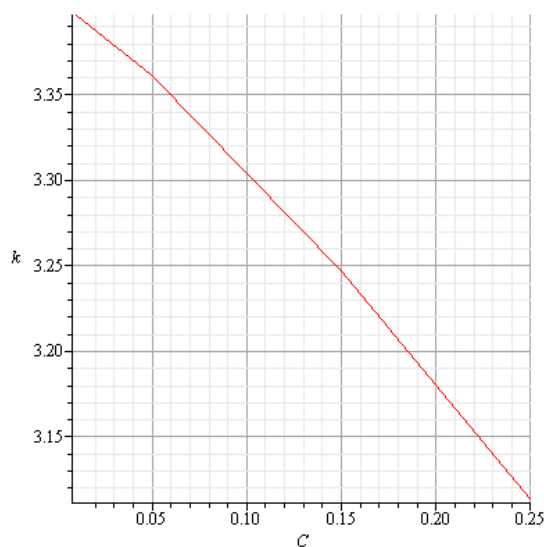


Figure 1 – Dependence of the observed rate constant for the formation of benzenesulfonic acid on the concentration of sulfur trioxide in oleum.

The concentration range of sulfur trioxide is 1÷25 mole%.

### Conclusion

Based on the results, it was found that the most likely mechanism for the sulfonation of benzene with the sulfurylium cation is as follows:

- interaction of sulfur trioxide with sulfuric acid to form pyrosulfuric acid;
- dissociation of pyrosulfuric acid into anion and cation;
- dissociation of the pyrosulfuric acid cation into a sulfurylium cation and a sulfuric acid molecule;
- interaction of benzene with sulfurylium cation to form benzenesulfonic acid cation;
- production of benzenesulfonic acid by ionic recombination of the benzenesulfonic acid cation and the pyrosulfuric acid anion. The limiting stage is the formation of benzenesulfonic acid, the rate constant at  $T = 333K(60^{\circ}C)$  is equal to  $9.8 \cdot 10^{-4}$ .

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## МЕХАНИЗМ СУЛЬФИРОВАНИЯ БЕНЗОЛА СУЛЬФУРИЛЛИЙ-КАТИОНОМ

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**Аннотация:** Бензолсульфокислота ( $C_6H_5SO_3H$ ) является важным продуктом химической промышленности и применяется как ПАВ для качественного устранения загрязнений, катализатор в реакциях конденсации и полимеризации, в производстве средств защиты растений. Наиболее распространенным методом получения бензолсульфокислоты является реакция сульфирования бензола ( $C_6H_6$ ). Для данного процесса предложено несколько альтернативных механизмов с разными сульфорирующими частицами ( $H_2SO_4^+$ ,  $SO_3$ ,  $H_2S_2O_7$ ). По литературным данным в олеуме самой активной сульфорирующей частицей является сульфурилий-катион ( $HSO_3^+$ ), таким образом, исследование механизма сульфирования бензола олеумом при предположении истинного сульфорирующего агента частицы сульфурилий-катиона является актуальной задачей.

**Ключевые слова:** сульфирование, бензол, сульфурилий катион, олеум.

## THE DEVELOPMENT OF THE FORMULATION OF THE LOW-ALCOHOLIC FRUIT HONEY DRINK

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### **Abstract**

The components (ingredients) of the formulation of a low-alcoholic drink (melomel) are considered. The tasks of studying their influence on the semi-finished product - wort and finished product are defined.

**Keywords:** fermentation, low-alcoholic drink, mead, melomel, pumpkin puree, yeasts.

Melomel is a low-alcoholic fermentation drink, prepared on the basis of honey, is a kind of mead. It is necessary to add berries, fruits, vegetables – in fresh form or in the form of juice, puree, dried fruits. The fruits in the mead have a characteristic taste and go well with the sweet and tannic balance of the mead. Various spices can also be added. The strength of the drink varies from 2 to 18 degrees.

At present, the demand for low-alcoholic beverages has increased in Russia, as much attention is paid to reducing the consumption of strong alcoholic beverages in favor of increasing the consumption of beverages with low ethyl alcohol content. There is also an increase in demand for niche alcoholic beverages, which have a special concept and a unique taste. Melomel could be one of those alternative options that would attract the attention of consumers to discover new and unusual types of alcohol.

The analysis of the market for low-alcohol beverages carried out by Alto Consulting Group in Russia shows these data: the main consumers of low-alcoholic products are young people aged 18 to 25 years, and if we take the data by gender, these products are consumed by women. These categories of consumers are more exposed to advertising. In comparison with strong alcohol for such products, the prices are lower [1].

The use of natural raw materials plays an important role in the development of the technology of low-alcoholic honey drinks, partly compensating for the lack of essential nutrients in the human body.

Due to the introduction of honey, various fruits and the provision of natural fermentation, the nutritional value increases, the content of essential substances of natural origin increases, the organoleptic indicators of the drink are improved.

The flavor of mead can vary depending on the source of the honey, additives, yeast used, and aging process. Mead, made from fruit juices, spices and herbs, can have different terminology: Cyser is prepared with the addition of apple juice or fresh apples. Morat is drink with mulberries. Black Mead is melomel with black currants. Red Mead is melomel with red currants. Rudamel is melomel with raspberries. Pymment is prepared using grape juice or ripe grapes. Omphacomel – grapes are also

added, only unripe ones. Bochetomel is melomel with blackberries, tayberries, elderberries are added, the honey itself is caramelized. Rhodomel is melomel with rose petals and rose hips. Bilbemel – the drink contains blueberries. Melomels are also made with cherries, raisins, various spices - cinnamon, cloves, sage, etc. [2].

The main role of honey in the production of mead is the stimulation of fermentation activity, as well as the formation of quality, taste and the aroma of the finished drink. For the manufacture of mead, it is recommended to use natural honey, fragrant varieties.

There are two main ways to prepare honey wort: hot and cold. In the hot method, honey is boiled, which leads to a loss of aroma and useful properties. The cold method is close to winemaking. In this case, the honey is dissolved by stirring in cold water or heated above 40 °C. Thus, the aroma and the various biologically active compounds of honey are preserved as far as possible. This method is well suited for light varieties of honey, which have a delicate aroma and harmonious taste [3].

For the preparation of mead, various types of *Saccharomyces* yeast are used: bakery, wine, beer, as well as special yeasts for mead. However, bakery yeast can give the drink a yeast smell and taste, so they are used less.

An interesting experiment can be used to add pumpkin puree to the mead formulation to acquire new organoleptic properties and increase the nutritional value of the drink. Pumpkin with honey is a regional raw material in the Tambov region.

Pumpkin is a source of antioxidant and beneficial biological properties in food production. Pumpkin contains vitamins such as: C, B1, B2, B6, E, carotene, phosphorus, potassium salt, calcium, zinc, iron, copper, etc., rich in folic acid, important for hematopoiesis; pantothenic acid (vitamin B3), the lack of which leads to metabolic disorders. The pulp's pumpkin contains various antioxidants that bring great benefits to the human body: they break down free radicals and prevent them from damaging healthy cells. This vegetable contains several antioxidant substances:  $\alpha$ -carotene;  $\beta$ -carotene;  $\beta$ -cryptoxanthin. These substances have a protective effect for the body. For example,  $\beta$ -carotene is converted into vitamin A. It strengthens the immune defenses and helps fight infections. If the diet contains significant amounts of carotenoids, the risk of developing certain types of cancer, in particular lung cancer and cardiovascular diseases, is reduced. Pumpkin pulp contains vitamin C, which increases the production of white blood cells and increases the efficiency of immune cells, strengthens immunity support with a combination of vitamin E, iron and folic acid. These substances, working in tandem, become more effective [4].

The main indicator of the suitability of the pumpkin for processing is the solids content. The higher it is, the more profitable it is for production since sugar consumption and production costs are reduced. Based on this, the goal of the upcoming work is to develop a technology for fruit honey drink using regional raw materials to increase the nutritional value.

In the future, it is planned to experimentally choose the ratio of pumpkin puree, honey and yeast. Since the honey wort with puree is high in density, and the speed and quality of the yeast depend on the solids, first of all it is necessary to determine the initial concentration of solids, which ensures a high fermentation rate. In addition, it is necessary to determine the need to use fertilization for yeast and acidification of

the wort. Evaluate the advisability of using pumpkin puree is planned in relation to the content of carotenoids in the wort before fermentation and in the final drink, as well as by the organoleptic characteristics of the finished drink.

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## РАЗРАБОТКА ТЕХНОЛОГИИ СЛАБОАЛКОГОЛЬНОГО ПЛОДОВОГО МЕДОВОГО НАПИТКА

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**Аннотация:** Рассмотрены компоненты (ингредиенты) рецептуры слабоалкогольного напитка - меломель и определены задачи исследования их влияния на полуфабрикат – сусло и готовый продукт.

**Ключевые слова:** брожение, дрожжи, медовуха, меломель, слабоалкогольные напитки, тыквенное пюре.

## MANAGEMENT OF THE TECHNOLOGICAL PROCESS OF NAPHTHALENE SULFONATION

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### **Abstract**

This article discusses the process of sulfonation of naphthalene. The analysis of the technological process and the existing control system is carried out. The structure of the automated process control system being developed and a set of technical means are selected.

**Keywords:** automatic control system (ACS), programmable logic controller (PLC), automated operator workstation (AOW), technological process, process of sulfonation of naphthalene, sulfonation of naphthalene.

### **Introduction**

The initial cost and quality of the finished product always depends on the technology of execution and management of the most complex processes. The sulfonation stage is one of the most important in the production of concrete additives, since at this stage the volume of the resulting product is formed. Maintaining a set temperature regime ensures the quality of the resulting product, since overheating of the product leads to its decomposition, and low temperature leads to a chemical reaction proceeding according to an unfavorable scheme [1]. This process is periodic. A simplified diagram of the reactor is shown in the Figure 1.

### **Materials**

The controller – OVEN PLC 110-60 is used as a PLC, an automated operator's workplace is built on the basis of the KRUG 2000 SCADA system.

### **Results and Discussion**

As a result of this work to improve the existing technological process, we have achieved a reduction in emergency situations, an increase in the quality of the final product, and a reduction in energy costs for production.

In the production of sulfonated naphthalene, the maintenance of outdated equipment takes up a large share of the costs. The exact observance of the required consumption will prevent overspending of resources. Manual control also contributes to material overruns. The development of a modern automated control system will improve working conditions and safety of workers and reduce the number of emergencies [2].

The information exchange between the PLC and the AOW is carried out over an Ethernet network.



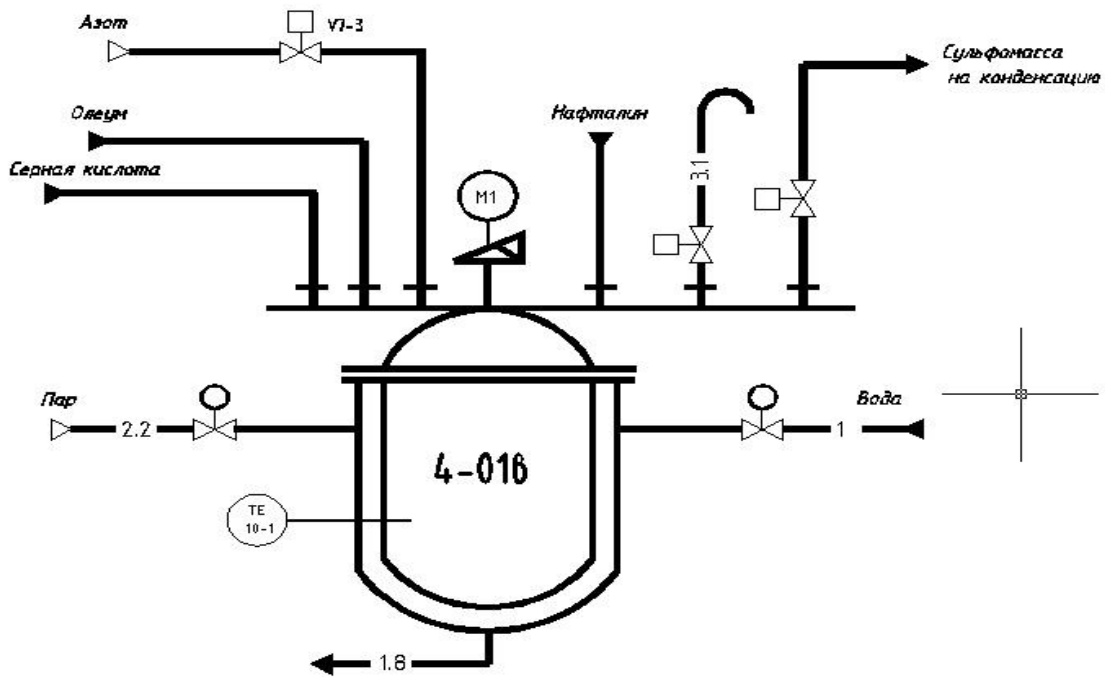


Figure 1 - Technological process

When choosing a process control system, it is necessary to take into account the reliability and efficiency of the automated facility, as well as the relatively low cost of the system. When building an automated control system, a hierarchical information structure (Figure 2) is used with the use of computing facilities of different capacities at different levels. A two-level structure has been chosen for the development of this automated process control system.

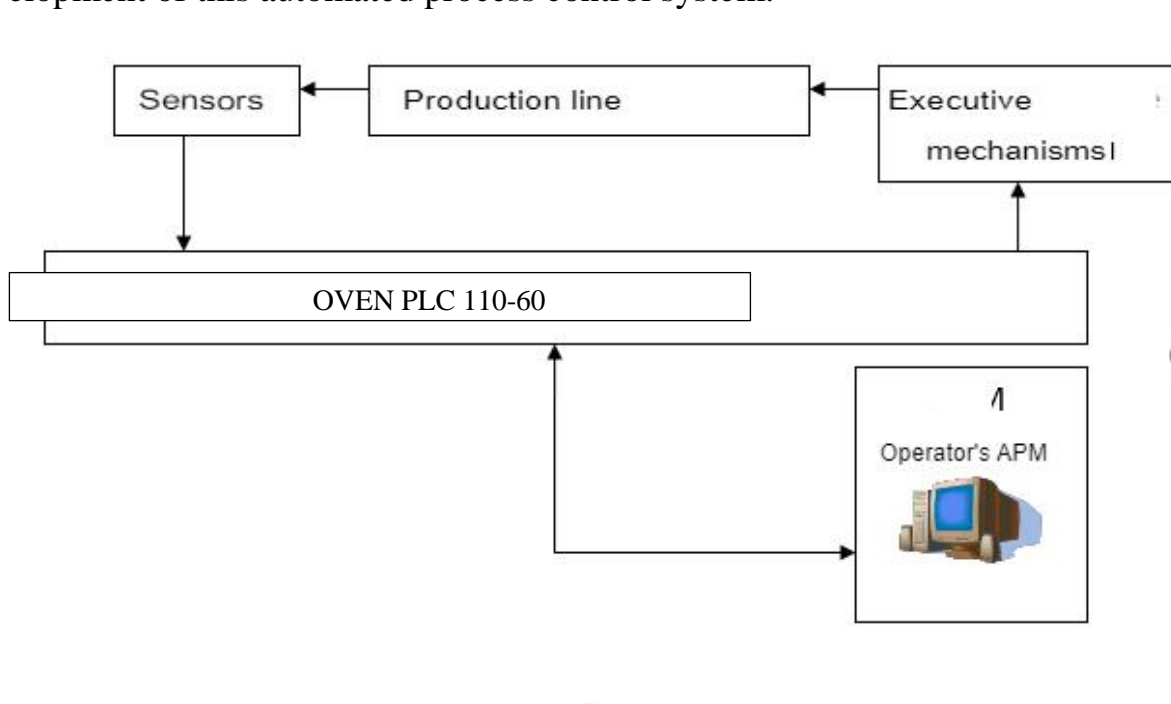


Figure 2- Hierarchical information structure

## Conclusion

In the scientific article, we examined the process of sulfonation of naphthalene, analyzed the technological process, and selected a technical control tool. Based on the choice of technical means, we designed a control system, developed an automated operator workstation.

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## УПРАВЛЕНИЕ ТЕХНОЛОГИЧЕСКИМ ПРОЦЕССОМ ПРОИЗВОДСТВА СУЛЬФИРОВАНИЯ НАФТАЛИНА

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**Аннотация:** Рассмотрен процесс сульфирования нафталина. Проведен анализ технологического процесса и существующей системы управления. Выбрана структура разрабатываемой АСУ ТП и комплекс технических средств.

**Ключевые слова:** автоматизированная система управления (АСУ), программируемый логический контроллер (ПЛК), автоматизированное рабочее место оператора (АРМ), технологический процесс, процесс сульфирования нафталина.

## DEVELOPMENT OF A SCIENTIFICALLY BASED FORMULATION OF SEMI-SOLID LUBRICANT FOR ROPES AND CHAINS

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### Abstract

The paper is devoted to the development of a scientifically based formulation and the method of obtaining semi-solid lubricants with improved performance based on used engine oils. The developed technology solves the environmental problem of waste disposal and improves the economic aspect of lubricant production through the reuse of waste materials.

**Keywords:** semi-solid lubricants, calcium soaps, thickener, wear spot, used oil.

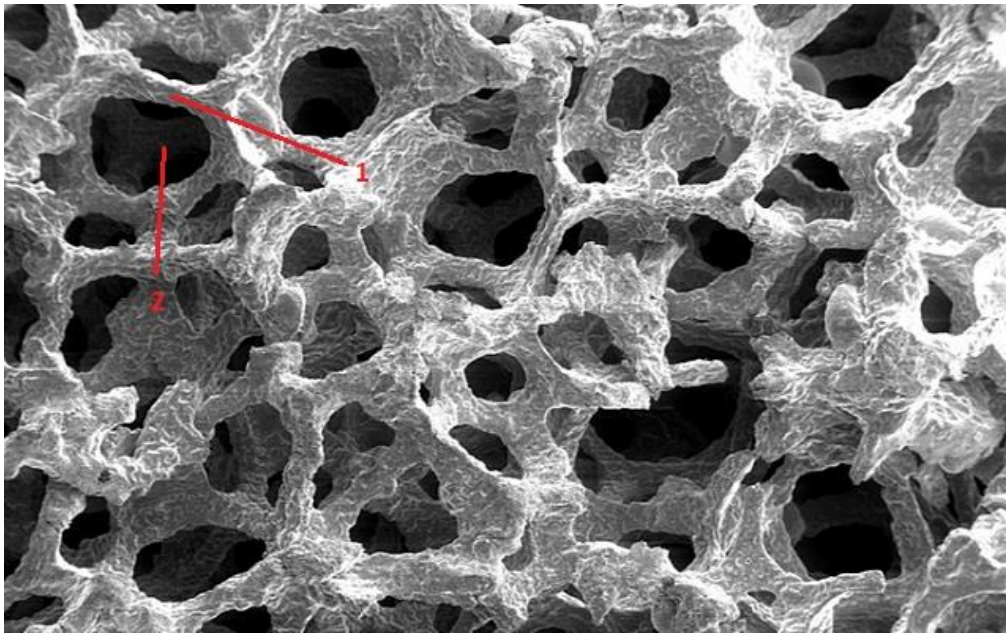
### Introduction

Currently, all production sectors of the economy are increasing the share of mechanized labor in order to meet the growing needs of society. It is natural that an increase in the fleet of machines and mechanisms is accompanied by an increase in the consumption of lubricants and the accumulation of an increasing amount of their waste (waste). There are quite a lot of classifications of equipment types. The subject of our research from this set will be devices whose nodes contain metal ropes and chains.

To increase the service life of chains and ropes and to reduce friction, they must be lubricated. At the moment, grease lubricants, which are susceptible to dust adhesion, have become widespread in such mechanisms. Adhering dust acts as an abrasive that wears down the rope or chain. As a result, the service life of chain and rope transmissions is reduced.

To solve the problem of dust adhesion, it is proposed to increase the thickener content in calcium grease (solidol). A thicker lubricant will not have such disadvantages due to its harder consistency (higher soap content), and the insolubility of calcium soaps in water increases the protection of the mechanism from moisture. At the same time, lubricating properties remain important parameters. As a result, the task comes down to finding the optimum consistency and lubricity.

Semi-solid lubricant – a dispersed system consisting of 2 main components of base oil and a thickener evenly distributed (dispersed) in it. Soap is usually used as a thickener as it is the cheapest and most accessible component. In addition to soaps, thickeners can be: silica gels, clay thickeners (bentonites), soot, polymers, for example, the most modern thickener is polyurea. The structure of a semi-solid lubricant is shown in Fig. 1.

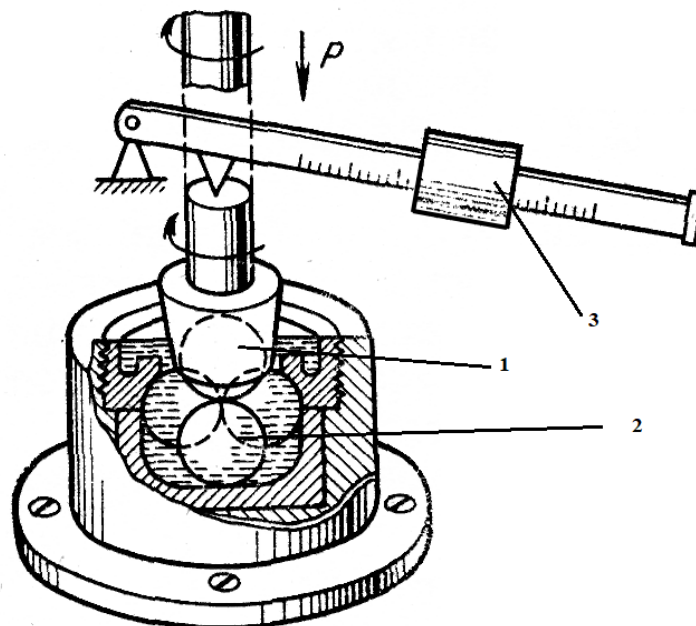


*Fig. 1. Structure of semi-solid lubricant.  
1 - thickener, 2 - base oil.*

In the lubricant being developed, the base oil is used motor oil, and the thickener is calcium soap.

Reducing friction and wear of lubricated parts occurs by replacing friction between two metal surfaces with friction between thickener threads, which have a fibrous structure.

A quantitative measure of friction and wear is the wear spot diameter, which is measured by testing a sample on a friction machine. A simple diagram of a friction machine is shown in Fig. 2.



*Fig. 2. Friction machine.  
1 - moving ball, 2 - stationary ball, 3 - load.*

As a result of rotation of the movable ball 1 under load, a friction spot appears on the stationary balls 2, which is measured by a microscope. The smaller the spot

diameter is, the less wear and friction is.

In the presented study, to measure the wear spot experimental samples were selected with different contents of used oil in the reaction mixture: 7.87%, 11.36 %, 17.61 %, and 24.27 %.

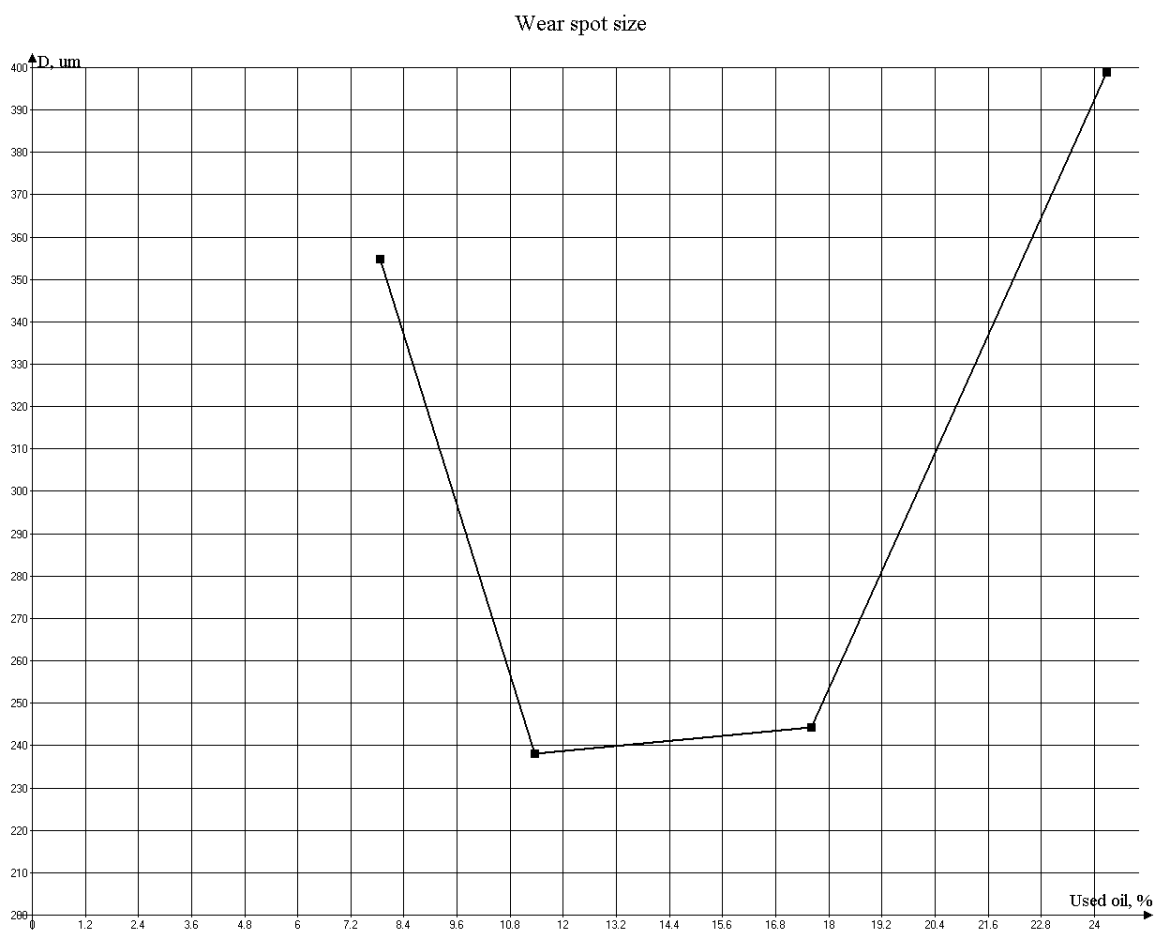


Fig. 3. Dependence of wear scar diameter on used oil content.

## Conclusion

All lubricants have a satisfactory solid consistency, which ensures low adhesion of dust. As can be seen from the graph, the dependence has an extremum and the best lubricants (tribological) properties shows a sample with a used oil content of 11.36%. This is due to the fact that with higher oil content, the strength of the thickener framework decreases, and with smaller quantities, self-destruction begins due to the phenomenon of “synerisis”.

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## РАЗРАБОТКА НАУЧНО-ОБОСНОВАННОЙ РЕЦЕПТУРЫ ПОЛУТВЕРДОЙ СМАЗКИ ДЛЯ КАНАТОВ И ЦЕПЕЙ

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**Аннотация:** Работа посвящена разработке научно обоснованной рецептуры и методу получения полутвердых смазочных материалов с улучшенными характеристиками на основе отработанных моторных масел. Разработанная технология решает экологическую проблему утилизации отходов и улучшает экономический аспект производства смазочных материалов за счет повторного использования отработанных материалов.

**Ключевые слова:** полутвердые смазки, кальциевые мыла, загуститель, пятно износа, отработанное масло.

## MATHEMATICAL MODELING OF THE PROPANE PYROLYSIS PROCESS

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### Abstract

The article discusses the mathematical modeling of the pyrolysis reaction of propane with the formation of propene and hydrogen.. The value of the reaction energy barrier and the reaction rate constants at different temperatures are determined.

**Keywords:** propane, propene, hydrogen, pyrolysis.

### Introduction

Pyrolysis is one of the main processes for the production of lower olefins – ethylene, propylene and other products. In industrial chemistry, pyrolysis is the thermal decomposition of marginal hydrocarbons (alkanes), accompanied by various and numerous parallel processes. That is why the composition of pyrolysis products is very It is diverse and can vary greatly depending on the type of feedstock and the technological conditions of the precessing. The key chemical reaction in the pyrolysis process is the splitting of long hydrocarbon chains into shorter ones, accompanied by dehydrogenation. Dehydrogenation is the removal of hydrogen molecules to form double bonds. Many chemical reactions in the petrochemical industry are reversible. In order to increase the yield of the required product within the framework of a chemical reaction, one must always keep in mind the concept of chemical equilibrium. Pyrolysis takes place at temperatures of 700-900 ° C and pressure close to atmospheric. The reaction takes place in tubular furnaces consisting of two compartments. In the first, the raw material is mixed with steam and heated to a temperature of about 600 ° C, after which it is fed into coil pipes placed in the combustion chamber, where the burning fuel creates the necessary temperature. In general, dozens of types of chemical transformations are realized in the pyrolysis process, running in parallel or sequentially. Depending on the type of raw material, its consumption and yield of the most important products vary significantly.

### Materials and methods

The reaction mechanism between propane pyrolysis has been studied using density functional theory. The wB97x-D4 functional was used to optimize molecular geometry and thermodynamic corrections [4]. The basic aug-cc-pVTZ set has been added. All calculations were performed in the ORCA quantum chemical package [4]. The pushed elastic band (NEB) method was used to find the transition state.

### Results

As a result of the pyrolysis of propane, the reaction occurs with the formation of an activated complex, then through a transitional state – a post-reaction complex. At the end of the reaction path, the complex decays, propane and hydrogen are formed (see Fig. 1).

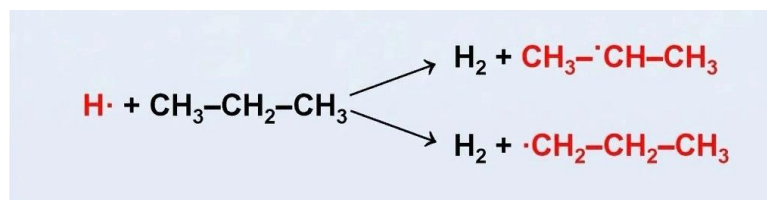


Figure 1 - The mechanism of propane pyrolysis

To understand the course of the reaction and the magnitude of the energy barrier, Gibbs energy change profiles were considered for infinitely distant reagents, pre-reaction, activated and post-reaction complexes, as well as for infinitely distant reaction products. Based on these data, a diagram of the Gibbs energy change was constructed (see Fig. 2).

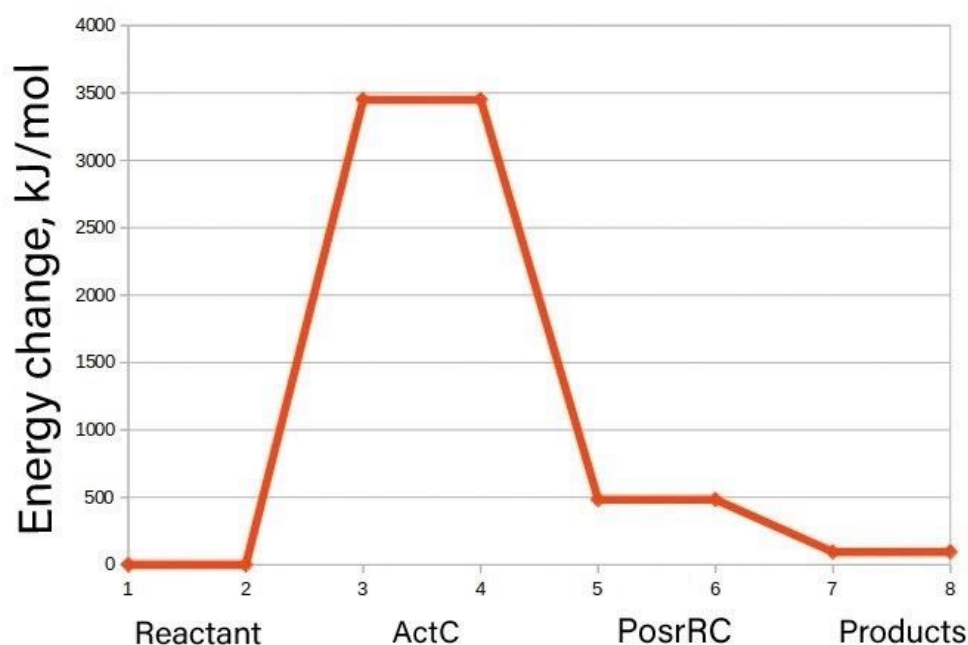


Figure 2 - Graph of electronic energy versus coordinates

It was noted that the post-reaction complex and products are stable, and the activated complex has a huge Gibbs energy. The energy barrier of the activated complex makes it difficult for this reaction to take place at room temperature, however, when using a catalyst, the barrier is completely overcome.

The reaction rate constant will be equal to:

$$k = \frac{\chi \times k_b \times T}{h} \times e^{\frac{-\Delta G^\ddagger}{R \times T}},$$

where  $k$  is reaction rate constant,  $s^{-1}$ ;  $T$  is the process temperature, K;  $k_b$  is Boltzmann constant, J/K;  $h$  is Planck's constant,  $J \times s$ ;  $\Delta G^\ddagger$  is Gibbs energy, J/mol;  $R$  is universal gas constant, J/(mol  $\times$  K);  $P_0$  is the atmosphere pressure,  $J/m^3$ .



The reaction rate constant will be calculated for a first order reaction as it is taken from the difference between the pre-reaction and activated complexes. These changes in the reaction rate constant are described in Table 1.

Table 1 – Dependence of the reaction rate constant on the process temperature

T, K	298	323	348	373
k, s <sup>-1</sup>	0.223	1.79	9.31	49.43

It can be concluded that the reaction rate constant depends on the temperature increase, since the Gibbs energy remains practically unchanged.

### Conclusion

Analyzing the above graph, we see that the activated complex has enormous energy, so it is necessary to carry out this process in the presence of a catalyst.

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## МАТЕМАТИЧЕСКОЕ МОДЕЛИРОВАНИЕ ПРОЦЕССА ПИРОЛИЗА ПРОПАНА

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**Аннотация:** Рассмотрено математическое моделирование реакции пиролиза пропана. Определено значение энергетического барьера реакции и констант скорости реакции при разных температурах.

**Ключевые слова:** пропан, пропен, водород, пиролиз.

## ÖKOLOGISCHE SICHERHEIT BEI DER VERWENDUNG VON BIODIESEL

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### Zusammenfassung

Es sind die wichtigsten Faktoren und Bereiche der Umweltsicherheit untersucht, die die Notwendigkeit für den Einsatz von Biodiesel in verschiedenen Branchen bewirken.

**Schlüsselwörter:** der Biodiesel, die Emissionen, die Gesundheit, die Ökologie, die Ölbrennstoffe, die Umwelt.

### Inhalt

Energie- und Ressourcenschonungsfragen in der modernen Welt gewinnen in verschiedenen Wirtschaftszweigen immer mehr an Interesse. Dies liegt vor allem an der begrenzten Nutzung traditioneller Energiequellen – Öl- und Gasfelder. Bei der Nutzung dieser Energie wird eine enorme Menge an Kohlendioxid freigesetzt, die sich negativ auf die Umwelt auswirkt.

Russlands Ölreserven schrumpfen von Jahr zu Jahr. Nach Angaben (April 2021) des Leiters der Bundesagentur für Bodennutzung (Rosnedra), Evgeny Kiselev, verfügt Russland über genügend Ölreserven für 58 Jahre, davon nur 19 Jahre an hochrentablen Ölreserven. Allerdings entwickeln sich die Technologien weiter, und es ist möglich, schwer zugängliche Felder zu erschließen, während gleichzeitig die Produktionskosten steigen.

Zu den gefragtesten Erdölprodukten gehört Dieselmotorenkraftstoff. Die Verwendung von Dieselmotoren im modernen Maschinenbau verbessert die Wirtschaftlichkeit, Leistung, Zuverlässigkeit und Langlebigkeit der verwendeten Technik, weshalb diese Art von Motoren in verschiedenen Branchen des Industrie- und Wirtschaftskomplexes weit verbreitet ist. Abbildung 1 zeigt den Verbrauch von Dieselmotorenkraftstoff in der Landwirtschaft, im Transportwesen (hauptsächlich Straßen- und Schienenverkehr) usw.

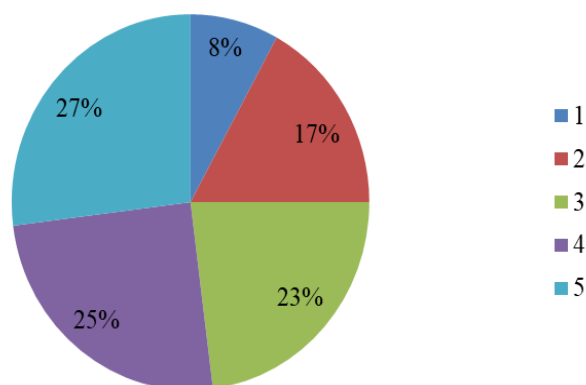


Abb. 1. – Hauptsektoren des Dieselmotorenkraftstoffverbrauchs

1 – Bauwesen; 2 – Sonstiges, darunter Verteidigungsministerium und

Ministerium für Notfälle; 3 – Wirtschaft; 4 – Landwirtschaft; 5 – Transportwesen.

Nach Angaben von Rosstat betrug der gewichtete Durchschnittspreis für Dieselkraftstoff an Tankstellen im Juni 2019 bei 45,7 Rubel, im Juni 2022 bei 51,74 und im Juni 2023 bei 55,17. Die Kosten für Dieselkraftstoff stiegen im Laufe des Jahres um 6,2 %. Die Kosten für Dieselkraftstoff steigen und Prognosen zufolge werden die Preise nur in den nächsten fünf Jahren steigen. Somit werden die Kosten für den Kauf von Kraft- und Schmierstoffe (FCM) zu einem bedeutenden Teil der Materialkosten.

Dieselmotoren emittieren Abgase, was sich negativ auf den Zustand der Umwelt auswirkt. Bei Abgasen von Dieselmotoren werden Schadstoffe wie Kohlenoxide (0,2%), Kohlenwasserstoffe (0,01%), Stickoxide (0,25%), Aldehyde (0,002%), Schwefeldioxid (0,03%), Ruß, Benz- $\alpha$ -pyren freigesetzt [1-3]. Jährlich werden bis zu 8 Milliarden Tonnen Kohlendioxid in die Erdatmosphäre freigesetzt. In den letzten zehn Jahren sind die Kohlendioxidemissionen um mehr als 20% gestiegen, und bis 2040 wird ein Anstieg auf 50% prognostiziert. 1997 wurde das Kyoto-Protokoll unterzeichnet, das sich auf die Begrenzung dieser Emissionen konzentriert.

Abgase haben einen negativen Einfluss auf die menschliche Gesundheit. Laut Statistik sind 8% der Sterblichkeit auf ungünstige Umweltbedingungen zurückzuführen, die aufgrund von Luftverschmutzung entstanden sind. Im Frühjahr 2021 treten neue Hygienevorschriften in Russland in Kraft. Die Grenzwerte für Schadstoffkonzentrationen in der Luft wie Benzol, 1,3-Butadien, schwefelhaltige Verbindungen, Tetrachlormethan wurden überarbeitet. Alle aufgeführten Substanzen beziehen sich auf Karzinogene, die das Leben und die Gesundheit einer Person nachteilig beeinflussen und tödliche Krankheiten verursachen. Tabelle 1 zeigt den erforderlichen Schadstoffgehalt in Emissionen bei Verwendung unterschiedlicher Kraftstoffklassen.

Tabelle 1 - Europäische Qualitätsstandards für Kraftstoff

Emissionen	Normen				
	Euro 1	Euro 2	Euro 3	Euro 4	Euro 5
Kohlenoxid, %	2,72	1	0,64	0,5	0,5
Kohlenwasserstoffe, %	0,97	0,9	0,56	0,3	0,23
Schwefel, mg/kg,		500	350	50	10
Stickoxide, %			0,5	0,25	0,18

Die Verwendung europäischer Standards bedeutet, dass der Anteil der schädlichen Emissionen reduziert wird. Die Verringerung des Schwefels führt jedoch zu einer verminderten Schmierfähigkeit des Kraftstoffs und zu einem Ausfall der Kraftstoffausrüstung des Motors.

Somit tragen alle aufgeführten Faktoren zur Entwicklung alternativer Energie bei. Eine vielversprechende Richtung ist die Verwendung von Erdölbrennstoffen in Verbindung mit Biodieselsbrennstoffen auf Basis von nachwachsenden Rohstoffen und Produktionsabfällen.

In modernen Technologien werden Biokraftstoffe aus Pflanzenölen durch eine Umesterungsreaktion gewonnen. Die Umesterungsreaktion erfordert keine komplexe Ausrüstung und hohe Temperaturen, und das Resultierende Ester-gemisch unterscheidet sich strukturell von den Kohlenwasserstoffen von Erdölbrennstoffen und weist bessere Umwelt- und Schmiereigenschaften auf.

Biodiesel ist ein Öl verschiedener Pflanzen (Soja, Rettich, Senf, Sonnenblume, Soße, Fuchs usw.) oder Methylester der Fettsäuren dieser Pflanzenöle, die als Additiv zur Herstellung eines Dieselmischbrennstoffs verwendet werden. Die physikalisch-chemischen Eigenschaften von Biodieselmischbrennstoffen auf Basis von Methylestern von Pflanzenölen sind den Eigenschaften von Erdöldiesel am nächsten.

Die Verwendung von Biodiesel führt zu einer Verringerung der schädlichen Abgasemissionen. Die hohe Zündtemperatur (über 120 °C) macht die Verwendung, den Transport und die Lagerung von Biodiesel im Vergleich zu Erdölbrennstoffen sicherer. Ein weiterer wichtiger Vorteil von Biodiesel ist die Fähigkeit zur biologischen Zersetzung. Biokraftstoffe aus pflanzlichen Rohstoffen können in bestehenden Motoren verwendet werden, verlängern die Lebensdauer von Motoren, haben eine hohe Cetanzahl [4]. Die Verwendung von Biokraftstoffen als Bioadditiv für Öldiesel wird seine ökologischen und verschleißfesten Eigenschaften verbessern.

Die Verwendung von Biodiesel wirkt sich auf das Problem der Ernährungssicherheit aus, da für seine Synthese hauptsächlich pflanzliche Öle landwirtschaftlicher Nutzpflanzen verwendet werden. Dies führt zur Notwendigkeit einer zusätzlichen Erhöhung der Anbaufläche, Bewässerung und Verarbeitung. Die Verwendung von wenig verbreiteten, nicht nahrhaften Ölpflanzen, die auf unbehandelten Flächen angebaut werden, einigen Stämmen von Mikroalgen und Produktionsabfällen wird helfen, dieses Problem zu lösen.

### **Schlusswort**

Daher wird die Verwendung von Biodiesel auf Basis von Pflanzenölen in verschiedenen Branchen den Bedarf an Ölressourcen reduzieren, Probleme der Umweltsicherheit lösen und die Auswirkungen des Menschen auf die Umwelt reduzieren. Biodiesel ist somit eine der Nischen des globalen Marktes für alternative Energien.

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## **ЭКОЛОГИЧЕСКАЯ БЕЗОПАСНОСТЬ ПРИ ИСПОЛЬЗОВАНИИ БИОДИЗЕЛЬНОГО ТОПЛИВА**

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**Аннотация:** Рассмотрены основные факторы и направления экологической безопасности, обуславливающие необходимость применения биодизельного топлива в различных отраслях.

**Ключевые слова:** биодизельное топливо, выбросы, здоровье, нефтяное топливо, окружающая среда, экология.

## A REVIEW OF WASTEWATER TREATMENT METHODS AT INDUSTRIAL ENTERPRISES

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### Abstract

This article analyzes the characteristics of industrial wastewater and reviews commonly used methods of wastewater treatment at industrial enterprises.

**Keywords:** treatment methods, wastewater, wastewater parameters.

### Introduction

Currently, the costs of treating industrial wastewater are taken into account, since for the discharge of water into natural reservoirs, regulatory rules are introduced at the legislative level, given in the Article 44 of the Water Code of the Russian Federation “Use of water bodies for the purpose of discharging wastewater, including drainage water” [1]. Wastewater from industrial plants containing waste liquids may include domestic and storm water resulting from climate-related events. Both combined and separate wastewater treatment is practiced at local and standard treatment facilities.

### Characteristics of industrial wastewater

Industrial wastewater is generated in technological processes of various industries: food, pharmaceutical, chemical, metallurgical, manufacturing industries, and has a diverse composition of pollutants that differ in origin, chemical and physical properties [2].

1. Biological contamination is typical for biotechnological and a number of food processing enterprises. They are cells of different groups of microorganisms, in particular, such as bacteria, yeast, algae, etc. Their vital activity is facilitated by organic pollution of plant and animal origin.

2. Chemical pollution is the most common type of pollution, representing both individual elements and organic and inorganic compounds: heavy metals, surfactants, acids and alkalis, petroleum products, etc.

3. Physical pollution of wastewater can be represented by particles of sand, clay, sludge, etc.

Wastewater differs in the concentration of pollutants; Table 1 shows the classification of wastewater according to this indicator.

Table 1 – Classification of pollutant concentrations [2]

Name	Quantity, mg L <sup>-1</sup>
Lightly polluted	1 – 500
Moderately polluted	500 – 5 000
Heavily contaminated	5 000 - 30 000
Dangerous	< 30 000

To determine the composition of wastewater, its physicochemical, chemical, microbiological analysis is carried out, based on the results of which the category of wastewater is established and the treatment method is selected. Based on the analysis of information sources, table 2 shows the main average indicators of wastewater corresponding to a number of industrial facilities.

Table 2 - Wastewater indicators

Indicator	Beet sugar production	Hydrolysis plant	Meat processing plants	Alcohol starch plant	Metallurgical plant
pH	7,7	5,5	6,5	7,2	8
Total hardness, meq L <sup>-1</sup>	17	14	10	11	12
Total alkalinity, meq L <sup>-1</sup>	7,3	8	10	8,9	11
Suspended substances, mg L <sup>-1</sup>	10700	950	1 500	470	500
COD, mg L <sup>-1</sup>	6 000	4 900	2 000	8 300	50
BOD <sub>5</sub> , mg L <sup>-1</sup>	2 700	2 400	800	360	-
Ammonium nitrogen, mg L <sup>-1</sup>	80	150	30	45	-
Phosphates, mg L <sup>-1</sup>	8,1	40	60	15	-

It has been established that the production of food industry enterprises has wastewater with a predominance of high levels of organic contaminants and requires multi-stage wastewater treatment with various treatment methods.

### **Methods for treating industrial wastewater**

At present, along with traditional methods of wastewater treatment - mechanical, physico-chemical, biological and chemical, new processes and techniques are offered [3].

#### *Mechanical methods*

Mechanical methods are the simplest and are distinguished by their reliability and low cost. These methods are based on the separation of two fractions - water and impurities under the influence of a gravitational field.

The most common mechanical methods are straining and settling wastewater. These methods are an important part of wastewater treatment from contaminants - mostly large particles of debris and suspended matter, and are used in almost all biological treatment schemes for industrial wastewater. The following equipment is used for cleaning: grids, sieves of different sizes, settling tanks, centrifuges, and filters.

#### *Physico-chemical methods*

Physicochemical methods are widely used in practice, which include flocculation, coagulation, flotation, extraction, sorption, ion exchange, heat treatment and others.

The presented methods make it possible to remove fine suspended particles, dissolved gases and metals, difficult-to-oxidize and organic compounds from water.

Currently, flocculation and coagulation methods are often used as a second stage of purification, when, through the introduction of chemical compounds in the form of coagulants and flocculants, it is possible to remove difficult-to-sediment fine and colloidal particles by gluing them into larger aggregates.

#### *Biological methods*

One of the important methods for removing organic impurities is biological treatment, which is an environmentally friendly and chemically safe method.

The biological treatment method involves the use of microorganisms in the processing of suspended organic matter in wastewater. There are two possible options for cleaning – in artificial and natural conditions [4]. Natural conditions for biological treatment are carried out in fields of irrigation, filtration and biological ponds.

The equipment used for artificial purification methods is biofilters, methane reactors and aeration tanks, the main active component of which is activated sludge. As a result of biological processes, wastewater pollution after settling tanks in aeration tanks oxidizes and mineralizes organic compounds due to activated sludge.

#### *Chemical methods*

Chemical purification is based on the occurrence of chemical reactions between the impurities contained in water and the reagents used. This method justifies itself as the final stage of water treatment - disinfection or before submission to the biological treatment stage. There are several types of wastewater disinfection: chlorination and ozonation. Ozonation is a more promising method of disinfection, since at certain concentrations water purification is achieved without contaminating it with toxic compounds. Chlorination, while often providing effective antimicrobial results, has hygienic and environmental limitations due to the high toxicity of chlorine.

#### **Conclusion**

The choice of scheme and methods of wastewater treatment for each industrial enterprise takes into account the volume and composition of wastewater and involves the use of a set of methods to achieve an effective result before discharge into the natural environment.

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# ОБЗОР МЕТОДОВ ОЧИСТКИ СТОЧНЫХ ВОД ПРОМЫШЛЕННЫХ ПРЕДПРИЯТИЙ

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**Аннотация:** В статье рассмотрены характеристика промышленных сточных вод, представлен обзор часто использующихся методов очистки сточных вод на промышленных предприятиях.

**Ключевые слова:** методы очистки, параметры сточных вод, сточные воды.

## THE EFFECT OF CURRENT DENSITY AND TEMPERATURE ON THE KINETICS OF COLLOIDAL NANOGRAFITE PRODUCTS USING THE ELECTROCHEMICAL EXFOLIATION METHOD

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### Abstract

The paper is devoted to the study of kinetics of nanographite colloidal solution production. For this purpose, a series of experiments with "Graflex" electrodes in 0.1N sodium hydroxide solution at  $T=30-60^{\circ}\text{C}$  and current density from 0.02 to 0.1A/cm<sup>2</sup> were carried out using electrochemical exfoliation. The works were carried out on a laboratory unit for the study of kinetics in semi-automatic mode. The relevance of this study is justified by the use of graphite particles for modification of paint and varnish materials.

**Keywords:** exfoliation, nanographite, optical density, current density, sodium hydroxide, graphite electrode, temperature.

### Introduction

To date, there are a huge number of products and materials produced using nanomaterials. The most famous of them are nanographite [1-3] or multilayer graphene [4]. Nanographite has a huge functionality, which makes it possible to find its application in a wide variety of fields. Based on this, scientists continue to search for new methods for the synthesis of colloidal nanographite and equipment. Equipment is also being developed to measure the concentration of a colloidal solution of nanographite while varying such technological parameters of the process as the concentration and temperature of the electrolyte, as well as the strength, frequency and shape of the electric current supplied to the electrolyte.

### Research methods

A 0.1N solution of sodium hydroxide was used to study the kinetics of obtaining colloidal nanographite. To prepare this solution, 4 g of sodium hydroxide is dissolved in a small volume of distilled water, transferred to a measuring flask at 1 dm<sup>3</sup> and the solution is brought to the mark with distilled water. The concentration of the resulting solution is checked by titrometric method. A 0.1N hydrochloric acid solution was used as a titrant.

The study of the kinetics of obtaining nanographite was carried out using a laboratory installation, the description and principle of operation of which is described in the article "Methodology and equipment for kinetic studies of electrochemical exfoliation of graphite." [5]

This study describes a series of experiments conducted to obtain a colloidal solution of nanographite and to study the kinetics of this process under certain conditions.

The experiment examines the process of obtaining nanographite from Graflex electrodes under the following conditions:

Temperature 30°C, current density (0,1; 0,08;0,06;0,04;0,02 A/cm<sup>2</sup>)

Temperature 40°C, current density (0,1; 0,08;0,06;0,04;0,02 A/cm<sup>2</sup>)

Temperature 50°C, current density (0,1; 0,08;0,06;0,04;0,02 A/cm<sup>2</sup>)

Temperature 60°C, current density (0,1; 0,08;0,06;0,04;0,02 A/cm<sup>2</sup>)

Before the experiment, measurements were carried out and the electrode area of 16.14 cm<sup>2</sup> was calculated. Based on the selected current density values, we find the currents whose values will be set on the dashboard of the laboratory installation.

During the experiment, it was revealed that such modes as: temperature 30°C, current density (0.02; 0.04; 0.06 A/cm<sup>2</sup>); temperature 40°C, current density 0.02 A/cm<sup>2</sup>; temperature 60°C, current density 0.02 A/cm<sup>2</sup> are not suitable for obtaining nanographite by this method as it occurs the formation of a gas film on the surface of the electrode, which prevents the separation of graphite particles from the electrode.

As a result, we obtained 15 samples of colloidal nanographite at different current densities and temperatures. In the Excel program, graphs were constructed for each sample showing the change in optical densities over time.

For further work, samples with solid phase content were obtained using the gravimetric method. The measurement was carried out in two parallels, for which 5 g of nanographite suspension was placed in pre-weighed buckets and dried in a drying cabinet at 105 °C. Knowing the average concentration of dry matter for each sample, it is possible to reduce them to one concentration (5 g/l) using the dilution method.

To obtain information about the number of nanoparticles in solution, we will use the photometric method. For better wetting and preventing particles from sticking together, add 1 cm<sup>3</sup> of 1% OP-7 to 5 cm<sup>3</sup> of the solution. After that, all samples are placed on an ultrasound machine for the best mixing and uniform distribution of nanographite particles in a colloidal solution. The process is carried out for 40 minutes, after which all samples are photometric.

According to the obtained values of optical densities, the Excel program plots the dependence of optical density on temperature, which will allow you to choose the most suitable sample for further work.

## **Results**

The study showed that at the highest value of optical densities is achieved at a temperature of 40 °C and a current density of 0.1 A/cm<sup>2</sup>

## **Conclusion**

The obtained samples of colloidal nanographite will be used for further work on the production of paint and varnish material as a functional additive. In the future, experiments will be conducted with similar samples in order to establish the effect on the formulation.

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## **ВЛИЯНИЕ ПЛОТНОСТИ ТОКА И ТЕМПЕРАТУРЫ НА КИНЕТИКУ ПОЛУЧЕНИЯ КОЛЛОИДНОГО НАНОГРАФИТА МЕТОДОМ ЭЛЕКТРОХИМИЧЕСКОЙ ЭКСФОЛИАЦИИ**

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**Аннотация:** Работа посвящена исследованию кинетики получения коллоидного раствора наногрфита. Для этого при помощи электрохимической эксфолиации была проведена серия экспериментов с электродами марки "Графлекс" в 0,1Н растворе гидроксида натрия при  $T=30-60^{\circ}\text{C}$  и плотности тока от 0,02 до 0,1А/см<sup>2</sup>. Работы проводились на лабораторной установке для исследования кинетики в полуавтоматическом режиме. Актуальность данного исследования обоснована применением частиц графита для модификации лакокрасочного материала.

**Ключевые слова:** эксфолиация, наногрфит, оптическая плотность, плотность тока, гидроксид натрия, графитовый электрод, температура.

## AN ADSORPTION-ALKALINE METHOD OF REGENERATION OF ENGINE OIL

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### **Abstract**

The purpose of this study is to develop and test a new method for the regeneration of used engine oil using the example of a mixture of synthetic engine oils. The work consists in creating a modified adsorbent. A layer of alkali, sodium hydroxide, is applied to the surface of the silica gel using a cylinder type agitating machine. The efficiency of regeneration processes was evaluated as a result of monitoring the values of the acid number from time to time at different values of NaOH concentration.

**Keywords:** adsorption, engine oil, machine oil, oil regeneration.

### **Introduction**

During the operation of machine oils, they are oxidized, which leads to a change in the physical and chemical properties caused by oxidation [4]. High-molecular (products of oxidative polymerization) and low-molecular (formic, acetic and other low-molecular organic acids) oxidation products with high corrosive activity are isolated [2]. Since the presence of these substances changes the properties of the oil and does not allow it to be reused in most cases, regeneration is necessary. There are three methods of regeneration: physical, physico-chemical [3] and chemical. They cannot remove all oxidation products, so they use combinations of the presented methods. Therefore, conducting research in the field of combined methods of regeneration of engine oils is becoming very relevant.

### **Methods**

Pure silica gel with a spherical granule size from 1.5 to 2.4 mm, an average pore size of 0.9-1.0 nm, and an average specific surface area of 1030 m<sup>2</sup>/g was calcined at 450 °C using the BET method for 4 hours. After that, it was cooled in a desiccator to room temperature. At the next stage, 20 g of silica gel was poured into a KT-6808 cylinder type agitating machine with the addition of 0.2 g and 1 g of NaOH to obtain modified sorbents containing 1 wt.% and 5 wt.% alkalis. The prismatic drum has a diameter of 150 mm. The time of processing the sorbent with caustic soda is 10 minutes. with a change of direction every 30 seconds. The resulting modified sorbent was stored in tightly sealed polyethylene containers. Used synthetic oil of 150 g was poured into 3 conical flasks with a volume of 250 ml each. 15 g of modified sorbent were added to the oil. An unmodified silica gel was used in the third flask. The flasks were corked and mounted on a Kavalier shaking machine with 6 flask racks. It has a longitudinal oscillation amplitude of 85 mm and a frequency of 2 Hz. At time points 15, 30, 60, 90, 120 min. samples were taken from each flask to measure the acid number according to GOST 11362-96 [1]. The initial value of the acid number calculated for "pure" oil is 0.18 mg NaOH/g.

## Results and Discussion

To understand the acid number measurements, consider the graphs of the dependence of the change in the average value of the acid number of synthetic engine oil on time for sorbents with different NaOH content, which are shown in Figs. 1 and 2.

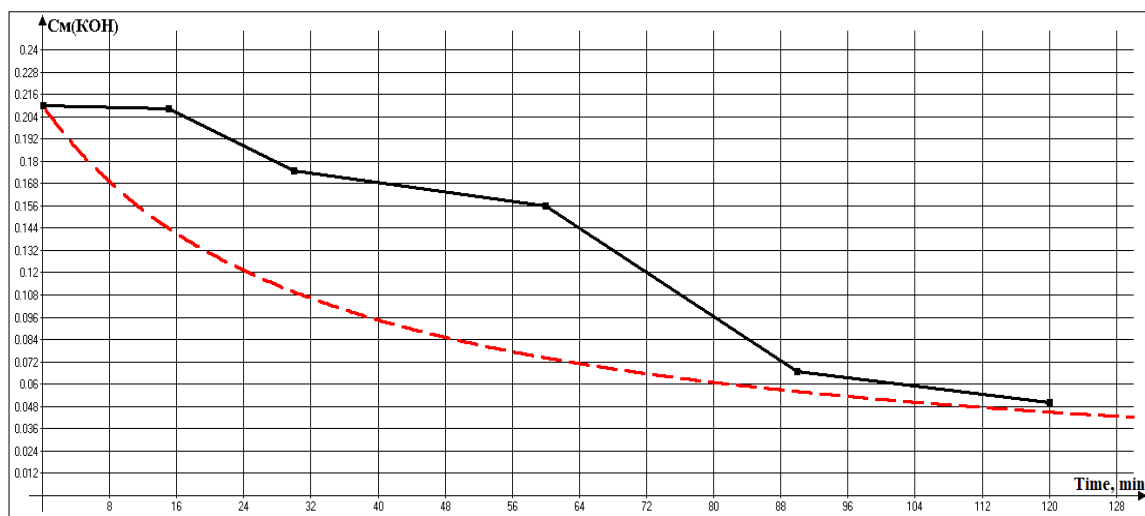


Figure 1 – Kinetics of the process of deoxidation of used synthetic engine oil with a content of 0.1 wt.% NaOH of silica gel

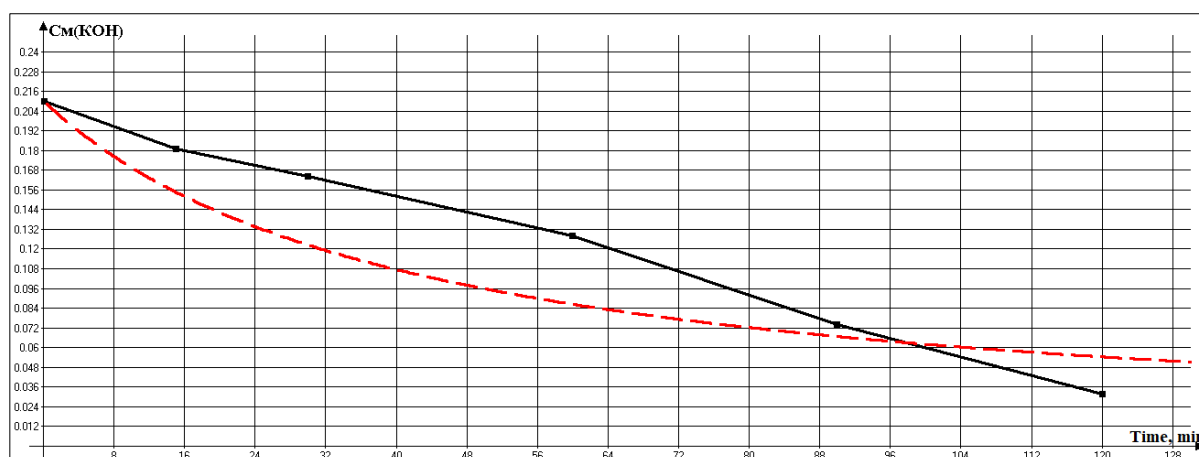


Figure 2 – Kinetics of the process of deoxidation of used synthetic engine oil with a content of 5 wt.% NaOH of silica gel

It can be noted that with a processing time of up to 30 minutes, there is practically no difference in the concentration of alkali in the modified sorbents. Also, as can be seen from Figs 1 and 2, with an increase in the concentration of NaOH, the final value of the acid number (KH) of the regenerated synthetic engine oil decreases. At a concentration of 5 wt.% NaOH, AN is significantly less than at a concentration of 0.1 wt.%, which indicates a greater efficiency of the first sample shown in Figure 2. The best processing time at which NaOH overruns do not occur is 90 minutes.

## Conclusion

When silica gel is added as a sorbent (modified by 5% wt. NaOH) in an amount of 10% by weight depending on the mass of the regenerated oil, the acid number values for the engine oil are achieved during processing within 90 minutes.

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## АДСОРБЦИОННО-ЩЕЛОЧНОЙ МЕТОД РЕГЕНЕРАЦИИ МАШИННОГО МАСЛА

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**Аннотация:** Целью данного исследования является разработка и проведение испытаний нового метода регенерации отработанного машинного масла на примере смеси синтетических моторных масел. Работа заключается в создании модифицированного адсорбента. На поверхность силикагеля нанесен слой щелочи - гидроксид натрия с помощью галтовочной машины барабанного типа. Оценка эффективности процессов регенерации осуществлялась в результате контроля значений кислотного числа от времени при различных значениях концентрации NaOH.

**Ключевые слова:** адсорбция, машинное масло, моторное масло, регенерация масла.

## COMPREHENSIVE ASSESSMENT OF THE DEGREE OF WATER BODIES CONTAMINATION IN THE TAMBOV REGION

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### Abstract

A comprehensive assessment of the degree of water contamination represents information about the quality of water or the degree of its contamination, based on the results obtained during monitoring of surface water bodies. The article outlines a method for a comprehensive assessment of the degree of water contamination of the basis of hydrochemical indicators, the results obtained through monitoring of the rivers in the Tambov region, which allows for a more in-depth study of trends, dynamics of the degree of contamination or quality of natural water.

**Keywords:** natural water, specific combinatorial index of water contamination, water quality class

In recent years, a negative situation has arisen with surface water bodies in the Tambov region. The quality of rivers in the Tambov region is extremely negatively affected by the absence or ineffective operation of biological treatment facilities and storm sewer systems in the cities and towns of the region. In addition, there is an increase in agricultural sector facilities that pollute water areas with agrochemicals (fertilizers and pesticides), as well as waste and effluent from enterprises specializing in livestock farming.

The most informative indicators for assessing the quality of surface water according to the degree of pollution are:

- specific combinatorial indicator of water contamination (SCIWC);
- water quality class.

The SCIWC value can vary from 1 to 16 depending on the level of pollution in natural waters. To assess complex indicators, List No. 1 (Appendix B) RD 52.24.643-2002 for 15 contaminations is used.

It is admitted that the optimal number of analyzed indicators to be taken into 10 to 25, depending on the goals set, taking into account the observation program, and the availability information on the chemical composition surface waters and terrain features. Obviously, in a region with a developed oil industry, it is advisable to determine the total content petroleum products. If an industry such as mechanical engineering is developed in the region, it makes sense to regularly determine the amount iron, aluminum, zinc, copper and other metals in natural water.

Depending on the degree contamination, surface waters are divided into 5 classes (Table 1).

Table 1 The natural water quality classes

Class	Water contamination index
1	conditionally clean
2	slightly contaminated
3	contaminated
4	dirty
5	extremely dirty



The calculation the contamination index water bodies is based on the results of 2023 for each the four hydrological posts on four water bodies the Tambov region: the Plavitsa River (Petrovsky district), the Karai River (Muchkapsky district), the Karachan River (Zherdevsky District) and the Bityug River (Mordovian district).

12 indicators determine the hydrochemical composition of natural water: ammonium ion, nitrate ion, nitrite ion, biochemical oxygen consumption (BOC), chemical oxygen consumption (COC), dissolved oxygen, petroleum products, chloride ion, sulfate ion, copper, zinc and iron.

A preliminary assessment of the degree of contamination of these rivers is carried out using the water pollution complexity coefficient (K). The characteristics of the values of water pollution complexity coefficients in 2023 are calculated (Fig.1).

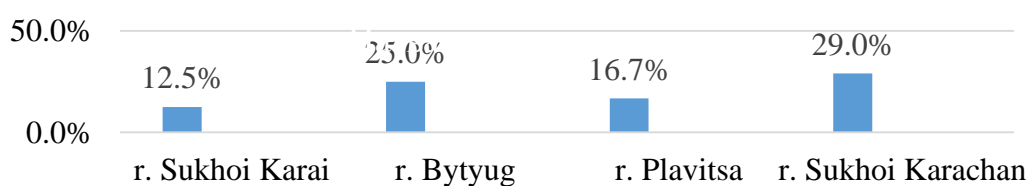


Figure 1 - The coefficient complexity water contamination (K)

As van be seen from Fig. 1, the waters in the rivers Bytyug, Sukhoi Karai, Sukhoi Karachan and Plavitsa in the alignment had average complexity coefficient in 2023.

Exceeding the maximum permissible concentration in natural river water was observed for 3 out of 12 determined indicators of the chemical composition of water.

For the Plavitsa River, the chemical composition of water did not undergo significant changes during 2023 - the spread of the complexity coefficient was 0%, for the Sukhoi Karachan and Bytyug rivers - 16.6%, for the Sukhoi Karai River - 8.4%.

The requirements of RD 52.24.643-2002 [2] establish the procedure and stages to calculate the combinatorial index of water contamination, determine the sum of generalized assessment points for each pollutant and make it possible to calculate a specific combinatorial index of water pollution and determine the class of water pollution.

Taking into account all the initial data and results obtained in 2023, according to a set of certain indicators, the natural waters of the rivers under study are characterized as follows (Table 2).

Table 2 Water contamination characteristics

Name the water body	Class	Discharge	Water contamination characteristics
R. Plavica	2		slightly contaminated
R. Bityug R. Sukhoi Karai	3	a	contaminated
R. Sukhoi Karachan		b	very contaminated

Emphasizing the importance of the indicator as one of the main characteristics of its condition, it should be noted that this indicator can be used to compare the degree of contamination of various water bodies that are not sufficiently studied. Reliable determination of the amount of pollutants and the frequency of exceeding maximum permissible values allows solving many problems, the most important of which are:

- determining the safety of water for human and animal health is an assessment of the harm that can be caused to a reservoir or river as a result of human economic activity,

- measuring the degree of reversibility/irreversibility of changes that have occurred in the ecosystem as a result of the damage caused,

- setting goals and developing stages of the environmental rehabilitation program for a water body (or part of it) that has been contaminated.

Using the values obtained according to the methodology for the rivers in the Tambov region under study, one can understand whether it is possible to use natural water for specific purposes, whether measures for the environmental rehabilitation water bodies, which are priorities regional socio-economic policy.

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## КОМПЛЕКСНАЯ ОЦЕНКА СТЕПЕНИ ЗАГРЯЗНЕННОСТИ ВОДНЫХ ОБЪЕКТОВ ТАМБОВСКОЙ ОБЛАСТИ

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**Аннотация:** Комплексная оценка степени загрязненности поверхностных вод предполагает использование сведений о качестве воды или степени ее загрязненности, основанных на результатах, полученных при мониторинге поверхностных водных объектов. В статье описан метод комплексной оценки степени загрязненности поверхностных вод по гидрохимическим показателям, полученным при мониторинге рек Тамбовской области, позволяя более углубленно изучать тенденции, динамику степени загрязненности или качества природной воды.

**Ключевые слова:** класс качества воды, природная вода, удельный комбинаторный индекс загрязненности воды.

## **DIE BEZIEHUNG ZWISCHEN UMWELT- UND CO<sub>2</sub>-FUßABDRUCK**

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**Zusammenfassung:** Heutzutage bezeichnen sowohl die Wissenschaft als auch die Wirtschaft den Begriff „Fußabdruck“ als Kriterium oder Abrechnungsmechanismus zur Berechnung des Verbrauchs von Umweltressourcen durch die Verbrauchergemeinschaft. Die Berechnung und Bewertung des Fußabdrucks ermöglicht es, die Auswirkungen der Menge an Naturkapital auf anthropogene Aktivitäten in der Vergangenheit zu analysieren. Daher hilft es, den möglichen Bedarf anhand der Verfügbarkeit natürlicher Ressourcen in absehbarer Zukunft vorherzusagen. In diesem Zusammenhang sind der ökologische Fußabdruck und der CO<sub>2</sub>-Fußabdruck die beliebtesten Instrumente zur Messung des Ressourcenverbrauchs. Dieser Artikel kann ein besseres Verständnis dafür vermitteln, wie diese Tools dabei helfen, den Bedarf menschlicher Aktivitäten an natürlichen Ressourcen zu berechnen.

**Schlüsselwörter:** ökologischer Fußabdruck, CO<sub>2</sub>-Fußabdruck, Ressource, Mensch, Bewertung.

Um den Zusammenhang zwischen Umwelt-Fußabdruck und CO<sub>2</sub>-Fußabdruck zu definieren, ist es notwendig, jeden Begriff zu definieren. In der internationalen Gemeinschaft wird die von William Reese vorgeschlagene Definition des ökologischen Fußabdrucks verwendet, wonach der ökologische Fußabdruck ein bedingtes Konzept ist, das den Verbrauch von Biosphärenressourcen durch die Menschheit widerspiegelt [1]. Im Wesentlichen handelt es sich um einen Indikator, der den Grad der Auswirkungen menschlicher Aktivitäten auf den gesamten Planeten misst, vorausgesetzt, dass die gesamte Erdbevölkerung einem bestimmten Lebensstil einer bestimmten Person oder Gruppe von Menschen folgt.

Bei der Bewertung des ökologischen Fußabdrucks steht zunächst die Berechnung der Fläche und Wasserfläche im Vordergrund, die zur Deckung menschlicher Bedürfnisse und anthropogener Aktivitäten in einer bestimmten Region sowie zur Aufnahme und Verarbeitung von Abfällen erforderlich ist. Diese Schätzung variiert je nach geografischem Standort einer Einzelperson oder einer Gruppe von Einzelpersonen aufgrund von Unterschieden im Naturkapitalbestand und der CO<sub>2</sub>-Absorption. Aufgrund der Schwierigkeit, die für eine genaue Schätzung des ökologischen Fußabdrucks erforderlichen Daten zu sammeln, wurde CO<sub>2</sub> als Hauptschadstoff ausgewählt, der bei der Kraftstoffverbrennung entsteht [2]. Die Ergebnisse lassen sich unter anderem dahingehend interpretieren, wie viele Planeten Erde benötigt werden, um den Bedarf der Menschheit zu decken, wenn alle Bewohner des Planeten der erwarteten Lebensweise folgen.

Die Berechnung von Schätzungen des ökologischen Fußabdrucks ermöglicht es Produzenten, Strategien, Methoden und Maßnahmen zu entwickeln, um die anthropogene Belastung zu reduzieren und natürliche Kapitalressourcen zu schonen. Für Produktionskampagnen könnte diese Lösung ein Übergang zu umweltfreundlichen Materialien und optimierten Produktionsabläufen sein, und der

Verbraucher könnte sich für Produkte mit einem geringeren ökologischen Fußabdruck entscheiden.

Der CO<sub>2</sub>-Fußabdruck bezeichnet üblicherweise die direkten und indirekten Emissionen von Treibhausgasen (THGs), die während der Produktion oder anderen menschlichen Aktivitäten über einen bestimmten Zeitraum hinweg entstehen. Dabei handelt es sich um ein skalares Kriterium, ausgedrückt in CO<sub>2</sub>-Äquivalent-Einheiten [3]. Anhand des CO<sub>2</sub>-Fußabdrucks kann man die anthropogene Belastung der Biosphäre beurteilen und Möglichkeiten zur Vorhersage des Klimawandels gewinnen.

Der CO<sub>2</sub>-Fußabdruck ist ein bedeutendes und schnell wachsendes Element des allgemeineren ökologischen Fußabdrucks menschlicher Aktivitäten [4]; Nach verschiedenen Expertenschätzungen macht es etwa 64 % des gesamten ökologischen Fußabdrucks aus. Der Rest der CO<sub>2</sub>-Emissionen wird von den Ozeanen absorbiert. Wenn wir den CO<sub>2</sub>-Fußabdruck als ökologischen Fußabdruck ausdrücken, dann ist der CO<sub>2</sub>-Fußabdruck der „Land“-Teil des ökologischen Fußabdrucks. Der CO<sub>2</sub>-Fußabdruck berücksichtigt jedoch nicht die Kompensation der in die Atmosphäre freigesetzten Treibhausgase [5]. Der Hauptzweck des CO<sub>2</sub>-Fußabdrucks besteht darin, die öffentliche Aufmerksamkeit auf das Problem der mangelhaften Überwachung und Kontrolle von Treibhausgasemissionen zu lenken. Es gibt mehrere Möglichkeiten, den CO<sub>2</sub>-Ausstoß zu reduzieren. Beispiele für solche Wege könnten die Umsetzung technologischer und planerischer Maßnahmen und der Übergang zu einer abfallfreien Produktion sein.

Zu den Hauptfunktionen der Bewertung des CO<sub>2</sub>-Fußabdrucks [6] gehören die Entwicklung von Methoden und Strategien für das Emissionsmanagement, die Rationalisierung des Ressourcenmanagements auf der Grundlage der gewonnenen Daten; Überwachung von Treibhausgasemissionen; Vermeidung einer CO<sub>2</sub>-Steuer.

Ähnlichkeiten zwischen ökologischem und CO<sub>2</sub>-Fußabdruck:

- Umwelt- und CO<sub>2</sub>-Fußabdruck – Kriterien, die ein beschreibendes Merkmal der anthropogenen Belastung tragen;
- Der CO<sub>2</sub>-Fußabdruck ist der schnell wachsende und zerstörerischste Teil des ökologischen Fußabdrucks.
- beide Tracks befassen sich mit der Nutzung von Ressourcen;
- Messungen eines dieser beiden Kriterien fördern die Entwicklung und Optimierung von Maßnahmen zur Verringerung der Auswirkungen menschlicher Aktivitäten auf das Naturkapital, zur Verbesserung des Lebensstils und der industriellen Produktion.

Ökologischer Fußabdruck und CO<sub>2</sub>-Fußabdruck sind zwei Konzepte, mit denen wir den Ressourcenverbrauch und die anthropogenen Auswirkungen auf die Umwelt klar beschreiben können [7]. Kohlenstoff ist ein Sonderfall der Bewertung anthropogener Auswirkungen, und der ökologische Fußabdruck ist ein allgemeineres Merkmal. Der ökologische Fußabdruck umfasst alle ressourcenabhängigen Aktivitäten, den Ressourcenverbrauch und die daraus resultierenden Verluste sowie die Kompensation dieser Verluste. Der CO<sub>2</sub>-Fußabdruck wiederum umfasst nur menschliche Aktivitäten, die direkt oder indirekt Treibhausgase ausstoßen. Dazu gehören Aktivitäten wie die Verbrennung fossiler Brennstoffe, die Produktion und

der Verbrauch von Strom, die Produktion und Lieferung von Produkten usw. Somit ist diese Unterscheidung der bedeutendste Unterschied zwischen ökologischem Fußabdruck und CO<sub>2</sub>-Fußabdruck.

Darüber hinaus erhält man bei der Bewertung des CO<sub>2</sub>-Fußabdrucks einen Indikator, der die ungefähre Menge der Treibhausgasemissionen in Tonnen pro Jahr aus den erfassten Quellen charakterisiert [8]. Im Gegenteil: Der ökologische Fußabdruck liefert die Werte der territorialen und aquatorialen Fläche, die erforderlich sind, um das verbrauchte Naturkapital zu ersetzen. Diese Differenzierung der erhaltenen Schätzungen kann als ein weiterer Punkt in der Heterogenität der Schätzungen vermerkt werden. Der CO<sub>2</sub>-Fußabdruck fungiert unter anderem als notwendiges Kriterium für Maßnahmen zur Reduzierung der anthropogenen Belastung der Umwelt durch die Verhinderung der globalen Erwärmung und der Verhinderung von Katastrophen im Zusammenhang mit dem Klimawandel. Andererseits berücksichtigt der ökologische Fußabdruck alle Probleme des Naturkapitals und der Biosphäre und zielt auf ein nachhaltiges Zusammenleben von Mensch und Natur ab.

Die Reduzierung der Treibhausgasemissionen ist einer der grundlegenden Schritte zur Reduzierung des nicht nachhaltigen Ressourcenverbrauchs. Und um ein umfassendes Bild der tatsächlichen Auswirkungen zu erhalten, die sich auf die Lösung von Problemen wie Wilderei, Überfischung, ungesunder Beweidung und mutwilliger Abholzung auswirken müssen, brauchen wir einen ökologischen Fußabdruck. Es ist auch sehr wichtig, dass der Gesetzgeber beide Kriterien in seinem Bereich nicht außer Acht lässt und nutzt, um natürliche Ressourcen zu verwalten und das Wohlergehen der Menschen zu gewährleisten.

Zusammenfassend lässt sich festhalten, dass der ökologische Fußabdruck und der CO<sub>2</sub>-Fußabdruck zwei notwendige Kriterien für die Überwachung sind, wenn ein Unternehmen auf ein ressourceneffizienteres und umweltfreundlicheres Modell übergeht.

Ökologischer Fußabdruck und CO<sub>2</sub>-Fußabdruck sind zwei ziemlich weit gefasste Konzepte, die die anthropogene Belastung des Naturkapitals bewerten. Um die Unterschiede zwischen ökologischem Fußabdruck und CO<sub>2</sub>-Fußabdruck zusammenzufassen: Der ökologische Fußabdruck definiert den menschlichen Bedarf an Naturkapital. Andererseits gibt der CO<sub>2</sub>-Fußabdruck ein Teilbild der Emissionen in Form von CO<sub>2</sub>-Äquivalenten wieder. Außerdem erwies sich der CO<sub>2</sub>-Fußabdruck als hervorragende PR-Kampagne, die Menschen beeinflussen und den Trend zur Minimierung von Treibhausgasemissionen in die breite Masse tragen konnte.

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## ВЗАИМООТНОШЕНИЕ ЭКОЛОГИЧЕСКОГО И УГЛЕРОДНОГО СЛЕДА

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**Аннотация:** На сегодняшний день и научное, и корпоративное сообщество называют термин «след» критерием или механизмом учета для расчета скорости потребления экологических ресурсов потребителем сообществом. Расчёт и оценка следа позволяют проанализировать влияние размера естественного капитала на антропогенную деятельность в прошлом. Следовательно, это помогает спрогнозировать возможный спрос с доступностью природных ресурсов в обозримом будущем. При рассмотрении в таком контексте наиболее популяризированными инструментами для измерения потребления ресурсов являются экологический след и углеродный след. В данной статье можно получить лучшее понимание функционирования этих критериев и их взаимодействие между собой.

**Ключевые слова:** экологический след, углеродный след, ресурс, человек, оценка.

## ELECTROCHEMICAL EXFOLIATION METHOD FOR KINETICS OF COLLOIDAL NANOGRAFITE SYNTHESIS

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### Abstract

The purpose of this study is to analyze the kinetics of obtaining colloidal nanographite using electrochemical exfoliation in 0.1N sodium hydroxide solution at  $T=30^{\circ}\text{C}$  and frequencies from 0.01 to 0.5 Hz. The study considers a kinetic-study laboratory machine in semi-automatic mode. The relevance of the study is the use of graphite particles to modify coolant-cutting fluid.

**Keywords:** absorbance; conductance; exfoliation; graphitized electrode; nanographite; sodium hydrate; temperature.

### Introduction

Literature review shows how the number of materials and products that are produced with colloidal graphite particles, also known as nanographite [1-3] or multilayer graphene [4], has increased. At present, it is necessary to search for new techniques for the preparation of colloidal nanographite, the design and staging of the synthesis, as well as the development of special equipment that allow us to establish the relationship between the conditions of production and kinetic, physical and chemical properties of nanomaterials, and in particular nanographite. The main objective of this study is to approve the methodology for studying the kinetics of obtaining colloidal nanographite samples at a given mode of operation of the laboratory unit.

### Methods

To study the kinetics of colloidal nanographite synthesis, 0.1N sodium hydroxide solution was used. It was dissolved ready in a 1L flask. The concentration of the resulting solution was controlled by acid-base titration. A 0.1N hydrochloric acid solution was used as the titrant. The study of the colloidal nanographite synthesis kinetics was carried out using a laboratory machine shown in Fig.1.

Graphite electrodes 2 are fixed in the thermostated electrochemical cell 1. The electric voltage is supplied to the electrodes from the H-bridge 3, realized on field-effect transistors of MOSFET technology n and p structure. The voltage to the H-bridge is supplied from the power supply 4, which is regulated through the voltage and current regulator 5. The values of electric voltage and current are set manually according to the readings of a digital device. H-bridges are controlled by microcontroller on the basis of ATmega328 chip 6. The necessary hydrodynamic regime in the electrochemical cell is maintained by means of mechanical stirrer 7, which is driven by gearmotor 8 with nominal speed of 300 rpm. The gearmotor is also controlled by a microcontroller through a voltage regulator 9 using a pulse width modulation method. Temperature values are recorded with the help of sensor 10. The study of the kinetics of the electrochemical exfoliation process is carried out with the

use of photometric method, realized with the use of emitter 11 and photodetector 12, which are installed in special housings and located on opposite sides of the transparent electrochemical cell. A semiconductor laser with a wavelength of 650 nm, power of 5 mW is used as an emitter, the power supply of which is left from a stabilized power supply 13.

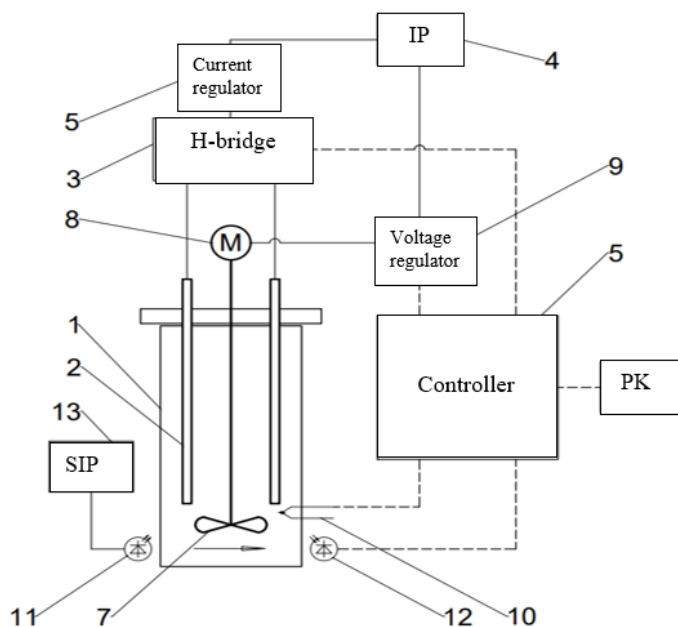


Figure 1 - The schematic illustration of the experimental laboratory machine setup for studying the kinetics of electrochemical graphite exfoliation.

As a result, we obtained 5 samples of nanographite at a temperature of 30°C and different frequencies of electric current in a 0.1N sodium hydroxide solution.

### Results

As a result, the dependence of linear speed on current frequency was obtained.

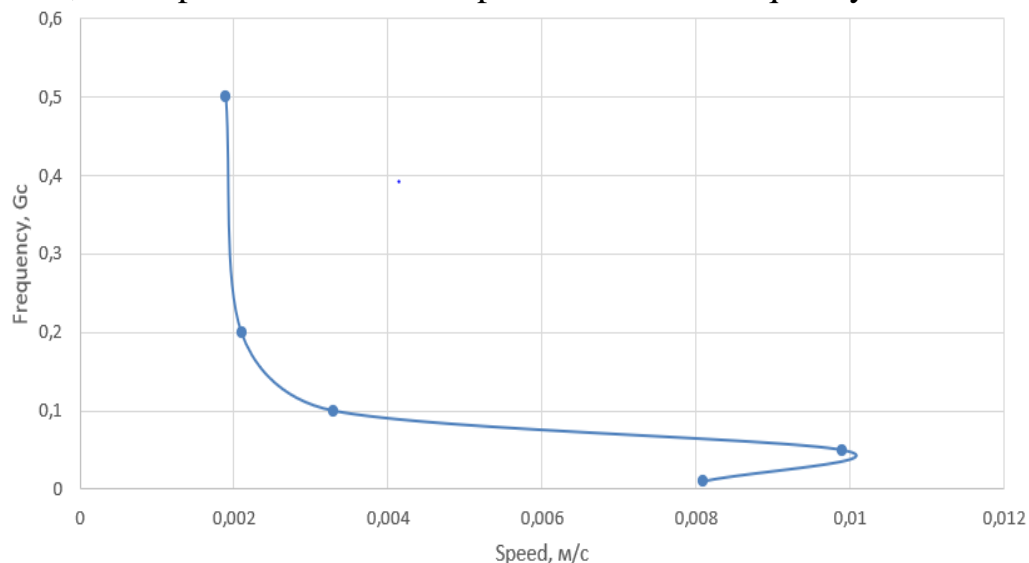


Figure 2 - Dependence of linear process speed on current frequency



## Conclusion

The obtained samples of colloidal nanographite will be used to further stabilize the consumer properties of acrylic emulsion topcoats and coolant-cutting fluids. It is promising to obtain similar colloidal nanographite samples, but at different temperature regimes, to be able to select the best conditions for obtaining nanographite with subsequent stabilization of the products in question.

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## КИНЕТИКА ПОЛУЧЕНИЯ КОЛЛОИДНОГО НАНОГРАФИТА МЕТОДОМ ЭЛЕКТРОХИМИЧЕСКОЙ ЭКСФОЛИАЦИИ

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**Аннотация:** Целью данной работы является исследование кинетики получения коллоидного наногрфита способом электрохимической эксфолиации в 0,1Н растворе гидроксида натрия при  $T=30^{\circ}\text{C}$  и частотах от 0,01 до 0,5 Гц. Рассмотрена лабораторная установка для исследования кинетики в полуавтоматическом режиме. Актуальность исследования обоснована применением частиц графита для модификации смазывающе-охлаждающих жидкостей.

**Ключевые слова:** гидроксид натрия, графитовый электрод, наногрфит, оптическая плотность, температура, эксфолиация.

## INVESTIGATION OF THE SORPTION CAPACITY OF POLYMER MEMBRANES IN SOLUTIONS OF SODIUM CHLORIDE AND CALCIUM CHLORIDE

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### Abstract

The purpose of the paper is to study the sorption capacity of polymer membranes OPMN-P and MGA-95P for aqueous solutions of sodium chloride and calcium chloride of various concentrations. The task is to analyze the ratio of the sorption capacity of different concentrations of the initial distribution coefficients of OPMN-P and MGA-95P membranes from the temperature and concentration of an aqueous solution of calcium chloride and sodium chloride. Membrane technologies play a key role in the purification of wastewater and process solutions from dangerous toxic elements. The expected results are the calculation of empirical coefficients for the equation..

**Keywords:** distribution coefficient, reverse osmosis, sorption capacity.

The treatment of industrial wastewater is an important and relevant topic, both from the environmental side and from the economic side, for the possible reuse of purified water in production.

The main component of pigment production wastewater is sodium chloride; calcium chloride, calcium bicarbonate and calcium acetate are also present in large quantities. These components can have a toxic effect on the human body.

Membrane technologies are one of the advanced methods for treating industrial wastewater. This method is distinguished by its economic efficiency, since it does not require significant energy consumption and minimizes the use of reagents for cleaning membranes. An additional advantage of osmotic water purification is its small dimensions, which do not affect the productivity of the installation [1].

To understand the mechanism of mass transfer in membranes, information on the sorption capacity of these membranes is necessary. This indicator reflects the ability of membranes to absorb solutes, which directly affects the retention coefficient and specific solvent flow. The scientists conducted studies of the sorption characteristics of membranes in relation to aqueous solutions containing calcium chloride and sodium chloride, studying various concentrations and temperatures of the initial solutions. The results of these studies made it possible to clarify the mechanisms of sorption and mass transfer in membranes [2].

Figures 1, 2 show the dependences of the distribution coefficients of OPMN-P and MGA-95P membranes on the temperature and concentration of an aqueous solution of calcium chloride and sodium chloride.

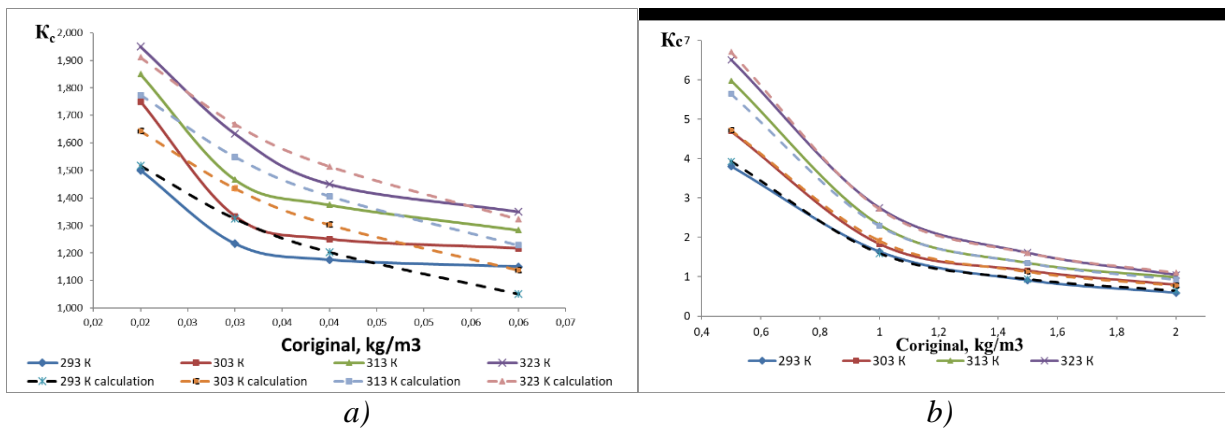


Figure 1 - Distribution of the concentration coefficients of an aqueous solution of calcium chloride (a), sodium chloride (b) on temperature values for the OPMN-P membrane (solid line - experimental data, dotted line - calculation).

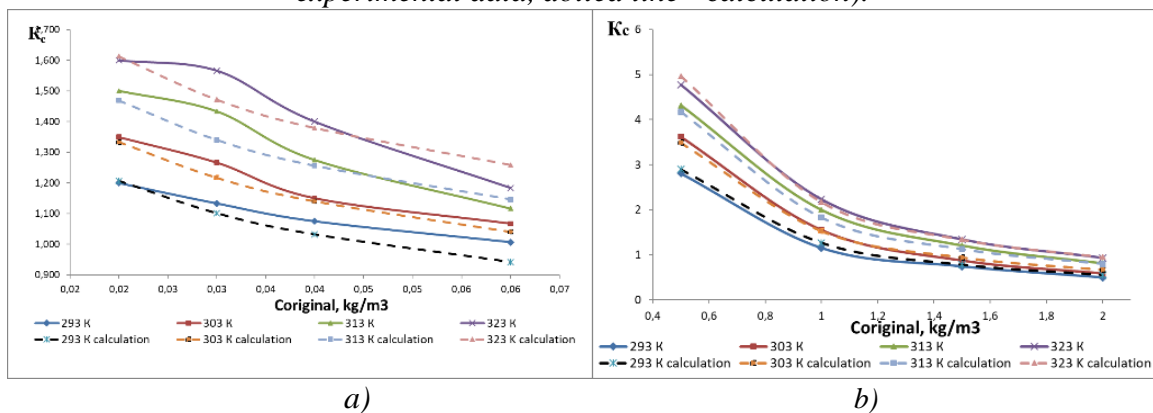


Figure 2 - Distribution of concentration values of an aqueous solution of solutions of calcium chloride (a), sodium chloride (b) on temperature values for the MGA-95P membrane (solid line - experimental data, dotted line - calculation).

The analysis of the dependencies shown in Figs 1 and 2 allows us to conclude that an increase in the concentration of the substance in the initial solution leads to a decrease in the sorption capacity of the membranes. This is due to the fact that the sorbed substances fill the volume of pores, the cross section of which is significantly reduced. The smallest pores can be completely filled with adsorbed molecules which cause them to be "blocked" for water transfer. All this is important for explaining the dependence of kinetic characteristics on a number of parameters in the process of electrobaromembrane separation of solutions.

It can also be noted that the sorption capacity of OPMN-P membranes is higher than that of MGA-95P. This is explained by the physico-chemical properties of the matrix of semipermeable membranes and the charge sign of the active membrane layer (polyamide membranes have a positive charge, acetylcellulose membranes have a negative charge). The nature and size of the pores of polymer membranes have a significant effect.

The effect of temperature on the process of sorption of substances from the solution is significant. Studies [3, 4] have shown that temperature has an ambiguous effect on the sorption process. In a specific case, studies have found that with an increase in the temperature of the studied solutions, the sorption capacity of polymer

membranes also increases.

To calculate the equilibrium distribution coefficient, we used an approximation equation based on the Freundlich equation:

$$k_p = (b \cdot C_{ucx}^n \cdot (293/T)^m) / C_{ucx}$$

where b, n, m are empirical coefficients. The values of the empirical coefficients are shown in Table 1.

Table 1. – Values of empirical coefficients for equation

Solution	Type of membrane	b	n	m
Calcium chloride	MGA-95P	0.50	0.77	-2.98
	OPMN-P	0.41	0.67	-2.36
Sodium chloride	MGA-95P	1.10	-0.10	-6.44
	OPMN-P	1.59	-0.30	-5.49

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## ИССЛЕДОВАНИЕ СОРБЦИОННОЙ ЕМКОСТИ ПОЛИМЕРНЫХ МЕМБРАН В РАСТВОРАХ ХЛОРИСТОГО НАТРИЯ И ХЛОРИСТОГО КАЛЬЦИЯ

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**Аннотация:** Цель работы состоит в исследовании сорбционной емкости полимерных мембран ОПМН-П и МГА-95П для водных растворов хлористого натрия и хлористого кальция различных концентраций. Задача - проанализировать отношения сорбционной емкости разных концентрация исходного коэффициентов распределения мембран ОПМН-П и МГА-95П от температуры и концентрации водного раствора хлористого кальция и хлористого натрия. Мембранные технологии играют ключевую роль в очистке сточных вод и технологических растворов от опасных токсичных элементов. Ожидаемые результаты заключаются в расчете эмпирических коэффициентов для уравнения.

**Ключевые слова:** обратный осмос, коэффициент распределения, сорбционная емкость.

## RESEARCH ON TECHNOLOGICAL PARAMETERS OF MILK SUGAR HYDROLYSIS

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### Abstract

This paper presents studies of the technological parameters of milk lactose fermentolysis using the enzyme  $\beta$ -galactosidase. The reaction rate and the most optimal modes of the process in production conditions are determined.

**Keywords:** lactose intolerance, low lactose dairy products, lactose hydrolysis.

Currently, dairy industry enterprises are actively expanding their range and offering new innovative products to ensure competitiveness. Of particular interest are low-lactose and lactose-free dairy products in the diet of people with lactose intolerance, as well as a group of the population adhering to a low-calorie diet and leading a healthy lifestyle [1].

Technologies for the production of low-lactose and lactose-free products involve processing milk to reduce or completely remove lactose using ultra- and nanofiltration methods, the use of enzyme preparations, as well as a combined method [2].

The enzymatic method of breaking down milk sugar has an advantage for manufacturers due to the ease of implementation without significant changes in the equipment design of the line, the availability of a technological additive, achieving the required concentration of lactose in the final product while maintaining the original nutritional value.

To adapt the production technology of low-lactose and lactose-free dairy products to the realities of an operating enterprise, it is necessary to determine the dose of the lactase enzyme preparation and the temperature conditions for its action.

Experimental studies were carried out on the kinetic patterns of lactose hydrolysis in whole pasteurized milk using  $\beta$ -galactosidase Mayalact 5000. This enzyme preparation is a product of microbiological synthesis by neutral yeast *Kluyveromyces lactis* under submerged conditions. The concentration of lactose in raw materials was determined by the iodometric method according to GOST 29248-91.

To determine the temperature optimum for the enzymatic hydrolysis of lactose, a weighed portion of the enzyme preparation was added to pasteurized whole milk with a lactose fraction of 4.3 at the rate of 0.25 grams per kilogram of milk, and the temperature was maintained 22°C, 27°C and 32°C. At regular intervals, the lactose concentration in the raw materials was determined. The dependence of changes in milk sugar hydrolysis with increasing the dose of the enzyme preparation by 2 times was also established.

Figure 1 shows a diagram of the dependence of the degree of lactose hydrolysis on temperature and dose of the applied drug.

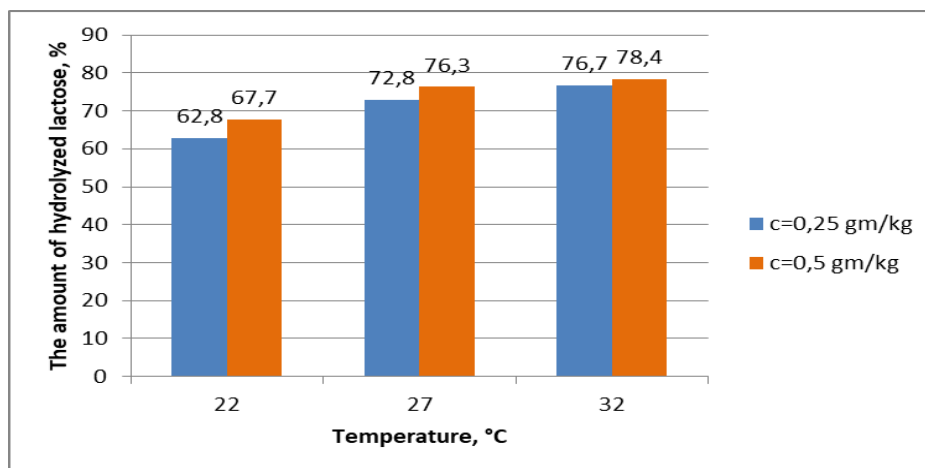


Figure 1 - Diagram dependence of the degree of lactose hydrolysis on temperature and dose

It is found that with a dose of the enzyme preparation of 0.25 g/kg of milk and maintaining the temperature of the raw materials at 22 °C, the proportion of lactose decreased by 62.8% of the original amount, at a temperature of 27 °C by 72.8%, and at a temperature of 32 °C, the proportion of lactose decreased by 76.7%. Under the same conditions, but at a dose of 0.5 g/kg of milk, the lactose concentration decreased by 67.7%, 76.3% and 78.4%, respectively.

To study the kinetics of the enzymatic reaction of lactose hydrolysis with the Mayalact 5000 enzyme, the temperature of the reaction medium was set at 32 °C, the amount of the drug added was 0.5 g/kg of milk, the current amount of lactose was determined at different points in time for 21 hours (Table 1).

Table 1. Lactose content in milk

Reaction time, h	Amount of lactose, g
0	4.3
3	0.93
5	0.49
16	0.38
21	0.36

The graphical dependence of the change in the rate of the enzymatic reaction is presented in Figure 2

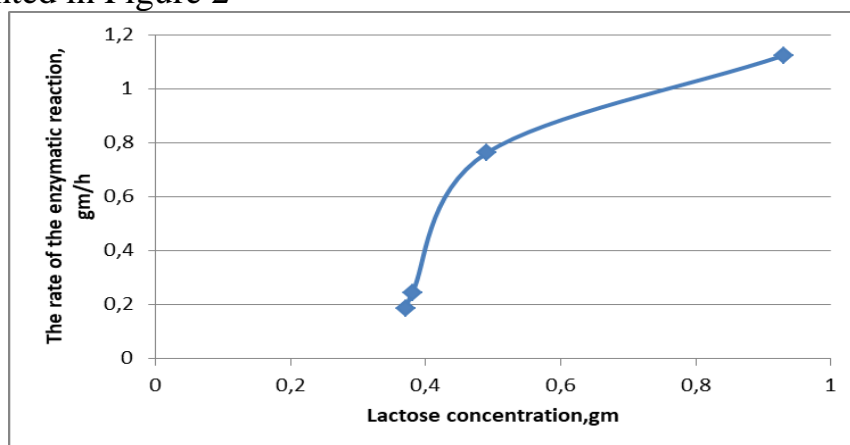


Figure 2 - Graphical dependence of the change in the rate of the enzymatic reaction

The graph shows that the enzyme preparation exhibits the highest speed already in the first 3 hours, reducing the amount of lactose, which acts as a substrate, to 0.93g. After 5 hours, the rate of the enzymatic reaction sharply decreases, which is due to a decrease in the concentration of the substrate.

Thus, during the experiment it was established that in order to obtain a lactose-free dairy product under production conditions, milk fermentation must be carried out at a temperature of 32 °C for 5 hours at a dose of the enzyme preparation of 0.5 g/kg of milk.

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## ИССЛЕДОВАНИЕ ТЕХНОЛОГИЧЕСКИХ ПАРАМЕТРОВ ГИДРОЛИЗА МОЛОЧНОГО САХАРА

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**Аннотация:** Приведены исследования технологических параметров проведения ферментализации лактозы молока с использованием фермента β-галактозидазы. Определена скорость реакции и наиболее оптимальные режимы протекания процесса в производственных условиях.

**Ключевые слова:** непереносимость лактозы, низколактозные молочные продукты, гидролиз лактозы

## **HARDWARE-UND TECHNOLOGISCHE GESTALTUNG DES PRODUKTIONSPROZESSES VON SORPTIONSMITTELN AUF BASIS VON AKTIVKOHLEMATERIAL**

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### **Zusammenfassung**

Die Relevanz der Forschung im Bereich der Entwicklung von Aktivkohlematerialien mit hoher spezifischer Oberfläche und Porosität ist aufgezeigt.

**Schlüsselwörter:** Hochtemperaturaktivierung, Aktivierungsmöglichkeiten, Eigenschaften des Kohlenstoffmaterials, Merkmale der technologischen Gestaltung des Prozesses.

### **Einführung**

Die Analyse von Arbeiten zur Entwicklung und Erforschung hochporöser Kohlenstoffmaterialien mit großer spezifischer Oberfläche und Porosität mit überwiegend Mikro- und Mesoporen ist ein relevanter Bereich vieler Studien, deren Ergebnisse in einer Reihe der Zweige der modernen Industrie gefragt sind. Dies kann dadurch erklärt werden, dass Mikroporen und Mesoporen in ihrer Struktur eine große spezifische Oberfläche haben, wodurch zusätzliches Volumen für zusätzliche Hohlräume entsteht. Um von einem Ort zum anderen zu gelangen, gibt es spezielle Autobahnen, die aus Hohlräumen bestehen. Unter den offensichtlichen Vorteilen kann man die vorherrschende Stabilität dieser Materialien hervorheben, und man kann auch die ziemlich gute Inaktivität dieser Substanzen hervorheben [1].

Bei der Analyse der Literatur stellen wir fest, dass die Ergebnisse der Studien zur alkalischen Hochtemperaturaktivierung sehr widersprüchlich sind. Zudem werden sie hauptsächlich unter Laborbedingungen betrachtet und berücksichtigen nicht die Besonderheiten und Merkmale der realen Produktion.

Um das gewünschte Ergebnis zu erzielen, können daher zwei Aktivierungsmöglichkeiten unterschieden werden:

Die erste Option – Aktivierung mit einem Aktivator – Alkali bei hohen Temperaturen – stellt den Prozess des Erhitzens einer Reaktionsmischung bestehend aus Carbonat mit Alkali in einem bestimmten Verhältnis auf bis zu 400 °C dar, gefolgt von einer Stunde Halten und weiterem Erhitzen und Halten bei 750 °C – innerhalb von zwei Stunden. Während des gesamten Aktivierungsprozesses wird durch die Zufuhr von Argon eine inerte Umgebung im Reaktor aufrechterhalten.

Zweite option: Aktivierung mit Alkali und Wasserdampf als Aktivator. Dabei kommt es zu einer Boudoir-Redoxreaktion, die durch die Strömung des aktivierten Reaktionsgemisches entlang der Phasengrenze an der Oberfläche gekennzeichnet ist.

Da die Temperatur des Prozesses der Hauptunterschied zwischen den betrachteten Aktivierungsmöglichkeiten ist, werden der Prozess und das Ergebnis ihrer Umsetzung in Bezug auf diesen Parameter betrachtet. Anschließend werden die



erfolgreichsten Aktivierungsmöglichkeiten miteinander verglichen.

### **Materialien und Methoden**

Um den Prozess der Hochtemperaturaktivierung mit den beiden Aktivierungsmöglichkeiten 1 und 2 zu untersuchen, wurde eigens ein experimenteller Laboraufbau entwickelt.

Um die notwendigen Schlussfolgerungen zu ziehen, war es notwendig, eine Reihe von Experimenten gemäß den vorgeschlagenen Optionen durchzuführen, mehrere gleichzeitig, nämlich fünf bei unterschiedlichen Temperaturen im Bereich von sechshundert bis neunhundert Grad. Aufgrund der technischen Parameter der Geräte wurden keine Experimente mit hohen Temperaturen durchgeführt, da es nicht möglich war, den korrekten Ablauf des Prozesses zu erzeugen, so dass in diesem Fall auf die Theorie zurückgegriffen werden muss, sondern auf Prozesse mit niedrigeren Temperaturwerten waren erfolgreich.

Als Ausgangsmaterialien wurden folgende Verbrauchsmaterialien verwendet: Die Ausgangskohlenstoffrohstoffe sind Carbonat und Graphenoxid.

Die Diagnostik der spezifischen Oberflächenparameter und der Porosität des resultierenden Aktivkohlematerials erfolgte mit einem Analysekomplex nach der Stickstoffadsorptionsmethode. In den durchgeführten Arbeiten wurden die sogenannten „BET“- und „BFT“-Modelle verwendet, um die Abmessungen, die spezifische Oberfläche und das von Hohlräumen eingenommene Volumen genauer zu bestimmen. Die während der Arbeiten angesammelten Materialien wurden nach einem zuvor erstellten Plan untersucht, der speziell für diese Forschung entwickelt wurde [4].

### **Ergebnisse und Diskussion**

Dadurch wurden Materialien mit einer bestimmten Oberfläche und einem bestimmten Porenvolumen erhalten, wovon Mikroporen mehr als 80 % ausmachten. Die Analyse experimenteller Daten zeigte, dass Aktivkohlematerialien mit sehr ähnlichen Parametern erhalten werden. Aufgrund der konkreten Umsetzung einer bestimmten Aktivierungsmöglichkeit ist jedoch eine deutliche Verschiebung extremer Modi zu beobachten.

Bei der Durchführung der Aktivierung gemäß der ersten Möglichkeit kann davon ausgegangen werden, dass die Hauptreaktionen bei einer Temperatur von etwa 750 °C am intensivsten ablaufen.

Die zweite Option hatte einen ähnlichen Effekt, der effektivste Temperaturwert liegt bereits bei 600 °C. Nach der Analyse der abgeschlossenen Prozesse können wir zu dem Schluss kommen, dass die Aktivierungen erfolgreich waren.

Zum jetzigen Zeitpunkt können wir sagen, dass die durchgeführten Optionen einander in nichts nachstehen und ihre eigenen Vor- und Nachteile haben. Der einzige Unterschied besteht darin, dass bei Option 1 keine zusätzlichen Aktivatoren verwendet wurden, sondern nur ein Alkali, das auf relativ hohe Temperaturen erhitzt wurde. Dieser Aktivator selbst wird benötigt, um den Prozess erheblich zu beschleunigen, hat jedoch einen wesentlichen Nachteil: Um ihn herum findet der Prozess der Zerstörung von Metalloberflächen statt.

Bei Option Nummer 2 wurde Wasserdampf hinzugefügt, was den Prozessverlauf veränderte, da hierfür ein Experiment durchgeführt werden musste, bei dem die

Температура в печи явно понижена, но также здесь могли бы быть достигнуты необходимые результаты, которые достигаются с помощью этого метода [2, 3].

Для сохранения лучших пористых структур, необходимо изменить используемое оборудование, чтобы улучшить технические свойства, и поэтому в настоящее время над этим работают.

### **Заключение**

Было установлено, что в настоящее время существуют различные подходы к активации, что связано с неоднозначностью процессов и их взаимным влиянием. Кроме того, это в первую очередь связано с накоплением экспериментальных данных в лабораторных условиях.

Анализ вариантов активации показал, что в первом случае особое внимание следует уделять выбору конструктивных материалов и дизайна оборудования. Во втором случае необходимо уделять больше внимания технологическим режимам при более низких температурах.

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## **АППАРАТУРНО-ТЕХНОЛОГИЧЕСКОЕ ОФОРМЛЕНИЕ ПРОЦЕССА ПРОИЗВОДСТВА СОРБЕНТОВ НА ОСНОВЕ АКТИВИРОВАННОГО УГЛЕРОДНОГО МАТЕРИАЛА**

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**Аннотация:** Показана актуальность исследований в области разработки активированных углеродных материалов с высокой удельной поверхностью и пористостью.

**Ключевые слова:** высокотемпературная активация, варианты проведения активации, характеристики углеродного материала, особенности технологического оформления процесса.

## MÉTHODE DE RÉGÉNÉRATION ALCALINE PAR ADSORPTION DE L'HUILE DE MOTEUR SYNTHÉTIQUE USÉE

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### Résumé

Le but de cette étude est de développer et de tester une nouvelle méthode de régénération des huiles de moteur usagées en utilisant comme exemple un mélange d'huiles de moteur synthétiques. Une couche d'alcali, d'hydroxyde de sodium, a été appliquée sur la surface du gel de silice. Une méthode a été proposée pour créer un sorbant modifié à l'aide d'une machine à culbuteur à tambour, qui peut être utilisée dans les technologies industrielles pour la régénération des huiles de machines. L'efficacité des processus de régénération a été évaluée en surveillant les valeurs de l'indice d'acide. La cinétique des changements d'indice d'acide lors de la régénération de l'huile moteur a été étudiée.

**Mots clés:** adsorption, huile de machine, régénération d'huile, huile moteur.

### Introduction

Le développement moderne de la société nécessite le développement d'approches pour une utilisation rationnelle et sûre des ressources. Le chiffre d'affaires des lubrifiants ne fait pas exception [1]. Malheureusement, il convient de noter qu'il n'existe actuellement pas en Russie de système centralisé de collecte et de traitement des lubrifiants défectueux, qui présentent un potentiel élevé en matières premières. Un certain nombre de domaines d'utilisation des huiles de moteur usagées (HMU) sont pris en compte dans la littérature. Par exemple, la transformation de l'HMU en combustible marin ou pour chaudières et fours, la régénération pour une utilisation ultérieure pour son objectif d'origine, la transformation pour une utilisation dans d'autres domaines (plastifiants, composés anticorrosion, lubrifiants à d'autres fins).

Lors du fonctionnement des huiles de moteur, elles subissent des modifications physiques et chimiques liées principalement à leur oxydation, et leur défaillance qui est due à l'accumulation de produits d'oxydation. Des produits d'oxydation de haut et de bas poids moléculaire peuvent être distingués. Le premier groupe comprend les produits de la réaction de polymérisation oxydative, qui comprennent principalement les composés aromatiques et naphthéniques contenus dans l'huile. Leur formation entraîne un noircissement de l'huile moteur et une augmentation de sa viscosité. Le deuxième groupe comprend les acides organiques de faible poids moléculaire (formique, acétique), très corrosifs, notamment en présence d'eau. L'eau est également un produit d'oxydation. La présence de ces substances nécessite des mesures pour les éliminer, appelées régénération. Actuellement, toutes les méthodes de régénération peuvent être divisées en physiques [2] (décantation, séparation, filtration, distillation), physico-chimiques [3] (adsorption, coagulation, séchage thermique sous vide, dissolution sélective) et chimiques (acide, alcaline, hydrotraitement).

Le choix de la méthode dépend de l'état initial et la nature de l'huile usée et son application future. Si le but de la régénération est de remettre l'huile de moteur en circulation, il est alors nécessaire de choisir des méthodes capables d'éliminer à la fois les produits d'oxydation de faible poids moléculaire et de haut poids moléculaire. Dans le même temps, si la tâche consiste à transformer l'HMU en graisses [4], la présence de composés de haut poids moléculaire ne fait qu'augmenter la capacité portante du lubrifiant et, par conséquent, la tâche consiste à éliminer les acides de faible poids moléculaire qui ont un effet corrosif. La plupart des méthodes répertoriées ne peuvent pas éliminer tous les produits d'oxydation. Par exemple, les méthodes mécaniques éliminent bien l'eau et les impuretés mécaniques, mais n'ont pratiquement aucun effet sur la réduction de l'acidité. Dans le même temps, les méthodes chimiques alcalines désoxydent très bien l'huile, mais ne peuvent pas neutraliser les produits de polymérisation oxydative de haut poids moléculaire. Il faut également comprendre que le processus d'oxydation des huiles en produits d'oxydation de faible poids moléculaire est un processus séquentiel dont les substances intermédiaires sont des alcools, des cétones et des aldéhydes. Même si un traitement alcalin de haute qualité est effectué, il ne permet pas de les éliminer, ce qui entraîne une diminution de la durée de vie de l'HMU régénéré. Pour obtenir un bon résultat dans l'élimination des produits d'oxydation, des combinaisons de méthodes de régénération sont utilisées dans la pratique [5]. À cet égard, il est très pertinent de mener des recherches scientifiques dans le domaine de l'application de méthodes combinées de régénération des huiles de moteur à des fins diverses.

### **Partie expérimentale**

**Formulation du problème.** Il est nécessaire de mener une étude expérimentale de la cinétique du processus de régénération de l'huile de moteur synthétique en utilisant une méthode combinée d'adsorption alcaline utilisant du gel de silice avec de l'hydroxyde de sodium déposé à sa surface, avec une concentration de 0,1 et 5,0 % en poids en poids de gel de silice.

### **Technique expérimentale**

Le sorbant a été préparé selon la procédure suivante. Le gel de silice original avec une taille de granules sphériques de 1,6 à 2,5 mm, une taille moyenne de pores de 0,9 à 1,0 nm, une surface spécifique moyenne selon la méthode BET de 1030 m<sup>2</sup> /g a été calciné à une température de 450 °C pendant 4 heures, après quoi il a été refroidi à la température ambiante dans un dessiccateur. À l'étape suivante, 20 g de gel de silice ont été versés dans une machine à culbuter à tambour KT-6808 avec l'ajout de 0,02; 0,1; 0,2; 1 g de NaOH pour obtenir des sorbants modifiés contenant 0,1, 0,5, 1, 5 % de poids des alcalis. Le tambour est prismatique d'un diamètre de 150 mm. Le temps de traitement 10 min. avec la marche arrière toutes les 30 s. Le sorbent obtenu a été stocké dans des conteneurs en polyéthylène hermétiquement fermés.

L'huile synthétique usagée, 150 g chacune, a été versée dans 5 flacons coniques d'un volume de 250 ml. 15 g de sorbant modifié. Le cinquième flacon est un flacon témoin; le gel de silice non modifié a été utilisé. Les flacons ont été hermétiquement bouchés et placés sur une machine à agiter Kavalier. L'amplitude des vibrations longitudinales est de 85 mm, la fréquence des vibrations est de 2 Hz. À des moments de 15, 30, 60, 90, 120 minutes, des échantillons ont été prélevés pour mesurer l'indice

d'acide conformément à GOST 5985-79. L'indice d'acide initial est de 0,21 mg KOH/g. Les résultats de mesure de la série ont été moyennés à l'aide de la méthode de la moyenne arithmétique. La température dans le laboratoire au moment de l'expérience était de 20 °C.

### Résultats de la recherche et discussion

La dépendance de la variation de la valeur moyenne de l'indice d'acide de l'huile de moteur synthétique en fonction du temps pour des absorbants avec de différentes teneurs en NaOH est représentée sur la Fig. 1 et 2.

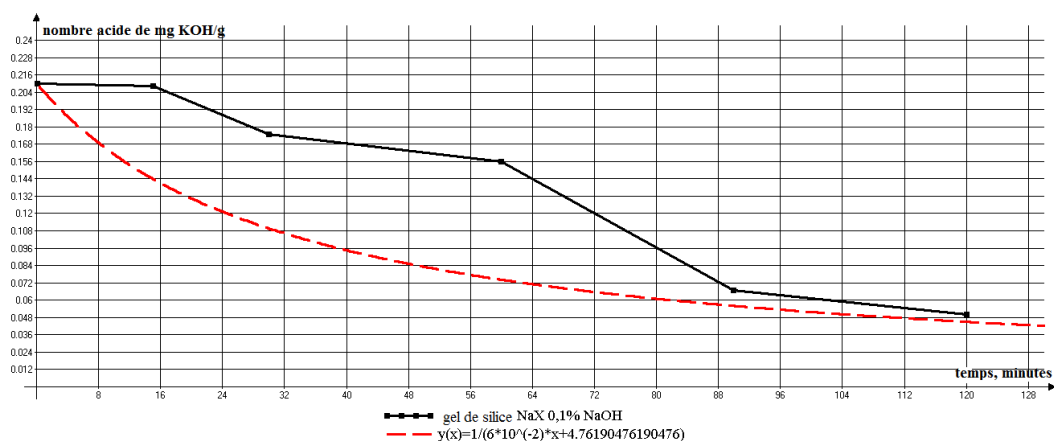


Figure 1 - Cinétique du processus de désoxydation de l'huile de moteur synthétique usagée contenant 0,01 % de NaOH en poids de gel de silice

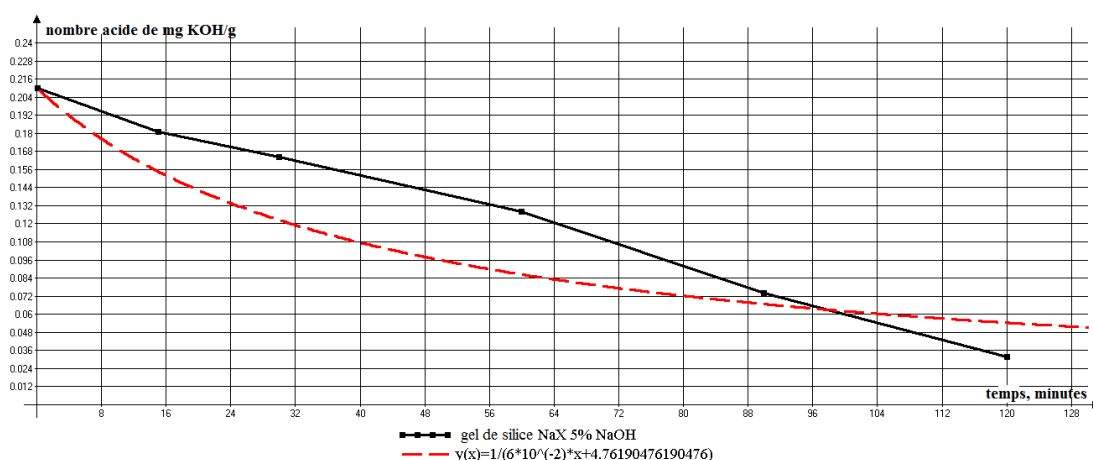


Figure 2 - Cinétique du processus de désoxydation des huiles de moteur synthétiques usagées contenant 5 % de NaOH en poids de gel de silice

Comme on peut constater, aux étapes initiales (durée de traitement jusqu'à 60 minutes), il n'y a pratiquement aucune différence dans les absorbants utilisés. L'absorbant contenant de l'hydroxyde de sodium 0,1 % en poids montre un résultat pire, qui peut s'expliquer par l'encapsulation de la surface du gel de silice avec un alcali; pour un autre échantillon modifié, cet effet est compensé par une teneur plus élevée en NaOH. Avec un traitement ultérieur, les absorbants modifiés montrent une meilleure efficacité dans l'élimination des produits d'oxydation de faible poids moléculaire.

Il existe une dépendance monotone de la diminution de la valeur finale de l'indice

d'acide (AN) de l'huile de moteur synthétique régénérée à mesure que la concentration d'hydroxyde de sodium augmente.

### **Conclusion**

L'utilisation d'une méthode originale et relativement simple de régénération des huiles de moteur usagées permet de restaurer efficacement leurs performances. Pour atteindre les paramètres standard de l'huile de moteur synthétique, l'interaction des huiles de moteur usagées est nécessaire pendant 120 minutes avec le gel de silice contenant 5% en poids d'hydroxyde de sodium.

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## **АДСОРБЦИОННО-ЩЕЛОЧНОЙ МЕТОД РЕГЕНЕРАЦИИ СИНТЕТИЧЕСКОГО ОТРАБОТАННОГО МОТОРНОГО МАСЛА**

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**Аннотация:** Целью данного исследования является разработка и проведение испытаний нового метода регенерации отработанного машинного масла, на примере смеси синтетических моторных масел. На поверхность силикагеля нанесен слой щелочи, в качестве которой использовали гидроксид натрия. Предложен способ создания модифицированного сорбента с помощью галтовочной машины барабанного типа, который можно применять в промышленных технологиях регенерации машинных масел. Оценка эффективности процессов регенерации осуществлялась в результате контроля значений кислотного числа. Изучена кинетика изменения кислотного числа в процессе регенерации машинного масла.

**Ключевые слова:** адсорбция, машинное масло, регенерация масла, моторное масло.

## DEVELOPMENT OF A MECHATRONIC MODULE FOR SULFUR DOSING

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### Abstract

The study aims to make a sulfitation process more predictable. In order to achieve the goal a control system for the mechatronic module for supplying sulfur to the furnace was designed, as well as a pneumatic drive for installing sulfur supply to the furnace in the technological process of feedwater sulfitation. The air mass flow was calculated. A pneumatic circuit diagram of a pneumatic drive has been developed and pneumatic equipment has been selected. A basic electrical and structural diagram of the control system has been developed.

**Keywords:** mechatronic module, pneumatic drive, sulphitation, sulfur.

### Introduction

Sulfitation is the treatment of sugar solutions with sulfur dioxide. According to the technological scheme, filtered juice of the second saturation, a mixture of syrup with clearing and water supplied for diffusion are subjected to sulfitation. Improving automated sulfitation systems is a priority as it directly affects the quality of beet juice in diffusion plants, where the greatest loss of sucrose occurs. Currently, at the Kristall LLC sugar plant, an imperfect installation for supplying sulfur to the furnace is used in the technological process of feedwater sulfitation. The main disadvantages of the unit are the pneumatic system, which has no speed control, the design of the feed mechanism, due to which more than 30 percent of the sulfur fed into the furnace spills on the floor, the lack of indication of the sulfur hopper load and the pH value.

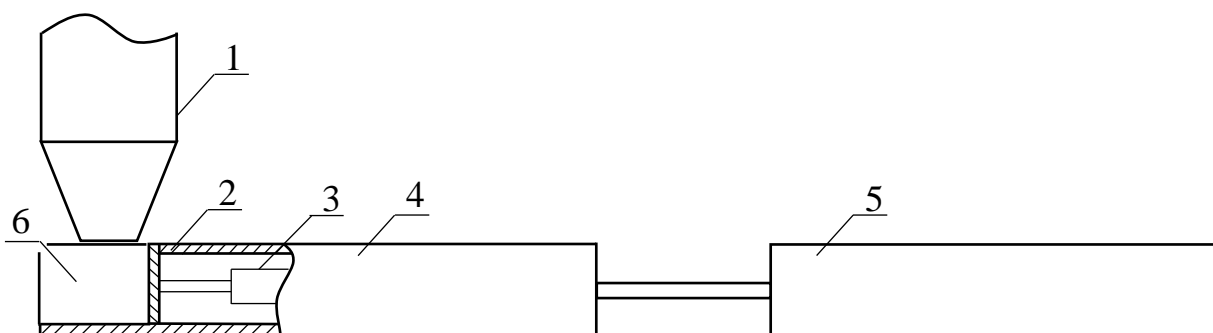
The sulfur dosing installation, for which the drive was designed in the work, relates to the technological process of influent water sulfitation, which is one of the stages of sugar extraction using the diffusion method. Sugar extraction is the extraction of sucrose from beet chips with specially prepared water. Diffusion is the spontaneous transition of substances from places of higher concentration to places of lower concentration due to Brownian motion of the molecule.

The technological process of sulfitation begins with the supply of sulfur to a sulfur-burning furnace by a separate unit. The operator of diffusion installations, analyzing the readings of the pH meter, decides to turn on the installation. The bunker is filled with sulfur manually. After starting the installation, the pneumatic cylinder extends the rod, which in turn moves the rectangular profile on which sulfur is poured. The amount of substance dosed into the furnace per cycle depends on the gap between the hopper and the profile. The sulfur filling is stopped by blocking the hopper opening with a metal plate welded onto the profile.

During the operation of the installation for dosing sulfur into the furnace, the following shortcomings were identified. Due to the lack of speed control and the absence of sides on the profile, when the rod extends, some of the sulfur spills onto

the floor without having time to get into the furnace. Sulfur spills out in the furnace by a sharp movement of the rod back, causing some of the sulfur to remain on the profile or fall to the floor.

To solve these problems, a new design of the feeder was designed, the diagram is shown in Figure 1. Sulfur is poured into box 6, which is formed by cutting out the upper part of a rectangular profile. When the installation starts, the cylinder rod 5 extends, thereby moving the profile 4 and closing the opening of the hopper 1. When the cylinder rod 5 reaches its final position, the pneumatic cylinder 3 is activated, which extends the partition 2, thereby pouring sulfur into the furnace. The cylinders return to their original position in the reverse order. The amount of sulfur dosed depends on the size of the box.



1 – bunker; 2 – partition; 3 – small pneumatic cylinder; 4 – profile with cutout; 5 – large pneumatic cylinder, 6 – box

*Figure 1 – Modernized sulfur dosing unit*

A pneumatic control circuit for the installation cycle was developed. Its main feature is that the position of the pneumatic cylinder rods is controlled by pressure. Such control circuits are used when it is impossible to install limit switches or it is necessary to control the pressure value. The basic principle of operation is that the rod cavity of the cylinder is connected to the control cavity of the distributor 1, which remains turned on until the pressure in the rod cavity drops to a pressure at which the distributor can switch under the action of its spring. This will happen only when the piston completes its stroke to the right, and the distributor will communicate with the pressure source to the left cavity of the distributor 2, which will switch and the cylinder piston will return to its original position. The system also has only one electrical signal (to complete the cycle), which provides explosion and fire protection, which is a big plus when dosing sulfur.

The mechatronic module control system consists of seven main blocks presented in the structural diagram. The operating principle of the developed mechatronic system is based on the analysis of readings of the sulfur bunker level, using B8D strain gauges, and the pH of sulfated water, using a pH/ORP meter type pH-4122, which has a pH combination electrode with built-in temperature sensor, Polilyte (measuring glass electrode and auxiliary (reference) electrode in one housing), and based on the data received by the controller (Siemens S7-1200), timely turning on the drive. Sulfur is fed into the furnace in portions of 0.14 g. Such a small dosing weight was chosen due to the inertia of pH changes. Inertia occurs due to the relatively long



time it takes for all stages of sulfitation to pass before the sensor detects changes. The speed of the sulfur feed cycle is controlled using pneumatic throttles.

### **Conclusion**

The work done led to the following results:

1. The development of a new design for the mechanism for supplying sulfur to the sulfitation furnace made it possible to reduce the amount of spilled sulfur, as well as to make the portions of supplied sulfur per cycle constantly equal, and therefore make the sulfitation process more predictable;
2. The development of a pneumatic control circuit made it possible to make the speed of the drive adjustable over a wide range, as well as to remove unnecessary electrical signals, which increased explosion and fire safety.

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## **РАЗРАБОТКА МЕХАТРОННОГО МОДУЛЯ ДОЗИРОВАНИЯ СЕРЫ**

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**Аннотация:** Целью проведенной работы было сделать процесс сульфитации более предсказуемым. Для достижения поставленной цели была спроектирована система управления мехатронным модулем подачи серы в печь, а также пневмопривод установки подачи серы в печь в технологическом процессе сульфитации питательной воды. Рассчитан массовый расход воздуха. Разработана пневмосхема пневмопривода и подобрано пневмооборудование. Разработана принципиальная электрическая и структурная схема системы управления.

**Ключевые слова:** мехатронный модуль, пневмопривод, сера, сульфитация.

## THE INFLUENCE OF BIOCHAR PARAMETERS ON THEIR SORPTION CHARACTERISTICS

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### Abstract

The work carried out sorption studies of highly efficient sorption materials based on secondary raw materials from sunflower processing. The materials were obtained by hydrothermal carbonization (Sunf./HTC), followed by carbonization (Sunf./HTC/C) and activation (Sunf./HTC/C/KOH). The kinetics of liquid-phase adsorption on the developed materials of an organic dye, methylene blue (MB), was studied. It was revealed that the adsorption capacity of the obtained materials according to MB is: Sunf./HTC – 1500 mg/g, Sunf./HTC/C – 1700 mg/g, Sunf./HTC/C/KOH – 2400 mg/g. The sorption time was 10 minutes.

**Keywords:** activation, adsorbent, carbonization, methylene blue, sunflower.

### Introduction

A rapidly developing area that occupies a special niche is the development of technologies for the creation and use of new sorption materials made from recycled materials [1, 2]. This approach allows us to minimize the burden on the environment and save natural resources. In this work, a line of samples of hydrothermal carbon synthesized from sunflower meal was studied. It is known that carbon obtained by carbonization of sunflower meal has a macroporous structure. Activation promotes the formation of meso- and micropores, which significantly increases the sorption capacity of the material [3].

The initial stage of material synthesis is hydrothermal carbonization of the meal. The meal is pre-crushed for 50 seconds and sifted through a sieve less than 2 mm in size. The crushed meal and distilled water are placed in a 100 ml autoclave. The autoclave is placed in a drying cabinet, preheated to 180°C and kept for 12/24 hours. The contents of the autoclave are filtered by a water jet pump through a fabric filter to remove reaction by-products. Next, the resulting material is dried at 110°C to constant weight.

For carbonization, the precursor material is loaded into a reactor and placed in a muffle furnace. Carbonization is carried out in an inert environment with a constant supply of argon (flow rate 1 l/min) in 3 stages by heating and holding the sample at 150, 500 and 750°C in steps for an hour at each temperature.

For activation, potassium hydroxide is added to the precursor material in a ratio of 1 to 6, after which it is loaded into the reactor and placed in a muffle furnace. Activation is carried out in an inert environment with a constant supply of argon (flow rate 1 l/min) in 2 stages by heating and holding the sample at 400 and 750°C stepwise for an hour at each temperature.

After activation, the resulting material is washed with distilled water, then the remaining alkali is neutralized with hydrochloric acid, after which the material is washed with distilled water. Next, the material is sent for drying in an oven at a

temperature of 100°C.

Figure 1 shows SEM images of the structure of hydrothermal carbon before and after alkaline activation.

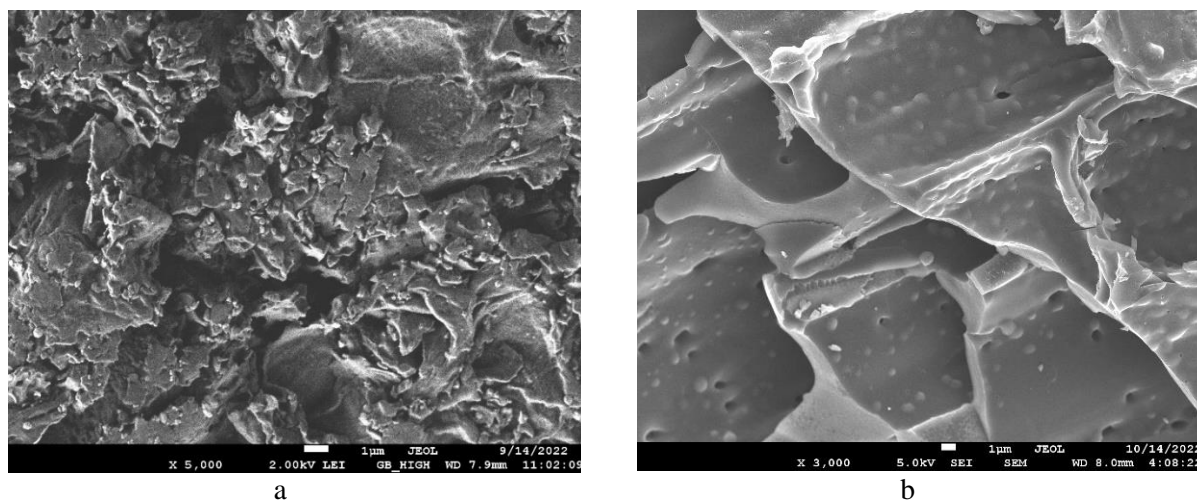


Figure 1 - Structure of hydrothermal carbon before (a) and after alkaline activation (b)

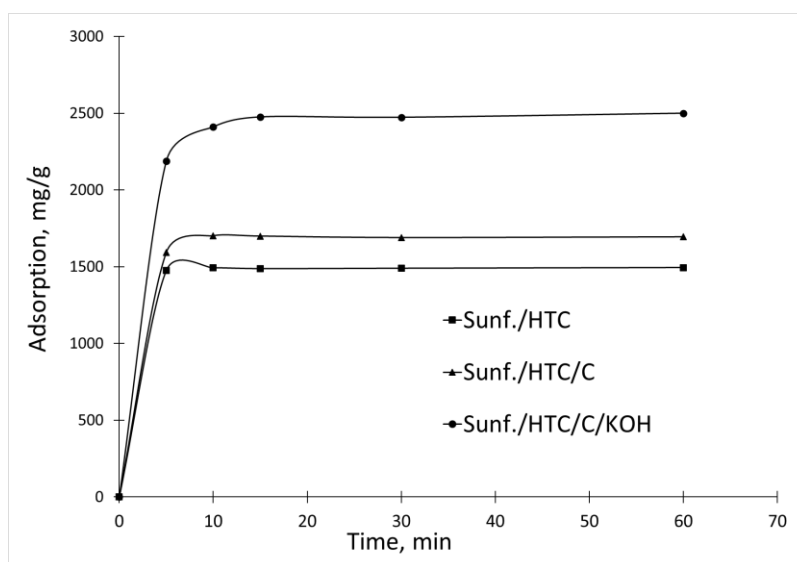


Figure 2 - Kinetic dependences of MB dye adsorption on materials Sunf./HTC, Sunf./HTC/C, Sunf./HTC/C/KOH

In the process of carrying out sorption studies, 0.01 g of the synthesized material is placed in a test tube with a model MB solution [4] (initial concentration 1500 mg/l) with a volume of 30 ml. Contact times were 5, 10, 15, 30 and 60 min. As a result of the studies, the kinetic dependences of the process of liquid-phase extraction of MB were obtained, presented in Fig. 2.

Analyzing the data obtained, we can conclude that the material shows a high activity in the absorption of MB molecules from aqueous systems. The adsorption capacity for the obtained materials Sunf./HTC, Sunf./HTC/C, Sunf./HTC/C/KOH was 1500 mg/g, 1700 mg/g, 2400 mg/g, respectively, with a sorption time of 10 minutes.

### Conclusion

Thus, alkaline activation is a strategy for the formation of hierarchical porosity

and increasing the surface area of hydrothermal carbon, and, accordingly, increasing the sorption capacity of the material synthesized from sunflower meal.

### **Acknowledgements**

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## **ВЛИЯНИЕ ПАРАМЕТРОВ ПОЛУЧЕНИЯ БИОУГЛЕЙ ИЗ ОТХОДОВ НА ИХ СОРБЦИОННЫЕ ХАРАКТЕРИСТИКИ**

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**Аннотация:** В работе проведены сорбционные исследования высокоэффективных сорбционных материалов, основанные на вторичном вторсырье органического происхождения – подсолнечник. Материалы были получены путем гидротермальной карбонизации (Подс./ГТК), с последующим прохождением карбонизации (Подс./ГТК/К) и активации (Подс./ГТК/К/КОН). Была изучена кинетика жидкофазной адсорбции на разработанных материалах органического красителя – метиленового синего (МС). Выявлено, что адсорбционная емкость полученных материалов по МС составляет: Подс./ГТК – 1500 мг/г, Подс./ГТК/К – 1700 мг/г, Подс./ГТК/К/КОН – 2400мг/г. Оптимальное время сорбции 10 минут.

**Ключевые слова:** адсорбент, активация, карбонизация, метиленовый синий, подсолнечник.

## MATHEMATICAL MODELING OF THE CARBAMIC ACID FORMATION REACTION

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### Abstract

The article discusses mathematical modeling of the reaction of formation of carbamic acid from sulfuric and isocyanic acids. The value of the energy barrier of the reaction and the reaction rate constants at different temperatures were determined.

**Keywords:** carbamic acid, DFT, isocyanic acid, sulfonation, sulfuric acid.

### Introduction

The synthesis of carbamic acid derivatives is an important step in the production of polyurethane materials, which are used in various industries, including the automotive industry, construction, furniture manufacturing. It is known that carbamic acid esters are obtained by adding alcohols to organic isocyanates or isocyanic acid ( $R=H$ ) [1]:



Under the influence of sulfuric acid and heat, if necessary, the carbamic acid esters can undergo cleavage, which will essentially reverse this addition reaction and ultimately produce sulfamic acids. Since it is known that sulfamic acids are formed by the reaction of organic isocyanates or isocyanic acid with sulfuric acid:



In addition, studies show that isocyanic acid reacts with sulfuric acid by two mechanisms: the formation of urethane-like structures or carbamic acid. The second mechanism is preferable because it requires much milder conditions [2].

In this regard, there is a need to study the mechanism of carbamic acid formation.

### Materials and methods

The reaction mechanism between sulfuric and isocyanic acids was studied using density functional theory (DFT). To optimize the molecular geometry and thermodynamic corrections, the range-separated functional  $\omega$ B97x-D4 was used [3]. Basis set aug-cc-pVTZ was added. The influence of the solvent was taken into account by the COSMO continuum model. To calculate the electron energy, a single-point DLPNO-CCSD(T) calculation with an complete basis set (CBS) was used, as a result of which good results were obtained at a reduced cost of solving the problem. All calculations were carried out in the ORCA quantum chemical package [4]. The nudged elastic band (NEB) method was used to find the transition state.

### Results

As a result of the interaction of  $H_2SO_4 + HNCO$ , the reaction proceeds with the formation of a pre-reaction complex, then through the transition state - the migration of the  $H^+$  and  $OH^-$  proton to isocyanic acid on the nitrogen and carbon atoms, respectively. At the end of the reaction path, the complex disintegrates  $SO_3$  and

$H_2N - C(=O) - OH$  are formed (see Fig. 1).

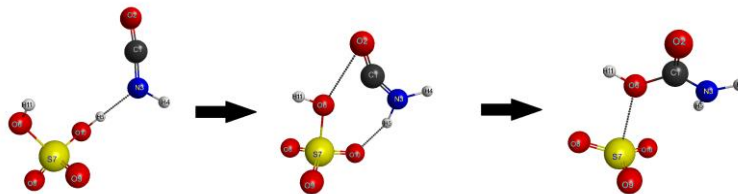


Figure 1 - Interaction mechanism  $H_2SO_4 + HNCO$

The complete reaction path is shown in the graph (see Fig. 2).

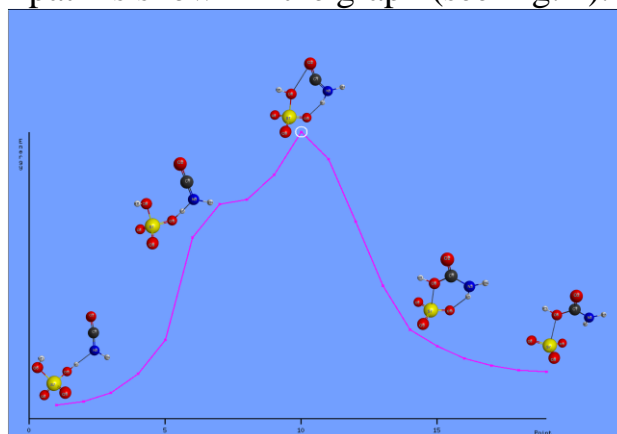


Figure 2 - Graph of electronic energy versus coordinates

To understand the progress of the reaction and the magnitude of the energy barrier, profiles of changes in the Gibbs energy ( $\Delta G$ ) were considered (see Fig. 3). For comparison, calculations were carried out at four temperatures: 298 K, 323 K, 348 K, 373 K.

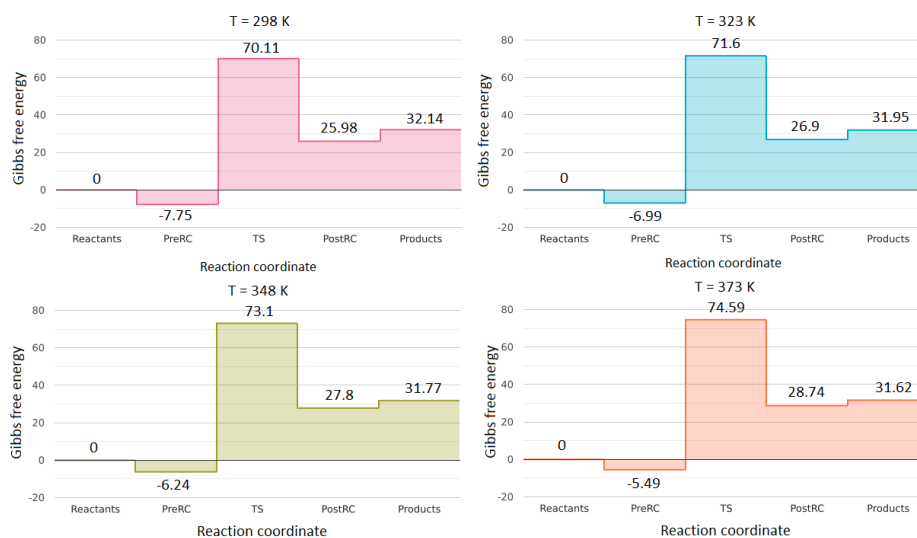


Figure 3 - Gibbs energy profiles at 298 K, 323 K, 348 K and 373 K

It was noted that the pre-reaction complexes are stable at these temperatures, and the post-reaction complex is also stable.

The energy barrier for the transition state (TS) makes it difficult for this reaction to occur at room temperature, however, at temperatures of the order of 70÷80 °C, a

barrier of 70 kJ/mol is completely surmountable. Because of this, carbamic acid can be detected in the reaction mass.

Reaction rate constant  $H_2SO_4 + HNCO \rightarrow H_2N - C(=O) - OH + SO_3$  will be equal to:

$$k = \frac{\chi \times k_b \times T}{h} \times e^{\frac{-\Delta G^\ddagger}{R \times T}},$$

where  $k$  is the reaction rate constant,  $s^{-1}$ ;  $T$  is the process temperature, K;  $k_b$  is the Boltzmann constant, J/K;  $h$  is Planck's constant,  $J \times s$ ;  $\Delta G^\ddagger$  is Gibbs energy, J/mol;  $R$  is universal gas constant, J/(mol  $\times$  K);  $P_0$  is the atmosphere pressure,  $J/m^3$ .

The reaction rate constant will be calculated for a first order reaction as it is taken from the difference between the pre-reaction and activated complexes. These changes in the reaction rate constant are described in Table 1.

Table 1 – Dependence of the reaction rate constant on the process temperature

T, K	298	323	348	373
k, $s^{-1}$	0,137	1,29	8,81	46,76

It can be concluded that the reaction rate constant depends on the increasing temperature, since the Gibbs energy remains almost unchanged.

### Conclusion

Thus, at low temperatures, the formation of urea acid is difficult, but with increasing temperature, it becomes possible. This is important to understand for further study of the mechanism of carbamic acid formation.

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## МАТЕМАТИЧЕСКОЕ МОДЕЛИРОВАНИЕ РЕАКЦИИ ОБРАЗОВАНИЯ КАРБАМИНОВОЙ КИСЛОТЫ

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**Аннотация:** Проведено математическое моделирование реакции образования карбаминовой кислоты из серной и изоциановой кислот. Определено значение энергетического барьера реакции и констант скорости реакции при разных температурах.

**Ключевые слова:** изоциановая кислота, карбаминовая кислота, серная кислота, сульфирование, DFT.

УДК 621.516  
ББК 31.565

## THE PROBLEM OF INPUT LINK SELECTION FOR THE LIQUID RING VACUUM PUMP WITH ROTATING BODY

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### Abstract

The article is devoted to substantiation and selection of the input link for the design of liquid ring vacuum pump with rotating body. Brief about units and main disadvantages are given. The main tendencies of development of such pumps are marked. The scheme of the pump with a rotating body is presented and the schemes of force transmission in similar kinematic mechanisms depending on the selected input link are described.

**Keywords:** input element, liquid-ring machines; liquid-ring vacuum pump; rotating body.

### Introduction

Liquid ring vacuum pumps (LRVP) are used in technological processes of various industries as auxiliary equipment. For example, in the chemical industry they can be used in mass transfer processes, in agriculture they are used for transportation of bulk materials (grain, flour, etc.), as well as in the production of construction materials, mechanical engineering, etc. Such widespread use of LRVP is due to their reliability, high degree of maintainability, insensitivity to penetration of solid particles into the working cavity, and they have no special lubrication systems (except for bearing units, which need grease lubrication) [1]. But such units have several main disadvantages - high energy consumption and relatively low efficiency. Usually, this is explained by the design features of the lubricators themselves. Therefore, one of the urgent tasks is the search for technical solutions aimed at eliminating the above disadvantages.

### Discussion

Among such technical solutions, those which consist in the development of rotating casing designs are particularly notable, but they are quite rare. This is due to the complexity of individual pump components. Nevertheless, it is proved that the use of rotating casing rotary liners allows to reduce the power input to the pump shaft by at least 20% [1, p. 25].

The scheme of such a pump is shown in Figure 1. Its main parts are impeller 1 and rotating casing 2. In the considered scheme of the pump it is acceptable to use both rotating casing and vane wheel as an inlet link. However, the dynamic conditions of interaction of working (mating) profiles in these cases will be different.

As a rule, the transmission of forces in kinematic pairs of mechanisms is carried out in a direction different from the direction of motion of the corresponding points



of the links to which these forces are applied. The angle between the force vector and the velocity vector of the point of its application is called the pressure angle. It is not a constant value for a particular kinematic pair, and varies depending on the position of the mechanism, and in some points of the cycle can take maximum values. Exceeding the permissible values of the pressure angle leads to self-locking (jamming of the mechanism). Thus, in order to reduce the wear of working profiles due to the reduction of reactions in kinematic pairs, increasing the efficiency of the mechanism, it is necessary to strive to reduce the value of the pressure angle when designing.

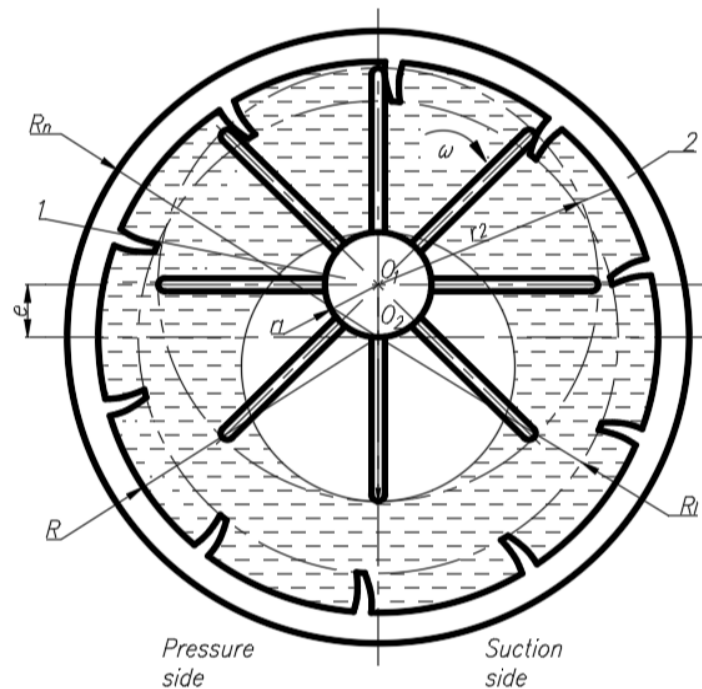


Figure 1 – Schematic diagram of the internal device of the rotating case: 1 – impeller, 2 – rotating case,  $R_n$  – outer radius of the case,  $R$  – inner radius of the case,  $R_i$  – radius of the circumference of the protrusions (blades) of the case,  $r_1$  – impeller hub radius,  $r_2$  – outer radius of the impeller,  $O_1, O_2$  – centers of rotation of the shaft and the case respectively,  $\omega$  – direction of rotation of links

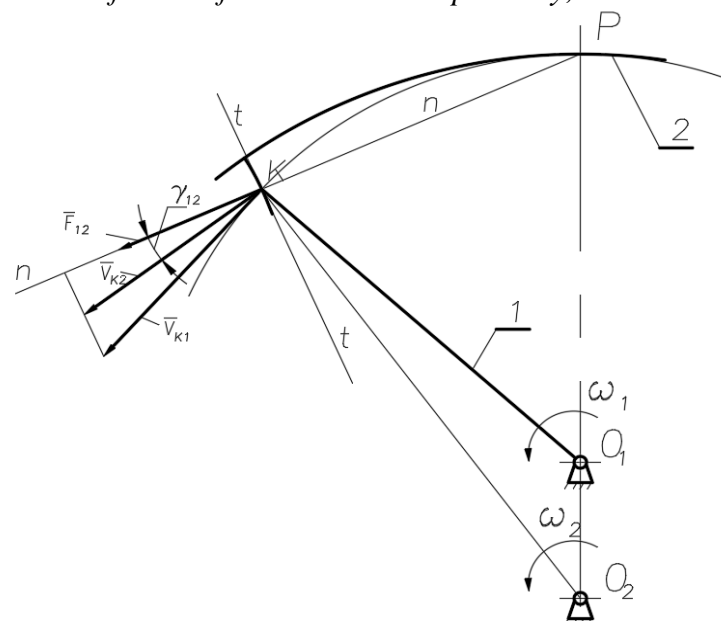


Figure 2 – Determining the pressure angle for force transmission from link 1 to link 2

We consider the conditions of force transfer between the working profiles of the LRVP mechanism in the case when the input link is the impeller 1 (Fig. 2) and in the case when it is the rotating body 2 (Fig. 3). The reaction in the highest kinematic pair, without taking friction into account, is directed along the common normal  $n-n$  to the contacting surfaces.

In Fig. 2, the symbol  $\bar{F}_{12}$  indicates the force transmitted from link 1 to link 2. The interaction of the links is realized at point  $K$ . However, the point  $K$  belonging to impeller 1 moves in the direction perpendicular to the segment  $KO_1$  with velocity  $\bar{V}_{K1}$ . In turn, the velocity  $\bar{V}_{K2}$  of the point  $K$  belonging to the body 2 is perpendicular to the segment  $KO_2$ . Since in this case, the force taking link  $\bar{F}_{12}$  is the pump casing 2, the pressure angle  $\gamma_{12}$  is the angle between the vectors  $\bar{F}_{12}$  and  $\bar{V}_{K2}$ .

In Fig. 3, the input is body 1 and the force  $\bar{F}_{21}$  is transmitted from link 2 to link 1. The angular velocities of the links  $\omega_1$  and  $\omega_2$  as well as the velocity vectors  $\bar{V}_{K1}$  and  $\bar{V}_{K2}$  change their direction to the opposite direction. In this case, the force  $\bar{F}_{21}$  is absorbed by impeller 1, and the pressure angle  $\gamma_{21}$  is the angle between the vectors  $\bar{F}_{21}$  and  $\bar{V}_{K1}$ .

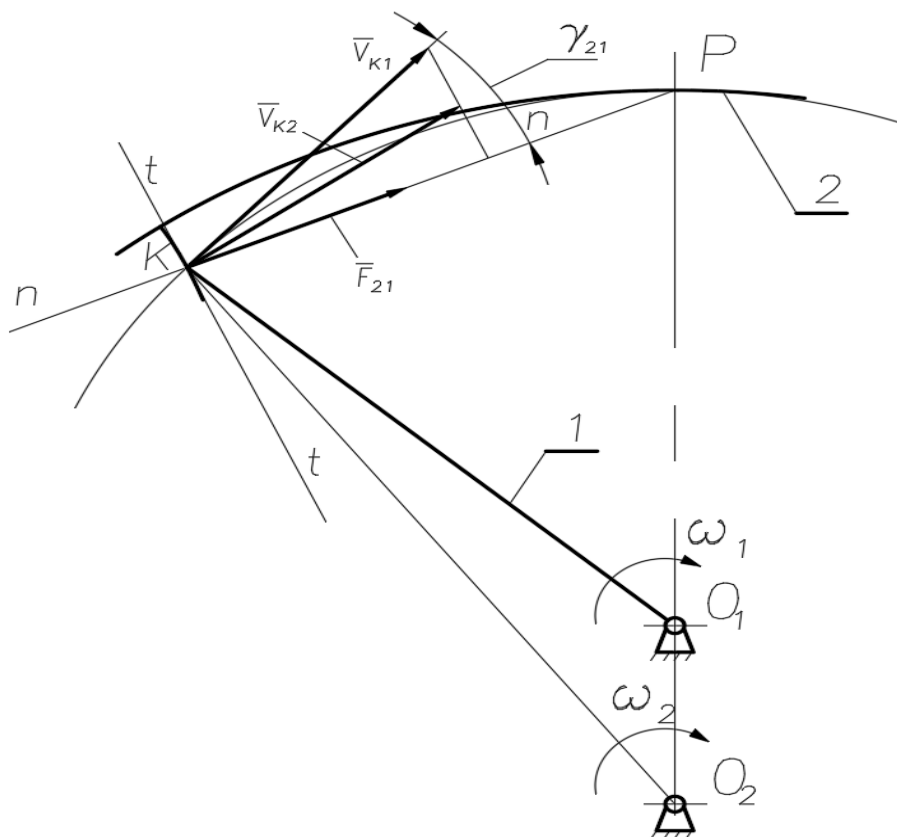


Figure 3 – Determining the pressure angle for force transmission from link 2 to link 1

### Conclusion

From the analysis of Figs. 2 and 3, it can be concluded that in any position of the links between the pressure angles, the ratio  $\gamma_{12} < \gamma_{21}$  will be maintained, therefore, in order to create better conditions for the transmission of force through the kinematic pair, the impeller should be selected as the input link.

Thus, a number of articles [2, 3, 4] devoted to the theoretical study of the interaction of conjugate profiles in the designs of liquid ring vacuum pumps with a rotating body substantiate the expediency of further applied research in the field of development of such units.

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## ПРОБЛЕМА ВЫБОРА ВХОДНОГО ЗВЕНА ДЛЯ ЖИДКОСТНОКОЛЬЦЕВОГО ВАКУУМНОГО НАСОСА С ВРАЩАЮЩИМСЯ КОРПУСОМ

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**Аннотация:** Статья посвящена обоснованию выбора входного звена для конструкции жидкостнокольцевого вакуумного насоса с вращающимся корпусом. Приведены краткие об агрегатах и основных недостатках. Отмечены основные тенденции развития таких насосов. Представлена схема насоса с вращающимся корпусом и описаны схемы передача сил в подобных кинематических механизмах в зависимости от выбранного входного звена.

**Ключевые слова:** жидкостнокольцевые машины; жидкостнокольцевой вакуумный насос; вращающийся корпус; входное звено.

## DIGITAL ENGINEERING SYSTEMS FOR AUTOMATED CALCULATION OF ALLOWANCES AND CUTTING MODES

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### **Abstract**

The article presents an overview of digital engineering systems developed by graduate students of Tambov State Technical University for process engineers of machine-building enterprises. The systems are designed for automated calculation of allowances and cutting modes, which is especially useful when compiling technological processes for machining parts. The presented programs ensure the accuracy of calculations, as well as significantly reduce the time for their execution.

**Keywords:** algorithm, code, mechanical engineering, program, system

### **Introduction**

Over the past half century, mechanical engineering has made a huge leap in development. The development of electrical engineering and computer technology has made it possible to create machines with numerical control (CNC), which can perform processing in several planes. The use of a conveyor on assembly lines has significantly increased the speed of assembly of finished products. Finally, manipulators and industrial robots, which were able to replace humans in many workplaces, appeared. Special programs for computer-aided design have also appeared, allowing you to create 3D models of parts and develop technological processes for their manufacture. That is why the prefix "digital" is increasingly being added to the word "mechanical engineering". Digital engineering is characterized by an increase in requirements for the technical level, quality and reliability of products, and a reduction in the time of moral aging of equipment. This leads to the need to constantly reduce the design time while simultaneously improving the designs of new machines and their manufacturing technology, introducing new materials, and more accurate calculation methods.

However, despite all the innovations, man plays a significant role in production. Process engineers face a lot of tasks that the machine is not able to solve. Such tasks include: the development of technological processes, the selection of tools and equipment, ensuring the quality of products, calculating the allowance for machining parts and others.

This article describes two systems developed by the authors of the article on the basis of Tambov State Technical University.

An automated system for calculating allowances for machining parts [1], developed using the Python programming language and aimed at accelerating and improving the accuracy of the allowances calculations performed. The system can work with different workpieces: rolling, forging, stamping, casting; allows you to perform calculations for turning operations when processing internal and external

surfaces of rotation and end processing, milling operations when processing flat and cylindrical surfaces. In addition, the system offers various ways to fix the workpiece on the machine, which affects the processing error. According to the formulas embedded in the algorithm of the program, errors are calculated, and thus the accuracy of the calculations performed increases.

The developed algorithm of the program allows not only to calculate the allowance for a specific operation, but also to determine the required number of transitions: rough, semi-finished and finishing, as well as assign tolerance fields to interoperative dimensions, which allows for high accuracy of the machined surfaces of the part. The program has a built-in database, which contains information about the roughness of the treated surfaces and various errors, which is used in calculations.

The system calculates the optimal size of the allowances and the appropriate size of the workpiece to achieve the accuracy of the part specified in the drawing. This is useful when it is necessary to determine the parameters of the workpiece, for example, casting. In order to find out the thickness of the allowance, taking into account the already known workpiece, a module for the program was developed [2].

The program and module were tested for the dimensions of the part shown in Fig. 1.

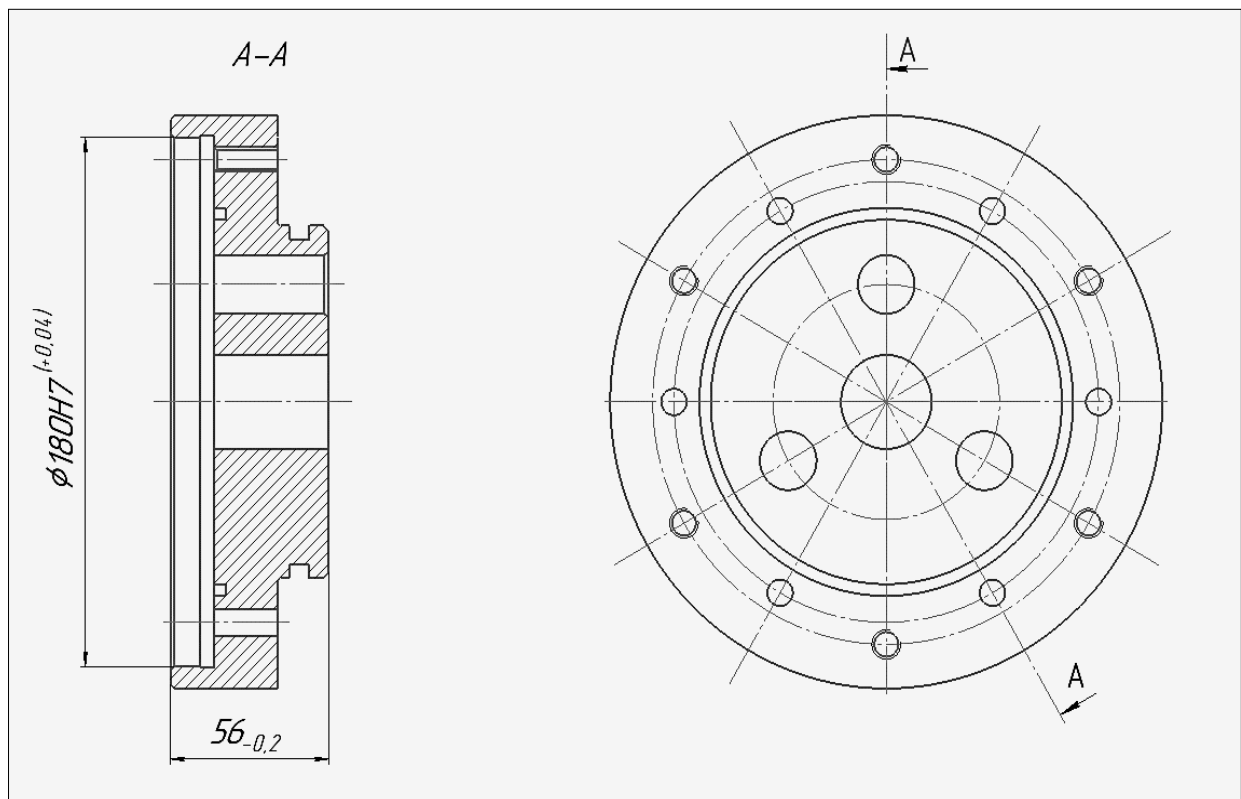


Figure 1 - Sketch of the part and dimensions for which the allowances were calculated

To assess the effectiveness of the system, calculations of allowances for the same size were carried out both manually and using a program, after which a comparison of the time spent was carried out. When calculating the allowances for 180 manually, 27 minutes and 36 seconds were spent, when calculating using the program – 47 seconds. Thus, the efficiency was 3523% [3].

The second system developed is an automated system for calculating cutting modes [4]. Its purpose is to perform calculations of speed, feed and cutting depth based on the initial data. The program provides the user with a wide range of processed materials: carbon, high carbon, alloy, heat-resistant and high-speed steels. In addition, the user can choose the appropriate tool for processing different workpieces. The program calculates the processing modes for both roughing and finishing.

### **Conclusion**

The developed programs will significantly facilitate the work of process engineers and programmers of CNC machines by automating the processes performed. At the same time, high accuracy of calculations is ensured, which affects the improvement of the quality of manufactured parts. Certificates of registration of computer programs were issued for the developed programs [1, 2, 4].

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## **СИСТЕМЫ ЦИФРОВОГО МАШИНОСТРОЕНИЯ ДЛЯ АВТОМАТИЗИРОВАННОГО РАСЧЕТА ПРИПУСКОВ И РЕЖИМОВ РЕЗАНИЯ**

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**Аннотация:** В статье представлен обзор на системы цифрового машиностроения, разработанные аспирантами Тамбовского государственного технического университета для инженеров-технологов машиностроительных предприятий. Системы предназначены для автоматизированного расчета припусков и режимов резания, что особенно полезно при составлении технологических процессов механической обработки деталей. Представленные программы обеспечивают точность расчетов, а также существенно сокращают время на их выполнение.

**Ключевые слова:** алгоритм, код, машиностроение, программа, система.

## **A STUDY OF THE EXPERIENCE OF USING A HYPERSPECTRAL CAMERA IN VARIOUS FIELDS**

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### **Abstract**

A hyperspectral camera is a device that is used in various industries to image objects over a wide range of wavelengths, providing information about their chemical composition and structure. The article discusses examples of the use of hyperspectral cameras in agriculture, medicine, and others. In agriculture, cameras are used to monitor plant health, identify diseases and pests, and assess soil quality. In medicine, hyperspectral cameras are used to diagnose various diseases and conditions. In document science, such cameras can be used to restore low-contrast text in archival documents. The examples provided confirm that the hyperspectral camera is an effective tool for solving various problems in different industries.

**Key words:** agriculture, documentation, hyperspectral camera, hyperspectral data, literature review, medicine.

### **Introduction**

A hyperspectral camera is a specialized type of camera capable of capturing images across a wide spectrum of electromagnetic radiation. It allows for the retrieval of information about various object properties, such as color, moisture, content of different substances, and so on. In recent times, hyperspectral cameras have found extensive applications in various fields due to their high precision and reliability. This article aims to explore the experience of using hyperspectral cameras in different industries and the results obtained through their application.

### **Application of hyperspectral camera in agriculture**

A hyperspectral camera in agriculture is used to assess the condition of plants and monitor crop quality. It can determine the presence of diseases, pests, as well as soil moisture and fertility levels. This enables timely measures to improve plant condition and increase yields.

In their research, the authors of [1] utilize the Specim IQ series camera to address two tasks. One of them involves studying infected root rot and healthy wheat seedlings. It was found that the reflective characteristics of healthy and infected wheat seedlings differ in the visible (400-700 nm) and near-infrared (700-900 nm) ranges. Vegetation indices were identified, which differ most significantly between healthy and diseased seedlings.

The second task for the authors of [1] involved studying the spectral characteristics of potato tuber flesh (*Solanum tuberosum* L.). Analysis of the data revealed distinct sample groups with variations in the intensity of spectral reflection in the 400-500 nm and 900-1000 nm ranges. It was concluded that this may be related to the areas of melanin absorption in the first identified spectral range and water molecules and OH groups in the second range.

In their study, the authors of [2] selected soil from the Rostov region as the object

of analysis for its humus content. Data was obtained using the Specim IQ hyperspectral camera series. Based on the analysis of the data, the authors concluded that the working range for analyzing soil humus can be considered as 430-950 nm. It was noted that it is advisable to use the camera only in the case of spatial heterogeneity within the sample, as "otherwise, a point spectrometer is sufficient" [2].

### **Application of hyperspectral camera in medicine**

In medicine, the hyperspectral camera is used for diagnosing various diseases. It provides information about the condition of tissues and organs, as well as detecting pathological processes at early stages. This helps to improve the effectiveness of treatment and reduce the risk of complications.

The authors of article [3] evaluated the viability of abdominal tissue organs. The study was conducted on a clinically healthy laboratory rat. The condition of the intestinal tissue was assessed using an RGB lamp, the Specim hyperspectral camera series, and diffuse reflection spectroscopy. Additionally, an LED surgical illuminator with controlled color parameters was used. It was concluded that the RGB lamp illumination at 500 and 593 nm range contributes to better visualization of ischemic and necrotic areas. The use of diffuse reflection spectroscopy and hyperspectral imaging allowed for calculating tissue blood perfusion and saturation values. Thus, the application of a hyperspectral camera and diffuse reflection spectroscopy are objective methods for evaluating tissue viability.

### **Application of a hyperspectral camera in document science**

In the field of document analysis, a hyperspectral camera can be used for document analysis and classification. It can be employed to determine document authenticity, as well as to detect hidden inks or watermarks, examine document materials and their quality, and more.

The authors of article [4] explore the application of hyperspectral analysis technology for restoring low-contrast texts in archival documents. The Specim FX10e camera was utilized for document analysis. The automatic analysis of hyperspectral documents is based on the principal component method. It was concluded that the greatest contrast between objects (text) and background (paper type) is achieved in the second and third principal components, with the first principal component containing background information. The authors concluded that the use of hyperspectral technology led to an increase in text contrast relative to the background by a factor of 1.2 to 25.

### **Application of a hyperspectral camera for the analysis of chemisorbents**

In modern science and industry, there are numerous tasks related to the analysis of chemical substances and their interactions with other substances. In the future, we plan to explore the possibilities of using a hyperspectral camera for the analysis of chemisorbents - substances capable of absorbing gases or vapors on their surface.

The application of a hyperspectral camera in the analysis of chemisorbents includes the following stages:

- registration of the chemisorbent spectrum;
- processing of the obtained data using specialized algorithms;
- interpretation of the obtained results.

Advantages of using a hyperspectral camera:



- high accuracy and resolution of the obtained data;
- ability to analyze a large number of samples simultaneously;
- real-time analysis capability;
- possibility of automating the analysis process.

At present, we are studying the ULTRIS X20 Plus hyperspectral camera, its technical characteristics, capabilities, and its software.

### **Conclusion**

In conclusion, it can be said that hyperspectral cameras are an important tool for solving various tasks in different industries. Their application enables increased work efficiency, reduced costs, and improved product quality.

The analysis of the application of hyperspectral cameras in the fields of agriculture, medicine, and document analysis has led to the conclusion that the 400-1000 nm range is sufficient for obtaining various types of spectral data. However, in some studies, this range either proved insufficient, or the data obtained were inaccurate due to camera visibility errors. At the same time, the material and structure of the object under control were taken into account.

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## **ИССЛЕДОВАНИЕ ОПЫТА ПРИМЕНЕНИЯ ГИПЕРСПЕКТРАЛЬНОЙ КАМЕРЫ В РАЗЛИЧНЫХ ОБЛАСТЯХ**

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**Аннотация:** Гиперспектральная камера – это устройство, которое используется в различных отраслях для получения изображений объектов в широком диапазоне длин волн, что позволяет получить информацию об их химическом составе и структуре. В статье рассматриваются примеры использования гиперспектральных камер в сельском хозяйстве,

медицине и другие. В сельском хозяйстве камеры используются для мониторинга состояния растений, определения болезней и вредителей, а также оценки качества почвы. В медицине гиперспектральные камеры применяются для диагностики различных заболеваний и состояний. В документоведении с помощью такой камеры можно восстановить малоконтрастный текст архивных документов. Приведенные примеры подтверждают, что гиперспектральная камера является эффективным инструментом для решения различных задач в разных отраслях.

**Ключевые слова:** гиперспектральная камера, гиперспектральные данные, документоведение, литературный обзор, медицина, сельское хозяйство.

## THE IMPACT OF INCREASED TEMPERATURE ON WATER ABSORPTION AND SWELLING OF WOOD FIBREBOARD

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### **Abstract**

In the modern world with its rapid technological progress and growing human needs, the problem of providing comfortable and safe housing is becoming more and more relevant. It is especially important to consider their resistance to various external influences. Some of the most unfavorable factors that can affect the material are swelling and water absorption.

**Keywords:** fiberboard, tests, water absorption, swelling.

### **Introduction**

One of the main materials used in construction is fiberboard, which has a number of advantages, such as environmental friendliness, availability and ease of processing [1]. However, an important aspect affecting the quality and durability of fiberboard is its properties when exposed to elevated temperatures, namely water absorption and swelling. One of the main advantages of fiberboard is its versatility. (Fig. 1).



*Figure 1 - Wood fiberboard*

One of the main disadvantages of fiberboard is its susceptibility to moisture. If not protected, fiberboard can deform, swell or even collapse when exposed to water or high humidity. In addition, when the material is exposed to unfavorable climatic influences such as high temperatures, the structure of the material may change [2].

To determine the effect of the duration of heat exposure on water absorption and swelling, the present study was carried out. Thermal aging processes were modelled in a drying cabinet at a temperature of 80 °C [3].

To determine the water absorption of the material, samples after exposure to unfavourable temperature effects are weighed using laboratory scales with an error of no more than 0.02 g. To determine the amount of swelling, a caliper is used. Next, the samples are placed in a vessel with distilled water for a given time, after which they are re-weighed and the section height is measured [4].

Water absorption (W) in per cent by weight is calculated by the formula:

$$W = \frac{m_2 - m_1}{m_1} \cdot 100\% , \quad (1)$$

where  $m_1$  is weight of dry sample, g;  $m_2$  is weight of the sample after a given exposure to water, g.

To determine swelling, the formula is used:

$$H = \left[ \frac{h_{\text{wet}} - h_{\text{dry}}}{h_{\text{dry}}} \right] \cdot 100\% , \quad (2)$$

Where  $h_{\text{dry}}$  is height of dry sample, mm;  $h_{\text{wet}}$  is height of the sample after soaking, mm.

The results in each case are rounded to 0.1 %.

The results of the dependence of water absorption on the duration of heat exposure are presented in the graph (Fig. 2).

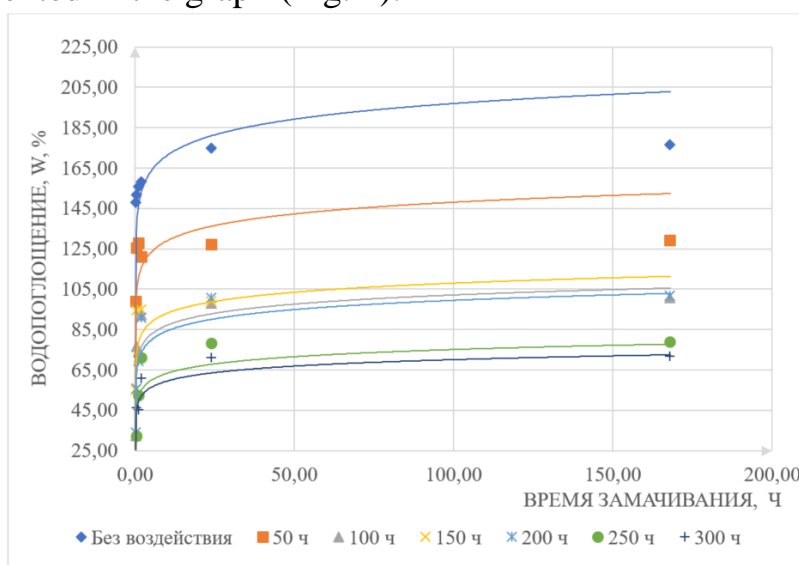
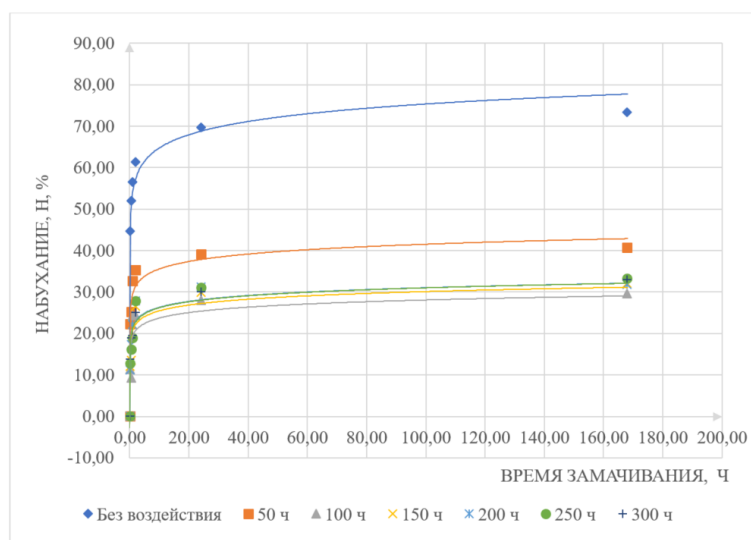


Figure 2 - Dependence of water absorption on the duration of heat exposure

A similar dependence is observed in the graphs of swelling determination of samples (Fig. 3).



## Conclusion

Thus, it was established that under prolonged thermal influence on fibreboard two opposite processes occur in the structure of the material. The first process is associated with the hardening of resin in the composition of fibreboard, and the second process causes the destruction of wood fibres. It is also established that the impact of 80° C temperature for up to 200 hours reduces its water absorption and swelling.

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## ВЛИЯНИЕ ПОВЫШЕННЫХ ТЕМПЕРАТУР НА ПРОЦЕССЫ ВОДОПОГЛОЩЕНИЕ И НАБУХАНИЕ ДВП

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**Аннотация:** В современном мире с его стремительным техническим прогрессом и растущими потребностями человека проблема обеспечения комфортного и безопасного жилья становится все более актуальной. Особенно важно учитывать их устойчивость к различным внешним воздействиям. Одними из наиболее неблагоприятных факторов, которые могут повлиять на материал, являются набухание и водопоглощение.

**Ключевые слова:** древесноволокнистая плита, испытания, водопоглощение, набухание.

## METHODS OF CLEANING FUEL INJECTORS

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### Abstract

The article presents the main methods of fuel injector cleaning. The features of using each method and related to different technological features and conditions of use are considered.

**Keywords:** cleaning, cleaning methods, electromagnetic nozzles.

### Introduction

Different devices and technical solutions are used in each of the solenoid nozzle cleaning options. Here is a more detailed description for each of them:

#### 1. Ultrasonic cleaning:

- Ultrasonic bath: This is a special device that contains a reservoir of liquid in which the nozzle is placed. Ultrasonic waves are generated by piezoelectric transducers immersed in the liquid, creating microscopic bubbles that collapse and remove contaminants.

- Ultrasonic jets: This is a device that creates ultrasonic waves in the air. The nozzle is subjected to a stream of ultrasound that creates bubbles and removes contaminants.

- Ultrasonic brushes: These are special brushes with built-in ultrasonic transducers. When these brushes are used, ultrasonic waves are transmitted through the brushes to the surface of the nozzle, removing dirt.



Figure 1 - Ultrasonic bath



Figure 2 - Ultrasonic brush



Figure 3 - Ultrasound generator

#### 2. Chemical cleaning:

- Chemical Solutions: A variety of chemical solutions can be used to clean

nozzles. For example, acids or solvents can be applied to the surface of the nozzle to dissolve or break down contamination.

- Chemical Apparatuses: These are special devices that are allowed to be applied to the surface of the nozzle using atomizers or other methods. The solutions can then be removed from the surface of the nozzle, removing contaminants.



*Figure 4 - Chemical solutions*



*Figure 5 - Chemical apparatus*

### 3. Pneumatic cleaning:

- Compressed Air: Pneumatic cleaning utilizes a compressor that creates compressed air or gas. This compressed air is delivered through special nozzles or nozzles, creating a strong stream that blows contaminants out of the nozzle.

- Air guns: These are devices that use compressed air to create a strong stream that is directed to the surface of the nozzle to remove contaminants. Air guns can have different nozzles and settings for optimal cleaning.



*Figure 6 - Compressor*



*Figure 7 - Air gun*

### 4. Mechanical cleaning:

- Brushes: Different types of brushes can be used for mechanical cleaning of the nozzles. These can be metal or nylon brushes, which can be rotating or static. The brushes can be applied directly to the surface of the nozzle to remove contamination.

- Mechanical devices: There are special mechanical devices that are used to clean nozzles. For example, devices with vibrating elements or high-pressure nozzles can be used to remove contamination.



Figure 8 - Brush set

### 5. Laser cleaning:

- Laser systems: These are special devices that generate a laser beam of a specific wavelength and energy. The laser beam is directed to the surface of the nozzle where it interacts with the contaminants, causing them to vaporize or break down.

- Optical systems: Laser systems can be equipped with optical systems to precisely aim and focus the laser beam onto the nozzle surface. This allows for more efficient and precise removal of contaminants.

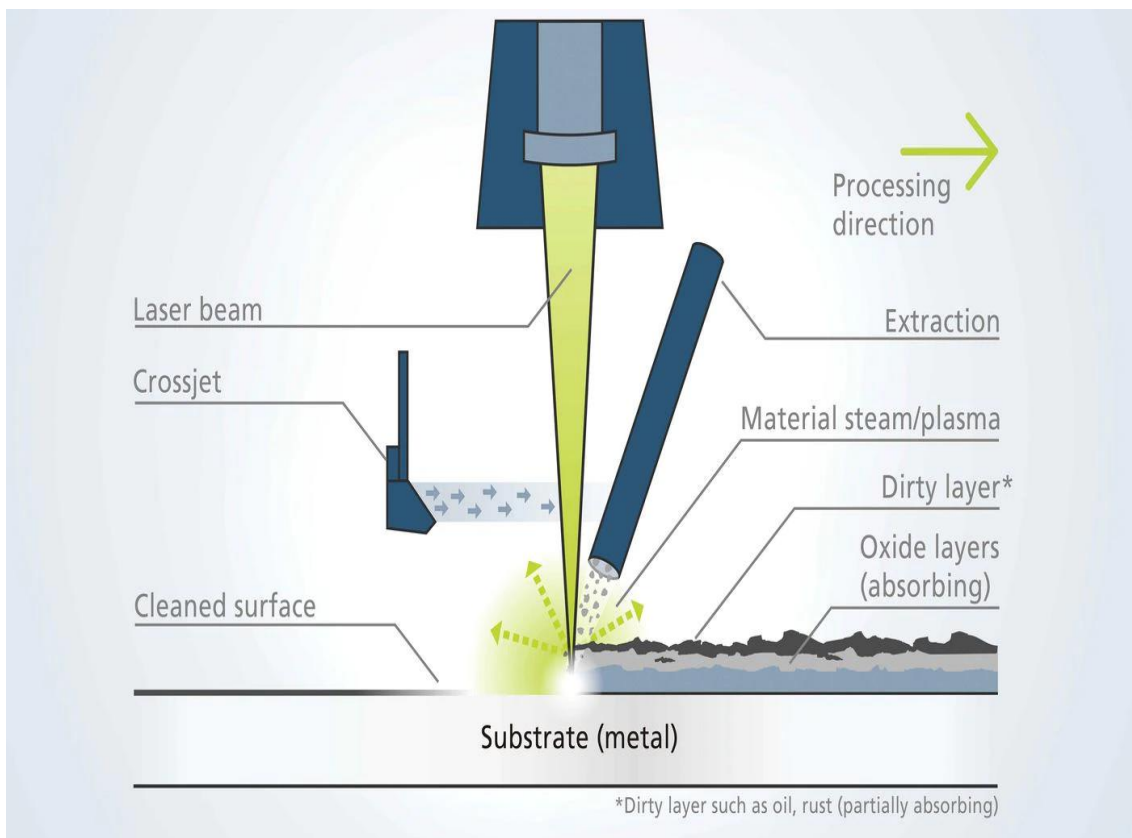
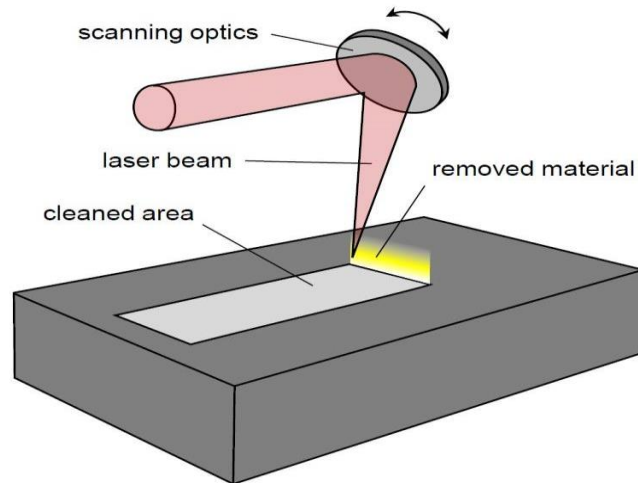


Figure 9 - Schematic diagram of the laser device

6. Combination cleaning methods: Combination methods are sometimes used that combine several cleaning methods to achieve the best results. For example, ultrasonic cleaning can be used in combination with pneumatic or chemical cleaning to remove different types of contaminants.





*Figure 10 - Schematic diagram of the laser optical system*

7. Automated Cleaning Systems: Automated systems can be designed to clean nozzles in an efficient and repeatable manner. These systems may include robotic arms or specialized devices that automatically apply cleaning solutions, apply ultrasonic waves, or perform other cleaning methods.



*Figure 11 - Automated washing*

8. Monitoring and control: An important part of the nozzle cleaning process is monitoring and control. For this purpose, various sensors and instruments can be used to monitor the cleaning efficiency, detect the presence of contaminants and take appropriate measures to ensure optimum nozzle performance.

9. Cleaning solutions and agents: Various cleaning solutions and agents can be used for chemical cleaning. For example, alkaline or enzyme based solutions may be used to remove organic deposits. Acid solutions may be used to remove mineral deposits or rust. It is important to select appropriate cleaning solutions that effectively dissolve or break down specific contaminants while being safe for the nozzle material.

10. Control of cleaning parameters: It is important to monitor and control various parameters during nozzle cleaning. This is necessary to prevent damage to the cleaning objects themselves, as well as to maximize efficiency and consequently reduce the cost of production.

## Conclusion

Having analyzed the methods described above, the most promising direction of development can be defined as the method of ultrasonic cleaning with the ability to perform diagnostics and quality assessment of nozzle cleaning on a single stand. Such a method will help to reduce the cost of equipment, increase the productivity of the site, automate the process.

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## СПОСОБЫ ОЧИСТКИ ТОПЛИВНЫХ ФОРСУНОК

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**Аннотация:** Представлены основные методы очистки топливных форсунок. Рассмотрены особенности использования каждого метода и связанные с разными технологическими особенностями и условиями использования.

**Ключевые слова:** методы очистки, очистка, электромагнитные форсунки.

## ROBOTIC THERMAL QUALITY CONTROL OF COMPOSITE PRODUCTS: CURRENT STATE AND DEVELOPMENT PROSPECTS

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### **Abstract**

Robotic thermal inspection (RTI) is a promising method for detecting concealed defects in composite materials. This paper provides an overview of RTI, their principles, applications, and future prospects. Composite materials are widely used in various industries for their unique properties, such as high strength and low weight. However, the assurance of quality remains a challenge due to the presence of concealed defects. RTI utilizes infrared cameras and specialized software to measure surface temperatures and analyze data, allowing for the detection of defects such as delaminations and voids. RTI has been successfully applied in industries such as aerospace, automotive, and construction. The future of RTI lies in improving accuracy and efficiency, developing automated control systems, and exploring the potential for expanding applications to other industries. In conclusion, RTI plays a vital role in ensuring high product quality while reducing the probability of defect determination and extending the service life of composite products. Further research and development are needed to fully realize the potential of this technology.

**Keywords:** composite materials, defects, infrared camera, quality control, robotic thermal control.

### **Introduction**

In the modern world, composite materials have become an integral part of many industries, such as aerospace, automotive, marine, energy and construction. Due to their unique properties, such as high strength, low weight, high corrosion resistance and adaptability, composites are widely used in various fields. However, the use of composite materials also creates new challenges for product quality control, as they have a complex structure and can have various types of defects.

One of the innovative methods of composite quality control is robotic thermal inspection (RTI). This method is based on measuring the temperature distribution on the surface of the product and analyzing the data obtained using special software. RTI allows to detect hidden defects, such as delaminations, cracks, voids and inhomogeneities, which can lead decreasing of strength and reliability of the product.

The main current tasks of RTI are:

- Development of new methods and tools that can improve the accuracy and efficiency of monitoring, as well as reduce labor intensity and improve work safety.
- Development of computer-integrated systems for operating in various conditions, including high-risk environments.
- Development of methods and tools for automated processing and analysis of the results of thermal control, allowing to increase the efficiency of control and reduce the complexity of work.
- Development of methods and tools for integrating robotic thermal control systems into automated process control systems.

## **Advantages of robotic thermal quality control**

Robotic thermal quality control offers a number of advantages:

- **High accuracy:** Robots are able to perform measurements with high accuracy and repeatability, which ensures reliable product quality control.
- **Efficiency:** Robots can work continuously without fatigue, which increases the productivity and efficiency of the quality control process.
- **Fast response:** Automated systems are able to perform quality control much faster than a human, which reduces production time.
- **Reducing the risk of errors:** Using robots reduces the probability of human errors in quality control, which helps to improve the reliability and accuracy of results.
- **Improved safety:** Robots can perform tasks in hazardous environments or environments where human work may be dangerous or impossible.
- **Lower costs:** While the implementation of robotic systems requires initial investment, in the long run it can lead to lower quality control costs by improving process efficiency.
- **Integration with other systems:** Robotic systems can be easily integrated with other production systems, which ensures a smoother and more automated operation of the entire production process.
- **Data monitoring and analysis:** Robots can collect large amounts of data about the quality control process, which allows for more detailed analysis and optimization of production processes. [2]

These advantages make RTI an attractive choice for many manufacturing plants.

Currently, robotic thermal quality control is constrained by the following circumstances:

- **High cost:** Robotic thermal quality control systems can be expensive to purchase, install, and maintain.
- **Limited capabilities:** Robotic systems can only be programmed to perform certain tasks, which limits their versatility. They may not be suitable for all types of products or processes.
- **Complexity of use:** Operating robotic thermal quality control systems requires technical knowledge and training. They can be difficult to set up and maintain.
- **Size and Shape restrictions:** Robotic systems can be limited in their range of sizes and shapes of the products they can inspect. They may not be suitable for checking non-standard or large products.
- **Lack of haptic feedback:** Robotic systems do not have haptic feedback, which can lead to errors when checking products with different textures or surfaces.
- **Need for training:** Robotic systems require training on specific products and processes. This can be an expensive and time-consuming process.
- **Risk of product damage:** Improperly programmed or maintained robotic systems can damage the products being tested.

- Maintenance requirements: Robotic systems require regular maintenance and calibrations this can lead to downtime and additional costs.
- Limited adaptability to changes: Robotic systems may be less adaptive to changes in production processes or product requirements than manual inspection.

### **Development prospects**

RTI of composite products plays an important role in manufacturing, especially in industries where complex and high-tech composites are used. Below are some prospects for the development of this area:

- Process automation: The development of robotics and automation technologies makes it possible to create more accurate and efficient thermal control systems. Robots can check the quality of products faster and more accurately, which reduces production time and increases its efficiency.
- Using artificial intelligence: The use of machine learning and artificial intelligence methods allows to create more intelligent quality control systems. This allows to detect defects at earlier stages of production and improve control processes.
- Development of sensors and data processing technologies: with the continuous development of sensors and data processing technologies, it is possible to create more accurate and reliable thermal monitoring systems. This allows to detect defects and inconsistencies with high accuracy.
- Integration into production lines: RTI systems are increasingly being integrated into production lines, allowing quality control to be carried out continuously and without delays. This reduces production time and reduces the chance of manufacturing defects.
- Development of mobile robots: The ability to use mobile robots for thermal monitoring allows you to check the quality of products at various points in the production process. This increases the flexibility and efficiency of quality control.
- Environmental sustainability: The development of robotic systems based on environmentally friendly and energy-efficient technologies helps to reduce the negative impact of production on the environment.

The development of robotic thermal quality control of composite products will continue in the direction of improving the accuracy, speed and efficiency of control processes, which will ultimately lead to an improvement in the quality of manufactured products.

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# РОБОТИЗИРОВАННЫЙ ТЕПЛОЙ КОНТРОЛЬ КАЧЕСТВА ИЗДЕЛИЙ ИЗ КОМПОЗИТНЫХ МАТЕРИАЛОВ: СОВРЕМЕННОЕ СОСТОЯНИЕ И ПЕРСПЕКТИВЫ РАЗВИТИЯ

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**Аннотация:** Роботизированные тепловые инспекции (RTIS) являются многообещающим методом обнаружения скрытых дефектов в композитных материалах. В этом документе представлен обзор RTIS, их принципов, применений и будущих перспектив. Композитные материалы широко используются в различных отраслях промышленности благодаря своим уникальным свойствам, таким как высокая прочность и малый вес. Однако обеспечение качества остается сложной задачей из-за наличия скрытых дефектов. RTIS используют инфракрасные камеры и специализированное программное обеспечение для измерения температуры поверхности и анализа данных, позволяя обнаруживать дефекты, такие как расслоения и пустоты. RTIS успешно применяются в таких отраслях, как аэрокосмическая промышленность, автомобилестроение и строительство. Будущее RTIS заключается в повышении точности и эффективности, разработке автоматизированных систем управления и изучении потенциала расширения применения в других отраслях. В заключение отметим, что RTIS играют жизненно важную роль в обеспечении высокого качества продукции, снижая вероятность возникновения дефектов и продлевая срок службы композитных изделий. Необходимы дальнейшие исследования и разработки, чтобы полностью реализовать потенциал этой технологии.

**Ключевые слова:** инфракрасная камера, композитные материалы, контроль качества, роботизированный тепловой контроль, дефекты, прогнозирование, развитие технологий.

## THE INFLUENCE OF ULTRAVIOLET EXPOSURE DURATION ON MECHANICAL PROPERTIES OF FIBERBOARD

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### Abstract

In modern construction, the trend of using building materials both inside and outside the building is very developed. But not all building materials can maintain their hardness and strength when operating conditions change. One of the most adverse effects of the environment is ultraviolet exposure. To obtain data on how the material will behave in the new operating conditions, it is necessary to conduct a number of experiments, that is, to recreate the operating conditions as close as possible to the real ones.

**Keywords:** fiberboard, tests, ultraviolet, mechanical properties.

### Introduction

One of the most popular building materials in construction is fiberboard. This product is used not only for internal and external construction work, but also for the construction of factory-made houses, as well as low-rise buildings.

In order to obtain data on the effect of ultraviolet exposure duration on mechanical properties, namely Brinell strength and hardness of fiberboard according to the unrecovered imprint method, it is necessary to carry out the tests [1]. Modeling of ultraviolet exposure was carried out in a special chamber using a DRT-1000 lamp, the maximum duration of exposure was 300 hours [2-4].

A six-position bench was used to test the strength of the samples in transverse bending (Fig. 1).

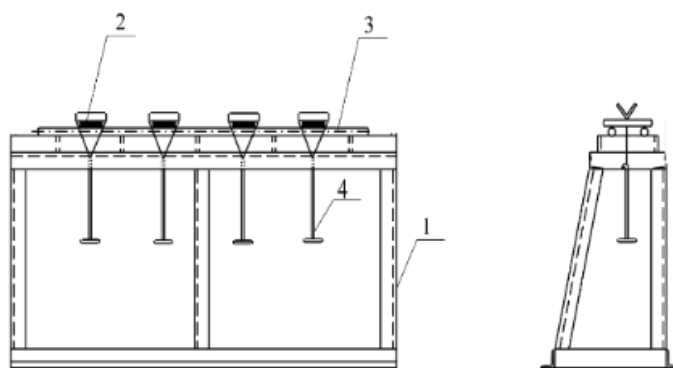


Figure 1 - Test bench for transverse bending

The results of ultraviolet exposure to fiberboard strength parameters are shown in the graph (Fig. 2).

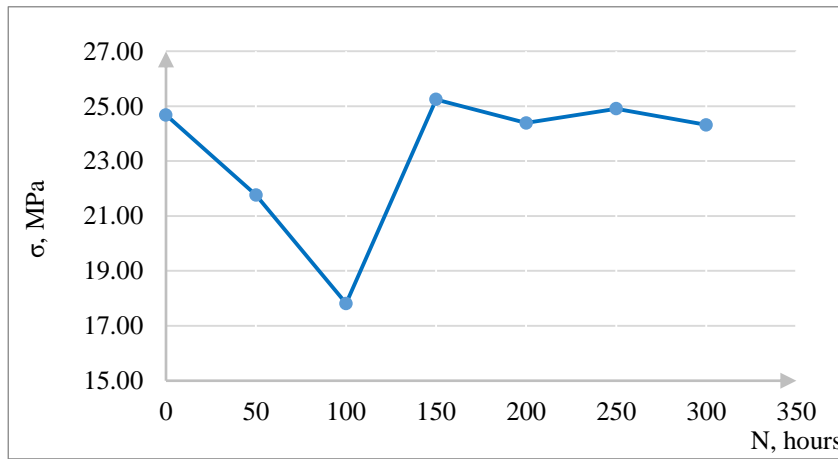


Figure 2 - Graph of variation of fiberboard strength values on ultraviolet exposure duration

After analyzing the graph (Fig. 2), we can conclude that the main decrease in strength by 1.5 times is observed in the first 100 hours, after which the strength value stabilizes.

The Brinell hardness value was determined by the unrecovered imprint method using the following formula:

$$HBW = \frac{F}{\pi Dh'}$$

where F is the applied load, N; D is the ball diameter, mm; h is the indenter penetration depth, mm.

The graph of dependence in coordinates N (quantity) - HBW (MPa) is shown in Figure 3.

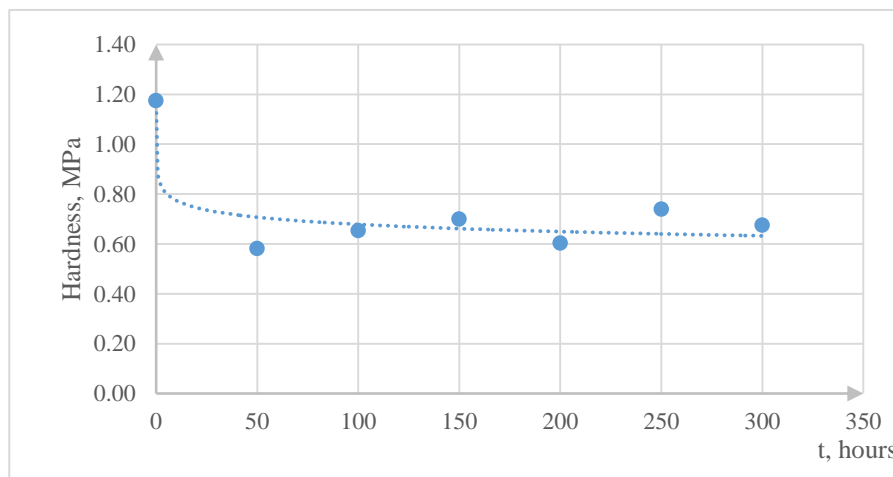


Figure 3 - Graph of dependence of change in Brinell hardness of fiberboard according to the method of unrecovered imprint on the duration of ultraviolet exposure

After analyzing the graph, we can conclude that a significant decrease in hardness, more than 2 times, is observed in the first 50 hours, after which the hardness values begin to stabilize.

### Conclusion

Analyzing this experiment, it can be concluded that ultraviolet exposure



negatively affects hardness and strength, as evidenced by a significant decrease in hardness and strength in the first 50 and 100 hours, respectively. This indicates that fiberboard is not recommended for use inside and outside of structures that are subject to unfavorable ultraviolet exposure.

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## ВЛИЯНИЕ ПРОДОЛЖИТЕЛЬНОСТИ УЛЬТРАФИОЛЕТОВОГО ВОЗДЕЙСТВИЯ НА МЕХАНИЧЕСКИЕ СВОЙСТВА ДВП.

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**Аннотация:** В современном строительстве очень развита тенденция применения строительных материалов как внутри, так и снаружи здания. Но не все строительные материалы могут сохранить свои твердость и прочность при изменении условий эксплуатации. Одним из самых неблагоприятных воздействий среды является ультрафиолетовое воздействие. Для получения данных о том, как поведет себя материал в новых условиях эксплуатации, необходимо провести ряд экспериментов, т. е. воссоздать максимально приближенные к реальным условия эксплуатации.

**Ключевые слова:** древесноволокнистая плита, испытания, ультрафиолет, механические свойства.

## ULTRASONIC AND RADIOGRAPHIC TESTING OF WELDED JOINTS IN MODERN FLAW DETECTION

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### **Abstract**

This article reveals the essence of ultrasonic and radiographic testing of welded joints in modern flaw detection of welds within the framework of production and quality assessment in accordance with GOST 34347-2017. The advantages and disadvantages of both methods are described. Conclusions are drawn about the use of both methods in the inspection of welded joints.

**Keywords:** radiographic testing, ultrasonic testing, welded joints.

Flaw detection of welded joints is necessary to search for internal discontinuities that reduce the strength of the welded joint and can lead to accidents (man-made situations) at industrial enterprises. This article discusses steel welded vessels and apparatus operating under excess pressure, intended for use in technological installations in the chemical, petrochemical, oil refining, gas processing, oil, gas and other industries. The main document that regulates the manufacture and acceptance of such vessels is the interstate standard GOST 34347-2017. According to this document, the design of vessels must be technologically advanced, reliable during the service life established in the technical documentation, and must ensure safety during manufacture, installation and operation.

The scope of inspection is selected based on the apparatus group (groups 1 and 2 - 100% of the length of the inspected welded joints). The testing method (ultrasonic, radiographic or a combination of both) is selected by a certified specialist who carries out the testing based on the possibilities of more complete and accurate identification of unacceptable defects, taking into account the specific physical properties of the metal, as well as the specifics of the testing methodology for a given type of welded joint of a vessel (assembly units, parts).

Ultrasonic testing of welded joints should be carried out in accordance with STO 00220256-005-2005 (testing methods and assessment standards) and GOST R 55724-2013.

Ultrasonic testing technology using the echo method is based on a simple physical law: the trajectory of sound waves in a homogeneous medium remains unchanged. Using a flaw detector and a piezoelectric transducer, elastic vibrations with a frequency of more than 20 kHz are introduced into the material. They come from the emitter (piezoplate), enter the test object, refract at the interface, and are further reflected from defects or the bottom surface.

This article discusses ultrasonic testing as a combination of three components:

1. Ultrasonic testing of echo by the pulse method using an ultrasonic flaw detector operating in A-scan mode.
2. Ultrasonic testing using ultrasonic devices operating on the principles of phased arrays, allowing you to display an S-scan sector scan image on the screen.

In Figure 1 shows an image of the display of the HARFANG VEO ultrasonic flaw detector during the inspection process, in which a defect was detected at a depth of 13.53 mm in the root part of a welded joint with a thickness of 15 mm. In the upper part there is an image in S-scan format, in the central part there is a projection of a top view, in the lower part there is a projection of a side view, in the right part (vertically oriented) there is an A-scan.

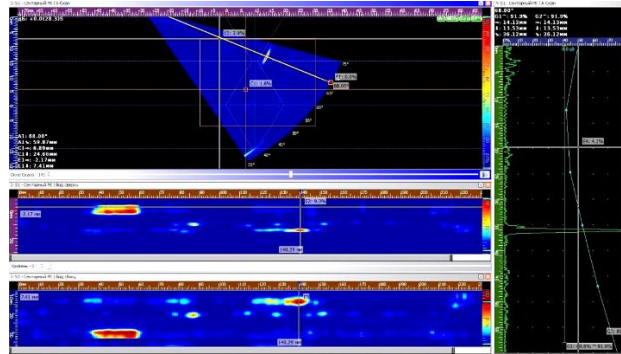


Figure 1 - Image of the screen of the HARFANG VEO ultrasonic flaw detector. Scanning S-scan (on the top), A-scan (on the right)

3. Ultrasonic testing using instruments that allow you to work with diffraction waves (scattering waves). This method is called TOFD (Time of Flight Diffraction). In Figure 2 shows an image of the display of the HARFANG VEO ultrasonic flaw detector in TOFD mode during the inspection process, in which artificial cuts are visible on the outer and inner sides in a sample with a thickness of 18 mm.

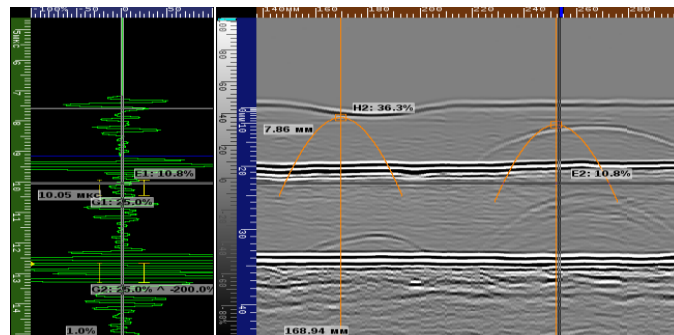


Figure 2 - Screen image of the HARFANG VEO ultrasonic flaw detector in TOFD mode

The advantages of ultrasonic testing are that it is more sensitive to planar defects, although this does not interfere with the detection of volumetric defects, especially when using phased arrays, time diffraction and other advanced technologies. At the same time, ultrasonic testing is harmless to the health of flaw detectors, the equipment for it is cheaper, the research speed is high, the mobility of the ultrasonic flaw detector is high, there is no chemical and photographic processing of films (when compared with film radiography), the work is safe from the point of view of the harmful influence of production factors.

The disadvantages of ultrasonic testing include:

- the need to prepare the surface for introducing ultrasound into the metal;
- the need to use contact liquids (propylene glycol, oil), and when monitoring vertical surfaces, thicker contact liquids should be used to prevent rapid drainage;

- the need to use ground-in transducers (with a radius of curvature of the base  $R$  equal to  $0.9-1.1R$  of the radius of the controlled object), which in this form are unsuitable for testing products with flat surfaces

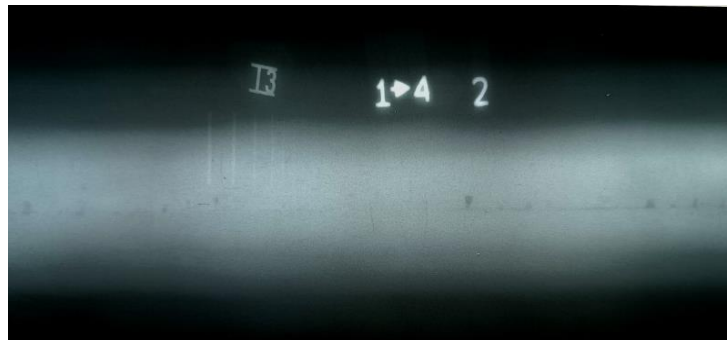
- about the actual size of the defect, conclusions can be drawn based on the reflectivity of the discontinuity in the direction of the receiver;

- it is difficult or impossible to control small parts or parts with complex shapes;

- when testing materials with a coarse-grained structure and a high attenuation coefficient (austenitic steel, for example), noise and interference appear. In addition, in some cases, ultrasonic testing is biased due to the high attenuation coefficient.

Radiographic testing of welded joints should be carried out in accordance with the current regulatory and technical documentation, GOST 7512, GOST 23055 (assessment standards) and STO 00220368-010-2007.

As part of the inspection of welded joints of capacitive equipment, constant or pulsed X-ray machines are usually used as a radiation source, which interact with the material of the test object through X-ray radiation, forming a radiation image on a cassette with radiographic film (Fig. 3).



*Figure 3 - Image of lack of fusion at the root on radiographic film*

Radiographic testing gives a sufficient idea of the quality of the welded joint. The sizes of defects and their location relative to the length and width of the inspected area are determined. From the image on the film, the characteristics of discontinuity and their possible negative impact on the design of the product are clear. It is believed that radiographic inspection is most effective for detecting volumetric discontinuities and their clusters. Despite this, if the inspection requirements are met, flat defects located along the transmission vector are also detected. Small parts or parts with complex shapes can be easily controlled. The result of the control is that the radiographic film is stored in the archive and can be presented to the customer upon request.

The disadvantages of radiographic testing include:

- high cost of research, since buying equipment for radiographic testing is cost-effective in case of high and constant volumes of work;

- a large number of related equipment and consumables, the need for periodic verification and calibration;

- the process of radiographic testing is complex and requires highly qualified personnel (periodic confirmation of qualifications in the relevant certification centers is necessary);

- X-raying of control objects is a potentially dangerous activity, the reason for which is the possibility of receiving a large dose of radiation.

It should be noted that both control methods have their advantages and disadvantages. I believe that ultrasonic and radiographic testing are not interchangeable, but complementary. A competent combination of both methods is, to a large extent, a consequence of the work of qualified non-destructive testing specialists. The strengths of both methods should be used, while keeping in mind the objectives of NDT: quality products according to industry regulations

The choice of non-destructive testing methods in matters of modern flaw detection leads to optimization of interaction between the main production services and the non-destructive testing department.

The study was carried out under the guidance of M.V. Sokolov, Doctor of Engineering, Professor of the Federal State Budgetary Educational Institution of Higher Education "TSTU".

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## УЛЬТРАЗВУКОВОЙ И РАДИОГРАФИЧЕСКИЙ КОНТРОЛЬ СВАРНЫХ СОЕДИНЕНИЙ В СОВРЕМЕННОЙ ДЕФЕКТОСКОПИИ

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**Аннотация:** Раскрыта сущность ультразвукового и радиографического контроля сварных соединений в современной дефектоскопии сварных в рамках изготовления и оценки качества согласно ГОСТ 34347- 2017. Описаны оба метода, преимущества и недостатки. Сделаны выводы об использовании обоих методов при контроле сварных соединений.

**Ключевые слова:** радиографический контроль, сварные соединения, ультразвуковой контроль.

## THE ANT ALGORITHM IN THE DEVELOPMENT OF OPTIMAL MANUFACTURING PROCESSES

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### **Abstract**

This work presents the task of designing the technological process of manufacturing metal parts by solving the problem using the theory of ant colonies. This method of finding a path is used in the presence of one common – reference path, relative to which local ways of solving new additions – complications will be built.

**Keywords:** Ant algorithm, optimal technological process.

### **Introduction**

The ant algorithm is a decision-making system with the probability of solving the search for the optimal route – more than a million options. This algorithm chooses a rational path and builds new solutions based on it, spending minimal resources, but performing any change required by the task.

In mechanical engineering, a change can be called the introduction of a new part into production, somewhat different from those already produced, or the writing of technology to other equipment due to the current overload of equipment.

The idea of the ant algorithm is to model the behavior of ants associated with their ability to find quickly the shortest path from an anthill to a food source and adapt to changing conditions by finding a new shortest path. As the ant moves, it marks the path with a pheromone, and this information is used by other ants to choose the path. This is an elementary rule of behavior and determines the ability of ants to find a new path if the old one turns out to be inaccessible [1].

An ant colony usually goes the shortest way if suddenly there is an obstacle on the way. Having reached the barrier, ants are equally likely to bypass it from the right and from the left. The same thing will happen on the reverse side of the barrier. However, those ants that randomly choose the shortest path will pass it faster, and in a few movements it will be more endowed with a pheromone [2, 3]. Since the movement of ants is determined by the concentration of the pheromone, the following will prefer this particular path, continuing to enrich it with it until this path becomes unavailable for some reason.

Positive feedback leads to the fact that most of the ants will follow a short route, and modeling pheromone evaporation – negative feedback – guarantees us that the locally optimal solution will not be the only one – the ants will look for other ways. If we model the process of such behavior on some graph, the edges of which represent possible ways of moving ants, for a certain time, then the most pheromone-enriched path along the edges of this graph will be the solution to the problem obtained using the ant algorithm.

The most important rule when selecting and choosing the order of operations is

the point: There is a relationship between transitions and surface parameters described by the function  $M_i: P_i \rightarrow P_{i+1}$ , - a surface with lower quality parameters  $P_i$  is transformed into a surface with higher quality parameters  $P_{i+1}$  by means of the  $M_i$  transition. It is especially important that these transitions are not unnecessary – this increases the time and money spent on the technological operation. The selection of operations should be such that machine time tends to be minimized.

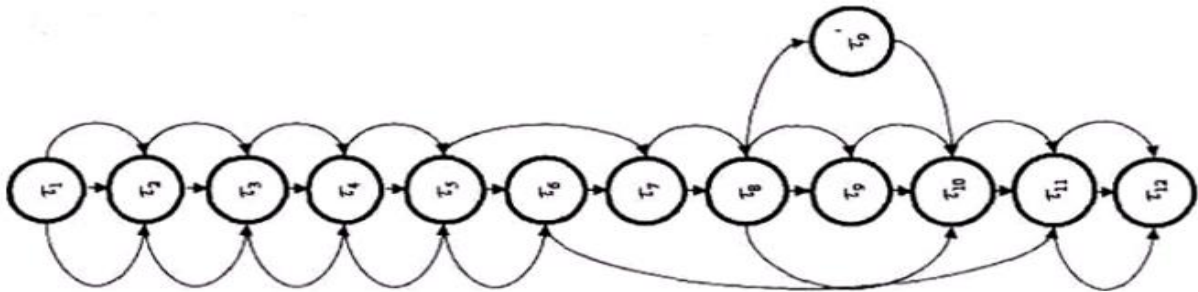


Figure 1 - The relationship of technological operations and the sequence of their execution  
 1 – preparation, 2 – stretching of the base hole, 3 and 4 – roughing and finishing turning of the contour of the gear wheel, 5 and 6 – roughing and finishing cutting of teeth, 7 – volume hardening, 8 – grinding of the base hole, 9 – sheving teeth, 10 – lapping teeth, 11 – washing, 12 – control technical requirements

My option to demonstrate the behavior of ants when choosing technological operations is to place them on a free field of graphs, where each graph carries information about technological parameters (cutting modes, time, and shape of the part after the operation). After that, give a reference – a typical technological process of a similar part. The ants will analyze the shape of the part at each stage of production and compare it with the real conditions of the task – the workpiece, the intermediate and final dimensions, the mechanical characteristics of the metal.

It is possible to connect this system with a system that monitors the workload of equipment in the workshop in real time to improve the economic effect of the route, reducing losses from machine downtime.

Let me give an example. The drawing shows a bushing with a central hole according to the ninth accuracy standard, the outer surface is not processed; the workpiece for the part is a rod of circular cross-section. The ant colony reads from the database the standard processing route of the sleeve with an exact central hole, billet – casting, forging: countersinking – countersinking – boring – deployment. The diagram of the graph field is shown in Fig 2.

### Conclusion

This method of creating technical processes can solve a problem in serial production to wasting time qualifier specialists for development simple details, relating type hollow cylinders. System can automatically build ready technological process with big economy of time for engineers, technologists and other workers.



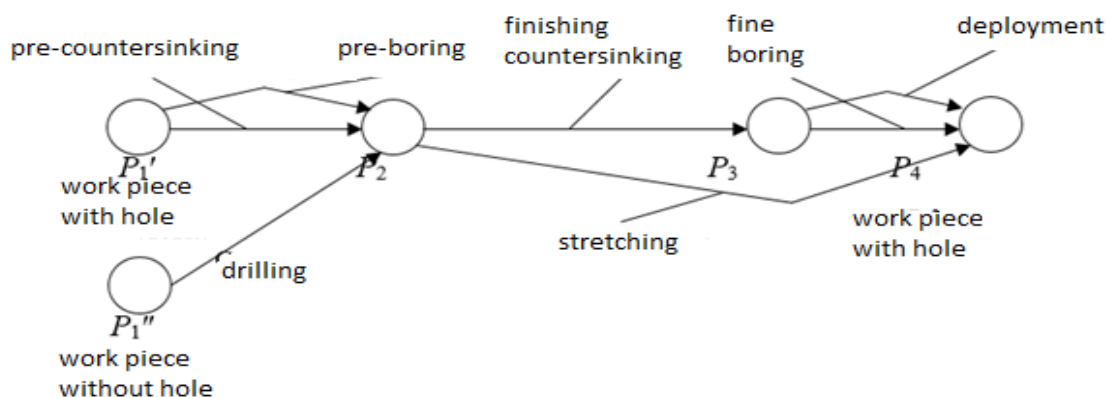


Figure 2 - An example of building a process with a preform condition

## Acknowledgements

I hope this work will get your acknowledgement and I will expand on this topic in more detail in my magister's dissertation. Special thanks to the faculty of the mechanical engineering department and engineers-specialists in machine factories.

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## МУРАВЬИНЫЙ АЛГОРИТМ В РАЗРАБОТКЕ ОПТИМАЛЬНЫХ ТЕХНОЛОГИЧЕСКИХ ПРОЦЕССОВ

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**Аннотация:** Представлена задача проектирования технологического процесса изготовления металлических деталей путем решения задачи с использованием теории муравьиных колоний. Данный метод нахождения пути используется при наличии одного общего – эталонного пути, относительно которого будут строиться локальные способы решения новых дополнений – усложнений.

**Ключевые слова:** Муравьиный алгоритм, оптимальный технологический процесс.



## MANAGEMENT OF THE TECHNOLOGICAL PROCESS OF WAFFLE SHEETS PRODUCTION

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### 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 Waffle sheets 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, Waffle sheets production, programmable logic controller (PLC), mathematical model.

### Introduction

Waffles are flour confectionery products, which are thin baked sheets, layered with or without filling. Waffle sheets have a special property of crunching when bitten. This is due to the low moisture content, the corrugated checkered surface and the finely porous inner structure of the sheets. One of the main parameters affecting the quality of waffle sheets is temperature. The purpose of the work is to study the control process of waffle sheet production using temperature control.

### Materials, Results and Discussion

To build an automatic temperature control system in the oven, it is necessary to analyze the input and output flows.

From the analysis of literary sources [1-2] and the experience of industrial operation, it follows that in the process of manufacturing a waffle sheet, the main output parameters are the temperature in the oven  $t_p$  and the pressure of flue gases in the oven  $R_p$ .

The disturbing influences are: gas pressure in the  $P_{vx}$  line, air pressure entering the  $P_{vxy}$  oven, air temperature in the production room  $t_{oc}$ , oven performance  $G_t$ .

The input influences are the degree of valve opening on the gas line  $\mu_1$  and air line  $\mu_2$ .

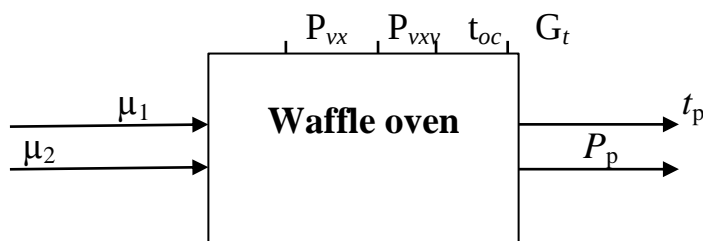


Figure 1 - Oven as a control object

*The choice of the automated control system structure. Development of a structural scheme of management and control*

When choosing a process control system, it is necessary to take into account the cost, reliability and efficiency of the system.

When creating automated control systems, they use a hierarchical information model using computing tools of various capacities at different levels of the system [3].

To create an automated control system at this facility, a two-level structure has been selected (Figure 2).

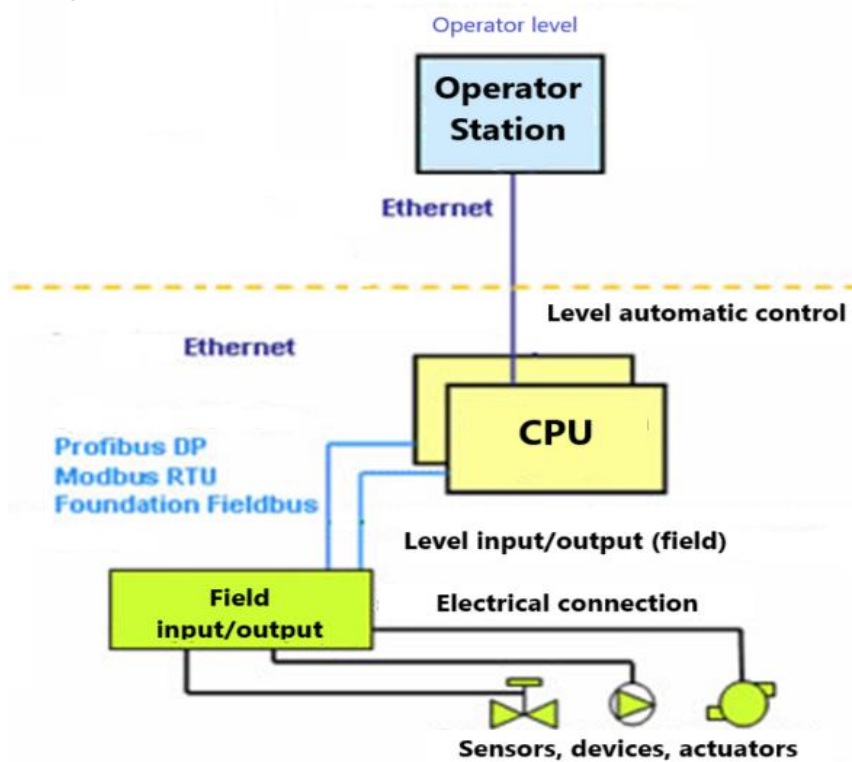


Figure 2 - Block diagram of the automated process control system

At the controller level, information is collected from sensors and control actions are implemented for actuators through the field input/output level [3]. This level is implemented on the basis of controllers of the OVEN PLK110 model and I/O modules Mx-110.

The operator's WORKSTATION implements requests to the controller over the network, implements the display of information to the operator and the ability to control and monitor the technological process in real time. The implementation of these tasks is possible when using the KRUG-2000 SCADA system operator for the design of the automated control system [3].

### Conclusion

The development and implementation of a modern automated control system will significantly improve the working conditions and safety of service personnel, increase labor discipline, reduce the impact of the human factor, significantly reduce the number of emergencies, significantly reduce the cost of operation and maintenance of the process control system.

1. The analysis of the technological process of waffle sheet production has been carried out.
2. The analysis of the process as an object of management is carried out.

3. The structure of the automated control system has been selected.

4. The choice of a set of software and hardware tools is justified. The choice of the main technical means of the automated control system is justified.

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### УПРАВЛЕНИЕ ТЕХНОЛОГИЧЕСКИМ ПРОЦЕССОМ ПРОИЗВОДСТВА ВАФЕЛЬНЫХ ЛИСТОВ

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**Аннотация:** Проведен анализ технологического процесса и существующей в настоящее время системы управления. Выбрана структура и комплекс технических средств. Существующая в настоящее время система управления технологическим процессом производства вафельных листов не отвечает современным требованиям, предъявляемым к современным техническим средствам, поскольку себестоимость продукции достаточно большая, а ресурсные и энергетические затраты слишком высоки.

**Ключевые слова:** автоматизированная система управления (АСУ), технологический процесс, производство вафельных листов, программируемый логический контроллер (ПЛК), математическая модель.

## FORECASTING METHODS AND THEIR APPLICATION IN MECHANICAL ENGINEERING

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### **Abstract**

The purpose of this study is to review forecasting methods, their specificity and the possibility of application in mechanical engineering. In the course of the study, two methods of calculating and determining accuracy, as well as the principle of qualimetric forecasting, will be considered. The relevance of the research lies in the need for mechanical engineering systems for continuous quality improvement, which in turn requires new methods for predicting the quality of products.

**Keywords:** forecasting methods, review, qualimetric forecasting.

### **Introduction**

The main task of today in mechanical engineering is to create systems for continuous improvement of product quality. To achieve this goal, various forecasting methods will be required, both for the whole branch of mechanical engineering, with forecasting the path of development, and, accordingly, with solving related tasks, and in a special case, that is, the development of separate methods for predicting the quality indicators of specific parts when processed in a specific way. But first it is necessary to define forecasting and define the purpose of the forecast.

### **Forecasting**

In a generalized sense, forecasting is a prediction made by studying statistical data and past patterns [1]. Forecasting is an important link between theory and practice in all areas of society. It has two different planes of concretization: descriptive and prescriptive. Forecasting implies a description of possible or desirable prospects, states, and solutions to future problems. Prescription is actually the solution to these problems, the use of information about the future in purposeful activities. Thus, two aspects are distinguished in the problem of forecasting: theoretical-cognitive and managerial, related to the possibility of making managerial decisions based on the knowledge gained.

The purpose of forecasting is to obtain scientifically based variants of trends in the development (change) of a controlled object (indicators of its condition) in time and space. As already mentioned, in mechanical engineering, the most important goal is to achieve the necessary accuracy, and to achieve this, various methods of forecasting them are used.

Calculation and analysis of technological accuracy can currently be carried out using two methods: computational and analytical and statistical.

### **Forecasting methods**

The computational and analytical method is based on theoretical and experimental studies aimed at identifying primary errors and establishing a functional relationship between errors and the factors that generate them. The total error in the

computational and analytical method is determined depending on the nature and interaction of the primary errors.

With the statistical method, the total error is determined directly (without analyzing the primary errors) by measuring a certain number of details and processing the measurement results using mathematical statistics.

Simplification has led to the widespread use of the statistical method to assess the accuracy of manufacturing parts. It is especially convenient when the mechanism of phenomena has not been studied. It is advisable to use the statistical method in the study of accuracy for practical verification of the results and conclusions obtained on the basis of the computational and analytical method.

Using the computational and analytical method, the causes of accuracy violations are revealed and the technological process is affected. Using a statistical method for an already studied process (using a single methodology and relatively simple) the established practical manufacturing accuracy is revealed.

The computational and analytical method, in comparison with the statistical one, has the undeniable advantage that, using this method, the technologist simultaneously analyzes the technological process and sees ways to influence it.

Currently, dependencies and initial data have not yet been found that would allow for the real design of technological processes for manufacturing parts to use only a computational and analytical method for evaluating the accuracy of processing, therefore, computational and analytical and statistical methods do not exclude, but complement each other.

With the statistical method of accuracy research, random and systematic errors are distinguished. Random errors arise from the actions of many unrelated causes, each of which, at the same time, may affect the appearance or non-appearance of a particular processing error. Systematic errors arise from the action of well-defined reasons and remain constant or naturally change their value in the batch of processed parts. The study of random and systematic errors in the statistical method is based on the conclusions of probability theory and mathematical statistics, which are set out in the specialized literature.

It is also worth considering a relatively new principle of forecasting in mechanical engineering, namely qualimetric forecasting.

### **Qualimetric forecasting in mechanical engineering**

These are all forecasting methods that allow us to anticipate significant changes in the nature, structure and volume of consumer requirements for individual components of the quality of mechanical engineering products or for the product as a whole and on this basis ensure satisfaction of future requirements, high competitiveness and income growth of the corresponding machine-building enterprise or sub-industry as a whole[2]. Qualimetric forecasting (QF) does not represent a single established trend in forecasting and uses a wide range of techniques and methods from the so-called "engineering", "scientific and technical" and other areas of forecasting. In particular, QF uses methods of socio-economic forecasting, market research methods borrowed from marketing, and others.

Thus, the object of qualimetric forecasting is the future requirements of the consumer for mechanical engineering products, which, of course, may change under

the influence of:

- 1) changes in living and working conditions;
- 2) the appearance of new properties in products of a similar purpose provided by manufacturers, which leads to the emergence of new, previously non-existent requirements for the consumer;
- 3) the appearance of products that make it unnecessary to use previously purchased ones (for example, the appearance of ultrasonic washing machines makes it unnecessary to use conventional ones with a rotating drum).

In addition to consumer requirements, the object of a qualimetric forecast may be the prediction of possible changes in the technical parameters of manufactured products, as well as the prediction of technological achievements (inventions, technology changes, fundamental technical solutions, etc.) and science, which may affect the principles of operation and basic design parameters of products and, consequently, stimulate the emergence of new consumer requirements.

### **Conclusion**

In most cases, the forecasting methods described earlier are used on a small scale — in relation to a group of manufactured products or even an individual product, on the scale of a workshop or enterprise. However, the choice of strategic directions for improving technology is impossible without long-term forecasts. At the same time, long-term forecasts of the development of science and technology are developed by many specialized organizations (the Institute of National Economic Forecasting, branch institutes of scientific and technical information, and others). It is more rational to use the results of their developments than, without much experience, to spend time creating your own forecast.

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## **МЕТОДЫ ПРОГНОЗИРОВАНИЯ И ИХ ПРИМЕНЕНИЕ В МАШИНОСТРОЕНИИ**

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**Аннотация:** Целью данного исследования является обзор методов прогнозирования, их специфика и возможность применение в машиностроении. В ходе исследования будут рассмотрены два метода расчета и определения точности, а также принцип квалиметрического прогнозирования. Актуальность исследования заключается в необходимости машиностроением систем непрерывного повышения качества, что в свою очередь требует новых методик прогнозирования качества изделий.

**Ключевые слова:** методы прогнозирования, обзор, квалиметрическое прогнозирование.

## INCREASING EMULSION PROCESSING EFFICIENCY UNDER CONDITIONS OF HYDRODYNAMIC CAVITATION USING EMULSIFYING AGENTS

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### Abstract

The purpose of the article is to determine the effect of the Twin-20 emulsifier. It is expected that the emulsifier will reduce the multiplicity and, accordingly, the time and energy consumption for obtaining a finely dispersed emulsion with the smallest average particle diameter during processing in a cavitator. The emulsification process is implemented in various industries and is in high demand.

**Keywords:** cavitator, emulsion, hydrodynamic treatment multiplicity

### Introduction

The emulsification process is implemented in various industries both directly for the production of finely dispersed emulsion systems such as oil/water, water/oil, and as an auxiliary process for other chemical and technological processes, for example, liquid-phase extraction. In any case, the emulsification process should ensure the dispersion of one liquid into another liquid, provided that they do not have the ability to completely or partially dissolve in each other. This is mainly due to the polarity of the liquid molecules – one of the liquids is polar, while the other is nonpolar.

To obtain stable finely dispersed emulsions, static mixers are widely used, which are characterized by high productivity, low specific energy consumption and simplicity of design [1]. Static mixers that provide high quality mixing of components due to an intensive hydrodynamic regime, in which developed turbulence, intense cavitation, macro- and micro-pressure pulses in the flow of the treated liquid are generated, are called hydrodynamic cavitators and are widely used to obtain finely dispersed and colloidal heterogeneous systems, changes in the physico-chemical characteristics of liquids [2, 3].

One of the factors affecting the dispersion of the emulsion is the multiplicity of treatment. As a rule, it is not always possible to achieve the required particle size in one pass in flow devices. Traditionally, in order to obtain a given quality, emulsion systems are processed several times, organizing the cyclic movement of liquid along the closed circuit of the installation. On the other hand, it is impossible to exceed the energy consumption for crushing emulsion particles with excessive multiplicity of its processing. An indicator of the sufficiency of the number of processing cycles is a decrease in the degree of crushing of emulsion particles with each subsequent processing cycle.

### Results and discussion

Experimental studies on emulsification were carried out on an installation with a flow-through hydrodynamic cavitator with Venturi tubes. When pumping water at a pressure of 12 bar, the flow rate through the cavitator is 1 m<sup>3</sup>/hour. The technological scheme of the skid is shown in Fig. 1. The skid includes a cavitator, a plunger pump, an emulsion

container, flow, pressure and temperature measuring devices. The rotation frequency of the pump shaft was regulated by a frequency converter. The treatment was carried out by pumping the emulsion from the tank with a pressure pump into the cavitator and back into the tank.

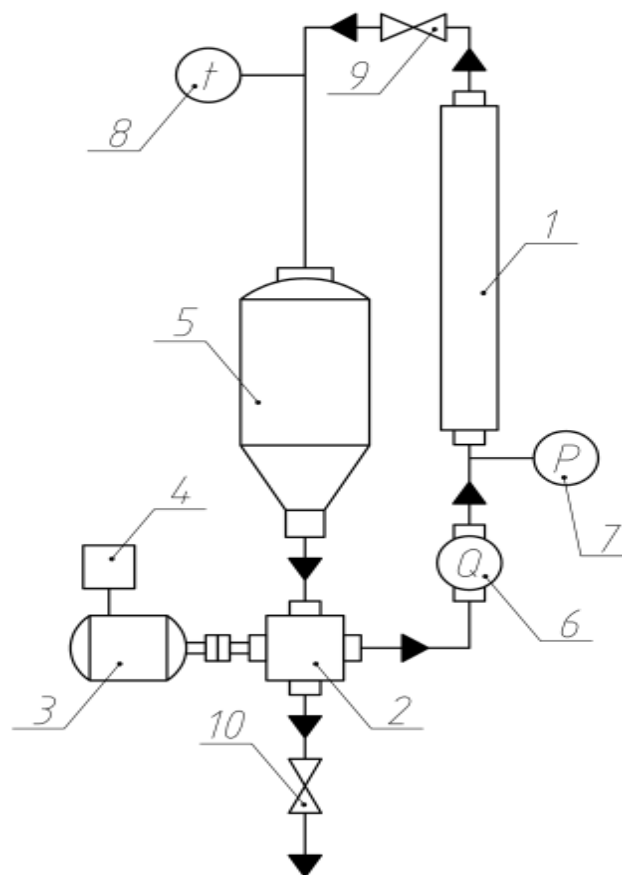


Figure 1 - Process scheme of the skid:

1 – hydrodynamic cavitator; 2 - plunger pump; 3 - pump electric motor; 4 - frequency converter; 5 - tank; 6 – liquid meter; 7 - pressure gauge; 8 – thermometer; 9, 10 – cranes.

The ratio of water and oil in the emulsion was assumed to be 9:1. Emulsification was carried out without addition and with the introduction of the emulsifier Twin-20 (2%). Twin-20 is a polyoxyethylene (20) sorbitan monooleate – nonionic surfactant, with a hydrophilic-lipophilic balance (HLB) of about 15. To obtain a stable emulsion of sunflower oil in water,  $HLB = 8$  is sufficient [4].

Distilled water was poured into the tank of the installation and then an emulsifier was added to it. With the help of a frequency converter, a small pump supply of about 2 liters/min was created. After dissolving the emulsifier in water, sunflower oil was added to the container and circulating mixing was carried out to obtain a coarse emulsion during 2 cycles of emulsion turnover through the hydraulic system. Then a sample of the coarse initial emulsion was taken.

To treat the emulsion in the skid, a pump electric motor was started using a frequency converter to create a pressure at the inlet to the cavitator of 20 bar and a flow of 33 l/min. The emulsion was processed in a cyclic mode due to the circulation of the emulsion through a closed hydraulic circuit from the tank to the pump, then under pressure to the



cavimator and back to the tank, the number of processing cycles was determined by the liquid meter. During the treatment, the volume of liquid passed through the cavimator, the temperature of the emulsion and the pressure at the inlet to the cavimator were recorded.

The particle sizes of the emulsion were determined using the NICOMP-380ZLS Particle Size and Zeta Potential Analyzer device. The results of experimental studies to determine the average diameter of the emulsion particles from the number of processing cycles are shown in Fig. 2. The average diameter of the untreated emulsion without emulsifier was 3897 nm, with emulsifier – 2749 nm. These points are not shown in the graphs to better illustrate the dependence of particle size on the multiplicity of processing, since the average particle diameter of the emulsion treated in the cavimator is many times smaller than the untreated coarse emulsion. The change in the average diameter of the emulsion particles after passing through the cavimator 4 times is more than 120 times for an emulsion with an emulsifier, and 60 times without an emulsifier.

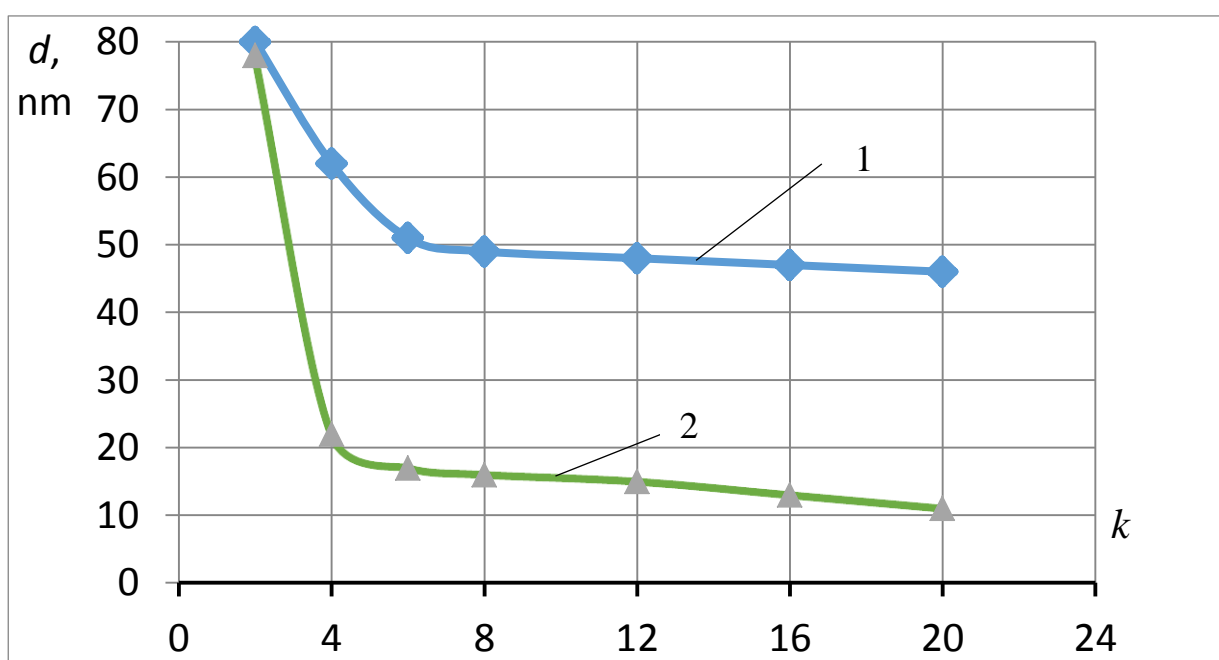


Figure 2 - Graphs of the dependence of the particle size of the emulsion  $d$  on the number of processing cycles  $k$ :

1 - emulsion without emulsifier; 2 – emulsion with emulsifier.

As can be seen from the graphs in Fig. 2, for an emulsion with an emulsifier, after passing through the cavimator 4 times, the decrease in the average particle diameter is almost negligible. For an emulsion without an emulsifier, the dispersion (the inverse of the particle size) does not increase after 6-fold treatment of the emulsion in a cavimator.

### Conclusion

Thus, it can be concluded that the maintenance of the Twin-20 emulsifier makes it possible to reduce the multiplicity by 1.5 times and, accordingly, the time and energy consumption to obtain a finely dispersed emulsion with the smallest average particle diameter for these conditions. The average particle size of an emulsion of vegetable oil in water with the addition of the emulsifier Twin-20 is 8 times smaller than the average particle size of an emulsion without an emulsifier.

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## ПОВЫШЕНИЕ ЭФФЕКТИВНОСТИ ОБРАБОТКИ ЭМУЛЬСИИ В УСЛОВИЯХ ГИДРОДИНАМИЧЕСКОЙ КАВИТАЦИИ С ИСПОЛЬЗОВАНИЕМ ЭМУЛЬГАТОРА

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**Аннотация:** Цель статьи - определить эффект эмульгатора Твин-20. Ожидается, что эмульгатор позволит сократить кратность и, соответственно, время и энергозатраты на получение тонкодисперсной эмульсии с наименьшим средним диаметром частиц при обработке в кавитаторе. Процесс эмульгирования реализуется в различных отраслях промышленности и крайне востребован.

**Ключевые слова:** эмульсия, гидродинамический кавитатор, кратность обработки.

**THEORY OF LINEAR OBJECTS REGULATION AND  
DETERMINATION OF THEIR STATES**

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**Abstract**

The article studies the creation of mathematical models for solving linear programming problems in relation to information system. The information system is considered as dynamic system of stationary linear objects. Special attention is paid to the theory of linear objects regulation and the determination of their states.

**Keywords:** control law, dynamic system, existing matrices, system noise, system state

Considering the information system as a system of stationary linear objects dynamics -  $\Sigma$ , we introduce the concept of the control law. The control law is a mapping  $k : T \times X \rightarrow U$  that corresponds to each state  $x(t)$  and each moment of time  $t$  the value  $u(t) = k(t, x(t))$  of the input effect at this moment in time. Here  $U$  – is a fixed set of input effects values on the system. In general, the segment of the system input action cannot be a completely arbitrary function  $\omega : (t_1, t_2) \rightarrow U$ , it must belong to some class  $\Omega$ , where  $\Omega$  is not an empty set. Understanding of the state  $x(t_1)$  and the segment of the input action  $x(t_2) = \varphi(t_2; t_1, x(t_1), \omega)$ , all this means that the value of the input effect at each moment of time depends only on the state of the system  $x(t)$  at that moment of time, and also, possibly, on  $t$ . At the same time, other parameters  $2$  may affect the specific nature of the function  $k$  [2].

In the above definition of the control law, it is implicitly assumed that at each moment of time it is available what state the system is in; in other words, all internal variables of the object can be measured and obtained as output quantities. This is actually the case in most practical situations. In fact, we should always imagine the state of an object as some abstract quantity describing unreachable variables inside the object.

It follows from the definition of a dynamic system that information of two different types is needed to find the state of an object:

- it is necessary to know the structure of the object, i.e. its transient display, its output display, etc.

- it is necessary to know the actual input effects and output values of the object.

Let's consider two types of tasks for determining the state of the system [2]:

- the *observation task* is related to determining the present state of  $x(\tau)$  from data on the behavior of output quantities in the future,  $\{y(\sigma) : \sigma \geq \tau\}$ ;

- the *identification task* requires the determination of  $x(\tau)$  from data on the behavior of output quantities in the past  $\{y(\sigma) : \sigma \leq \tau\}$ .

In this case, it will always be assumed that  $\varphi$ ,  $\eta$  defining the output values and  $\omega$  for the system under study are known. In the first case, we observe the future effects

of the present state and try to reestablish the root cause. In the second case, we try to restore the current state without having complete information about the actual state changes [2].

Two events  $(\tau, x_1)$  and  $(\tau, x_2)$  of a dynamical system  $\Sigma$  belong to the same observation class (or indistinguishable in the future) if and only if

$$\eta(t, \varphi(t; \tau, x_1, \omega)) = \eta(t, \varphi(t; \tau, x_2, \omega))$$

for all  $t \geq \tau$ , and any  $\omega$ .

observation class (or indistinguishable in the future) if and only if

$$\eta(\sigma, \varphi(\sigma; \tau, x_1, \omega)) = \eta(\sigma, \varphi(\sigma; \tau, x_2, \omega))$$

for all  $\sigma \leq \tau$ , and any  $\omega$ .

An event  $(\tau, x)$  of a linear dynamical system  $\Sigma$  is unobservable if and only if it belongs to the class of observations  $(\tau, 0)$ , i.e. if and only if

$$\eta(t; \tau, x, 0) = 0 \text{ for all } \sigma \leq \tau, \text{ and any } \omega.$$

A linear system  $\hat{\Sigma}$  is called an asymptotic estimation system of a linear system  $\Sigma$  state if and only if

$$\tilde{x}(t) = x(t) - \hat{x}(t) = 0 \text{ at } t \rightarrow \infty$$

In this case, the system  $\hat{\Sigma}$  is described by a system of equations:

$$\frac{d\hat{x}}{dt} = F_{\Sigma}(t)\hat{x} + L(t)[y(t) - H_{\Sigma}(t)\hat{x}] + G_{\Sigma}(t)u(t),$$

$$\hat{y}(t) = \hat{x}(t)$$

Here, the subscripts  $\Sigma$  of the matrices indicate only that these matrices define the system  $\Sigma$  [2].

Consider the model of the state vector changing given by the linear differential equation [1]

$$\dot{X}(t) = A(t)X(t) + G(t)W(t), \tag{1}$$

where  $X(t)$  is the system state,

$W(t)$  is the system noise,

$A(t)$  and  $G(t)$  are the existing matrices.

The additive mixture values of the state vector linear transformation and the observation noise are available for observation and processing

$$Z(t) = H(t)X(t) + V(t), \tag{2}$$

where  $Z(t)$  is the observation vector,

$V(t)$  is the observation noise vector,

$H(t)$  is the existing matrices of extent.

The filter algorithm has the following form

$$\dot{\hat{X}}(t) = A(t)\hat{X}(t) + K(t)[Z(t) - H(t)\hat{X}(t)], \tag{3}$$

$\hat{X}(t)$  is the optimum estimation.

Substitute (2) in (3), we obtain

$$\dot{\hat{X}}(t) = A(t)\hat{X}(t) + K(t)H(t)X(t) + K(t)V(t) - K(t)H(t)\hat{X}(t). \tag{4}$$

To determine the filtering error, subtract (4) from (1)

$$\dot{X}(t) - \dot{\hat{X}}(t) = [A(t) - K(t)H(t)](X(t) - \hat{X}(t)) + G(t)W(t) - K(t)V(t). \tag{5}$$

By introducing the notation, we obtain:

$$P(t) = [X(t) - \hat{X}(t)][X(t) - \hat{X}(t)]^T,$$

$$\dot{P}(t) = [\dot{X}(t) - \dot{\hat{X}}(t)][X(t) - \hat{X}(t)]^T + [X(t) - \hat{X}(t)][\dot{X}(t) - \dot{\hat{X}}(t)]^T + \\ + [G(t)W(t) - K(t)V(t)][G(t)W(t) - K(t)V(t)]^T.$$

Accounting for the independence of all vectors included in the value (5), and considering the peculiarity of introduced notation, we obtain

$$\dot{P}(t) = [A(t) - K(t)H(t)]P(t) + P(t)[A(t) - K(t)H(t)]^T + \\ + G(t)Q(t)G^T(t) + K(t)R(t)K^T(t). \quad (6)$$

$$\text{Cov}\{W(t), W(\tau)\} = Q(t)\delta(t - \tau),$$

$$\text{Cov}\{V(t), V(\tau)\} = R(t)\delta(t - \tau).$$

Differentiating (3) by  $K(t)$  and equating the result to zero, we obtain

$$K(t) = P(t)H^T(t)R^{-1}(t). \quad (7)$$

Substituting (7) into (6), we obtain the variance matrix of the minimum error

$$\dot{P}(t) = A(t)P(t) + P(t)A^T(t) - P(t)H^T(t)R^{-1}(t)H(t)P(t) + \\ + G(t)Q(t)G^T(t).$$

Thus, the information system was presented as a dynamic system of stationary linear objects. For this purpose, the concept of control law is introduced. Since information of two different types is needed to find the state of an object, which follows from the definition of a dynamic system, we have considered two types of tasks to determine its state.

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## ТЕОРИЯ РЕГУЛИРОВАНИЯ ЛИНЕЙНЫХ ОБЪЕКТОВ И ОПРЕДЕЛЕНИЕ ИХ СОСТОЯНИЙ

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**Аннотация:** В статье рассматривается создание математических моделей для решения задач линейного программирования применительно к информационной системе. Информационная система рассматривается как система динамики стационарных линейных объектов. Особое внимание уделяется теории регулирования линейных объектов и определению их состояний.

**Ключевые слова:** динамическая система, закон управления, известная матрица наблюдений, состояние системы, шум системы.

## A NEW CONCEPTUAL MODEL FOR GRID DECISION SUPPORT SYSTEMS IMPLEMENTATION

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### **Abstract**

A lot of scenarios involving important decisions take place in a dynamic, quickly evolving, and frequently unpredictable distributed environment. We require highly decentralized, current data sets from multiple sources in these kinds of circumstances. In contrast to traditional decision-making instruments, Decision Support Systems (DSS) specifically engineered for these circumstances face the obstacle of obtaining this dispersed information while surmounting all geographical and temporal limitations and maintaining a high level of cooperative engagement. This paper suggests a novel DSS model and method for these situations. Its primary contribution is the integration of Grid DSS's (cooperative data sharing system) cooperative nature with the recognized benefits of distributed data management. This approach makes use of intelligent age-appropriate communication with its distributed database management system and standard engineering architecture of a Grid Decision Support System. The proposed model aims to advance current DSS approaches by emphasizing collaborative decision-making with data from many sources.

**Keywords:** Decision Support Systems (DSS), Grid DSS, collaborative decision-making, distributed database management.

### **Introduction**

Previously, database users were meant to share the entire database, which was meant to be hosted on a server computer. This method of managing databases was known as centralized database management. The numerous issues with traditional systems—such as data redundancy, lack of sharing, security, consistency, etc—had been greatly outweighed by this method [1]. Subsequently, it was seriously considered that one of the main bottlenecks in this system was the entire database being stored on one site, which negatively impacted system performance. Moreover, as the database size was raised to noticeably larger levels, this strategy was unable to deliver faster "Access Time" and "Response Time." The term distributed database system first appeared in the 1980s as a result of the combination of computer networking and database systems [3].

### **Distributed Database Management in Grid DSS**

The majority of center data, corporate databases, and large-scale data can all be made less complex by using the Grid DSS's suggested Conceptual Model. Standard computer operating systems can benefit from the addition of Data Base Management Systems (DBMS), which are designed to enhance standard operating systems by providing enhanced data integration, sophisticated file organization, speedy changes and retrieval, and improved data security, among other features [2].

### **The Conceptual Model of Grid DSS**

The system  $S$  is the  $i$ -th set of compositions  $M_i$ , constructed from the ratio  $R_i$  to

the law of the composition  $Z_i$  from the primary elements  $M_i^{(0)}$  of the set of bases isolated  $A_i^{(0)}$  from the set M.

From this result it follows that in the general case, not one, but many grounds  $A_i^{(j)}$ , relations  $R_i^{(j)}$  and laws of composition  $Z_i^{(j)}$  are realized on the  $S_i$  system.

The Conceptual Model (CM) of the Grid DSS is represented by a set of concepts defining the system and the relationships between these concepts (links). Formal connection between the integral original system  $\Sigma_0$  and its morphological aspect  $\Sigma_\mu$ , the homomorphic representation of the form:  $\Sigma_\mu^0 = \text{Morf}G_0^\mu : \{\Sigma^0 \rightarrow \Sigma_\mu^0\}$ .

The conceptual metamodel of the structure  $St = \langle E, \pi_\mu^E, \pi_\mu^E(t); C, \pi_\mu^C, \pi_\mu^C(t); \Psi_\lambda, \pi_\mu^\Psi, \pi_\mu^\Psi(t) \rangle$ .

Let us define the rules for structuring information:

$$\exists(\mu \in \text{Hom}(M_i^k, M_j^k)) \rightarrow ((M_i^k, \varphi)N(M_j^k, \nu))$$

where is  $M_b^k$  – the basis of the model,  $(M_0^k, \psi)$  – initial situation,  $(M_i^k, \lambda)$  – derivative situation,  $\lambda \in \text{Hom}(M_i^k, M_b^k)$  &  $\exists \omega \in \text{Hom}(M_0^k, M_i^k)$  – comparability condition, N – inheritance operation.

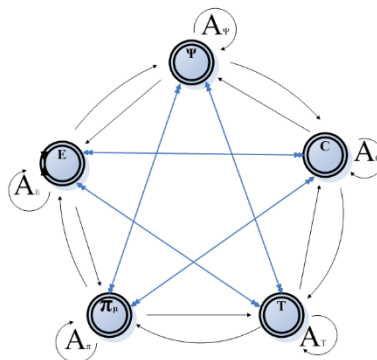


Figure 1 - Graphical representation of the Conceptual Model

### Conclusion

In this study, we investigated the various approaches to Decision Support Systems that exist today, both technical and business, we arrived at an optimal solution for the implementation of such Grid DSS for large organizations and governments. This proposed model includes a comprehensive view of a Grid Decision Support System, which will effectively improve the decision-making process. It can fit for a variety of data types, especially image processing and video monitoring data because it uses distributed database systems to process image frames. It allows to identify the current state of the objects as well as any further modifications or changes made to them within a specified time period.

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## НОВАЯ КОНЦЕПТУАЛЬНАЯ МОДЕЛЬ ВНЕДРЕНИЯ ГРИД-СИСТЕМ ПОДДЕРЖКИ ПРИНЯТИЯ РЕШЕНИЙ

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**Аннотация:** Множество сценариев, связанных с принятием важных решений, происходят в динамичной, быстро развивающейся и часто непредсказуемой распределенной среде. В подобных обстоятельствах нам требуются высоко децентрализованные текущие наборы данных из нескольких источников. В отличие от традиционных инструментов принятия решений, системы поддержки принятия решений (СППР), специально разработанные для этих обстоятельств, сталкиваются с препятствием получения этой разрозненной информации, преодолевая при этом все географические и временные ограничения и поддерживая высокий уровень взаимодействия. В этой статье предлагается новая модель и метод СППР для таких ситуаций. Ее основным вкладом является интеграция кооперативного характера Грид СППР (cooperative data sharing system) с признанными преимуществами распределенного управления данными. Этот подход использует интеллектуальную коммуникацию, соответствующую возрасту, с распределенной системой управления базами данных и стандартной инженерной архитектурой Грид системы поддержки принятия решений. Предлагаемая модель направлена на развитие современных подходов СППР, делая акцент на совместном принятии решений с использованием данных из многих источников.

**Ключевые слова:** системы поддержки принятия решений (СППР), Грид СППР, совместное принятие решений, управление распределенными базами данных.



## PROTECTING INFORMATION METHODS FROM LEAKAGE THROUGH THE ACOUSTO-OPTIC CHANNEL

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### Abstract

The purpose of this study is to analyze existing methods of protecting information from leakage through the acousto-optic channel. The relevance of the study is in using of laser acoustic reconnaissance is invisible to human eyes. However, an attacker promptly obtains some confidential information. This as a result, it is necessary to consider active and passive information methods and their parameters that affect the signal received by the attacker.

**Keywords:** acousto-optic information leakage channel; active and passive protection methods; laser acoustic reconnaissance system.

### Introduction

In the last decade, the development and active use of information technologies has led to an increase in the number of computer crimes. For example, there was a leak of the source codes of Yandex services at the end of January 2023 [1]. The attacker can cause damage by cloning services and further promoting them on the market or analyze the source code for further attacks on Yandex services. Due to the growing number of cyber attacks, a large number of information developments are aimed at protecting against hacker attacks, malware, attacks on banking systems, etc.

However, the most important and urgent information is usually transmitted when two or more people are talking. Timely receipt of such information allows the attacker to change the plans of the speakers or, for example, pass off the voiced idea as his own. Therefore, the protection of speech information from its leakage through technical channels is still a relevant problem.

There are five channels of leakage of speech information: direct acoustic, acousto-vibration, acousto-electromagnetic, acousto-electric and acousto-optic [2]. The acousto-optic channel is one of the unobtrusive ways to obtain confidential speech information. The attacker receives sound vibrations using a laser acoustic reconnaissance system on a remote object (for example, window glass of a neighboring building).

Methods of ensuring information security against unauthorized removal through the acousto-optic channel are divided into passive and active. Moreover, using a combination of these methods is considered a more effective solution in protecting speech information. Passive and active methods of information protection are aimed at reducing the signal-to-noise ratio at the border of the controlled area. In passive protection methods, a reduction of the signal-to-noise ratio is achieved by reducing the level of a dangerous signal [3]. Active protection methods involve the use of additional equipment that allows us to prevent the receipt of useful information. This equipment generates masking acoustic and vibration interference and it increases the noise level in the signal-to-noise ratio.

### **Passive protecting information methods**

The simplest passive method of ensuring information security from its removal by the laser acoustic reconnaissance system is to ensure the sound and vibration insulation of room windows. This method allows eliminating or significantly reducing dangerous information vibrations on the outer surfaces of window glasses. To achieve this result, it is necessary to take into account the following characteristics of window structures:

- the number of glasses;
- the thickness of the used glasses;
- the filling of the space between the glasses;
- the thickness of the window frame.

The most obvious solution to increase the sound insulation of the window structure is to increase the number of glasses installed inside the frame. An example of such a window can be a triplex that consists of two or more glasses. This solution has the greatest impact on sound insulation due to the non-standard arrangement of the window glasses.

It is possible to increase the sound insulation of the window by using a thicker glass than usual. At the same time, if the window consists of several glasses, then the best solution would be to insert glasses of different thicknesses into the window structure. At a resonant frequency, the failure of noise insulation will be less than when implementing a window structure with glasses of the same thickness.

The usual filling of the space between the window glasses is dehumidified air. Inert gas can be pumped into the interior of the window chambers to ensure sound insulation and thermal insulation.

As an alternative to the proposed passive method of information protection, tinting films or blackout curtains can be used. Most window films are made of vinyl or environmentally friendly PVC with a sticky layer, which reduces the level of glass vibrations and complicates the allocation of an audio signal in the received laser radiation. The use of dense or specially designed sound-absorbing curtains reduces the possibility of intercepting speech information due to properties such as opacity and sound absorption. The main properties of soundproof curtains that allow effective protection are:

- weight;
- thickness;
- size;
- material.

### **Active protecting information methods**

One of the active methods of protecting speech information is to change the angle of incidence and reflection of the laser beam. This becomes possible as a result of opening the windows by several centimeters. The periodic change of the window to an open and closed position during negotiations leads to the fact that the attacker will be obliged to quickly change his location, which is almost impossible.

The purchase, installation and use of an acoustic vibration noise reduction system may be a more economical option to secure the room from listening. This system

allows to reduce the level of verbal intelligibility of speech to such values that it does not allow the attacker to obtain confidential information. The acoustic vibration noise reduction system consists of the following elements: a noise generator, vibration emitters and acoustic emitters.

The security of a conversation between several persons depends on what kind of noise is used because the attacker's knowledge of the noise reduction algorithm allows him/her to use additional software or hardware that clears the received signal from the generated interference. There is a change in the signal-to-noise ratio due to an increase in the interference energy, which leads to illegibility of the received speech signal.

### **Conclusion**

The implementation of leakage protection through the acousto-optic channel involves the use of active or passive protection methods with the possibility of increasing efficiency by combining these protection methods. The use of the acoustic vibration noise reduction system is a frequently used method of active protection. The purchase and implementation of special devices reduces the level of sound vibrations in the glass of the window structure.

The structure of the glass can also have an impact on obtaining confidential information when the window is irradiated with a laser acoustic separation system. For example, the use of a triplex in the window frame reduces the level of vibrations on the outside of the window structure. This causes difficulties in receiving a useful speech signal by persons using laser acoustic reconnaissance systems. Therefore, it is important to take into account the structure of the glass when developing a protection plan against leakage of acoustic information.

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## **МЕТОДЫ ЗАЩИТЫ ИНФОРМАЦИИ ОТ УТЕЧКИ ПО АКУСТОПТИЧЕСКОМУ КАНАЛУ**

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**Аннотация:** Целью данного исследования является анализ существующих методов защиты информации от утечки по акустооптическому каналу. Актуальность исследования заключается в том, что применение лазерных систем акустической разведки незаметно для человеческих глаз. Однако злоумышленник оперативно получает конфиденциальные сведения. В результате этого необходимо рассмотреть активные и пассивные средства защиты информации и их параметры, влияющие на полученный злоумышленником сигнал.

**Ключевые слова:** активные и пассивные методы защиты, акустооптический канал утечки информации, лазерная система акустической разведки.

## THE DEVELOPMENT OF A MULTIBEAM PLANAR ANTENNA ARRAY FOR RADIO SUPPRESSION SYSTEMS USING ARTIFICIAL INTELLIGENCE

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### **Abstract**

It is proposed to develop a multibeam planar antenna array for radio suppression systems. The main aspects of the development are considered, including the system structure, training and optimization algorithms, as well as methods of integration with existing electronic warfare systems.

**Keywords:** antenna array, artificial intelligence, electronic warfare, intelligent control system, neural network, radio suppression.

### **Introduction**

Antenna arrays are special devices designed to improve the reception and transmission of radio signals. They consist of an array of elementary antennas mounted on a plane and coordinated with each other. Such arrays are used in a variety of applications ranging from telecommunications and data transmission to radar and astronomy.

One of the main advantages of antenna arrays is their high directivity. Thanks to such a device, it is possible to focus the signal in a certain direction, which is especially important in the case of data transmission over long distances. And in this case the detection of an object. It also reduces the impact of interference and improves the quality of signal reception.

Another advantage of antenna arrays is their ability to operate on different frequency ranges. Thanks to this, they can be used in cellular communications, radar, satellite communications and other areas where the transmission and reception of signals of different frequencies is required.

However, when designing antenna arrays, many factors such as electromagnetic compatibility, signal loss, directivity, and so on must be considered. Therefore, the design and use of antenna arrays requires highly qualified engineers and specialists in the field of radio engineering.

Multi-beam antenna arrays in communication systems multiply their radio frequency resource, which makes it possible to simultaneously serve a large number of subscribers. This is ensured either by spatial-frequency separation or by spatial-temporal separation of information transmission between beams (due to fast jumps of beams in space)[1].

In this case, MBAA allows to optimally use the information capacity of the system depending on the current traffic in the working area of each beam. As a result, a low cost of transmitting a unit of information and optimal (corresponding to the current traffic) use of the communication system resource in the service area are achieved.

A neural network is a computer model that mimics the workings of the human brain and is capable of processing information, extracting patterns and making

decisions based on this data. Neural networks are used in the field of artificial intelligence and machine learning for a variety of tasks such as pattern recognition, natural language processing, prediction and many others. Neural networks consist of many interconnected nodes called neurons that transmit and process information. Neural networks are capable of learning from large amounts of data and adapting to new conditions, making them ideal for solving complex problems.

Artificial intelligence is the ability of a computer to perform tasks that would normally require human intelligence. It can be realized using a variety of algorithms and methods, including neural networks[2]. Artificial intelligence can be used to automate processes, optimize decisions and improve the efficiency of systems.

Overall, AI and neural networks have great potential to solve complex problems and improve people's lives. They can be used in various fields such as medicine, transport, education and entertainment. However, it is also necessary to consider the possible risks and ethical issues associated with the use of AI and neural networks, such as privacy breaches, job loss, and unfairness in decision making [3].

Before developing an intelligent control system for an antenna array, it is necessary to identify the main tasks that the system should perform. These tasks can include object detection, coordinate detection, velocity and direction detection, and object classification and type detection [4].

To solve the problems described above, it is necessary to choose suitable algorithms and methods. In our case, we can use neural networks such as convolution networks, recurrent neural networks and transformers, which have shown good results in 2D image processing tasks.

Convolutional networks (CNNs) are a type of neural networks that are used to process images and other one-dimensional or two-dimensional data. They are so named because of the analogy with convolutional neurons that are used in their architecture.

Recurrent neural networks (RNNs), on the other hand, are used to process sequential data such as text or audio. They consist of neural layers that can memorise information about previous input data, allowing them to take into account the context and dependencies between sequential elements.

Transformers are a newer type of neural network that was proposed in 2017. Transformers utilize an attention mechanism that allows the network to focus on different parts of the input data and make connections between sequence elements. This allows the model to learn from semantic dependencies between sequence elements, making it particularly suitable for 2D image processing tasks. Once the algorithms and methods have been selected, it is necessary to train the neural networks on large amounts of data. Optimization methods such as gradient descent, additive gradient descent and moment optimization methods can be used for this purpose. Training and optimization should be carried out in a way that is specific to monopulse radar and radio assembly [5].

A multibeam antenna array consists of a radiator array and a pattern-forming circuit. The pattern-forming circuit serves to provide independent power supply to the array radiators through different inputs. When the transmitter is connected to one of the inputs of the circuit in the radiators of the array is created quite definite, peculiar only to this input amplitude-phase distribution of the directivity pattern. Connecting the transmitter to any other input of the pattern-forming circuit causes a change in the

amplitude-phase distribution in the grating radiators and, accordingly, the formation of another, different from the previous, directivity pattern.

Neural networks are used in radio warfare to detect and analyze radio frequency signals, to optimize the performance of radio electronic systems, and to create autonomous devices capable of adapting to changing combat conditions. Neural networks can be trained to identify types of radio signals, classify them and predict their future actions. Neural networks can also be used to optimize the parameters of radio transmitters and receivers, as well as to create autonomous control systems for radio equipment.

After training and optimization of neural networks it is necessary to implement them in the control system of the Flat Multibeam Antenna Array. Programming languages such as Python and C++ can be used for this purpose. After implementation, the system should be tested under different conditions and with different objects to evaluate its efficiency and accuracy.

### **Conclusion**

In this article, we proposed to develop a multibeam planar antenna array for radio suppression systems based on neural network and artificial intelligence. We described the theoretical framework, design process, implementation and testing of the system. This development can significantly improve the performance of the antenna array and radio suppression, which in turn can lead to improved safety and efficiency of systems for various applications.

In conclusion, antenna arrays are an important element in modern communication and radar systems. They provide high directivity, compactness and versatility, which makes them a popular solution for various technical applications.

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## **РАЗРАБОТКА МНОГОЛУЧЕВОЙ ПЛОСКОЙ АНТЕННОЙ РЕШЕТКИ ДЛЯ СИСТЕМ РАДИПОДАВЛЕНИЯ С ИСПОЛЬЗОВАНИЕМ ИСКУССТВЕННОГО ИНТЕЛЕКТА**

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**Аннотация:** Предлагается разработать многолучевую плоскую антенную решетку для систем радиоподавления. Рассмотрены основные аспекты разработки, включая структуру системы, алгоритмы обучения и оптимизации, а также методы интеграции с существующими системами радиоэлектронной борьбы.

**Ключевые слова:** искусственный интеллект, интеллектуальная система управления, антенная решетка, нейронная сеть, радиоподавление, радиоэлектронная борьба.

## INTERCEPTION OF UAVS IN THE ABSENCE OF APRIORI INFORMATION

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### Abstract

The article reflects the problem of countering unmanned aerial vehicles (UAVs). A variant of intercepting a UAV with a complex that has an air (UAV) and ground component is presented.

**Keywords:** interception technique, UAV, UAV interception.

Due to the aggravation of the situation of the use of unmanned aerial vehicles in modern armed conflicts, the increasing simplicity of developing and assembling platforms capable of firing at remote positions, the question of the possibility of detecting and destroying them on approach to target objects sharply arises. The greatest priority in this case is the need to intercept them, since this allows you to get the maximum amount of information about the place of production, launch, and, in the future, to develop the most effective ways to counter this type of UAV.

Since the creation of new types of UAVs is constantly underway, the development of highly specialized interception equipment for each UAV has low efficiency. It is advisable to consider methods of intercepting UAVs in the absence of a priori information about it.

UAV interception refers to the process of taking control of the trajectory of the UAV in order to bring it to the target square, crash-free landing while blocking the control of its original operator. Since the impact can be carried out on various classes of UAVs, it must be borne in mind that its operator may be located at a considerable distance or, in the case of UAV control via satellite repeaters, be outside the conflict area. It is advisable to consider the UAV itself as the main object of influence, without taking into account the possibility of influencing its control point or repeaters.

The systems that can be affected when using a UAV as an object can include:

- receivers of control signals from the control point (repeaters);
- receivers of satellite radio navigation systems.

One of these channels can be used to intercept UAVs.

When performing radio interception by influencing the receivers of the control signals of the UAV, the equipment must simulate the signal of the control point. In this case, a kind of so-called "intermediary attack" can be used, where equipment simulating the transmission protocol is used as a signal source, as well as the addresses of the control point and the UAV that is being affected. This method requires a large amount of a priori information about the UAV that is being affected and about its control protocol.

In modern military conflicts, it is possible to use a huge number of different UAVs. At the same time, data transmission protocols are constantly being improved

not only for military UAVs of developed foreign countries. Today, the control system can be created on the basis of any commercial radio communication, LTE, Wi-Fi, NStream, commercial satellite networks.

When radio interception is carried out by influencing the receivers of satellite radio navigation systems, the so-called "false navigation field" is generated. The implementation of a hardware and software complex for simulating selective satellite navigation systems is currently a fairly simple task. There are several commercial implementations of these systems on the market, for example, the GPS/GLONASS GSG-62 signal simulator, in frequency such a function exists in the R&S SMBV100A vector signal generator [1],[2]. These systems predict the availability of a satellite grouping over a given area, generate a navigation message, and generate a pseudo-random code of the satellite grouping.

Most modern UAVs are remotely controlled. This means that, unlike remotely piloted UAVs, they form a flight path independently along a route defined by them, set by the operator. The advantage of this method is the ease of control, the absence of the need for constant transmission of UAV commands in the air, the great survivability of the device due to the possibility for it to return to base and land independently. An example of such a device is the RQ-11 Raven UAV, widely used in the US Army. At the same time, most of these UAVs use satellite radio navigation systems as the main navigation system [3].

A remotely controlled UAV can be intercepted when solving the following tasks:

1. Determining a given UAV route.
2. Blocking the control channel, forcing the UAV to switch to automatic flight along a given route.
3. Distortion of the navigation field in the area where the UAV is located in order to impose on it the trajectory of movement necessary for interception, escorting it to the desired landing site.

To implement the UAV interception algorithm, it is necessary to open the route assigned to it. At the moment, the task of detecting the fact of the use of UAVs by the enemy and determining its position in the air is a priority when organizing the defense of facilities. For this purpose, both radar stations and methods of bearing and range-difference determination of the location of the radio signal source are used in the case of a constantly functioning UAV data reset channel. In practice, these methods show low efficiency for several factors:

1. Small effective UAV dispersion surface.
2. The need to detect the UAV control signal transmitted to it from the NPU.
3. Low probability of the UAV using a constantly functioning data reset channel.
4. The possibility of using repeater satellites to transmit control signals.

In addition, most modern UAVs have protection against the effects of SRNS radio interference emitted from ground sources, consisting in the use of antennas, the diagram of which is directed upwards.

Based on this, the UAV interception system can be built on the principle of having an aerial (using UAVs) and a ground component.

The task of the air component can include:

1. Deployment (flight) at echelons above the estimated presence of UAVs.



2. Visual search and detection of UAVs. At the same time, the enemy's UAV stands out from above as an object moving along a straight trajectory, having a greater contrast compared to ground-based equipment. At this stage, it is possible to use neural networks.

3. Detection of the UAV control signal (NPU-UAV channel) and transmission of frequency ratings to the ground component.

4. Signal generation-interference to the control channel of the intercepted UAV in the case of control via a repeater satellite.

5. The formation of a distortion of the navigation field.

The task of the ground component can include:

1. The formation of an interference signal to the control channel of the intercepted UAV.

2. Detection of the UAV control signal (satellite repeater channel-UAV) and transmission of frequency ratings to the air component.

This technique has a number of disadvantages related to the presence of the composition of the minimum necessary information:

1. The applied echelon of the target UAV (flight altitude).

2. The fact of using algorithms for following the route in flight (whether it is remotely controlled).

3. The fact that target UAVs use satellite radio navigation systems.

4. Possible range of the channel for receiving commands from the ground control point of the target UAV.

In addition, the question of the functioning of the air component of the complex in conditions of distortion of the navigation field is open. However, this problem can be solved by creating and using a local radio navigation system.

To conclude, we discussed the current topic of combating UAVs, examined the channels through which they can be intercepted. In addition, we considered the tasks in which the UAV could be attacked, and some methods of radio interception of UAVs were described along with their advantages and disadvantages. Further improvement of UAV interception techniques is the path to the development of military doctrine for conducting ground combat operations.

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## ПЕРЕХВАТ БПЛА ПРИ ОТСУТСТВИИ АПРИОРНОЙ ИНФОРМАЦИИ

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**Аннотация:** В статье отражена проблема противодействия беспилотным летательным аппаратам (БПЛА). Представлен вариант перехвата БПЛА комплексом, имеющим воздушную (БПЛА) и наземную составляющую.

**Ключевые слова:** беспилотный летательный аппарат, методика перехвата, перехват БПЛА.

## INFORMATION MODEL OF THE EVAPORATION APPARATUS

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### Abstract

An information model is presented for determining the dimensions of the parts of the lower part of the heating chamber of the evaporator, as well as a model for determining the location of the elements of the evaporator.

**Keywords:** information model; construction; elements; evaporation apparatus

### Introduction

In industrial production, due to the huge demand for evaporators, it becomes necessary to automate their design, since each enterprise provides a different technical specification, which reflects different initial data, such as the type of solution, type of evaporator, pressure, ambient temperature, etc.

### Methodology

Automated information systems (AIS) are used to automate the design of technological equipment, which are also designed by evaporators. There are many methods for developing AIS, but the main one will be the information logic model (ILM) method. Using this method, it is possible to create an information model for determining the parameters of the elements of the evaporator and the location of the elements of the evaporator.

*The model for determining the parameters of the elements of the evaporator has many rules, but as a demonstration of the operation of this model, the rules  $P^{pp}$  will be taken.*

These rules are necessary in order to determine the dimensions of structural elements that are missing from regulations and standards after technological calculations.

Let's take as an example the lower part of the heating chamber in the evaporator and assume that the inner diameter is located and assigned to all interconnected body elements: shell, elliptical lid, flanges.

*The model for determining the location of the elements and parts of the evaporator is used when it is possible to assemble and accurately determine the positions of the elements in relation to each other.*

The model works according to the rule that any solid-state geometric object is characterized by a tuple [1]:

$A^{3D} = \langle O_s, L, Gr, S^P \rangle$ , where  $O_s = \{os\}$  is the set of axes;  $L = \{l\}$  is the set of edges;  $Gr = \{gr\}$  – a set of surfaces (faces);  $S^P = \{s^P\}$  – a set of interfaces (positioning links) between  $O$ ,  $L$ , and  $Gr$ .

The formal representation of the model with structural elements looks like this:

$$M_2 = \langle A^{3D}, R^{SP}, B^r \rangle,$$

where  $R^{SP}$  is a register of types of interfaces between the base axes, edges and faces of elements;  $B^r$  are the rules that define the interfaces between the basic geometric parameters of the elements.

Therefore, the model (Fig. 2) can be shown as:

*Elliptical cover.* $O_3 \odot$  *Shell.* $O_1$ , *Elliptical cover.* $\Pi_3 \cap$  *Shell.* $\Pi_1$ ,

*The flange.* $O_4 \odot$  *Shell.* $O_1$ , *The flange.* $\Pi_4 \cap$  *Shell.* $\Pi_8$ ,

*Circulation pipe.* $O_5 \odot$  *Shell.* $O_2$ , *Circulation pipe.* $\Pi_5 \cap$  *Shell.* $\Pi_2$ ,

*Fitting 1.* $O_6 \odot$  *Shell.* $O_2$ , *Fitting 1.* $\Pi_6 \cap$  *Shell.* $\Pi_2$ ,

*Fitting 2.* $O_7 \odot$  *Elliptical cover.* $O_3$ , *Fitting 2.* $\Pi_7 \cap$  *Elliptical cover.* $\Pi_9$ ,

where  $\odot$  is the alignment;  $\cap$  is the location in the same plane.

### Results

Using the model for determining the parameters of the elements of the evaporator, we obtained an assembly that is determined by the parameters of the parts for the lower part of the heating chamber of the evaporator. This assembly is shown in Figure 1.

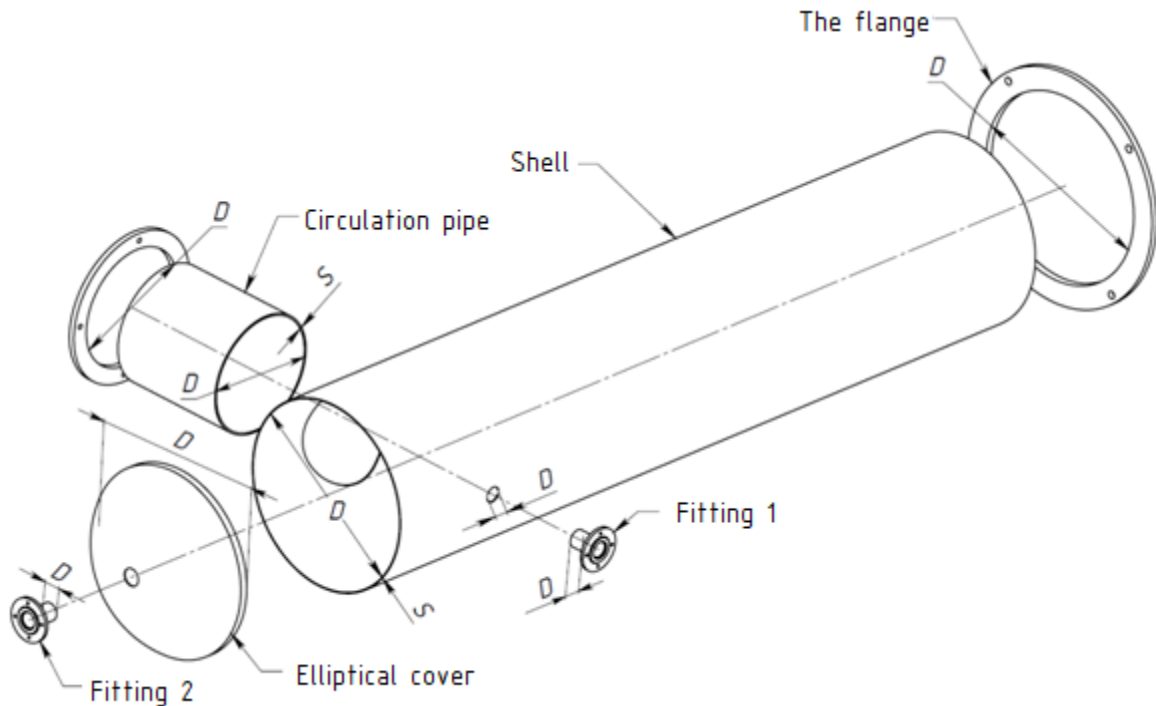


Figure 1 - Assembly with the defined parameters of the parts of the lower part of the heating chamber of the evaporator

Also, using the model for determining the location of the elements and parts of the evaporator, we received another assembly in which the locations of the parts for the lower part of the heating chamber of the evaporator were determined. This assembly is shown in Fig.2.

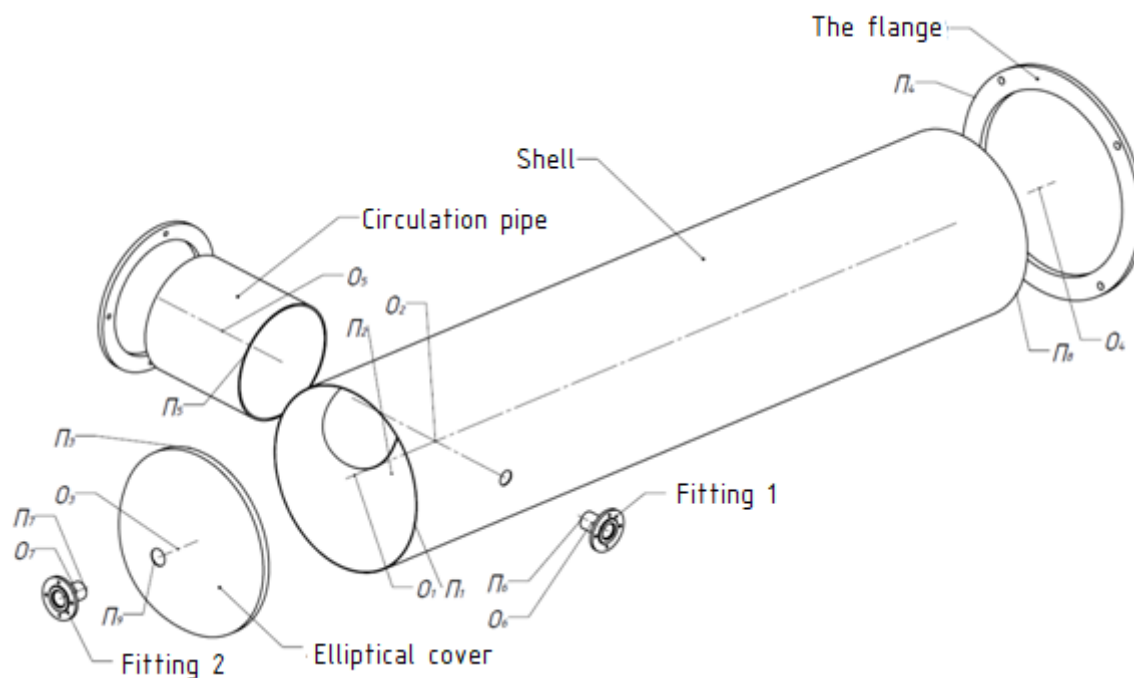


Figure 2 - Elements of the coupling of the parts of the lower part of the heating chamber of the evaporator

The presented model is used in the computer-aided design system of technological equipment being developed with the participation of the author [1-5].

### Conclusion

Using the information logic model (ILM) method, it is possible to create the necessary information models. These information models will subsequently serve to optimize the design of evaporators in industrial production.

### Acknowledgements

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# ИНФОРМАЦИОННАЯ МОДЕЛЬ ВЫПАРНОГО АППАРАТА

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**Аннотация:** Представлена информационная модель определение размеров деталей нижней части греющей камеры выпарного аппарата, а также модель определения расположение элементов выпарного аппарата

**Ключевые слова:** информационная модель; конструкция; элементы; выпарной аппарат

## MODERN WEB TECHNOLOGIES IN DECISION SUPPORT SYSTEMS FOR OPTIMIZING COURSE SELECTION IN THE UNIVERSITY

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### **Abstract**

The article examines modern web technologies in the context of their application to optimize the selection of subjects in universities. The focus is on the integration of artificial intelligence and machine learning into decision support systems. The article presents an intelligent web platform designed to effectively guide students in choosing courses using recommendation algorithms. The benefits of personalized course selection scenarios, created based on students' preferences and academic performance data, are discussed in detail. The impact of web applications that provide convenient access to information about courses, instructors, and reviews is also discussed. The results of experiments confirm improvements in student satisfaction and the optimization of the learning process. The article aims to draw attention to the possibilities of modern web technologies in the context of educational solutions, providing a practical view of their implementation in the university environment.

**Keywords:** web technologies, artificial intelligence, machine learning, decision support systems, course selection, university, recommendation algorithms, personalization, web applications, optimization of the learning process.

### **Introduction**

Currently, the dynamic evolution of educational technologies and constant changes in academic curricula pose a challenge for higher education institutions to provide effective support to students in the course selection process. The rapid advancement of modern web technologies, coupled with the active integration of artificial intelligence and machine learning into the educational process, opens new perspectives for creating innovative decision support systems. This research aims to analyze and apply modern web technologies in the context of their role in optimizing course selection in universities. With a focus on artificial intelligence, machine learning, and decision support systems, the article introduces an intelligent web platform designed to create personalized scenarios for course selection, thereby providing students with a more efficient and satisfying learning experience. The goal of this study is to identify the advantages of using these technologies in the educational environment and to assess their impact on student satisfaction and the overall effectiveness of the learning process in contemporary universities.

### **Overview of modern web technologies in education**

Modern web technologies play a pivotal role in transforming the educational process, offering unique opportunities for optimization and improvement of pedagogical effectiveness. This section provides an overview of key web technologies aimed at supporting educational research and optimizing learning processes. Artificial Intelligence (AI) has become an integral part of the educational

environment, providing innovative possibilities for personalized learning. AI enables the creation of intelligent systems capable of adapting to individual student needs, offering personalized materials, and feedback. The application of machine learning and data analytics in education is focused on identifying patterns in educational processes and providing valuable information for decision-making. Machine learning algorithms can predict student success, optimize courses, and offer personalized recommendations. Decision support systems combine the benefits of artificial intelligence and machine learning, providing students and educators with tools for more informed choices and organization of educational materials. These systems take into account individual preferences and student achievements, optimizing the learning process. All the mentioned technologies interact, creating an integrated approach to optimizing the educational process and ensuring the effective use of modern web technologies in university education. In particular, decision support systems based on artificial intelligence and machine learning provide powerful tools for students and educators to make informed choices and organize educational materials consciously. Considering individual preferences and student achievements, this system not only optimizes the learning process but also ensures a personalized approach, contributing to a more efficient and satisfying educational experience.

### **Development of an intelligent web platform**

To implement an intelligent web platform that optimizes the course selection process in universities, a modern technology stack will be utilized, comprising React for the frontend, Node.js for the backend, PostgreSQL as the database, and elements of artificial intelligence (OpenAI API). Additionally, the entire project should be containerized using Docker to facilitate deployment and scalability.

The user interface is being developed using the React library, enabling the creation of dynamic and responsive web applications [2]. The component-based approach of React ensures simplicity in maintenance and the ability to extend the platform's functionality.

The backend should be developed using Node.js, ensuring high performance and efficient request processing. The Node.js ecosystem provides a wide range of libraries for implementing business logic and interacting with the database [3].

For storing data related to courses, students, and preferences, a relational database, PostgreSQL, has been chosen [4]. This ensures structured and efficient data storage and provides opportunities for complex queries.

Elements of artificial intelligence, including the OpenAI API, should be utilized for data analysis. The OpenAI API offers powerful tools for natural language processing and textual information analysis, enhancing the functionality and adaptability of the system [1].

The project should be packaged into Docker containers to create a uniform and portable environment. This ensures ease of deploying the platform on different servers and environments, simplifying the process of scaling and updating the application.

This technology stack, complemented by the OpenAI API, creates a powerful and intelligent web platform capable of adapting to the unique needs of students and providing them with a personalized and optimized educational experience.



## **Experiments and results**

Let me consider a specific example of the successful use of a Decision Support System (DSS) to optimize course selection in a university in practice. Suppose the DSS was implemented at Tambov State Technical University with the aim of increasing the efficiency of the educational process and improving the adaptability of the curriculum to individual student needs. One notable use case of the system was the scenario involving a student named Alexander. Alexander, a third-year student, faced uncertainty regarding the choice of specialization and courses for the upcoming semesters. By using the DSS, Alexander provided the system with data about his current academic status, interests, and long-term career plans. The DSS analyzed this information and offered Alexander a personalized study plan. The system took into account his academic progress, identified key courses aligned with his interests, and provided information about possible specialization directions. Additionally, the system considered current labor market requirements, helping Alexander formulate a more informed plan for his future career. Throughout his studies, the DSS regularly updated data and analyzed Alexander's progress in selected courses. If the system detected potential difficulties, it provided additional resources and recommendations to improve his performance. Ultimately, thanks to the Decision Support System, Alexander was able to focus on the most important aspects of his education, reducing uncertainty and increasing confidence in his course selections. His academic achievements improved, and, in the end, he made an informed choice of specialization that aligned with his personal interests and career ambitions.

## **Conclusion**

In this article, we explored modern web technologies in the context of their application in decision support systems to optimize course selection in universities. Integrating artificial intelligence, machine learning, and data analytics into the educational process enables the creation of innovative solutions aimed at increasing efficiency and personalization of learning. The successful examples of decision support system implementations in universities demonstrate significant positive changes in student performance, satisfaction with the educational process, and optimization of the use of educational resources. Personalized approaches, taking into account individual needs and preferences of students, have a substantial impact on education.

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# СОВРЕМЕННЫЕ ВЕБ-ТЕХНОЛОГИИ В СИСТЕМАХ ПОДДЕРЖКИ ПРИНЯТИЯ РЕШЕНИЙ ДЛЯ ОПТИМИЗАЦИИ ВЫБОРА КУРСА В ВУЗЕ

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**Аннотация:** Рассмотрены современные веб-технологии в контексте их применения для оптимизации выбора предметов в вузах. Основное внимание уделяется интеграции искусственного интеллекта и машинного обучения в системы поддержки принятия решений. В статье представлена интеллектуальная веб-платформа, предназначенная для эффективного руководства студентами в выборе курсов с использованием рекомендательных алгоритмов. Подробно рассмотрены преимущества персонализированных сценариев выбора курсов, созданных на основе предпочтений студентов и данных успеваемости. Также обсуждается влияние веб-приложений, обеспечивающих удобный доступ к информации о курсах, преподавателях и отзывах. Результаты экспериментов подтверждают повышение удовлетворенности студентов и оптимизацию процесса обучения. Целью статьи является привлечь внимание к возможностям современных веб-технологий в контексте образовательных решений, предоставив практический взгляд на их внедрение в университетской среде.

**Ключевые слова:** веб-технологии, искусственный интеллект, машинное обучение, системы поддержки принятия решений, выбор курсов, вуз, рекомендательные алгоритмы, персонализация, веб-приложения, оптимизация учебного процесса.

## COMPUTING SYSTEMS AND SEISMIC HAZARD

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### **Abstract**

The purpose of this study is to calculate the performance of a computer system for calculating seismically hazardous regions of Russia. This system is focused on calculating the trajectory and other characteristics of seismically hazardous areas. The relevance of the study lies in the fact that the characteristics of seismic activity in a certain area are important in various aspects of human life, such as the design and construction of huge buildings and infrastructure projects, growing crops, calculating tariffs for insurance payments and much more.

**Keywords:** computer system (CS), seismic hazard (SH), seismic activity (SA).

### **Introduction**

High-performance computing systems (CSs) are increasingly used in solving highly loaded mathematical problems in the field of forecasting atmospheric phenomena, in various geological projects in order to search for the development of deposits, seismic forecasting, and in the aerospace industry. These CSs are indispensable in areas where it is unacceptable to spend a lot of time calculating various characteristics.

### **Materials and methods**

Seismic hazard (SH) is the probability of an earthquake occurring in a specified region within a specified period of time. This depends on many factors, including the geology of the area, the presence of active faults and the history of past earthquakes.

Calculation of seismic activity (SA) and probabilities in earthquake-prone areas plays an important role in preventing and mitigating the consequences of earthquakes. This text examines the main aspects of these issues.

A seismic zone is an area at risk of earthquakes of a certain strength and magnitude. Determining these zones requires not only taking into account seismic and geodynamic processes in the territory, but also analyzing geological and historical data.

Various models and methods are used to calculate probabilities and identify SH zones, including seismic zoning, seismic wave analysis, and seismic modeling.

Also, the calculation of the probability of SH can be carried out using various methods. One of the most common is time series analysis. This includes examining historical seismic data and identifying trends and patterns.

In general, identifying zones of SH and SA is a high-performance task that requires a volumetric approach and the use of various methods and data.

Next, to determine the complexity of the calculations, we will use information from sources [1-2]. Calculations for identifying SH were first formulated by C. Allyn Cornell in 1968 and, depending on the level of their significance and use, are often quite energy-intensive. Regional geology and seismology first examine the origins

and logic of the occurrence of earthquakes, both underground and above it according to seismometer data; secondly, the influence of these sources is considered and analyzed in conjunction with geological rocks, soil types, as well as inclination angles and characteristics of groundwater. Accordingly, scientists identify and map areas with a high probability of potential earthquakes. There are many such areas. The East African Rift is a rift valley that stretches thousands of kilometers across East Africa and is where the African and Arabian plates collide, causing geodynamic activity. The North Anatolian Fault is located in Turkey and is known for its high seismic activity, which regularly causes earthquakes in the region. The Mid-Atlantic Ridge in the middle of the Atlantic Ocean, where lithospheric plates spread out. This is one of the largest fault lines on Earth and plays an important role in the theory of continental drift. These faults are of great importance to geology and seismology and continue to attract the attention of scientists and the public due to their impact on the environment and human activities.

Each site is assigned properties associated with the potential source: number of earthquakes per year, maximum size of earthquakes (maximum magnitude), etc. Finally, the calculations require formulas that give the necessary risk indicators for this earthquake size, as well as distances. For example, some applications favor the use of peak acceleration, others prefer peak velocity, and more demanding applications require a spectral ordinate response.

A computer program is then integrated into all areas and creates probability curves for key ground motion parameters. In the end, the result gives the “probability” of going beyond the specified values over a certain period of time. Building standards and homeowners' regulations may refer to a 1 in 500-year chance, but nuclear plants are looking at a time frame of 10,000 years. A longer seismic history can be obtained using paleontology. The results can be presented as a response spectrum of soils for use in seismic analysis. The practical algorithm used to predict seismic regions is based on matrix calculation and the CPI parameter to increase the complexity of each region, requiring about  $10^3$  search operations.

### Results

Let us consider calculating the probability of an earthquake for Russia. Area of the country  $S_{\text{Russia}} = 17125191 \text{ km}^2$ . We also take a square with a side of 100 m as one sector and get  $S_{\text{sector}} = 1 * 10^{-2} \text{ km}^2$ . Using the formula:  $S_{\text{Russia}}/S_{\text{sector}}$ , we get:  $1.71 * 10^7 \text{ km}^2 / 1 * 10^{-2} \text{ km}^2 = 1.72 * 10^9$  design zones.

Since changes in zone parameters may not occur frequently, the model can be created every day for a month:  $v = 1 * 30 = 30$ .

Using the formulas, one can find out the total load P of a computing task:

$$P = S_{\text{Russia}}/S_{\text{Sector}} * v * N = 1.72 * 10^9 * 3 * 10^1 * 10^3 = 5.16 * 10^{13} \text{ operations.}$$

Then the performance of the CS Q for creating a model in 5 minutes can be calculated using the formula, and it will be equal to:

$$Q = P/t = 5.16 * 10^{13} / 60 = 8.6 * 10^{12} \text{ operations/sec.}$$

## Conclusion

As a result of the calculations, the final performance of the aircraft was obtained for performing tasks related to predicting the probability of earthquakes in Russia. This research can be used in the future to design and build a CS with various parameters.

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## ВЫЧИСЛИТЕЛЬНЫЕ СИСТЕМЫ И СЕЙСМИЧЕСКАЯ ОПАСНОСТЬ

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**Аннотация:** Целью данного исследования является расчет производительности вычислительной системы для расчета сейсмически опасных районов России. Данная система ориентирована на расчет траектории и прочих характеристик сейсмически опасных районов. Актуальность исследования заключается в том, что характеристики сейсмической активности определенного района важны при различных аспектах человеческой жизни, например, таких как проектирование и строительство огромных зданий и проектов инфраструктуры, выращивание урожая, расчет тарифов для страховых выплат и др.

**Ключевые слова:** вычислительная система (ВС), сейсмическая опасность (СО), сейсмическая активность (СА).

## **EARTH SURFACE MONITORING SYSTEM WITH APPLICATION OF AI METHODS**

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### **Abstract**

This article is devoted to the development of a system for monitoring the Earth's surface using AI methods. This system will be based on satellite altimetry. Using this method of remote sensing of the earth, the system will produce the construction of the earth and ocean surface to solve various technical and industrial problems. The system will use such artificial intelligence method as neural networks for pattern recognition, prediction and optimization of the whole process of functioning.

**Keywords:** altimetry, artificial intelligence, intelligent control monitoring, neural networks, remote sensing,

### **Introduction**

Earth surface monitoring is an important aspect of modern scientific research and practical applications. In recent years, the intensive development of artificial intelligence (AI) technologies has opened up new opportunities for creating effective monitoring systems. The Earth surface monitoring system is a set of integrated technologies, methods and tools designed for continuous and systematic observation of the condition and changes occurring on the Earth's surface. The main objective is to provide reliable and accurate collection of land surface information to support scientific research, decision making in various fields including ecology, agriculture, geology and natural resource management [1].

### **Machine Learning**

Machine learning is one of the main AI techniques used to create models that can classify, predict and analyze data. In the context of Earth surface monitoring, machine learning can be used to identify features and attributes that help determine the state of the surface, such as moisture level, temperature, pollution level, etc.

### **Deep learning**

Deep learning is an approach in machine learning that utilizes layered neural networks to process large amounts of data. In Earth surface monitoring, deep learning can be used to analyze satellite images, geodata, and other types of data to identify features and changes on the surface.

### **Neural Networks**

Neural networks are computer programs that mimic the workings of the human brain. They consist of many neurons that are interconnected and process information. In Earth surface monitoring, neural networks can be used to classify and predict changes in the surface, as well as to detect anomalies and identify risks [3].

### **Parameters and characteristics of the designed system**

The system for monitoring the Earth's surface using AI methods is a set of integrated technologies, methods and tools designed to construct the Earth and ocean surface, track changes in crustal heights and waves. According to the time of return

of the probing pulse, the distance from the satellite to the surface under study is calculated, which makes it possible to determine its height, and the system begins to build this surface, whether it is land or ocean, based on this data. Systematic monitoring of the surface will allow tracking changes in elevation, and the neural networks applied will be able to predict these changes. The use of space images will allow the system, to build the surface not only with the obtained altitudes, but also its topographic view.

The main components of the system are:

- 1.Spatial data: Information related to geographical position such as coordinates, shapes and attributes of objects.
- 2.Coordinate systems: Means for determining and specifying the location of objects on the Earth's surface.
- 3.Analysis and processing tools: Algorithms and tools for spatial analysis, computation and visualization.

### **Systematization and generalization of the obtained results**

The result of the Earth surface monitoring system with the application of AI methods will be the constructed projection of the Earth or ocean surface with its topographic view. It will also use a system of planar geographic coordinates that characterize the location of given points relative to the original points, lines or planes. The monitoring system will be able to systematize the data on the obtained heights and any point of the constructed surface will be able to express in numerical value using the system of absolute and relative heights [2].

The integration of neural network will enable more accurate image processing, change detection and automatic pattern recognition, which reduces the analysis time and improves the accuracy of the results.

The prediction of land surface or ocean level change based on neural network will have the following algorithm:

- obtaining a time series with an interval of a selected time iteration;
- filling "gaps" in the history;
- smoothing the series using the moving average method (or other);
- obtaining a series of relative changes in the forecasted value;
- generation of a table of "windows" with the depth of time intervals;
- adding additional data to the table (change in the value for previous years);
- scaling [1].

### **Computer modeling of the designed system using AI methods**

The process of computer modeling includes the creation of an information model of the Earth surface monitoring system using AI methods on a computer and conducting a computational experiment to study its characteristics. Computer modeling is a powerful tool for solving scientific and technical problems.

The essence of computer modeling of the Earth surface monitoring system using AI methods is to develop a computer program that describes the behavior of the system elements in the process of its operation. This program takes into account the interaction between the elements of the system and its interaction with the external environment. By conducting computational experiments on the computer, it is possible to study the characteristics of the system, optimize its functioning, and

predict new phenomena [4].

The modeling results obtained using MatCad software environment were integrated into the system of monitoring the earth surface using AI methods. This made it possible to select optimal parameters of data collection. This approach increases the operational efficiency of the radio monitoring system of the Earth's surface.

### **Conclusion**

The developed system of earth surface monitoring using AI methods is innovative due to the use of satellite altimetry. This gives the most accurate altitude characteristics of the investigated Earth surface. Together with the use of topographic images of the Earth from satellites and georeferencing to the coordinate system, the constructed projection will display the holistic information of the surface of the probed land or ocean, with the correct orientation relative to the planet. The trained neural network will optimize the operation of this system, and the developed forecasting algorithm will allow calculating possible changes in the height of the Earth's surface or the level of waves and the world ocean.

In conclusion, it should be noted that the development of a system for monitoring the Earth's terrain using AI methods is an urgent and promising task in modern science and technology. In this article, the main aspects of creating such a system, including methods of data processing and analysis, machine learning and neural network algorithms, as well as information visualization and presentation technologies, were considered.

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## **СИСТЕМА МОНИТОРИНГА ЗЕМНОЙ ПОВЕРХНОСТИ С ПРИМЕНЕНИЕМ МЕТОДОВ ИИ**

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**Аннотация:** Статья посвящена созданию системы мониторинга земной поверхности с применением методов ИИ. Данная система будет основана на спутниковой альтиметрии. С помощью данного метода дистанционного зондирования земли, система будет производить построение земной и океанической поверхности для решения различных технических и промышленных задач.

**Ключевые слова:** альтиметрия, дистанционное зондирование, интеллектуальная система мониторинга, искусственный интеллект, нейронная сеть.



## PATTERN RECOGNITION OF THE STATE REGISTRATION PLATE OF A VEHICLE

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### **Abstract**

Vehicles today play an important role in the daily lives of all people. They have become a source of income, means of transportation and travel, and their number is growing rapidly. Therefore, it becomes extremely difficult to manage the traffic of so many vehicles. One of the most important factors in transportation safety is predicting traffic violations. In this study, the application of pattern recognition techniques for detecting and recognizing traffic violations is discussed. Using algorithms and various technologies, pattern recognition for detecting traffic violations identifies and automatically detects actions or behaviors that are against the law. The combination of artificial intelligence, computer vision and machine learning technologies leads to significant improvements in this sector. The problem of automobile image recognition is formulated in the form of a six-step algorithm.

**Keywords:** algorithm; convolutional neural networks; deep learning; machine learning; pattern recognition; traffic violations; vehicles.

### **Introduction**

The need for monitoring and management of traffic flows is increasing due to the extreme diversity and complexity of transport phenomena on road networks, as well as growing demands from users. Any country needs transportation for its socio-economic development, and it is difficult to imagine significant economic progress in the absence of an efficient transportation infrastructure. In addition, the number of personal and municipal vehicles is growing at a tremendous rate.

Monitoring systems can be categorized into automatic and manual detection methods, the latter requiring the constant presence of an operator. For short-term vehicle counting, manual systems are better, since human operators are better able to cope not only with vehicle type identification and detection, but also with analyzing its movement and the driving habits of its passengers. They have to monitor everything that happens on the roads around the clock and detect every offense to improve detection efficiency and reduce dependence on traffic police [1, 2]. Automatic detection of traffic violations is crucial.

The authors of the paper [3] proposed a centralized vehicle tracking and identification system. After pre-processing the video stream, the *You Only Look Once* (YOLO) model and *Convolutional Neural Networks* (CNN) model, which was applied for character recognition, are used to identify and recognize license plates. Real-time vehicle tracking is achieved by using a deep sorting algorithm: 90% of vehicles and 95% of license plates were detected [3].

In [4], the researchers created an automated method to identify traffic violations by utilizing a CNN approach. The system is created in a step-by-step process. It first recognizes three types of items in the video stream: automobiles, crosswalks, and pedestrians. Subsequently, it tracks the movement routes of both automobiles and

humans. Finally, it analyses the moving patterns of both individuals and cars to establish if a traffic violation has taken place within a set timeframe. The system utilizes the *YOLO Version 3* neural network for real-time object identification, involving persons and cars [4]. A segmentation method based on user-defined markings is used to detect crosswalk.

In modern databases of traffic tracking, traffic offenses a huge amount of heterogeneous information is accumulated: text, tabular, audio, video, multimedia, etc. Recognition of images in such diversity is quite an urgent task.

### **Statement of the research problem**

The aim of our research: to improve the efficiency of the functioning of traffic offense databases in the Tambov region through the development and application of pattern recognition methods, neural network technologies and rule solvers.

One of the techniques that is often used for the classification and recognition of images is CNN. It is a part of the technologies of deep learning.

We expect to improve image identification performance by utilizing Regions with R-CNN to enhance the object detection process. This technique usually adheres to a certain algorithm: first, potential areas are recognized using Selective Search. The areas are adjusted to meet the dimensions needed by the *CaffeNet* CNN. A 4096-dimensional feature vector is then retrieved using CNNs. Next, N linear Support Vector Machines are used to perform N binary classifications for each feature vector. Linear regression is used on the elements of the area frame to improve the accuracy of object localization.

Let us formulate the problem of recognizing car images by the following algorithm:

1. There is some set of objects in the form of cars of a given number of varieties, each of which modifies the image based on The monitoring of the camera's direction, the prevailing weather conditions, and the object's dynamic characteristics at a given moment.

2. The provided collection is divided into categories according to the chosen categorization idea, which includes segments of the car's state registration mark. This leads to the classes's alphabet is compiling.

3. A dictionary of characteristics is created in advance, containing structural, logical, probabilistic, and deterministic elements. Every object category has characteristics using approaches such as self-learning, the directly handling the initial data training.

4. A set of technical means (cameras, communication lines, computers, software, etc.) is created, which ensure the determination of each of the highlighted features.

5. Pre-designed algorithms inside the identification system's computational architecture are used to compare the posterior data of an unknown car with specified attributes from past knowledge. The comparison thus helps categorize the automobile. Particular algorithms are used to determine different features of the car, like its license plate, brand, colour, owner, etc., to help govern the system's operations.

6. An approach to assess the effectiveness of vehicle image identification systems

is developed by defining performance indicators and analyzing them, including accuracy of identifications, time taken to complete recognition jobs, and cost of obtaining additional data, etc. The selected performance indicators are evaluated by a conducting experiments study on the recognizing systems or its physical or mathematical modelling.

### **Conclusion**

Authors [3, 4] used pattern recognition methods, deep learning techniques and obtained useful results. We have developed an algorithm whose implementation uses multiple sources to detect traffic violations, which improves the accuracy of recognition prediction.

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## **РАСПОЗНАВАНИЕ ОБРАЗА ГОСУДАРСТВЕННОГО РЕГИСТРАЦИОННОГО ЗНАКА ТРАНСПОРТНОГО СРЕДСТВА**

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**Аннотация:** Транспортные средства сегодня играют важную роль в повседневной жизни всех людей. Они стали источником дохода, средством передвижения и путешествий, их количество быстро растёт. Поэтому управлять движением такого количества транспортных средств становится крайне сложно. Одним из важнейших факторов транспортной безопасности является прогнозирование нарушений правил дорожного движения. В данном исследовании рассмотрено применение методов распознавания образов для обнаружения и распознавания нарушений правил дорожного движения. Используя алгоритмы и различные технологии, распознавание образов для выявления нарушений правил дорожного движения определяет и автоматически обнаруживает действия или поведение, которые противоречат закону. Объединение технологий искусственного интеллекта, компьютерного зрения и машинного обучения приводит к значительным улучшениям в этом секторе. Сформулирована задача распознавания образов автомобилей в виде алгоритма из шести этапов.

**Ключевые слова:** алгоритм; свёрточные нейронные сети; глубокое обучение; машинное обучение; распознавание образов; нарушения правил дорожного движения; транспортные средства.

## THE INFORMATION SYSTEM FOR THE REGISTER OF CULTURAL HERITAGE OBJECTS OF THE TAMBOV REGION

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### **Abstract**

The purpose of this study is to develop an information system for the organization of the register of cultural heritage objects of the Tambov region. The study considers the process of information system design: the diagram of use cases is described, based on which the application of the information system for the organization of the register of cultural heritage objects of the Tambov region was developed.

**Keywords:** information system, information technology, model, object-oriented modeling.

### **Introduction**

In recent years, there has been a growing interest in the preservation of cultural and architectural heritage among various social groups. This interest does not go unnoticed by public authorities at all levels.

Increased activity in this area entails an increased burden on the authorities that deal with all issues related to cultural heritage objects, including the maintenance of the register, which includes the collection and processing of information in the form prescribed by law [1].

A significant part of the management activity is conducted according to outdated schemes, which slows down the efficiency of functions execution. This is a significant disadvantage, which should be corrected by the designed information system. For this reason the purpose of this study is to develop an information system for the organization of the register of cultural heritage objects of the Tambov region.

### **Methods and materials**

UML control models were developed using CASE tool Rational Rose Enterprise 2007 (Rational Software, USA). Rational Rose software product is designed to automate software analysis and design processes, as well as to generate codes in various languages and produce project documentation.

For the full functioning of the information system being developed for the organization of the register of cultural heritage objects of the Tambov region, it is necessary to have software with the help of which employees will be able to work with the register. To implement the demo version, the Qt Creator (The QT Company, Norway) software tool was used – a cross-platform integrated development environment (IDE) in C, C++ and Python [2].

### **Results and discussions**

During the design of the information system, a use case diagram was built and a demo of the application was created.

Figure 1 shows the initial conceptual representation or conceptual model of the system in the process of its design and development. The essence of this diagram is

that the designed system is represented as a set of entities or actors interacting with the system with the so-called use cases [3].

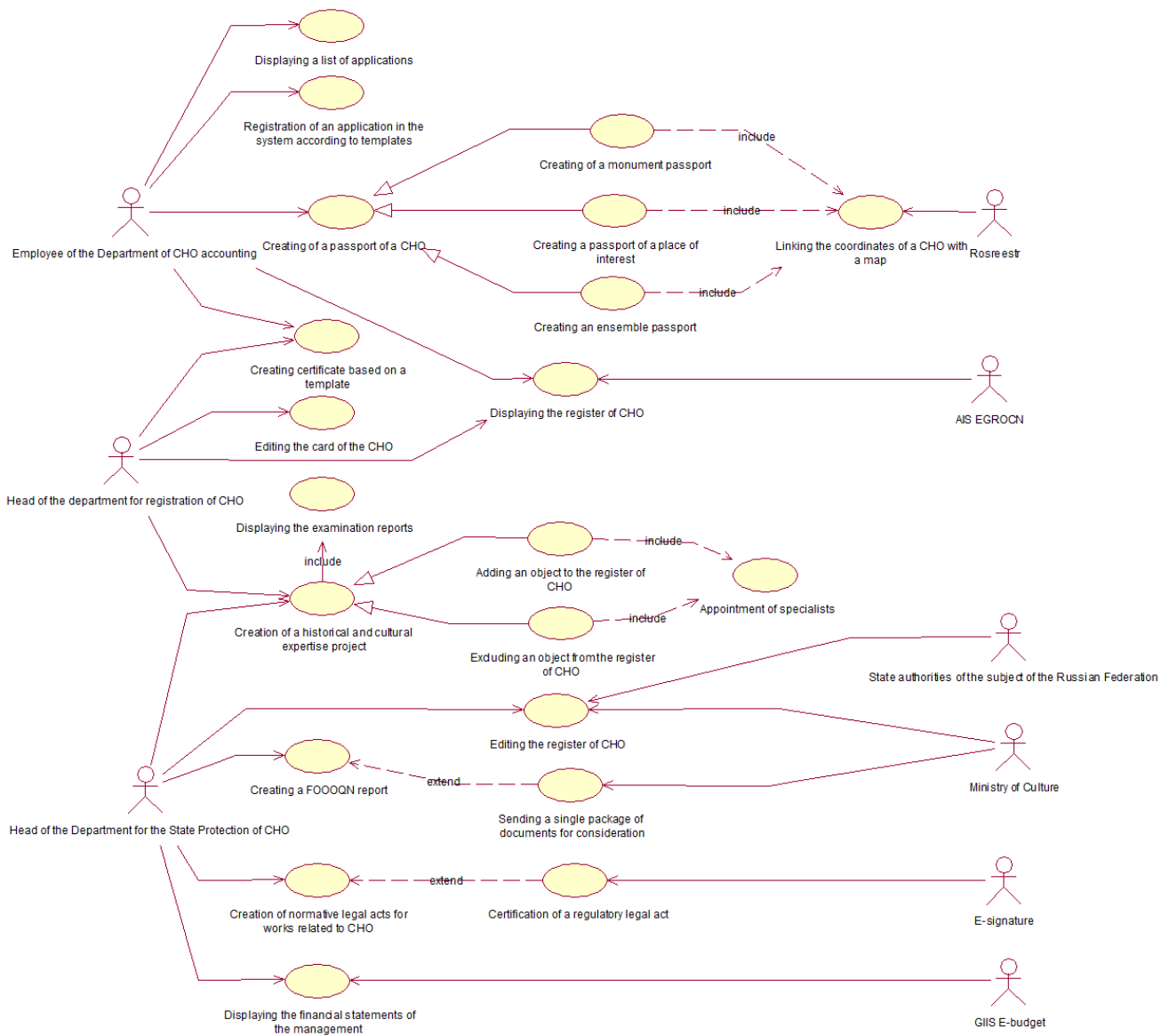


Figure 1 - Diagram of information system use cases

The system offers a single workspace for employees of the relevant department. The main goal is to automate the process of keeping the register of cultural heritage objects (CHO). The system also includes a system of templates and functionalities for interaction with the registry: issuance of various kinds of extracts and passports of objects, formation of expertise.

Based on the diagram of information system (IS) use cases, a demo version of the application was developed. The main page of the program contains a set of the most important tabs in the work, such as opening of the register of CHO, list of documents, quick menu for access to templates. The look of the main page is presented in Figure 2.

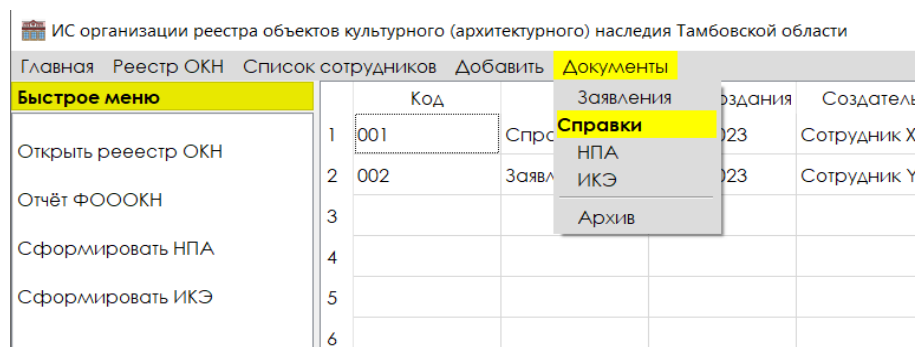


Figure 2 -The main page of the application

Functional testing of the main elements of the developed information system for the organization of the register of cultural heritage objects of the Tambov region showed that the system performs its functions correctly, has no visible errors and malfunctions, which is a positive result of the development of the information system

### Conclusion

The developed object-oriented model and a demo software product for the IS of the organization of the register of cultural heritage objects of the Tambov region are able to provide convenience and correctness of the organization of the register of CHO of the Tambov region with the necessary degree of automation.

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## ИНФОРМАЦИОННАЯ СИСТЕМА ОРГАНИЗАЦИИ РЕЕСТРА ОБЪЕКТОВ КУЛЬТУРНОГО НАСЛЕДИЯ ТАМБОВСКОЙ ОБЛАСТИ

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**Аннотация:** Целью данного исследования является разработка информационной системы для организации реестра объектов культурного наследия Тамбовской области. В исследовании рассмотрен процесс проектирования информационной системы: описана диаграмма вариантов использования, на основе которой было разработано приложение информационной системы организации реестра объектов культурного наследия Тамбовской области.

**Ключевые слова:** информационная система, информационные технологии, модель, объектно-ориентированное моделирование.

## A REVIEW OF TOOLS FOR CREATING 3D MODELS OF ARCHITECTURAL PAPER-BASED OBJECTS

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### **Abstract**

The article presents a review of contemporary tools for digitizing paper drawings of architectural objects, as well as tools for creating their three-dimensional models. The article explores key trends in the field of architectural design, focusing on the integration of traditional methods such as paper drawings and plans with modern 3D modeling technologies. Tools such as SketchUp, AutoCAD, ArchiCAD, and other programs specifically designed to transfer concepts created on paper to virtual space will be presented and analyzed.

**Keywords:** architectural modeling, digitizing paper drawings, 3D modeling.

### **Introduction**

Despite the gradual integration of digital technologies, paper drawings remain a significant medium for architectural information. The transformation of this information into digital format becomes a crucial task to enhance the visual perception of projects and ensure a high level of detail in the design process.

The aim of this research is to conduct a review of tools for digitizing paper drawings of architectural objects, with the subsequent goal of creating 3D models. The study focuses on identifying modern approaches to transforming traditional paper documents into three-dimensional visualizations.

Since the majority of 3D modeling programs lack tools for digitizing paper drawings [1], we separately discussed the tools for digitizing paper drawings and the tools for building 3D models.

### **Software solutions for digitizing paper drawings**

First and foremost, let us discuss tools for digitizing paper drawings since the process of converting a document into electronic form precedes the model-building stage.

Table 1 presents the most popular tools for converting drawings into electronic format, along with their key characteristics.

As evaluation criteria for these programs, the following characteristics were selected:

— Affordability - reflects how easily users can access the tool.

— Format Support - the list of file formats supported by the respective tool.

Tools that support a wider range of formats provide users with greater flexibility when working with different types of drawings and documents.

Table 1. Software solutions for digitizing paper drawings

<b>AutoCAD</b>	Industry standard for creating 2D and 3D drawings.	Paid	Wide format support, including DWG	2D & 3D	Vectorization tools, coordinate binding
<b>Adobe Illustrator</b>	Graphic editor with vectorization capabilities for drawings.	Paid (trial version)	Wide format support	2D (vector)	Vectorization tools, editing vector objects
<b>DraftSight</b>	Tools for creating and editing technical documentation.	Free (with paid versions)	DWG, DXF, PDF	2D (vector)	Vectorization tools, editing vector objects
<b>Scan2CAD</b>	Specialized program for converting raster images.	Paid (trial version)	Raster formats	2D & 3D (vector)	Vectorization toolsv
<b>Software</b>	<b>Description</b>	<b>Affordability</b>	<b>Format support</b>	<b>Output Data Type</b>	<b>Digitization tools</b>

— Output Data Type - the format or file type generated as a result of the conversion. This characteristic is important for determining how fully and accurately information is preserved during the transformation. For example, if volumetric characteristics of an object need to be preserved, a 3D image may be preferable. If high detail and scalability are important, a vector graphics format may be preferred

— Digitization Tools - describes the method of digitizing the original document.

The choice between these programs largely depends on the specific needs of the developer and budget constraints. AutoCAD [4] provides extensive functionality for professional design, while Adobe Illustrator is oriented towards a narrower niche of tasks. DraftSight serves as a free alternative for technical drawing, and Scan2CAD is designed for converting raster images into vectors.

### Software Solutions for 3D Modeling

In this section, we will explore software solutions designed for the creation and visualization of three-dimensional models of architectural objects.

Table 2 is a summary table of the most popular tools for three-dimensional architectural modeling.

Table 2. Software solutions for 3D modeling



<b>Blender</b>	Industry standard for 2D and 3D drawings	Free	BLEND, FBX, OBJ, and others	Various 3D modeling algorithms	Vector and raster objects
<b>AutoCAD</b>	Industry standard for 2D and 3D drawings	Paid	DWG, DXF, and others	CAD algorithms	Vector, and raster objects
<b>ArchiCAD</b>	Graphic editor with vectorization capabilities	Paid (trial version)	GSM, DWG, DXF, and others	BIM technologies, analysis, and design algorithms	BIM, vector, and raster objects
<b>Revit</b>	Program for creating diagrams and drawings with vectorization	Paid (trial version)	RVT, DWG, and others	BIM technologies, analysis, and design algorithms	BIM, vector, and raster objects
<b>SketchUp</b>	Specialized program for raster image conversion	Free	SKP, DWG, DXF, and others	Various 3D modeling algorithms	Vector and raster objects
<b>Software</b>	<b>Brief description</b>	<b>Affordability</b>	<b>Output file formats</b>	<b>Used technologies and algorithms</b>	<b>Input data</b>

Let us consider the presented characteristics:

—Affordability - as in the previous table, reflects information about the ease of access to the tool.

—Used Technologies and Algorithms - the main technologies and mathematical algorithms used in the program to perform its functions.

Examples of technologies and algorithms include:

—BIM Technologies: Methodologies related to creating and managing a Building Information Model.

—CAD (Computer-Aided Design) Algorithms: Methods for creating and editing geometric shapes and objects [2].

—Output File Formats - determine the structure and method of representing data created or processed in the program. These formats ensure compatibility and the ability to exchange information between different applications.

—Input Data - the foundation for the design and modeling process. This data defines how the created object will look and behave, and the program uses this information to create or modify a three-dimensional model according to the specified parameters and user requirements.

AutoCAD is focused on engineering and design activities, providing features for the development of drawings and plans for internal communications such as heating, ventilation, water supply, sewage, and electrical systems.

Revit and ArchiCAD operate on a completely different principle. Here, you immediately create the building in 3D, using pre-made elements and blocks to form walls, floors, beams, openings, windows, and doors, specifying their parameters, shape, and texture.

SketchUp is a simpler architectural modeling tool, easier to learn, and with an intuitive interface. It also has a free version for non-commercial use, which is a definite plus.

Blender provides a free solution for 3D modeling with a wide range of tools: creating complex 3D models, character and object animation, visual effects, video editing, texturing, lighting, and rendering. It is worth noting that Blender is not specialized in architectural objects, but its tools allow for the drawing of buildings.

In summary, AutoCAD, Revit, and ArchiCAD are complex professional programs for architectural modeling, making them the best choice for specialized organizations. The choice between them depends on the specific needs of designers. SketchUp is the best choice for small non-commercial projects, as it is free and relatively easy to master.

### **Conclusion**

In conclusion, let us summarize the specific achievements and results obtained during this work. It is important to emphasize that this review provided an analysis of modern technologies and software solutions, highlighting their advantages and limitations.

Our review included assessments of tools such as ArchiCAD, SketchUp, Revit, and also offered a comparison of their key characteristics.

As a result of the study, it becomes evident that the use of modern digitization and 3D modeling tools significantly enhances the processes of designing and visualizing architectural objects. These tools not only increase the quality of projects but also contribute to more efficient interactions between traditional and contemporary methods of architectural modeling.

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## **ОБЗОР ИНСТРУМЕНТОВ ДЛЯ СОЗДАНИЯ 3D-МОДЕЛЕЙ АРХИТЕКТУРНЫХ ОБЪЕКТОВ НА ОСНОВЕ БУМАЖНЫХ НОСИТЕЛЕЙ**

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**Аннотация:** Представлен обзор современных инструментов оцифровки бумажных чертежей архитектурных объектов, а также инструментов создания их трёхмерных моделей. Рассмотрены ключевые тенденции в области архитектурного проектирования, сфокусированные на интеграции традиционных методов, таких как бумажные чертежи и планы, и современных технологических инструментов 3D-моделирования. Представлены и проанализированы такие инструменты, как SketchUp, AutoCAD, ArchiCAD, а также другие программы, специально разработанные для переноса концепций, созданных на бумажных носителях, в виртуальное пространство.

**Ключевые слова:** архитектурное моделирование, оцифровка бумажных чертежей, 3D моделирование

## DEVELOPMENT OF A MOBILE BIOFEEDBACK SYSTEM BASED ON ECG DATA

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### Abstract

A hardware and software system based on biofeedback for determining stress levels is considered. Analysis of the subject area showed that there is a need to solve the problem of the multi-class classification of human stress based on the electrocardiogram. For this purpose, the concept of a system is being considered that allows real-time monitoring of the body condition and decision-making. The system includes: hardware for recording an electrocardiogram; software, including a communication module, a data pre-processing module, a signal frequency response module, a data recognition module, and a decision-making module. The developed architecture will be used for further testing of data analysis algorithms to determine the level of stress in a person.

**Keywords:** biofeedback, decision support system, electrocardiography, neural networks, stress.

### Introduction

Biofeedback is a method of self-regulation of human vegetative functions, allowing individuals to observe their own biological indicators and influence them. Systems that implement this approach consist of hardware and software tools, including devices for registering biological signals, software for analyzing biological data and making decisions, and devices for providing feedback to the user (such as displays, adaptive treadmills, tactile feedback gloves, etc.). Biofeedback systems can be useful for people who lead an active lifestyle or suffer from chronic diseases. Such systems can help individuals to more objectively assess their own health status and make decisions based on this assessment, such as avoiding physical exertion or changing their daily routine.

Previous studies aimed at developing mobile stress detection and decision-making systems based on biological data have mainly focused on solving a binary problem: whether or not there is stress [1]. Such technologies overlook the positive effects of positive stress on individuals, which help to increase physical exertion more quickly and successfully stabilize emotional state. Therefore, developing a new machine learning algorithm for recognizing stress and determining its acceptable threshold may be useful for regulating heart rate in both regular users and in exercise equipment, using feedback to keep the user within an acceptable range of stress to speed up rehabilitation.

This paper examines the concept of a biofeedback system consisting of surface sensors for recording electrical signals and a mobile device. The system allows the user to receive information about their body's state in real-time and make decisions based on this information [2]. The aim of this work is to develop methods for managing mobile systems in conjunction with electrophysiological techniques, using biological feedback to create control actions.

### Overview of the system

Figure 1 shows a prototype of an autonomous stress diagnostic system that uses Bluetooth to integrate an electrocardiograph with a mobile device.

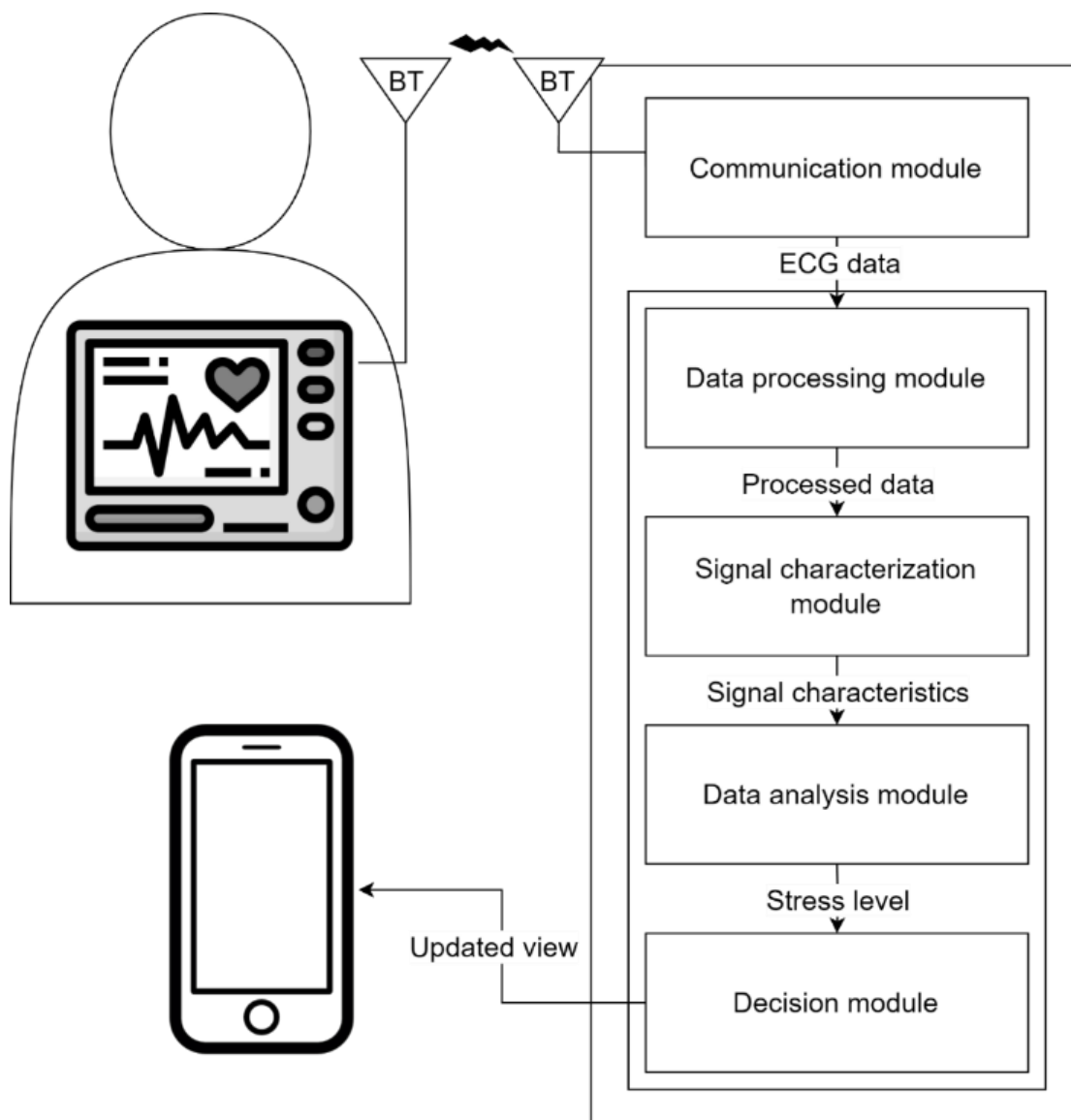


Figure 1 - Prototype of an autonomous stress diagnosis system

The hardware for recording biological signals is a device for conducting electrocardiography (ECG). ECG is a non-invasive method of studying heart rhythm by recording and analyzing the electrical fields generated during the heart's operation.

Another hardware device is an Android smartphone, which contains software consisting of several modules listed below.

The communication module provides a connection between a mobile phone and the ECG device via Bluetooth. The module is responsible for data transmission and ensures the correct connection of the device during transmission.

The data processing module is necessary because the original biological signals contain noise and artifacts that can distort the results when performing subsequent data analysis. When processing, it should be taken into account that the use of filters is associated with high computational costs, which makes it difficult for such algorithms to work in real-time. In analyzing existing processing algorithms, a filter based on singular value decomposition (SVD) was chosen, which can effectively decompose signals into separate components while preserving important characteristics. Therefore, this algorithm is often used to remove noise during signal processing [3].

The signal frequency feature (SFF) extraction module is necessary for training a machine learning model on the obtained features. For feature extraction, it is recommended to use wavelet transformation [4] as a more modern (compared to Fourier transformation) method of extracting SFF. When conducting wavelet analysis, the choice of the mother wavelet is an important aspect. The most suitable choice for analyzing ECG data is the Morlet wavelet. Next, a wavelet scalogram is constructed, which allows visualization of the distribution of power in the ECG signal over time and frequency. When using this approach, changes in SFF over time are identified, for example, to detect periodic patterns and anomalies.

The data recognition module applies clustering, neural networks, and machine learning algorithms. Stress recognition will be conducted on multiple (more than two) levels. However, further research will be required to determine the best method for classifying stress based on ECG data, which will be the subject of future articles.

The decision-making module is responsible for forming biological feedback in the system. It depends on third-party software connected to the system. For example, a treadmill whose speed adjusts to the runner's pace in order to keep them at a constant acceptable exercise stress. The decision-making module may also include notification to the driver of a vehicle about losing consciousness while driving. Thus, this module in a biological feedback-based system is an important component that must be developed depending on the intended use of the system.

At the end of the formation of the control response, based on the decision made, control responses in biofeedback systems are represented in the following ways: sound signal, visual indicator, tactile signal, etc.

### **Conclusion**

This paper discusses the concept of a software-hardware system based on biofeedback. The system's software modules include data processing, signal characteristic extraction, data recognition, and decision-making based on data analysis. Additionally, methods for representing control responses in biofeedback systems, such as sound signals or visual indicators, are proposed. The purpose of the system is to monitor health and manage stress in real-time.

Further research will focus on creating software modules that collect, process, and analyze medical data for a more accurate adaptation of the virtual trainer to each user's individual characteristics.

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## **РАЗРАБОТКА МОБИЛЬНОЙ СИСТЕМЫ БИОЛОГИЧЕСКОЙ ОБРАТНОЙ СВЯЗИ НА ОСНОВЕ ДАННЫХ ЭКГ**

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**Аннотация:** Рассмотрена программно-аппаратная система на основе биологической обратной связи для определения уровня стресса. Анализ предметной области показал, что существует потребность решения задачи мультиклассовой классификации стресса человека на основе электрокардиограммы. Для этого рассматривается концепция системы, которая позволяет в режиме реального времени отслеживать состояние организма и принимать решения. Система включает в себя: аппаратное обеспечение для регистрации электрокардиограммы; программное обеспечение, включающее модуль связи, модуль предварительной обработки данных, модуль извлечения частотных характеристик сигнала, модуль распознавания данных и модуль принятия решений. Разработанная архитектура будет использована для дальнейшего тестирования алгоритмов анализа данных для определения уровня стресса у человека.

**Ключевые слова:** биологическая обратная связь, нейронные сети, система поддержки принятия решений, стресс, электрокардиография.

## A MODEL OF NON-CONTACT THERMAL EFFECT ON THE OBJECT OF STUDY FROM A MOBILE HEAT SOURCE

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### **Abstract**

Currently, there is a pressing issue of rational use of fuel and energy resources, which is why various heat-insulating building materials (such as foam concrete, gas-filled polystyrene, etc.) with higher thermal insulation properties compared to traditional building materials are actively being synthesized. In addition, the task of determining the thermal insulation properties of ready-made multilayer structures often arises in building heat engineering, as the thermal-physical properties of these structures may change during operation due to the impact of various destabilizing factors. It is important to maintain the integrity of the investigated building objects. Therefore, the task of controlling the thermal-physical properties of materials and finished products while preserving their operational characteristics is relevant, and to solve this task, it is necessary to create new non-destructive testing information-measuring systems (IMS) for controlling the thermal-physical properties of the investigated objects.

**Keywords:** heat capacity of materials, thermal conductivity, thermal protection properties of materials, thermophysical properties of materials.

### **Introduction**

The mathematical description of measurement procedures and circuits for non-destructive testing of thermal-physical characteristics (TPC) and thickness of protective coatings of materials (TPC) and products requires the development of mathematical models that adequately describe thermal processes in these physical objects during the thermal-physical experiment.

The most comprehensive information about thermal processes within the studied materials and products is found in the temperature field. This field is determined by solving the boundary value problem for heat conduction, taking into account different thermal actions and experimental conditions. Therefore, in order to create mathematical models of thermal phenomena within physical objects, it is essential to determine the temperature field within the object under different types of heat input on its surface. The type, mode, and shape of the heat source, as well as the experimental conditions, are selected in such a way as to ensure that simple mathematical models are able to accurately describe the physical principles underlying thermal processes.

The theory of most thermal non-contact non-destructive testing methods for the thermal-physical characteristics of solid materials is based on the phenomenon of the intrinsic thermal radiation from the surface of the materials and products under investigation, which is proportional to the fourth power of the absolute temperature. The most widespread methods and means in the field of non-destructive testing of thermal-physical characteristics and thickness of materials and products are the active thermal quality control methods based on heating their surface with a mobile continuous point heat



source, registering the temperature of the heated surface with one or several thermocouples moving at the same speed as the heat source.

Initially, we will examine the temperature distribution within a semi-infinite thermal body when it is subjected to a point heat source of power while the body moves at a constant velocity relative to the source and the stationary coordinate system along the x-axis direction (refer to Figure 1). The heat source is focused at the origin and releases an amount of heat  $q_0$  per unit time. Secondly, we will determine the temperature at a fixed point  $(x, y, z)$  at time  $t$ . At the origin, for an infinitesimal time interval  $dx$  at time  $t'$ , an amount of heat  $q^{-dt}$  - is released. Moreover, the point within the moving medium (body), with coordinates  $(x, y, z)$  at time  $t$ , will have coordinates  $x-V(t-t')$ ,  $y, z$  at time  $t'$ . It is understood that the temperature distribution in an infinite body at any specific time as a result of the influence of a momentary heat source at the point with coordinates  $(x_1, y_1, z_1)$  is determined by the relationship [2].

$$T(x, y, z, x_1, y_1, z_1, \tau) = \frac{q_0}{8cp(\pi a \tau)^{3/2}} \exp \left[ -\frac{(x - x_1)^2 + (y - y_1)^2 + (z - z_1)^2}{4a\tau} \right]$$

where  $a$  - is the thermal conductivity,  $c$  - is the specific heat capacity, and  $p$  - is the density of the body.

Given that the heat source acts at the origin, i.e.  $(x_1, y_1, z_1) = (0, 0, 0)$ , the temperature at the point  $(x, y, z)$  at time  $t$ , caused by the release of the heat quantity  $P_0 \cdot dt'$  at time  $t'$ , will be equal to:

$$T(x, y, z, \tau) = \frac{q_0 \cdot d\tau'}{8 \cdot c \cdot \rho [\pi a (\tau - \tau')]^{3/2}} \exp \left\{ -\frac{[x - V(\tau - \tau')]^2 + y^2 + z^2}{4a(\tau - \tau')} \right\}$$

The temperature at time  $t$ , due to the release of the same amount of heat at the origin during the time from 0 to  $t$ , is equal to:

$$T(x, y, z, \tau) = \frac{q_0}{8 \cdot c \cdot \rho [\pi a]^{3/2}} \int_0^\tau \exp \left\{ -\frac{[x - V(\tau - \tau')]^2 + y^2 + z^2}{4a(\tau - \tau')} \right\} \frac{d\tau'}{(\tau - \tau')^{3/2}}$$

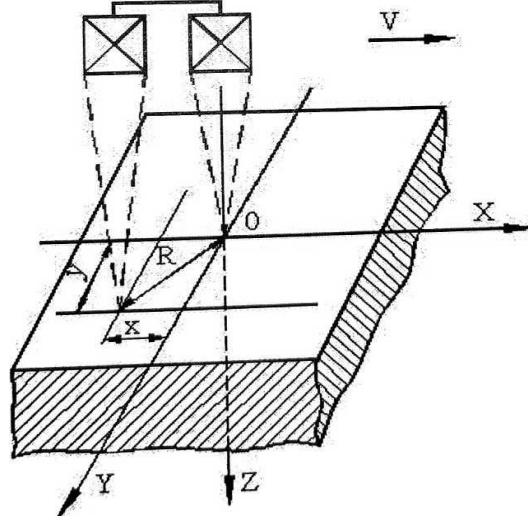


Figure 1 - A physical model for determining TP in a measuring object under non-contact thermal exposure from a stationary source.

During a thermal physics experiment conducted under real conditions with non-contact thermal exposure to the surface of the object being studied from a mobile heat source, thermal losses occur as the surface cannot be completely insulated. This significantly impacts the temperature field of the objects being studied under the specific type of thermal exposure. These losses occur due to incomplete absorption of thermal energy from the heat source on the surface of the object, as well as convective and radiative heat transfer between the object's surface and its surroundings. Most of the heat ends up being absorbed by the surroundings as well, when radiation from the heat source passes through them due to absorption and scattering by dust and other water-based substances in the surroundings.

Taking these factors into account, the following thermal balance equation can be derived:

$$Q_{sou} = Q_{abs} + Q_{ref} + Q_k + Q_l + Q$$

Where  $Q_{sou}$  is the power of the heat source;  $Q_{abs}$  is the heat power losses due to absorption by the surrounding environment;  $Q_{ref}$  is the heat power losses due to partial reflection of energy because the material being studied has a reflection coefficient different from zero;  $Q_k$  is the heat power losses due to convective heat exchange;  $Q_l$  is the heat power losses due to radiative heat exchange;  $Q$  is the power propagated in the studied body due to conductive heat conduction.

The next step is breaking down the components of the equation in more detail.

Losses of thermal power due to absorption by the surrounding environment of some of the energy from the heat source radiation are determined by the expression:

$$Q_{abs} = Q_{sou} * [1 - \exp(-y * l)] = q_{sou} * [1 - B]$$

where  $y$  - is the attenuation coefficient of the environment;  $l$  - the distance between the heat source and the object being studied;  $B$  - is the environmental transmission index.

Accounting for the loss of thermal energy due to insufficient absorption of radiation by the surface of an opaque object during the study.  $Q_{abs}$ :

$$Q_{ref} = B - r * Q_{sou} = B(1 - a) * Q_{sou}$$

where  $r$  - is the reflection coefficient and  $a$  - is the absorption coefficient.

It is known that at a given temperature, the radiation coefficient from a body is equal to its absorption coefficient  $a$ , i.e.  $E = a$ . With this in mind, the expression can be written as follows [1]:

$$Q_{ref} = B * (1 - e) * Q_{HT}$$

The heat power losses to the surrounding environment resulting from radiative heat exchange can be calculated use a specific formula based on the principles of thermal radiation:

$$Q_k = a_k * (T - T_c) * S$$

where  $a_k$  - represents the convective heat exchange coefficient in  $W/m^2K$ ;  $T$  - denotes the temperature of the surface of the heated object in kelvin;  $T_o$  - signifies the temperature of the surrounding environment in kelvin;  $S$  - stands for the surface area dissipating heat, [ $m^2$ ].

The heat power losses to the surrounding environment resulting from radiative heat exchange are determined by the following expression:

$$q_l = a_l * (T - T_c) * S$$

Where,  $a_l = \varepsilon \cdot C_0 \left[ \left( \frac{T}{100} \right)^4 - \left( \frac{T_0}{100} \right)^4 \right] / (T - T_c)$

$a_l$ - is the radiative heat exchange coefficient in  $W/m^2K$ ;  $T$ - represents the temperature of the surface of the heated body in kelvin;  $T_0$  - denotes the temperature of the surrounding environment in kelvin;  $E$  - is the emissivity coefficient of the surface of the heated body,  $\sigma = 5.67 \cdot 10^{-8}$  - the Stefan-Boltzmann constant in  $[W/m^2K^4]$ ,  $S$  - is the area of the heat dissipating surface [1].

By utilizing the relationships for each term in the equation and conducting mathematical transformations, one can derive the distribution of temperature in a semi-infinite body subjected to a moving point heat source, considering heat losses from the body's surface to the surrounding environment, in the following manner:

$$T(R, x) = \frac{\varepsilon \cdot \beta \cdot q_{sou}}{2\pi \cdot \lambda \cdot R \cdot \exp\left(\frac{V(R-x)}{2a}\right) + (a_k + a_l) \cdot S} + T_c$$

Experimental studies have shown that the calculated temperature values obtained using formula (1), at distances close to the radius of the point heat source, differ greatly from the actual temperature values. Even with small heat losses, the discrepancy can be as high as 40%. This is because, at these distances, the point heat source cannot be considered a point source anymore. Instead, it must be modeled as a circular heat source in order to solve the thermal conductivity equation accurately. However, if we increase the distance between the heat source and the point to an eight times the diameter of the source, the difference between the actual and calculated temperatures using formula (1) becomes less than 5%. Therefore, formula (1) is accurate for distances greater than ten times the size of the heat source.

### Conclusion

The limitations of model (1) are directly considered in the implementation of the developed non-contact methods for non-destructive testing of TPC materials. It is essential to establish parameter ranges within the model so that when there is a lack of prior information on the TPC of materials, the model remains reliable and does not lead to the damage of the tested materials.

Specifically, the distance  $R$  from the point of the heat source to the surface point being analyzed on the test object is chosen to exceed ten times the diameter of the heat source's point spot. Additionally, in order to fulfill the requirement of a slowly moving heat source, the velocity  $V$  and the radius  $\gamma_0$  of the heat source's point spot need to be set at the smallest possible values. This requires selecting a material with the lowest thermal conductivity coefficient for these calculations. As a result, when there is insufficient prior knowledge about the Thermal Performance Coefficient (TPC) of the materials being tested, their range is expanded to ensure precise testing.

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## **МОДЕЛЬ БЕСКОНТАКТНОГО ТЕПЛООВОГО ВОЗДЕЙСТВИЯ НА ОБЪЕКТ ИССЛЕДОВАНИЯ ОТ ПОДВИЖНОГО ИСТОЧНИКА ТЕПЛА**

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**Аннотация:** В настоящее время остро стоит вопрос о рациональном использовании топливно-энергетических ресурсов, в связи с чем активно ведется синтез различных теплоизолирующих строительных материалов (пенобетоны, газонаполненные пенопласты и т.д.), теплозащитные свойства которых выше по сравнению с традиционными строительными материалами. Кроме того, часто в строительной теплотехнике возникает задача определения теплозащитных свойств готовых многослойных конструкций, теплофизические свойства (ТФС) которых в процессе эксплуатации могут меняться из-за воздействия различных дестабилизирующих факторов. При этом важно сохранить целостность исследуемых строительных объектов. Поэтому задача контроля ТФС материалов и готовых изделий с сохранением их эксплуатационных характеристик является актуальной, и для ее решения необходимо создавать новые информационно-измерительные системы (ИИС) неразрушающего контроля (НК) ТФС исследуемых объектов.

**Ключевые слова:** теплоемкость материалов, теплозащитные свойства материалов, теплофизические свойства материалов, теплопроводность.

## QUALITÄTSMANAGEMENT IN DER ENTWICKLUNG VON WEBSITES

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### **Zusammenfassung**

Dieser Artikel untersucht die Schlüsselaspekte des Qualitätsmanagements im Prozess der Website-Entwicklung. Wir betrachten die Definition des Qualitätsmanagements, die Vorteile seiner Integration in die Webentwicklung und Methoden zur Erreichung hoher Qualität von Webprodukten. Dieser Artikel bietet grundlegende Prinzipien und Empfehlungen, die durch wissenschaftliche Forschung und praktische Beispiele gestützt werden.

**Schlüsselwörter:** Website, Website-Entwicklung, Qualität.

### **Einleitung**

Die Entwicklung von Websites ist zu einem wesentlichen Bestandteil der modernen Geschäftsumgebung und Gesellschaft geworden. Qualitätsmanagement spielt eine wichtige Rolle bei der Erzielung erfolgreicher Ergebnisse. In diesem Artikel untersuchen wir, wie das Qualitätsmanagement effektiv in den Prozess der Website-Entwicklung integriert werden kann.

#### **1. Qualitätsmanagement in der Webentwicklung**

Qualitätsmanagement umfasst viele Aspekte, aber für unsere Forschungszwecke definieren wir es als einen Prozess, der darauf abzielt, Produkte und Dienstleistungen zu schaffen, die den Bedürfnissen der Kunden entsprechen und den festgelegten Standards entsprechen.

Dieser Prozess umfasst die Erfüllung der Anforderungen der Benutzer, die Einhaltung der Standards für die Entwicklung von Websites und die Überprüfung von Leistung, Sicherheit und Benutzerfreundlichkeit.

#### **2. Vorteile des Qualitätsmanagements in der Webentwicklung**

Die Integration des Qualitätsmanagements in die Entwicklung von Websites hat viele Vorteile. Qualitativ hochwertige Websites, die das Qualitätsmanagement berücksichtigen, entsprechen besser den Bedürfnissen der Kunden und den Erwartungen der Benutzer.

Das Qualitätsmanagement in der Webentwicklung hilft auch dabei, Probleme frühzeitig zu erkennen und zu beheben, was das Risiko reduziert und Ressourcen einspart.

Die Leistung ist ein weiterer entscheidender Aspekt. Qualitativ hochwertige Websites funktionieren effizienter, was die Benutzererfahrung verbessert und die Konversion erhöht.

#### **3. Integration des Qualitätsmanagements in den Prozess der Website-Entwicklung**

Die Integration des Qualitätsmanagements in die Entwicklung von Websites erfordert eine sorgfältige Planung und die Umsetzung der folgenden Schritte:

- Definition der Qualitätsanforderungen: Zu Beginn des Projekts müssen die Qualitätsanforderungen klar definiert werden, einschließlich Leistung, Sicherheit und Benutzerfreundlichkeit.

- Einhaltung von Standards: Webentwickler müssen sich an moderne Standards für die Entwicklung von Websites halten, wie z.B. HTML5, CSS3 und andere.

- Testing und Qualitätskontrolle: Testing, einschließlich funktionaler Tests, Belastungstests und Sicherheitsüberprüfungen, sollte ein wichtiger Bestandteil des Entwicklungsprozesses sein.

- Überwachung und Feedback: Nach der Bereitstellung der Website ist es wichtig, ihre Leistung sorgfältig zu überwachen und Feedback von Benutzern zu sammeln, um die Qualität kontinuierlich zu verbessern.

**Fazit:** Qualitätsmanagement ist ein wesentlicher Bestandteil erfolgreicher Website-Entwicklung. Die Integration von Prinzipien und Methoden des Qualitätsmanagements hilft dabei, hochwertige Webprodukte zu schaffen, was wiederum zur Zufriedenheit von Kunden und Endbenutzern beiträgt. Weitere Forschung und Entwicklung in diesem Bereich spielen eine wichtige Rolle in der Zukunft der Webentwicklung.

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## **УПРАВЛЕНИЕ КАЧЕСТВОМ В РАЗРАБОТКЕ ВЕБ-САЙТОВ**

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**Аннотация:** Исследованы ключевые аспекты управления качеством в процессе разработки веб-сайтов. Дано определение управлению качеством, выявлены преимущества его интеграции в веб-разработку и методы для достижения высокого качества веб-продуктов. Представлены фундаментальные принципы и даны рекомендации, подкрепленные научными исследованиями и практическими примерами.

**Ключевые слова:** веб-сайт, разработка веб-сайтов, качество

## NOISE-RESISTANT METHOD OF ACOUSTIC EMISSION MONITORING OF RESERVOIRS

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### Abstract

An approach to diagnosing reservoirs under conditions of high process noise is proposed. Acoustic emission monitoring of equipment condition was used as the main tool in the work. The article presents the results of using a noise-immune method for analyzing acoustic emission data. The method is based on the implementation of a multi-stage adaptive storage-detector circuit, which ensures reliable detection of a useful signal both in experimental and production conditions

**Keywords:** acoustic emission, defect, digital signal filtering, interference, monitoring.

Currently, methods for diagnosing equipment based on the principle of monitoring are being actively implemented at chemical industry enterprises. The basis of such systems can be one of the most common methods of technical diagnostics of technological pipelines – the acoustic emission (AE) method. This method is integral, which makes it possible to carry out a comprehensive assessment of the condition of the equipment in comparison with classical methods of non-destructive testing, which are usually local in nature. Another advantage is the technical ability to carry out AE control without decommissioning the facility. In the case of tanks, this is a fundamental task, since there are often technical difficulties in stopping the technological process. In addition, in the case of AE control in monitoring mode, special measures are not required to prepare the object for diagnosis. Most of the equipment installed in tank farms is significantly worn out and has a service life of over 15 years. In conditions of continuous exposure to aggressive corrosive media, constant monitoring of the current state is required. The problem also lies in the fact that corrosion processes are most often local, heterogeneous in nature and without special diagnostic measures; such defects are practically not detectable until the onset of a pre-destructive state and the occurrence of an accident. In these conditions, the development of specialized diagnostic monitoring systems for reservoirs which could work on an ongoing basis and inform control services about changes in the condition of equipment in real time plays an extremely important role.

The problem of technical diagnostics of hazardous production facilities without decommissioning them is extremely urgent. An important role in this case is played by the improvement of specialized systems for monitoring the technical condition of equipment. The main requirement for monitoring the condition of technical devices is to work in the current operating conditions of the equipment and timely inform the control services about any deviations in its operation.

Acoustic emission method is traditionally used as the main integrated diagnostic method in monitoring systems. The acoustic emission method is based on the registration and analysis of the parameters of the AE signals of the material of the

controlled object due to the presence and development of defects in it. The practice of carrying out technical diagnostics of tanks indicates that the main mechanism of destruction in this case is the corrosive wear of metal. In this case, the AE signal has a low amplitude character. In addition, high attenuation is observed during the passage of the signal due to the presence of characteristic deposits of the working medium and corrosion on the inner walls of the tank. As a result, the regulated location of sensors is not always effective in terms of sensitivity indicators, and expert decisions on the choice of processing parameters and interpretation of incoming signals are difficult.

Useful sources of AE correspond to the processes of crack development, the transition of the material to a plastic state, etc., as well as processes associated with the presence of defects – friction of the crack banks, the formation of corrosion products in the crack cavity, destruction and detachment of slag inclusions. However, in addition to useful ones, there are a number of other interfering AE signals that prevent or make it impossible to monitor reservoirs. First of all, we are talking about production factors inherent in the operation of equipment that generate multiple noise sources: turbulent or cavitation modes of movement of the working medium, synthesis reactions, rubbing nodes and parts, electrical interference, vibrations, and other unavoidable technological noises unrelated to the operation of the device being diagnosed. All of the above together can create an additive interference signal, which in its amplitude level is much higher than the signals from useful AE sources. The main problem of AE control is low noise immunity, which imposes certain restrictions on the working conditions. On the other hand, since the sensitivity of the method significantly depends on the background noise level, it often becomes impossible to conduct AE monitoring of equipment operating under conditions of increased technological noise, vibration and thermodynamic loads. In these conditions, for real production facilities, the primary task is to develop methods for detecting a useful signal in highly noisy AE time series, which in turn makes it possible to assess the technical condition of tanks without decommissioning equipment in the presence of high-amplitude noise.

It follows from the above that the actual problem of applying the AE method to full-scale control objects (reservoirs, technologically pipelines, vessels) is to develop an interference-resistant algorithm that provides reliable detection and isolation of a useful AE signal from an interference signal in real time and over a wide range of signal-to-noise ratios. Existing methods of processing noisy data in both the frequency and time domains, including modern approaches based, for example, on wavelet decomposition and principal component analysis, are threshold in nature, have, accordingly, weak noise immunity and, thus, can be effectively used for AE diagnostics only with a signal ratio/the noise is greater than one.

The AE control systems used in modern practice, based on the principle described above, cannot be used for diagnosis in high noise conditions, not only from the point of view of processing, but also signal registration. As part of this work, a significant innovation is the proposal to use the principle of threshold-free data registration (BRD), which will allow you to obtain all information about the object of control and opens up wide opportunities for processing and interpreting AE control data.



Filtering tasks in this case are no longer solved by hardware by setting the discrimination threshold, but using software tools, using modern technologies for filtering experimental time series (fast Fourier transform, principal component method, adaptive filtering method, etc.). All these methods are based on the allocation of this signal, responsible for the development of destruction processes on a real object, based on its causal characteristics. The problem of applying such filtering methods to traditional AE systems is that the time series obtained at the output of the AE system has a discrete structure, as a result of which the introduction of a discrimination threshold excludes information about defects whose signal amplitude is below the set threshold. At the same time, the tasks of further noise filtering do not have a stable positive solution.

The difficulty of using DBMS lies in the fact that the array of information generated at the output requires significant resources for data processing. We are talking about the primary digitization and recording of the input signal with a minimum frequency of 5 Mbit/s and above. It follows that the registration of such a signal from one measuring channel will take several gigabytes of information on the hard disk of the registration system within a few minutes. In this case, the task of optimizing the placement of registered channels at the monitoring facility and reducing their number to the required minimum is of fundamental importance. In these conditions, it is extremely important to increase the maximum permissible range between measuring channels without loss of information content. For this purpose, a method has been proposed for additional use in the hardware signal registration chain of a selective low-frequency (LF) filter with corresponding low-frequency AE sensors, which allow recording a signal from a defect propagating in the material with a low-frequency filter frequency of 2 kHz (for comparison, traditional PAE and AE signal registration schemes operate in the filter frequency band from 80 kHz and above). The conducted studies have shown that under such conditions, the AE signal can be stably registered at distances of at least 100 meters and above. In addition, in the selective region of the filter, the level of the signal-to-noise ratio is improved by an order of magnitude, as a result of which the volume of calculations in postprocessing mode can be significantly reduced.

The fundamental link of the monitoring system is the decision-making unit on the technical condition of the facility. The current requirements of the regulatory documentation (PB 03-593-03) from the point of view of criteria for assessing the degree of danger of AE sources are not applicable to monitoring systems. The adopted classification system is directly related to the pressure change schedule, and the applied criteria are qualitative, not universal and practically inapplicable in conditions of a low signal-to-noise ratio. In addition, the criteria for detecting defects are subjective; the parameters are poorly parameterized, and are of a qualitative nature. It is established that an urgent problem is the development of a modern system for assessing the technical condition of equipment using AE control in the following directions: improving the accuracy of defect identification; improving the noise immunity of the method. The principle of continuity of the recorded time series of the AE signal in the BRD system allows solving the problem in a different way. We are talking about the use of statistical processing and nonlinear dynamics

approaches in the analysis of experimental data in various fields of knowledge. It is established that the signal at the output of the BRD filtration system meets the necessary requirements for the application of nonlinear dynamics approaches.

A promising method for optimal processing of highly noisy signals is associated with the use of digital adaptive filtering systems, the parameters of which can be adjusted in real time to the spectral, correlation and statistical characteristics of the input signal. The main feature of an adaptive system is its time-varying functioning with self-regulation. The need for such functioning is due to the large degree of variations in the AE signal, which means that there is a statistical uncertainty of the data at the input of the system. Adaptive algorithms built on this basis successfully detect a useful signal in the presence of strong interference or non-stationary noise with different nature and a priori unknown properties with a signal-to-noise ratio less than one. The advantage of the AF method is that there is no need for a priori information about the input signals or their statistical or deterministic relationships.

The general structure of the adaptive filter is as follows: the input discrete signal is processed by a discrete filter, resulting in an output signal. This output signal is compared with the "model" signal, the difference between the signals forms the so-called "error signal". The task of the adaptive filter is to minimize the error of reproducing the sample signal. For this purpose, the adaptation unit, after processing each sample, analyzes the error signal and additional data coming from the filter, using the results of this analysis to adjust the parameters (coefficients) of the filter. In relation to noise reduction tasks, the signal indicating the presence of a defect is an error signal at the filter output.

Adaptive filtering mechanisms have found their application in areas such as sonar, seismology, navigation, digital telephony, etc. There is no information about the use of adaptive filters (AF) in acoustic emission diagnostics and the construction of noise-resistant detection systems for weak AE signals based on them in the modern literature. In this paper, a standard adaptive algorithm for direct identification with training was tested in solving the problem of AE monitoring of the defective state of the object of control (OK) in the process of its deep plastic deformation. It is significant; however, that AF was used not to extract a pulsed AE signal from a time series of interference, but to restore its shape distorted by weak technological noise in conditions when the signal-to-noise ratio was obviously greater than one.

This paper presents the results of using an interference-resistant method for analyzing AE data based on the implementation of a multistage adaptive storage-detector circuit and providing reliable detection of a useful signal in conditions of high technological noise (the signal-to-noise ratio is much less than one).

Within the framework of this method, an extended AE signal registration scheme is proposed. A distinctive feature is the introduction of an additional channel using a parallel connection scheme: both channels register a noisy signal. Postprocessing consists in calculating the function of mutual correlation between the useful signals at the outputs of a two-stage AF and their corresponding noise components. It can be seen that deterministic AE signals having a common source are strongly correlated, while there is practically no correlation between random noise components undergoing additional phase distortions. Thus, an increase in cross-correlation in the

output stages of an adaptive detector can serve as an important diagnostic sign of the appearance of incipient defects in the equipment.

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## ПОМЕХОУСТОЙЧИВЫЙ МЕТОД АКУСТИКО-ЭМИССИОННОГО МОНИТОРИНГА РЕЗЕРВУАРОВ

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**Аннотация:** Предложен подход диагностирования резервуаров в условиях высоких технологических шумов. В качестве основного инструмента в работе использовался акустико-эмиссионный контроль состояния оборудования. В статье представлены результаты использования помехоустойчивого метода анализа данных акустической эмиссии. Метод основан на реализации схемы многокаскадного адаптивного накопителя-обнаружителя, который обеспечивает уверенное обнаружение полезного сигнала как в экспериментальных, так и в производственных условиях.

**Ключевые слова:** мониторинг, акустическая эмиссия, цифровая фильтрация сигнала, помеха, дефект.

## ASSESSMENT INTEREST FOR SOCIAL NETWORK POST BASED ON STATISTICAL CHARACTERISTICS OF COMMENTS

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### Abstract

The purpose of this study is to assess the possibility of determining interest in a publication on a social network based on the statistical parameters of comments to it. Using the example of one of the communities of the social network Reddit, data for six months was reviewed and analyzed, secondary statistical parameters were determined, and a correlation matrix was constructed for the primary assessment of possible connections between parameters. Different results were shown when trying to determine the significance of a publication by only one of the parameters. Using the found coefficients, the complexity of assessing interest in a publication based on statistical indicators in the presence of a large number of comments is shown graphically. Also, based on the data studied, conclusions were drawn about different forms of interest and ways of expressing them and about the exponential relationship between the number of discussion participants and interest in the publication.

**Keywords:** correlation matrix, social network, statistics.

### Introduction

Social networks today accumulate most of the information necessary for Internet users and are a means of communication both between people who know each other and strangers who unite in various communities of interests. Usually, the reaction of members of a group to publications on social networks is within the average range; sometimes a certain post causes increased interest, called hype in the Internet environment.

In the case of active public discussion of an acute social problem, the activities of community members can move both to other platforms for dialogue and lead to initiatives and actions off the Internet. Some of these actions may have a negative impact or potentially lead to undesirable consequences.

Forecasting such actions is an urgent task, because responding to a problem before the onset of active actions will minimize the damage from negative consequences or avoid it altogether.

There are many ways to collect statistical information [1], but most commonly it is impossible to draw a conclusion based on absolute values and primary data. For example, consider open data on comments in the WallStreetBets (WSB) community of the social network Reddit from 2020-06-01 to 2021-01-01 [2], a period of six months is long enough to see existing patterns, if any exist. In the data sample we compare the five most popular topics by the total number of ratings for comments, by their total number, as well as by the comment with the highest number of ratings (see tables 1-3). It can be seen that completely different posts were obtained for all three parameters of the most popular topics.

**Table 1.** The first 5 posts in the WSB group containing the comment with the highest number of "like" ratings

Post ID	Number of "like" ratings for the most popular comment
t3_hx0nol	4706
t3_hxo91u	4052
t3_hvh6ue	3976
t3_kh48uz	3002
t3_iswt0r	2933

**Table 2.** The first 5 publications in the WSB group with the total number of "like" ratings for all comments in the publication

Post ID	Total number of "like" ratings for all comments
t3_kftjzt	11004
t3_idvifw	10433
t3_hx90gx	10307
t3_i9t8hn	10158
t3_iqy7be	9979

**Table 3.** The first 5 publications in WSB group by number of comments

Post ID	Total number of comments on the publication
t3_gt08v2	5510
t3_g7fkq6	5400
t3_g39g3g	5286
t3_fb1gsq	5264
t3_feig6i	5043

### Secondary statistical indicators of user activity

To continue the statistical analysis, we will introduce secondary indicators based on the initial data. Having grouped all comments by the initial topic of discussion, we will add such parameters as the average comment rating, median, maximum, standard deviation of the rating, the sum of all ratings, the number of reviews, the number of users who left them, as well as their ratio. To search for possible regularities, let us construct a correlation matrix for all the above-mentioned secondary indicators [3], using the Pearson correlation method (see table 4).

Most of the indicators under consideration do not have a linear relation with each other. The high correlation coefficient between the standard deviation of scores and their mean value, as well as the weak correlation of the median score with any other parameter is noteworthy. To visualize more clearly, we build a scatter plot for the mean and median scores for cases where the mean score is greater than 20 (see Fig. 1).

**Table 4.** Correlation coefficient matrix of secondary indicators of user activity in the comments of the WSB community of the Reddit social network from 2020-06-01 to 2021-01-01

	Average comment score	Max comment score	Median score	Standard deviation score	Number of likes	Number of comments	Total rating of all comments	Number of comments / number of users	Total rating / number of users
Average comment score	1	0.643302	0.513732	0.887827	0.002040	0.005664	0.174415	-0.024915	0.983157
Max comment score	0.643302	1	0.094333	0.896270	0.066980	0.081897	0.333550	0.010571	0.647248
Median score	0.513732	0.094333	1	0.233436	-0.024977	-0.030583	0.007703	-0.052523	0.477022
Standard deviation score	0.887827	0.896270	0.233436	1	0.014344	0.022729	0.246146	-0.008181	0.881792
Number of likes	0.002040	0.066980	-0.024977	0.014344	1	0.960704	0.921841	0.191628	0.035507
Number of comments	0.005664	0.081897	-0.030583	0.022729	0.960704	1	0.897982	0.174530	0.037075
Total rating of all comments	0.174415	0.333550	0.007703	0.246146	0.921841	0.897982	1	0.177322	0.210044
Number of comments / number of users	-0.024915	0.010571	-0.052523	-0.008181	0.191628	0.174530	0.177322	1	0.082888
Total rating / number of users	0.983157	0.647248	0.477022	0.881792	0.035507	0.037075	0.210044	0.082888	1

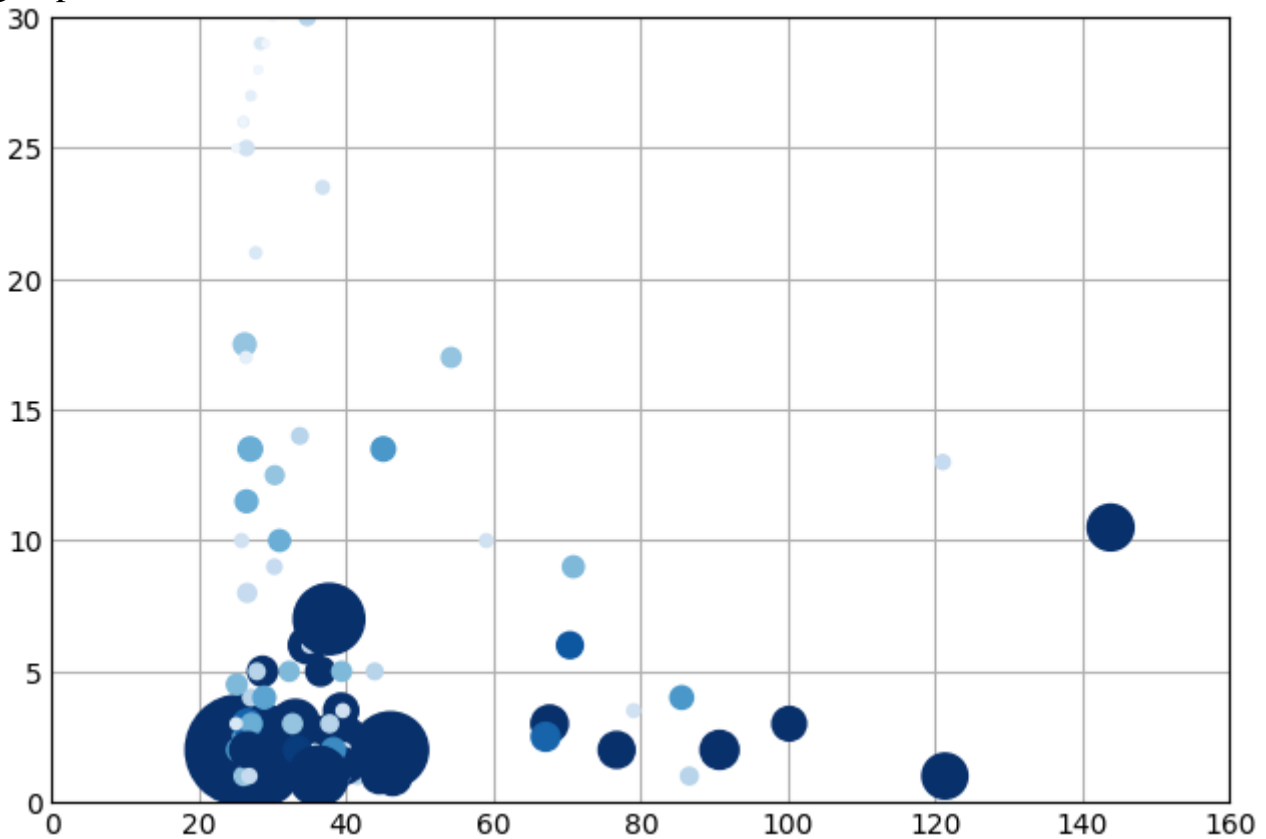
The median score reaches high values only when the number of comments is relatively small, when they count increase, median starts to tend to one. The average value tends to have the same tendency, in this case it tends to range from 20 to 45. Probably, both of these parameters cannot be used directly in assessing interest in the recording.

#### **Correlation between the number of commenters and the total number of ratings**

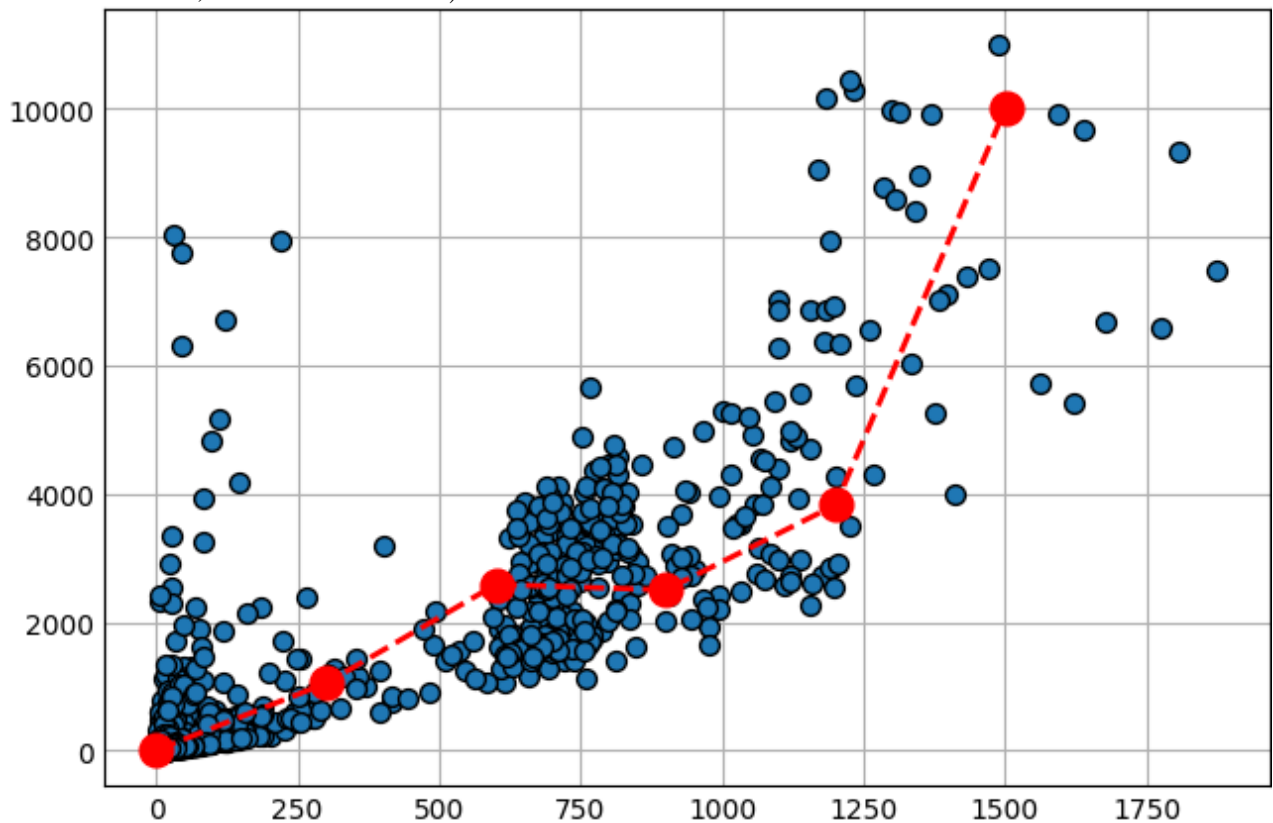
The total number of evaluations is quite strongly related to the number of unique commenters, the correlation coefficient between these two parameters is 0.897982 (see Table 4). From this we can conclude that those users who interact with content non-verbally are more interested in observing a discussion with a large number of participants. Based upon by the scatter plot and interpolation of values, entered does not grow linearly, the more unique commentators a particular post has, the more interest in the publication grows (see Fig. 2).

Visually, you can divide all publications into 3 large groups with the number of commenters from 0 to 500, from 500 to 1000 and from 1000 to 1500. The first group

contains statistical anomalies, representing news with a relatively small number of participants (up to 250) and more than 6000 comments, which is characteristic of the third group.



**Figure 1** - Scatter plot between mean (X-axis) and median (Y-axis) scores. The size of each publication in the graph shows the number of comments, and the color shows the number of unique users who left comments (the more saturated the color, the more commenters)



**Figure 2** - Scatter plot between the number of unique commenters (X-axis) and the total number of ratings

from all commenters (Y-axis). The dotted line indicates the interpolation line

However, having considered the mean values and the interpolation line, we can present the dependence of interest in the publication expressed by the total number of ratings to comments on the number of discussion participants as an exponential function (see formula 1).

$$y = 640 \cdot e^{1,77E-03x} \quad (1)$$

where  $y$  is the total number of ratings for all comments and  $x$  is the number of participants in the discussion.

### Conclusion

A huge amount of information is published in social networks every day, which puts its own imprint on the features of the study of user activity there and the relevance of the topics discussed. Due to the large number of participants, some statistical parameters in popular publications do not correlate with the total number of views, comments. Moreover, if we evaluate the importance of news by only one of the parameters, completely different topics will be leading in each such evaluation, which may indicate different forms of interest even within one specialized community in a social network.

Hence, we can conclude that the assessment of the importance and relevance of a publication should be made on the basis of a combination of several parameters. In addition, judging by the number of "like" marks, the popularity of a post grows exponentially depending on the number of participants discussing it.

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## ОЦЕНКА ИНТЕРЕСА К ПУБЛИКАЦИИ В СОЦСЕТИ НА ОСНОВЕ СТАТИСТИЧЕСКИХ ХАРАКТЕРИСТИК ЕЕ КОММЕНТАРИЕВ

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**Аннотация:** Целью данного исследования является оценка возможности определения интереса к публикации в социальной сети по статистическим параметрам комментариев к ней. На примере одного из сообществ социальной сети Reddit рассмотрены и проанализированы данные за полгода, определены вторичные статистические параметры и для первичной оценки возможных связей между параметрами построена матрица корреляции. Показаны разные результаты при попытке определить значимость публикации только по одному из параметров. При помощи найденных коэффициентов и графически показана сложность оценки интереса к публикации на основе статистических показателей при наличии большого количества комментариев. Так же на основе исследуемых данных были сделаны выводы о разных формах интереса и способах их выражения и об экспоненциальной зависимости между количеством участников обсуждения и интересом к публикации.

**Ключевые слова:** матрица корреляции, социальные сети, статистика.



## THE IMPORTANCE OF DIGITAL TECHNOLOGIES IN CHOOSING AN EDUCATION TRAJECTORY

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### Abstract

The purpose of this article is to describe the problem of applicants choosing an individual learning path and justify the use of digital technologies to solve it. The relevance of this problem in recent years is discussed. The reasons why the problem of choosing an individual learning path recently requires a solution are considered.

**Keywords:** digital technologies in education, economic losses due to expulsion, educational mobility, educational trajectory, university admission.

### Introduction

The problem of choosing an educational trajectory has become increasingly relevant in recent years. The field of higher education is a huge set of different options for ways in which you can get a particular profession. These paths are often quite confusing. For people working in higher education, it all seems pretty obvious. However, for the ninth grade students and their parents, everything is confusing.

Students and their parents need to approach the choice of an educational trajectory quite early. Over the past few years, education in colleges based on the 9th grade has become very popular in Russia [1]. Nowadays, the number of ways to obtain the necessary skills for a profession is growing rapidly. This is due to the popularization of training in vocational education programs.

Previously, there was a question about choosing an educational path for higher education. Recently, the question has been raised about choosing a complete educational path before obtaining the opportunity to earn money in a profession [2]. The point is that choosing the path to obtaining an education in the format “vocational education → bachelor’s degree → master’s degree” or “10-11 grades → bachelor’s degree → master’s degree → Ph.D. degree” requires processing a large amount of information. The previous choice of educational path answer only the question “which university is the most important to apply to” and required less information.

Thus, applicants and their parents are faced with the formidable task of sorting out most options for obtaining a profession. At the same time, only one level of higher education requires serious immersion in the topic.

Students of the 11th grade put a lot of effort into finding the educational path they need. But after passing the Russian unified state exam, many of them are still unable to find the right way. This is partly due to the fact that a lot of attention and effort was devoted to preparing for the exams.

University admissions officers have to spend a lot of time explaining all the nuances to applicants. Because of this, too much time is wasted. For this reason,

many applicants simply do not have time to either receive or process the information received to the fullest extent. As a result, applicants cannot choose the areas in which they would like to realize themselves.

We are not talking about a global failure to enter the profession, but about choosing the wrong narrow specialty. For example, in the field of IT there are a large number of professions that look very similar, but require completely different training. The same applies to many other global specializations.

The problem of enrolling in the wrong field within your specialty is greatly underestimated. The first half of training in most areas consists of working with general knowledge. It contains a small number of disciplines with a narrow focus. For this reason, during the first several years of study, a student may not notice that his learning does not quite meet expectations. However, after a long period of time, special disciplines are introduced into the program. At this point, some students begin to realize that they are not gaining the competencies that they originally wanted.

In Russia, as in many other countries, it is possible to transfer to another related area, but is associated with great risks. According to statistics, most students can do that during their first year [3-4]. However, even for them, transferring causes many problems. This is due to the need to eliminate the difference between academic schedules which, can take a lot of time even within the same university and similar specialties. Students may also encounter bureaucratic problems due to their inexperience in this matter. All this takes time and nerves. The student may also be frightened by the risk of losing current progress in learning. In this case, the problem of losing a deferment from the army for studies, which is issued for higher education once, is relevant.

These problems are amplified several times when it comes to students who are trying to transfer after the 2nd year. That is why students with the idea of transferring in their third year of study are more likely to decide to stay and finish what they started.

The problems described above lead to the presence of a large number of unclaimed specialists in the job market. These specialists have average skills in their specialty, that is why they are often not confident in their abilities. Ultimately, most of them completely lose the skills without practice that have acquired before and, at best they can find themselves after a long time in a completely different area. These problems cause a global economic downturn and a shortage of large numbers of specialists in some industries. This happens despite the large number of graduates with higher education in these specialties.

This problem needs to be solved. One of the solutions may be the introduction of the simple and understandable decision support system for choosing an educational trajectory at a university. Modern technologies have made great progress in recent years in understanding what exactly a user needs based on his text queries.

We are talking about creating a system that, based on data received from the user, will try to predict his optimal trajectory for the development of competencies at the university for the next few years. This is not a distributor, but only an assistant in formulating the questions that the applicant will ask at the admissions committee of the university to which he plans to enroll.

This system will operate on the basis of an algorithm, the purpose of which is to evaluate the information received and combine it with study options at a particular university. This system will process not only the user's text wishes, but also all the certificates/diplomas collected by him/her about participation in various olympiads/competitions. The results obtained to understand the user's interest in participating in a particular event will be assessed automatically.

System is designed to analyze the applicant's achievements in such a way as to understand his real inclinations. This will lead to the unloading of admissions officers, so that they will be able to answer applicants' questions more productively. With more knowledgeable information, applicants will choose the most appropriate learning path for their skills. This will ultimately lead to an improvement in the quality of training of specialists in many industries.

### **Conclusion**

Based on previous information, we can draw a conclusion about the relevance of the problem of applicants choosing an individual learning path. The relevance of the problem confirms the rationality of creating this system for solving it.

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## **ВАЖНОСТЬ ПРИМЕНЕНИЯ ЦИФРОВЫХ ТЕХНОЛОГИЙ В ПРОЦЕССЕ ВЫБОРА ОБРАЗОВАТЕЛЬНОЙ ТРАЕКТОРИИ**

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**Аннотация:** Целью данной статьи является описание проблемы выбора абитуриентами индивидуальной траектории обучения и обоснование использования цифровых технологий для её решения. Обсуждается актуальность данной проблемы в последние годы. Рассматриваются причины, по которой проблема выбора индивидуальной траектории обучения последнее время требует решения.

**Ключевые слова:** образовательная мобильность, образовательная траектория, поступление в университет, цифровые технологии в образовании, экономические потери вследствие отчисления.

## APPLICATION OF A NETWORK OF PROCESSES (OPERATIONS) AND CHECKPOINT TABLES TO DESCRIBE BUSINESS PROCESSES AT ZAVKOM JSC

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### **Abstract**

The purpose of this study is to compile a network of processes and a table of control points. The study will consider the production of carbon carbon nanotubes in ZAVKOM JSC. The relevance of the study lies in the fact that production processes do not always contain ordered information about themselves. As a result, it is necessary to build a network of processes that allows graphically displaying the stages of production of carbon nanotubes in the form of interconnected subprocesses. The diagram shows the control and mechanical actions for each subprocess, as well as the location of control points. The content of the work performed at the control points is shown in the table.

**Keywords:** controller of the technical control department, planning and technology department, design documentation.

The production process at ZAVKOM JSC is carried out in accordance with the current design documentation, technical specifications and technological processes. Figure 1 shows a network of subprocesses performed at ZAVKOM JSC, as well as control points K1, K2, ..., K8. The content of the work performed at each control point in the manufacture of carboxylic carbon nanotubes is presented in Table 1.

The Planning and Technological Department (PTO) draws up a monthly production plan for the workshop. The workshop is the main link in the production and provision of finished products to the end user. Untimely execution of the plan for any reason leads to disruption of the order.

The initial stage is to receive raw materials from the warehouse. Delivery to the production shop is carried out in accordance with the requirement form, which specifies the required amount of powdered carbon nanotubes and nitric acid.

Next, the loading of carbon nanotubes and nitric acid into the reactor begins. This operation is carried out by a machinist and represents work on a reactor. When using it, powdered CNTs and nitric acid are mixed, during which nitric acid vapors are formed, they pass through a reverse condenser installed on the reactor and return back, and the part that has not passed condensation is sent to the absorber for neutralization. An apparatus operating on the absorber processes the gas into a nitric acid product. While working on the agitator, the driver must monitor the load cells installed on the reactor, which monitor the loading of CNTs and acid, as well as the heat maintained in the reactor. If the temperature is insufficient, its internal contents will not be able to react properly, and the output will be a small amount of the finished product. Therefore, the reactor temperature parameter must be monitored throughout the entire work shift. After the mixing process is completed, the finished product enters the filter dryer. These devices are located in the same workshop, so a shift assignment is issued at a time.

The shift assignment is received before the start of the work shift and is issued by the site master. It includes voicing the daily production rate required to complete the plan. Every two hours of the work shift, the employee must make notes on the form in order to collect output statistics and track the appearance of defective products.

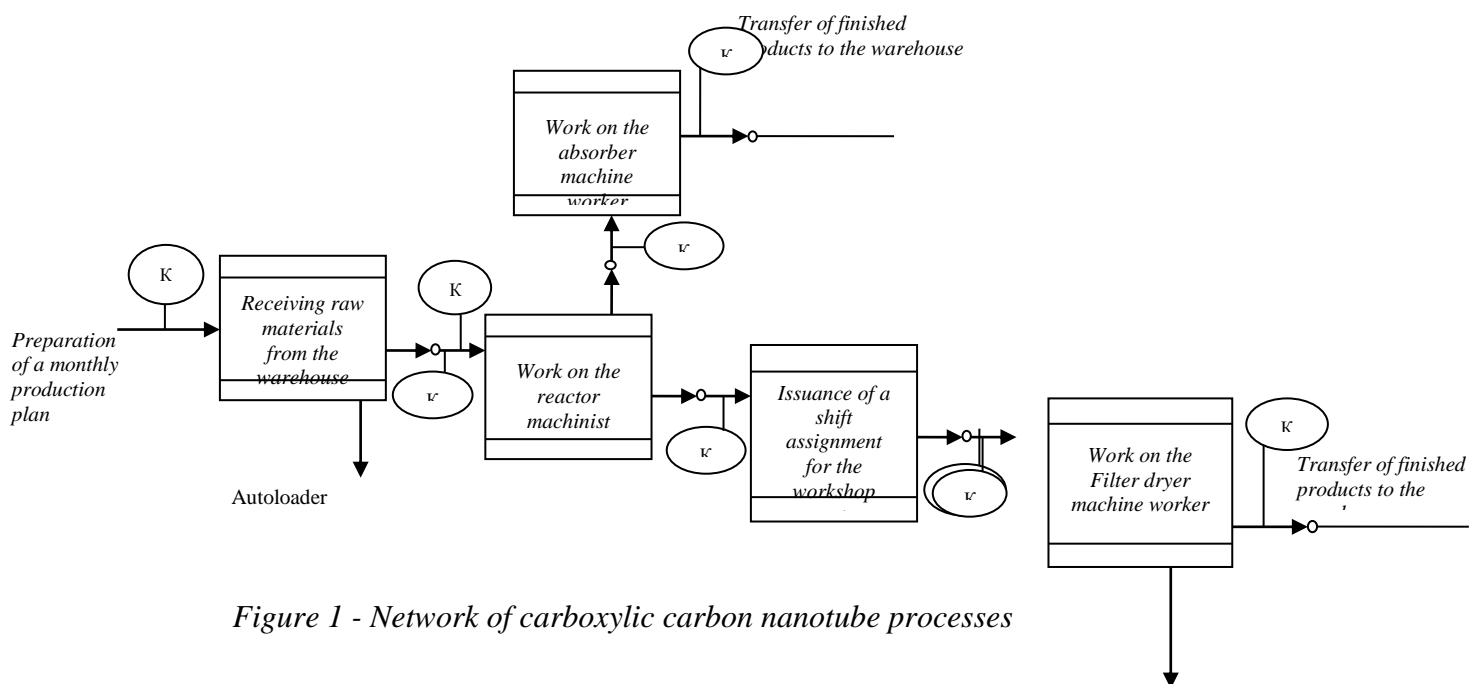


Figure 1 - Network of carboxylic carbon nanotube processes

This figure shows the network of processes for the production of carboxylic carbon nanotubes developed in the article. The next step is to work on the filter dryer. The machine worker performing this work first separates the reaction mass from the excess of unreacted nitric acid by filtration. At this stage, it is possible to release a small amount of gaseous products containing nitrogen dioxide, which are also supplied for absorption for neutralization.

Table 1. The content of the work performed at control points in the manufacture of carboxylic carbon nanotubes

No KP	Place of control	Controlled parameter	Unit of measurement	Limit value	Scope of control	Method, means of control	Responsible for control
1	2	3	4	5	6	7	8
K1	Planning and Technology Department	Production workshop schedule	pcs	1	1	visually	Head of the VET
K2	Finished goods warehouse	The amount of powdered CNTs and Nitric acid	1	75 HNO <sub>3</sub> - 65% (98,49 mass.%, CNT (1,51 mass.%) )	75 HNO <sub>3</sub> - 65% (98,49 mass.%, CNT (1,51 mass.%) )	visually	Dispatcher
K3	The reactor	The amount of powdered CNTs and Nitric acid	1	75 HNO <sub>3</sub> - 65% (98,49	75 HNO <sub>3</sub> - 65% (98,49	visually	Driver

				mass.%, CNT (1,51 mass.%)	mass.%, CNT (1,51 mass.%) )		
K4	Absorber	The amount of uncondensed gas	l.	-	0,1-0,5%	pattern	Machine worker
K5	Finished goods warehouse	The amount of nitric acid product	gr	-	0,1-0,5%	scales	Head of the VET
K6	The reactor	The amount of the finished suspension	kg	105	99,5-99,9%	visually	Machinist
K7	Production workshop	Shift assignment	kg	105	99,5-99,9%	GOST R ISO 13053-2-2015, checklist	Workshop master
K8	Finished goods warehouse	Number of carboxylic carbon nanotubes	kg	105	99,5-99,9%	Magazine of finished products, scales	QC Controller

The filtrate enters the nitric acid storage tank by means of a pump. The container performs an important function of collecting nitric acid and storing it safely before disposal, for example, acid from a container with a concentration of ~ 45% can be used to clean carbon nanotubes from catalyst particles or after purification and strengthening it can be reused in the process of producing carbon nanotubes. To remove the residues of the reaction mass, the reactor is washed with distilled water supplied from an industrial distiller (not shown in the diagram). The flushing from the reactor is also fed into the filter dryer. After that, the soil is washed from nitric acid residues. To do this, distilled water is supplied to the filter dryer. The paste is rinsed to a neutral pH of the filtrate. For more complete removal of water from the carboxylic carbon nanotubes paste, inert gas pressure filtration or vacuum filtration is used. Filtrate with impurities of colloidal particles of amorphous carbon and small CNT aggregates is pumped into a container of spent nitric acid, from where it then enters for neutralization and/or disposal (for example, in the production of nitrogen fertilizers). After a number of rinsing cycles, the product is dried in the filter dryer. Drying is carried out in an inert gas current (argon). To unload the product (KUNT), a filter dryer agitator is used or lowering the lower body using hydraulic cylinders and unloading the product together with a filter cloth.

The final stage of the KUNT manufacturing process is the delivery of products to the quality control department (QC). The acceptance is conducted by the controller in the presence of the master of the manufacturing workshop. In the case of defect-free production of products, the controller issues a signed control card, which confirms the quality of the finished product and entitles it to shipment. If there are deviations from the CD, the controller reports to his master about the existing inconsistencies, and then a decision is made on the possibility of using non-conforming products.

Upon positive consideration, the manufacturer issues a temporary permit card signed by the chief engineer. In case of negative consideration, the QC department issues a flaw detection report.

### **Conclusion**

The above approach, based on the recommendations [1], allows using a graphical model to visually represent the network (chain) of subprocesses and operations performed within the framework of a business process, and using a table to compactly present the content of work at each control point, which provides conditions for successful quality management of work in the workshop.

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## **ПРИМЕНЕНИЕ СЕТИ ПРОЦЕССОВ (ОПЕРАЦИЙ) И ТАБЛИЦЫ КОНТРОЛЬНЫХ ТОЧЕК ДЛЯ ОПИСАНИЯ БИЗНЕС-ПРОЦЕССОВ НА АО «ЗАВКОМ»**

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**Аннотация:** Целью данного исследования является составление сети процессов и таблицы контрольных точек. В исследовании будет рассмотрено производство карбоновых углеродных нанотрубок в АО "ЗАВКОМ". Актуальность исследования заключается в том, что производственные процессы не всегда содержат упорядоченную информацию о себе. В результате необходимо построить сеть процессов, позволяющую графически отображать этапы производства карбоновых углеродных нанотрубок в виде взаимосвязанных подпроцессов. На схеме обозначены управляющие и механические воздействия для каждого подпроцесса, а также расположение контрольных точек. Содержание работ, выполняемых в контрольных точках, приведено в таблице.

**Ключевые слова:** контролер отдела технического контроля, плано-технологический отдел, конструкторская документация.

## DATA FORMATION MODEL IN A PROBLEM-ORIENTED LIBRARY- MUSEUM-ARCHIVAL-INFORMATION MASSIVE

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### Abstract

The developed information model of data formation on user's request in the field of nobelistics is presented and described, which reflects the really functioning subject-oriented library-museum-archival-information massive of the International Nobel Information Center, consisting of: Nobel Scientific Library, Museum of the Nobel Family and Nobel Prize Laureates, Archive of the Nobel Family and Nobel Prize Laureates, electronic databases on nobelistics. The data is formed in such a way that the user receives retrieval results in the form of factography, factology, documents in various formats. The database management system monitors the results of each act of information retrieval according to six quality elements: relevance, pertinence, accuracy, completeness, clarity, and consistency.

**Keywords:** problem-oriented data massive, library-museum-archival-information data, data formation models, information model.

### Introduction

The idea of combining information resources of libraries, museums, archives and electronic repositories into a single library-museum-archival-information massive (LMAIM) with the help of modern information technologies emerged long ago [1, 2]. It is based on the analysis of the requirements of scientific information users (scientists and specialists) who need to get a complete and accurate answer to their request regardless of the massive where the sources they are looking for are located and in what format they function: in the form of library or archival documents, museum exhibits or electronically in the global network. This idea is partially realized in the Internet, but due to many known reasons problem-oriented search in scientific documents is still extremely inaccurate and incomplete.

A convenient example for modeling and testing the performance of information retrieval models is the LMAIM of the International Nobel Information Center (INIC), in which all four problem-oriented arrays function simultaneously and interconnected: Nobel Research Library (NRL), Museum of Nobel Family and Nobel Prize Laureates (MNF&NPL), Archive of Nobel Family and Nobel Prize Laureates (ANF&NPL), and many electronic databases (DB) on nobelistics [3, 4]. INIC has many years of experience in providing scientists and specialists with the help of problem-oriented massive on nobelistics in the local execution of retrieval technology.

The purpose of this study is to develop a data model to implement networked information retrieval in LMAIM on nobelistics. Based on this model, it is planned to develop an information retrieval system on nobelistics, which in any retrieval uses all information resources available in INIC.



## Data formation model

Data in the local LMAIM on nobelistics are presented in the following amount: about 10 thousand books and brochures in the library, more than 6 thousand museum exhibits, more than 100 thousand sheets of archival documents, 20 databases of electronic documents on nobelistics with the volume of 2Tbytes. It is more than enough for formation of information problem-oriented system with high level of accuracy and completeness of retrieval in all directions of nobelistics.

Let's present the information data model with information flows (fig.1) in the process of providing information retrieval on nobelistics. Information objects (entities) here are elements of the subject area are documents, which are either retrieval objects themselves, or represent secondary data about retrieval objects, which is carried out with the help of database management system (DBMS).

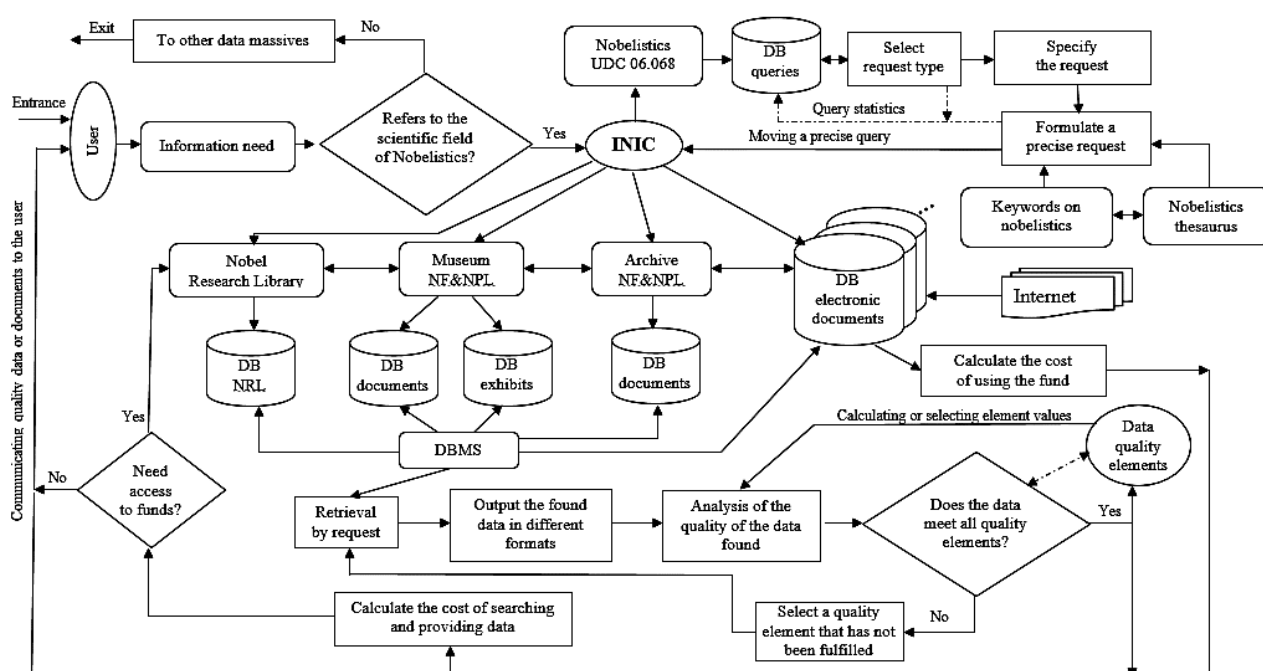


Figure 1- Information model of data generation by user request for retrieval in the field of nobelistics

In this model the data are formed and placed so that the retrieval results for any query in the field of nobelistics can be: 1) factographic or factologic data obtained from the INIC DB; 2) documents (books, archival documents, museum exhibits), which the user studies and completes the retrieval for the sought information independently. For each result, the search cost is calculated according to a pre-entered algorithm. Each retrieval operation is evaluated by a set of six main elements of retrieval quality: relevance, pertinence, accuracy, completeness, clarity, consistency. The first four elements are calculated as indicators based on the entered parameters, the last two are selected based on a fuzzy scale. If the user is not satisfied with the value of any quality element, the information retrieval system changes the query and repeats the search. Only after sufficient values of all six quality elements of the retrieval the data or documents are transferred to the user and the service cycle

is completed. Nobelistics data obtained from the Internet are expertly evaluated and corrected or discarded if they represent misinformation (more than 70% of cases).

The proposed model of data formation and information retrieval on the basis of problem-oriented massive on nobelistics allowed to bring relevance, pertinence, accuracy and completeness of search to 0.9-1.0, and clarity and consistency to the value of “very high”. Such results are unlikely to be achieved if the retrieval massive is not problem-oriented and if the data is generated in such a way that the total number of documents in the massive is unknown.

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## МОДЕЛЬ ФОРМИРОВАНИЯ ДАННЫХ В ПРОБЛЕМНО-ОРИЕНТИРОВАННОМ БИБЛИОТЕЧНО-МУЗЕЙНО-АРХИВНО-ИНФОРМАЦИОННОМ МАССИВЕ

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**Аннотация:** Представлена и описана разработанная информационная модель формирования данных по запросу пользователя в области нобелистики, которая отражает реально функционирующий предметно-ориентированный библиотечно-музейно-архивно-информационный массив Международного Информационного Нобелевского Центра, состоящий из: Нобелевской научной библиотеки, Музея семейства Нобелей и лауреатов Нобелевских премий, Архива семейства Нобелей и лауреатов Нобелевских премий, электронных баз данных по нобелистике. Данные сформированы таким образом, что пользователь получает результаты поиска в виде фактографии, фактологии, документов в различных форматах. Система управления базами данных контролирует результаты каждого акта информационного поиска по шести элементам качества: релевантность, пертинентность, точность, полнота, ясность, согласованность.

**Ключевые слова:** проблемно-ориентированный массив данных, библиотечно-музейно-архивно-информационные данные, модель формирования, информационная модель.

## PROBLEMS OF PREPROCESSING A 3D MODEL BEFORE PRINTING

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### Abstract

3D printing is a rapidly developing industry. During printing, many problems can arise that lead to product rejection. The article provides examples of defects that arise during printing related to the preprocessing of three-dimensional models in slicer programs. Such operations as scaling, installing supports and rotation are considered.

**Keywords:** 3D models, separation of 3D models, slicers, three-dimensional printing.

3D printing is an amazing opportunity to bring a lot of creative and innovative ideas to life, turning them from virtual concepts into real objects. There are many different printing technologies and materials available, each suited to specific objectives and projects. Among the most widespread and popular technologies are FDM and SLA

Each of these technologies has its own characteristics and problems that may arise during the printing process. Often problems are related to the settings of the printing device and the properties of the material used. In addition, problems associated with preliminary preparation of the model before printing are no less important. Specific settings and location of the model can significantly affect the entire manufacturing process and the quality of the final product.

Before starting the 3D printing process, it is necessary to develop a detailed 3D model design of the future product using various modeling software. After this, the project is loaded into the slicer program. It allows you to make the necessary settings and operations to achieve optimal results depending on your printing task.

One of the possible operations that can be performed when preparing a model for 3D printing is resizing. If the original model was created with certain parameters, and the current project requires completely different dimensions, then you can use the scaling operation. This results in two situations.

The first situation is that the boundaries of the model extend beyond the permissible printable area of the device. In such cases, it is necessary to make changes to the drawing itself and divide it into several parts so that each can be printed within the available area. This may require additional effort and time, since the process of separating a model into parts and then connecting them is not always a trivial task. One of the reasons for this problem is that the process of creating a model and then printing it is not ideal due to the limitations of the printing devices themselves. Even small deviations of a few microns at the separation boundaries can lead to visible defects on the surface and seams when connecting separate parts of the product. This requires careful monitoring and adjustment of the printing process to

achieve optimal results.

Examples of methods for dividing models into parts can be considered in the following publications [1-2].

The second situation is when the size of the model is reduced to such a size that the printer is not able to convey all the details of the original model. This is due to resolution limitations and minimum layer thickness in SLA printers, as well as nozzle size in FDM printers. This problem is particularly noticeable when printing thin walls or long, narrow parts.

Downsizing may result in material omissions, print distortions, and other defects. This problem can be solved only by completely changing the original three-dimensional scheme and increasing the volume of the model in critical areas. This will preserve all the small details and achieve a more accurate reproduction of the original model when printed.

The next important step is the placement of additional support elements. This operation is necessary to strengthen those parts of the model that during printing are in the air or protrude significantly beyond the boundaries of the main volume of the product. In some situations, printing without supports becomes simply impossible. However, certain problems arise when separating the supports from the completed product.

Firstly, there is a risk that the material from the supports will partially remain on the surface of the product parts. Or the opposite situation will separate the necessary particles from them, which may affect the quality of the final product. Secondly, too much support in the area of small parts can lead to their damage. The presence of an automatic support placement system in the slicer program does not always provide optimal solutions. Therefore, it is necessary to closely monitor this process and manually adjust the support distribution.

Rotation relative to the print build platform can help solve the problems described above, or can create new ones. These difficulties include the step effect on surfaces, loss of crisp corners, parts tearing or warping during printing, and formation of holes.

Steps are formed due to the layer-by-layer creation of the product, the angle of inclination of the plane relative to the projection of the print and the height of the print layer. By choosing the optimal turn, you can reduce the visibility of the steps.

Delamination and deformation of product elements occur as a result of the action of various forces on the material during the printing process. For SLA printers, these may be resin viscosity, elastic force and gravity [3]. A certain angle of the part relative to the print plane can reduce the influence of these forces. Finding this angle is difficult without printing expertise.

It is important to remember that automatic rotation in a slicing program does not always take into account all the features of your model, so careful setup and testing is required before printing.

Pre-processing a 3D model before printing on a 3D printer can encounter various problems such as incorrect scaling, incorrect orientation, mismatch with printing requirements, and insufficient support. However, careful checking, adjustment and preparation of the model before printing will avoid these problems and ensure a successful result.

It is important to spend enough time on the 3D model preparation stage to achieve high quality 3D printing and obtain the desired final product. It is also necessary to take into account the features of the selected 3D printing technology and its capabilities for optimizing the printing process and quality. You can collaborate with other 3D printer users and share experiences and tips on improving the quality of models and speeding up the printing process.

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## ПРОБЛЕМЫ ПРЕДВАРИТЕЛЬНОЙ ОБРАБОТКИ ТРЕХМЕРНОЙ МОДЕЛИ ПЕРЕД ПЕЧАТЬЮ

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**Аннотация:** Трехмерная печать является быстроразвивающейся отраслью. Во время печати может возникнуть множество проблем, которые приводят к отбраковке изделий. В статье приведены примеры возникающих дефектов во время печати, связанные с предварительной обработкой трехмерных моделей в программах слайсерах. Рассмотрены такие операции как масштабирование, установка поддержек и вращение.

**Ключевые слова:** 3D модели, разделение 3D модели, слайсеры, трехмерная печать.

## DATA PROCESSING SUBSYSTEM IN VIRTUAL TRAINING COMPLEXES

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### Abstract

The article discusses the issue of introducing a data processing subsystem into virtual training complexes. We propose relevant conditions, under which the implementation of this subsystem as a separate component. The main tasks solved by this subsystem, as well as the components responsible for solving these problems, are presented.

**Keywords:** data processing, data synchronization, real-time system, virtual training complex.

### Introduction

In recent years, virtual training systems have become widespread in the fields of education and professional training [1]. The development of computer graphics technologies, as well as the emergence of relatively cheap virtual reality systems, including those with the ability to operate autonomously without the use of a computer, have made such training complexes available not only for large training centers, but also for schools, universities, and small private companies.

The term “virtual training complex” includes a fairly wide range of software and hardware systems designed to ensure interaction between the user and the virtual environment. In the simplest case, the complex includes only a visualization subsystem, a user data input subsystem, and a set of training scenarios. However, to increase the level of user immersion in the virtual environment, and therefore the effectiveness of the learning process, the set of simulator components can be significantly expanded.

For example, to increase the realism of user interaction with a virtual environment, various motion capture systems can be used instead of a keyboard or VR controllers to control the user’s movement in virtual space. To implement automatic adjustment of the virtual environment to the current user's state, a biological feedback mechanism can be used. This mechanism includes the collection of various biomedical metrics from the human body, such as pulse, muscle activity, etc. Based on the values of these metrics, the simulator control system can make adjustments to the virtual environment behavior. A user's data visualization system can help the instructor monitor the learning process in real time and give competent recommendations to the user [2].

The implementation of each of the components described above increases the number of data streams involved in the training complex operation. Thus, it becomes relevant to introduce a new global subsystem into the training complex – a data processing subsystem. This component solves the problem of centralized collection and processing of all information necessary for the training complex operation. The

main ones of these tasks are:

- receiving raw data streams from all data sources within the training complex. Instead of sending information directly to each component of the system that needs it, all the original data streams are combined at the central node of the data processing subsystem, so-called data-hub;

- filtering and normalization of raw data streams. Various components of the simulator, such as positioning systems, medical sensors, etc. may require pre-processing of incoming information, for example, filtering to reduce the influence of various noises, transformation of coordinate systems, etc.;

- synchronization of data streams. Each of the system components has its own measurement delays, and can also have different sampling rates, from tens of times per second (computer vision systems) to hundreds or thousands of times per second (medical sensors, VR positioning systems) [3];

- sending processed data to all components that are data consumers. Each of the simulator components, which requires this or that information to operate, receives it from the data-hub, and not directly from the source.

Additionally, this arrangement of the data processing subsystem allows, if necessary, to maintain a centralized recording of all incoming information for subsequent analysis. In this case, you can save both the original raw data and the data after filtering and synchronization.

The structure of the data processing subsystem includes corresponding software modules designed to solve each of the listed tasks. Let's look at these modules in more detail. The data acquisition module implements obtaining information from each data source in a complex. It includes a set of drivers that implement interaction with data sources using the protocols that the sources provide. For example, receiving information over a local network from wireless devices, interacting via USB or serial port with wired devices, or receiving data via API from third-party applications. At the output of the data acquisition module, the information is converted to a common unified structure, which is used within the entire data processing subsystem.

The data filtering and normalization module implements a set of various mathematical algorithms and signal processing methods. Different filters may be needed for different data sources, for example a low-pass filter for signals that change slowly enough over time that any small but fast fluctuations can therefore be considered as a noise. Also, different sensors may use different units of measurement for the same dimensions. To create a unified digital model of user state, all these values must be brought to a common standard and a single dimension system.

The data synchronization module is one of the most complex components of the subsystem. This module implements the integration of data streams arriving at different frequencies and different delays into a single digital model. The choice of a specific synchronization method depends on the required response speed and the required accuracy of the data obtained at its output. One of the simplest synchronization algorithms is caching: using previous measured values for a particular data source until a new value is received from that source. This algorithm provides the highest system response speed, since the output state is updated when any of the sources changes, but the accuracy of the obtained values in this case will

be relatively low.

The processed data publishing module interacts with those components of the training complex that are data consumers. For example, information about the user's position is transmitted to the visualization subsystem for the correct camera movement in the virtual environment, data from medical sensors is transmitted to the virtual environment control system to operate the feedback mechanism, etc.

Thus, the data processing subsystem makes it possible to significantly simplify the construction of virtual training complexes, which include many different data sources and consumers, by unifying the processes of acquisition and processing of the incoming information.

### **Conclusion**

Virtual training systems can include many different data sources, as well as many components that require incoming information to operate. Implementing the interaction of each pair of such components independently of each other leads to a significant complication of the whole system, as well as duplication of functionality. A possible solution to this problem is the creation of a centralized data processing subsystem, which will reduce the number of repetitive components and unify the operations associated with data processing.

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## **ПОДСИСТЕМА ОБРАБОТКИ ДАННЫХ В ВИРТУАЛЬНЫХ ТРЕНАЖЕРНЫХ КОМПЛЕКСАХ**

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**Аннотация:** В статье рассматривается вопрос внедрения подсистемы обработки данных в виртуальных тренажерных комплексах. Предложены условия, при которых реализация данной подсистемы как отдельного компонента является актуальной. Приведены основные задачи, решаемые данной подсистемой, а также компоненты, отвечающие за решение данных задач.

**Ключевые слова:** виртуальный тренажерный комплекс, обработка данных, синхронизация данных, система реального времени.



## ARTIFICIAL INTELLIGENCE IN EVERYDAY LIFE

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### **Abstract**

This article explores the pervasive impact of artificial intelligence (AI) in various aspects of daily life. It highlights the role of AI in enhancing efficiency and decision-making processes in sectors such as healthcare, finance, and transportation. The discussion includes the use of machine learning algorithms, natural language processing, and predictive analytics. The integration of AI in personal devices, smart home systems, and mobile applications is also examined, emphasizing how AI contributes to personal convenience and lifestyle optimization. Furthermore, the article delves into ethical considerations, challenges, and the future trajectory of AI in everyday life.

**Keywords:** artificial intelligence, machine learning, natural language processing, predictive analytics, ethical considerations.

### **Introduction**

In an era where digital transformation is reshaping every aspect of our lives, artificial intelligence (AI) stands at the forefront of this revolution, offering unprecedented opportunities and challenges. AI's role extends far beyond technological novelty. It has become a critical tool in enhancing human capabilities and solving complex global challenges. This article explores the multifaceted impact of AI in everyday life, from personal gadgets to large-scale industrial applications, and discusses its potential in shaping a more efficient, sustainable, and inclusive future [1].

### **Exploring AI's Impact**

The integration of AI into personal technology has revolutionized our interaction with everyday devices. Voice assistants and smartphones, now equipped with AI, understand and respond intelligently to user needs, optimizing functionality based on individual behaviors. Similarly, AI in smart home devices adapts to our living habits, ensuring energy efficiency and enhancing security measures.

In the healthcare sector, AI's role is particularly transformative. Advanced AI algorithms have improved the accuracy of diagnostics and predictive medicine, leading to more personalized and effective patient care. These technologies manage and analyze vast amounts of patient data, substantially contributing to medical research and healthcare delivery [2].

Financial services have also been reshaped by AI, particularly in fraud detection and risk management. AI algorithms efficiently identify fraudulent activities, offering robust risk assessment tools. Moreover, AI-driven financial technologies provide personalized investment advice, revolutionizing individual financial management [3].

The transportation sector is witnessing a significant shift due to AI. The development of autonomous vehicles and smart traffic management systems is reducing traffic congestion and emissions, paving the way for more efficient urban

mobility. This transformation marks a critical step towards sustainable city planning and management [3].

In the field of education, AI is personalizing learning experiences, catering to individual learning styles and needs. It provides educators with valuable insights and tools, enhancing teaching methodologies and improving educational outcomes. This personalized approach is redefining educational experiences and expectations [4].

The ethical and societal considerations surrounding AI are as significant as its technological advancements. Issues of data privacy, algorithmic bias, and the socio-economic impacts of AI necessitate careful consideration. Addressing these challenges is imperative to ensure the responsible development and equitable use of AI [4].

### **Conclusion**

Artificial intelligence is a transformative force redefining every aspect of daily life. While its applications across various sectors enhance efficiency and offer personalized experiences, they also introduce complex challenges and ethical considerations. As AI evolves, adopting a balanced approach to harness its potential and mitigate its risks is crucial. This evolution promises a future replete with innovative solutions, demanding ongoing exploration and adaptive strategies for positive human progress.

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## **ИСКУССТВЕННЫЙ ИНТЕЛЛЕКТ В ПОВСЕДНЕВНОЙ ЖИЗНИ**

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**Аннотация:** Рассмотрено влияние искусственного интеллекта (ИИ) на различные аспекты повседневной жизни. Особое внимание уделяется роли ИИ в повышении эффективности и процессах принятия решений в таких секторах, как здравоохранение, финансы и транспорт. Обсуждаются использование алгоритмов машинного обучения, обработки естественного языка и прогнозирующего анализа. Также рассматривается интеграция ИИ в личные устройства, системы умного дома и мобильные приложения, подчеркивая, как ИИ способствует личному удобству и оптимизации образа жизни. Кроме того, статья затрагивает этические соображения, проблемы и будущую траекторию ИИ в повседневной жизни.

**Ключевые слова:** искусственный интеллект, машинное обучение, обработка естественного языка, прогнозирующий анализ, этические соображения.

УДК 18  
ББК 87.8

## THE SUPREMACY OF VISUAL IMAGES. THE ROLE OF DESIGN IN THE FORMATION OF SOCIAL HIERARCHY

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### **Abstract**

This article examines the influence of design on the formation of social hierarchy in modern society. Design is considered as the result of professional activity within various creative industries: advertising, architecture, industrial design, interior design, exterior, landscape, fashion, cinema, video, music, theater, performing arts art, publishing, and so on.

**Keywords:** design, social portrait, the structure of the society, creative industries, visual information

### **Introduction**

In modern society, design plays an important role in shaping social hierarchy and status determination, influencing the perception and behavior of people in various aspects of life. First of all, the design of products and consumer goods can serve as an indicator of social status.

Some brands and designer goods are associated with high status and wealth, and their owners often use them to demonstrate their social status. For example, high-end cars, pieces of furniture by famous designers, expensive watches and other items can become a symbol of social prestige.

In addition, interior and architectural design can contribute to the creation of visual signs of social status. For example, luxury residences, elite clubs and restaurants, offices of large companies – all of them create a special perception and can become a place where people demonstrate their social status through design and architecture.

In addition, fashion design is also essential for the formation of a social hierarchy. Clothing and accessories can act as signs of social status and be a tool for expression their belonging to a certain social group.

Thus, design plays an important role in shaping social hierarchy, determining social status and prestige, as well as influencing people's perception and behavior. It is important to realize that design can be used to strengthen social inequality, so it is necessary to carefully to relate to the choice and perception of designer products in order to create a more inclusive and equitable society.

### **Hypothesis**

The designer is the creator of a product that Subsequently, it is a social indicator. Therefore, he is the person who can set the vector of social development for different

categories of society. "Since happiness is determined by expectations, the two pillars of our society are – Media and Advertising" [1], - Yuval Noah Harari, *Sapiens* (edition 2022, p. 457).

### **Goal**

The social hierarchy in modern society is a conditional system of social stratification in which people are divided into different categories based on their social status, power, wealth and prestige. This perception is often tacit. Nevertheless, in such a hierarchy there are usually upper, middle and lower classes based on certain characteristics, and each of them has its own characteristics, capabilities and privileges.

Social hierarchy can have both positive and negative effects on society as a whole, as it can be a source of motivation and innovation, but can also contribute to social discrimination and inequality.

The social position of a person within a particular team it is formed on the basis of his actual and conditional regalia and achievements, such as education, work, security, influence, family and origin, personal qualities (intelligence, sense of humor, degree of determination, responsibility, category of needs, attitude to others, behavior, goals in life, beliefs, and so on). Most often, this information is formed into a single collective image, which can be called a "social portrait".

A social portrait is the result of an analysis by one person (or an element of the structure of society) of another person. It is necessary to have a sufficient amount of data for analysis.

Without them, a person's social portrait is formed solely on the basis of a visual impression. For example, the portrayal of successful and wealthy people in movies, television, and other media content may reinforce the idea that success and status are available only to those who meet certain standards of beauty, wealth, or lifestyle. It may lead to increased differences in the social hierarchy and even to infringement self-esteem among people who feel inadequate to these standards.

The visual impression of the environment as a whole is the result of visual impact on an individual, which is read using visual information: color, shape, texture, lighting and composition, symbols and other indicators. Often, this information causes a person to have certain emotions, associations, or memories. Impression is an important aspect of perception of the world around us, and it can have a significant impact on a person's emotional state and behavior.

Galina Lola, professor, lecturer at the British Higher School of Design, in her book "Design Code: a methodology of semiotic discursive Modeling" argues that creating an impression is the goal of design [2]. Achieving the goal is considered as a positive result of a well-thought-out scenario developed by the designer. It is important that the creation of a visual impression belongs to the category of emotions experienced by a person, such as pleasure, interest, curiosity, admiration, awe, appeasement, disgust, envy, indignation and so on. Based on Galina Lola's statement, if the projected object does not create any impression for the user, then it will not be a design product.

The subject of design is always considered from the point of view of the user's desire to acquire it from the intended target audience. The formation of a visual

image of the desired product is one of the professional tasks of the designer, while his most difficult task. That, how many users want to purchase the developed product. It is a criterion for the success of its design, among other things.

Individual emotions can have a significant impact on the formation of desires and goals in a person. Of course, each person is unique and has their own goals and needs, and even considering a person in the context of the social hierarchy, the list of attributes of success remains wide and multifaceted: fame, respect, importance in society, fame in certain circles, financial independence, rise up the career ladder, love from loved ones, but for everyone the significance of these points will be individual.

The design often allows you to demonstrate this success by being a brand, the "label" of belonging to a certain social group. For example, there are various categories of housing (business, comfort, economy, and so on), both permanent and temporary. The category of this housing It will be compared with the category of the potential owner of this housing, his social portrait, including habits, interests and lifestyle. Brand awareness is proportional to their value (and proportional to their illegal copying). All this suggests that the brand of design chosen by the user and tried on is an indicator within the social hierarchy.

Design often manipulates human desires based on associations, images, myths and legends, stories and supposed positive user impressions. Often, design "gives", "promises", "guarantees", "helps", "inspires". Design methods take into account a person's emotions, forming his personal desires, where the word "I want" is often the key even to such a seemingly monumental and unshakable definition as "beauty". At the same time, it is not always based on the rules of aesthetics as a science when forming a visual image.

By controlling the desires of the target audience, often "dictating" them, the design forms the value of the product, often completely based solely on the emotional basis of the user, which reflects its similarity to some extent with art objects and their value.

"Cultural industries are engaged in the management and sales of a special kind of work. Since the Renaissance, and especially in the era of Romanticism in the XIX century — It has been accepted that "art" is the highest form of human creativity." [3] - David Hezmondalsch. Cultural industries (2018, p. 17).

### **Conclusion**

The importance and influence of design in the modern world of business, economics, culture and art can be considered as one of the key brands for assessing prestige and position in the social hierarchy.

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# ДИКТАТУРА ВИЗУАЛЬНЫХ ОБРАЗОВ. РОЛЬ ДИЗАЙНА В ФОРМИРОВАНИИ СОЦИАЛЬНОЙ ИЕРАРХИИ

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**Аннотация:** Рассмотрено влияние дизайна на формирование социальной иерархии в современном обществе. Дизайн представлен как результат профессиональной деятельности в различных креативных индустриях, таких как реклама, архитектура, промышленный дизайн, дизайн интерьера и экстерьера, ландшафтный дизайн, мода, кино, видео, музыка, театр, исполнительское искусство, издательское дело и многие другие.

**Ключевые слова:** дизайн, социальный портрет, структура общества, креативные индустрии, визуальная информация.

## USING NEURAL NETWORKS IN MODERN ARCHITECTURE: OPPORTUNITIES AND PERSPECTIVES

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### **Abstract**

This paper explores the key role of neural networks in modern architecture, examining the multidimensional benefits and perspectives they provide. As architecture becomes increasingly technologically sophisticated, neural networks are emerging as transformational tools for solving design challenges. They facilitate the creation of detailed project visualizations, helping clients envision future outcomes, and allow architects to conduct thorough analysis of building elements and materials. The use of neural networks is particularly relevant in the context of climate change, where they are becoming an indispensable tool for improving energy efficiency, optimizing heating and ventilation systems, and integrating innovative renewable energy solutions. The article highlights the automation of design and construction processes using neural networks, freeing architects to be more creative and create personalized solutions. Neural networks not only predict design trends, but also improve project management by identifying risks and optimizing budgeting. In the construction phase neural networks bring important advantages by controlling robotic systems and autonomous structures, which increases efficiency and shortens work times while minimizing risks for workers. Ultimately, neural networks play a key role in shaping the future of architectural development, influencing everything from design innovation to the creation of sustainable and high-tech buildings.

**Keywords:** architecture, building sustainability, collective intelligence, design automation, design innovation, energy efficiency, neural networks.

### **Introduction**

Modern architecture is becoming increasingly technological, and neural networks play a crucial role in this transformation. Architectural design faces challenges that require innovative approaches and the use of advanced technologies. In this article, we will explore the advantages and possibilities that neural networks provide for architects and how they can enhance design processes to bring ambitious ideas to life.

### **Advantages of using neural networks in architecture**

Neural networks enable architects to create detailed visualizations of future projects, aiding clients and stakeholders in better envisioning the outcomes. Modeling and virtual reality serve as excellent tools for this purpose.

Effective analysis of structures and materials is a key component in architectural design. Neural networks allow for a more thorough examination of the impact of various parameters on the strength and stability of constructions, leading to optimized design solutions.

In the context of contemporary challenges related to climate change, neural networks become indispensable tools for architects working on energy efficiency and building sustainability. They optimize heating, ventilation, and air conditioning systems, as well as introduce innovative solutions for utilizing renewable energy sources. Neural networks

can model and analyze various scenarios, ensuring the creation of resilient and environmentally efficient architectural forms.

The application of neural networks in automating specific aspects of design and construction allows architects to focus on more creative aspects of their work. This includes generating drawings, project cost calculations, and resource usage optimization, reducing the labor involved in routine tasks and enabling architects to concentrate on creative aspects.

Neural networks also provide architects with the opportunity to create personalized design solutions, considering individual client needs. This opens new horizons for developing unique architectural concepts tailored to specific requests and preferences.

Data analysis performed by neural networks not only enables architects to forecast future design trends but also provides tools for more efficient project management. This includes risk identification, project timeline forecasting, and budget optimization.

The integration of neural networks into architectural design contributes to scientific research and development. They offer architects the opportunity to experiment with innovative concepts and forms, stimulating progress and advancement in the field of architecture.

The use of neural networks fosters the formation of collective intelligence, bringing together professionals from different fields—architects, engineers, programmers, and designers—to effectively collaborate, exchanging data and ideas through networks, leading to the creation of innovative and unique concepts.

Not only in the design phase but also during construction, neural networks can provide significant advantages. AI-controlled robotic systems and autonomous structures enhance the efficiency of construction processes, reducing timelines and minimizing risks for workers.

The integration of neural networks into architectural practices opens doors to new horizons and technological transformations for the industry. From innovations in design to the creation of sustainable and high-tech buildings, the role of neural networks in architecture is becoming a key element in the future development of this discipline.

## **Conclusion**

In conclusion, the use of neural networks in architecture promises significant advantages. From increased efficiency in design processes to the creation of more intelligent, sustainable, and personalized buildings, these technologies are becoming a fundamental element in the modern architectural industry.

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## **ИСПОЛЬЗОВАНИЕ НЕЙРОСЕТЕЙ В СОВРЕМЕННОЙ АРХИТЕКТУРЕ: ВОЗМОЖНОСТИ И ПЕРСПЕКТИВЫ**

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**Аннотация:** Рассмотрена ключевая роль нейросетей в современной архитектуре, выделены многоаспектные преимущества и перспективы, которые они предоставляют. По мере того, как архитектура становится все более технологически сложной, нейросети выступают в качестве трансформационных инструментов для решения дизайнерских задач. Они облегчают создание детализированных визуализаций проектов, помогая клиентам представить себе будущие результаты, а также позволяют архитекторам проводить тщательный анализ строительных элементов и материалов. Особую актуальность приобретает использование нейросетей в контексте изменения климата, где они становятся неотъемлемым инструментом для повышения энергоэффективности, оптимизации систем отопления и вентиляции, а также интеграции инновационных решений для использования возобновляемых источников энергии. В статье отмечается автоматизация процессов дизайна и строительства с использованием нейросетей, что позволяет освободить архитекторов для творческой деятельности и создания персонализированных решений. Нейросети не только предсказывают тенденции в дизайне, но и улучшают управление проектами, выявляя риски и оптимизируя бюджетирование. В строительной фазе нейросети придают важные преимущества, управляя роботизированными системами и автономными конструкциями, что повышает эффективность и сокращает сроки работ, минимизируя риски для рабочих. В конечном итоге, нейросети играют ключевую роль в формировании будущего архитектурного развития, влияя на все – от инноваций в дизайне до создания устойчивых и высокотехнологичных зданий.

**Ключевые слова:** архитектура, автоматизация проектирования, инновации в дизайне, коллективный интеллект, нейросети, устойчивость зданий, энергоэффективность.

## WAYS OF ADAPTING CULTURAL HERITAGE OBJECTS FOR MODERN USE

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### **Abstract**

The possibilities of coexistence of new and historical buildings in the same space, as well as the problems of modern use, preservation and adaptation of cultural heritage objects are considered. The existing situation of the selected research site is analyzed in order to include the modern development into the historical context, the architectural monuments located on the territory are identified. The main methods of approaches to solving the problems of integration are considered. The ways of forming facades of newly erected buildings in relation to the surrounding urban environment and purpose are investigated. Taking into account the set of elements of the surrounding buildings, various approaches to the formation of the facade of a modern building in the historical environment are developed. Examples of new buildings are given on the basis of a specific situation. The choice of a particular method depends on many factors, the purpose of transformation of the historical environment is to ensure its integrity in the semantic and visual meaning.

**Keywords:** historical building, contrast, cultural heritage objects, integration, stylization.

### **Introduction**

Historical buildings are an integral part of the material component of the city and are significant in terms of architecture, urban planning, art, social culture, ethnology and anthropology, as they are a reflection of the life of society.

### **Methods and materials**

Adapting and adding novelty to historical buildings for modern use is one of the ways to preserve them. This allows the object of cultural heritage not to lose its significance and to attract more public interest.

The adaptation of object of cultural heritage for modern use differs from conservation, repair and restoration in that two different tasks are simultaneously solved in one volume. This is the preservation of the monument and its safe use with a new functional content.

The aim of the research of this article is to identify the properties and mechanisms entailing a certain method of adaptation to modern conditions of architectural monuments.

With all the variety of approaches to solving the problems of restoration with adaptation, several main methods can be emphasized:

- stylization;
- contrast of epochs;
- modern interpretation of historical decorations;
- mirroring of the historical building;
- neutral facade [2].

Stylization was widely practiced in the past, but at the present stage is not

relevant. Through stylization creates a kind of "fake", this method borders on falsification, so it should be used only in some cases and with great care.

Contrast of eras implies a sharp difference in the style and materials of erected and existing objects. At the moment, the approach is often used, but the results are not always full-fledged. The more fragmentary the building is preserved, the more variations open up for the choice of new forms and subsequent reconstruction of compositional integrity, the possibility of functioning of the object of cultural heritage in modern conditions. The method of contrasts requires filigree execution, the possibility of its use is conditioned by the peculiarities of the monument, its degree of preservation, stylistics and admissibility of fundamental changes. For example, often the design code does not allow the use of materials and methods that argue with the historical connotation. For example, on 26.10.2023, deputies of the Tambov City Duma approved amendments to the rules of land use and development of the regional center. The regulations stipulate strict requirements for decoration materials and architectural solutions. Bright colors, solid and colored glazing, the use of modern siding, concrete slabs and metal profiles are prohibited. Small architectural forms should correspond to the spirit of the historical era, and posters should not contrast with the existing urban environment [1, 3].

### **Results and discussion**

The modern interpretation of historical decoration is universal and allows the restoration architect to act with great scope. The interrelation of new and historical elements is a creative process that has no universally accepted approach.

The site between the Shorshorov House (9 Kommunalnaya Street) and the former revenue house (14 Kommunalnaya Street) was chosen for consideration. This space is now occupied by a pizzeria "Dodo Pizza" (Figure 1) and a stationery store "Topol". Ventilated facade, wood and siding panels, metal element for signage, continuous glazing, and arched decorative elements were used. The façade design does not relate to the adjacent historic development and violates the October 2023 land use regulations.

Three facade variants were executed as an example of the use of different adaptation methods.



*Figure 1 - Pizzeria, located between the buildings at 9 Kommunalnaya St. and 14 Kommunalnaya St.*

The stylization option is a borrowing of the principles of previous eras (Figure 2). As an approach to the facade configuration, the principle of symmetry is chosen, as the adjacent facades of the buildings are symmetrical. The main entrance is highlighted by rustication on both sides, the shape of the windows as well as the glazing corresponds with the historical one. The building has a frieze with

rectangular decorative elements. The volumes have a vertical division defined by the likeness of gables. Horizontally, the lines of the building extend the guides of the existing historic building: the interstorey cornice is juxtaposed with the entablature of the new building, the plinths of all three buildings are at the same level, and the rustication also has a single repeating configuration.



*Figure 2 -Use of stylization method*

Contrast of epochs allows to combine new and historical buildings in the same space (Figure 3). Contrast can be expressed in different ways. Here is an example of contrast of forms and material. All the buildings on the selected site are mostly made of brick, while this example is made of wood. The combination is achieved through glazing, which makes the object lighter and less prominent.



*Figure 3 - Using the contrast method*

The combination of new and historical elements brings together already immortalized principles and new views. Thus, in Figure 4, the main elements of stylization have been retained: historical glazing, duplication of the rails of the interstorey cornice and their transition into the entablature of a single-storey building, the height of the plinth and its highlighting with color, and rustication. However, the decorative elements were simplified, instead of symmetry the principle of minimal intervention was proposed and it was decided to retain the existing arrangement of commercial premises with their entrances. A spiral staircase was also added, and the roof was proposed to be used as a summer café or viewing platform-photo-zone.

The realization of restoration and adaptation projects is important. It should be noted that the restoration and adaptation of architectural monuments for modern functions should be carried out in an integrated manner.



Figure 4 - The method of modern interpretation of historical decoration

## Conclusion

Since historical territories are part of people's everyday life, their harmonious combination with modern reality is the basis for urban development. The main principle in choosing methods of transformation of the historical environment is the preservation of its semantic and visual-aesthetic value.

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## СПОСОБЫ ПРИСПОСОБЛЕНИЯ ОБЪЕКТОВ КУЛЬТУРНОГО НАСЛЕДИЯ ДЛЯ СОВРЕМЕННОГО ИСПОЛЬЗОВАНИЯ

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**Аннотация:** Рассмотрены возможности сосуществования новой и исторической застройки в одном пространстве, а также проблемы современного использования, сохранения и приспособления объектов культурного наследия. Проведен анализ существующей ситуации выбранного участка исследования для включения современной застройки в исторический контекст, выявлены находящиеся на территории памятники архитектуры. Рассмотрены основные методы подходов к решению задач интеграции. Исследованы способы формирования фасадов вновь возводимых зданий относительно окружающей их градостроительной среды и назначения. С учетом совокупности элементов окружающих зданий разработаны различные варианты подхода к формированию фасада современного строения в исторической среде. На основе конкретной ситуации приведены примеры новых объектов. Выбор конкретного метода зависит от множества факторов, целью преобразования исторической среды является обеспечение её целостности в смысловом и визуальном значении.

**Ключевые слова:** историческая застройка, контраст, объект культурного наследия, интеграция, стилизация.

## VEHICLE POSITIONING BASED ON A NETWORK OF TRANSPONDER TAGS

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### **Abstract**

Recently, more and more cars have been appearing on the roads and their movement in the urban environment is only becoming more complicated. Based on this, it is necessary to develop the most effective system for recognizing and controlling the movement of vehicles in order to identify the dangerous driving style of some drivers, the busiest sections of the highway, the location of some vehicles to calculate their exact arrival time and come up with solutions to the identified problems. Eventually, it is planned to create a system for obtaining reliable information from radar sensors and transponder tags.

**Keywords:** transponder label, transponder of sensing, vehicle transponder tag.

The use of radar devices in cars is due to the following main properties of such devices. Radars function in all weather conditions, even such adverse ones as heavy rain and fog, radar signals can penetrate obstacles. While a human driver can only look in one direction at a time, radar sensors work simultaneously and scan different directions; the results from all of them can be displayed in the driver's field of view on the windshield (windshield display system).

The technology of using radar devices in automotive technology is based on the use of multiple frequency modulation (FMCW) radars with a dynamically variable radiation pattern. Most modern systems can even process probing signals and echoes from radar sensors of other machines. Such devices are connected to additional sensors such as infrared cameras or lasers [1].

To create a model for recognizing a moving object, transponder tags are installed in the city. Data systematization is provided by filtering in the state space.

According to available data, the GPS navigator will be detected in an open area for 5 months and will be able to produce large. When the signal is re-reflected, a diffraction effect occurs, which implies the formation of dead zones, and they, in turn, can also be noisy.

To reduce uncertainty, reading data from stationary sensors using a code response is used. However, the accuracy of location determination using satellites may be low. In combination with the active location detection method with an active response, a special high-precision method for measuring angular coordinates can be used. The phase method is based on measuring the phase difference of electromagnetic oscillations received by two antennas. The output voltage of the phase detector will be determined only by the phase difference of the oscillations (the amplitudes of both oscillations at the detector inputs can be considered the same).

This method is the most common method of geodetic location of an area and is used in almost all light and radiometric devices. It allows you to track targets, but pays off with low resolution.



However, when using different frequencies in transponders, this can be solved [3]. The ambiguity of measuring angular coordinates by phasing is eliminated by using narrowly directional antennas in the direction finder. In addition, when using a modulating signal with a sufficiently free choice of frequency to measure the phase difference, rather than a carrier signal, there are good opportunities for this.

In addition, the possibility of the influence of the Doppler frequency difference between the two channels was investigated. But in the situation under consideration, this effect may be insignificant, since the phase shift will be small. Modeling has shown that with small object sizes, this value can be ignored. Modeling has shown that with small object sizes, this can be ignored. Localization using a range of radars can most accurately determine the location of the desired vehicle, and if there are several tags at once, you can even cut off the noise component and thereby increase the signal-to-noise ratio, improving the search

Radars of the type in question operate in the frequency range of 24 GHz (K-band). The developed system will improve the structure and safety of the environment and will be able to provide a forecast of certain events that may occur on the roadway. The model has the property of interchangeability of sensors due to the similarity of parameters and is the most mobile for combining many situations

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## ПОЗИЦИОНИРОВАНИЕ ТРАНСПОРТНОГО СРЕДСТВА НА ОСНОВЕ СЕТИ МЕТОК-ТРАНСПОНДЕРОВ

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**Аннотация:** В последнее время на дорогах появляется все больше автомобилей, и их передвижение в городских условиях становится только сложнее. Исходя из этого, необходимо разработать наиболее эффективную систему распознавания и контроля движения транспортных средств, чтобы выявить опасный стиль вождения некоторых водителей, наиболее загруженные участки шоссе, местоположение некоторых транспортных средств, рассчитать их точное время прибытия и предложить решения выявленных проблем. В конечном итоге планируется создать систему получения достоверной информации с радарных датчиков и меток-транспондеров.

**Ключевые слова:** метка-транспондер, метка-транспондер зондирования, метка-транспондер автотранспорта.

## COLIVING AS A METHOD FOR ORGANIZING LIVING SPACE

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### Abstract

The study aims to investigate coliving as a form of cohabitation, its relevance, classifications and organizational principles. The paper explores the concept of coliving as a new way of organizing living space. Coliving is a modern form of cohabitation where people with different interests and professions rent a common living space and share common spaces and resources.

**Keywords:** coliving, living together, living space, social connections, quality of life.

Coliving is a form of cohabitation in which people rent common housing and share space and resources. Coliving as a kind of cohabitation comes in different forms. Today, in the world, coliving is organized around the principle - "to create a strong community with common values and interests". Coliving space usually has common areas, such as a kitchen, living room and bathroom that residents share. Each has its own bedroom, but the rest of the space is shared. [1]

Today, coliving has become a popular choice not only for young professionals, students and artists, but also for the elderly. They represent not only cozy accommodation, but also the opportunity to communicate with different people, share experiences, find support and even find new partners for projects.

There are several varieties of coliving, which differ in the organization of the living space. One of the most popular forms of coliving is communal apartments. In such rooms, tenants rent separate rooms and a common kitchen, bathroom and other spaces. Communal apartments are often chosen by young people or students who want to save on rent and create a social environment.

Another type of coliving is coworking. These are modern workspaces where people rent jobs and share common areas for work and leisure. Coworkings offer a more convenient solution for freelancers, entrepreneurs and anyone who works remotely. Here you can not only work, but also communicate with other people, share experience and find new partners.

There are also specialized coliving for certain groups of people, such as travelers or young families. Such coliving areas offer not only accommodation, but also additional services such as a common dining room, laundry and playground. Coliving varies in comfort and degree of community.

Take for instance "Bettersea Place" for the elderly, which is located in the heart of London, in the area of Battersea. Tenants of the coliving housing are united by the common life. It consists in a variety of activities. The residents of this private club play bridge in the evenings, listen to music, watch movies, show each other family photos, entertain guests and much more that the community manager will come up with. But privacy is always possible, if not in your apartment, then in the library.

Located west of London, the "High Street House" coliving housing consists of 12



micro-apartments and common rooms. It consists of coworking space on the ground floor, which also serves as a venue for events such as seminars, exhibitions and discussions. In addition, the house has a spacious kitchen, dining room, laundry and stairs that serve as a common library.

An interesting example of coliving was created on the principle of permaculture. In England there is permacultural commune "Lilac". Its houses are energy-efficient, built of straw panels, are jointly owned by all members of the community. There is a common laundry, dining room, common hall for joint activities. All this is harmoniously integrated into the natural environment. There is a joint pond, a forest garden and the opportunity for each individual to grow organic vegetables. Many unusual rational solutions to the organization of space and human relationships have also been applied.

Compact housing and large public areas - is implemented in a coliving project set up by The Collective in northwest London. The design room is small (10 square meters), with a small common kitchen. But on the 11th floor there is a bar, a restaurant, a movie theater, a spa, a gym, a rooftop terrace, a spacious living room with a kitchen where you can make friends and have fun, as well as common areas such as a library that also serves as a working area. [2]

The "TSH" coliving housing is located in Amsterdam in the Netherlands. This community is a mixture of hotel, apartment, club, office and entertainment space. This format was created to encourage residents to communicate. For this purpose, "TSH" organizes recreation areas, gazebos for listening to lectures, billiard tables and 24-hour dining rooms. Tenants can stay here for two weeks to 12 months, but the community also encourages the use of restaurants and playgrounds to maintain the spirit of integration.

"Flacon Community Village" is located in the Moscow region in Russia. The village is a new format where you can live, work and relaxes. It is a creative space without walls and fences with original architecture, interesting events and like-minded neighbors. The connecting spaces in this koliving are coworking, office and lecture hall.

The village of programmers is located in the Slobodsky district of the Kirov region on the shore of a large pond. Around the forest and several small rivers. Mostly cottages are purchased here for permanent residence and remote work by developers and designers. So far, nine families live in the commune. The village has many small houses made of timber, and you can buy a plot of land. However, in order to buy a property in the community of programmers, you need to pass a personal interview with already living here. [3]

In addition, there are also a number of significant advantages over traditional forms of cohabitation. First, they significantly reduce the cost of housing and utilities through collective payments. Secondly, by providing a diverse infrastructure and a vibrant social life, they create conditions for comfortable living and development. [4]

Thus, new forms of cohabitation offer not only low-cost housing, but also comfortable spaces for interaction, development and communication. Co-living has its own characteristics and requires a certain adaptation. Residents should be open to socializing and participating in collective life. It was also important to establish rules

for cohabitation and to respect the privacy of other residents.

The incredible dynamism and energy of coliving make it an ideal choice for those who want not only to find a roof over their heads, but also a real family and the ability to realize their needs and ambitions.

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## КОЛИВИНГИ КАК СПОСОБ ОРГАНИЗАЦИИ ЖИЛОГО ПРОСТРАНСТВА

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**Аннотация:** Представлен анализ организации жилого пространства в форме коливингов. Выявлена актуальность данного формата, представлены классификации и принципы организации такого типа жилья. Исследуется концепция коливингов как нового способа организации жилого пространства. Коливинги представляют собой современную форму совместного проживания, где люди с разными интересами и профессиями снимают общую жилую площадь и делятся общими пространствами и ресурсами.

**Ключевые слова:** коливинги, совместное проживание, жилое пространство, социальные связи, качество жизни.

## BASIC PRINCIPLES OF BUILDING MODULAR HOUSES FROM SHIPPING CONTAINERS

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### Abstract

This article presents the use of sea cargo containers as housing. The main design features of the container house used in low-rise modular construction are shown. At all times the creation of comfortable and functional housing was the main task in construction. Today, a container house is one of the most economical ways to create the necessary conditions for human life, and also serves as an example of solving many modern environmental problems. Autonomy and energy efficiency of the house are important factors that guarantee its popularity for many years.

**Keywords:** housing, modular home, constructor, shipping container, sustainability.

A house from a shipping container is an innovative solution that is becoming increasingly popular in modern construction. They are metal boxes that are used in international cargo transportation, and today have an active application in residential construction as well.

Container houses have a great number of advantages in terms of sustainability and ecology. A second life for shipping containers can reduce construction costs as they are already manufactured and do not require additional materials. Containers can also be energy efficient and equipped with all the necessary engineering systems for comfortable living.

The design of a container home is based on the use of modular shipping containers, usually in standard sizes of 20 or 40 feet [3]. The future dwelling can consist not only of one container, but also of 2-3 containers, which allows to create entire compositions.

The main structural elements of a container house include:

1. Shipping containers: serve as the main building volume of the container house. Containers have a sturdy metal construction that can support the weight of other containers as well as climatic loads.

2. Insulation: the temperature inside the container depends on the climatic conditions, as the metal structure is heated or cooled, depending on the temperature of the air on the outside of the container. Therefore, it is necessary to take measures to insulate all additional structures: walls, floors and ceilings, to ensure comfortable living conditions.

3. Interior finishing: after the container is insulated, interior finishing is carried out. New partitions are erected for functional zoning of the future house. For finishing the room are used different materials, based on individual preferences.

5. Roof: it is not always enough just to put the container, you need all the necessary measures to protect the future home from adverse weather conditions, so the container house can be installed a roof. Basically flat roofing is used, it does not distort the proportions of the container. [1]



*Figure 1 - The design scheme*

6. Windows and doors: in the original form of the container is a closed space, so to create comfortable living conditions in the metal base of the container cut out holes for future windows and doors, which provides natural light and the possibility of entry.

7. Ventilation and systems: as in any room, so in the container is necessary to install air ventilation system, so the container house should be equipped with vents, heating system for living in all seasons and air conditioning.

All of the above elements of the container house guarantee a comfortable living environment.

Advantages and disadvantages of a container home:

Advantages:

1. Low cost of construction: by utilizing an existing container, construction costs are minimal.

2. Mobility: the shipping container can be easily transported to any location when needed.

3. Environmental friendliness: recycling shipping containers as living quarters greatly reduces the consumption of resources and building materials.

4. Durability: with proper maintenance, these homes can last more than 20 years. However, the number of years depends on the initial condition of the container itself.

Disadvantages:

1. Limited space: shipping containers have standardized dimensions, which significantly limits a person in erecting such a house. However, it is possible not to be limited to just one container when building, but to use several boxes, assembling a constructor from them.

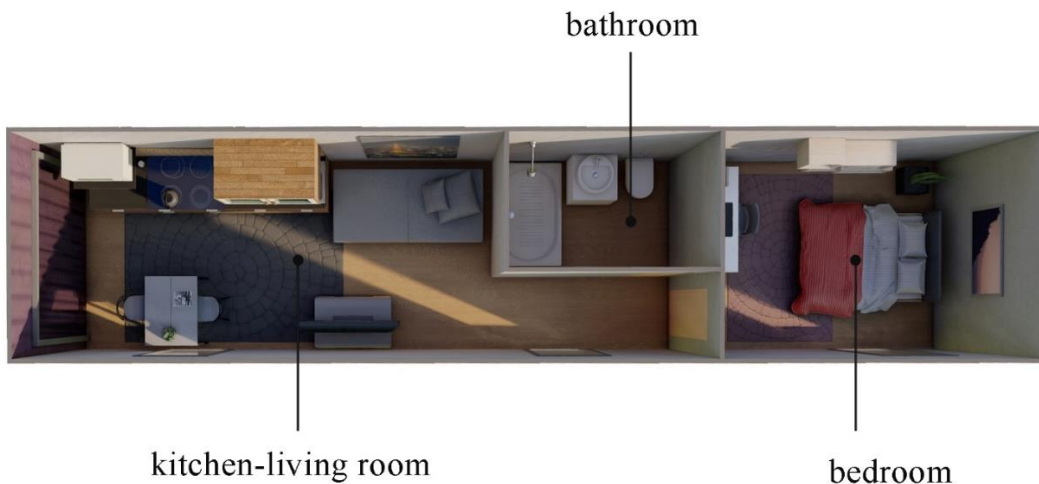
2. Insulation: it is not enough to just put up a container, additional structural elements must be brought in for comfortable living.

3. Corrosion: since the container is completely metal it is prone to corrosion when in a humid environment. Corrosion can be prevented by regular painting of the container.

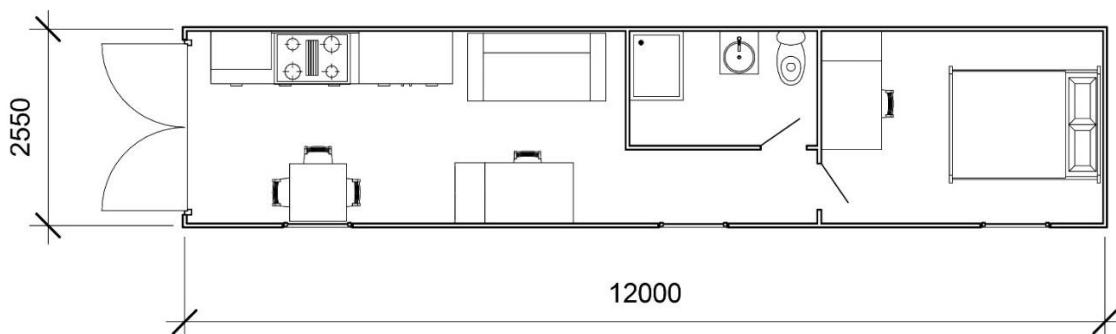
Below is an example of using a 40-foot shipping container as a living space.



*Figure 2- General view*



*Figure 3- Top view*



*Figure 4- Layout*

One of the main advantages of using sea containers as housing is their mobility. Transportation and installation does not take a lot of time, so the container can serve

as a temporary residence, and for permanent. The cargo container can be used not only as a living space, but also for public spaces (modular hotel, office)

The technology of construction from shipping containers not so long ago appeared on the construction market and in Russia is not popular in the field of low-rise housing. Therefore, many private developers do not trust this format of housing. However, many foreign architectural bureaus have been creating modern projects of residential houses from shipping containers for several years, thus confirming their reliability, durability and practicality.

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## ОСНОВНЫЕ ПРИНЦИПЫ СТРОИТЕЛЬСТВА МОДУЛЬНЫХ ДОМОВ ИЗ ГРУЗОВЫХ КОНТЕЙНЕРОВ

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**Аннотация:** Описаны возможности использования морских грузовых контейнеров в качестве жилья. Показаны основные конструктивные особенности дома-контейнера, применяемые в малоэтажном модульном строительстве. Во все времена создание комфортного и функционального жилья являлось основной задачей в строительстве. Дом – контейнер сегодня является одним из самых экономичных способов создания необходимых условий для жизни человека, а также служит примером решения многих современных экологических проблем. Автономность и энергоэффективность дома являются важными факторами, гарантирующими его популярность на протяжении долгих лет.

**Ключевые слова:** Жилье, модульный дом, конструктор, грузовой контейнер, экологичность.

## SMART CITY: VEHICLE POSITIONING BASED ON A NETWORK OF TRANSPONDER TAGS

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### Abstract

The article is devoted to the study of road safety monitoring systems. The analysis proved that systems currently in use are capable of reading most violations. It is assumed that any such system will necessarily be based on radar to determine the coordinates and position of the vehicle, as well as a video recording camera that continuously records violations, depending on the purpose of the system.

**Keywords:** transponder tag, Global Positioning System (GPS).

The goal of creating a "smart city" is set to solve the problems of improving the safety of a vehicle with automated traffic control, by developing methods and algorithms for the functioning of a network of radio sensors ("transponder tag"), and navigation channels that take into account the physical characteristics of the traffic environment for their work to increase the accuracy and stability of coordinate estimation and movement parameters, coordinates and movement parameters of the accomplices of the movement, as well as a quantitative assessment of the degree of danger to the vehicle emanating from the accomplices of the movement.

To achieve the goal, the following tasks are set:

1. Evaluate the pros and cons of using a transponder tag;
2. Improve the quality of safe driving on the road;
3. Analysis of the research results.

The use of transponder tags will help to avoid traffic accidents on the roads and build a safe route. Also, using the transponder tags, you can switch completely to autonomous driving, which will improve real-time control on the road.

The principal feature is that vehicle numbers are recognized throughout the entire control area. The video archive and data on recorded violations are stored in the memory of the photoradar unit and can be transferred to the data center via secure wired or wireless communication channels for subsequent centralized processing. The data on the violation also includes the recognized number, the recorded speed of the vehicle, the type of violation, the direction of movement, the date and time of the violation, the value of the maximum permissible speed on this section of the road, the name of the controlled section, geographical coordinates, and the serial number of the complex. [1, 5 c.]

The position of the vehicle on a public road is determined using a video camera and a processing system, in the algorithm of which the boundaries of the lanes and the area of the carriageway are clearly entered, the presence of which is considered a violation of traffic rules.

The advantage of this complex is the infrared illumination for working at night,

which allows it to remove violations even at night. But the disadvantage of video cameras is that they cannot function normally in harsh weather conditions. Heavy fog or snowfall makes it difficult to video record violations and such a complex becomes unusable.

Transponder tags have pros and cons. Systems based on optical cameras and LiDAR do not work effectively in weather conditions. The radar works much better in such conditions, but its resolution is low to accurately assess the trajectory of a vehicle maneuver. Using GPS will also not be the best option, as it has low accuracy due to dense urban development, or due to unclear weather. Localization using the MTA and MTZ radar range can make it possible to accurately determine the location of urban transport. Using this method will also allow you to transmit information not only about the location, but also makes it possible to calculate mileage, fuel consumption and other functions. [2, 1 c.]

With the improvement of transponder tags, it will also be possible for the car to receive information about which hotels, workshops, shops and gas stations are nearby. This will allow you to always have an idea of what is around and choose a more suitable option for further movement. Figure 1 shows what a transponder tag might look like.



*Figure 1 - Example of a transponder tag*

If you use more tags, you can increase the radar field that these tags form. As a result, even with a small amount of measurement data, it is possible to more accurately estimate the location of the vehicle for further operations.

It clearly follows from the review that radar technology has significant advantages over other competing technologies. Thus, the transponder tag based on radar technology allows not only to respond quickly, accurately and effectively to the movement of an unmanned vehicle, but also allows you to choose the most optimal and safe route for movement in real time.

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## **УМНЫЙ ГОРОД: ПОЗИЦИОНИРОВАНИЕ ТРАНСПОРТНОГО СРЕДСТВА НА ОСНОВЕ СЕТИ МЕТОК-ТРАНСПОНДЕРОВ**

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**Аннотация:** Статья посвящена исследованию систем мониторинга безопасности дорожного движения. Проведенный анализ показал, что используемые в настоящее время системы способны считывать большинство нарушений. Мы предположили, что любая такая система обязательно будет состоять из радара для определения координат и положения транспортного средства, а также камеры видеозаписи, непрерывно фиксирующей нарушения, в зависимости от назначения системы.

**Ключевые слова:** метка-транспондер, глобальная система позиционирования (GPS).

## ARCHITECTURAL TRADITIONS OF ORTHODOX CHURCHES OF TAMBOV PROVINCE OF THE 18TH- EARLY 20TH CENTURIES

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### Abstract

The main architectural style of the church stone architecture of the Tambov diocese since the end of the 18th century has been classicism. The external appearance of the temples was characterized by porticos, triangular pediments, the silhouette of the crowning part was formed by a five-domed with a tiered covering of the heads. The plastered facades had a two-tone finish with colored surfaces and white architectural details. Manor churches, the construction of which has been intensified since 1765, were built according to the exemplary designs of the most famous architects of the capital. One of the examples of manor temple construction in the classical style is the Church of the Resurrection of Christ in Gagarino village (Pichaevsky district, the Tambov region), recognized as an object of cultural heritage. The grandiose temple, cruciform in plan, is completed with a traditional five-domed wedding, side chapels and a refectory adjoin the main volume, the western facade is flanked by two symmetrical bell towers completed with spires. The side facades of the temple are decorated with six-column porticos and a triangular pediment. Currently, the temple is in a dilapidated state, but with all the losses it has preserved the original three-dimensional structure, the integrity of perception, is a genuine example of classicism architecture of manor religious buildings, represents a high-rise dominant. The Church of the Resurrection of Christ in the village of Gagarino requires conservation and further restoration work.

**Keywords:** Orthodox Church, domed five-domed building, classicism, columned porticos, cruciform plan, exemplary projects, cultural heritage site.

By the opening of the Tambov Diocese in 1682, there were 186 parish churches in the region. At the same time, there were about 2,000 parishioners in each parish. And by 1873, there were already 1,103 churches and 18 monasteries in the diocese, in 1913 – 1,500 churches and 30 communities and monasteries.

Since the 13th century, wooden Orthodox churches have been built in the Tambov Region. Stone churches began to be built from the middle of the 18th century. The exception was the Transfiguration Cathedral, which was laid in stone in 1694.

The church architecture of the Tambov Diocese from the 1770s to the first legislative regulation of church construction in 1825 represents architecture in the classical style [1].

The first Tambov church, created in the image and likeness of the Assumption Cathedral in Ryazan, was the Transfiguration Church, the construction of which began in 1694 by Bishop Pitirim of Tambov, but was completed only in 1783, subsequently the appearance of the temple was changed, and in 1839-1840 a two-story porch was added to the cathedral. The style of the temple can be attributed to the Baroque, given the techniques of window decoration.

The Churches of the Nativity of John the Baptist in the Forerunner-Tregulyaev Monastery (1808 – destroyed in Soviet times) and the Kazan Icon of the Mother of

God (1831) of the Vyshenskaya Desert belong to mature classicism. The plastic of these temples is distinguished by the presence of columned porticos, the absence of rust and the characteristic stucco decoration on the windows. In all these temples, the silhouette of the crowning part is a prerequisite: a five-domed completion with a double repetition of the tiered covering of the chapters.

At the beginning of the 19th century, a single type of five-domed cathedral, decorated with characteristic porticos with double columns and an arch in the entablature resting on them, became widespread in the county towns. It is assumed that the Trinity Cathedral in Ranenburg (1806-1818, now the city of Chaplygin, Lipetsk region), the Transfiguration Cathedral in Spassk (1819, demolished), the Assumption Cathedral in Kirsanov (1820, demolished) and the Kazan Cathedral of the Vyshenskaya Desert (1831-1844, Ryazan region.) were built according to similar designs, having a common source from the circle of architect N.A. Lvov. In Tambov cathedrals, there is a direct correlation between the use of porticos with arched spans and their symbolic significance in the context of the urban environment. Such cruciform cathedrals had plastered facades painted in two colors: the main volume of the walls – in any color, and architectural details (columns, cornices, etc.) - in white (Fig. 1).

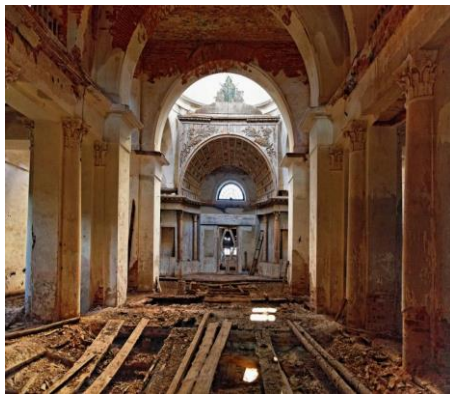


*Figure 1 - Church architecture of the Tambov diocese in the classical style (Spaso-Preobrazhensky Cathedral in Tambov, Trinity Cathedral in Ranenburg)*

At the end of the 18th century, the active construction of manor churches began. This is due to the publication by Catherine II of the Letters Patent to the Russian nobility in 1762 and the Manifesto on the general delimitation of lands in 1765, which allowed the nobles to acquire their own land plots and carry out large-scale manor construction on their estates. The most popular examples for the construction of manor churches were the projects of the most famous architects of the capital V.I. Bazhenov and M.F. Kazakov [2]. At the beginning of the 19th century, for the first time, a unified approach was taken in the field of temple construction: there is a direct instruction to build temples according to exemplary drawings. The projects from the album "Collection of plans, facades and profiles for the construction of stone churches" in 1824 began to be used both in the construction of churches in county towns and on the territory of villages and landlords' possessions.

In the Tambov province, many churches were built using parts of exemplary projects made in the classical style (classicism). In the temples, the traditional five-domed ancient Russian classicism turned out to be combined with ancient forms. Classicism is characterized by the elegance of the strict lines of the exterior, the lack of splendor of the exterior, the relative simplicity of the stone decoration with the use of only a few decorative elements. Until the beginning of the 20th century, classicist traditions dominated the temple architecture of the Tambov diocese.

One of the examples of manor temple construction in the classical style is the Church of the Resurrection of Christ in Gagarino village (Pichaevsky district of the Tambov region). The church was built in 1833 at the expense of landowner A.A. Pashkov [3].



*Figure 2 - Church of the Resurrection of Christ in Gagarino village (1833)*

The stone temple composition, cruciform in plan, is a quadrangle bearing a traditional five-domed wedding. The main volume is flanked by side chapels from the north and south, a rectangular refectory, the western facade is flanked by two symmetrical bell towers completed with spires. The side, eastern and western facades of the temple are decorated with six-columned porticos and a triangular pediment (Fig. 2). The inner volume of the quadrangle, divided by four pillars, is covered with domed vaults. The inner surface of the arch above the altar is decorated with coffers, richly decorated with elements of floral ornament. The entablature supporting the arch is supported by elegant columns of the Corinthian order. The Church of the Resurrection of Christ was one of the largest religious buildings in the Tambov diocese, accommodating up to 3 thousand people. In the 1930s, the church was closed and used as a warehouse.

According to the Order of the Department for the State Protection of Cultural Heritage Objects of the Tambov region dated 11/13/2023 No. 353, the Church of the

Resurrection of Christ (Tambov region, Pichaevsky district, Gagarino village 1st, Yuzhnaya str., 2b) is an object of cultural heritage of regional significance.

Currently, the temple is in a dilapidated state, the roof, dome coverings, roof are destroyed, the decor of architectural elements is partially lost inside. Brick facades are being destroyed. When exposed to atmospheric precipitation, there is still the possibility of loss of bearing capacity by arches and columns.

Nevertheless, with all the losses, the temple has preserved its original spatial structure, the integrity of perception, and is a genuine example of the architecture of manor religious buildings in the classicism style of the first third of the 19th century. In addition, the building is a high-rise dominant, organizing the space of a village with a single-storey building and the surrounding natural environment. The Church of the Resurrection of Christ in the village of Gagarino requires conservation and further restoration work.

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## АРХИТЕКТУРНЫЕ ТРАДИЦИИ ПРАВОСЛАВНЫХ ХРАМОВ ТАМБОВСКОЙ ГУБЕРНИИ XVIII – НАЧАЛА XX ВЕКОВ

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**Аннотация:** Главным архитектурным стилем церковной каменной архитектуры Тамбовской епархии с конца 18 века являлся классицизм. Внешний облик храмов характеризовался портиками, треугольными фронтонами, силуэт венчающей части формировался пятиглавием с поярусным покрытием глав. Оштукатуренные фасады имели двухцветную отделку с цветными поверхностями и белыми архитектурными деталями. Усадебные церкви, строительство которых активизировалось с 1765 года, возводились по образцовым проектам известнейших столичных зодчих. Одним из примеров усадебного храмового строительства в стиле классицизм является Церковь Воскресения Христова в с. Гагарино (Пичаевский район Тамбовской области), признанная объектом культурного наследия. Грандиозный храм, крестообразный в плане, завершен традиционным пятикупольным венчанием, к основному объему примыкают боковые приделы и трапезная, западный фасад фланкируют две симметричные колокольни, завершенные шпилями. Боковые фасады храма украшены шестиколонными портиками и треугольным фронтоном. В настоящее время храм находится в полуразрушенном состоянии, однако при всех утратах сохранил первоначальную объёмно-пространственную структуру, целостность восприятия, является подлинным образцом архитектуры классицизма усадебных культовых зданий, представляет высотную доминанту. Храму Воскресения Христова в селе Гагарино требуются работы по консервации и в дальнейшем – восстановлению.

**Ключевые слова:** православный храм, купольное пятиглавие, классицизм, колонные портики, крестообразный план, образцовые проекты, объект культурного наследия.

## RUSSIAN-BYZANTINE STYLE IN TEMPLE ARCHITECTURE

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### **Abstract**

The paper studies the process of the emergence of the Russian-Byzantine style in temple architecture, as well as searches for the origins of architectural imagery of the Church of the Resurrection in the village of Staraya Olshanka, Uvarovsky district, Tambov region.

**Key words:** object of cultural heritage, Russian-Byzantine style, temple architecture, church.

*“The temple is the line connecting the earth with the sky, or the earthly sky. It is where the true element of our souls is present; here our spiritual food is...”*  
*Holy Righteous John of Kronstadt*

Temples, churches, bell towers and their ensembles, like any other result of architectural creativity have their own artistic appearance. Humanity has inherited a large number of architectural ensembles most of which have cultural and architectural value.

The architects of those times had the ability to realize their ideas in a specific format. Our ancestors built churches, temples, bell towers and other structures in such a way that they could describe the entire world around us, all its relationships, order, measures and similarities. The building radiated reliability, calm and harmony into the surrounding space which were transmitted to the person, setting him in the appropriate mood.


The “Russian-Byzantine style” was based on the fact that it was from Byzantium that Ancient Rus adopted Christianity and it was from there that the canon of the cross-domed four-pillar temple came [1]. The essence of the style is to create an architectural image based on a symbiosis of forms of medieval Russian architecture and elements of Byzantine architecture. The founder of the Russian-Byzantine style is considered to be the architect Konstantin Ton.

Pattern-characteristics were taken from the end of the 18th – 19th centuries to the turn of the 19th – 20th centuries from the architectural direction in order to clearly trace and understand which direction of architecture dominated before and after the Russian-Byzantine style. Eclectic, “Russian-Byzantine” architecture of the mid-19th century: the use of architectural motifs from different eras; mechanical use of elements of Byzantine and Old Russian architecture in external design.

Studying the process and principles of formation of the architecture of the “Russian-Byzantine style” of the Church of the Resurrection in the village of Old Olshanka is impossible without considering the origins of such structures in the world practice of architecture (Table 1) [2].



Table 1 – Study of imagery

<p>1.</p>	<p>Dome, central drum</p>	   <p><i>Temple of the Resurrection Christova 1795 p. Nikolskoye Tver region</i></p> <p><i>Jerusalem Rotunda Resurrection IV century. Jerusalem</i></p> <p><i>Church of the Beheading chapters of John the Baptist, 1529</i></p>
<p>2.</p>	<p>Bell towers, massiveness, zakomary</p>	   <p><i>Church of the Beheading of John the Baptist, 1529</i></p> <p><i>Alexander Nevsky Cathedral, 1861 Paris</i></p> <p><i>Cathedral of St. Apostle Paul, 1823 Gatchina, the Leningrad region</i></p>
<p>3.</p>	<p>Gable completion of arches</p>	   <p><i>Cathedral of St. Paul the Apostle</i></p> <p><i>Church John the Baptist</i></p> <p><i>Alexander Nevsky Cathedral</i></p>

The analysis of exemplary construction of churches in the Russian-Byzantine style [3].

Features of the Russian-Byzantine style in the volumetric layout of temples:

- four-pillar cross-domed type of temple with a large central dome and four small domes at the corners;
- mandatory five-domed structure (for small churches - one dome);
- strict centricity of the plan and facades;
- mirror symmetry of facades;
- sculpture of the facades - elaboration of all the details on the facades

The following characteristic features can be identified in the detailing of a temple of this style:

- disappearance of porticoes and other classical forms from facades;
- the use of architectural elements characteristic of Byzantine, as well as Russian architecture of the pre-Petrine era (semicircular arches and arched openings, keel-shaped zakomaras, stepped entrance portals, massive columns and pilasters);
- massiveness and weightiness of architectural forms.

Russian, Orthodox people have their own symbolism in everything.

The Church of the Resurrection in the village of Staraya Olshanka is a unique phenomenon in the temple architecture of the 40-50s of the 19th century. This red brick church stands out from a number of monuments of temple architecture with its largely unusual layout, as well as the use of non-standard construction solutions, developed thanks to the close cooperation of architect R.N. Kuzmin and artist K.A. Moldavsky.

Unfortunately, over the last three quarters of the last century, during the period of Soviet power, a large part of the wealth of expressive silhouettes of church architecture was lost, thousands of temples, churches and bell towers were destroyed, wiped off the face of the earth, many of the richest traditions of religious architecture that had developed over centuries, the principles and methods of their formation were also lost.

At the present stage, there is an active development of architectural activity and the rise of an entire branch of church construction and many forgotten cultural traditions in the spiritual revival of the country.

*The Church unites everyone not in the name of achieving political or any other human goals, but only for the sake of the eternal salvation of people, which begins here on earth through the establishment of a peaceful and fair life for all.*

*His Holiness Patriarch Kirill*

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## **РУССКО-ВИЗАНТИЙСКИЙ СТИЛЬ В ХРАМОВОМ ЗОДЧЕСТВЕ**

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**Аннотация:** Целью работы является изучение процесса зарождения русско-византийского стиля в архитектуре храмового зодчества, а также освещение с различных позиций истоков архитектурного образа церкви Воскресения Христова в селе Старая Ольшанка Уваровского района Тамбовской области.

**Ключевые слова:** объект культурного наследия, русско-византийский стиль, храмовая архитектура, церковь

## DEVELOPMENT PROSPECTS OF “STUDENT CAMPUS FOR TSTU” PROJECT

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### Abstract

Our country is on the path of updating and modernizing university student campuses, improving their functionality and comfort, as well as designing and building modern, innovative technology campuses throughout Russia. In this regard, the authors consider the possibility and feasibility of developing a modern campus project for TSTU. It is planned to place all the necessary facilities on the campus to create a comfortable educational, cultural and recreational student environment.

**Keywords:** TSTU campus, student, student environment, campus, university.

It is known that the surrounding space has a great influence on the educational activities of students. Recreation and communication of young people, walking distance to the necessary facilities, as well as the comfort of staying within the walls of an educational institution significantly affects the quality of student life. These factors significantly save the student's time and allow them to use it to a greater extent to improve their knowledge.

Currently, university campuses are found all over the world. Over the past 20 years, special attention has been paid to student campuses in Russia, which is largely due to the creation of research universities of federal significance. Such facilities are already operating in major cities such as Moscow, St. Petersburg, Tomsk, Kazan, Novosibirsk.

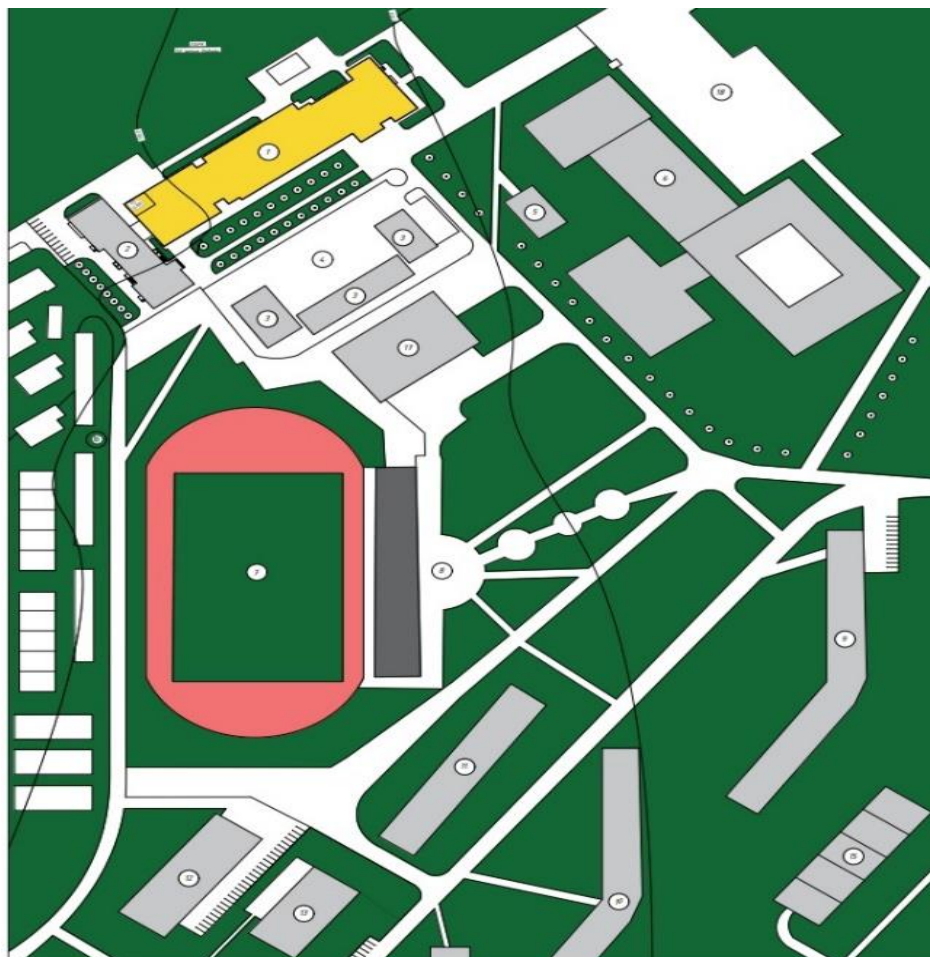
In 2023, the President of the Russian Federation instructed the Ministry of Construction and Housing and Communal Services of the Russian Federation to develop innovative projects and create a network of modern campuses for universities in our country by 2030. Within the framework of the project "Development of infrastructure for scientific research and training", according to the Resolution [1], work is actively underway to create "student campuses" [2].

The authors of the article are preparing for the development of a space-planning solution for the campus and the creation of an innovative comfortable educational environment for students of the Tambov State Technical University (TSTU), which will certainly increase the attractiveness for applicants not only of the Tambov region, but also of other regions.

The project of a modern multifunctional campus will be a complex of buildings united by recreational space.

At the moment, TSTU has 8 academic buildings, 4 dormitories, the Vernadsky technopark, as well as 2 recreation centers and sports facilities (stadium, swimming pool).

More than 9,5 thousand students study at the university, 55% of them study in buildings A, D, E at the address Michurinskaya 112. In this regard, the placement of the campus in a complex with these buildings is of priority importance. Also on the territory there is already a swimming pool "Vigor", a driving school of TSTU and dormitories. Dormitories do not have an attractive appearance and do not have comfortable living conditions. The general plan of the territory is shown in Figure 1.



*Figure 1 - General plan of the territory*

Multifunctional buildings will be located on the campus: modern dormitories, leisure space for students, research laboratories and centers equipped with innovative equipment and equipment, halls for various events and creative classes of students. All facilities will be connected by a landscaped territory with a park area, as well as pedestrian paths - arteries connecting different corners of the campus.

The exterior of the buildings will be a single architectural ensemble to emphasize the overall concept of the campus.

To create a modern and comfortable campus, it is necessary to rely on domestic and foreign design experience, selecting the most interesting ideas for the implementation of a campus project for TSTU.

Today, the construction of campuses in Russia is a promising and necessary direction. The construction of the NSTU campus will increase the research potential and the quality of the university's educational structure, as well as ensure a close

connection between the university and the urban environment. The existing foreign and domestic experience will allow us to create a modern campus for TSTU, which will have the most rational and effective design solutions.

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## ПЕРСПЕКТИВЫ РАЗРАБОТКИ ПРОЕКТА СТУДЕНЧЕСКОГО КАМПУСА ДЛЯ ТГТУ

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**Аннотация:** Наша страна идет по пути обновления и модернизации студенческих кампусов вузов, повышения их функциональности и комфортности, а также проектирования и строительства современных, инновационных по применяемым технологиям кампусов по всей территории России. В связи с этим авторами рассматривается вариант создания современного кампуса для ТГТУ, который будет представлять собой территорию, на которой расположены все необходимые объекты для создания комфортной образовательной, культурной и оздоровительной студенческой среды.

**Ключевые слова:** кампус ТГТУ, студент, студенческая среда, студенческий городок, университет.

УДК691.168

БК39.311

## GESCHICHTE DER ENTWICKLUNG VON NORMATIVEN DOKUMENTEN FÜR ASPHALTBETON IM STRAßENBAU

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### **Zusammenfassung**

Der Artikel zeigt eine Chronologie der Entwicklung von normativen Dokumenten für eine Asphaltbetonmischung in der Russischen Föderation. Es sind Ziele für die Entwicklung eines normativen Rahmens in diesem Bereich festgelegt.

**Schlüsselwörter:** (Autostraße, Asphaltbeton, Asphaltbetonmischung, design von Reisekleidung, normativ-technische Dokumente)

Asphaltbeton ist eines der beliebtesten Materialien in der Straßenbranche, das beim Bau und der Rekonstruktion von Autobahnen verwendet wird. Statistisch gesehen haben etwa 97 % der russischen Straßen eine nicht starre Konstruktion von Straßenkleidung mit einer Asphaltbetonbeschichtung. Die Auswahl dieses Materials basiert aufgrund der nicht hohen Kosten im Vergleich zu Zementbeton sowie der Arbeitszeiten, der Verarbeitbarkeit und der Wartbarkeit der Konstruktion von Straßenkleidung.

Um die Qualität und Zuverlässigkeit von Autobahnen zu verbessern, ändern sich die Anforderungen an die Ausführung von Arbeiten, Straßenbaumaterialien, einschließlich Asphaltbetonmischungen. Das erste normative Dokument mit den Anforderungen für Asphaltbeton von 1932 «Technische Bedingungen, Regeln und Vorschriften für die Untersuchung, Planung, Konstruktion, Reparatur und Wartung von Autobahnen und Brückenbauwerken» wurde später regelmäßig im Jahr 1938 als «Technische Bedingungen für den Bau von Autobahnen und Brücken» und 1945 «Technische Regeln für den Bau von Straßenbelägen aus heißem Asphaltbeton» veröffentlicht [1].

In Fortsetzung der Entwicklung der technischen Bedingungen wurden staatliche Standards für Asphaltbeton erlassen, nämlich:

1959 Jahr – GOST 9128-59 «Asphaltbetonmischungen (heiß) Straße. Allgemeine Anforderungen. Anforderungen an Materialien für ihre Herstellung»;

1967 Jahr – GOST 9128-67 «Mischungen aus Asphaltbeton (heiß und warm). Straße und Flugplatz. technische Voraussetzungen»;

1976 Jahr – GOST 9128-76 «Mischungen aus Asphaltbeton, Straßen-, Flugplatz- und Asphaltbeton. technische Bedingungen»;

1984 Jahr - GOST 9128-84 «Mischungen aus Asphaltbeton, Straßen-, Flugplatz- und Asphaltbeton. technische Bedingungen»;

1997 – GOST 9128-97 «Mischungen aus Asphaltbeton, Straßen-, Flugplatz- und Asphaltbeton. technische Bedingungen»;

2009 - GOST 9128-2009 «Mischungen aus Asphaltbeton, Straßen-, Flugplatz-

und Asphaltbeton. technische Bedingungen»;

2013 - GOST 9128-2013 «Mischungen aus Asphaltbeton, Polymersfaltobeton für Autobahnen und Flugplätze. technische Bedingungen».

Mit dem Ziel, einheitliche Prinzipien für die Produktion von öffentlichen Straßen zu bilden, im Jahr 2015 trat die technische Verordnung der Zollunion TR TC 014/2011 «Sicherheit von Autobahnen» in Kraft, und bereits im Jahr 2016 wurde ein regulatorisches Dokument für die Asphaltbetonmischung in Form des vorläufigen nationalen Standards von PNST 184-2016 «Öffentliche Straßen für Autos" veröffentlicht. Mischungen aus Asphaltbeton. Technische Bedingungen", und im Jahr 2019 - PNST 184-2019 "Öffentliche Straßen. Mischungen aus Asphaltbeton. Technische Bedingungen». Später im Jahr 2020 nach der Approbation PNST 184-2019 wurde in die Kategorie GOST R 58406.2-2020 «Öffentliche Straßen. Mischungen aus heißem Asphaltbeton. Technische Bedingungen» gültig für aktuelle Zeiten.

Im Laufe der Zeit änderten sich nicht nur die Vorschriften und Anforderungen, sondern auch die Sorten von Asphaltmischungen wurden geändert, und solche Mischungen wurden aktiv verwendet wie:

- schotter-Mastix;
- gegossen;
- kalte;
- warme;
- farbige;
- serasfaltobeton;
- nach dem System der räumlichen und funktionalen Gestaltung.

Die Entwicklung der normativen Dokumente zu Asphaltbetonen und der Konzeption von Mischungen und der Verwendung von Materialsorten zielt darauf ab, die Zuverlässigkeit und den Transport- und Betriebszustand der Straßenbekleidung zu verbessern, um die Verkehrssicherheit zu gewährleisten und die Reparaturzeit von Autobahnen zu erhöhen, was ein integraler Bestandteil des nationalen Projekts «Sichere Qualitätsstraßen» ist.

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## **ИСТОРИЯ РАЗВИТИЯ НОРМАТИВНЫХ ДОКУМЕНТОВ НА АСФАЛЬТОБЕТОН В ДОРОЖНОМ СТРОИТЕЛЬСТВЕ**

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**Аннотация:** В статье представлена хронология развития нормативных документов на асфальтобетонную смесь в Российской Федерации. Намечены пути развития нормативной базы в данной области.

**Ключевые слова:** автомобильная дорога, асфальтобетон, асфальтобетонные смеси, конструкция дорожной одежды, нормативно-технические документы.

## MODERN MATERIALS IN THE CONSTRUCTION OF NOISE SHIELDS ON HIGHWAYS

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### Abstract

The purpose of using modern materials in the design and installation of noise shields during construction and installation work on highways in the city is primarily to reduce noise pollution, as well as to prevent the negative effects of noise on human auditory organs. In accordance with the requirements of SanPiN 1.2.3685-21 "Hygienic standards and requirements for safety and (or) harmlessness of living conditions for humans", the maximum noise level for non-permanent sources in residential premises during the daytime should not exceed 55 dB, and at night - 45 dB. This article is devoted to the environmental aspects of noise pollution during construction and installation work on highways in the urban area.

**Keywords:** noise pollution, ecology, noise, noise shields, modern materials

### Introduction

Noise pollution (acoustic pollution) is an irritating noise of anthropogenic origin that disrupts the vital activity of living organisms and humans. During the production of construction and installation works on highways in urban conditions, such pollution occurs and can significantly affect the behavior of living organisms [1].

Excessive noise levels that occur during the construction period, as well as the subsequent operation of transport infrastructure facilities (highways, bridges, overpasses and overpasses) in the city is an important problem at the present time. The increase in the volume of repair work caused by the exhaustion of their physical and, in some cases, moral resources of the structural layers of road coverings of highways built in the 20th century leads to a significant increase in noise and noise pollution of the surrounding space. To ensure an adequate standard of living for people during the construction and operation of highways located within the settlement, it is necessary to install specialized structures that absorb and reflect (scatter) sound waves.

To achieve the above goals, noise shields are used.

The noise shield is a panel filled with noise-absorbing or noise-reflecting material with a height of 2-6 meters. The canvas is fixed on metal racks and attached to the foundation, usually made of concrete. To improve the performance, the screen is tilted towards the noise source, or its upper part is bent. This reduces the noise output angle and, accordingly, the level of its impact. Noise protection screens are arranged in the immediate vicinity of the noise source, that is, along the edge of the roadway, railway tracks, workshops and depots, construction sites [2-4]. Traditionally, the following materials are used in the noise shields:

Table 1 - Comparative characteristics of noise protection screen materials [2]

Material	Advantages	Disadvantages
Wood	- high acoustic absorption qualities	- difficult to maintain; - short-lived
Concrete	- high acoustic qualities; - durability; - simplicity of content	- heavy weight; - complexity of the structure
Metal	- high acoustic absorption qualities	- short-lived due to corrosion
Plastic	- low weight of the structure; - ease of installation	- high cost; - complexity of the content

The noise produced during construction works has a detrimental effect on the health of citizens of the Russian Federation. A sound wave exceeding the normative values can, with prolonged exposure, reduce hearing acuity, as well as lead to an emotionally stressful state that reduces both the general mood of the population and work productivity.

The work of a number of researchers from Russia and abroad is devoted to the problem of protecting construction sites from noise exposure [4-8]. The vast majority of works consider the problem of protecting the population from background noise on already built highways, without directly affecting the process of highway construction. Thus, the rules of SP 51.13330.2011 "Noise protection" established that the permissible noise level from the highway for residential buildings should be: no more than 55 decibels during the daytime (from 7 a.m. to 23 p.m.), and no higher than 45 decibels at night. According to [3], noise from construction machinery is accepted:

- Cargo a/transport - 85...96 dBA;
- passenger car/transport - 70...80 dBA;
- bus - 80...85 dBA;
- railway composition - 80 ... 100 dBA.
- scraper: when setting the ground - 83...84 dBA, when unloading - 80 dBA;
- unloading of a/dump truck - 82...83 dBA;
- bulldozer > 73.6 kW - 90 dBA;
- diesel hammer - 110 dBA;
- vibration loader - 92 dBA;
- motor saw "Druzhba" - 111 dBA;
- pneumatic jackhammer - 115 dBA.
- grader (in the cabin / at a distance of 7 m) - 92 / 85 dBA;
- the roller is heavy (in the cabin / at a distance of 7 m) - 90/80 dBA;
- the excavator is heavy duty. bucket 2 m<sup>3</sup> (in the cabin / at a distance of 7 m) - 95/92 dBA;
- the excavator is heavy duty. bucket of 1 m<sup>3</sup> (in the cabin / at a distance of 7 m) - 90/88 dBA;
- the excavator is heavy duty. bucket 0.5 m<sup>3</sup> (in the cabin / at a distance of 7 m) - 87/85 dBA;
- compressor with internal combustion engine (in the cabin / at a distance of 7 m)



- 101 / 87 dBA;

- compressor with electric drive (in the cabin / at a distance of 7 m) - 93/80 dBA;

- vehicle with a load capacity of > 10 tons (in the cabin / at a distance of 7 m) - 85/90 dBA.

From the available data, we see that the noise produced by construction equipment significantly exceeds the permissible values, which indicates the relevance of the object of study under consideration.

It should also be mentioned that quite often works on the construction or repair of highways both in Russia and abroad are carried out at night. Noise coming from construction equipment, as well as light pollution, interferes with people living in densely built-up areas. Reducing the duration of sleep or reducing its quality leads to the fact that engineers, doctors, as well as current specialists in other industries involved in a number of important technological operations do not work at an effective maximum.

The above-described problems lead to a decrease in the level and number of goods and services produced, which strongly affects the economic component as a whole.

In acoustic practice, there are two main methods for measuring sound absorption: determining the sound absorption coefficient of a material, and measuring the sound absorption coefficient indoors.

To determine the sound absorption coefficient of the material, the method of comparing the amplitudes of standing waves is used. The tests are carried out using a Kundt acoustic transfer tube. A sample of the material is placed at the end of the pipe, and measurements of the wave amplitude are carried out at different points in space.

The sound absorption coefficient of the material is determined by measuring the sound pressure and sound intensity at several points in the room. The data obtained is then used to calculate the average sound absorption coefficient using a special formula. This formula takes into account the number of surfaces with a certain level of sound absorption, the total area of these surfaces, as well as the sound absorption coefficient of the material itself.

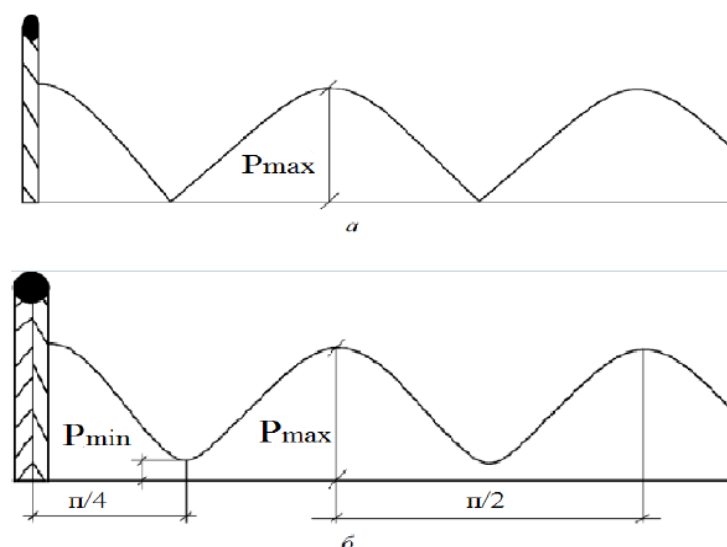


Figure 1 - The nature of standing waves formed in the measuring path: an ideal sound-reflecting barrier (a) or sound-absorbing material (b) is placed at the end of the pipe [4]

Table 2 shows data on the sound absorption coefficient of materials at an angle of inclination of 20 degrees. With this tilt, the sound absorption efficiency increases, since the sound wave travels a longer distance to the back wall of the screen. This makes it possible to improve sound absorption performance without significantly increasing the thickness of the screen, and therefore without significantly increasing the cost and weight of the structure. The improvement in sound absorption can be up to 3-5%.

Table 2 - The coefficient of sound absorption of materials when the material is positioned at an angle of 20° [4]

No	Material	Values of $\alpha_{mat}$ in octave bands with geometric mean frequencies, Hz							
		125	250	500	1000	2000	3000	4000	6000
1	Wood	0.32	0.32	0.19	0.13	0.11	0.11	0.10	0.10
2	Penoplex	0.68	0.73	0.80	0.88	0.93	0.97	0.99	0.99
3	Extruded Polystyrene foam	0.55	0.62	0.75	0.79	0.82	0.88	0.91	0.91
4	Foam concrete	0.25	0.18	0.13	0.13	0.23	0.27	0.28	0.30
5	Fiberglass	0.13	0.37	0.88	0.94	0.99	0.99	0.99	0.99
6	Basalt fiber	0.29	0.75	1.0	1.0	1.0	1.0	1.0	0.99
7	Nylon compressed fiber	0.16	0.48	0.87	0.96	0.94	0.94	0.94	0.94
8	Construction felt	0.18	0.25	0.58	0.66	0.59	0.56	0.54	0.51
9	Mineral pressed cotton wool	0.33	0.45	0.53	0.75	0.81	0.85	0.83	0.81
10	Foam asbestos	0.39	0.52	0.79	0.82	0.86	0.87	0.86	0.84

The choice of an angle of inclination of 20 degrees is due to the fact that such noise protection panels are the most efficient and economical in production. They provide maximum sound absorption with minimum thickness and cost. Tilting the panel towards the noise source increases the path of the sound wave through the material, which leads to its attenuation before reflection from the back wall. The reflected sound wave has less energy and does not return to the source, which reduces the noise level.

### Conclusion

Thus, experimental methods have proven the effectiveness of modern materials used in the filling layers of noise shields in urban development.

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## **ПРИМЕНЕНИЕ СОВРЕМЕННЫХ МАТЕРИАЛОВ В КОНСТРУКЦИЯХ ШУМОЗАЩИТНЫХ ЭКРАНОВ НА АВТОМОБИЛЬНЫХ ДОРОГАХ**

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**Аннотация:** Целью использования современных материалов при разработке конструкции и установке шумозащитных экранов в период строительно-монтажных работ на автодорогах в черте города является в первую очередь уменьшение шумового загрязнения среды, а также предотвращение негативного воздействия шума на слуховые органы человека. В соответствии с требованиями СанПиН 1.2.3685-21 «Гигиенические нормы и требования к безопасности и (или) безвредности для человека условий среды обитания», максимальный уровень шума для непостоянных источников в жилых помещениях в дневное время не должен превышать 55 дБ, а в ночной период - 45 дБ. Данная статья посвящена экологическим аспектам шумового загрязнения при проведении строительно-монтажных работ на автодорогах в городской черте.

**Ключевые слова:** шумовое загрязнение, экология, шум, шумозащитные экраны, современные материалы

## UTILIZATION OF WASTE FROM CELLULOSE-CONTAINING PRODUCTION USING FUNGAL MYCELIUM

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### **Abstract**

The purpose of this article is to present the research results of recycling wood waste using mycelium. The study considers the problem of waste recycling and its possible solutions. As a result, the effect of fungal mycelium on wood was revealed and the possibility of its use for the disposal of wood waste was proved

**Keywords:** disposal, mycelium, substrate, waste.

In the design of building structures, one of the most important parameters is durability, which consists of many factors, but the main thing is the performance of the material itself, the possibility of its application in a specific situation.

Waste disposal is a process involving the complete elimination or recycling of garbage. The development of this area is necessary to preserve the environment and improve the ecological situation, as well as for the safety of animals in the wild.

When processing wood at production sites, as well as manufacturing the final product from it, wooden waste remains. These products are absolutely harmless to humans and most of them are sent for processing and further use. Usually, wood waste is collected for the purpose of further incineration, pyrolysis or gasification. Fiberboard, pellets, briquettes, and other products are made from wood waste. Needles and bark of coniferous plants are cooked and used in the production of cosmetics, vitamins, animal feed, flour and medicines. However, sometimes these wastes become so much that it is not economically feasible to export and recycle them, and cheap methods of on-site disposal are very often aesthetically unattractive, not eco-logical and unsafe.

One of the solutions to this problem is to use these wastes as a substrate for mycelium. The fungal mycelium is the vegetative body of the fungus, which consists of a network of thin filaments called hyphae. Mycelium is the basis for the growth and development of fungi, responsible for their nutrition, reproduction and interaction with the environment. The mycelium also forms the fruit bodies of fungi, which we see and collect in nature [1].

For the study, sawdust from deciduous trees, which are very often waste from cellulose-containing production, was selected from the production site, and mycelium of oyster mushrooms was also purchased.

Before planting mycelium in sawdust, they were previously soaked with water in order to absorb moisture and become a more favorable environment for fungi. Next, the mycelium was planted in the substrate. For this purpose, glass containers were prepared, which underwent sterile treatment, in which the studied components were

placed. The container with sawdust and substrate was covered with foil with slots for air intake, which created a favorable microclimate inside it. A few days later, the first results were already visible. The mycelium has sprouted, as indicated by the white shoots [2].



*Figure 1 - Mycelium in sawdust after 3 days*

After 10 days, it was already possible to observe many foci of growth of the mycelium of the container. As can be seen from Fig. 2, the mycelium has grown significantly and began to gradually absorb sawdust, thereby continuing the recycling process that began.



*Figure 2 - Mycelium in sawdust after 10 days*

30 days after planting, the mushroom mycelium almost completely absorbed all the sawdust, forming a solid structure, acquired the ability to hold the shape adopted in the jar.



Figure 3 - Mycelium in sawdust after 30 days

## Conclusion

The results obtained during the study indicate that the fungal mycelium has almost completely absorbed sawdust, that is, the process of recycling waste from pulp-and-paper production has actually occurred, that is, fungal mycelium can be used as one of the methods of recycling these wastes. If certain rules and processing technologies are followed, it is possible to obtain material from this organic compound that is used in construction production, household needs, as an interior item and much more. The main thing is that wood waste is disposed of in one of the most environmentally friendly, useful and practical ways.

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## УТИЛИЗАЦИЯ ОТХОДОВ ЦЕЛЛЮЛОЗОСОДЕРЖАЩЕГО ПРОИЗВОДСТВА С ПОМОЩЬЮ ГРИБНОГО МИЦЕЛИЯ

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**Аннотация:** Цель данной статьи - представить результаты исследований по переработке древесных отходов с использованием мицелия. В исследовании рассматривается проблема переработки отходов, а также возможные пути ее решения. В результате было выявлено влияние грибкового мицелия на древесину и доказана возможность использования для утилизации древесных отходов.

**Ключевые слова:** мицелий, отходы, субстрат, утилизация.

## THE INFLUENCE OF MOISTURE SORPTION ON MECHANICAL AND STRENGTH PROPERTIES OF CEMENT-BONDED WOOD BOARDS

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### Abstract

The purpose of this study is to analyze the effect of moisture sorption on various technical properties of cement-bonded wood boards, untreated and treated with various compositions. The initial data, graphs and results of the study are given.

**Key words:** bitumen primer, cement-bonded wood boards, moisture sorption.

### Introduction

Cement-bonded wood boards (CBWB) is a sheet composite building material that contains thin wood chips of fine or medium fraction, portland cement M500, water and additives. It is one of the most used materials in construction. The material is widely available on the market around the world. It is used not only in industrial construction, but also in residential low-rise construction for external and internal wall covering. This building material is not only environmentally friendly, vapor-permeable (breathable) with a high specific heat capacity and a long warranty period, but also has a number of advantages comparing with other materials.

Cement particle boards consist of several components, presented in Table 1. One of the main parameters that determine quality is the uniform distribution of components by volume. In practice the distribution of components in slabs is assessed visually.

Table 1. Composition of cement bonded particle boards

Components	%, massive
1	2
Wood shavings (fir, spruce, pine)	18,2
Aluminum sulfate	0,8
White lime	0,5
Soda soluble glass	0,9
Cement grade 500	49,9
Water	29,7

The purpose of this study is to analyze the effect of moisture sorption on various technical properties of cement-bonded wood boards, untreated and treated with various compositions. Tests of CBWB samples for sorption moistening were carried out.

Samples with dimensions 160x40x12(25) mm., 250x75x24 mm. и 450x450x12 mm. were prepared. Some of the samples were treated with finishing compounds and

primed with a bitumen primer.

Moisture sorption tests of samples were carried out in desiccators, where air humidity reached 98% [1-3].

Samples were tested for moisture in accordance with the requirements [4].

Measurements of the linear dimensions of the samples were measured by dial gage with an error of 0,01 mm.

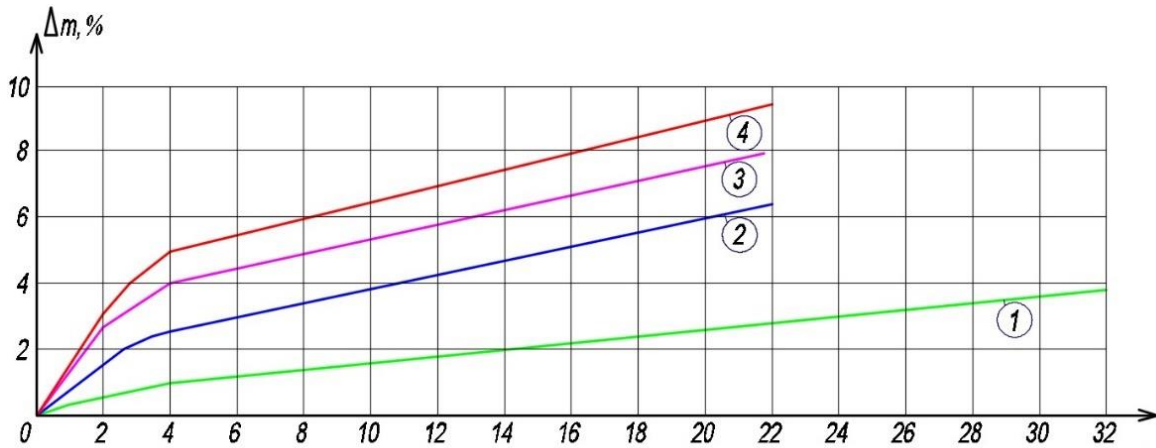


Figure 1 - Moisture sorption of 12 mm CBWB samples:

1 - treated with GP paint; 2 – primed with bitumen primer 2 times; 3 – primed with bitumen primer 1 times; 4 – unprocessed

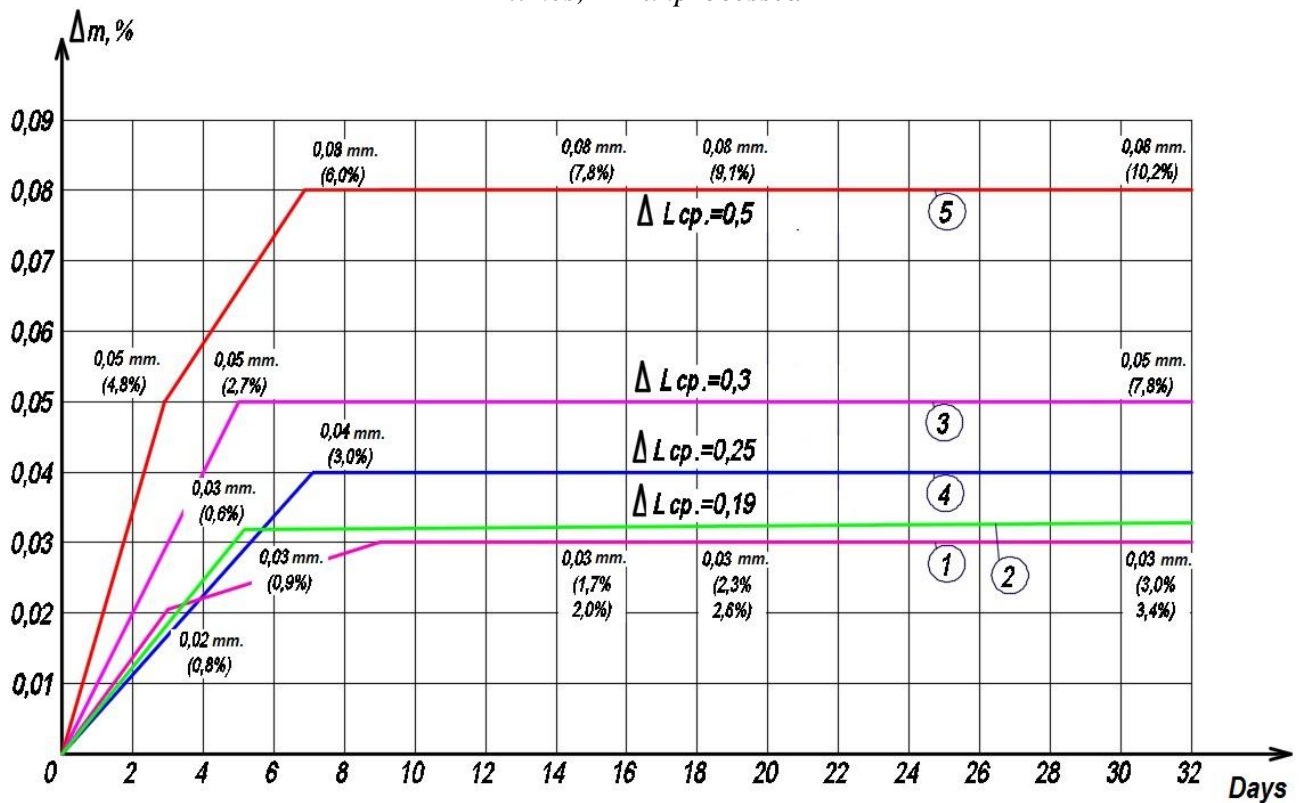


Figure 2 – Change in the linear dimensions of CBWB samples (size 160x40x12 mm.) during sorption moistening, treated with paint (primer):

1 – GP+PE; 2 – GP; 3 – paint + primer; 4 – bitumen primer 2 times; 5 – raw sample



### **Results of moisture sorption tests**

Tests have shown that samples treated with a finishing composition (for example, GP brand) were slightly moistened at high air humidity (Figure 1, position 1): after a month it was moistened by no more than 4%. Double treatment of samples with a bitumen primer reduced moisture sorption by 1,5 times compared to untreated samples, and single treatment did that by 1, 2 times.

### **Measuring the linear dimensions of CBWB during sorption humidification**

Figure 2 shows measurements of sample deformations during sorption humidification, which showed that even untreated CBWB samples have small deformations - up to 0,5 mm./r.m. (Figure 2, position 2); for a slab 3,2 m long they will be about 1,6 mm.

### **Conclusion**

CBWB treated with finishing compounds have slight deformations during sorption moistening (0,19 mm./r.m., Figure 2). These deformations will be insignificant when operating the slabs in room conditions (at a relative humidity of 50-60% and a constant temperature), that is why CBWB for room partitions can be used in any size.

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## **ВЛИЯНИЕ СОРБЦИОННОГО УВЛАЖНЕНИЯ НА МЕХАНИЧЕСКИЕ И ПРОЧНОСТНЫЕ СВОЙСТВА ЦЕМЕНТНО-СТРУЖЕЧНЫХ ПЛИТ**

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**Аннотация:** Целью данной статьи анализ влияния сорбционного увлажнения на различные технические свойства необработанных и обработанных различными составами ЦСП. В работе приведены исходные данные, графики и результаты исследования.

**Ключевые слова:** битумный праймер, сорбционное увлажнение, цементно-стружечные плиты.

## THE PRINCIPLES OF CREATING AND ENSURING THE SAFETY OF TECHNICAL DOCUMENTATION DURING THE OPERATION OF APARTMENT BUILDINGS

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### **Abstract**

Modern regulatory requirements for the creation and storage of technical documentation for apartment buildings are considered; the level of responsibility of management organizations for maintaining and storing documentation is indicated.

**Keywords:** apartment buildings; technical documentation of the house; management of an apartment building; homeowners.

One of the most important tasks of managing the multi-apartment housing stock and maintaining it in proper condition for effective operation is the timely creation, maintenance and storage of organizational and technical documentation for each specific apartment building in operation. Currently, as the analysis of documentation for operated apartment buildings in the Tambov region shows, there are significant problems in creating the necessary set of documentation and especially documentation on their current technical operation. This is mainly due to the lack of understanding among the owners of the premises about the required amount of documentation and its importance in the operation of the house. Management organizations also do not fully feel their responsibility for creating and storing the necessary documentation. At the same time, the housing inspectorate practically does not control the organization and maintenance of technical documentation. This is largely facilitated by the lack of specific departmental instructions in the region on the organization and maintenance of documentation, which, among other things, should specify the measures of responsibility of management organizations for non-compliance with the requirements for the creation, storage and use of documentation.

Below, in the article, based on the available resolutions of the Government of Russia, a list of necessary technical documentation for apartment buildings is given and some issues of their storage and use are considered.

The list of documents included in the technical documentation for an apartment building is set out in paragraphs 24 and 26 of the Rules for the Maintenance of Common Property, approved by Decree of the Government of the Russian Federation No. 49 dated 08.13.2006.

According to paragraph 24 of the Rules, the list should include the following documents:

- documents of the technical accounting of the housing stock, containing

information on the condition of the common property, including, without fail, the technical passport of the building. The documents are determined in accordance with the "Instructions on the accounting of housing stock in the Russian Federation", approved by Order of the Ministry of Land Construction of the Russian Federation dated 08.04.1998 No. 37;

- documents (acts) on acceptance of work results;
- inspection certificates, condition checks (tests) of engineering communications, metering devices, mechanical, electrical, sanitary and other equipment servicing more than one room in an apartment building, structural parts of an apartment building (roofs, enclosing load-bearing and curtain structures of an apartment building, objects located on a land plot and other parts of common property) for compliance of their operational qualities with the established requirements;
- instructions for the operation of an apartment building.

In addition to the listed documents, paragraph 26 of the Rules for the maintenance of common Property specifies other documents necessary for the management of an apartment building. These include:

- a copy of the cadastral plan (map) of the land plot, certified by the body responsible for maintaining the state land cadastre;
- an extract from the register containing information about the registered rights to real estate objects that are common property;
- a copy of the urban development plan of the land plot certified by the authorized local government body in the prescribed form (for apartment buildings, construction, reconstruction or major repairs of which were carried out on the basis of a construction permit obtained after the Government of the Russian Federation established the form of the urban development plan of the land plot – 01.25.2006);
- documents indicating the content and scope of the easement or other encumbrances, with the attachment of a plan certified by the relevant organization (body) for state registration of immovable property objects, on which the scope and boundary of the easement or other encumbrances relating to a part of the land plot are marked (if there is an easement);
- project documentation (a copy of the project documentation) for an apartment building, in accordance with which the construction (reconstruction) of an apartment building was carried out (if available);
- other documents related to the management of an apartment building, the list of which is established by a decision of the general meeting of owners of premises.

In turn, according to the Rules and Regulations on the technical operation of the housing stock, approved by Resolution of the State Construction Committee of the Russian Federation dated 09.27.2003 No. 170, there should be a mandatory list of technical documentation for long-term storage, which includes:

- a plot plan on a scale of 1:1000 – 1:2000 with residential buildings and structures located on it;
- design and estimate documentation and executive drawings for each house;

- acceptance certificates of residential buildings from construction organizations;
- certificates of the technical condition of the residential building for the transfer of the housing stock to another owner;
- schemes of indoor water supply networks, sewerage, central heating, heat, gas, electricity, etc.;
- passports for each residential building, apartment and land plot.

In addition, the documentation should include estimates, inventories of work for current and major repairs, acts of technical inspections, ventilation measurement protocols and other current documents compiled during operation.

Estimates, acts, protocols and other similar documents should be replaced with new ones due to the expiration of their validity period.

The absence of these documents should be regarded by the housing inspectorate as a violation of the rules for the maintenance and repair of residential buildings, that is, as an offense. In this case, management organizations and HOAs should be held administratively liable.

It should be borne in mind that the technical documentation belongs to the owners of the premises in an apartment building. Management organizations and HOAs only keep it, make the necessary changes to it, and gratuitously transfer it to their successors in the form of newly selected management organizations and HOAs. Retention of documentation is considered as creating obstacles to the management of an apartment building. The new management entity has the right to demand from its predecessor a set of technical documentation, at least through an appeal to the court.

The lack of technical documentation makes it impossible to manage an apartment building. Therefore, in case of loss of documentation, it is urgently necessary to restore it. At the same time, the restoration of the project documentation for the house should be carried out by a specialized organization licensed for this type of activity.

There are features of the formation of technical documentation when putting a new building into operation.

According to paragraph 25 of the Rules for the maintenance of common property, the developer is obliged to transfer, against receipt, the HOA established in the house under construction, as well as the first owner of the premises who applied, the instructions for the operation of an apartment building. This must be done within a month after receiving permission to put the apartment building into operation.

According to the Regulation on the development, transfer, use and storage of instructions for the operation of an apartment building, approved by Order No. 45 of the Ministry of Regional Development of the Russian Federation dated 06.01.2007, the instruction contains information necessary for the subsequent operation of the house.

It should include information about the developer, designer, construction contractors, as well as characteristics of the house as a whole and a list of common property with a description of the building elements, including the materials from which they are made, recommendations for the maintenance and repair of common property and recommended service life of its individual elements.

It should be noted that earlier the procedure for acceptance of apartment buildings was regulated by territorial building regulations, the provisions of which practically repeated the norms of SNiP 3.01.04–87 "Acceptance of completed construction facilities. The main provisions". The norms listed the documents that were submitted to the state acceptance commissions by the contractor and the customer, and it was also indicated that these documents should be kept by the operating organization after the acceptance of the object. Currently, due to the introduction of a new procedure for the acceptance of facilities – on the basis of a permit for the commissioning of the facility, territorial building regulations have been canceled. However, in the documents issued by the construction supervision authorities, the list of documentation that the developer must submit for verification actually remained the same. This documentation must be handed over to the operating organization after the facility is put into operation.

The article considers only some individual issues related to the provision of technical documentation for the operated multi-apartment housing stock. It can be seen that at present it is necessary to apply more drastic measures to solve this problem, including the creation of the above-mentioned instructions for the creation, storage and use of organizational and technical documentation.

## **ПРИНЦИПЫ СОЗДАНИЯ И ОБЕСПЕЧЕНИЯ СОХРАННОСТИ ТЕХНИЧЕСКОЙ ДОКУМЕНТАЦИИ ПРИ ЭКСПЛУАТАЦИИ МНОГОКВАРТИРНЫХ ДОМОВ**

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**Аннотация:** Рассмотрены современные нормативные требования к созданию и хранению технической документации на многоквартирные дома; указан уровень ответственности управляющих организаций за ведение и хранение документации.

**Ключевые слова:** многоквартирные дома; техническая документация дома; управление многоквартирным домом; собственники жилья.

## METHODOLOGICAL FOUNDATIONS OF ACCELERATED SURVEYS OF MULTI-APARTMENT RESIDENTIAL BUILDINGS THAT ARE OBJECTS OF CULTURAL HERITAGE

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### Abstract

The methodological foundations for assessing the technical condition of multi-apartment residential buildings that are objects of cultural heritage are considered. Accelerated methods of studying their technical condition are proposed in order to determine the type and scope of repair and restoration work in advance.

**Keywords:** cultural heritage sites, major repairs of buildings, inspection of buildings, apartment buildings.

Currently, there are a large number of multi-apartment residential buildings in the city of Tambov that have the status of cultural heritage sites. Most of them are in poor technical condition [1,2]. Prior to carrying out major repairs on them, it is necessary to conduct preliminary surveys with the establishment of the type and scope of repair and restoration work. The main provisions for the accelerated conduct of such surveys are discussed below.

To determine the list of priority repair and restoration measures, it is necessary to assess the technical condition of the house and determine the causes of defects. With a large number of residential buildings-monuments, work on their inspection should be carried out according to the type of express survey, which allows you to quickly determine the general condition of the building and propose measures for its major repairs.

According to the results of such a survey, a category of the technical condition of the house as a whole or separately for each of its construction volumes should be assigned, a building passport should be drawn up and the frequency of its subsequent inspections should be assigned. The results of the survey should be presented in the form of recommendations on ensuring the safety of operation, the type and composition and frequency of monitoring, strengthening and restoration of house structures.

The accelerated survey makes it possible to determine the preliminary amount of repair and restoration work and to establish the possible cost of capital repairs of the facility for inclusion in the program of capital repairs of the building. The survey methodology should take into account the need to identify the causes leading to damage to residential buildings-monuments.

The main causes of damage to buildings are divided into groups:

1. *Geological, hydrogeological conditions on the territory of the development.* These include changes in the groundwater level, suffusion processes, and frost heaving. These conditions have an impact on the condition of the foundations. Such causes occur quite often and in this regard, an assessment of their impact is necessary at most facilities.

2. *Violation of temperature and humidity conditions in houses.* As a result, mold appears on the walls, rotting and fungal damage to wooden structures occurs. Due to such damage, it becomes necessary to completely replace the plaster and wooden structures. Their partial preservation requires a detailed justification based on the results of the survey.

3. *Low initial quality of construction.* This often applies to foundations and walls. For example, there is a variable depth of foundation, heterogeneity of rubble masonry, etc. At the same time, specific deformations of walls occur, which manifest themselves in through cracks. Similar deformations are typical for residential buildings in Tambov, built in the late 19th and early 20th centuries. The degree of danger of such deformations should be established during the examination.

4. *Technogenic processes in the territory of the building.* These include the rise of the cultural layer of the earth [3], new construction in the immediate vicinity of the building, the influence of an aggressive environment, dynamic loads, the laying of underground utilities, etc. These phenomena are characteristic of urban conditions.

5. *The influence of the human factor on the condition of the building.* This includes, first of all, the lack of proper technical operation. For example, the destruction of coatings in need of constant repair, layering of masonry and destruction of walls during the construction of new floors and punching openings, waterlogging of foundations and walls due to improper condition of blind areas, lack of horizontal waterproofing, improperly performed landscaping, etc. [4].

Based on these factors, the following measures are among the priority measures for the preservation of monument buildings for the period before their major repairs:

1. Issues of ownership and responsibility of the owner of the monument building must be resolved. This is primarily necessary for the preparation of a passport and its monitoring program.

2. The monument building must have a passport and a sign on the wall with its name, history, and in case of emergency, a warning about the danger of collapse.

3. A preliminary survey of the condition of houses should be considered based on the basic conditions of an accelerated survey of monument buildings, namely, the minimum cost of work with the maximum number of buildings surveyed.

4. The results of the survey should be presented in the form of recommendations on ensuring the safety of operation, composition and frequency of monitoring, strengthening of individual structures and the building as a whole. The basic documents in this case should be Federal Law No. 73-FZ, SP 13-102-2003, GOST 53778-2010, GOST R 55567-2013, GOST R 56198-2014.

Thus, at the initial stage of taking measures to preserve residential buildings, monuments, an accelerated survey of buildings is necessary.

*The purpose and composition of the accelerated survey of monument buildings*

The purpose of the survey is to determine the operational suitability of the building or its individual volumes, establish the technical condition and issue recommendations on the necessary priority work at the facility. The decision on the possible demolition of the building should be made on the basis of a more detailed study and justification. The composition and timing of the accelerated examination should be minimal, and the recommendations received should be accepted for execution as soon as possible after the examination.

For this reason, a visual inspection of building elements should mainly be carried out. The characteristics of materials should be determined by non-destructive methods [5]. The results of the surveys should be clarified by interviews with people involved in one way or another in the operation of the building, studying the available information about the geology of the area, soil studies using manual drilling, studying the documentation for the building (if any).

With this approach, the amount of work provided for in the regulatory documentation can be significantly reduced in order to reduce the time and cost of surveys. The composition of the team conducting the survey should consist of the minimum required number of specialists. Minor details may not be considered during the accelerated examination.

The report on the results of the accelerated survey should include detailed photographic fixation, necessary measurements, a list of significant defects and destructions, a description of engineering and geological conditions, information on the operation of the building for a long period, a conclusion on the causes that led to the appearance of defects and damage, calculations of structural reinforcement (if necessary).

Based on the survey, a category of the technical condition of the building as a whole or each of its construction sites is assigned, a building passport is drawn up and the frequency of inspections of the building is determined in the process of subsequent monitoring of its technical condition.

Recently, monument buildings, including residential buildings, have been disappearing in the Tambov region, taking with them information about the development of culture and architecture of our region, historical information about the formation and development of cities and other settlements. In this regard, the implementation of the proposal to conduct accelerated research of monument buildings makes it possible to assess their condition as soon as possible and take measures to preserve them for a period before carrying out full-scale repair and restoration work.

To organize accelerated surveys of residential buildings-monuments located on the territory of Tambov, it is currently necessary to develop methodological recommendations for conducting this type of surveys.



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## МЕТОДИЧЕСКИЕ ОСНОВЫ УСКОРЕННЫХ ОБСЛЕДОВАНИЙ МНОГОКВАРТИРНЫХ ЖИЛЫХ ЗДАНИЙ, ЯВЛЯЮЩИХСЯ ОБЪЕКТАМИ КУЛЬТУРНОГО НАСЛЕДИЯ

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**Аннотация:** Рассмотрены методические основы оценки технического состояния многоквартирных жилых зданий, являющихся объектами культурного наследия. Предложены ускоренные методы исследования их технического состояния с целью предварительного определения вида и объема ремонтно-реставрационных работ.

**Ключевые слова:** объекты культурного наследия, капитальный ремонт зданий, обследование зданий, многоквартирные жилые дома.

## ROAD INFRASTRUCTURE OF THE TAMBOV REGION: ON THE WAY TO SUSTAINABLE DEVELOPMENT

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### **Abstract**

The paper analyzes the state of the public road infrastructure in the Tambov region over the last decade. In particular, the total length of roads in the region, the main directions of movement of cargo and passengers, as well as the current state of federal and regional roads are discussed.

**Keywords:** local materials, normative state, regional roads of Tambov region

### **Introduction**

Most of the roads in Tambov were built between the 1960s and 1980s, and they are not up to modern standards. The roads were built with the standards that were in place at the time, but those standards don't meet modern safety and load requirements. In crisis conditions of the 1990s, the amount of road construction works in the Tambov region and the country as a whole significantly decreased, as a result, in the 2000s, only 20% of the region's highways met regulatory requirements [1]. In this regard, since the 2010s, the government of the Tambov region have taken active measures to rehabilitation roads. Investments were attracted from both the regional and federal budgets. As a result, the condition of roads in the Tambov region has improved, but some segments still require recontouring and modernization

Public roads in the Tambov region have a total length of 19,402 km. Of these, 636.6 km are federal highways, 1,964.3 km are roads of regional significance, and 16,801.5 km are local roads. The main traffic of cargo and passengers is carried out on federal and regional highways. However, 23.3% of the aforementioned roads operate in overload mode.

As of 2024, federal roads in the region are nearly fully compliant with normative state, while regional roads are only 59.71% compliant. The repairing works are carried out under the state program.

The costs of implementing the government program in the Tambov region from 2014 to 2024 amounted to 61.343 billion rubles. The information on the distribution of funds over the years is shown in Figure 1. It can be seen that the costs of road repair keep going up every year.

As part of the national project «Safe and Quality Roads», there is a task of implementing new technologies for road repair and the use of alternative road construction materials in the development of project documentation. For example, the percentage of road repairs design documentation that involved the use of new materials and technologies in the total volume of work on capital repairs of roads was 10% in

2019 and increased to 66% in 2023.

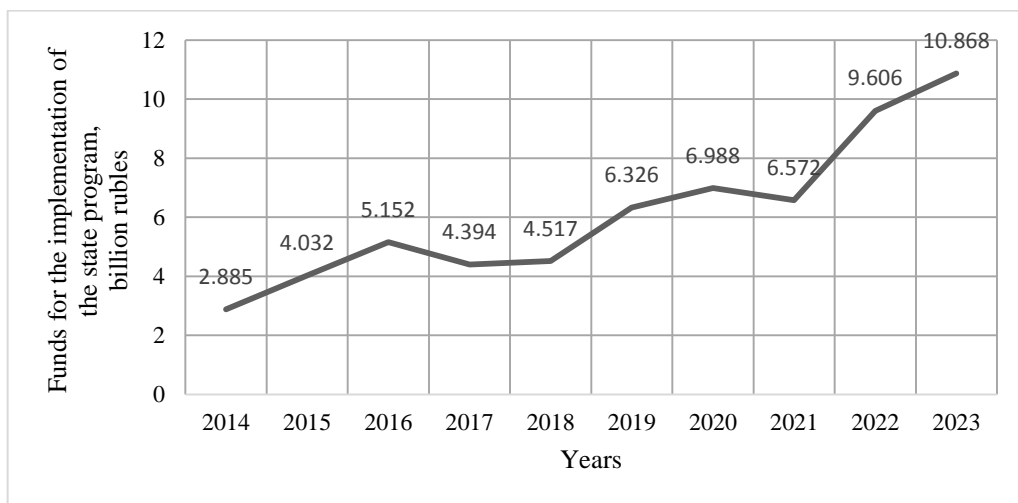


Figure 1 - The costs of implementing the state program in 2014-20`23 at the expense of all sources of financing

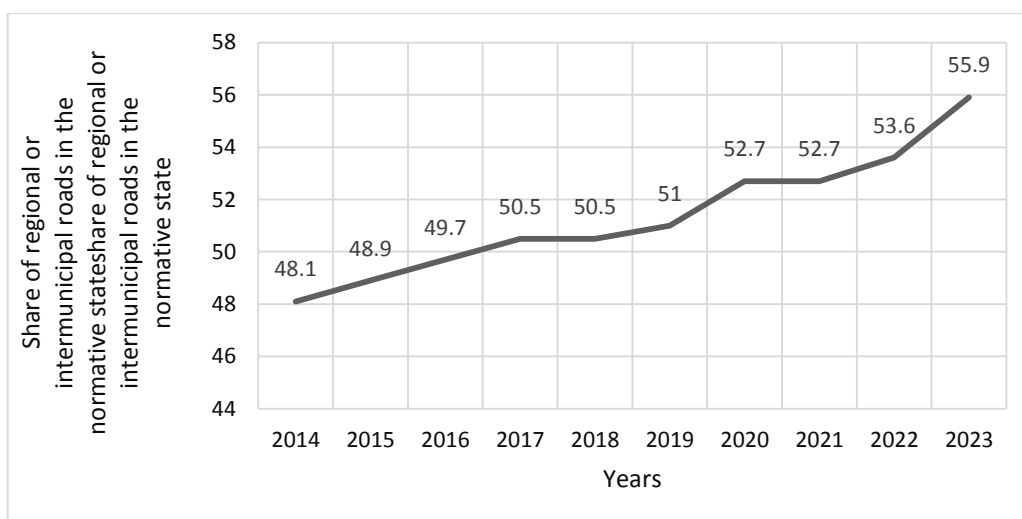


Figure 2 - Graphic of changes in the share of regional roads in the normative condition

The analysis of the current road quality in the Tambov region shows a trend of gradual improvement of the regional or intermunicipal road network of the region. However, to optimize expenditure for bringing roads into compliance with standards, additional research is needed to consider the use of local materials and modern road recycling technologies.

Most roads of regional significance don't meet modern standarts and requirements for axial loads, design speed, and road traffic safety. This leads to the need for strengthening the road surface when repairing to give the roads the necessary characteristics.

The use of cold recycling asphalt pavement technology allows significant cost savings through the reclaimed of material from the existing pavement and its subbase. The main idea behind this technology is to recycle existing material of defective

asphalt pavement and subbase layer. Skeletal material (crushed stone) is added to the damaged asphalt surface in order to improve grain size distribution. A special machine then mixes old asphalt and crushed stone with a binder (cement or bitumen emulsion), in order to strengthen and solidify the layer. This technology allows to reduce costs compared to the classic repair technology, namely the construction of new layers of the subbase and asphalt surface. Also, the advantage of this technology is the homogeneity of the resulting layer, which helps to improve the frost resistance and durability of the pavement. An important example of the effective use of cold regeneration technology is the repair of 70.15 km of regional roads in 2023. This experience shows that such innovative approaches are not only economically feasible but also allow achieving the required quality of road surfaces.

### **Conclusion**

Thus, the active use of local materials and the development and improvement of modern technologies in road construction allow for reducing financial costs for road repairs while maintaining the required quality, which will ultimately benefit both the region's economy and all users of the transportation infrastructure. To make the roads in the Tambov region better, we need to do more research to find ways to save money on road repair works. We should use local materials and advanced technologies of road repair to achieve that.

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## **ДОРОЖНЫЙ СЕКТОР ТАМБОВСКОЙ ОБЛАСТИ: НА ПУТИ К УСТОЙЧИВОМУ РАЗВИТИЮ**

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**Аннотация:** В статье анализируется состояние дорожной инфраструктуры общего пользования Тамбовской области за последнее десятилетие, а именно указывается общая протяженность автомобильных дорог общего пользования, основные направления движения грузов и пассажиров, а также современное состояние федеральных и региональных дорог.

**Ключевые слова:** местные материалы, нормативное состояние, региональные дороги Тамбовской области.

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## COMPOSANTE AXIOLOGIQUE DE LA METAPHORE DANS LA COMMUNICATION MEDICALE EN LIGNE

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### Résumé

L'article est consacré à l'analyse de la composante axiologique de la métaphore dans la communication médicale mise en œuvre grâce aux technologies Internet modernes. Les concepts clés de la pratique médicale sont examinés : maladie et santé, aussi que le rôle de la relation médecin-patient dans le processus de traitement est évalué. L'étude est menée sur les métaphores de la communication médicale en ligne des établissements médicaux en France.

**Mots clés:** axiologie, communication médicale en ligne, langue française, métaphore.

### Introduction

L'axiologie est la science des évaluations et des valeurs, de leurs relations, de leur développement et de leur changement. L'étude de l'axiologie de l'activité médicale est réalisée par des spécialistes du domaine de l'éthique médicale professionnelle et de la déontologie, des sociologues, des philosophes et des psychologues.

Les concepts centraux qui déterminent l'essence et le sens de l'activité médicale sont *la vie* et *la santé* du patient. Par conséquent, tous les processus et phénomènes évalués seront considérés du point de vue de leur impact sur la valeur fondamentale de la médecine : la santé du patient. Le concept qui s'oppose à la santé et qui est une source constante de lutte est *la maladie*.

La perception par la société de cet état humain signifiant a toujours été en corrélation avec le paradigme socioculturel pertinent pour l'époque considérée. La maladie a toujours été perçue comme un mal, un malheur, mais à différentes étapes historiques, des significations supplémentaires ont accompagné la compréhension de la maladie et l'explication de son apparition : elle a été interprétée comme une honte sociale, une punition des forces surnaturelles, une épreuve (Barrakat). Le médecin, en tant que force opposée à la maladie, était doté de propriétés et de capacités humaines et surnaturelles exceptionnelles qui l'aidaient, lui et son patient, à la surmonter.

Plus tard, avec le développement de la science, le fait de la maladie a été révélé dans la description et l'explication des conséquences des causes physiopathologiques naturelles qui surviennent dans un organisme vivant. Cependant, malgré les avancées remarquables de la science médicale au cours du siècle dernier, la compréhension de la maladie en tant qu'entité incompréhensible demeure dans l'esprit des gens, ce qui s'explique par le manque de compréhension de nombreuses conditions pathologiques.

Par conséquent, dans la compréhension des gens, il reste l'opinion selon laquelle seule une personne possédant des capacités surnaturelles peut guérir une maladie. Cela se reflète logiquement dans les unités linguistiques des langues modernes lorsqu'elles décrivent le niveau professionnel des médecins ou l'expérience d'interaction du patient avec eux.

Les chercheurs s'intéressent également à la santé et au bien-être du patient du point de vue de son importance pour la médecine. Selon Mettini Emiliano, tout d'abord, l'activité médicale est subordonnée à la moralité humaine universelle. Les valeurs fondamentales qui déterminent son essence et son idée sont la vie et la santé du patient. Ces valeurs, réalisées et volontairement acceptées par un travailleur médical, deviennent le moteur de ses activités, leur cause profonde, et la préservation et le maintien de la santé et de la vie des patients sont un devoir absolu et le sens principal du travail. En développant la pensée du chercheur, nous arrivons à la conclusion que la valeur de la médecine est la personne, son bien-être et sa santé, et la hiérarchie développée des relations entre le médecin et le patient joue ici un rôle de soutien dans la réalisation de l'objectif fixé conjointement par le sujet et l'objet de l'activité médicale - la santé du patient.

Le rôle le plus important dans le succès de la pratique médicale est joué par la qualité de la relation entre le médecin et le patient. Traditionnellement, le rôle principal dans ces relations est joué par le médecin, qui occupe une position dominante dans la dyade médecin-patient. Le médecin engage une conversation avec le patient, donne des recommandations, détermine et prescrit un traitement ; le patient, à son tour, obéit aux décisions du médecin, suit ces recommandations et suit les schémas thérapeutiques. Il a été établi que le succès du traitement dépend du respect de cette répartition des rôles sociaux.

De nombreux ouvrages de linguistes modernes et étrangers sont consacrés à l'étude de la métaphore dans le discours médical à partir de l'exemple des langues européennes les plus courantes. Selon le paradigme linguistique moderne, la métaphore n'est pas tant un moyen d'expression et de décoration du langage, mais plutôt un moyen pratique d'exprimer la pensée. Il convient de noter brièvement ici que la métaphore dans la communication médicale remplit des tâches différentes selon le type de discours. Ainsi, dans le discours scientifique, les termes-métaphores prédominent ; dans le discours quotidien, les métaphores professionnelles sont utilisées conjointement avec les métaphores du discours quotidien.

La composante axiologique d'une unité lexicale porte en elle une évaluation du concept appelé. Dans le cas où l'unité linguistique est une métaphore, la coloration sémantique de l'expression s'intensifie, puisque le caractère figuratif initial de la métaphore révèle le potentiel sémantique du concept d'un point de vue différent, non utilisé auparavant dans la communication.

Dans la communication médicale, le fait de la maladie, la douleur ainsi que les obstacles qui surviennent pour surmonter le problème existant sont évalués négativement. Une évaluation positive est portée par les faits de santé, de récupération,

ainsi que par les facteurs qui accélèrent la récupération ou contribuent à la préservation de la santé. Ici, il convient de noter que dans l'interaction entre un médecin et un patient, les facteurs qui contribuent à la préservation de valeurs universelles telles que le temps, l'argent et l'attitude respectueuse du médecin envers le patient sont évalués positivement, et vice versa, les métaphores utilisées pour décrire des situations ont une connotation sémantique négative, où ces valeurs humaines universelles n'ont pas été prises en compte par le professionnel de la santé dans le processus d'interaction avec le patient.

L'imagerie d'une métaphore est inversement proportionnelle à la fréquence de son utilisation, d'où proviennent les métaphores effacées et neutres, et c'est pourquoi les métaphores de l'auteur sont souvent les plus mémorables. Un communicateur ordinaire est souvent capable d'utiliser une métaphore dans le discours qui n'a pas été utilisée jusqu'à présent, mais décrit avec succès et succinctement le concept dont l'auteur cherche à nous transmettre le sens dans son message.

Les processus décrits sont caractéristiques non seulement du texte littéraire, mais aussi de la communication quotidienne. Notre étude a analysé les composantes axiologiques des métaphores de la communication médicale en ligne. Un corpus de métaphores a été collecté à partir de sites français dédiés à la description et à la discussion de situations liées aux problèmes de santé, de forums et de sites officiels d'établissements de santé en France. L'analyse repose sur le regroupement de métaphores selon la projection sémantique de la zone source sur la zone cible.

### **Métaphores du domaine des phénomènes et processus physiques**

*La digestion me pompe mon énergie.* Dans cet exemple, selon le contexte, le processus de digestion entraîne des difficultés pour une personne ; il est associé à une perte d'énergie. Le patient associe ce processus au pompage d'une substance matérielle. Par une telle substance, le communiant entend l'énergie immatérielle, et dans l'exemple étudié, les lois de la physique du monde matériel s'y appliquent d'une manière ou d'une autre. Dans son contexte, la métaphore porte une évaluation négative, puisqu'elle décrit un phénomène désagréable pour le patient, forcé et inévitable, qui conduit à une détérioration de son état de santé.

### **Métaphores religieuses**

*C'est 1/4d'heure en enfer à me froter tout le corp ( en particulier les jambes)...* L'état décrit par le patient se caractérise par des démangeaisons sévères, insupportables et si désagréables que le patient associe ce temps au temps d'être en enfer. La composante axiologique de cette métaphore porte donc une forte évaluation négative, puisque l'enfer, au sens religieux, est le lieu du plus haut degré de souffrance.

### **Métaphores du domaine de la cuisine**

*La brioche masculine part mieux avec un minimum de régime.* Dans l'exemple donné, on compare le ventre d'un homme avec un produit de boulangerie sucré (Le Robert : Ventre proéminent (d'un adulte). La connotation sémantique axiologique du concept la brioche est positive ; dans le cas où il est utilisé par rapport à la description d'un léger excès de poids sur le ventre, le sens sémantique est noté une nuance de

tolérance et même d'approbation avec un élément prononcé de composante humoristique, bien sûr, si un tel état du patient ne nuit pas à sa santé.

### **Conclusion**

Ainsi, la composante axiologique de la métaphore d'un texte médical porte dans la plupart des cas une connotation sémantique soit négative, soit positive du fait que dans le domaine médical - anthropocentrique par essence - il n'y a pas d'évaluation intermédiaire ou neutre, mais il y a soit facteurs qui contribuent à la préservation et au renforcement de la santé (où la norme est évaluée positivement) ou nocifs pour la santé humaine et, par conséquent, évalués négativement. Dans les deux cas, la métaphore contribue à la meilleure représentation du concept décrit par le communicateur.

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## **АКСИОЛОГИЧЕСКИЙ КОМПОНЕНТ МЕТАФОРЫ В МЕДИЦИНСКОЙ ОНЛАЙН КОММУНИКАЦИИ**

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**Аннотация:** Статья посвящена анализу аксиологической составляющей метафоры в медицинской коммуникации, реализуемой посредством современных интернет-технологий. Рассматриваются ключевые понятия медицинской деятельности: болезнь и здоровье, дается оценка роли взаимоотношений врача и пациента в процессе лечения. Исследование проводится на метафорах медицинской онлайн-коммуникации лечебных учреждений Франции.

**Ключевые слова:** аксиология, медицина онлайн-коммуникаций, метафора, французский язык.



## UTILISATION DE LA MÉTAPHORE DE L'ESPACE DANS LE DISCOURS D'INTERNET: ASPECT COGNITIF

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### **Résumé**

Sont examinées les métaphores conceptuelles utilisées dans le domaine de l'INTERNET. Est étudiée l'interprétation des métaphores par l'école linguistique française. Est révélé que parmi les métaphores interprétant l'Internet, les métaphores de l'espace prédominent: Agora, labyrinthe, forêts, tunnels, grottes, mines, nids, toile d'araignée, châteaux, villes, village global, autoroutes, réseau. Les plus productives sont les métaphores de l'espace aquatique: océan, mer, source, flux, surf, navigation. Sont analysées les sources du modèle métaphorique de l'espace. Sont montrées les nouvelles tendances dans la représentation métaphorique des concepts d'Internet. Sont présentées les perspectives d'autres recherches sur les métaphores du domaine de l'Internet.

**Mots-clés:** métaphore conceptuelle, métaphores de l'espace, représentation métaphorique, métaphores ontologiques

### **Introduction**

Le présent article s'inscrit dans le domaine des études cognitives considérant les métaphores aidant à la connaissance du monde réel, y compris celles qui sont utilisées pour verbaliser les notions et les concepts de l'Internet.

Cet article propose un examen du matériel théorique accumulé par les linguistes français qui étudient les métaphores de la cognition, en particulier les métaphores spatiales. L'analyse montre que dans la linguistique française la métaphore est assez largement interprétée [1; 2]. Dans le même temps, presque toutes les métaphores françaises d'Internet sont terminologiques et empruntées à l'anglais / américain, car Internet en tant que phénomène est né aux États-Unis et comme toute langue pour les spécialistes, a été «imprégné» des métaphores, qui ont été immédiatement et sans changement calquées dans la langue française. L'étude du corpus des modèles métaphoriques ontologiques français du domaine de l'Internet témoigne de la prédominance des métaphores dans lesquelles le signe du mouvement, du glissement, du déplacement dans l'espace est actualisé. La tâche de cet article consiste à étudier le rôle de la métaphore, en particulier la métaphore spatiale, dans le processus de la métaphorisation du langage d'Internet.

### **Métaphores de l'espace et leur rôle dans la représentation de l'Internet**

Les métaphores qui catégorisent les possibilités pratiques de tracer les limites dans l'espace sont des métaphores ontologiques. La notion d'espace définit la distinction de base entre «dans» et «à partir de». Une personne est constamment dans un certain espace. Le processus de la transmission d'informations (ou de communication) est interprété comme un mouvement de significations «remplissant» les expressions linguistiques le long d'un «canal» reliant le locuteur et l'auditeur. Les expressions

linguistiques sont des conteneurs remplis d'informations sous forme de pensées, de jugements. Les métaphores ontologiques déduites dans le discours d'Internet sont:

**Agora** c'est une réunion de citoyens de la Grèce Antique pour discuter librement des nouvelles et prendre des décisions relatives à la vie publique; la place de la ville pour ces réunions, ainsi que pour le divertissement (y compris le théâtre et la gymnastique), plus tard pour le commerce. Les métaphores qui interprètent l'Internet comme "agora" soulignent son caractère démocratique, la possibilité de la libre communication: Agora c'est un espace public mondialisé où les acteurs de la société civile et les représentants politiques prennent part aux débats. Le signe "Agora" est utilisé aujourd'hui dans les noms des associations, des organisations, des portails, des groupes sur réseaux.

**Labyrinthe** c'est une figure symbolique et une image mentale qui renvoie à la mythologie grecque, plus précisément au mythe de Thésée, qui a dû faire face à un choix de chemin parmi de nombreuses routes. Ces difficultés ont été surmontées grâce au fil d'Ariane, la seule issue a été trouvée. La notion de labyrinthe est activement utilisé comme moyen de connaissance, et l'on recourt aussi à d'autres métaphores anthologiques pour présenter les voies de recherches: *forêts, tunnels, grottes, mines, toile d'araignée, châteaux, montagne, routes, autoroutes, village global, réseaux.*

**Océan** c'est la métaphore ontologiques qui apparaît dans "Le nouvel Organon" de F. Bacon. La notion de l'océan est accompagnée de celle de "navigateur". Les mots utilisés comme sources de la métaphore de ce domaine de connaissance sont: *surf, surfeur, surfeur, égoserfing, égoserfer, égoserfer naviguer.* Les termes du thème marin ont reçu une signification métaphorique (qu'ils n'avaient pas auparavant) juste en relation avec l'avènement de l'Internet et le développement de l'idée d'obtenir des informations à la suite d'un glissement, d'un déplacement sur la surface lisse de l'océan.

D'autres métaphores maritimes apparaissent aussi: *débarquer sur Internet, pirate informatique, inondation, flux, îlot, passerelle éclose.* Ces métaphores océaniques sont heuristiques: elles parlent des risques des promenades en mer (ou des voyages), des erreurs possibles. Elles font appel à des qualités humaines telles que l'ingéniosité, la rêverie, le désir d'imagination.

### **Métaphores comme étiquettes dans les vastes étendues de l'Internet**

L'énorme vitesse de la propagation de l'Internet, sa pénétration dans tous les domaines de l'activité humaine à partir des blogs et de la publicité jusqu'aux opérations bancaires et aux achats domestiques par les habitants, a posé aux utilisateurs de nouvelles tâches liées à la facilitation du choix de la recherche de l'information nécessaire dans les vastes étendues de l'Internet, ainsi que de nouvelles désignations, y compris métaphoriques. Le nombre de métaphores a commencé à augmenter, sans se limiter au plan verbal en raison de la facilité avec laquelle elles ont commencé à se reproduire. L'imagination a poussé à la recherche de nouvelles formes et images, et la métaphore a commencé à doubler l'aspect iconique (si l'on se souvient de la classification des signes de Pierce) [3]. Les deux principaux navigateurs du

réseau, Explorer et Netscape, ont une désignation métaphorique visuelle: la planète et l'océan à prédominance bleue, incarnant des images de voyages spatiaux ou océaniques. Les promenades, les voyages, les aventures et les découvertes possibles dupliquent non seulement dans le monde virtuel le développement d'espaces géographiques et spatiaux spécifiques, mais nécessitent également des conseils, des instructions, des guides. En tant que ces derniers sont les soi-disant métaphores-étiquettes, qui ont une incarnation graphique: cadres, boutons, pointeur (main ou flèche), etc. Le signe @ sert non seulement à indiquer l'adresse de la boîte aux lettres virtuelle, mais aussi à offrir un service sur le réseau (*en s@voir plus*).

Un autre symbole important et une métaphore-étiquette peut être considéré comme le signe # - grille qui se transforme en un lien, un hashtag. Le célèbre linguiste et lexicographe français Alan Rey estime que le mot «hashtag» a été emprunté en français en 2009 [4].

La présence de métaphores-étiquettes permet non seulement de progresser rapidement et délibérément dans les vastes étendues d'informations, mais aussi, si nécessaire, de revenir au point de départ du chemin ou de reporter les liens nécessaires pour y revenir plus tard. Ainsi, la notion de “navigation” et de “surf” s'enrichit de nouveaux sens significatifs, devenant une “stratégie cognitive” [5].

### **Conclusion**

L'étude des métaphores cognitives d'Internet à la base du matériel théorique accumulé par les linguistes français montre que l'école linguistique française consacre de nombreux travaux à ce sujet et interprète les modèles conceptuels analysés comme des métaphores de la cognition, dans lesquelles les métaphores de l'espace jouent un rôle important, tandis que les thèmes marins dominant dans les sources des métaphores. Les métaphores de l'espace se distinguent par leur caractère heuristique et leur iconicité. En plus des métaphores verbales, il y a aussi celles visuelles, y compris des signes et des symboles métaphoriques qui peuvent être interprétés comme des métaphores-étiquettes aidant à assurer la recherche de l'informations dans les vastes étendues de l'océan des informations publiées sur Internet.

La rapidité avec laquelle l'Internet se développe et son application pratique transforment le langage moderne de l'Internet d'une langue spécialisée en une langue proche de la langue parlée. L'émergence et la prolifération rapide des réseaux sociaux ont entraîné des changements importants dans le langage des internautes, y compris de nouvelles métaphores. Nous voyons la perspective de recherches ultérieures dans l'étude de la communication métaphorique verbale et non verbale dans les réseaux sociaux, ainsi que dans l'analyse des métaphores interprétant l'efficacité de la recherche d'informations dans l'Internet.

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## **ИСПОЛЬЗОВАНИЕ МЕТАФОР ПРОСТРАНСТВА В ИНТЕРНЕТЕ: КОГНИТИВНЫЙ АСПЕКТ**

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**Аннотация:** Исследуются концептуальные метафоры, используемые в предметной области ИНТЕРНЕТ. Показана интерпретация метафор познания французской лингвистической школой. Выявлено, что среди метафор, интерпретирующих Интернет, преобладают метафоры пространства: Агора, лабиринт, леса, туннели, гроты, шахты, гнезда, паутина, замки, города, «глобальная деревня», автотрассы, сеть. Самыми продуктивными являются метафоры водного пространства, а именно: океан, море, источник, поток, серфинг, навигация. Проанализированы источники метафорической модели пространства. Перечислены тенденции в метафорической репрезентации Интернета. Предложены перспективы дальнейших исследований метафор предметной области ИНТЕРНЕТ.

**Ключевые слова** концептуальная метафора, пространственная метафора, метафорическая репрезентация, онтологическая метафора

## SOME ASPECTS OF CREATING A COMIC EFFECT IN THE LANGUAGE OF THE MEDIA

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### **Abstract**

The article analyzes some aspects of creating a comic effect in the media. The author considers the factors influencing the final form and content of humorous messages broadcast through mass media channels to be customers, goals, functions, conditions and means of their expression.

**Keywords:** journalism, comic effect, political humor, media.

Nowadays, humor is a popular manipulative tool. Mentioning the works of Socrates, we can state the relevance of rhetorical tricks at the present time, of which the most prominent are breaking the cognitive pattern and surprise. These two components are central elements of verbal humor. The humorous effect is a good means of breaking down cognitive barriers and ensuring that messages penetrate the consciousness of another person [4, p. 7]. “Humorous discourse” has enormous manipulative potential, shaping the point of view of the recipient of the message.” [2, p. 85]. At the same time, humor causes them to unconsciously open up cognitive barriers and makes them receptive to messages that, if heard otherwise, without humor, they might not be open to or disagree with. These are politicians who need power to influence people and their reactions. The most efficient way is to do this through the media: in interviews and political discussions, debates, in television shows.

Today, the media play a central role in shaping the image of the “new politician”, since television and the Internet have opened up unlimited opportunities for manipulating the views of the audience [3, p. 8].

In order to win public favor and approval, politicians can demonstrate their interest in social issues, as President Obama did in the following speech excerpt, by playing on contrast and abundance and using the effect of surprise to create humorous affect, since humor is an unusual cognitive tool, the ability to understand the human condition: “They have a sense that in fact government is the problem, not the solution, and that if we just dismantle government, piece by piece, if we break it up in tax cuts to the wealthy and if we just make sure that we privatize Social Security and we get rid of public schools and we make sure that we don’t have police on the streets, we hire private security guards and we don’t have public parks, we’ve got private parks and if we just break everything up, then in fact everybody’s going to be better off – that in fact we don’t have obligations to each other, that we’re not in this together but instead you’re on your own.” [4, p. 11].

Moreover, humor has become a confrontational tool in the political domain.

Politicians have learned that it is preferable to use humorous rhetoric to attack one's opponent and damage their image due to the positive attitude and receptiveness of the public to this approach. Humor in its essence is not aggressive, and even when it is, the aggressiveness is concealed or softened. That is why it is used for criticism ultimately often.

Here is an example of Barack Obama's use of the Socratic model in creating a humorous template in his November 2007 speech to his rival for the Democratic presidential nomination, Hillary Clinton. He said that she was a skilled and seasoned politician who was conducting her campaign "by the book," but that "the problem is the book itself" [4, p. 11].

The use of political humor is sometimes used to express criticism of politics. For example, Obama attacks his opponent with dignity and subtle humor, as seen in the following example, where words in italics indicate the opposite idea: "I don't think George Bush is a bad man. I think he's a patriotic person and I don't think that the people who work for him are stupid people. I think a lot of them are smart *in their own way*. I think that the problem is that they've got *a different idea of America than we've got*." [4, p. 11].

Therefore, it is important not only to attack with humor, but also to be able to parry such an attack also in humorous manner as the politics of humor challenges the political status quo and strengthens the values and dominant aspects of politics [4, p. 6]. It is possible because humor has the ability to neutralize negative emotions in others. For example: "The fact that you have now questioned my sincerity and my desire to put aside politics for the public interest is regrettable, but it does not in any way diminish my deep respect for you, nor my willingness to find a bipartisan solution to this problem." [4, p. 10]. In this response, following the Socratic model, Obama appears to humble himself and say that his opponent is stronger than him and that respecting him is the main thing. However, later there is a turnabout that makes his words seem to be only a basis for creating a comic affect (irony) at his rival's expense, meant actually to diminish his importance. When Obama was asked about the letter, he responded: "The tone of the letter, I think, was a little over the top, but John McCain's been an American hero and has served here in Washington for twenty years, so if he wants to get cranky in a while, that's his prerogative." [4, p. 10].

It is also important who is the source and who is the target of the joke. "Humorous messages about politics influence attitudes towards individual politicians and the political system as a whole." [1, p. 31]. For example, if a joke is made about the politics in general, the public is likely will have a negative attitude towards it, as humor itself is an expression of the laughing person's attitude at the object of the joke. Another important factor for gaining citizens' the support and approval by political discourse is the use of language and humor that is understandable to the public (message peculiarities are the second factor). The context of the joke should also be clear (public awareness is the third factor) [1, p. 31].

It can be concluded that the customers, as well as the creators, of journalistic texts

broadcast by the media are government institutions and their representatives.

The comic effect is used in the media, first of all, due to its ability to inspire confidence, to make to trust, which makes it possible to increase the size of the electorate and convey the necessary thoughts to the public. Political humor makes it possible to form the necessary attitude and reaction among the masses towards social phenomena, that is, to manipulate their consciousness and behavior. Secondly, due to the nature of irony, its ability to expresses a negative position: ridiculing a political opponent damages their image. Irony has become the main means of struggle for dominating, power in political discourse, as it must fit the civilized framework. Thanks to the ability of the comic to soften aggressiveness, political humor, irony, sarcasm, and political satire are often used in the media.

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## НЕКОТОРЫЕ АСПЕКТЫ СОЗДАНИЯ КОМИЧЕСКОГО ЭФФЕКТА В ЯЗЫКЕ СМИ

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**Аннотация:** Проанализированы некоторые аспекты создания комического эффекта в средствах массовой информации. К факторам, влияющим на конечные форму и содержание юмористических сообщений, транслируемых через каналы массового информирования, автор относит заказчиков, цели, функции, условия и средства их передачи.

**Ключевые слова:** журналистика, комический эффект, политический юмор, средства массовой информации.

## CLOSE READING AS A TOOL FOR COMPREHENSION AND INTERPRETATION OF TEXT IN THE UNIVERSITY ECOSYSTEM

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### Abstract

Today 'close reading' is becoming one of the most important methods of comprehension of both artistic and scientific texts. Close reading is a method of literary analysis that involves a detailed examination of a text, focusing on its language, structure and themes. The purpose of our research is to find out how we can organize 'close reading' in the classroom with students, what problems of comprehension and interpretation we face in the process of reading a text, how to maintain the emerging skill and use it in the learning process. This topic will be of interest not only to teachers of humanities disciplines, but also to anyone who understands education as the formation of skills for setting research problems and solving them. A number of case studies are developed and specific practical recommendations are given.

**Key words:** analysis, close reading, comprehension, interpretation, meaning.

'Close reading' means using active reading skills to gather information and details from a text. Active reading means underlining, asking questions and taking notes while reading. 'Close reading' helps activate brain to engage with and analyze a text. The goal of close reading is to develop a better understanding of what you need to find deeper meanings. 'Close reading' is defined as "the mindful, disciplined reading of an object (i.e. text) with a view to deeper understanding of its meaning." [2: 3].

What is the point of close reading? Why do we think it can be recommended not only to philologists but to all students? Why should such lessons be conducted in the classroom at a higher education institution?

The phenomenon itself has been the object of close study by philologists and sociologists for the past quarter of a century [1, 2, 3].

"When a student engages in 'close reading', he or she analyzes the text at the word or phrase level and the sentence and paragraph levels. By considering the weight of meaning of particular phrases or sentences in a section of a text, the student can begin to see how important details fit together to support the author's central idea in a section of the text or the whole text (in complex texts, there will be more than one central idea.)" [3: 26] These are essential skills for our students to cultivate in a world where they are constantly bombarded with information they need to understand in order to be active participants in society.

The author's arrangement of punctuation marks is also the subject of "close reading". It is important to pay attention to every detail of the text including punctuation marks.

We analyze the beginning of the first line in Pushkin's poem "I loved you". In the phrase "I loved you:" colon means that further there will be an explanation of what



was said a little earlier. "I loved you:" and so we are waiting for some explanation of what was said. In Pushkin's poem "I loved you" is repeated 3 times in 8 lines. The verb "love" is in the past tense, which indicates that the action in the present is no longer taking place, but it's followed by a colon. This close attention to punctuation can lead us to other meaningful aspects of the text. This poem is not about love that has passed, but about love that is here and now. This poem is about the fact that the feeling has not disappeared anywhere, but maybe became stronger and got other emotions: «And may God grant you to be loved again».

If we pay attention to punctuation marks, it leads us to a different interpretation. The problem with studying modern literature is that students have a set of ready-made interpretations rather than paying attention to the text and being able to read it slowly and consistently.

Understanding the text should not turn into memorizing interpretations such as "Onegin is a superfluous person in literature", "Oblomov is distinguished by laziness and apathy", "Bazarov is a nihilist, and he denies everything". The point is not to memorize a set of shortcuts, but to be able to come to these conclusions on our own when reading the text slowly and carefully. These general judgments are true, but in part, because they are not filled with the inner world that the reader himself brings. If we are talking about the 'close reading' technique itself, it is important for us to understand what elements of the text to pay attention to.

We get a mechanism that helps us to formulate the meaning of a text in an evidential and verifiable way. It will not be our subjective perception of "it seems to me so" or "I see it so". It will be an evidential explanation of exactly how the text is organized that way.

By reading actively we are also doing interpretive work. It is absolutely pointless to ask the author what he wanted to say; even he himself cannot answer this question. It is more appropriate to ask what the text is telling us. The modern text of the 20th, 21st century is organized in such a way that it retains invisible threads of connection with other texts; it is not created in a vacuum.

The main objective in using the "close reading" method is, of course, a greater understanding of the text than is possible with a cursory reading. In this case, we can draw attention both to punctuation marks and to separate elements of the text, which are marked in a special way by the author, and in order to see the marking we have to relate a certain element of the text with other elements or with repetitions of elements within it.

First, we should study the microstructures that appear at the level of a paragraph, an episode, then, when we relate them to each other in sequence, we get a provable semantic picture. Careful 'close reading' reveals imperceptible elements of the text, aspects of its poetics. It is important not so much to analyze, but to comment on what we read and offer an evidential interpretation. For a full understanding of the text, it is important to read and understand every detail of the text. Naturally, it is about quality reading and in-depth comprehension. It enriches us as readers and shows our students

how we can operate at the level of the simplest reading algorithms, latching on to individual meanings and connotations, unwinding the chain of meaning. It is difficult to read a text with a system of contexts around it and ‘close reading’ is exactly how contexts can be attracted to individual words and elements of the text.

Similarly, in physics or math, ‘close reading’ shows how one formula relates to another showing contextual connection. From our point of view it is useful if one is in the technical sciences and understands math not as a set of formulas, but as an understanding of how the universe works and one cannot help but make contextual connections. It is good practice for students one day a week to engage in a discipline of another specialty: a programmer may choose to study linguistics, and a philologist, on the contrary, may choose balance construction, etc. Professional success of students of technical specialties increases if they are engaged in humanities disciplines.

‘Close reading’ includes a hermeneutic circle, when we grasp the whole, then, reading slowly, establish connections and relations, see certain semantic structures, examine this whole in parts, and then, again, reconstruct the whole, but now in a different semantic volume, with a different number of semantic aspects and details. We can metaphorically compare ‘close reading’ with the resolution of a camera matrix. At first reading, grasping the images can be compared to a camera matrix-soapbox, at ‘close reading’ — to a digital photo of high quality. From flat superficial reading with decreasing reading speed we move to more complex stereoscopic reading and getting through the text of three-dimensional semantic figures.

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## «МЕДЛЕННОЕ ЧТЕНИЕ» КАК ИНСТРУМЕНТ ПОСТИЖЕНИЯ И ИНТЕРПРЕТАЦИИ ТЕКСТА В ЭКОСИСТЕМЕ УНИВЕРСИТЕТА

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**Аннотация:** Сегодня «медленное чтение», или «close reading» становится одним из наиболее значимых методов постижения как художественного, так и научного текста. Цель нашего исследования – выяснить, как можно организовать «медленное чтение» на занятиях со студентами, в чём состоит его смысл, с какими проблемами понимания и интерпретации мы сталкиваемся в процессе чтения текста, как поддерживать формирующийся навык и использовать его в процессе обучения. Данная тема заинтересует не только преподавателей гуманитарных дисциплин, но и всех, кто понимает образование как формирование навыков постановки исследовательских задач и их решения. В ходе работы разработан ряд конкретных кейсов и даны конкретные практические рекомендации.

**Ключевые слова:** анализ, интерпретация, медленное чтение, понимание, смысл.

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## MODALPARTIKELN IN DER DEUTSCHEN SPRACHE. DIDAKTISCHER ANSATZ: PROBLEME UND LÖSUNGEN

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### Zusammenfassung

Der vorliegende Beitrag beschäftigt sich mit dem Problem der Didaktisierung der Modalpartikeln (MPn) der deutschen Sprache. Die MPn finden nicht immer direkte Entsprechungen in anderen Sprachsystemen. Dies führt zu Schwierigkeiten im DaF-Unterricht. Nach einer Einführung in die Partikelforschung des Deutschen bietet der vorliegende Beitrag eine Darstellung des Phänomens der MPn und liefert Überlegungen in Bezug auf die Probleme, die mit der Vermittlung der MPn im DaF-Unterricht verbunden sind. Darauf basierend wird im Beitrag ein Vorschlag für die Didaktisierung der MPn gemacht, der als konkreter Versuch verstanden werden soll, das Phänomen der MPn im universitären Bereich einzuführen.

**Schlüsselwörter:** Modalpartikeln, Unterricht Deutsch als Fremdsprache, Didaktik, kommunikative Funktion.

In diesem Artikel wird das didaktische Problem untersucht, fremdsprachigen Studierenden die kompetente Beherrschung und korrekte Verwendung von Modalpartikeln (im Folgenden MPn genannt) in der deutschen Sprache zu vermitteln. Modalpartikeln der deutschen Sprache finden nicht immer direkte Übereinstimmungen in anderen Sprachsystemen. Dies führt zu gewissen Schwierigkeiten beim Unterrichten von Deutsch als Fremdsprache. Machen wir zunächst einen kurzen Exkurs in die Geschichte der Modalpartikelforschung in der deutschen Sprache.

Der Begriff Modalpartikel bezeichnet eine Gruppe von über 20 Lexemen, die ein typisches Phänomen der deutschen Sprache sind. MP wird oft als Merkmal der gesprochenen Sprache angesehen, aber dieses Phänomen findet sich auch in geschriebenen Texten, die gesprochene Sprache repräsentieren. Die Liste der deutschen Modalpartikeln umfasst die folgenden Lexeme: *aber, also, auch, bloß, denn, doch, eben, eigentlich, einfach, etwa, erst, halt, ja, noch, nun, nur, mal, ruhig, schon, vielleicht, überhaupt, wohl*.

Die ersten Grammatiklehrbücher betrachteten MPn als bedeutungslose und unnötige Elemente [4, S. 71] oder „Läuse im Pelz der deutschen Sprache“ [3, S. 340]. In systematischen Studien zu deutschen Partikeln war jedoch ihre Fähigkeit festgestellt, verwandte Konzepte zu korrelieren und in einem Kontext über den Rahmen des Satzes hinaus zu funktionieren, was für die syntaktische Semantik des Textes wichtig ist [1, S. 57-60]. Das Interesse an der Erforschung der deutschen Sprache ist im Zusammenhang mit der Fokussierung der Sprachwissenschaft auf die kommunikativen Funktionen der Sprache, also mit der pragmatischen Wende in der

Linguistik, entstanden.

Einer der wichtigsten Aspekte, die die MP-Forschung berührt hat, ist Homonymie und Heterosemie bzw. Polysemie sowie Polyfunktionalität. Beide Begriffe weisen darauf hin, dass bestimmte Lexeme unterschiedliche Funktionen haben können. Fast alle als MPn klassifizierten Lexeme können neben der Funktion einer Modalpartikel auch in einer indexikalischen Funktion verwendet werden und den Inhalt des Geäußerten mit einem pragmatischen Kontext verbinden. Verschiedene Arten der Verwendung von Lexemen werden Heterosemie genannt. Das Heterosemie einer MP wird durch Lexeme dargestellt, die die gleiche morphologische Form wie die entsprechende MP haben, sich jedoch syntaktisch, prosodisch oder semantisch unterscheiden. Beispielsweise kann das Lexem *denn* als Modalpartikel (1) oder als koordinierende Konjunktion (2) auftreten:

(1) *Hast du denn einen Führerschein?*

(2) *Er kommt nicht zur Arbeit, denn er ist krank.* (Beispiele: [2, S. 106; 110]).

Es ist zu beachten, dass deutsche MPn in anderen Sprachen sowie im Russischen keine eindeutigen Entsprechungen haben und auf unterschiedliche Weise übersetzt werden. Vergleichen Sie:

„Das soll sich wohl machen lassen, sagte mein Vater und streckte seine Hand aus“ [5, S. 32].

«Как-нибудь. Поживем – увидим! – сказал отец, протягивая руку» [6, с. 34].

„Wo ich Ihnen doch gern hab` wie einen Sohn“ [7, S. 5].

«Ведь вы мне очень дороги, так дороги – прямо как родной сын!» [8, с. 5].

„Schön, dann trinken Sie das Glas mal aus!“ [7, S. 4].

«Правильно. Вот и выпейте рюмку!» [8, с. 4].

„Zeig doch mal den Wagen, Otto“, sagte Lenz“ [7, S. 12].

«Да покажи ты ему машину, Отто», сказал Ленц» [8, с. 13]

Wie ein kurzer Überblick über die Literatur zur Untersuchung von Modalpartikeln zeigt, haben sie einen ziemlich bedeutenden Platz in der Semantik, Syntax und funktionalen Grammatik eingenommen. Allerdings sind sie in der Methodik des Deutsch-als-Fremdsprachen-Unterrichts kaum erforscht. Gleichzeitig sind MPs ein für die deutsche Sprache typisches Phänomen, was darauf hindeutet, dass die Didaktik des Deutschen als Fremdsprache dieses Phänomen nicht ignorieren kann.

In diesem Bericht stellen wir eine der Möglichkeiten vor, Schülern deutsche Partikeln beizubringen und Fähigkeiten zu entwickeln, sie in der Sprache zu verwenden. Wie die Unterrichtspraxis zeigt, beginnt das MP-Studium nur in seltenen Fällen auf der Grundstufe. Die hier beschriebene didaktische Erfahrung versteht sich als Versuch, die sprachliche und metalinguistische Kompetenz von Deutsch als Fremdsprache erlernenden Personen zur theoretischen Darstellung der Funktionen der MPn zu nutzen.

Es wird erwartet, dass der Unterricht in zwei aufeinanderfolgenden Modulen organisiert wird. Das erste Modul besteht aus der Darstellung des Phänomens MP wobei jeweils eine kurze Bedeutungsbeschreibung anhand von Zitatvorschlägen aus

der einschlägigen Fach- oder Belletristik erfolgt. Diese konkreten Beispiele werden in Form von Blöcken dargestellt, also als prototypische Modelle für die weitere spontane Verwendung der entsprechenden MPn in den entsprechenden Satztypen. Zum Beispiel:

**ja:** Mit diesem Teilchen glaubt der Sprecher, dass die Fakten wahr und bekannt sind. Es kann auch davon ausgegangen werden, dass der Zuhörer über ein anderes Wissen verfügt. Beispiel: „*Na ja... „ sagte ich dann, „immerhin <...> Sie finden mich wohl etwas idiotisch, was?“*“ [7, S. 48]. Kommt in Aussage- und Ausrufesätzen vor.

**doch:** – ein Hinweis auf etwas Bekanntes, aber auch ein Signal der Korrektur und Widersprüche überwinden. Der Sprecher signalisiert, dass sich die bisherigen Annahmen, Erwartungen oder das Verhalten des Zuhörers ändern müssen. Kommt in Aussagesätzen, Aufforderungssätzen, Ausrufesätzen und seltener in Fragesätzen vor. Beispiel: „*Das ist doch das höchste, was es gibt*“ [7, S. 8].

**denn:** signalisiert eine Frage, auf die der Sprecher keine passende Antwort hat. Die Antwort und der Grund für das Missverständnis finden Sie im vorherigen Kontext. Funktioniert in der Regel in Fragesätzen. Beispiel: „*Was kostet er denn?*“ [7, S. 12].

**mal:** dient der Abschwächung der Bitte. Kommt in Bittesätzen und Fragesätzen vor. Beispiel: „*Schauen Sie sich mal erst die Rippchen an!*“ [7, S. 35].

Um die kommunikative Funktion von MPn besser zu erkennen, werden die Studierenden gebeten, Beispiele für MPn in Dialogen aus Belletristik und Fachliteratur zu identifizieren und in der zweiten Aufgabe entsprechende Partikeln in die Dialoge einzufügen.

Im zweiten Modul werden die untersuchten Partikeln aus der Perspektive der Übersetzung in die Muttersprache untersucht. Diese Phase besteht zunächst auch aus ersten theoretischen Informationen, mit deren Hilfe das Problem der Gleichwertigkeit des deutschen und russischen Wortschatzes gelöst wird. Dabei werden sowohl eindeutig äquivalente sprachliche Einheiten verwendet, als auch Übersetzungen auf verschiedene Arten und schließlich allgemein unübersetzbare MPn.

Generell zeigt sich, dass es beim Studium der deutschen Sprache als Fremdsprache ratsam ist, das Thema MPn in mehreren Etappen zu studieren, da Kompetenzen und grammatikalische Kenntnisse die „funktionale Basis“ von MPn bilden, die zur Lösung der komplexen Problematik ihres Verständnisses und ihrer Verwendung in der Sprache beiträgt.

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## **МОДАЛЬНЫЕ ЧАСТИЦЫ В НЕМЕЦКОМ ЯЗЫКЕ. ДИДАКТИЧЕСКИЙ ПОДХОД: ПРОБЛЕМЫ И РЕШЕНИЯ.**

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**Аннотация:** Рассмотрена проблема обучения модальным частицам (МЧ) немецкого языка. МЧ не всегда находят прямые эквиваленты в других языковых системах. Это приводит к трудностям на уроках немецкого языка как иностранного. После краткого экскурса в историю изучения немецких частиц в этой статье анализируется феномен МЧ и формируются предложения относительно проблем, связанных с обучением МЧ на занятиях по немецкому языку как иностранному. На основании этого в статье выдвигается предложение по методике преподавания и обучения употреблению и переводу модальных частиц немецкого языка. под которым следует понимать конкретную попытку внедрения феномена МЧ в университетскую сферу образования.

**Ключевые слова:** модальные частицы, преподавание немецкого языка как иностранного, дидактика, коммуникативная функция.

## FEATURES OF NON-VERBAL COMMUNICATION IN FOREIGN LANGUAGE TEACHING

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### Abstract

Non-verbal communication plays a crucial role in foreign language teaching, allowing learners to comprehend and express ideas effectively. This paper explores the features and significance of non-verbal communication in foreign language teaching. Various non-verbal cues, such as gestures, facial expressions, and body language are examined in relation to their impact on learners' comprehension, motivation, and cultural understanding. Understanding and utilizing these non-verbal features can enhance the overall language learning experience and improve communication skills in the target language.

**Keywords:** communication skills, foreign language teaching, non-verbal communication, non-verbal cues.

Foreign language teaching has experienced significant advancements over the years, with increased recognition of the role non-verbal communication plays in language learning. Non-verbal cues provide context, express emotions, and convey cultural nuances indispensable for effective communication in a foreign language. By incorporating non-verbal features into language instruction, educators can create a more immersive and engaging learning environment that fosters language acquisition and cultural understanding. This article investigates various features of non-verbal communication in foreign language teaching and outlines their influence on language learners.

Despite frequent evidence in favor of the need to include non-verbal cues in the process of foreign language teaching as a socio-cultural competence, a meaningful model of non-verbal means as one of the important constructive factors has not yet been developed in language teaching methods, although studies of this phenomenon have been carried out repeatedly [1–5, 7]. In this regard, V.U. Nogaeva notes that “the lack of mastery of non-verbal means of communication prevents the understanding of foreign language information and, as a result, slows down the process of sociocultural interaction in an intercultural context, since it is known that nonverbal means are culturally conditioned. Communication can be completely successful only if its participants are able to interpret non-verbal means of communication” [6, p.5].

### Body language

Body language encompasses posture, movements, and physical interaction. 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.

While teaching a foreign language, educators can utilize body language to engage learners and create a dynamic learning environment. For instance, utilizing movements, such as walking around the classroom or using hand gestures to animate a story, can capture learners' attention and make the language input more memorable. Body language can also be used to provide context, support meaning, and emphasize certain points during instruction.

Utilizing body language introduces an interactive and dynamic element into language teaching, which can enhance learner motivation and engagement.

*Practical strategies for foreign language teachers to incorporate body language into their teaching practices:*

a. Role-Playing: Encourage students to engage in role-plays to practice using appropriate body language for various contexts.

b. Video Analysis: Utilize videos, films, or TV shows to analyze and discuss body language expressions, both cultural and individual.

c. Gestures and Facial Expressions: Teach students culturally appropriate gestures and facial expressions, as they play a crucial role in effective communication.

d. Visual Aids: Deploy visual aids, such as pictures or diagrams, to illustrate concepts related to body language. Visual aids, such as images, videos, or real-world objects, are significant non-verbal tools that facilitate language learning. Visual elements help learners reinforce vocabulary, comprehend grammar structures, and understand abstract concepts. Incorporating visual aids into foreign language instruction enhances learners' understanding, particularly when words or linguistic cues might not be sufficient to convey meaning accurately.

Incorporating these strategies can significantly enhance language learning outcomes. By integrating non-verbal cues, instructors can facilitate authentic communication, enhance student engagement, and develop cultural competence among learners.

### **Gestures**

Gestures are an inherent part of human communication. In foreign language teaching, gestures can be utilized as an effective tool to support verbal instruction. Incorporating gestures into foreign language teaching holds great potential for enhancing language acquisition and comprehension. Teachers can use gestures to convey specific meanings, clarify complex concepts, or create associations with words. For instance, demonstrating the verbs "to eat" or "to drink" while saying the corresponding words can help learners establish a link between the word and its action, facilitating vocabulary acquisition.

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.

While it presents challenges and limitations, empirical research supports the benefits of utilizing gestures as an effective pedagogical tool. By understanding the theoretical foundations, practical applications, and potential cultural considerations, educators can maximize the efficacy of gestures in facilitating foreign language learning. Continued research in this area will contribute to the further development of innovative and inclusive teaching methodologies.

### **Facial expressions**

Facial expressions are fundamental in expressing emotions and attitudes, often transcending language barriers. Facial expressions play a crucial role in conveying emotions and attitudes, which differ across cultures. Understanding and recognizing these expressions aid in cross-cultural communication and language comprehension.

In foreign language instruction, teachers can employ facial expressions to enhance comprehension and elicit emotion. Adopting appropriate facial expressions while conveying different ideas or roles can aid learners in grasping the intended meaning. Moreover, facial expressions can assist in teaching cultural nuances, as they vary across cultures and can indicate politeness, respect, or social hierarchy.

Teachers can use facial expressions to enhance comprehensible input, creating a supportive learning environment. Expressing emotions and meaning non-verbally aid in conveying messages and making language input more memorable. Incorporating authentic materials, such as videos, movies, and images, can expose learners to real-life situations where facial expressions are common. Engaging learners in role-plays and activities require them to practice facial expressions facilitates active learning and reinforces the connection between language and non-verbal cues.

### **Proxemics**

Proxemics refers to the study of personal space and physical distance between individuals during communication. Understanding the importance of proxemics in foreign language teaching can help educators create culturally appropriate and etiquette-sensitive classrooms, leading to effective language acquisition and intercultural competence. In foreign language teaching, awareness of proxemics is crucial for promoting cultural sensitivity and effective communication. Understanding appropriate distances during conversation, greetings, and other interactions can prevent

learners from unintentionally causing discomfort or violating cultural norms when communicating with native speakers.

Proxemics can also help break the ice as it can be utilized as an ice-breaker to encourage students to interact and communicate with each other in the target language while considering cultural norms of personal space.

Incorporating proxemics in language instruction allows learners to understand how spatial proximity influences speech acts, non-verbal cues, and social dynamics. This fosters authentic language use and pragmatic competence.

By analyzing proxemic patterns, students can develop an understanding of the relationship between body language, vocal projection, and speech clarity. This awareness contributes to effective pronunciation and intonation.

*Practical strategies for incorporating proxemics in language classrooms:*

a. **Pair and Group Activities:** Designing activities that involve proximity-based instructions enables learners to navigate spatial boundaries, adjust social distances, and negotiate intercultural differences.

b. **Role-Plays and Simulations:** Engaging students in role-plays and simulations within a cultural context deepens their understanding of proxemics and enhances their ability to use language appropriately in various social situations.

c. **Cultural Immersion:** Implementing field trips, guest lectures, or video conferences with native speakers provides students with immersive cultural experiences. Encouraging students to observe and analyze proxemic behaviors helps to bridge the gap between language and culture.

Thus, the utilization of proxemics in foreign language teaching contributes to developing an interculturally competent learner. By understanding and integrating proxemics, educators can create more engaging and effective language learning experiences that take into account cultural norms and build cultural sensitivity among students. Incorporating proxemics into language instruction fosters authentic language use, enhances interpersonal communication, and ultimately aids in the overall language acquisition process.

In conclusion, non-verbal communication features contribute significantly to foreign language teaching, enhancing language comprehension, cultural understanding, and overall fluency. Educators play a crucial role in promoting the integration of non-verbal communication into foreign language classrooms, facilitating a holistic and immersive learning environment. By consciously incorporating gestures, facial expressions, body language, proxemics into instruction, educators can create a more immersive learning environment, fostering language acquisition and encouraging effective communication in the target language. Recognizing and utilizing the power of non-verbal communication can lead to a more engaging and culturally competent learning experience for foreign language learners.

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## **ОСОБЕННОСТИ НЕВЕРБАЛЬНОГО ОБЩЕНИЯ ПРИ ОБУЧЕНИИ ИНОСТРАННОМУ ЯЗЫКУ**

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**Аннотация:** Невербальное общение играет решающую роль в преподавании иностранного языка, позволяя учащимся эффективно понимать и выражать идеи. В данной статье исследуются особенности и значение невербального общения в обучении иностранному языку. Различные невербальные сигналы, такие как жесты, мимика и язык тела, исследуются на предмет их влияния на понимание, мотивацию и культурное понимание учащихся. Понимание и использование этих невербальных особенностей может улучшить общий опыт изучения языка и улучшить навыки общения на целевом языке.

**Ключевые слова:** коммуникативные навыки, обучение иностранному языку, невербальное общение, невербальные сигналы.

## THE FUNCTIONS OF THE LANGUAGE GAME IN THE LINGUOCREATIVE SPACE OF AN ARTISTIC WORK

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### Abstract

The article analyzes the functions of the language game in fiction. The writer realizes the significance of the language code to create an aesthetic effect and comic meanings due to the generation of “nonclassic” forms of verbal signs through the language game’s mechanism.

**Keywords:** artistic text, language game, functions of language game, artistic discourse.

The artistic text is an exceptional playing field within which a writer is granted freedom of speech creativity from the linguistic system. The author deliberately resorts to using a non-standard language code that actualizes a sign’s formal side against the background of an associative context. A creative experiment consisting in manipulating expressive forms of speech implements the linguistic-creative function developing the thinking of the addresser and the addressee, as well as enriching the language (individual creativity through multiple decoding and recoding of information is fixed in the language system of a particular ethnic society as a new way of expressing thought). The linguistic-creative function is close to the linguistic-cognitive function: the language game in the writer’s hands becomes an instrument of cognition of the language code which helps him to translate his own ideological-thematic and artistic-aesthetic attitudes [3, p. 26]. The writer has an opportunity to recreate the language material in a new associative context: “... he thought I was a **tag-along** and a kid” [2, p. 12] (substantiation of the verb “to tag along”).

Thus, unique author’s playful techniques at different levels of text functioning organize an artistic work’s space for broadcasting new associative links between the meanings of lexical units during the creative-communicative activity. In this case, language game performs two functions at once: a meaningful function (creation of a new content through non-standard linguistic “innovations”): “You **dig** okay, baby” [2, p. 20] (the verb “dig” in the sense of “to understand”, “to realize”), “We were gaining on him, but he had a **block's head start**” [2, p. 78] (a literal translation is “he was just running forward”) and an expressive one: “...he looked like some **Greek god** come to earth” [2, p. 15] (an appeal to the artistic device “comparison” that acts as a means of embodying of a memorable character’s image).

The language game is usually programmed to work with the figurative and tropic possibilities of the language to achieve a humorous outplay of the surrounding reality [3, p. 28]. A language joke activates the process of perception of external alogism and additional occasional meanings, generating a comic effect: “Shoot, you’re ninety-six if **you’re a day**” [2, c. 19] (this expression can be decoded as “at least” or “I think you're

at least ninety-six years old, and I would be very surprised if I am wrong”). Therefore, one of the distinctive functions of this linguistic phenomenon is a comic one, that is, creating a humorous mood through irony, sarcasm or satire: “We really picked them up...We’re really **Arabian slave traders** and we’re thinking about shanghaiing them. **They’re worth ten camels** apiece at least” [2, p. 19].

The language game’s multifaceted “technique” is built, first of all, due to the aesthetic essence of the work of art and the individual handwriting of its creator [1, p. 4-5]. The author of the artistic work has got an advantage – time to choose the most effective linguistic form of expression that can bring aesthetic pleasure. So the word game introduced into the context performs the function of aesthetic impact: the task is to push the recipient to experience a sense of beauty from the very form of speech (“**Pony boy** Curtis” [2, p. 17], “My name’s Sherry, but I’m called **Cherry** because of my hair. **Cherry Valance**” [2, p. 17]), while “having an unlimited choice of forms and modalities of discursive transformation and representation of the surrounding world’s realities” [4, p. 11]. In the above examples, the formation of onyms is obvious due to the mechanism of using the associative potential of the self-described name.

In the paradigm of the study of aesthetic impact the language game can be considered as a special technique of creating a “play” style of an artistic work. This style is designed for the reading elite, ready to play by the writer’s rules and bypass the “set traps” [1, c. 21]: “**Johnycake**, you and Pony wanta come” [2, c. 13] (the nickname of one of the main characters of the novel “Outsiders”, taken from the English fairy tale “Johnny-cake”, an analogue of the Russian fairy tale “Kolobok”, embodies the life circumstances of the character). Due to this fact, it is possible to distinguish not only a gaming function, but also an entertainment one. For example, the text of a fairy tale can be completely permeated with the spirit of the game to create an atmosphere of natural communication for children. Unexpected images conceived by the author with the help of lexical units that have the right forms, but provocative meaning, should make the child laugh or perturb, but in any case – draw his attention to the word. Awareness of the deviation of poetic word usage from the norm of the native language favors the child’s “linguistic maturity”, the formation of linguistic personality.

Another function of the language game is a masking one: a wittily placed language joke in the context allows the author to bypass the “cultural censorship”, that is, to hide indecent or forbidden thoughts, as well as to express trivial, strange and absurd things: “Get thee hence, **white trash**,” Two-Bit said in a snobbish voice” [2, p. 62] (“white trash” is a contemptuous nickname of white Americans from southern states who haven’t been educated).

In the analyzed communicative sphere, the language game also performs an important characterological function, which correlates with the characters’ images from the point of view of their social status, general and speech culture, the presence of certain behavioral and character features. The language game is most often used in character dialogues: “**Didya** catch ‘em?” [2, p. 11], “Yeah, since it ain’t a school night” [2, p. 13] (a technique of eye dialect marking the spoken language of teenagers from

poor families in the southern regions of America); and the author's narration in the first person: "He was **the gang's pet**, everyone's kid brother" [2, p. 12] (outplaying causal links: the nickname embodies the hero's social characteristic), "Soda attracted girls **like honey draws flies**" [2, p. 12] (focusing on the attractive appearance of the figure).

Moreover, it should be noted that realizing the ideological and thematic attitudes of the author in the literary text, the language game can perform a number of particular functions: associative, allusive, the function of creating a sound and rhythmic-intonation organization of the text, suggestive, relaxing, etc. [1, pp. 30-31].

In works of art the language game appears as a form of linguocreative thinking, focused on the internal resources of expressing the writer's thoughts. This phenomenon acts both as a genre feature and as an example of the mechanism of individual style. During the language game expressively designed messages reveal all the exceptions, deviations and difficulties, simultaneously eliminating the seriousness of the tone and producing the effect of comedy.

Finally, it can be concluded that in fiction the language game can perform the following functions: linguistic-creative, linguistic-cognitive, meaningful, expressive, comic, the function of aesthetic impact, gaming, entertainment, masking and characterological.

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## ФУНКЦИИ ЯЗЫКОВОЙ ИГРЫ В ЛИНГВОКРЕАТИВНОМ ПРОСТРАНСТВЕ ХУДОЖЕСТВЕННОГО ПРОИЗВЕДЕНИЯ

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**Аннотация:** Проанализированы функции языковой игры в сфере художественной литературы. Благодаря порождению «неканонических» форм вербальных знаков через механизм языковой игры писатель акцентирует и реализует значимость языкового кода с установкой на создание эстетического эффекта и комических смыслов.

**Ключевые слова:** художественный текст, языковая игра, функции языковой игры, художественный дискурс

## THE IMPACT OF ARTIFICIAL INTELLIGENCE ON TEACHING FOREIGN LANGUAGES

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### **Abstract**

This article delves into the evolving landscape of foreign language education, exploring the profound impact of Artificial Intelligence (AI) on pedagogical practices. A comprehensive analysis is presented, addressing the integration of AI-driven tools, adaptive learning platforms, natural language processing, and virtual reality applications in the teaching of foreign languages. The article also examines the challenges, ethical considerations, and future prospects associated with the incorporation of AI in language education.

**Keywords:** artificial intelligence, teaching, foreign language

### **Introduction**

In the dynamic realm of education, Artificial Intelligence (AI) has emerged as a transformative force, particularly in the teaching of foreign languages. This article investigates the multifaceted ways in which AI technologies are reshaping language pedagogy, fostering personalized and immersive learning experiences. From adaptive platforms to virtual language tutors, the integration of AI has the potential to revolutionize the landscape of foreign language education.

### **Adaptive Learning Platforms**

One of the key areas where AI is making significant inroads is in the development of adaptive learning platforms. These platforms leverage AI algorithms to analyze learner data, tailoring educational content to individual needs. The adaptive nature of these platforms ensures a personalized learning journey, allowing students to progress at their own pace. This adaptive approach has demonstrated considerable success in enhancing language proficiency compared to traditional classroom settings [2].

One of the most popular adaptive learning platforms is Duolingo. It offers lessons and courses in over 20 languages. The platform employs a variety of learning methods, including games and interactive activities, to assist students in improving their language skills.

Platform Memrise provides users with interactive courses and lessons for learning over 100 languages. It utilizes various memory techniques, such as flashcards and games, to help users acquire new words and expressions more quickly and efficiently.

Rosetta Stone: utilizing a language immersion approach, this platform offers users lessons and activities that simulate real-life communication situations in the target language. Additionally, it provides adaptive lessons that adjust to the user's knowledge level.

Babbel: offering courses and lessons designed by professional teachers, Babbel provides users with the opportunity to learn various languages. The platform adopts an

adaptive approach to learning, adjusting to the user's level of knowledge and individual needs.

### **Natural Language Processing (NLP) in Language Teaching**

Natural Language Processing (NLP) stands at the forefront of AI's contributions to language education. NLP facilitates the understanding, interpretation, and generation of human-like language by machines. Virtual language tutors equipped with NLP capabilities engage learners in authentic conversations, providing real-time feedback on pronunciation, grammar, and vocabulary usage. This interactive approach fosters improved language skills and a more nuanced understanding of language structures.

### **Virtual Reality Applications**

VR applications create virtual environments that simulate real-world scenarios, allowing language learners to immerse themselves in authentic settings. Whether navigating a virtual marketplace or participating in simulated conversations, learners can practice language skills in contexts that closely resemble those encountered in daily life. This immersive approach enhances language proficiency by reinforcing practical language use [1].

VR facilitates cultural exploration by transporting learners to virtual landscapes that reflect the cultural context of the language they are studying. Through VR experiences, students can virtually visit historical landmarks, explore cultural events, and engage with native speakers. This cultural immersion not only enhances language comprehension but also fosters a deeper appreciation for the cultural nuances embedded in language.

VR enables the creation of interactive language exercises that go beyond traditional textbook learning. Language learners can engage in VR scenarios that require them to apply language skills in real-time. For example, ordering food in a virtual restaurant or participating in a virtual business meeting provides practical language use within a controlled environment, offering valuable experiential learning.

VR technology can be employed to provide targeted feedback on language pronunciation and accent. Virtual language tutors equipped with speech recognition capabilities can analyze learners' pronunciation and provide immediate feedback. This personalized feedback helps learners refine their pronunciation skills and work towards achieving native-like accents.

VR platforms facilitate virtual language exchange programs, connecting learners with native speakers around the world. Through virtual conversations, learners can practice speaking, listening, and cultural exchange in a dynamic and interactive manner. This not only improves language skills but also promotes cross-cultural understanding and global collaboration.

Integrating gamification elements into VR language learning experiences adds an element of competition and motivation. Virtual language challenges and games encourage learners to actively participate and progress through language levels. The gamified approach makes language learning enjoyable, fostering sustained engagement and motivation.



## Challenges and Ethical Considerations

While the integration of AI in foreign language education holds immense promise, it is crucial to acknowledge and address challenges and ethical considerations. Privacy concerns related to learner data, potential biases in AI algorithms, and the impact on employment in the language education sector are among the key challenges that warrant careful examination. Ethical considerations must be at the forefront to ensure responsible and equitable use of AI in language teaching.

## Future Prospects

Looking ahead, the future of foreign language education holds exciting possibilities with ongoing advancements in AI. The integration of AI with augmented reality, the development of advanced conversational agents, and the incorporation of emotion recognition technologies are areas under exploration [4]. These innovations promise to further elevate language-learning outcomes and reshape the landscape of language education.

## Conclusion

In conclusion, the transformative potential of AI in teaching foreign languages is evident in the diverse applications explored in this article. From personalized learning platforms to immersive virtual reality experiences, AI is ushering in a new era of language pedagogy. While challenges exist, the responsible integration of AI, coupled with ethical considerations, will undoubtedly contribute to a more effective and engaging foreign language education landscape.

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## ВЛИЯНИЕ ИСКУССТВЕННОГО ИНТЕЛЛЕКТА НА ПРЕПОДАВАНИЕ ИНОСТРАННЫХ ЯЗЫКОВ

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**Аннотация:** Проведен анализ текущей ситуации в области обучения иностранным языкам и влияние искусственного интеллекта (ИИ) на образовательный процесс. Рассмотрены различные инструменты, интегрированные в обучение иностранным языкам на базе искусственного интеллекта, системы адаптивного обучения, технологии обработки естественного языка и приложений виртуальной реальности. В статье также затрагиваются проблемы, этические аспекты и будущие возможности, связанные с применением ИИ в образовании.

**Ключевые слова:** искусственный интеллект, обучение, иностранный язык.

## PROJECT-BASED LEARNING AS A WAY TO ENHANCE STUDENT MOTIVATION

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### **Abstract**

The experience of project-based learning using the “City Stars” series is considered in the article. The possibilities of organizing different kinds of project activities in English classes are explored. Different types of projects organized on the basis of the interactive platform for City Stars are described.

**Keywords:** project-based learning; communicative teaching; gamified approach; personalized learning experience.

### **Introduction**

Project-based learning (PBL), a popular teaching approach in various fields, is gaining momentum in foreign language education. PBL motivates learners by allowing them to engage in activities they enjoy and avoid tasks they dislike. The potential of this method has been widely explored [1, 2, 3]. Compared to traditional methods, PBL offers numerous benefits and has been extensively studied for its ability to enhance intellectual, physical, ICT, social, and independent learning skills.

Project-based learning (PBL) can significantly enhance student motivation in ESL classes by providing a meaningful and engaging learning experience. Firstly, it allows students to work on real-world tasks and projects that are relevant to their interests, experiences, and future goals. This makes the learning experience more meaningful and engaging for students, motivating them to actively participate and invest in the project. Secondly, PBL gives students more autonomy and ownership over their learning process. They have the freedom to make decisions, set goals, and choose how to approach and complete the project. This sense of control and responsibility can increase students' motivation to learn and succeed. And finally, PBL often involves collaborative work, where students work together in teams to achieve a common goal. Collaborating with peers fosters a sense of community, support, and shared responsibility, which can boost motivation and engagement among students.

This article investigates how materials from the *City Stars* textbook can be used to enhance motivation.

### **Brief overview of *City Stars* series**

*City Stars* is a comprehensive educational resource that includes a textbook and online platform designed for teachers, students, and parents. Teachers can access a variety of teaching materials such as lesson plans, webinars, video lectures, and assignments. Students have access to audio courses, portfolio materials, and additional resources, including interactive case studies. Parents can also engage with the content

of the textbook and support their children in their English language learning journey.

*City Stars* also incorporates a unique gamified approach to learning, which makes the educational experience more engaging and interactive for students. Through the online platform, students can participate in quizzes, games, and challenges related to the content of the textbook, helping them reinforce their learning in a fun and enjoyable way. This gamified aspect not only motivates students to actively participate in their learning but also helps them retain information more effectively.

Additionally, *City Stars* offers a personalized learning experience for each student. The platform tracks students' progress and performance, allowing teachers and parents to monitor their development and provide targeted support where needed. This personalized approach ensures that each student can learn at their own pace and receive the necessary assistance to succeed in their English language studies.

With the interactive platform students can make use of the resources to their advantage. They can have access to different materials. The student's webpage comprises *Moscow Interactive*, *My Moscow extra*, *Audio resources*, *Supplementary materials* and *Self-check*.

### **Project-based learning opportunities**

The *City Stars* online platform offers a variety of project-based learning opportunities that align with different types of projects, including research projects, creative projects, role-playing projects, interdisciplinary projects, and information projects. These project types provide students with a well-rounded and engaging approach to learning English language skills while exploring the rich history and culture of Moscow.

For research projects, *City Stars* provides a structured framework that includes defined goals, rationale for the research subject, reference to sources of information, methods, and results. This helps students develop their research skills and critical thinking abilities while deepening their understanding of the content.

Creative projects in *City Stars* allow students to showcase their creativity and present project results in an appropriate manner. These projects encourage students to think outside the box and express themselves through various mediums.

Role-playing projects on the platform involve participants taking on specific roles related to the nature and content of the project. This immersive approach helps students understand different perspectives and engage with real-world scenarios in a meaningful way.

Interdisciplinary projects in *City Stars* vary in size and complexity, involving coordinated work among multiple creative groups to solve complex issues relevant to all project participants. This collaborative approach fosters teamwork, communication skills, and a holistic understanding of interconnected subjects.

Information projects on the platform focus on gathering, analyzing, synthesizing, and presenting information on specific objects or phenomena. The structured nature of these projects allows for systematic adjustments throughout the project and provides students with valuable research and presentation skills (

## Conclusion

Overall, *City Stars* stands out as a comprehensive and innovative educational resource that not only covers essential language skills but also focuses on the rich history and culture of Moscow, providing a well-rounded learning experience for students.

By working on projects, students have the opportunity to communicate with their peers and teachers, both verbally and in writing, which helps improve their language proficiency. They also learn how to collaborate with others, make decisions, and problem-solve, all of which are essential skills for success in the real world.

Project-based learning can enhance student motivation in ESL classes by promoting relevance, autonomy, collaboration, creativity, hands-on learning, and a sense of achievement. By engaging students in meaningful and interactive projects, PBL can inspire them to become active, motivated, and lifelong learners.

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## ПРОЕКТНОЕ ОБУЧЕНИЕ КАК СПОСОБ ПОВЫШЕНИЯ МОТИВАЦИИ ОБУЧАЮЩИХСЯ

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**Аннотация:** Представлен опыт проектного обучения на примере УМК «City stars». Проанализированы возможности организации различных видов проектной деятельности на занятиях по английскому языку с использованием материалов УМК. Описаны различные типы проектов, организованных на базе интерактивной платформы City Stars.

**Ключевые слова:** проектное обучение; коммуникативное обучение; геймифицированный подход; индивидуальный подход к обучению.

## TERMINOLOGISCHE DERIVATION ALS KOGNITIVER TERMINOLOGIEMECHANISMUS AM BEISPIEL DER MODERNEN DEUTSCHEN BANKENSPRACHE

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**Zusammenfassung:** Der vorliegende Artikel beschäftigt sich mit den kognitiven Mechanismen der terminologischen Derivation und der Rolle der Sprache im Erwerb von Wissen. Hier wird die Entstehung neuer Begriffe und sprachlicher Konstruktionen unter kognitiven Gesichtspunkten untersucht. Zudem werden Einblicke in die Typologie der Wortbildungskategorien und deren Bedeutung für die Analyse der sprachlichen Strukturen angeboten.

**Schlüsselwörter:** kognitive Mechanismen in der deutschen Terminologielehre, terminologische Derivation, Bankenterminologie, Sprache und Denken.

Die kognitiven Mechanismen der Terminologie spielen eine wichtige Rolle bei der Erstellung, dem Verständnis und der Verwendung des speziellen Fachwortschatzes in verschiedenen Bereichen der Wissenschaft. Vor allem helfen sie, das Wissen in einem bestimmten Bereich zu organisieren und zu strukturieren. Die Strukturierung des Wissens wird durch Konzeptualisierungsprozesse gewährleistet. Der Begriff wird von diesen Positionen nicht als Konzept betrachtet, sondern als Verbalisierung eines speziellen Konzepts, das als operative Inhaltseinheit des Denkens, als Einheit oder als Quantum strukturierten Wissens verstanden wird, wodurch die Darstellung des Referenten in allen Phasen seiner Existenz als sinnlich und gedanklich wahrnehmbares Objekt verfolgt werden kann [2, S. 9].

Viele Forscher der Terminologie (T. N. Velikoda, S. L. Michlanova, I. V. Finikova, O. A. Zyablova, E. A. Selivanova, S. R. Tlechatuk, V. N. Prochorova, L. M. Alekseeva) wenden sich an Materialien verschiedener Sprachen und Terminosysteme, wobei sie auf die verschiedenen kognitiven Mechanismen der Terminologie hinweisen, meistens auf Metaphern, seltener auf Metonymie, Profilierung, Neudefinition, Modellierung, Präfix- oder Suffixierung sowie Wortzusammensetzungen.

Präfixierung, Suffixierung und Komposita gehören zu den kognitiven Prozessen der terminologischen Derivation, bei denen bestehende Wörter oder Morpheme verändert oder umgeformt werden. Dieser Prozess findet weite Anwendung in der Linguistik, insbesondere bei der Schaffung von spezialisierten Terminologien in verschiedenen wissenschaftlichen Disziplinen und Wissensbereichen. Derivationsprozesse sind von herausragender Bedeutung für die Gestaltung des sprachlichen Weltbildes. Nach Ansicht von E.S. Kubryakova gibt es "nichts Natürlicheres als die Analyse derivativer Phänomene aus kognitiver Sicht: Es ist

offensichtlich, dass die Verknüpfung dieser Phänomene mit dem Prozess des Erkennens und der Verankerung seiner Ergebnisse es ermöglicht, einerseits zu beobachten, in welchen Formen kognitive Prozesse in der Sprache abliefen, und andererseits zu verstehen, wie sich die Sprache unter dem Einfluss dieser Prozesse veränderte und wie ihre ständige Bereicherung und Entwicklung bei ihrer Umsetzung erfolgte" [3, S. 91].

Somit führt die Generierung von Derivaten hauptsächlich zur Verankerung menschlicher Erfahrungen, was dazu führt, dass die kognitiven Ergebnisse der Weltwahrnehmung in den Einheiten der Derivatologie reflektiert werden. Dieser Prozess ist einer der Hauptwege zur Erweiterung der Terminologie in verschiedenen Wissensbereichen. Oft entstehen neue Begriffe zur Beschreibung neuer Konzepte und zur präzisen Darstellung spezialisierter Begriffe. Die Entwicklung des Terminus ist eng mit den morphologischen und semantischen Aspekten der Sprache verbunden. Prozesse wie die Addition von Affixen oder die Veränderung der Wortform implizieren eine Änderung der morphologischen Struktur und die Einführung neuer semantischer Bedeutungen.

Oft wird die terminologische Derivation verwendet, um die Terminologie in einem bestimmten Bereich zu spezialisieren, wobei neue Begriffe zur präzisen Beschreibung von Konzepten geschaffen werden. Unter der terminologischen Derivation als globalen Prozess der sprachlichen Entwicklung versteht man die Schaffung von Begriffen in einem bestimmten kognitiven Bereich, der als sekundärer Benennungsprozess im Terminologiesystem betrachtet wird und auf einer Vielzahl von Mechanismen und Methoden zum Strukturieren, Entstehen und Produzieren terminologischer Zeichen basiert. Die Entwicklung des Terminus basiert immer auf dem Derivationssystem der nationalen Sprache. Jedoch entwickelt die Wissenschaftssprache auf der Grundlage der vorhandenen Methoden und Modelle der Wortbildung in der literarischen Sprache ihr eigenes Derivationssystem und passt es ihren Anforderungen und Funktionen an.

Betrachten wir die Besonderheiten dieses Prozesses in der deutschen Sprache. Die Entwicklung des Terminus in der deutschen Sprache hat ein reiches historisches Erbe, das sich in der Entwicklung der deutschen Sprache widerspiegelt. Viele Begriffe und Wörter in der deutschen Sprache haben indogermanische Wurzeln, welche als Grundlage für die Schaffung neuer Wörter und abgeleiteter Begriffe dienen. Im mittelalterlichen Deutschland begannen sich viele Terminologien und darüber hinaus eine spezialisierte Lexik aktiv zu entwickeln, wobei die Derivationsprozesse eine wichtige Rolle bei der Bildung neuer Wörter und Konzepte spielten, um verschiedene Tätigkeitsbereiche zu beschreiben. Intensiv werden Affixe (Präfixe, Suffixe) eingesetzt, die dem Wortstamm zur Bildung neuer Begriffe hinzugefügt werden.

Zum Beispiel bildet das Suffix "-heit" Substantive mit der Bedeutung "Zustand" oder "Qualität". Ebenso wird aktiv der Kompositionsprozess genutzt. Dies ermöglicht die Kombination mehrerer Wörter oder Morpheme zur Bildung spezialisierter Begriffe. In der deutschen Sprache gibt es Affixe, die in spezialisierten

Wissensbereichen verwendet werden. Zum Beispiel ist in der deutschen medizinischen Terminologie die Terminodervierung ein wichtiger Mechanismus zur Bildung neuer Begriffe, der medizinische Konzepte und Prozesse bereichert und präzise beschreibt. So bedeutet das Präfix "*bio-*" lebend oder lebensbezogen, während das Präfix "*neuro-*" mit dem Nervensystem zusammenhängt. Dermatologie (Dermatologie) - *derma* (Haut) + *-logie*, also die Wissenschaft der Haut. Herzinfarkt (Myokardinfarkt) - *Herz* + *Infarkt*. Psychotherapeut - *Psycho* + *Therapeut*.

In der modernen Bankterminologie werden die Derivate genutzt, um neue Begriffe zu bilden, die Finanzprozesse, Operationen und Instrumente widerspiegeln. Die Schaffung neuer Begriffe durch Derivation trägt zur Einheitlichkeit und Klarheit in der Kommunikation zwischen Bankmitarbeitern und Kunden bei. Hier sind einige Beispiele aus dem deutschen Bankwesen. Das Wort *Einlage* ergibt sich aus Abwandlung des Wortes „Lage“ von "legen" mit dem Präfix "ein-". Bankkonto ist eine Kombination der Wörter "Bank" und "Konto". Vom Wort "sicher" und dem Suffix "-heit" (*Sicherheit, Garantie*). Die Kombination der Wörter "Kredit" und "Vergabe" ist *Kreditvergabe*. Die Verbindung der Wörter "Einlage" und "Sicherung" ist *Einlagensicherung*. Die Kombination von "Konto" und "Verwaltung" ist *Kontoverwaltung*. Die Verbindung von "Kredit" und "Würdigkeit" ist *Kreditwürdigkeit*. Die Kombination von "Zahlung" und "Eingang" ist *Zahlungseingang*. Diese Beispiele verdeutlichen, wie Derivate des Terminus und Komposita in der deutschen Bankterminologie zur Schaffung präziser und einheitlicher Fachbegriffe beitragen.

Im Kontext der kognitiven Linguistik wird dieser Prozess durch die Linse kognitiver Operationen und Strukturen betrachtet, die die Grundlage für sprachliche Kategorien bilden. Die Derivation des Terminus als kognitiver Prozess der Terminologisierung stellt ein wichtiges Phänomen in der Sprache dar, wobei kognitive Aspekte eine entscheidende Rolle bei der Bildung neuer Begriffe und sprachlicher Konstruktionen spielen. Die Erforschung dieses Prozesses vertieft nicht nur unser Verständnis für Terminologie, sondern offenbart auch die Verbindung zwischen Sprache und Denken.

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# ТЕРМИНОДЕРИВАЦИЯ КАК КОГНИТИВНЫЙ МЕХАНИЗМ ТЕРМИНОЛОГИЗАЦИИ НА ПРИМЕРЕ СОВРЕМЕННОГО НЕМЕЦКОГО ЯЗЫКА БАНКОВСКОГО ДЕЛА

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**Аннотация:** В настоящей статье рассматриваются когнитивные механизмы терминологического вывода и роль языка в получении знаний. Здесь рассматривается появление новых терминов и лингвистических конструкций с когнитивной точки зрения. Также предлагается понимание типологии словообразовательных категорий и их значения для анализа языковых структур.

**Ключевые слова:** когнитивные механизмы в немецкой терминологии, терминологическая деривация, банковская терминология, язык и мышление.



## TRENDS IN PROFESSIONALLY ORIENTED FOREIGN LANGUAGE TEACHING AT TECHNICAL UNIVERSITIES

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### Abstract

The importance of professionally oriented foreign language teaching at a technical university is beyond doubt. The purpose of this article is to present current trends inherent in this type of training. The article describes examples of the possible implementation of digital technologies in language teaching at a non-linguistic university, presents useful online platforms, and also highlights some ideas and strategies for project-based teaching of a foreign language.

**Keywords:** language learning platforms, professionally oriented language teaching, project-based language learning.

### Introduction

Professionally oriented foreign language teaching in technical universities plays a vital role in preparing students for successful careers in today's globalized and interconnected world. There are some key reasons why such language teaching is essential in technical universities. The first is *the need to communicate in a globalized economy*. In technical industries, proficiency in a foreign language can enhance job prospects and create opportunities for career advancement, especially in multinational companies. Technical fields often involve collaboration with international partners, requiring effective communication in a shared language to facilitate projects and initiatives. Many technical companies have a global customer base, and being able to communicate effectively in the customers' language can improve service quality and customer satisfaction. The second reason is *the access to specialized knowledge*. Proficiency in a foreign language allows students to access a wide range of technical literature, research papers, and resources that are not always available in their native language. Many technical innovations and advancements originate from research conducted in various countries. Understanding foreign languages can help students stay up-to-date with the latest developments in their field. And finally, the third reason is *global competitiveness*. Employers value candidates who can communicate fluently in multiple languages, especially in technical roles where global collaboration is common. Being proficient in a foreign language can help students establish and nurture professional relationships with colleagues, clients, and industry experts from around the world.

Over the past few years, there have been two main trends in professionally oriented foreign language teaching in technical universities: technology incorporation in the process of teaching and project-based language learning as a method of organizing work. It is precisely these two trends that we would like to describe in this paper.

Nowadays many technical universities incorporate technology into foreign language teaching, such as using online platforms for language practice, virtual reality for immersive language experiences, and language learning apps for self-study. These platforms often combine interactive lessons, exercises, quizzes, games, and even live tutoring sessions to make language learning engaging and effective [1].

The examples of the most popular online language learning platforms are: *Duolingo*, *Babbel*, *Rosetta Stone*, *Memrise*, *Busuu*, *Pimsleur* etc. Each platform has its own unique features and approaches. For example, *Duolingo* offers courses in many languages and uses a gamified approach to learning. It's great for beginners and those looking to build a strong foundation in a language. *Babbel* focuses on real-life conversations and practical vocabulary. It's designed to help students speak the language confidently in various everyday situations. *Rosetta Stone* uses immersive methods to teach languages, focusing on contextual understanding rather than translation. It's known for its interactive software and speech recognition technology. *Memrise* uses spaced repetition and mnemonic techniques for remembering vocabulary effectively and also incorporates user-generated content, making learning more dynamic. *Busuu* offers a community aspect where you can practice with native speakers and covers topics ranging from beginner to advanced levels. As for *Pimsleur*, it focuses on audio learning, helping you improve your listening and speaking skills.

Another modern feature of professionally oriented foreign language teaching at a technical university is project-based language learning. Very often professors move towards project-based learning in foreign language classes, where students work on real-world projects related to their field of study. This helps students apply their language skills in a practical context and prepares them for future professional challenges [2].

Integrating project-based learning of foreign languages into technical universities can be a powerful way to enhance students' language skills while connecting language acquisition with real-world applications in their field of study. Here are some tailored project ideas for incorporating project-based learning of foreign languages in technical university settings:

- *Technical Documentation Translation*

Ask students to translate technical documents, manuals, or research papers from the target language into their native language or vice versa. This project can enhance their vocabulary related to their technical field.

- *Multilingual Coding Projects*

Assign coding projects that require students to document their code, comments, and project reports in the target language. This can improve their technical writing skills in a foreign language.

- *Presentation on Technical Topics*

Ask students to give presentations on technical topics in the target language. This can help improve their speaking and presentation skills while demonstrating their technical knowledge.

▪ *Simulated Business Negotiations*

Organize a project where students participate in simulated business negotiations in the target language. This can enhance their professional communication skills while focusing on technical terms.

For implementing these project ideas following strategies can be used:

- *interdisciplinary collaboration* (collaboration between language departments and technical departments to create projects that integrate language learning with technical skills);

- *industry-relevant projects* (projects that simulate real-world scenarios in technical industries to provide students with practical language skills that they can apply in their future careers);

- *feedback and assessment* (constructive feedback on language proficiency and technical content to help students improve their language skills and technical knowledge simultaneously);

- *cultural integration* (introduction of cultural aspects of the target language-speaking countries into projects to help students develop intercultural competencies alongside their language and technical skills);

- *innovation encouraging* (student's support in exploring innovative ways to apply their language skills in technical projects, fostering creativity and problem-solving abilities).

By integrating project-based learning of foreign languages into technical universities, students can develop a holistic skill set that includes language proficiency, technical expertise, and intercultural competence, preparing them for success in a globalized technical space.

### **Conclusion**

By incorporating professionally oriented foreign language teaching in technical universities, students gain a competitive edge in the global job market, develop a broader perspective on their field of study, and acquire skills that are increasingly valuable in a multicultural and multilingual work environment. It not only enriches their academic experience but also equips them with the tools needed to thrive in a diverse and dynamic professional landscape. The introduction of modern technologies and methods into professionally oriented training helps to develop the professional competencies of future specialists in technical fields.

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# ТЕНДЕНЦИИ ПРОФЕССИОНАЛЬНО-ОРИЕНТИРОВАННОГО ОБУЧЕНИЯ ИНОСТРАННОМУ ЯЗЫКУ В ТЕХНИЧЕСКИХ ВУЗАХ

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**Аннотация:** Важность профессионально ориентированного обучения иностранному языку в техническом вузе не подлежит сомнению. Цель данной статьи – представить современные тенденции, присущие данному виду обучения. В статье описаны примеры возможного внедрения цифровых технологий в обучение языку в неязыковом вузе, представлены полезные онлайн платформы, а также описаны некоторые идеи и стратегии для проектного обучения иностранному языку.

**Keywords:** платформы для изучения языка, проектное обучение языку, профессионально-ориентированное обучение языку.

## THE “UNITECH” INFORMATION SYSTEM: THE ROLE AND PLACE IN THE EDUCATIONAL PROCESS

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### **Abstract**

The Unitech information system, created to support and develop practice-oriented training of interpreters in higher educational institutions is under study. The problem of using online courses in the process of training the interpreters is being updated. The goals and key features of creating the experience base of the Unitech system are determined. Courses of particular interest for foreign language teachers of technical universities are considered.

**Keywords:** knowledge base, online course, translation project, translation technologies, interpreter's professional competence, professional training.

The modern translation services market has long been global and highly competitive. The development of the Internet and specialized translation project management systems (TMS) made it possible to work effectively within distributed teams, whose members (project managers, interpreters, editors, proofreaders, typesetters, programmers) can work remotely from different cities or even countries. This form of cooperation is beneficial for customers, for whom it allows to reduce expenses by eliminating the cost of paying for the downtime of full-time interpreters, which is becoming increasingly relevant with the growing requirements for specialization and non-linguistic competence of performers. These trends are also relevant for Russia, where the share of freelance interpreters has also increased significantly in recent years.

Unitech - APP is an information system designed to support the educational process, in terms of developing the professional skills of interpreters, under the guidance of the Interpreter Teachers Association in Higher Education Institutions.

The Unitech - APP materials are presented in the form of Massive Open Online Courses (MOOCs). They are designed for foreign language teachers and translator trainers at the institutions of higher education.

The use of Unitech - APP in professional training courses for interpreters helps to bring the skills of graduates in line with the requirements of employers. Many professionals took an active part in the development and promotion of these courses. Among them there are the representatives from translation companies, practicing interpreters, engineers, teachers, and students with language and technical backgrounds.

Each course contains theoretical material, control tasks (tests) and practical assignments. It helps students to get specialized knowledge, skills, and abilities, while university teachers receive pre-made modules for integration into academic disciplines.

Employers also receive valuable personnel who are trained in accordance with their specific working conditions.

To get technical knowledge, to master modern translation techniques, tools and teamwork skills, to develop product orientation and familiarity with employers is hard and unreal without practice. In this course it all is adapted and weighed to maximize effective solutions to the tasks faced by each user.

The Unitech experience base is a collection of basic information about the most commonly used technical objects (machines, devices, and systems) in various industries. Each object is described with its definition, purpose, design, operating principle, rules for use, and examples of interactions with other objects.

During a process of forming this experience base the main goal was to give the opportunity to the students of translation programs and working interpreters to study the fundamental principles of commonly used objects in a way that is both comprehensive and useful for their work in the industry.

The main characteristics of this experience base are: commitment to the students of translation faculties of universities and budding interpreters; specialized knowledge influenced on technical texts understanding; the distant nature of educational process; lack of strict time reference; optimized for mobile devices; easy integration into the educational process of the university; technical and information support for all user groups; free use/

The experience base combines and describes objects that experienced interpreters have basic knowledge about and beginners lack.

The selection of these articles was executed by the method of expert assessments. Based on the corpus of texts of various subject areas with a volume of 100 thousand words, 3 frequency dictionaries were compiled: one-word, two-word and three-word. Then 500 of the most frequent technical terms were selected from these dictionaries, from which independent terms ("bearing", "pump", "pressure gauge") were isolated, and conceptual groups of generalizing terms were formed (for example, many terms such as "hydraulic booster", "hydraulic drive, "hydraulic oil" are combined into a group "Hydraulic system").

The final list of more than 350 terms was submitted to an expert group consisting of 12 interpreters and engineers whose professional activities are closely related to the technical documentation of the following subject areas: "Aviation and Cosmonautics", "Automotive Industry", "Railway transport", "Information Technology", "Test equipment", "Mechanical engineering and industrial equipment", "Microelectronics", "Oil and gas equipment and processes", "Defense industry", "Machine tool construction", "Safety equipment", "Chemical industry", "Electrical engineering".

The experts needed to answer the question of how often a specific object occurs in professional activity.

According to the received data, the list of terms was arranged so that at the top of the list there were terms that are often found in the professional activities of most

experts.

At the moment, there is only a general technical classifier. It is also in the planning to create similar classifiers for individual industries — so, it will be possible to get a list of terms that are often found by experts in a certain subject area, as well as to build various combinations (for example, information technology in the aircraft industry).

The course "General technical training course for linguists and interpreters" is of particular interest to foreign language teachers at the technical universities. The general technical training course for linguists and interpreters is completely free, including the issuance of a certificate and employment assistance. The advantage is the possibility of conducting classes by a university teacher as part of academic activity. It is suggested to conduct the course from 3-4 years of study, when students have already received the necessary knowledge in their main specialty. The course consists of 30 lessons; the recommended duration is 30 classroom and 30-50 hours of homework.

The course is designed to enhance the general technical literacy among students of translation departments at universities and to cultivate the skills for logically sound technical translations among students of technical colleges. The course may be conducted under the supervision of a university instructor. The staff of the information systems provides technical and informational support for students and instructors.

After successful course passing, the students who pass the end-off-exam get a certificate confirming their possession of basic knowledge in the covered topics. This course will help you to minimize the interpreter's expenses for getting the necessary knowledge and skills in the field of technical translation. It will also provide higher competence and increase competitiveness in this area.

Linguists and interpreters who work in the field of technical translation often have a general understanding of the device, the principles of operation, and the use of certain types of technical devices. This knowledge is often gained on the job, which can be difficult because of the lack of systematic training and the pressure of tight deadlines and high translation standards. As part of the study, it was determined nearly 30 most common technical devices whose elementary knowledge is available to experienced interpreters, but not to beginners. Among them there are control and measuring devices, electrical motors, bearings, hydraulic and pneumatic systems, and lubrication. The basic properties of these objects were described in relevant articles. The information was presented in a formalized manner with illustrations, animations, and videos in order to create more complex mental images. This module provides students with the opportunity to study the elementary properties of the most common technical objects in such a minimal volume that will give the most useful effect in conditions of industry uncertainty, since only such knowledge is offered that will be required throughout their professional activities related to technical translation, regardless of the subject area.

After doing the exercises for translating from English into Russian, students may watch video analysis of these translations. The reviews present several options for

translating texts, often made mistakes are analyzed and possible translation options for a particular phrase are provided.

Access to the final test students can get after studying the course. The end-of test contains 120 questions, four questions on each topic. Three of them are the multiple-choice question (where 1 from three suggested options is correct and 2 are false), and one is the choice of the desired area in the image. The student should indicate his confidence degree in the correctness of the answer for each question (3 categories are provided).

When completing the course, students complete a form that contains questions to estimate students' concernment and accomplishment, track the dynamics of interest in technical translation, intentions for detailed study of special technical disciplines, intentions to work in the field of technical translation, and others.

Summing up the above, we can state the fact that the Unitech information system was created to support and develop practice-oriented training of interpreters in higher educational institutions. Currently, work is continuing on the search, development and implementation of simple and effective solutions that cannot appear in a university environment, but which can easily be implemented by teachers and students. All resources are designed for independent work of students and are absolutely free.

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## ИНФОРМАЦИОННАЯ СИСТЕМА «ЮНИТЕХ»: РОЛЬ И МЕСТО В УЧЕБНОМ ПРОЦЕССЕ

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**Аннотация:** В статье рассматривается информационная система «Юнитех», созданная для поддержки и развития практико-ориентированной подготовки переводчиков в высших учебных заведениях. Актуализируется проблема использования онлайн-курсов в процессе обучения переводческой деятельности. Определены цели и ключевые особенности создания базы знаний системы «Юнитех». Рассмотрен курс общей технической подготовки лингвистов-переводчиков, представляющий особый интерес для преподавателей иностранных языков технических вузов.

**Ключевые слова:** база знаний, онлайн-курс, переводческий проект, переводческие технологии, профессиональная компетентность переводчика, профессиональная подготовка



## ON THE FEATURES OF LEXICAL AND GRAMMATICAL FORM OF SPEECH INFLUENCE IN THE ACADEMIC DISCOURSE OF BILINGUALS

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### Abstract

The paper is concerned with the discursive potential of language in the academic discourse of bilinguals inasmuch as it reflects persuasion in developing academic concepts. We have analyzed academic speech events of a lecture by an English-speaking Russian bilingual and interpreted the choice of relevant vocabulary and grammar as the tools of effective speech influence. Analysis of lecture transcripts indicates the bilingual's use of language that actualizes the norms of scientific exchange and the corresponding discourse devices with a view to streamline understanding of complex notions and phenomena.

**Keywords:** academic discourse, academic concept, nominative units, discourse markers, speech influence

### Introduction

The increasing role of communication today determines the relevance of studying discourse in a variety of communicative contexts. Discourse as a “dynamic process unfolding in time” [2, p. 10] relates to a specific person, their goals and intents. Based on a critical appraisal of literature on discourse, we can observe an increasing importance of academic discourse in the system of modern discourse studies. According to K. Hyland, academic discourse changes the view of the world, becoming the main way of its interpretation [1, p. 172].

We consider academic discourse of bilinguals a culturally defined type of institutional discourse which is centered on epistemological tasks. We also interpret it as a semiotic system for knowledge transfer that bilinguals use to construct new meanings of scientific concepts which are “expressed in language and perceived through language” typical of a certain academic community [3]. In this case, the meaning of a scientific concept “is disclosed <...> to the extent that the process of cognition requires it, depending on the conditions of communication” [5, p. 78].

In academic discourse, bilinguals form new meanings of scientific concepts based on their worldview and encode these meanings according to the mental interaction of their language systems. This creates conditions for altering their verbal behavior.

Scientific concepts are verbalized in the speech-thought activity of bilinguals through linguistic nominations that disclose the particular aspects of a scientific phenomenon, adapt the semantic content of a scientific concept to the individual lexicon of bilinguals. Based on the activity approach in psycholinguistics, the understanding of speech activity of motivated speakers implies speech influence. Speech influence in academic discourse manifests itself through nominative units and

expressive means of language (discourse markers). These linguistic devices help construct discourse with a view to optimal accessibility of complex scientific concepts for bilinguals on the basis of figurative perception. It should be emphasized that the meanings of scientific concepts in academic communication of bilinguals align with adequate internalization of the presented material, in that verbalization of scientific concepts is most frequently observed at the lexical and grammatical levels.

### **Methods and materials**

The aim of the study was to identify and describe the lexical and grammatical structures in bilingual speech that appear to have speech influence potential and contribute to productive communication.

The material of the study included edited YouTube automatic captions in recordings of lectures on humanities available on the Internet.

Using the methods of discourse analysis, contextual and semantic analysis, and linguistic description, we identified the linguistic devices used by the speaker for speech influence and described their functional significance in realizing the goal of interaction.

### **Results**

Typical participants of the discourse are described as follows. The producer (lecturer) is an English-speaking bilingual whose first language is Russian. The recipients are university students whose bilingualism is sequential. To illustrate the lexical and grammatical potential of bilingual speech, we shall examine a lecture under the title of *Silence full of sounds* [4].

The purpose of the discourse on the part of the producer is to convey the meaning of the concept of sign language. The intention of the recipient is to acquire new knowledge about this phenomenon and use it in further educational and professional activities.

(1) *hi my name is Lily and today I'm going in English today I'm going to talk about deaf people and sign languages* – in this fragment the self-presentation of the producer is objectified by means of the proper name (*hi my name is Lily*); the nomination of the topic is marked by means of a nominative word combination (*sign languages*) and a proposition (*today I'm going to talk about*) expressed by present continuous tense in the meaning of planned future.

(2) *many people ask me why I chose to learn a sign language was it for maybe to become a social worker was it to become an interpreter* – the producer draws attention to the significance of the topic by means of a combination with an indefinite pronoun (*many people*) and rhetorical questions (*was it for maybe to become a social worker was it to become an interpreter*); the producer emphasizes the main concept of the lecture in sign language by means of recurrent forms in the form of anaphora (*was it to become*), a propositional phrase with a verb in the past tense.

(3) *when you think about something in another language you see the situation differently which is really important* – the producer confirms the importance of knowing sign languages with the help of a clause (*which is really important*) and

content words (*important, really*) that emphasize that knowing how to communicate in sign language helps to see the world differently and adopt new views.

(4) *an actress once told me she heard me speaking three languages in ten minutes and she told me that I looked and sounded like three different people* – the producer argues that speaking in another language means a change of speech behavior using a proposition (*an actress once told me*). In this proposition exemplifiers are represented at the morphological level by nominalization with the indefinite article (*an actress*), and at the lexical and grammatical levels by an adverb a verb of speech in simple past tense (*once told me*). The use of metaphor (*I looked and sounded like three different people*) gives significance and persuasiveness to the statement through the figurative representation of polylingualism.

(5) *this is gonna be very slowly but yeah just for you* – the producer asserts their lack of ability to express thoughts in sign language at a natural pace, illustrating the thesis through positive self-criticism. To this end, they use a proposition with a shortened version of the verb in the present continuous tense (*this is gonna be*), a conjunction and an adverb (*but yeah*).

(6) *you see deaf people give you sign names based on your last name or what you look like* – the producer elaborates on the specific features of communication in sign languages and argues that a sign name is based on a person's surname or appearance. For this purpose, an emphasis is made on one of the main concepts of the lecture (the nomination *sign names*) to indicate its relevance to the topic. Emphasis through recurrence, repetition of a personal pronoun (*you*) creates the effect of the recipient's involvement in the discussion.

(7) *you see there are a lot of sign languages around the world they're very different from one another and they're not really based on vocal languages we speak and we use in different countries* – continuing to explain how sign languages are different from vocal languages, the producer presents background information about this concept by means of an introductory construction (*you see*) and the use of a pronoun (*a lot of*). These devices help the producer to point out the existence of different types of sign languages. They also use a proposition with the negative verb form and an adverb (*not really based on vocal languages we speak*). This allows the producer to convey the idea of independent sign languages in relation to existing vocal languages.

(8) *contrary to popular belief it's way easier to explain something using your hands than your voice* – the producer furthers the comparison of vocal and sign languages and applies antithesis at the syntactic level in the form of an introductory construction (*contrary to popular belief*). The producer optimizes understanding of the mentioned difference between the types of languages, strengthening the evidential argumentation by means of a proposition (*it's way easier*), including an adverb in the comparative degree and an intensifying adverb.

(9) *you use your body to show that there are two options like tea or coffee to your coffee which is why it's pretty easy* – the producer reinforces the significance of the

thesis about the accessibility of communication in sign languages by means of lexical intensification expressed by an adjectival phrase with an adjective (*easy*) and an adverb (*pretty*).

(10) *we hearing people use so many unnecessary words and we fill our speech with so much useless information now we really lose track of what matters* – in order to show the audience's involvement in the problem in question, to emphasize the interaction in the discourse the producer uses a phrase with a personal pronoun (*we hearing people*), strengthens the justification of the thought through the use of recurrence in the form of anaphora (*so many, so much*) and synonymous adjectives (*unnecessary, useless*), as well as an idiom (*lose track of what matters*).

(11) *that doesn't sound right it's crazy statistics and that's because nobody ever counted we don't care* – the producer expresses his value judgment in relation to statistical data using absolute negation, a verb in the negative form (*doesn't sound right*); in addition to epistemic value judgment, emotional judgment is used through an adjective with an expressive connotative meaning (*crazy*), which reflects the producer's attitude to the problem, indicating its severity with idiomatic negation (*don't care, nobody ever*).

(12) *we relegate them to a subclass of humanity by that we don't let them into our society* – the producer confirms their position with an emotional judgment using a verb with a negative connotative meaning (*relegate*), a morphological nomination, a noun with the prefix *sub* at the morphological level with a pejorative in the context of linguistic meaning (*subclass*).

(13) *what I want you to think about is this deaf people say hearing people do not hear us* – in conclusion, the producer invites the recipient to reflect on the problem with the help of a proposition containing the intentional verb *want* (*want you to think*). The stance of the producer is clearly expressed using wordplay (*hearing people do not hear us*).

### **Conclusion**

According to the results of an analytical study of bilingual speech, it can be stated that the meaning of a scientific concept in professional discourse is formed by lexical and grammatical language elements according to the norms of academic discourse community in a relevant foreign language.

It is shown that the variability of the choice of language means for the productive implementation of new knowledge for bilinguals who are not experts in the target field is allowed. The choice of discourse language means (morphological forms of adjectives, adverbs, verbs, lexemes with expressive connotation, idiomatic expressions, wordplay, etc.) and rhetorical techniques does not contradict mutual understanding but contributes to the development of communicative relevance in the discourse of bilinguals.

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## **НЕКОТОРЫЕ ОСОБЕННОСТИ ЛЕКСИКО-ГРАММАТИЧЕСКОГО ОФОРМЛЕНИЯ РЕЧЕВОГО ВОЗДЕЙСТВИЯ В АКАДЕМИЧЕСКОМ ДИСКУРСЕ БИЛИНГВОВ**

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**Аннотация:** В исследовании анализируется речевой потенциал языковых единиц в академическом дискурсе билингов, отражающий речевое воздействие на реципиента при изложении научно-профессиональных концептов. Произведен анализ академических речевых произведений русскоязычного билинга в жанре лекции и интерпретирован выбор наиболее релевантных лексико-грамматических средств как инструментов продуктивного речевого воздействия. Анализ скриптов лекций позволил выявить в речи билинга языковые единицы, объективирующие нормы академического дискурса при трансляции научной информации и дискурсивные средства с целью оптимального понимания сложных понятий и явлений.

**Ключевые слова:** академический дискурс, научный концепт, номинативные единицы, дискурсивные маркеры, речевое воздействие

## LANGUAGE OF INFLUENCE AND LANGUAGE OF POLITENESS IN BUSINESS COMMUNICATION

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### Abstract

It is important to use the right words to achieve the desired impact and ensure clear understanding in business communication. The choice of the language of influence can establishing dominance in communication. This style contrasts with "powerless" language that softens requests with excessive phrases. The use of disjunctive questions, qualifiers, and amplifiers convey different degrees of certainty and emphasis. Prolonged requests can hinder clarity, so direct language should be used for better communication. Communication pauses and expressions of courtesy emphasize message impact. Overall, a balance between forceful communication and politeness should be achieved to ensure effective delivery of the intended message in a business setting.

**Keywords:** business communication, language of influence, language of politeness

### Introduction

In the realm of business communication, adeptly managing and adjusting the influence of statements on the interlocutor is imperative. We believe this aspect is particularly crucial to consider in the context of professionally oriented foreign language instruction.

### Influence and Politeness

The language of influence and the utilization of branching communication strategies are key components in establishing dominance within interpersonal business communication. When one participant consistently employs the language of influence more frequently than the other does, it becomes evident who holds sway and control over the communication process.

Equally noteworthy are speech patterns designed to diminish the assertiveness of a statement. These patterns, known as the "powerless" linguistic style, involve the addition of excessive words and phrases to the main utterance. For instance, consider the following request: "It would be greatly appreciated if you could kindly consider lending me your jacket for the evening, would you mind?". This formulation may sound more polite compared to a more concise request, such as "Could you lend me your jacket?", due to the inclusion of additional phrases aimed at softening the request.

In many instances, the strength of a statement and its influence inversely correlate with its level of politeness. Politeness in language often involves the incorporation of additional words and phrases into discourse, as well as the utilization of specific grammatical structures. Let us explore these techniques in terms of their influence on clarity, precision, emphatic expression, and their contribution to politeness.

## Strategies in Business Communication

Disjunctive questions serve to alter the tone or implication of a statement. For instance, "You are going to do the shopping, aren't you?" may seek confirmation or imply a gentle reminder. They can function as substitutes for direct questions, like "Are you going to do the shopping?", or they may subtly convey commands/requests, as in "I assume you are going to do the shopping". Furthermore, they can solicit opinions on past events, such as "I did pretty good, didn't I?" which can be seen as a request for feedback. These questions often encapsulate a certain level of uncertainty or seek validation from the listener regarding the main idea conveyed in the statement.

Qualifiers are words or phrases introduced into a statement in order, as with disjunctive questions, to impart some degree of uncertainty to the context. Examples of barriers include the following words and expressions: "basically", "I guess", "rather", "sort of", "more or less", "maybe", and "kind of". In sentences it sounds like this: "I guess maybe I'll ask for an extension", "Yes, I suppose so".

Amplifiers are modifiers that emphasize the extreme nature of what they define. Intensifiers are usually placed before the word they define. Examples of enhancers are the phrases "so happy", "quite upset", and "terribly weary". Those who like to frequently use enhancers in their speech should be careful not to make their interlocutor smile by saying something like "exceedingly normal" or "very unique".

The use of prolonged or complicated requests, often characterized by vague and convoluted language, is a common communication tactic. Instead of direct and concise inquiries, individuals may employ such requests to soften the impact of their statements or to veil the importance of what is being asked for. For instance, phrases like "Well, I just would like to find out from you when you think would be a good time" are examples of this strategy.

While some may perceive prolonged requests as more polite and respectful, they often contribute little communicative value and can lead to confusion or misunderstandings. Supervisors may find that requests framed in this manner appear more deferential from subordinates, but it is important to balance politeness with clarity to ensure effective communication.

In many cases, opting for direct language can enhance clarity and efficiency in communication, leading to more productive interactions and outcomes. Therefore, it is essential to consider the intended message and the impact of language choices when making requests or inquiries.

Communication pauses, including words, short phrases, or voice pauses such as "like", "well", "oh", and "you know" reflect uncertainty and indecision on the part of the speaker. For instance, saying, "Oh, look here, you're, you know, failing this class," instead of simply stating, "You are failing this class," can diminish the speaker's confidence and clarity in their message.

Expressions of courtesy encompass phrases that convey good manners and respect, such as "sir", "ma'am", "excuse me", "beg your pardon", and "please". For instance, in a sentence, it may appear as follows: "Excuse me, sir, but is that your car over there?"

## Conclusion

It can be concluded that evasive statements reduce the power of the statement, especially if the speaker wants to create a kind of power and self-confidence around oneself. On the other hand, appropriate and selective use of evasive statements can provide the listener with a more complete and accurate understanding of the degree of uncertainty of what is being communicated. Interlocutors can conclude that the content of the statement is open for discussion. Courtesy expressions convey the impression of authority and influence, but this effect can be obscured when more formal forms, such as disjunctive questions and communicative pauses, are used in parallel.

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## ЯЗЫК ВОЗДЕЙСТВИЯ И ЯЗЫК ВЕЖЛИВОСТИ В ДЕЛОВОМ ОБЩЕНИИ

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**Аннотация:** Важно использовать правильные слова, чтобы добиться желаемого воздействия и обеспечить четкое понимание в деловом общении. Выбор языка воздействия может установить доминирование в общении. Этот стиль контрастирует с «бессильным» языком, смягчающим просьбы чрезмерными фразами. Использование разделительных вопросов, определителей и усилителей передает разную степень уверенности и акцента. Продолжительные просьбы могут помешать ясности, поэтому для лучшего общения следует использовать прямой язык. Паузы в общении и выражения вежливости подчеркивают воздействие сообщения. В целом, необходимо достичь баланса между настойчивым общением и вежливостью, чтобы обеспечить эффективную передачу предполагаемого сообщения в деловой среде.

**Ключевые слова:** деловое общение, язык воздействия, язык вежливости.



## FUNCTIONS OF WORDPLAY IN BRITISH PRINTED MEDIA

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### **Abstract**

The concept of wordplay as a phenomenon typical of printed media is discussed in this paper. The most frequent functions of wordplay have been identified and exemplified through the headlines of British newspapers.

**Keywords:** wordplay, pun, explicit, expressive, persuasive, humorous.

### **Introduction**

Wordplay or play on words is one of the phenomena characteristic of modern print media. According to its definition in *Cambridge Dictionary* it is “an amusing use of a word or phrase that has more than one meaning [1]. It is a method of transmitting information that involves targeted manipulation of linguistic resources in order to convey the author's intention through the expressive means of language. The play on words is always aimed at creating imagery and expressiveness, avoiding clichés. Many writers use this technique when they want to convey an idea without repetition, but showing originality and wit.

Wordplay often refers to intentionally using words and word forms that differ from the conventional or expected. In other words, it is often related to the violation of the linguistic norm.

It can be noted that wordplay is quite common for the language of mass media, which is constantly evolving and changing. One of the reasons for the changes in the language of the press is wordplay. The emergence of new words “updates” the language, while maintaining its uniqueness. It is assumed that wordplay is typical of headlines. One study suggests that English news headlines are likely to contain one or more clearly defined wordplay. [2].

Wordplay is characterized by a number of features and performs a variety of functions [3]. This paper aims to investigate the most typical functions of wordplay in British printed media.

### **Materials and methods**

The research was based on the linguistic analysis of the examples of wordplays from the British printed media, including *The Guardian*, *The Sun*, *The Daily Mail*, *Financial Times*, etc.

The following methods were used in the paper: general scientific (comparison, generalization, synthesis, analysis, quantitative data processing) and contrastive analysis of the linguistic means used in the texts from British printed media.

## Results and discussion

Firstly, it is aimed at using certain forms that shift the emphasis from the content to the verbalized presentation. In other words, it is not what is said that matters, but how it is said. Most often, this function is implemented in media advertising texts, which are replete with beautiful forms built on wordplay: *Coca Cola - FANTAbulous Proposal*. Graphically highlighting part of the word *FANTA* and playing with the ‘fabulous’ certainly creates a bright, memorable image that catches the readers’ attention. Thus, the wordplay here is based on focusing on the form, to make the message conveyed more explicit. In such cases, the form “reinforces” content.

Secondly, wordplay is often used to create a humorous effect by amusing the readers and causing them to smile. Take for instance the situation with the forced resignation of one of the popular news presenters who refused to make a public apology for unflattering comments he made following a television interview with Meghan Markle. As an example, below is the headline from the English newspaper *The Sun*:

*'Morgxit!' Piers quits GMB after bust-up (The Sun, March 10, 2021)*

As can be seen from the example, the noun + exit model is quite used to refer to Brexit, another coined word that is replicated in the British mass media.

Another good example is the headline from the British press:

*Spring it on! (The Sun 29 December 2020)*

It contains an allusion to the colloquial expression “*bring it on*” (usually used in situations where they want to emphasize that they are ready for a difficult test, ready to overcome difficulties). Replacing the verb bring with the noun spring introduces an element of play, the purpose of which is to cheer up the people of the UK on New Year's Eve and instill hope that the situation will change in the spring.

As most researchers note, creating humorous effect is one of the most common functions of wordplay. According to E.A. Zenskaya, M.A. Kitaigorodskaya and N.N. Rozanova, humor is the most frequent, but not the only attribute of wordplay [4]. As a rule, the comic effect is achieved through a pun.

For example, the headline “*See Naples and diet*” (*The Guardian*, 26 Oct 2002) refers to the famous expression “*See Naples and die*”, which emphasizes the splendor of Naples, which no other city can compare with. In the “modified” version of the title, the word die is replaced with diet, thereby changing the meaning of the original phrase, shifting the emphasis towards the gastronomic delights of the cuisine of Naples, as if hinting that after visiting this city you will need a diet, because its restaurants are so exquisite that it is impossible to resist temptation to try all the dishes. The comic effect of the situation is that instead of dying, it is enough to go on a diet.

Thirdly, one of the functions of wordplay is to persuade the reader to take action. One example is the headline from BBC news encouraging its readers to be careful with children’s vaccination.

*No green light to jab kids! (BBC news 18 June 2021)*

This headline sounds like a directive given to prevent anti-Covid vaccination of children. The authors of the headline use the figurative expression *No green light*, which means a ban (we won't give a green light) and a colloquial version of the word injection – *jab*. Thus, it can be argued that the goal is to convince the reader that vaccinating children is a careless step and to warn against rash actions.

Fourthly, wordplay makes the text more expressive. The media do not exist in isolation, but are part of a global communication environment that influences public opinion, social institutions and culture. Within this system, the wordplay becomes an evaluative mechanism that regulates public consciousness. Its expressive (influencing) function is to have a certain impact on the addressee, to make an impression, or to encourage action. Take for instance the headline from Financial Times:

*Could a resurrected Tulip help London bloom again* (Financial Times, 10 September 2020)

The wordplay is based on the name of the Tulip skyscraper and the verb bloom in relation to the situation related to the resumption of construction of a skyscraper, which was interrupted during the pandemic and a return to normal life after the lifting of Covid restrictions. The wordplay is achieved by using the lexis that describes the period of flowering and the birth of something new, which certainly evokes positive emotions.

Another example of an expressive function is the headline from the English newspaper Daily Mirror, which plays on such a technique as comparison:

*Harsh winter... brighter spring* (Daily Mirror, 5 December 2020)

The headline describes the current situation in the UK due to Covid restrictions and prospects for improvement in the spring. The implementation of the play on words is achieved through the use of the opposition *harsh – brighter*, which makes the title more vivid and memorable.

Another striking example that was used in the British press is the following headline:

*Joe Biden “gets to work” and “Trump the grump”* (BBC News, November 9, 2020)

It appeared in the press in connection with the resignation of Donald Trump as President of the United States. It plays on the combination of the proper name Trump and the consonant noun the grump, which denotes an unhappy person, a grouch, or a boring person. The end of Donald Trump's term in office and the transfer of power to his replacement, Joe Biden, were accompanied by scandals and discontent on the part of the former president, and expressions of grievance in the public space. Using the rhyme '*Trump the grump*', the author characterizes the former president.

### **Conclusion**

Wordplay performs a variety of functions in the British printed media. It aims to make the message more explicit, expressive, persuasive or humorous. It arouses curiosity, gives pleasure and attracts the reader.

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## О НЕКОТОРЫХ ФУНКЦИЯХ ИГРЫ СЛОВ В БРИТАНСКИХ ПЕЧАТНЫХ СМИ

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**Аннотация:** В статье рассматривается понятие игры слов как явления, характерного для печатных СМИ. Наиболее частотные функции игры слов были выявлены и проиллюстрированы на примере заголовков британских газет.

**Ключевые слова:** игра слов, каламбур, эксплицитный, экспрессивный, убедительный, юмористический.

## LINGUODIDACTICS AND METHODS OF TEACHING FOREIGN LANGUAGES

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### Abstract

This paper presents a brief overview of the basic principles and methods used in linguodidactics and methods of teaching foreign languages. They include various aspects, such as lesson planning, selection of teaching materials, application of technology in teaching and assessment of student success. The paper also examines general trends in the development of the field of linguodidactics from the end of the 19th – early 20th centuries, the integration of new methods and approaches, as well as current research in the field of language education. The current trends in language education cover the use of a communicative approach, active teaching methods and an individualized approach to each student. The purpose of the article is to conduct a comparative analysis of the points of view on the interpretation of the main terms "methodology of teaching a foreign language" and "linguodidactics". It is concluded that in the course of further development of linguodidactics and methods of language teaching as independent sciences within the multi-scientific system of language education, their differentiation will deepen and expand more and more, which is the norm in the history of the autonomization of sciences.

**Keywords:** communicative approach; differentiation; integration of methods; linguodidactics; methodology; multi-scientific system; strategy.

Today, language education is a value that is necessary for a modern person of the 21st century. It is the basis for the formation of a comprehensively developed personality with a high level of communicative competence, capable of perceiving and transmitting a variety of information. The article considers the theoretical foundations of the formulation and clarification of the meaning of the basic concepts of modern linguodidactics. The analysis of the essence of the language teaching method is carried out and the leading approaches to the interpretation of this concept are considered. Based on the understanding of traditional and innovative pedagogical experience, the place of the teaching method in the system of related linguistic and didactic concepts is substantiated.

Learning and mastering foreign languages can be considered as a multi-level process. Its main levels are considered to be linguodidactics and methods of teaching foreign languages. Linguodidactics is a scientific discipline that studies the theory of education and the process of learning and assimilation of language. The purpose of linguodidactics is to develop effective learning strategies and techniques that take into account the peculiarities of language, culture and individual needs of students. In the methodology of teaching a foreign language, the term "linguodidactics" is often used along with the term "methodology". Nevertheless, as the analysis of scientific and methodological literature shows, the points of view regarding the content and purpose of this term differ among scientists. Some researchers completely abandon the term

"methodology" and suggest using only the term "linguodidactics", others insist on the need for a clear distinction between these terms. Proponents of the differentiation of terms argue that linguodidactics substantiates the basic patterns of mastering a foreign language in educational institutions from the perspective of a student based on the philosophy of language, linguistics, psychology, psycholinguistics, and sociology. The methodology, interpreting linguistic and didactic patterns, explores the learning process, creates its system and embodies it in specific programs, textbooks, exercises.

Currently, the terms "linguodidactics" and "methodology" are used ambiguously by different scientific and methodological schools: in pedagogical terms, the term "methodology" is most often used in three meanings: 1) "methodology" as an educational technology, that is, a set of forms, methods and techniques of a teacher's work; this is the "technology" of professional practical activity; 2) "methodology" as an academic discipline; 3) "methodology" as a science. The methodology of teaching foreign languages is an independent, complex, theoretical and applied science that explores the patterns, goals, content, methods and means of teaching and educating students in foreign language lessons. It is aimed at researching effective learning strategies, developing new methods and technologies, as well as analyzing learning outcomes in order to improve the learning process. The formation of the methodology of teaching foreign languages as a science occurred in the late 19th – early 20th centuries. It was the result of a thousand-year evolution of teaching methods, first in classical languages (Latin, ancient Greek), and later in modern foreign languages. To date, linguodidactics and language teaching methods function as independent sciences within the multi-scientific system of language education. According to Shchukin's definition, linguodidactics is described as the theory behind language teaching, which establishes its methodological principles. Methodology, on the other hand, refers to the actual teaching process of a particular language under specific teaching conditions (private methodology), while also uncovering teaching patterns for languages in general (general methodology), irrespective of specific learning environments [5]. One of the founders of modern methods of teaching foreign languages, Michael West, emphasized that a foreign language cannot be taught, it can only be learned. To create the best conditions for learning and for a student or student to really want to learn a language is the main function of a teacher, which cannot be performed without knowledge of the methodology of the best organization of the teaching of students in a language course at a high level.

The use of the terms "linguodidactics" and "methodology" as synonyms is a fairly common phenomenon both among researchers and among university teachers and teachers of secondary schools. According to this point of view, it turns out that linguodidactics absorbs the methodology of language teaching, and vice versa – the methodology of language teaching absorbs linguodidactics. From our point of view, such a definition of these terms and the corresponding sections of language education does not stand up to serious criticism. For example, A. A. Mirolyubov considers the synonymous understanding of linguodidactics and methodology to be anti-scientific

[2, p. 35]. The same position is taken by A. N. Shchukin [5, pp. 21-22], [4, p. 5]. The idea of differentiating linguodidactics and methodology into independent sciences is supported by I. I. Khaleeva. According to her point of view, linguodidactics is a general theory of language acquisition (or a general theory of language learning) [3, p. 189].

To sum up all the above, it is noteworthy that the formation of the methodology of teaching a foreign language as a science occurred in the late 19th – early 20th centuries. At the present stage, it is an independent, complex, theoretical and applied science that explores the patterns, goals, content, methods and means of teaching and educating students in foreign language lessons.

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## **ЛИНГВОДИДАКТИКА И МЕТОДИКА ОБУЧЕНИЯ ИНОСТРАННЫМ ЯЗЫКАМ**

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**Аннотация:** Представлен краткий обзор основных принципов и методов, используемых в лингводидактике и методике обучения иностранным языкам. Рассмотрены ключевые аспекты процесса преподавания и изучения иностранных языков, включая выбор подходящих методов обучения, использование современных технологий и ресурсов, а также актуальные исследования в области языкового образования. Описаны общие тенденции развития области лингводидактики с конца XIX – начала XX веков, такие как использование коммуникативного подхода, активных методов обучения и индивидуализированного подхода к каждому учащемуся. Цель статьи: провести сопоставительный анализ основополагающих терминов «методика обучения иностранному языку» и «лингводидактика». Отмечается, что в ходе дальнейшего развития лингводидактики и методики обучения языку как самостоятельных наук внутри полинаучной системы языкового образования их дифференциация будет все больше и больше углубляться и расширяться, что является нормой в истории автономизации наук.

**Ключевые слова:** дифференциация; интеграция методов; коммуникативный подход; лингводидактика; методология; полинаучная система; стратегия.

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### **ROBBERY: A STUDY OF THE SOCIAL, PSYCHOLOGICAL AND LEGAL ASPECTS OF CRIME**

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#### **Abstract**

Robbery is a complex crime that has many social, psychological and legal aspects. In this article, we will study various aspects of robbery, including its social and psychological roots, as well as legal consequences and prevention measures. We will also review current research and approaches to combating robbery, and offer recommendations for improving the system of preventing and combating this crime.

**Keywords:** aspects, robbery, robbery causing factors, serious crime, threat of violence.

#### **Introduction**

Robbery is a crime committed by a group of persons aimed at obtaining property through coercion or the threat of coercion. This crime has a long history, and it is one of the most serious crimes that can cause significant physical and emotional suffering for victims and society as a whole.

#### **Materials and methods**

This article uses an interdisciplinary approach to study the notion of robbery, and analyze social, psychological and legal aspects of this type of crime.

In the literature, there are many approaches to studying social factors influencing robbery. One of the most famous is the theory of environmental influence, developed by Robert Ekman. This theory suggests that crime, including robbery, depends on the social environment in which the crime occurs.[2]

The psychological aspects of robbery are studied using various theories and approaches. One of the most famous is the general theory of crime developed by Langman and Samuelson. This theory suggests that crime, including robbery, results from a combination of personal and situational factors.

The legal aspects of robbery are studied using various legal approaches and theories. One of the most famous is the theory of criminal law, which defines crime as a violation of the law. In this context, robbery is defined as a violation of the law involving the misappropriation of another person's property using force or the threat of force.

#### **Results and discussion**

Based on the analysis of existing studies, we assume:

##### *1 Social aspects of robbery*

Social factors that may influence robbery include economic disparities, lack of



employment, poverty and social exclusion.

1. Economic inequality: Economic inequality can lead to some people feeling discriminated against and forced to seek alternative ways to obtain resources, which can lead to robbery.

2. Lack of employment: Lack of jobs and high unemployment may lead people to look for other ways to earn money, including robbery.

3. Weak economic policies: Ineffective economic policies can lead to an increase in crime, including robbery.

4. Difficult family conditions: Adverse family conditions, such as violence, alcoholism or drug addiction, can cause children and young people to become more vulnerable and may join criminal groups or resort to robbery.

5. Social isolation: People who feel isolated from society may seek alternative ways to express their aggression and grievances, including robbery.

6. Culture of violence: A culture of violence, which can be transmitted through media, music, video games and other forms of entertainment, can influence the way people perceive violence and aggression, which can lead to robbery.

7. Lack of social support: Lack of social support such as education, health care and psychological support can lead people to seek alternative ways to solve their problems, including robbery.

These factors can create conditions in which youth and other groups feel discriminated against and alienated from society, which can lead to criminal behavior.

## *2 Psychological aspects of robbery*

Psychological factors that may influence robbery include antisocial beliefs, aggressive behavior, low self-esteem and risky behavior. The psychological mechanisms underlying robbery are also important for understanding this crime[1]. We will look at how factors such as personality, motivation and social environment influence why people commit robbery.

1. Personality: Personality characteristics such as aggressiveness, emotional instability and antisocial behavior may predispose to crime, including robbery. In addition, some people may have a tendency to engage in risky behavior, which can lead to crimes such as robbery.

2. Motivation: Motivation can be one of the key factors influencing the commission of crimes. People may commit robbery out of a need for money, a desire to show off their strength, or for other personal reasons. Motivation may be related to economic hardship, lack of employment, or other factors that may lead to crime.

3. Social environment: Social environment can also play an important role in the commission of crimes such as robbery. A dysfunctional family background, lack of social support, weak connections to society and lack of education can create conditions in which committing crimes seems more attractive. In addition, the influence of friends and social groups that may support or promote criminal activity can lead to the commission of crimes such as robbery.[3]

Research also shows that robbers may suffer from mental disorders such as

depression or psychotic disorders.

### *3 Legal aspects of robbery*

The legal consequences associated with robbery can be serious.

In Russia, for example, robbery is defined as violent or threatening behavior for the purpose of taking property or obtaining monetary gain. According to Article 162 of the Criminal Code of the Russian Federation, robbery is punishable by imprisonment for up to 15 years. If the robbery is committed with the use of a firearm, the penalty may increase to 20 years in prison.[1]

The impact of robbery on the lives of the offender and his victims can be significant. The offender may be imprisoned for a long period of time, which may affect his career, family and social relationships. Victims of robbery can suffer not only material losses, but also psychological trauma caused by violence or threats.

### *4. Measures to prevent and combat robbery*

To combat and prevent robbery, a comprehensive approach must be taken that includes social programs, educational campaigns, and efforts to improve economic conditions and strengthen social inclusion. Cooperation of the police, the judiciary and social services to ensure effective crime control is important.

### **Conclusion**

The social dimensions of robbery were examined by analyzing data on social factors. The results showed that unfavorable social conditions can contribute to the emergence and spread of robbery. In particular, lack of education and economic opportunity, as well as uneven distribution of resources, can lead to increased criminal activity.

The psychological aspects of robbery were studied by analyzing the motivation of criminals and their behavior during the commission of a crime. Our findings showed that the motivation of criminals may be related to such factors as personal problems, stress, as well as the desire to obtain material benefits or satisfy their aggression.

The legal aspects of robbery have been studied through the analysis of trials and the application of legislation in relation to crimes related to robbery. The results showed that the judicial system may not be effective enough in combating robbery, which may lead to insufficient accountability for offenders and insufficient protection for victims.

Based on our findings, we offer several recommendations for preventing and reducing the prevalence of robbery. First, more attention needs to be paid to social factors such as education and economic development to reduce the disadvantages that may contribute to crime. Secondly, there is a need to improve psychological support for criminals to help them avoid criminal activity and integrate into society. Third, the legal system needs to be improved to more effectively prosecute crimes of robbery and ensure fair accountability for criminals.

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## **РАЗБОЙ: ИССЛЕДОВАНИЕ СОЦИАЛЬНЫХ, ПСИХОЛОГИЧЕСКИХ И ЮРИДИЧЕСКИХ АСПЕКТОВ ПРЕСТУПЛЕНИЯ**

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**Аннотация:** Разбой - это сложное преступление, которое имеет множество социальных, психологических и юридических аспектов. В статье рассмотрены различные аспекты разбоя, включая его социальные и психологические корни, а также юридические последствия и меры предотвращения. Проанализированы современные исследования и подходы к борьбе с разбоем, а также предложены рекомендации для улучшения системы предотвращения и борьбы с этим преступлением.

**Ключевые слова:** аспекты, грабеж, тяжкое преступление, угроза применения насилия, факторы, вызывающие ограбление.

УДК 342.51  
ББК 67.400.6

## ZUGANG ZU INFORMATIONEN ÜBER DIE AKTIVITÄTEN VON STAATLICHEN BEHÖRDEN, LOKALEN SELBSTVERWALTUNGSORGANEN UND UNTERGEORDNETEN ORGANISATIONEN DURCH DAS SYSTEM «GOSPABLIKA»

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**Zusammenfassung:** In diesem Artikel werden allgemeine Fragen zur Umsetzung der gesetzlichen Anforderung zur Schaffung von offiziellen Seiten im Informations- und Telekommunikationsnetz «Internet» durch staatliche Stellen, lokale Selbstverwaltungsorgane und die ihnen untergeordneten Organisationen behandelt. Die wichtigsten Perspektiven für das Funktionieren der Staatspapiere werden bestimmt.

**Schlüsselwörter:** Gospablik, offizielle Seite, Informations- und Telekommunikationsnetz «Internet», Vkontakte, Feedback-Plattform.

Seit der aktiven Einführung sozialer Netzwerke in den Alltag ist eine ziemlich lange Zeit vergangen, soziale Netzwerke werden nicht mehr als «Verwöhnung» wahrgenommen. Es wurden immer mehr Konten von Schulen, Kindergärten, Ministerien, Verwaltungen und anderen Behörden und Organisationen angezeigt, es gab jedoch keine ständigen Veröffentlichungen, es wurden keine Abonnenten rekrutiert, es fehlte ein einheitliches Verständnis für die Ziele der Präsenz öffentlicher Behörden in sozialen Netzwerken. Nach und nach wurde angenommen, dass die Ressourcen sozialer Netzwerke verwendet werden können, um bestimmte Funktionen der staatlichen Behörden zu erfüllen, nämlich den Aufbau eines offenen Dialogs in den Weiten sozialer Netzwerke [4].

8- FZ «Über den Zugang zu Informationen über die Aktivitäten von staatlichen und lokalen Behörden» (im Folgenden das Gesetz) [1], die die Platzierung von Informationen über die Aktivitäten von staatlichen, lokalen und zuständigen Behörden im Informations- und Telekommunikationsnetz «Internet» betreffen, sind am 1. Dezember 2022 in Kraft getreten. So werden Regierungsbehörden und Organisationen verpflichtet, offizielle Konten zu führen, um Informationen über ihre Aktivitäten zu veröffentlichen. Mit der Annahme dieser Änderungen wurde es nicht nur legitim, Regierungsbehörden und Organisationen in sozialen Medien zu finden, sondern es wurde zur Pflicht.

Das Gesetz sieht einen Begriff vor, der das Konto einer Behörde in einem sozialen Netzwerk definiert — das ist die offizielle Seite. Die Norm bezieht sich jedoch auf die Verordnung der Regierung der Russischen Föderation [2], die «Vkontakte» und «Mitschüler» durch soziale Netzwerke definiert, in denen staatliche Stellen, lokale Regierungen und ihre untergeordneten Organisationen verpflichtet sind, ihre offiziellen Seiten zu erstellen und zu führen. Gleichzeitig wurde der Telegram-

Messenger unter Regierungsbehörden und Organisationen weit verbreitet.

Ein Problem bei der Umsetzung des Gesetzes war, dass viele Regierungsbehörden und Organisationen keine Informationen hatten, die auf ihrer offiziellen Seite platziert werden konnten, mit anderen Worten, es gab keine verfügbaren Inhalte. Es gibt hier eine Ausnahme, nach der Artikel 10 des Gesetzes die Möglichkeit vorsieht, keine offiziellen Seiten von untergeordneten Organisationen zu erstellen, die die Besonderheiten ihres Tätigkeitsbereichs berücksichtigen, in Abstimmung mit den staatlichen und lokalen Regierungsbehörden, die von solchen Organisationen verwaltet werden. In der Durchsetzungspraxis wird diese Bestimmung so ausgelegt, dass die zuständigen Institutionen, die keine öffentlichen Dienstleistungen erbringen und ihre Aufgaben nicht mit der Interaktion mit der Bevölkerung zusammenhängen, von der Führung offizieller Seiten ausgenommen sind, wobei diese Berechtigung in lokalen Vorschriften verankert ist.

Diese Ausnahme gilt nicht für staatliche und lokale Behörden. Unter Beibehaltung der Pflicht, offizielle Seiten zu führen, wurden diese Publikationen in aktive (Flaggschiff-Publikationen werden hervorgehoben) und Visitenkarten eingestuft. Der Schwerpunkt liegt auf den Flaggschiff—Publikationen, die strengsten Anforderungen für die Platzierung von Inhalten werden gestellt, die absolute Mehrheit der offiziellen Seiten bezieht sich auf aktive Publikationen, der Rest auf Visitenkarten.

Die nächste regulatorische Anforderung ist die Bestätigung des Status der offiziellen Seite, technisch muss jede Behörde, lokale Regierung und Organisation über ein Konto einer juristischen Person in einem einheitlichen Identifizierungs— und Authentifizierungssystem verfügen (nachfolgend "ESIA"). Das Konto wiederum ermöglicht es Ihnen, eine spezielle Markierung «Staatliche Organisation» zu erhalten, die den Status der offiziellen Seite bestätigt.

Die nächste wichtige Voraussetzung ist die Platzierung von Widgets mit Links zu elektronischen Formularen der Feedback—Plattform (im Folgenden als PIC bezeichnet). Zunächst muss das Organ oder die Organisation an die Botschaft angeschlossen werden, um die Kommunikation der Bürger zu verarbeiten und Umfragen der Bevölkerung durchzuführen. Dadurch können Sie ein nachhaltiges Feedback zur Bevölkerung herstellen und die Antworten und Kommentare von Nutzern sozialer Netzwerke rechtzeitig bearbeiten.

Das Hauptziel der Schaffung von Staatsbüros ist es, Informationen über die Aktivitäten von staatlichen Behörden, lokalen Regierungen und ihren untergeordneten Organisationen dem Bürger schnell zu vermitteln, und gleichzeitig entsteht ein Ökosystem des Lebenszyklus, in dem die betroffene Person die Informationen erhält, die sie benötigt [3]. Neben dem Zugriff auf Nachrichten von Regierungsbehörden und Organisationen erhält der Benutzer die Möglichkeit, sein Problem zu lösen, indem er den Newsfeed im sozialen Netzwerk durchblättert. 59-FZ, in dem Fristen von bis zu 30 Tagen festgelegt sind und der Dialog zwischen dem Betroffenen und der zuständigen Behörde erheblich verzögert wird. 226-p vom 28.11.2022 Zum Beispiel darf die Vorbereitung der Antwort auf die Nachricht des Benutzers (hier gemeint ist der Bürger

oder die Organisation, der die Nachricht in sozialen Netzwerken platziert hat) je nach Wichtigkeit der eingegangenen Behandlung 7 Stunden nicht überschreiten, die Rangfolge wird durch das Informations- und Analysesystem «Incident Management» durchgeführt.

Die verantwortlichen Mitarbeiter überwachen neben der Erstellung einer Publikation im sozialen Netzwerk, der Verbindung mit der Feedback-Plattform die Aktualisierung von Inhalten, die Durchführung von Informationskampagnen und die Förderung der Publikation einschließlich ihrer Branding-Aktivitäten. Wenn es jedoch keine Schwierigkeiten mit der Aufgabe des Inhalts von staatlichen Dokumenten gibt, sollte die Erstellung von einbeziehenden Inhalten unter Berücksichtigung der Besonderheiten sozialer Netzwerke auf ein neues Niveau gebracht werden. Im Moment ist dies eine vorrangige Aufgabe der Bildung eines Ökosystems von staatlichen Arzneimitteln in jeder Region, da eine der Aussichten für die Entwicklung durchaus darin bestehen kann, staatliche Arzneimittel mit der Funktion zur Erbringung öffentlicher Dienstleistungen in sozialen Netzwerken zu versehen.

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## **ДОСТУП К ИНФОРМАЦИИ О ДЕЯТЕЛЬНОСТИ ГОСУДАРСТВЕННЫХ ОРГАНОВ, ОРГАНОВ МЕСТНОГО САМОУПРАВЛЕНИЯ И ПОДВЕДОМСТВЕННЫХ ОРГАНИЗАЦИЙ ЧЕРЕЗ СИСТЕМУ «ГОСПАБЛИКИ»**

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**Аннотация:** В статье рассматриваются общие вопросы реализации законодательного требования о создании государственными органами, органами местного самоуправления и подведомственными им организациями официальных страниц в информационно-телекоммуникационной сети «Интернет». Определяются основные перспективы функционирования госпабликов.

**Ключевые слова:** госпаблик, официальная страница, информационно-телекоммуникационная сеть «Интернет», Вконтакте, платформа обратной связи.

## APPLICATION OF TECHNICAL AND FORENSIC TOOLS AND METHODS TO SEARCH FOR TRACES OF CRIMES

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### Abstract

The article discusses the means and methods of finding crime traces applied by forensic investigators. The purpose of the article is to consider the major means of detecting and fixing traces at the crime scene. The author comes to the conclusion that the inspection of an incident scene is urgent and informative. It gives rise to the investigation process and serves as the most important investigative action.

**Keywords:** crime material traces, fixing methods, forensic technology, forensic tools.

As a rule, all crimes are accompanied by a change in the environment. This process has an objective character and is conditioned by the law of reflection. In criminology, such changes are called traces of crimes. At the same time, it is customary to divide the traces of crimes into two categories. The first category includes material traces that arise as a result of the contact interaction of various objects, the second consists of ideal traces that are displayed in the minds of people. Since the traces of a crime are causally related to the event of a crime, they are undoubtedly a source of the most valuable investigative and evidentiary information about the persons who committed it and the circumstances of its commission.

Forensic examination of traces enables the identification of a specific object that left behind a trace, such as identifying an individual through handprints, lip marks, and other types of physical evidence. It also aids in classifying and attributing traces to a particular category or type, such as determining the specific hacking tool utilized. Traces provide valuable insights into a person's anatomical, physiological, functional, and dynamic characteristics, shedding light on factors such as gender, age, and professional expertise. Moreover, traces can play a vital role in resolving non-identification diagnostic tasks, including determining the timeline of an investigated event, estimating the number of individuals involved, discerning the method of breach (whether from outside or inside), and establishing the direction of movement and transportation patterns. [1].

To date, the Investigative Committee of the Russian Federation possesses advanced technological resources that enable the detection of not only faint or inconspicuous evidence but also inconceivable to the naked eye. Their arsenal comprises a wide array of equipment, ranging from metal detectors to unmanned aerial vehicles, ensuring utmost versatility and functionality. The means of detecting traces of crimes include:

- optical devices that allow detecting small-sized objects or individualizing their features. These include forensic magnifiers, illuminated magnifiers, and so on;
- lighting means are portable sources of artificial lighting that are used with insufficient natural or stationary artificial lighting. They can be designed to illuminate specific objects, as well as for general illumination of the territory. This type of technical means includes ultraviolet and infrared illuminators, night vision devices;
- substances (reagents and pollinating substances) that, when interacting with a trace-forming substance, give it a well-visible, visually perceived color as a result of a chemical reaction or physical impact. These include solutions of silver nitrate in distilled water or ninhydrin, allaxane in acetone, iodine or cyanocrylate vapors, various fingerprint powders that detect invisible traces of fingers, toes, pheromagnetic powders for detecting shoe marks on linoleum;
- search devices that allow detecting objects of various nature in various environments (water, earth, brickwork, etc.) [3].

The means of fixing traces of crimes include:

- photographic means – cameras and accessories (flashbulbs, special lenses, tripods, light filters) of various modifications and their functional capabilities, providing high-quality photographs;
- audio and video recording tools;
- measuring instruments, including various measuring devices for household and industrial purposes (rulers, tape measures, protractors, calipers, micrometers);
- means of making casts and copies of traces – various materials and impression masses (gypsum, plasticine, paraffin), as well as dark and light-type trace-copying films used to copy handprints identified by special fingerprint powders of various types [3].

For example, an inspection of a car located at the scene of an accident is subject to consideration.

Initially, upon arrival at the scene, panoramic photography is carried out using a camera with a tripod, a fisheye lens, a flashbulb and appropriate software. Before the production of photography, the territory is designated by a barrier line where unauthorized persons are not allowed to preserve traces at the scene of the incident. After fixing the general plan, a detailed inspection of the car begins.

A forensic investigator using a xenon portable light source with an ultraviolet spectrum conducts a detailed examination of the driver's seat. On the inside of the door, as well as on the driver's seat itself, the investigator is trying to detect biological traces.

After the place of detection of a biological substance is recorded, its analysis is carried out by a specialist. Next, the car is inspected for fingerprints. It is necessary to look for them in the places of the most possible appearance, that is, the front control panel, steering wheel and rear-view mirror. After the fingerprint is detected, the location of the detection is photographed. The unified forensic suitcase for the removal of three-dimensional traces is designed to fix and remove traces at the crime scene in



order to conduct further examinations and research.

If a chain of shoe tracks is found during the inspection of the nearest territory, a gypsum-based solution is used, which must be thoroughly shaken and carefully poured onto the trail. After the plaster solidifies, you can find especially the soles of shoes on it.

With the help of the UFED complex, you can view the phone data found at the scene. The device allows data extraction at the physical, logical and file system levels, as well as password recovery from a wide variety of devices, including outdated and mobile phones, smartphones, portable GPS devices and tablet computers. It can be used to extract call log data, SMS messages, audio and video images. All this is necessary in order to restore the picture of what happened at the scene and promptly respond to incoming information. The complex has a large number of different adapters that allows you to work with any phone model. The information read from the phone can be written to a USB drive [2].

During the examination and solving of criminal cases, the identification and examination of evidence have consistently held a paramount role, as they have always been and continue to be the primary means of providing substantial information. The revelation of a crime and the triumphant outcome of an investigation heavily rely on the extent to which the identification, collection, examination, and proficient utilization of evidence reflecting the diverse aspects of the unlawful act can be accomplished.

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## ПРИМЕНЕНИЕ ТЕХНИКО-КРИМИНАЛИСТИЧЕСКИХ СРЕДСТВ И МЕТОДОВ ДЛЯ ПОИСКА СЛЕДОВ ПРЕСТУПЛЕНИЙ

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**Аннотация:** Рассмотрены средства и методы поиска следов преступления используемые следователями-криминалистами. Целью статьи является описание основных средств обнаружения и фиксации следов на месте преступления. Автор приходит к выводу, что осмотр места происшествия является неотложным, информативным, дающим начало процессу расследования, наиважнейшим следственным действием.

**Ключевые слова:** криминалистическая техника, криминалистические средства, материальные следы преступления, способы фиксации.

## FRAUD IN THE DIGITAL ENVIRONMENT

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### **Abstract**

The way development of a computer and network technology changed criminal behavior is a serious challenge for law enforcement agencies. The main goal of this article is to address the topic of cybercrime, its definition, and its classification. The study of internet fraud is extremely important because the digital world has already integrated itself into all parts of our daily lives and society, thus we need to find ways to protect ourselves from its dangers.

**Keywords:** Cybercrime, digital environment, internet fraud, phishing.

### **Introduction**

In the modern day and age, there is a wide variety of online services: online banks, social networks, and a large number of different apps and programs that coexist with an unstoppable flow of digital content and people who both use and consume all of them. This creates a very complex and sensitive relationship between those who provide internet services and those who use them. Trading our personal data, problems with security of digital bank accounts, right of privacy violations these are all very serious challenges, and we need to face them properly. There is no solution that would give us 100% protection from all dangers of the world, real of digital. It doesn't mean that we should stop looking for a solution to these problems, it means that there are many ways to maintain internet security. First of which is to know what is a digital crime and how can we categorize it.

### **What is a digital fraud?**

Fraud is currently a large and growing area of criminal activity. The general trend is that the share of fraud in the overall structure of crime has been constantly increasing, and the use of internet technology in fraud has been growing for a long time, even before 2020, when it had a huge boost, and is still on the rise today.

To create and implement effective measures against internet fraud, we need to understand its nature. Rodney T. Stamler, Hans J. Marschdorf, Mario Possamai define fraud as follows: commission of any act of deceit, deception, or the submission of false information or material that is designed to obtain some advantage or benefit, such as money, property, or legal rights [1].

Internet fraud is a type of fraud that takes place in the digital environment. The Internet gives fraudeurs a lot of new possibilities and advantages, first of all a global reach, internet, being network of networks, allow one person to communicate with many others over a large distance simultaneously and without being in the same space. This characteristic of internet fraud is extremely important because the victim, the offender and the target in online fraud are participants of the same event but they don't

share same physical space [2]. It is a unique condition that makes internet fraud possible and leads to some challenges that can't be dealt with using traditional crime prevention and detection.

Second advantage is an ability to change one's identity, a common thought about the Internet is that it is an anonymous space, but this idea is not entirely true and right now we might be in fact facing what Kevin D. Haggerty and Richard V. Ericson called «the disappearance of disappearance» as development of surveillance networks goes further, data we share publicly through the social networks increases just as amount of information providers of different services, including the internet itself, gather from our devices. All this stack of information is stored on the numerous servers and can be, and frequently is, illegally sold to a third party, who can be a fraudster or any other offender. It gives the criminals access to the information about their potential victims, and a way to conceal their real identity.

The lack of shared physical space, as mentioned earlier, enhances methods of fraud in the sphere of online commerce where retailers have clients from all globe while on the other side customers can't see what are they buying and from who. It's impossible to know who is on the other side for both parties and that factor combined with ability of criminals to conceal their identity creates a lot of ways to abuse this system. For example, sometimes criminal can use identity of others to make an online purchase for themselves in other cases criminal can create a shell company using someone else ID information and payment details to sell fakes or just to take money from customers without providing a product.

### **The classifications and types of digital crime**

Another way to learn how the internet shapes online fraud is to see what will happen if we eliminate the internet from the situation [3]. Using this characteristic we can see two distinct types of internet fraud: computer-dependent crimes and computer-enabled crimes. Computer-enabled crimes use internet features to commit offences but don't necessarily need them. This type of fraud could also be carried out if computers did not exist, although technology increases the extent and scope of such offenses.

The Ponzi scheme and pyramid scheme would be good examples of such criminal activity. It is important to differentiate one from another. The Ponzi scheme is a mechanism to attract investors with the promise of future returns. The operator can only maintain the scheme as long as new investors are attracted. On the other hand, the pyramid scheme recruits other people and encourages them to further bring in other investors. A member of a pyramid earns only a portion of his income and is used to generate profits by members higher up the pyramid. Today, with the popularity of cryptocurrencies and internet distribution, we see how both schemes change their narratives and appearance, but essentially they stay the same.

Cyber-dependent crimes are new types of offenses that came to be with invention of computers and the internet. The digital environment is an essential element for this type of crime. To show how important technology is for a cyber-dependent crime, let's examine phishing. Phishing is an act of stealing data from others through email that look like they are sent from an official banks of companies but in fact they redirect the

victim to a fraudulent website where user is asked to enter their personal data, frauders use different excuses like security notifications. When the person enters their personal criminal can use in a lot of different ways. Phishing heavily relies upon spamming big amount of emails to different people with hopes that one or two will work.

Obviously, phishing is impossible without the internet. The object of a crime is digital data; the methods used by criminals (spam technologies, fake websites) are digital as well. However, not every element of a cyber-dependent crime needs to be connected to computer or internet technology. A very common element of a phishing scheme is social engineering, using weaknesses in human behavior to your advantage. Prior knowledge of a victim and methods of social engineering used in fraud can differ from crime to crime. There are standard “email spam” that we have already covered; «spear phishing» is a more targeted attack in which the scammers know what specific person or organization they are targeting. In this situation, attackers need to investigate their victim much more thoroughly to make the attack more personalized and increase the chance of hitting the victim into their trap. Thus, cyber-dependent crimes, while necessitating a digital environment to exist, do include elements of the real world in their structure.

### **Conclusion**

Taking into account the mechanism of committing illegal acts is necessary when determining the balance of general, group, and individual (including victimological) prevention and resolving the issue of the relation between organizational, legal, and technical measures aimed at preventing crimes. Ideally, it is necessary to develop a crime prevention algorithm for each of the listed mechanisms for committing illegal acts using information and telecommunication technologies.

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## **МОШЕННИЧЕСТВО В ЦИФРОВОМ ПРОСТРАНСТВЕ**

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**Аннотация:** В последние годы серьезной проблемой для правоохранительных органов становятся преступления, совершенные с использованием телекоммуникационных технологий. Основной задачей данной работы является изучение интернет-мошенничества, выявление его основных свойств, формулирование определения и способов классификации данного вида преступлений. Необходимость изучения преступлений в сфере информационных технологий обусловлена влиянием цифровых технологий на многие аспекты нашей жизни, что, в свою очередь, порождает новые угрозы, от которых необходимо найти средства защиты.

**Ключевые слова:** киберпреступления, цифровое пространство, интернет-мошенничество, фишинг.

## QUALITY MANAGEMENT TOOLS IN SMALL BUSINESS ORGANIZATIONS

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### **Abstract**

Quality management is crucial for the success and sustainability of businesses, regardless of their size. While large corporations often have extensive resources and established quality management systems, small businesses face unique challenges in implementing and maintaining quality standards. This article explores the tools and strategies available to small business organizations for effectively managing quality.

**Keywords:** lean management, quality management tools, total quality management (TQM).

### **Introduction**

Quality management is crucial for the success and sustainability of businesses, regardless of their size. While large corporations often have extensive resources and established quality management systems, small businesses face unique challenges in implementing and maintaining quality standards. This article explores the tools and strategies available to small business organizations for effectively managing quality.

Small businesses typically operate with limited resources, including finances, manpower, and time. These constraints can make it difficult to invest in sophisticated quality management systems or hire dedicated quality assurance teams. Additionally, small businesses often face intense competition, making it imperative to deliver high-quality products and services to gain a competitive edge. Balancing the need for quality with resource limitations poses a significant challenge for small business owners.

Today, quality management tools imply a fairly wide range of means of influencing production processes and the personnel providing them. today they include the entire system of devices and technical support for the process of the enterprise's activities, and managerial relations with subordinate employees. In addition, each tool implies a number of options for its use, depending on the situation and type of activity. in general, any method of influencing the control object will be a tool for quality management at the enterprise.

Despite these challenges, small business organizations can leverage various quality management tools and techniques to improve their processes and outcomes. Some of the key tools include:

1. Total Quality Management (TQM): TQM is a comprehensive approach to quality management that emphasizes continuous improvement, customer focus, and employee involvement. While TQM principles were initially developed for large corporations, they can be adapted to suit the needs of small businesses. From a TQM

point of view, the organization is represented as a supplier, and the subjects are customers. TQM companies are no more labor intensive than traditional companies, but they are characterized by intensive brain activity based on intellectual property and creativity [2]. By fostering a culture of quality and empowering employees to contribute to improvement initiatives, small businesses can enhance their overall quality performance.

2. **Lean Management:** Lean management principles focus on eliminating waste and optimizing processes to improve efficiency and quality. Small businesses can apply lean tools such as value stream mapping, 5S (Sort, Set in order, Shine, Standardize, Sustain), and Kaizen (continuous improvement) to streamline operations and enhance quality. By identifying and eliminating non-value-added activities, small businesses can deliver greater value to customers while minimizing costs.

3. **Six Sigma:** Six Sigma is a data-driven methodology aimed at reducing defects and variability in processes. While traditionally associated with large corporations, Six Sigma concepts such as DMAIC (Define, Measure, Analyze, Improve, Control) can be adapted for small businesses. By using statistical tools and techniques to identify root causes of quality issues and implement targeted improvements, small businesses can achieve higher levels of quality and consistency. The main responsibility of the management of companies that have chosen Six Sigma is to encourage and stimulate efforts aimed at improvement. As a result, improving the products and services of such enterprises becomes part of the daily work of all employees [3].

4. **Quality Management Systems (QMS):** Implementing a QMS provides a structured framework for managing quality within an organization. While large businesses often invest in complex QMS software, small businesses can start with simpler, scalable solutions. Documenting processes, establishing quality objectives, and implementing regular audits are key components of a QMS that can help small businesses ensure consistency and compliance with quality standards.

5. **Supplier Quality Management:** Small businesses rely on suppliers to provide raw materials, components, and services necessary for their operations. Managing supplier quality is essential to prevent defects and maintain overall product quality. Small businesses can use supplier evaluation criteria, performance metrics, and supplier audits to assess and monitor the quality of their suppliers' products and services.

6. **Customer Feedback and Satisfaction:** Listening to customer feedback is essential for understanding their needs and expectations. Small businesses can gather customer feedback through surveys, reviews, and direct communication channels. Analyzing customer feedback allows small businesses to identify areas for improvement and make necessary adjustments to enhance customer satisfaction and loyalty.

7. **Employee Training and Engagement:** Employees play a critical role in ensuring quality within small businesses. An obligatory element of the organization's activities is the training of all employees, which ensures the implementation of the principle of continuous improvement. Learning becomes a form of life. The more people working

in an organization act for its benefit, the brighter prospects open up for it [1]. Providing comprehensive training on quality standards, processes, and tools equips employees with the knowledge and skills needed to maintain high-quality standards. Additionally, involving employees in quality improvement initiatives fosters a sense of ownership and commitment to quality within the organization.

### **Conclusion**

Effective quality management is vital for the success and sustainability of small business organizations. Despite resource constraints, small businesses can leverage various tools and strategies to enhance quality and achieve competitive advantage. By adopting principles such as TQM, lean management, Six Sigma, and implementing robust quality management systems, small businesses can consistently deliver high-quality products and services that meet customer expectations. Additionally, prioritizing customer feedback, managing supplier quality, and investing in employee training and engagement are essential components of a comprehensive quality management approach for small businesses. By embracing a culture of quality and continuous improvement, small businesses can position themselves for long-term success in today's competitive marketplace.

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## **ИНСТРУМЕНТЫ УПРАВЛЕНИЯ КАЧЕСТВОМ В ОРГАНИЗАЦИЯХ МАЛОГО БИЗНЕСА**

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**Аннотация:** Управление качеством имеет решающее значение для успеха и устойчивости бизнеса, независимо от его размера. В то время как крупные корпорации зачастую располагают обширными ресурсами и устоявшимися системами управления качеством, малые предприятия сталкиваются с уникальными проблемами при внедрении и поддержании стандартов качества. В этой статье рассматриваются инструменты и стратегии, доступные организациям малого бизнеса для эффективного управления качеством.

**Ключевые слова:** бережливое управление, инструменты управления качеством, всеобщее управление качеством (TQM).

## CONTROL OVER NOTARIAL ACTIVITY

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### **Abstract**

This article deals with aspects of control over notarial activity, issues in objective performance of this control and punishment of notaries.

**Keywords:** notary, Chamber of notaries, tax control, judicial control, self-regulating organizations

An inseparable part of our government's legal system is represented by notary. It is remarkable that in summer 2022, 43 notarial acts were performed per minute, and every 2 minutes a certification of will was made. The notary's main task is to detect and prevent the commitment of illegal actions from the appellant. Sometimes negative legal consequences are caused by notarial error, such as incorrect identification of the applying citizen. [3]

Organs of notaries are assigned to fulfill the main tasks of society and government, and this right is enshrined by the government. The government also grants the organs independence in making certain decisions, but keeps its supervisory and controlling functions in a notarial field. Due to the fact that notarial actions are made in the name of the government in the interests of legal entities, the expansion of the powers of the Ministry of Justice is required.

As it was mentioned previously, notary public is granted independence by the government when performing notarial actions. Practically no one has a right to force a notary to perform a notarial act. There is an exception for Court. This agency has a right to force a notary to perform a notarial act, as well as to define the method of performing this act. Main forms of control usually include tax control, professional control and judicial control.

Tax control is fixed in article 87 of the Tax code of the Russian Federation [2]. Audits that are confirmed by the law are allowed to be made by the tax agency. Those audits could take the form of checking the papers as well as on the object directly. Audits of the papers that are submitted by a taxpayer to the tax office and papers that are contained by the tax authorities are called office audit. The principle of this audit is that the tax body examines papers of a legal entity that pays its taxes to the tax body by place of residence.

The other form of control is professional control. The main task of this control is examining duties performed by a notary, particularly the accuracy of performed and its compliance with the law. This kind of control inspects all competencies notaries have the right to use from the point of view of the law.

Judicial control measures how the laws of our country are followed. Acts or decisions made by a notary may be appealed by the person whose right has been



violated, if certain violations are found. To do so, one must file a lawsuit within a period of time stated by the law. This lawsuit must contain information about which rights were violated in the opinion of the plaintiff, and what actions were taken by the notary to allow this violation to happen. This form of control is crucial. Judicial control is able to guarantee the plaintiff's restoration of his violated rights, as well as to force a notary to perform acts compliant with the law.

There is an opposition between the Chamber of notaries and public unions, since private lawyers' activity is under Chamber's supervisory. On that basis, we can tell that the law empowers non-commercial organizations with independent form, which distinguishes them from public unions and other forms of non-commercial organization that resemble self-regulating organizations so strongly. Notary fulfills a public law function he's empowered with, that is why control over activity of the entities that perform public law functions is required, but nothing similar to this is presented in our legal system at this moment. Due to the fact that notarial activity is tightly connected to civil society, it is necessary to allow non-commercial organizations to supervise notarial activity. Legislation of the new law on notarial activity would resolve the issue of local acts controlling public law institutions. The law on notarial activity project is to empower the Ministry of Justice with the right to supervise notarial activity on the territory of the subject of the Russian Federation, and to empower Chamber of notaries with this right, and define its competencies in the boundaries of the subjects of our country.

In article 12 of the Fundamental Principles of Legislation of the Russian Federation on the Notary it is mentioned that the court has a right to forbid a notary performing notarial activity in certain cases. As for the jurisdiction's disputes in which a notary plays a role as a plaintiff, they are usually being considered by district courts. The Arbitration court may also perform as a judicial body of consideration and solvation of such disputes. It is interesting that in the legal system of our country there are no stated forms and methods of control over notary. Because of that, it would be plausible to legislate the law on notarial activity that will contain forms and methods of supervisory over notarial activity.

There is no information on disciplinary responsibility related to notary. It means that this sanction cannot be imposed against the Chamber of notaries at this moment. Thus, a notary cannot be punished for legal norms violation. And again, it is clear that we need to legislate the law that would include all possible measures that could be taken towards the notaries who break the law. This new element in the legal system would enhance the entire structure of notary, and common citizens would not have any doubts left about how lawful a notary's activity is. By virtue of notaries' obedience to follow the new law, protection of legitimate rights and interests of the citizens would be fully provided. Also, the citizens' rights to get qualified legal assistance, which is provided by part 1 article 48 of the Constitution of the Russian Federation, would be implemented on a new level [1]. If we do not legislate this law, the number of violations made by notaries will be increasing, impunity will happen, and the rights of

legal entities, who perform activity compliant with the law, will be violated.

There were cases when notaries have committed different disciplinary offences, and have got away punishment due to chamber of notaries' decision not to take any measures. The topic of depriving a notary of its status has not even been considered, though there were reasons for implementing this punishment, such as when a notary repeatedly violated the law, which led to complaints and claims from those citizens who turned to the help of this notary. The necessity of finding a solution to all these problematic moments is clear, and it could be found in the legislation of the new law on notarial activity.

In conclusion, it is necessary to make the activity of the Chamber of notaries more visible and objective, it is necessary to make the control over the Chamber of notaries more correct, and to add more possibilities to supervisory agencies. We would also be able to talk about fair and legitimate punishment of notaries for their violations only after the legislation of new law. At the moment, there are many gaps in our legal system, many cases are not registered or not officially declared, which allows some notaries to avoid proper punishment for performing their job poorly, due to the absence of laws containing required legal aspects that would provide the ability to hold a notary fully accountable for his actions. Only then would the control of notary activity have a greater impact on their activities and fate, being a powerful guarantee of the protection of the rights and interests of citizens.

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## КОНТРОЛЬ ЗА ДЕЯТЕЛЬНОСТЬЮ НОТАРИУСОВ

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**Аннотация:** В статье исследуются аспекты контроля за деятельностью нотариусов, проблематика объективности приведения данного контроля и наказания нотариусов.

**Ключевые слова:** нотариат, нотариальная палата, налоговый контроль, судебный контроль, саморегулируемые организации.

## ARTIFICIAL INTELLIGENCE IN LEGAL PRACTICE

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### **Abstract**

The article discusses the concept of "artificial intelligence" and the problem of replacing a person in legal activity with artificial intelligence. The purpose of the article is to disclose the concept of "artificial intelligence", as well as to compare the capabilities of humans and artificial intelligence in legal practice. The author comes to the conclusion that the replacement of specialists with artificial intelligence is possible only in some sectors of legal activity.

**Keywords:** Artificial intelligence (AI), automated system, jurisprudence.

Modern technologies penetrate into all spheres of our life, including legal. With the development of artificial intelligence, the question arises about the possibility of replacing lawyers with automated systems. This topic causes a lot of controversy and discussion among professionals and the public.

Information about artificial intelligence can be found in various sources, including computer science textbooks, popular science articles, encyclopedias, company websites, specialized magazines, etc. The authors offer various definitions of the concept of "artificial intelligence". Let's look at some of them.

For example, the textbook "Artificial Intelligence: a Modern Approach" (S. Russell, P. Norvig) says: "Artificial intelligence is the study of what makes machines intelligent, as well as the development of computer programs that can have intelligence" [2]. This means that the concept of "artificial intelligence" includes the study of what processes and methods allow machines to approach the level of human intelligence, as well as the development of software capable of demonstrating intellectual abilities.

The Encyclopedia Britannica states: "Artificial intelligence, sometimes called machine intelligence, is a field of computer science that deals with the creation of programs capable of demonstrating mental abilities, such as learning, problem solving, planning, speech recognition and natural language processing"[1]. This definition means that artificial intelligence (also known as machine intelligence) is a field of computer science concerned with the development of programs capable of demonstrating mental abilities, including learning, problem solving, planning, speech recognition and natural language processing.

Thus, we can form our own concept of artificial intelligence: "artificial intelligence (AI) is a field of computer science that studies the creation of systems capable of performing tasks that usually require human intellectual abilities. AI is aimed at creating computer systems capable of solving problems, analyzing large amounts of data, making decisions, learning from experience, and even interacting with people in

an intelligent context."

Artificial intelligence is used in many fields of activity. In medicine, artificial intelligence is used to analyze medical data, diagnose diseases, predict the effectiveness of treatment and develop new treatment methods. In the financial industry, artificial intelligence analyzes market dynamics, predicts trends, manages risks, and is used to automate financial processes and prevent fraud. In manufacturing enterprises, AI is used to automate production processes, optimize the production chain, predict equipment failures and improve product quality. In the field of education, artificial intelligence solves the issues of personalization of educational programs, adaptive learning, assessment of student performance and the creation of learning tools.

Artificial intelligence is also actively used in legal practice. The development of artificial intelligence and automated systems can simplify and accelerate a number of processes related to solving legal problems. Such systems are capable of efficiently processing information, analyzing legislation and court decisions, as well as providing legal advice. Thanks to this, specialists can save a lot of time and resources.

At the moment, there are already a number of programs in legal practice that use artificial intelligence, such as: automated systems for analyzing legal information, virtual assistants and chatbots, systems for forecasting and analyzing court decisions, cloud legal platforms, systems for predicting changes in legislation.

Automated legal information analysis systems based on artificial intelligence are used to process and analyze large amounts of legal information, such as laws, legal practice, court decisions and precedents. This allows lawyers to investigate and analyze legal issues more efficiently and quickly.

Virtual assistants and chatbots are used by many law firms today, as artificial intelligence is able to provide qualified legal advice, answer customer questions and help with filling out legal documents.

Predicting and analyzing court decisions with the help of artificial intelligence is much faster and more accurate, since a computer program is able to compare a huge array of data in a few minutes, which is too much for a person, so such programs will help lawyers develop strategies for their clients based on previous decisions and statistics.

The most interesting and in demand today are cloud legal platforms or online systems that use artificial intelligence to automate legal processes, document exchange, automatic contract verification and other tasks.

Forecasting changes in legislation is also more efficient to perform with the help of systems with artificial intelligence, as a computer program will do it much faster and more accurately.

These examples show that artificial intelligence already plays an important role in modern jurisprudence, increasing the efficiency of lawyers and providing access to legal aid to a wide audience.

However, an important aspect of performing legal tasks is the human factor. A

lawyer has a number of advantages over artificial intelligence.

1. Flexibility and creativity: a lawyer is able to perceive complex legal issues from the point of view of ethics, justice and public benefit, which is a distinctive feature of human thinking. A lawyer is able to apply a creative approach to solving legal issues that may be difficult for artificial intelligence.

2. Empathy and understanding of human emotions: Lawyers have the ability to empathize and understand human emotions, which is important when working with clients in sensitive situations. Artificial intelligence does not have the ability to empathize and understand human emotions.

3. Communication and negotiation: An important part of a lawyer's job is the ability to negotiate, resolve conflicts and convince other people of their point of view. These skills are closely related to interpersonal relationships and communication, which are difficult to implement with the help of artificial intelligence.

4. Ethical decisions: A lawyer is obliged to follow ethical standards in his work, which requires making complex decisions based on the unique circumstances of each case. Ethical aspects of legal practice require human intervention and understanding of the context, which are difficult to implement in artificial intelligence.

These advantages show that, although artificial intelligence has its advantages in processing and analyzing large amounts of data, lawyers have unique qualities that cannot be completely replaced by artificial intelligence.

Thus, it can be said that the replacement of lawyers with artificial intelligence is possible only in some sectors of legal activity. For example, automated systems can be useful for processing large volumes of documentation and analyzing information. At the same time, the human factor is no less important for performing a number of tasks related to the emotional and social aspects of law, however, artificial intelligence can become a useful tool for improving the effectiveness of the legal system, but its complete replacement for lawyers currently seems unlikely.

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## ИСКУССТВЕННЫЙ ИНТЕЛЛЕКТ В ЮРИДИЧЕСКОЙ ПРАКТИКЕ

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**Аннотация:** В статье рассматривается понятие «искусственный интеллект» и проблема замены человека в юридической деятельности на искусственный интеллект. Целью статьи является раскрытие понятия «искусственный интеллект», а также сравнение возможностей человека и искусственного интеллекта в юридической практике. Автор приходит к выводу, что замена специалистов на искусственный интеллект возможна лишь в некоторых секторах юридической деятельности.

**Ключевые слова:** искусственный интеллект, автоматизированные системы, юриспруденция.

## PROSPECTS OF USING ARTIFICIAL INTELLIGENCE TO FORM AN INVESTMENT PORTFOLIO

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### **Abstract**

This article considers options for using artificial intelligence in the stock market, in particular when compiling an investment portfolio. The relevance of the topic under consideration lies in the fact that artificial intelligence is quite actively entering the life of a modern person. However, it is in the stock market that artificial intelligence is used insignificantly. Ways of using machine learning methods to improve decision making in the stock market are discussed. Prospects of using AI are assessed and conclusions are drawn.

**Keywords:** artificial intelligence (AI), investment portfolio, machine learning, stock market.

Artificial intelligence is capable of monitoring multiple risk factors in real time and checking the performance and resilience of an investment portfolio to market scenarios. In particular, AI can generate a system of early warning indicators of potential default. Some market makers are implementing AI models to minimize the risk of impairment of free financial assets and maximize the profitability of their balance sheet. Individual asset managers and hedge funds automate risk management and regulatory compliance processes by monitoring the behavior of managers of individual asset portfolios, automating daily reports on the quality of execution of transactions and procedures for assessing the risk of market liquidity [2].

Such algorithms can promptly detect changes and relationships that are implicit to humans, which can serve as prerequisites for developing an investment strategy. One of the most common tools for analyzing financial markets is neural networks. They can process massive amounts of data in real time and identify important trends and relationships in real time.

“Artificial intelligence can bring many advantages to the stock market. It provides more accurate data analysis, reduces the reaction time to market changes and increases the accuracy of forecasts about future trends. Some potential benefits of using artificial intelligence in the stock market include” [4]:

1. More accurate data analysis. Artificial intelligence can analyze vast amounts of data to uncover hidden trends and connections that may be overlooked by traditional analysis methods.
2. Faster response to market changes. Artificial intelligence can react to changes in the stock market more rapidly and accurately than a human analyst, directly impacting investment decision-making.
3. Forecasting trends. Artificial intelligence can analyze large amounts of data and identify patterns of behavior and trends that can be used to predict future movements in the

stock market.

4. Optimization of the investment portfolio. Artificial intelligence can help optimize an investment portfolio, taking into account goals and risks, as well as forecasts about future trends.

The general idea is that the use of these technologies in the stock market can improve the efficiency and accuracy of investment decision-making and optimize the results of investment activities. However, it is also necessary to take into account the risks associated with the use of AI in the stock market, such as the possibility of erroneous results and dependence on technological infrastructure. Next, let's look at specific methods that can be applied in the stock market.

Thus, the following methods of artificial intelligence and machine learning can be applied [3]:

1. Data analysis. Using machine learning to analyze a large amount of information, such as other market data, quotes, and news, can help you make better decisions.

2. Neural networks. This method provides a more accurate analysis and prediction of future market trends.

3. The genetic algorithm. These algorithms use an evolutionary process to develop optimal solutions.

4. Cluster analysis. This method is used to segment data into suitable groups, which in turn allows you to build more accurate models for predicting market trends.

5. Trading robots. They are used to automate stock market trading using machine learning algorithms.

6. Natural language processing. This method makes it possible to easily analyze news articles and other literature that may have an impact on the stock market.

All these methods can help investors and traders make more accurate and effective stock market decisions, which can lead to increased profits and reduced risks.

In addition, artificial intelligence can be used to automate trading operations. With the help of machine learning algorithms, it becomes possible to determine the optimal moment to buy or sell securities. As a result, artificial intelligence can significantly improve the efficiency of brokerage companies and reduce risks. Automation of many processes, from market analysis to risk management, helps to avoid mistakes related to the human factor.

Artificial intelligence can also be a useful tool for investment decisions and portfolio management. When it comes to managing investment portfolios, AI algorithms offer the advantage of faster profitability predictions compared to traditional methods. This enables swift opinion formation and facilitates the creation of recommendations for portfolio formation and rebalancing. Technical and fundamental analysis can also be automated, such as extracting economically significant information from corporate reports using natural language processing methods or constructing regression models to evaluate indicators at the general economic and company-specific level. The complexity of these algorithms allows them to account for changes in factors and their weights at different stages of analysis, including natural factors or growth rate fluctuations in leading global economies. When rebalancing an investment portfolio, a

so-called evolutionary algorithm can be used, which allows solving problems of optimal asset allocation with a small number of assets in the portfolio. It takes into account the model risk variable in the assessment (in particular, it calculates volatility coefficients for each asset as a result of erroneous model specification), which significantly reduces forecast errors. “Portfolios for which this technique is used tend to show a better Sharpa ratio (by about 10%) than those that do not take into account model risks. However, AI models can make forecast errors when unexpected shocks occur” [2].

For this reason, financial organizations prefer to use AI in parallel with classical methods to compare and evaluate the results obtained (for example, when preparing a rating or risk matrix) at the stages of pre- and post-trade analysis.

The conclusions of this publication are that the use of artificial intelligence in the stock market is really promising, since various methods will allow a more accurate approach to its analysis.

However, despite the advantages of the speed of evaluating market indicators, trading using AI algorithms has a number of disadvantages. For example, the high sensitivity of AI models to strong market shocks can create the effect of autocorrelation of algorithmic systems and increase systemic risks [2].

Therefore, at the moment, AI can only serve as an auxiliary tool, thanks to which it is possible to minimize risks and approach analysis more accurately and transparently.

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## ПЕРСПЕКТИВЫ ИСПОЛЬЗОВАНИЯ ИСКУССТВЕННОГО ИНТЕЛЛЕКТА ДЛЯ ФОРМИРОВАНИЯ ИНВЕСТИЦИОННОГО ПОРТФЕЛЯ

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**Аннотация:** Рассмотрены варианты использования искусственного интеллекта на фондовом рынке, в частности при составлении инвестиционного портфеля. Актуальность данной темы заключается в том, что искусственный интеллект достаточно активно входит в жизнь современного человека. Однако именно на фондовом рынке искусственный интеллект используется незначительно. Рассмотрено, какие методы машинного обучения могут помочь улучшить принятие решений на фондовом рынке. Дана оценка перспективам и сделаны выводы.

**Ключевые слова:** инвестиционный портфель, искусственный интеллект (ИИ), машинное обучение, фондовый рынок.



## REDESIGN OF THE CAR STUDIO WEBSITE

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### **Abstract**

The main stages, advantages and results of the redesign were considered in the article. The redesign of the automotive studio's website is designed to improve the user experience, increase conversion and strengthen the brand's position in the market. The main changes include improved navigation, adaptation to different devices, content optimization and the introduction of new features.

**Keywords:** car studio, website redesign, main stages of website redesign, advantages and results of website redesign.

In the modern world, websites are an integral part of any business, whether it is a small company or a large holding company. They play the role of a business card, providing potential customers with information about the company, its services and offers. One of the key points of a successful website is its design - appearance, structure and navigation.

The website of the automotive studio is the face of the company, which allows potential customers to learn about its services, promotions and offers. In order to attract more visitors and keep the old ones, the site must be user-friendly, functional and attractive. That is why many car studios turn to professionals to redesign their website.

First of all, it is necessary to determine the goals and objectives of the redesign. This may be updating an outdated design, improving functionality, optimizing the site for mobile devices, or something else. Then it is necessary to analyze the existing site, identify its weaknesses and suggest possible solutions to problems.

One of the important points is the choice of color scheme and fonts. They should be harmonious, not cause irritation and correspond to the theme of the automotive business. The site structure should be logical and user-friendly, and the navigation should be simple and understandable.

The adaptability of the site is also an important aspect. The site should display well on different devices and in different browsers. This will attract more users and increase the conversion rate.

When redesigning the website of the automotive studio, it is important to take into account the opinion of users. You can conduct a survey or test a new version of the site to see if users like the new design and whether it is convenient for them to use the site.

The redesign of the automotive studio website is the process of updating and improving the appearance and functionality of the site in order to increase its attractiveness to users and improve its position in search engines.

*The main stages of the redesign:*

- Analysis of the current state of the site;
- Defining the goals and objectives of the redesign, identifying weaknesses and suggesting possible solutions to problems;
- Choosing a color scheme and font that correspond to the subject of the automotive business;
- Updating the site structure taking into account user convenience and optimization for mobile devices;
- Improved navigation: creating a clear and simple site navigation system;
- Website adaptation for various devices and browsers;
- Testing the new version of the site to identify possible errors and flaws.

#### *Advantages of website redesign:*

- Improving the user experience: The redesign allows you to improve user interaction with the site, make it more intuitive and easy to navigate.
- Conversion boost: The updated design can attract more visitors to the site and increase the number of conversions.

#### *What results should be expected?*

After the redesign, the auto studio can expect an increase in the number of new customers, an improvement in brand reputation and an increase in the level of satisfaction of existing customers. In addition, the redesign can help increase sales of services and goods, as well as attract the attention of potential investors.

Thus, we can conclude that the redesign of the website is an important step for the automotive studio, which can help improve the company's image, increase profits, attract new customers and compete in the automotive services market, which makes it possible to attract the attention of investors.

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## **РЕДИЗАЙН САЙТА АВТОМОБИЛЬНОЙ СТУДИИ**

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**Аннотация:** В статье были рассмотрены основные этапы, преимущества и результаты редизайна. Редизайн сайта автомобильной студии призван улучшить пользовательский опыт, повысить конверсию и укрепить позиции бренда на рынке. Основные изменения включают улучшение навигации, адаптацию под различные устройства, оптимизацию контента и внедрение новых функций.

**Ключевые слова:** автомобильная студия, редизайн сайта, основные этапы редизайна сайта, преимущества и результаты редизайна сайта.

## PSYCHOLOGICAL ASPECTS OF THE RAPIST PERSONALITY WHEN CONCEALING A CRIME

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### **Abstract**

The article analyzes the psychological characteristics of the rapist personality when concealing a crime. The material on psychology and literature defining the general psychological characteristics of rapists trying to hide their crime is carried out and summarized. The most frequently used psychological characteristics that guide the rapists have been identified. General portraits of individual rapists who commit rape and pursue the goal of concealing the crime and getting rid of persecution have been formed.

**Keywords** rape, rapist personality, rapist profile, rapist psychology, rape concealment.

The study of personality characteristics of rapists and their psychological characteristics revealed during the commission of a crime and its concealment remains relevant in psychology and criminology.

The statistics from the Ministry of Internal Affairs of the Russian Federation show that from 13,500 to 14,200 sexual crimes is committed in the country every year [1]. At the same time, most of the crimes committed can be solved through the criminalistic and psychological analysis of the rapist identity.

The identity of the perpetrator, his motives, as well as how the rape was committed, what instruments of crime and other improvised means were available, whether a murder was committed concealing the rape – all this is studied in criminology and psychology, which forms a portrait of the criminal.

There are many different works and publications in the scientific literature on the study of the psychology of the personality of rapists and serial maniacs. The study of rape was carried out by such scientists as L.V. Ponomareva [2, 3], R.S. Belkin [4], V.N. Burlakov [5], N.D. Gomonov [5], P.T. Skorchenko [6], etc.

In this study, I would like to draw attention to the classification of actions performed by a rapist to conceal crimes, given by L.V. Ponomareva in her manual "Methods of investigating rapes":

- 1) threatening the victim to kill their relatives or members of the family if they report the rape to anyone;
- 2) washing or destroys clothes, as well as cleaning the genitals in order to destroy traces of a crime, and changing the style of clothing;
- 3) changing the appearance;
- 4) leaves the place of residence for a long time in order for the victim to erase from memory the signs of his appearance;
- 5) making the victim unconscious or helpless by causing injuries to vital organs,

soldering with alcohol or injecting narcotic drugs, potent drugs into her body, etc.

6) threatening the victim to tell the “truth” to their friends (employees, neighbors, etc.), relatives, including the names of sexual partners, who do not really exist.

7) killing the victim, and sometimes burning the corpse [2].

Despite the large number of publications in the study of the rapist identity, the personal characteristics of the perpetrator in the concealment of rape are not sufficiently studied in the scientific literature, which causes special interest in this problem and determines its novelty. The analysis of literature on psychology and criminology makes it possible to identify the following general and special signs of the identity of the rapist when concealing a crime.

The rapist psyche is often fractured. Almost all rapists have mental disorders that push them to commit a crime. Such tendencies are often associated with the sexualization of his personality. It is problems with sexuality and sexualization that push a person to commit rape. These same aspects force him to take various measures to conceal crimes.

The concealment of rape can occur in different ways, while in each case the rapist is guided by special psychological characteristics to conceal the crime.

Rapists, serial rapist maniacs are interested in keeping the crime unsolved. They try to plan their crime in advance, to provide ways to “escape” and conceal their actions, to destroy traces. The criminal, hiding his crime, pursues the goal of leaving as few traces and evidence as possible that can point to him, or highlight his criminal handwriting in multiple crimes.

Rapists who do not want to kill their victim often use intimidation, threats, for this they expose the victim to psychological and moral violence, for which they can prepare a speech for this in advance, or collect data about the victim for the greatest influence during intimidation. If the rapist knew the victim in advance, blackmail can be used to conceal the crime.

Rapes are often premeditated. In such cases, the perpetrator plans all the elements of the crime for a long time and carefully, selects the most appropriate and possible ways to commit violence, options in which his identity will not be established, all traces are hidden. In such cases, the criminal's strategy is particularly worked out, since he realizes that there is a high probability of his exposure. Rapists are especially emotional and nervous in such cases; their constant anxiety sometimes forces them to evade their own plan, and sometimes pushes them to murder in order to hide the traces of the crime.

Of particular interest are the psychological features of the criminals' tactics. The rapist tactics is one of the most, perhaps, researched issues, since serial maniacs and rapists. Due to their unhealthy psychological characteristics and fanatical manifestations in their perception they use “unique” tactics, which create the rapist “image”. A great contribution to the study of the criminal profiling was made by the American criminologist Robert Ressler, who also coined the term “serial killer” [7]. Leaving specific and “branded” traces at the crime scene indicates the need for

attention and popularity, narcissism, the desire to feel fear from the number and cruelty of crimes committed. By making themselves recognizable, rapists want to stand out and show their “skills”. This helped investigators identify all the crimes belonging to one criminal and prove their involvement in them.

With a complete mental personality disorder, some rapists are not even focused on hiding their illegal actions. Serious mental abnormalities and unstable mental state during the commission of a crime sometimes force the rapist to act spontaneously and unorganized. The criminal's panic does not allow him to sufficiently hide the traces of the crime and either influence the victim or fight the victim.

Some criminals repent after the committed action, realize their guilt and even try to “negotiate” with the victim. At the same time, remorse can often turn into aggression, which can be especially cruel and rude towards the victim. Spontaneous outbursts of rage can cause some deviations in the rapist's head and even affect the most important events that aggravate such a crime.

Thus, the conducted research made it possible to form and generalize some psychological characteristics of the criminal's personality in the process of concealing a crime, which may be useful in further forensic and psychological research. It is advisable to propose the development of a unified psycho-criminological reference guide, in which to highlight the most common features, as well as specific inclinations, according to which potential victims will be able to identify a possible rapist and, with the help of the recommendations set out in this manual, resist the rapist, his psychological impact, as well as avoid situations that endanger sexual freedom of the individual.

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# ПСИХОЛОГИЧЕСКИЕ АСПЕКТЫ ЛИЧНОСТИ НАСИЛЬНИКА ПРИ СОКРЫТИИ ПРЕСТУПЛЕНИЯ

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**Аннотация:** Проанализированы психологические особенности личности насильника при сокрытии преступления. Проведен и обобщен материал по психологии и литературе, определяющий общие психологические особенности личности насильника, пытающегося скрыть свое преступление. Выявлены наиболее часто используемые психологические особенности, которыми руководствуется насильник. Сформированы общие портреты отдельных насильников, совершающих изнасилования и преследующих цель сокрыть преступление и избавиться от преследования.

**Ключевые слова:** изнасилование, личность насильника, «почерк» насильника, психология насильника, сокрытие изнасилования.

## SOME ASPECTS OF CYBERCRIME PREVENTION AND CONTROL

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### **Abstract**

The article presents some data of the Ministry of Internal Affairs on the number of registered crimes using modern technologies. The purpose of the article is to identify several types of Internet fraud, as well as describe methods to combat them.

**Keywords:** computer system, cybercrime, fraud, methods of protection, the Internet.

In the conditions of informatization of modern society, there are negative phenomena associated with the problems of cybercrime, which are gaining relevance every year. Unfortunately, the Criminal Code of the Russian Federation does not contain the concept of “cybercrime”, so it is worth using the definition of this concept from a number of scientific sources, which gives a generalized understanding of this term as a certain set of crimes committed using modern information technologies and computers, using the capabilities of information and telecommunications networks [2].

Thus, according to data already for January – September 2022 from the Ministry of Internal Affairs of the Russian Federation, the Main Information Analytical Center of the Federal State Institution, 378.5 thousand crimes committed using information and telecommunications technologies or computer information were registered, while according to data for the same period, but for 2021, the number of registered crimes was less by 6.1%. Almost half of them are crimes related to the category of grave and especially grave. Almost three-fourths are committed with using the Internet and more than a third using mobile communications [4].

Almost three quarters of such crimes are committed by theft or fraud, while one in eight of them is committed for the purpose of illegal production, sale or shipment of narcotic drugs. From January to September 2022, 85407 cases were registered under Article 158 of the Criminal Code of the Russian Federation, 178161 cases were registered under Article 159 of the Criminal Code of the Russian Federation, 5695 and 315 cases were registered under articles 159.3 and 159.6 of the Criminal Code of the Russian Federation [4]. In order to effectively prevent and combat cybercrime, it is important to identify, based on statistical data, what methods attackers use to commit acts. Studies show that the most common ones used by attackers can be impoverished in the following [1]:

- request for help;
- sending sms;
- easy earnings;

- account blocking;
- dating sites;
- identity theft;
- vacancies;
- training and webinars;
- fake tags of organizations;
- "mirror" sites of organizations;
- trading through an online store.

A common feature for all methods is the significant role of the victim itself, i.e. the victim component.

At the same time, it should be noted that the establishment of contact with the victim usually occurs by e-mail or using social networks, when asked to answer by e-mail or call by phone. After establishing contact, the attackers try to log in the victim's trust, and the next step is requests for transfers of various amounts to electronic wallets or to a phone number that fraudsters have access to, or download an application.

Thus, the capabilities of law enforcement agencies can be significantly expanded through the use of not only active actions to identify and block the threats of attackers, but also through the use of measures aimed at reducing the level of victimization of the population and society in this area. Awareness of potential victims about. In this case, the current threats from cybercriminals work on the principle of "forewarned means armed." The victim who performs the "right" actions has the opportunity to get out of the current criminal situation with minimal losses, or no losses at all.

Law enforcement agencies should use all available methods to inform about the methods used by cybercriminals and measures to protect against cybercrime.

Some of these recommendations are very simple, but in practice significantly reduce the risk of becoming a victim of cybercriminals. So in the case of if you are asked to download and install an application, it is better not to download and install the application, but if this has already happened, then if you have a modern antivirus (with an updated database of malicious software), you should use it, the antivirus should inform you that an application that harms the computer is installed on the computer [3].

A very common way to steal money from a bank account is to carry out fraudulent activities using specially created "mirror copies" of bank websites. Criminals create a website whose pages are difficult to distinguish from the bank's official website. Attackers gain access to important information when the victim visits such a fake site. They can quite easily obtain the victim's login and password and log into his personal account.

The classic option, when fraudsters can access the victim's data, is to send messages to the mail, for example, that your account is blocked, to restore your account you need to enter your username and password. Other messages where it is reported that the victim has won the lottery, and in order to get a win, you need to enter your bank card details on a fraudulent website. Thus, attackers gain access to the



account or bankcard data.

If an attacker asks to transfer money, then at best, you should not have a dialogue with him, or you should ask about the reasons why they need to be transferred, asking various questions, this will help to establish inconsistencies in the attacker's history. The briefer the dialogue, the less likely it is to become dependent on an attacker.

At the moment, the following type of fraud has become very actively used, when a large amount of money is deposited into the victim's account and after some time there is a call from a person (or a message with a malicious link comes) who asks to transfer money back. In such cases, it is better to contact your bank and inform them that you received an unknown transfer, and then apply for a refund of the money that was credited by mistake. In no case should you use the funds received.

Thus, the identified current threats from cybercriminals suggest appropriate adequate measures to prevent and combat cybercrime, which, among other things, should be aimed at reducing the level of victimization of the population and society in this area, through the dissemination of information about the methods of theft of funds or personal information.

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## **ОТДЕЛЬНЫЕ АСПЕКТЫ ПРОФИЛАКТИКИ И БОРЬБЫ С КИБЕРПРЕСТУПНОСТЬЮ**

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**Аннотация:** В статье изложены данные Министерства внутренних дел о количестве зарегистрированных преступлений с использованием современных технологий. Цель выделить несколько видов интернет мошенничества, а также методы борьбы с ними.

**Ключевые слова:** киберпреступления, компьютерная система, методы защиты, мошенничество, сеть Интернет.

## COMPETITION AS A CHARACTERISTIC OF THE MARKET ECONOMY

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### **Abstract**

The purpose of this study is to analyze competition in the market economy. The study reveals the essence of competition, examines its functions and types. The positive and negative aspects of competition for both sellers and buyers are analyzed. The relevance of this topic lies in the fact that many companies, as a rule, consider competition to be something negative, because they do not know how to use it to their advantage. As a result, it is necessary to develop a set of measures that will allow the company to compete in its favor.

**Keywords:** competition, functions of competition, recommendations, types of competitions

Until now, it is customary in the world to distinguish four types of economic systems, namely: traditional, market, command-administrative and mixed. The economic system as a whole is necessary in order to structure the relationship between production and consumption as efficiently as possible.

In the modern world, a mixed economy predominates in most developed countries. It is based on separate elements of the market and command-administrative (planned) economic system. That is, we can conclude that most developed countries are based on a mixed economy with elements of market principles.

Considering the modern economic system, we can note its individual characteristic features, namely:

- A large number of different forms of ownership
- Prices for various goods and services are set freely.
- Business activity is free
- Availability and freedom of competition

Competition is inextricably linked with a market economy due to its characteristics. It plays a fairly large role and means competition between various economic entities for production, sales, quality goods and resources.

The means of competition are: range of goods, services, etc. In turn, the functions of competition are:

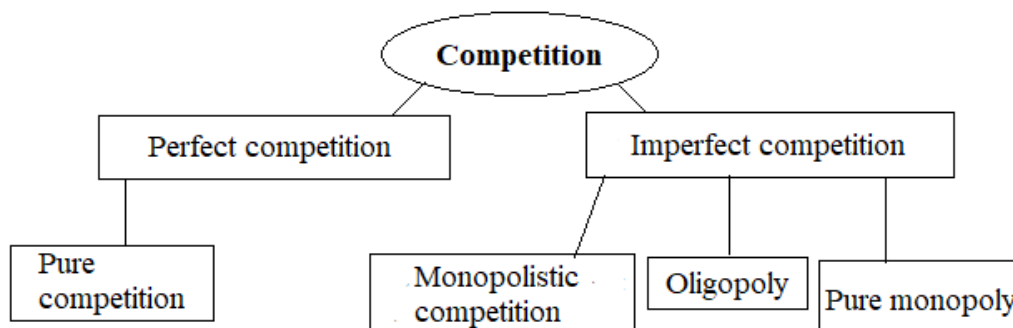
- 1) Innovative – based on the achievements of scientific and technological progress.
- 2) Controlling – designed to prevent the monopolistic dictate of some market participants over others.
- 3) Adapting – rational adaptation of enterprises to economic conditions, leading to expansion of the scope of activity.
- 4) Regulatory - influencing supply in order to establish optimal compliance with

demand.

5) Distributing - affects the distribution of the national product among consumers.

[1]

For a more visual representation, we display the types of competition in Figure 1



*Figure 1 - Types of competition*

In perfect competition, neither the seller nor the buyer is able to significantly influence the price of a particular product. That is, the manufacturer seeks to produce a product at minimal costs and sell it for a cost equal to these costs.

With imperfect competition, it becomes possible to influence the price of a product.

In monopolistic competition, there are a large number of selling firms that offer differentiated products. At the same time, price control is within narrow limits. An example is retail trade.

In an oligopoly, there are several selling firms that produce a standardized or differentiated product. The price for these goods is limited by an agreement between sellers, that is, upper and lower price limits are set, which cannot be exceeded.

Entering this industry is quite difficult. Examples are the production of automobiles and household appliances.

In a pure monopoly, there is one large sales company that produces a product that is unique in all its properties. The price is set by the company independently. Entry to this industry is blocked. An example is energy companies.

Competition has both positive and negative sides, looking at them in more detail.

Competition gives buyers the opportunity to choose a product. Also, if there is a choice of goods, the price will not be too high, because there will always be a seller with a lower price. Products will always improve because the seller has an incentive to attract buyers. There are no negative points for the buyer.

For sellers, competition provides an incentive to grow and improve their product. In addition to the growth of the company itself, the service is also growing. However, competition also has a negative side for the seller: lower prices, bankruptcy, shortening the life of the business.

First of all, competition shows which goods and services are in demand in the market. A popular mistake for beginners is to think that if there are no competitors,

then success is guaranteed. This is not true. Rather, it is an indicator that the consumer is not ripe for the offer yet.[2]

On the other hand, a highly competitive market forces an entrepreneur to conduct business based on numbers, because you will have to create a financial model to understand how realistic the company's plans are. It may not be worth opening a small grocery store in an area where federal supermarkets operate. Or still open, but with a competitive advantage. For example, it is open 24 hours a day and has a bar at night that sells alcohol [2].

Existing entrepreneurs do not relax precisely because of competition. We have to constantly come up with something and improve it so that clients don't leave for other companies [2].

There is no need to be afraid of competition. You will not be able to avoid this, so you should learn to react correctly and successfully fight your competitors. To do this, you need to follow several rules:

1. The introduction of new technologies will allow you to improve and bring your products to a higher level.
2. Employee training will speed up the production process.
3. Increasing the scale of your business will attract more clients.
4. It is necessary to analyze your competitors; this will help you avoid their mistakes.
5. Improving the quality of the product will allow you to surpass your competitors and then buyers will choose you.

Competition is an integral part of an economy based on market principles. There is no need to be afraid of it. You need to learn how to use it correctly in order to develop and reach a higher level.

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## КОНКУРЕНТНАЯ БОРЬБА КАК НЕОТЪЕМЛЕМАЯ ХАРАКТЕРИСТИКА РЫНОЧНОЙ ЭКОНОМИКИ

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**Аннотация:** Целью данного исследования является анализ конкуренции в экономике, основанной на рыночных принципах. Исследование раскрывает сущность конкуренции, рассматривает ее функции и виды. Анализируются положительные и отрицательные стороны конкуренции как для продавцов, так и для покупателей. Актуальность данной темы заключается в том, что многие компании, как правило, считают конкуренцию чем-то негативным, поскольку не умеют использовать ее в своих интересах. В результате необходимо разработать комплекс мер, которые позволят компании конкурировать в свою пользу.

**Ключевые слова:** виды конкуренции, конкуренция, рекомендации, функции конкуренции.

## THE LEGAL STATUS OF AN INDIVIDUAL IN THE DIGITAL SPACE

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### **Abstract**

The purpose of this study is to analyze the legal status of a person in the digital space. The study will consider the issue of legal guarantees for the protection of human rights, the legal status of a person and a citizen. The relevance of the research lies in the fact that digital technologies are currently rapidly developing, and therefore the issue of the legal status of an individual in the context of digitalization is particularly relevant. As a result, it is necessary to develop solutions to problematic issues in the legal regulation of the digital space based on the analysis of the legal status of an individual.

**Keywords:** declaration of human rights, digital space, individual legal status, legal relations, protection of human rights.

### **Introduction**

The adoption of the Universal Declaration of Human Rights by the United Nations on December 10, 1948 is one of the most important events in the history of mankind. Despite the fact that this document is of a recommendatory nature for all UN member states, its importance for the entire world community and each individual cannot be overestimated. For the first time, the Declaration defined internationally recognized fundamental rights that should be guaranteed to all people.

The Declaration, being a kind of guide in the system of international relations, defines clear norms for all peoples and States, the achievement of which "should be aimed at so that every person and every organ of society, constantly bearing in mind this Declaration, strive through education and education to promote respect for these rights and freedoms and ensure, through national and international progressive events, universal and effective recognition and implementation of them both among the peoples of the States - members of the Organization, as well as among the peoples of the territories under their jurisdiction" [1, p. 171].

### **Results and Discussion**

Legal science says that the legal status of an individual is a set of rights, freedoms and duties recognized and guaranteed by the state. These elements determine a person's position in society, and their violation entails legal liability. The realization of the legal status of a person at all levels is carried out through the use of certain legal mechanisms.

When analyzing the legal status of a person, theorists and law enforcement officers, as a rule, indicate first of all the rights and obligations of the relevant subject, whose status is being investigated, as well as the mechanism of their implementation.

Legal guarantees of such protection act as the main means of protecting human

rights. These guarantees are created by law and assume certain conditions, under which there are real opportunities and the most effective ways to implement the legal status of a person and a citizen. The international level is recognized as the most important level of implementation of this mechanism in the world community, which is associated with the development of international acts, declarations, conventions and the work of certain judicial and advisory bodies.

Currently, digital technologies are rapidly developing in the modern world, and therefore, issues related to the legal status of an individual in the context of digitalization are of particular interest.

The actual legal relationship in an online environment will always be "complicated" because it depends on the presence of an intermediary, such as an operator, provider or owner of digital content. Digital objects are the Internet, Internet resources (websites), social networks, messengers, as well as digital services and activities in general. The mutual rights and obligations of the participants are at the center of these relations.

The study of the subject of digital legal relations and his legal status begins with questions about the possession of certain rights and obligations, the determination of his legal status on the global Internet, his compliance with the principles and norms of law and the ability to bear legal responsibility.

### **Conclusion**

The analysis of the situation allows us to offer our solutions to problematic issues in the legal regulation of the digital space based on the analysis of the main legal issues.

We believe that a person in the digital space should have certain rights and freedoms, including such as "the right to freedom of speech in the digital space; the right to freely search, create, receive, transmit, use and distribute information in the digital space; the right to work in the digital space in the form of remote work self-employment (freelancer); the right to education in the digital space; the right to freedom of creativity in the digital space; the right to privacy in the digital space; the right to personal data protection" [2, p. 42].

Another important aspect of the legal status of an individual in traditional and digital relationships is responsibilities, which include performing lawful actions and refraining from actions that violate the rights and interests of others.

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# ПРАВОВОЙ СТАТУС ЛИЧНОСТИ В ЦИФРОВОМ ПРОСТРАНСТВЕ

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**Аннотация:** Целью данного исследования является анализ правового статуса личности в цифровом пространстве. В исследовании будет рассмотрен вопрос правовых гарантий защиты прав человека, правового статуса человека и гражданина. Актуальность исследования заключается в том, что цифровые технологии в настоящее время стремительно развиваются, и поэтому вопрос о правовом статусе физического лица в контексте цифровизации особенно актуален. В результате возникает необходимость выработки решений проблемных вопросов в правовом регулировании цифрового пространства на основе анализа правового статуса физического лица.

**Ключевые слова:** декларация прав человека, цифровое пространство, правовой статус личности, правоотношения, защита прав человека.

## METHODEN ZUR BEGEHUNG VON BETRUG IM BEREICH DER COMPUTERINFORMATIONEN

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### **Zusammenfassung**

Der Artikel enthüllt die Merkmale von Betrug im Bereich Computerinformationen. Besondere Aufmerksamkeit ist auf die Untersuchung des Themas und der neuesten Methoden zur Begehung der betreffenden Straftat sowie auf die Analyse der Gerichtspraxis gelegt. Es wird darauf hingewiesen, dass diese Art von Betrug zusätzlich mit anderen Straftaten im Bereich der Computerinformation klassifiziert werden muss.

**Schlüsselwörter:** Betrug, Computerinformationen, Computerinformationsbetrug, Diebstahl.

### **Einführung**

Die weit verbreitete Digitalisierung und die Stärkung der Rolle der Informationstechnologie im Leben der modernen Gesellschaft tragen zur Entstehung neuer Straftaten bei. Eine davon ist eine besondere Form des Betrugs – die Nutzung der Möglichkeiten der Informationstechnologie, wenn der Täter den unrechtmäßigen Zugriff auf gesetzlich geschützte Computerinformationen im Zusammenhang mit dem Eigentum oder Rechten an Eigentum zum Diebstahl nutzt. Solche Situationen waren wiederholt Gegenstand von Auslegungsverfahren des Plenums des Obersten Gerichtshofs der Russischen Föderation, die als Grundlage für die Festlegung eines gesonderten Artikels der Strafgesetzgebung der Russischen Föderation dienten. Mit dem Bundesgesetz Nr. 207-FZ vom 29. November 2012 wurde Artikel 159.6 des Strafgesetzbuches der Russischen Föderation „Betrug im Bereich Computerinformationen“ in das Strafgesetzbuch der Russischen Föderation aufgenommen [1].

Der Gesetzgeber entschlüsselt den Begriff des Betrugs im Bereich der Computerinformationen im Text des Artikels: „Der Diebstahl fremden Eigentums oder der Erwerb von Rechten an fremdem Eigentum durch Eingabe, Löschung, Sperrung, Änderung von Computerinformationen oder sonstige Eingriffe, das Funktionieren von Mitteln zur Speicherung, Verarbeitung oder Übertragung von Computerinformationen oder Informations- und Telekommunikationsnetzen“.

Betrug im Bereich der Computerinformationen wird tatsächlich in bestimmten Handlungen des Subjekts umgesetzt, indem heimlich Informationen von einem elektronischen Medium entfernt werden, das er anschließend verwenden wird. Das Ziel des Kriminellen besteht darin, Gelder zu stehlen, indem er eine spezielle Methode zum Knacken von Passwörtern, zum Erraten von PIN-Codes usw. anwendet.

Unter den kriminellen Handlungen, die unter Artikel 159.6 des Strafgesetzbuches fallen, sind die häufigsten Fälle, in denen Beamte von Unternehmen, die Zugang zu



Unternehmensdaten und Software der Organisation haben, als Angreifer fungieren. So wurde nach Artikel 159.6 des Strafgesetzbuches ein Bürger M. verurteilt, der als Spezialist für das Verkaufsbüro arbeitete. Nachdem er Zugang zu dienstlichen Computerinformationen hatte und unter seinem Benutzernamen und Passwort auf die Datenbanken des Unternehmens zugegriffen hatte, konnte er die Teilnehmernummern der SIM-Karten der Organisation neu registrieren, d.h. die Eingabe und Änderung von Computerinformationen im Informationssystem durchführen. M. hat im Namen des Unternehmens unerlaubte Umformungen und den Verkauf von SIM-Karten an uninformierte Bürger durchgeführt und diese anschließend als verloren markiert, was der Organisation einen großen Schaden in Höhe von 561 000 Rubel zufügen könnte, wenn er die Sache zu Ende gebracht hätte [4].

Es ist wichtig, zwischen Betrug im Bereich der Computerinformationen als rechtswidriger Handlung im Zusammenhang mit der Verletzung von Eigentumsrechten bei gleichzeitiger Verletzung des etablierten Prozesses der Verarbeitung, Speicherung und Übermittlung von Computerinformationen und anderen Formen des Diebstahls zu unterscheiden, die zwar dazu führen Der Zugriff des Täters auf Computerinformationen führt nicht zu Eingriffen in Computerinformationen, die Leistung von Computern oder deren Netzwerken.

Betrug im Bereich Computerinformationen, der durch unbefugten Zugriff auf Computerinformationen oder durch die Erstellung, Verwendung und Verbreitung schädlicher Computerprogramme begangen wird, erfordert eine zusätzliche Qualifikation gemäß Artikel 272 (Illegaler Zugriff auf Computerinformationen), 273 (Erstellung, Verwendung und Verbreitung von) bössartige Computerprogramme) oder 274.1 (Unrechtmäßige Einflussnahme auf die kritische Informationsinfrastruktur der Russischen Föderation) des Strafgesetzbuches der Russischen Föderation.

Somit hat Bürger T. durch sein vorsätzliches Handeln einen rechtswidrigen Zugriff auf gesetzlich geschützte Computerinformationen begangen, was dazu führte, dass eine Person, die ihre offizielle Position nutzte, Computerinformationen änderte. T. hat mit dem Login und dem Passwort eines anderen Mitarbeiters das Softwaremodul zur Änderung von Abonententransaktionen aufgerufen, eine Abonnennummer ausgewählt und bewusst fälschlicherweise vermerkt, dass der Inhaber der Nummer eine Rückerstattung beantragt habe. Anschließend leistete Bürger T. mit dem von ihm selbst erstellten Antrag eine Rückerstattung und entnahm der Kasse einen Betrag in Höhe von 4.900 Rubel 46 Kopeken [3]. In diesem Fall sollte die Straftat sowohl nach Artikel 159.6 des Strafgesetzbuches der Russischen Föderation als auch nach Artikel 272 des Strafgesetzbuches der Russischen Föderation qualifiziert werden.

Unter den so klassifizierten Straftaten sind Straftaten im Zusammenhang mit der Erstellung von Phishing-Seiten weit verbreitet. Eine der häufigsten Kategorien solcher Ressourcen sind die Websites nicht existierender Banken. Eine skrupellose Person schafft eine „Bank“-Ressource und beginnt, Gelder von Bürgern und juristischen Personen anzuziehen, um Einlagen zu schaffen und Kredite zu vergeben. Angreifer verwenden auch aktiv die Namen realer Banken und erstellen Klonseiten, wodurch sie

den Benutzer täuschen können [2]. Ohne das Wissen des Opfers werden Computerinformationen manipuliert und identifizierende Informationen für persönliche Zwecke des Angreifers manipuliert, um seinen eigenen Vorteil zu erzielen, wodurch gegen die festgelegte Informationsordnung verstoßen wird, die ihre sichere Verwendung gewährleistet.

Derzeit sind Organisationen auch durch Hackerangriffe bedroht, die darauf abzielen, Unternehmenssoftwaresysteme mit verschiedenen Arten von Schadsoftware (Viren, Backdoor-Programme (für illegale Fernverwaltung erstellt), Keylogger, Programme zum Stehlen von Passwörtern) zu infizieren und sie anschließend für die illegale Datenbeschaffung zu modifizieren.

### **Schlussfolgerung**

Straftaten im Zusammenhang mit Betrug im Bereich Computerinformationen zeichnen sich durch eine erhöhte Komplexität bei der Aufdeckung aus. Daher ist es erforderlich, erhöhte Wachsamkeit zu üben und ausschließlich offizielle und überprüfte Ressourcen sowie Internetanwendungen zu verwenden, um bestimmte Dienste zu bezahlen oder bereitzustellen Betreiber mit personenbezogenen Daten.

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## **СПОСОБЫ СОВЕРШЕНИЯ МОШЕННИЧЕСТВА В СФЕРЕ КОМПЬЮТЕРНОЙ ИНФОРМАЦИИ**

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**Аннотация:** В статье раскрываются особенности состава мошенничества в сфере компьютерной информации. Особое внимание уделяется исследованию предмета и новейших способов совершения рассматриваемого преступления, анализу судебной практики. Отмечается необходимость дополнительной квалификации данного рода мошенничества с иными преступлениями в сфере компьютерной информации.

**Ключевые слова:** компьютерная информация, мошенничество, мошенничество в сфере компьютерной информации, хищение.

## **ZIVILGESELLSCHAFT UND STAAT: BEZIEHUNG UND INTERAKTION**

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### **Zusammenfassung**

Der Artikel ist der Analyse der Wechselbeziehung und Interaktion zwischen Staat und Zivilgesellschaft gewidmet. Die Zivilgesellschaft wird als ein Element des institutionellen Teilsystems des politischen Systems betrachtet. Es werden Fragen der Wechselbeziehung zwischen Rechtsstaat und Zivilgesellschaft in Bezug auf Struktur, Organisation und Art und Weise der Bildung analysiert.

**Schlüsselwörter:** politisches System; Staat; Zivilgesellschaft; Rechtsstaatlichkeit.

### **Inhalt**

Während der gesamten Geschichte der menschlichen Entwicklung geht die maximale Suche nach einem Verhältnis zwischen Macht und Gesellschaft. Es ist allgemein bekannt, dass die Zivilgesellschaft und die Rechtsstaatlichkeit zwei sich ständig gegenseitig beeinflussende und entwickelnde Teile eines politischen Organismus sind. Die Zivilgesellschaft ist die Hauptvoraussetzung und gleichzeitig der wichtigste Faktor für die Herausbildung eines demokratischen politischen Systems als Ganzes.<sup>1</sup>

Der Begriff "politisches System" wird gewöhnlich verwendet, um eine Reihe von Beziehungen zu bezeichnen, die die Verwaltung des Staates und die politischen Prozesse in der Gesellschaft umfassen. Es ist ein komplexes Gefüge von institutionellen Strukturen des Staates und der Gesellschaft, Formen der Interaktion zwischen ihnen, die darauf abzielen, politische Macht, Management, Führung, Regulierung der sozio-politischen Prozesse auszuüben. Die Hauptfunktion eines demokratischen politischen Systems ist die Aufrechterhaltung von Stabilität und Ordnung, von bestehenden Bindungen und Beziehungen in der Gesellschaft und im Staat, die auf Gesetzen und einer hohen politischen und rechtlichen Kultur der Menschen beruhen. Als Teil des sozialen Systems besteht das politische System wiederum aus interagierenden Teilsystemen. Die Möglichkeit, verschiedene Grundlagen für die Strukturierung der Elemente des politischen Systems zu verwenden, spiegelt den hierarchischen Charakter seiner Komponenten wider, die ihrerseits nach einem eigenen Prinzip organisiert sind. Folglich besteht das politische System aus Teilsystemen (die ihrerseits vollwertige Systeme sind), deren Zusammenspiel eine politische Integrität bildet.

Es gibt mehrere Teilsysteme des politischen Systems: – institutionell (organisatorisch); – normativ; – kommunikativ; – kulturell und ideologisch; –

funktional. In der Regel wird das institutionelle Teilsystem – eine Reihe von Institutionen (Staat, Partei, sozio-politisch), die verschiedene Interessen in ihrer Bedeutung zum Ausdruck bringen und vertreten – von allgemein bedeutsamen bis hin zu Gruppen- und Privatinteressen – als Hauptelement des politischen Systems herausgehoben. Neben dem Staat umfasst das institutionelle Teilsystem sowohl politische (Parteien, Nichtregierungsorganisationen) als auch nicht-politische, aber mit erheblichem Einfluss auf die Macht ausgestattete gesellschaftliche Organisationen (Massenmedien, Kirche).<sup>4</sup> Vom institutionellen Teilsystem des politischen Systems werden die beiden Hauptinstitutionen - Staat und Zivilgesellschaft unterschieden.

Der Staat ist ein komplexes Instrument der politischen und rechtlichen Organisation der Gesellschaft. Der Staat ist eine hochentwickelte Form der Organisation des gemeinsamen Lebens der Menschen in einem bestimmten Gebiet. Er ist eine besondere Organisation der politischen Macht, die über einen Apparat verfügt, der die Macht auf der Grundlage des Rechts und mit Hilfe von Zwangsgewalt gegenüber der in einem bestimmten Gebiet lebenden Bevölkerung ausübt. Mit anderen Worten: Der Staat ist eine politisch-territoriale, souveräne Organisationsform der politischen Macht, die über einen besonderen Verwaltungs- und Zwangsapparat verfügt und Machtfunktionen ausübt. Gleichzeitig sollte das Funktionieren des Staates nicht nur als ein Prozess der Übertragung von Machtbefehlen vom Staat auf die Gesellschaft betrachtet werden, sondern auch als der umgekehrte Prozess: von der Gesellschaft auf den Staat. Die Funktionsweise des Staates sollte als eine besondere Beziehung zwischen Staat und Gesellschaft betrachtet werden, in der die Parteien durch eine Vielzahl direkter und umgekehrter Verbindungen miteinander verbunden sind, miteinander interagieren und sich gegenseitig beeinflussen; staatliche Funktionen sind das Ergebnis der Interaktion zwischen Staat und Gesellschaft.

Der Staat übt seine Funktionen durch den Staatsapparat aus, d. h. durch die Gesamtheit der staatlichen Organe und Institutionen, der Organisationen, die die staatliche Macht in der Gesellschaft ausüben. Staatliche Einrichtung ist ein Bestandteil des Staatsapparats (Person, Organisation), der mit staatlicher Autorität ausgestattet ist und an der Ausführung staatlicher Aufgaben beteiligt ist. Staatliche Einrichtungen sind staatliche Organisationen, die bestimmte staatliche Aufgaben erfüllen, aber nicht mit staatlicher Autorität ausgestattet sind (Bildungseinrichtungen, wissenschaftliche Forschungsinstitute, Bibliotheken, Postämter, Bahnhöfe, medizinische Einrichtungen, Polikliniken). Durch seine Funktionen verwirklicht der Staat die staatlichen Ideen, legt die Statistiken und die Dynamik des Staates und der Zivilgesellschaft fest.

Die Hauptaufgabe des Staates im politischen System ist die Bildung eines Rechtsstaates, der in der Ausübung seiner Funktionen durch das Gesetz

begrenzt ist, der Souveränität des Volkes untergeordnet ist und die Grundrechte und -freiheiten des Einzelnen gewährleisten soll. Der Rechtsstaat wird auf verschiedene Weise gebildet. Es handelt sich um die Umwandlung des Rechts in ein entscheidendes Mittel zur Steuerung der Gesellschaft (des öffentlichen Lebens) und die Erreichung eines so hohen Niveaus der Rechtskultur in der Gesellschaft, dass es profitabler wird, sich an die Gesetze zu halten, als sie nicht zu befolgen, sowie um die Dezentralisierung der Verwaltung.

Die Hauptaufgabe der Gesellschaft besteht darin, die Zivilgesellschaft zu bilden, zu schaffen.

Die Zivilgesellschaft kann als eine Reihe von staatlichen Bildungsvereinigungen und Gewerkschaften charakterisiert werden, die auf Initiative der Menschen selbst gegründet werden und ihre täglichen Ziele umsetzen und sie vor direkten staatlichen Eingriffen in ihre Aktivitäten schützen.

Wirkliche und greifbare Freiheit der Bürger wird in einer Gesellschaft mit echter Demokratie möglich, in der nicht der Staat, sondern die politische Macht die Gesellschaft und ihre Mitglieder beherrscht und die Gesellschaft gegenüber dem Staat einen unbedingten Vorrang hat. Der Übergang zu einer solchen Gesellschaft ist ein historisch langer Prozess, der mit der Herausbildung der Zivilgesellschaft verbunden ist.<sup>2</sup>

Für die Herausbildung der Zivilgesellschaft müssen bestimmte Voraussetzungen gegeben sein: – wirtschaftlich; – sozial; – politisch und rechtlich; – kulturell.

Eine der Voraussetzungen für die Herausbildung des Rechtsstaates ist das Vorhandensein einer Zivilgesellschaft sowie das Vorhandensein einer Vielfalt von Eigentumsformen, wirtschaftlicher Unabhängigkeit, eines demokratischen Regimes und das Vorhandensein einer echten Souveränität. Sowohl die Zivilgesellschaft als auch der Staat und die Staatsorgane weisen bestimmte Merkmale auf: persönliche Freiheit der Person; Vorhandensein von Privateigentum; demokratische politische Ordnung; Meinungspluralismus, unabhängige Massenmedien; gegenseitige Verantwortung von Staat und Bürger füreinander.

In der Struktur der Zivilgesellschaft lassen sich mehrere Komponenten unterscheiden: Gemeinschaft (soziale Einrichtung, Organisation, Vereinigung); Beziehungen zwischen diesen sozialen Einrichtungen, Organisationen usw.; besonderer Raum (Gebiet, in dem diese Interaktion stattfindet).

Der Lebensbereich der Zivilgesellschaft umfasst drei Sphären sozialer Beziehungen: sozial – die Sphäre des alltäglichen Lebens der Gesellschaft, der Familie, der Schule usw.; wirtschaftlich – die Sphäre der Produktion, des Austauschs, der Verteilung und des Verbrauchs von Gütern und Dienstleistungen, die die Gesamtheit der Beziehungen zur Schaffung und

Verteilung materieller Güter umfasst; politisch – das politische Leben der Gesellschaft, dessen Akteure die einzelnen Bürger, ihre sozio-politischen Vereinigungen und der Staat sind.

Die Art und Weise der Interaktion zwischen Staat und Zivilgesellschaft kann nach verschiedenen Kriterien analysiert werden: – nach realisierten Interessen, die Zivilgesellschaft verwirklicht private Initiativen, der Staat verwirklicht öffentliche Interessen; nach den Mitteln der Verwirklichung, die Zivilgesellschaft bedient sich der Überzeugung, rechtlicher und moralischer Normen, der Staat bedient sich der Verfassung, des Zwangs, der Rechtsnormen; – nach der Art der Verbindung – in der Zivilgesellschaft herrschen horizontale Verbindungen vor, der Staat besteht aus politischen Institutionen, die vertikal verbunden sind.

In der modernen Gesellschaft gibt es immer mehr Bereiche, in denen das Vorrecht der Tätigkeit vom Staat auf die Zivilgesellschaft verlagert wird. Die Entwicklung der Zivilgesellschaft ist mit der aktiven Beteiligung ihrer Mitglieder an den Aktivitäten des Staates verbunden. Doch nur "ein starker Rechtsstaat ermöglicht eine breite Beteiligung der Öffentlichkeit und der Bürger an den Tätigkeitsbereichen des staatlichen Mechanismus". Das Vertrauen des Staates in die Zivilgesellschaft zeigt sich darin, "inwieweit er den Bürgern erlaubt, einen zivilen Willen zu bilden und sich an der Ausübung staatlicher Funktionen zu beteiligen".<sup>3</sup> Eine Ausweitung der Beteiligung zivilgesellschaftlicher Institutionen an der Verwaltung des rechtlichen Bereichs des öffentlichen Lebens würde bedeuten, das Rechtssystem der Gesellschaft zu demokratisieren und es den Idealen der Rechtsstaatlichkeit anzunähern.

### **Schlusswort**

Die Analyse der Wechselbeziehung und der Interaktion zwischen dem Staat und der Zivilgesellschaft zusammenfassend muss noch einmal betont werden, dass eine gesunde Interaktion zwischen dem Staat und der Zivilgesellschaft nur dann möglich ist, wenn die Verfassung selbst günstige Bedingungen für die Entwicklung der Zivilgesellschaft schafft, d. h. wenn sie das verfassungsmäßige Recht der Bürger auf Vereinigungen garantiert, den Rechtsstatus der Institutionen der Zivilgesellschaft festlegt und eine staatliche Kontrolle und Aufsicht über die Aktivitäten der Zivilgesellschaft ausübt.

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## **ГРАЖДАНСКОЕ ОБЩЕСТВО И ГОСУДАРСТВО: СООТНОШЕНИЕ И ВЗАИМОДЕЙСТВИЕ**

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**Аннотация:** Статья посвящена анализу соотношения и взаимодействия государства и гражданского общества. Гражданское общество рассмотрено как элемент институциональной подсистемы политической системы. Проанализированы вопросы соотношения правового государства и гражданского общества по структуре, организации и пути формирования.

**Ключевые слова:** политическая система; государство; гражданское общество; правовое государство.

## ARTEN DER HAFTUNG FÜR NICHTZAHLUNG DER ALIMENTE

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**Zusammenfassung.** Der Artikel befasst sich mit den Arten der Verantwortung für die Nichtzahlung von Geldern für den Unterhalt der Kinder. Es sind Verfahren zur Einziehung von Unterhaltszahlungen für minderjährige Kinder in Rasskasowskij und Bondarskij Regionen des Tambower Gebiets untersucht. Es sind quantitative Daten vorgelegt, die bestätigen, dass die Zahl der Fälle, in denen Bürger wegen Nichtzahlung von Unterhaltszahlungen vor Gericht gebracht werden, zurückgegangen ist.

**Schlüsselwörter:** Unterhaltszahlungen, Nichtzahlung von Unterhaltszahlungen, Verwaltungs- und Straftatbestand, Haftung, Ermittlungsverfahren, Gründe für die Nichtzahlung.

Nach Artikel 38 der Verfassung der Russischen Föderation: "Die Familie steht unter dem Schutz des Staates. Die Betreuung und die Erziehung von Kindern sind die gleichen Rechte und Pflichten der Eltern. Arbeitsfähige Kinder, die das 18. Lebensjahr erreicht haben, müssen sich um unarbeitsfähige Eltern kümmern»[1]. Nach der Auflösung der Ehe muss einer der Eltern in der Regel Unterhaltszahlungen für die Kinder leisten.

Die Unterhaltszahlungen sind die Zahlungen für den Unterhalt eines Kindes oder eines volljährigen, unarbeitsfähigen Familienmitglieds. Die Unterhaltszahlung – es ist nicht nur der Wunsch, finanziell zu helfen, sondern auch eine direkte Pflicht. Die Unterhaltszahlungen müssen bezahlt werden: von Eltern, von arbeitsfähigen volljährigen Kindern, von Ehepartnern, auch Ehemaligen.

Die Bedingungen für die Zahlung von Unterhaltszahlungen hängen davon ab, an wen man Alimente bezahlt werden:

- Kinder bis zum Alter von 18 Jahren;
- Ehepartner (bis zur Erfüllung des Kindes im Alter von drei Jahren);
- Eltern – bis zu ihrem Tod oder der Beendigung der Not.

Einige Personen weigern sich kategorisch, materielle Hilfe für einen bedürftigen Verwandten zu leisten und scheuen sich, die Unterhaltszahlungen zu zahlen. Manchmal erreicht die Nichtzahlung von Unterhaltszahlungen mehr als ein Jahr, die Verschuldung steigt, und es ist nicht möglich, Ergebnisse für die Zahlung zu erzielen. Es gibt Haftungsmaßnahmen für Steuerhinterziehung [1].

Insgesamt in der Gerichtsvollzieherabteilung nach den Rasskasowskij und Bondarskij Bezirken der Verwaltung des föderalen Gerichtsvollzieherdienstes in der Region Tambow gibt es 440 exekutive Verfahren zur Einziehung von Unterhaltszahlungen für minderjährige Kinder, die durchschnittliche Summe der Schulden in dieser Kategorie beträgt 75000 Rubel. Die größte Anzahl von Schuldnern lebt in der Rasskasowskij Bezirk. Laut Statistik im Vergleich zum Jahr 2022 gibt es



reduzierte Rückstände der Vollstreckungsverfahren der Unterhaltszahlungen für minderjährige Kinder, weil die Schuldner einen festen Arbeitsplatz gefunden haben und nicht administrativ und strafrechtlich verfolgt werden wollten.

Die Gesetzgebung der Russischen Föderation sieht die Arten der Verantwortung für die Nichtzahlung von Unterhaltszahlungen für den Unterhalt der minderjährigen Kinder vor:

- 1) administrativ (Teil 1.2 des Artikels 5.35.1 des Code of RF);
- 2) kriminell (Teil 1 des Artikels 157 des Strafgesetzbuches).

Administrative Verantwortung. Wenn ein Bürger keinen Grund hat, ein Strafverfahren einzuleiten, erstellt ein Mitarbeiter des Föderalen Gerichtsvollziehers der Russischen Föderation ein Protokoll nach Absatz 5.35.1 des Strafgesetzbuches, das dann zur Prüfung und zur Erlassung einer entsprechenden Entscheidung an das Gericht übermittelt wird. Der Gesetzgeber im Code der Russischen Föderation sieht die folgenden Strafen für die Nichterfüllung von Entscheidungen über die Zahlung von Unterhaltszahlungen vor:

- 1) Verwaltungsstrafe;
- 2) Pflichtarbeit;
- 3) Verwaltungshaft.

So wurde in der Abteilung für Gerichtsvollzieher der Rasskasowskij und Bondarskij Bezirken von Region Tambow ein Vollstreckungsverfahren eingeleitet, um Unterhaltszahlungen für den Gehalt eines minderjährigen Kindes des Geburtsjahres 2014 zu beantragen. Laut der Gerichtsentscheidung ist der Vater des Kindes verpflichtet, Unterhaltszahlungen für den Unterhalt seiner Tochter in dieser  $\frac{1}{4}$  im Anteil aller Einkommensarten. Der Schuldner hat die Entscheidung des Gerichts jedoch lange Zeit nicht vollständig erfüllt, was zu der Erstellung eines Verwaltungsprotokolls für ihn in Teil 1.5.35.1 des Verwaltungsgesetzbuches der Russischen Föderation geführt hat. Der Schuldner wurde durch die Entscheidung des Weltrichters für schuldig befunden, eine Ordnungswidrigkeit begangen zu haben, und er wurde mit einer Strafe von 20 Stunden Pflichtarbeit bestraft. Diese Verwaltungsstrafe diente später als Grundlage für die offizielle Beschäftigung des Schuldners und die Rückzahlung der zuvor gebildeten Unterhaltsschulden.

Strafrechtliche Verantwortlichkeit. Es ist möglich, einen Bürger, der keinen Unterhalt zahlt, vor Gericht zu bringen, wenn er zuvor gemäß Artikel 5.35.1 des Strafgesetzbuches in einem ähnlichen Fall einer Verwaltungsstrafe unterzogen wurde; Das Urteil des Richters trat in Kraft und ist nicht ein Jahr ab dem Zeitpunkt abgelaufen, an dem die Person als strafbar gilt.

Die Reihenfolge der strafrechtlichen Bestrafung wird durch das Strafgesetzbuch der Russischen Föderation durch den Befehl des Justizministeriums vom 02.05.2006 Nr.139 "Über die Genehmigung einer einheitlichen Ordnung für die Organisation der Aufnahme, Registrierung und Prüfung von Meldungen über Straftaten im föderalen Gerichtsvollzieherdienst" bestimmt. Nach Artikel 157 des Strafgesetzbuches bedeutet eine erneute Nichtzahlung, dass die Verpflichtungen über einen längeren Zeitraum

ohne triftigen Grund nicht erfüllt werden. Um einen skrupellosen Elternteil zur Rechenschaft zu ziehen, sollte es folgendes Bedingungegeben geben:

- das Vollstreckungsverfahren zur Einziehung von Unterhaltszahlungen wurde eingeleitet;

- ausfuhrungsfristen von mehr als zwei Monaten;

- der Schuldner keine Informationen zur Verfügung gestellt hat, die die Verfügbarkeit bestätigen gute Gründe, die die Zahlung verhindern;

- der Schuldner gilt nicht als vermisst, er ist nicht auf der Fahndungsliste des Bundes aufgeführt.

So gibt es in der Abteilung für Gerichtsvollzieher in den Rasskasowskij und Bondarskij Bezirken der Verwaltung des föderalen Gerichtsvollzieherdienstes in der Region Tambow im Jahr 2022 etwa 44 Unterhaltszahler vor Gericht gestellt, wie in Teil 1 des Artikels 157 des Strafgesetzbuches vorgesehen, das ist deutlich höher als im Jahr 2023.

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## **ВИДЫ ОТВЕТСТВЕННОСТИ ЗА НЕУПЛАТУ АЛИМЕНТОВ**

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**Аннотация:** В статье рассматриваются виды ответственности за неуплату средств на содержание детей. Проанализирован порядок взыскания алиментов на содержание несовершеннолетних детей в Рассказовском и Бондарском районах Тамбовской области. Приведены количественные данные, которые подтверждают снижение количества случаев привлечения граждан к суду за неуплату алиментов.

**Ключевые слова:** алименты, неуплата алиментов, административное и уголовное преступление, ответственность, методика расследования, причины неуплаты.

## COMPARISON OF SELF-DEFENSE LAWS IN RUSSIA AND OTHER COUNTRIES

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### **Abstract**

The article deals with the problem of permissible self-defense. The purpose of the article is to compare the laws on self-defense of the two countries of Russia and the United States. The author comes to the conclusion that the correct interpretation and well-thought-out law lays down the correctness of the state itself, and also that it is necessary to finalize the current legislation of the Russian Federation

**Keywords: the law on self-defense, legislation.**

A person has the right to life, freedom and has the right to protect oneself in any way without violating the law. However, what are the boundaries of this "protection", what will happen if they are violated, how not to become punishable?

There are 2 terms in the criminal code: the first is "necessary defense", i.e., if a person is in danger, then any actions for protection are not considered criminal; the second is "extreme necessity", i.e. a situation in which a person defending his interests is forced to cause harm.

The conditions for recognizing the necessary defense must be met as follows. First, violence threatened the life of the defender or there was a direct threat of such violence, for example, a resident caught the thief in his apartment, inflicted serious harm to the thief's health, the police officers who arrived opened two criminal cases: one on theft, and the second on the fact of causing serious harm to the kidnapper. In this example, there is no means of self-defense because the thief did not threaten the owner's health, in this situation he had to call the police, thereby protecting his property. However, if a thief pulls out a knife and makes a swing or says – I'll kill you – then this can be perceived as a threat to health. Even if the thief dies, self-defense is recognized as legitimate. Second - if there is no threat to life, you can defend yourself. However, this does not mean that if an opponent insults, then you need to beat him.

The exception is surprise, when it is unrealistic to assess whether there is a threat to life or not. As an example, we can cite the situation in a dark alley, if a canister is applied to the taken pursuer, and he suffers, then in court proceedings it will be necessary to prove that the surprise led to the impossibility of assessing the situation.

What does a clear threat to life look like? If a person verbally threatens, it does not mean that you need to strike first. An employee of the Ministry of Internal Affairs, who will initiate a criminal case under Article 119 of the Criminal Code of the Russian Federation, will assess the reality of this threat.

Self-defense means in Russia are listed in the federal law "On Weapons" self-defense weapons are a separate type. Include: smoothbore long-barreled firearms, firearms of limited destruction, Mechanical sprayers, aerosol and other devices, electroshock devices of domestic production [2].

Responsibility for exceeding the limits of permissible self-defense is described in Articles 114, 108 of the Criminal Code of the Russian Federation. Both correctional labor and imprisonment can be applied [2].

The most reliable way not to get into trouble with the law is to avoid physical conflict. If there is an opportunity to leave the place, it is better to do it, even if you have to run away.

Self-defense mechanism in the United States: its structure and interpretation. In the various states of this nation, self-defense embodies the right to utilize necessary force as a protective measure against another individual, subject to specific conditions and situations.

In the United States, there is a general principle according to which "an individual has the right to use such force as is reasonably considered necessary to protect him or himself from an obvious threat of violence from the other side" [3 If we are discussing the utilization of non-lethal force, it means that an individual should employ a level of force that appears reasonable and indispensable to safeguard oneself against the evident threat of unlawful and immediate aggression from another individual.

Many individuals argue that the use of force was imperative in order to prevent potential unlawful physical harm. In the instance of utilizing lethal force during acts of self-defense, the individual must also possess rational confidence that such lethal force is immediately necessary to prevent causing significant harm to others or to avert death. Most states no longer mandate individuals to withdraw before resorting to lethal force. In those isolated cases where a retreat is mandatory, this is done only in cases where such a retreat is dangerous or when the individual is in his own home environment.

The exception is the situation when the The original instigator of the conflict cannot claim self-defense if they continue their aggression or if the other party's response was not excessive. It is the responsibility of the aggressor to inform the other party if they decide to cease their aggression. The concept of resisting unlawful arrest and utilizing self-defense is gradually being abandoned in today's legal landscape. In jurisdictions that still permit resistance against illegal arrest, the use of excessive force must be present for this defense to be valid.

The evolution of this rule can be seen in the landmark case "Bad Elk v. United States," where an off-duty tribal policeman was charged with murder for killing another off-duty policeman who was attempting an illegal detainment. The defendant faced a new charge due to the lack of information provided to the original trial's witnesses, failing to inform them about the possibility of a lesser charge like manslaughter. Some jurisdictions have flawed self-defense regulations. For instance, if an individual mistakenly believes that deadly force is justifiable in self-defense, but it

is not legally justified, they could be convicted of murder instead of manslaughter. The right to self-defense can be formulated as follows: it is the right of people to use reasonable and defensive force.

The legal defense in such cases heavily relies on assessing the level of threat faced by the individual. Factors taken into account include whether the threat was verbal and made the person feel sufficiently endangered to justify self-defense. Additionally, the immediacy of the threat is considered, determining if the person's life was truly in imminent danger. Several questions arise during the evaluation process: Was there a credible threat that was likely to occur? Did the person provoke the attacker? When the person was attacked, did their response in self-defense match the level of threat, or did it escalate to the point of causing unnecessary death? In some cases, the defense may invoke the "Castle doctrine," which applies when an individual intentionally breaks into another person's home and attempts to harm them or their family. In such situations, the occupants are allowed to defend themselves or others using deadly force.

Weapons for self-defense in the United States can be bought by anyone, except minors, mentally ill and previously convicted. It is allowed to carry many types of weapons, the exceptions are large-caliber and automatic weapons. In 2020, according to statistics in the USA 13.6 per 100,000 people were killed by firearms, compared with Russia - 0.9 per 100,000 [3].

Each legislation has its own advantages and disadvantages that need to be treated by authorized people based on statistics and history. For Russia, it is possible to rework some points in the legislation on self-defense, as an example – to exclude the possibility of outsiders being in the home "property protection", i.e. to increase the limit of permissible self-defense by adding a point on the boundaries of property to the legislation.

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## СРАВНЕНИЕ ЗАКОНОВ О САМООБОРОНЕ В РОССИИ И ДРУГИХ СТРАН

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**Аннотация:** Рассмотрена проблема допустимой самообороны. Целью статьи является сравнение законов о самообороне двух стран России и США. Автор приходит к выводу, что правильная трактовка и правильно продуманный закон закладывает правильность самого государства, а также, что необходима доработка текущего законодательства РФ.

**Ключевые слова:** закон о самообороне, законодательство.

## **DAS MARKTMODELL DES VOLLKOMMENEN WETTBEWERBS UND DIE GLEICHGEWICHTSBEDINGUNGEN DES UNTERNEHMENS IM KURZ- UND LANGBEREICH**

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### **Zusammenfassung**

Der Artikel ist einem der wichtigsten Themen der Mikroökonomie – der Untersuchung und kritischen Analyse des Konzepts des perfekten Wettbewerbs, nämlich des Marktmodells und der kurz- und langfristigen Gleichgewichtsbedingungen des Unternehmens gewidmet. Bei der Untersuchung des Marktmodells des vollkommenen Wettbewerbs sind die Merkmale des Verhaltens eines Unternehmens mit vollkommenem Wettbewerb untersucht und in dem Papier dargestellt.

**Schlüsselwörter:** Markt, Marktbeziehungen, Wettbewerb, Verlust, Preis.

Die Relevanz der Studie liegt darin begründet, dass das Phänomen des Wettbewerbs ein Schlüsselbegriff ist, der das Wesen der Marktbeziehungen zum Ausdruck bringt. Der Wettbewerb hat aufgrund grundlegender Veränderungen in der weltpolitischen Arena internationale und globale Bedeutung erlangt. Trends in der wirtschaftlichen Entwicklung der Weltgemeinschaft weisen auf die dominierende Rolle des Wettbewerbs für die Wirtschaft jedes Landes hin. Aufgrund dieser Tatsache ist es wichtig, das Problem des perfekten Wettbewerbs in seiner tatsächlichen Funktionsweise zu untersuchen. Einen wertvollen Beitrag zur Entwicklung dieser Theorie leistete A. Marshall [1]. Die Relevanz des Forschungsthemas wird auch durch die ständige Rivalität und den Wettbewerb der Marktteilnehmer um die besten Bedingungen für die Produktion und den Verkauf von Produkten sichergestellt.

Das Konzept des Wettbewerbs ist von grundlegender Bedeutung in der ökonomischen Theorie der Marktbeziehungen. Der Wettbewerb manifestiert sich auf allen Ebenen der Wirtschaft – von der Mikroebene bis zum globalen Wirtschaftssystem. Wettbewerb fördert die Rationalität, verbessert die menschlichen Güter und führt zu einer besseren Nutzung von Fähigkeiten und Wissen.

Für ein tieferes Verständnis des Wesens des perfekten Wettbewerbs wenden wir uns den Definitionen zu, die Ökonomen in ihren Werken geben. Zum Beispiel K.R. McConnell und S.L. Brju glauben, dass Wettbewerb die Präsenz einer großen Anzahl unabhängiger Käufer und Verkäufer auf dem Markt ist, die Möglichkeit für Käufer und Verkäufer, frei in den Markt einzutreten und ihn zu verlassen[2].

Das perfekte Wettbewerbsmarktmodell selbst hat eine sehr wichtige theoretische Bedeutung, da es einen idealen Markttyp darstellt, in dem es eine große Anzahl von Verkäufern und Käufern gibt, die keinen Einfluss auf den Preis haben, zu dem sie Produkte auf den Markt bringen, d. h. sind Preisnehmer. Das Modell eines

vollkommenen Wettbewerbsmarktes wird in der Arbeit von A. Marshall ausreichend detailliert behandelt. Betrachtet wird der Markt für internationale Wertpapiere. Der Ökonom stellt fest, dass deren Kurs auf dem gleichen Niveau bleibt und der Anstieg des Kurses an der Börse eines Landes zu einem Anstieg an anderen Börsen führt und umgekehrt (Sich: [1]). Dadurch wird die Tendenz verstärkt, das gleiche Preisniveau auf dem Markt aufrechtzuerhalten. Dies zeigt auch, dass unabhängige Unternehmen umso weniger Einfluss auf den festgelegten Preis haben können, je näher er dem reinen Wettbewerb entspricht.

Es ist auch wichtig, das Diagramm der Nachfragekurve eines einzelnen Unternehmens auf einem Markt mit vollkommenem Wettbewerb zu betrachten, das in Abb. 1 dargestellt ist.

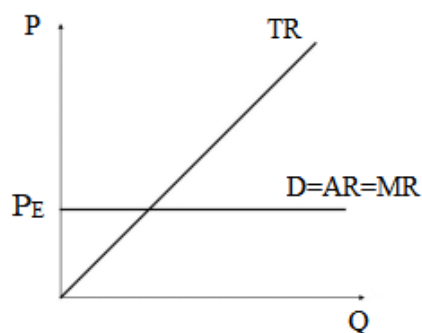


Abb. 1. Die Nachfrage des Unternehmens, sein Durchschnitts-, Grenz- und Gesamteinkommen unter Bedingungen des perfekten Wettbewerbs.

Der Nachfrageplan des unabhängigen Unternehmens ist vollkommen elastisch. Dies wird durch das Konzept des „Preisnehmers“ erklärt, bei dem das Unternehmen den speziell auf einem bestimmten KGV-Diagramm angegebenen Preis als ursprünglich angegeben akzeptiert. Daher wird ein Unternehmen, das unter reinen Wettbewerbsbedingungen existiert und einen solchen Nachfrageplan für die von ihm produzierten Waren hat, die Nachfrage nach seinen eigenen Produkten verlieren. Deshalb muss bei vollkommenem Wettbewerb die Nachfrage eines einzelnen Unternehmens gleich dem am Markt etablierten Preis sein ( $D=PE$ ).

Bei der weiteren Betrachtung dieser Grafik ist auch zu beachten, dass die Nachfragekurve für die Waren des Unternehmens auch die Kurve des Durchschnittseinkommens  $AR$  und des Grenzeinkommens  $MR$  ist. Wenn man weiß, dass das Durchschnittseinkommen dem Verhältnis des Gesamteinkommens und der Menge der verkauften Produkte entspricht, kann man verstehen, dass das Durchschnittseinkommen immer dem gleichen Wert entspricht, d. h. dem Preis.

Somit ist perfekter Wettbewerb eine Marktstruktur, in der es eine große Anzahl voneinander unabhängiger Unternehmen gibt, die homogene Produkte herstellen. Sie haben keine Möglichkeit, den Marktpreis zu beeinflussen, dessen Hauptfaktor der Wettbewerb zwischen den Teilnehmern ist. Es trägt zur Verbesserung der Produktionstechnologien bei, was im Allgemeinen die Effizienz der Wirtschaft steigert.

Sowohl bei perfektem als auch bei unvollständigem Wettbewerb besteht das Hauptziel des Unternehmens darin, den Gewinn zu maximieren oder die Kosten zu minimieren, was es uns ermöglicht, dieses oder jenes Verhalten auf dem Markt zu bestimmen. Der Gewinn wird als Differenz zwischen Gesamtumsatz TR und Gesamtkosten TC berechnet. Unter reinen Wettbewerbsbedingungen muss ein Unternehmen ein Produktionsvolumen wählen, bei dem Grenzerlös, Grenzkosten und Preis des Produkts gleich sind.

Eine wichtige Entscheidung für das Unternehmen wird zur Frage der Produktionsmengen. Nachdem es sich das Ziel gesetzt hat, den Gewinn zu maximieren oder die Kosten zu minimieren, muss es natürlich das optimale Produktionsvolumen von Gütern bestimmen, mit dem es dies erreichen kann. Dazu sollte sie das Produktionsvolumen ermitteln, bei dem die Differenz zwischen Einnahmen und Kosten am größten ist.

Der nächste zu berücksichtigende Schritt ist die kurzfristige Minimierung von Verlusten. Ein wettbewerbsfähiges Unternehmen kann kurzfristig einen Gewinn erzielen, aber wenn das Preisniveau sinkt und allmählich das Niveau der durchschnittlichen Gesamtkosten erreicht, wird das Unternehmen keinen wirtschaftlichen Gewinn erzielen können. Bei einem anschließenden Rückgang des Marktpreises kann es zu Verlusten für das Unternehmen kommen, unabhängig von der Produktion irgendeines Volumens. Kurzfristig sollte das Unternehmen die Produktion jedoch nicht einstellen, da dies zu noch größeren Verlusten führt, da der Unternehmer im Falle der Schließung die Fixkosten selbst tragen muss.

Betrachten wir eine Grafik, die den Fall zeigt, wo das Unternehmen kurzfristig Verluste minimiert.

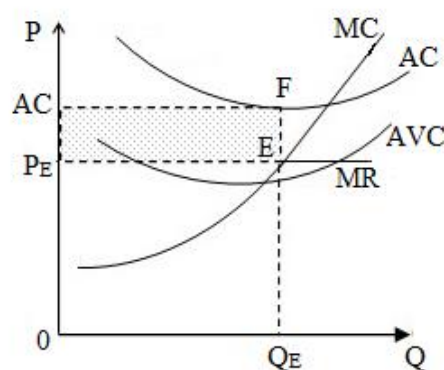


Abb. 2. Der Fall der kurzfristigen Minimierung von Verlusten auf einem vollkommen wettbewerbsorientierten Markt.

In diesem Fall wird der Wert der Verluste, die das perfekte Konkurrenzunternehmen erleidet, durch das Rechteck  $P_EACFE$  dargestellt. Um seine Verluste zu minimieren, muss das Unternehmen den Output finden, bei dem  $MC=MR$  ist. In diesem Schaubild wird dieser Output mit  $Q_E$  bezeichnet und der Gleichheitspunkt ist – E.



Der nächste Schritt ist die Betrachtung des Falles, in dem es für das Unternehmen besser ist, die Produktion kurzfristig einzustellen. In diesem Fall steht das Unternehmen vor einem Problem, wenn der Wert der durchschnittlichen variablen Kosten den Marktpreis übersteigt.

In einer solchen Situation ist das Unternehmen nicht mehr bestrebt, einen positiven Gewinn zu erzielen. Die Hauptaufgabe für das Unternehmen ist die Minimierung der Verluste. Um die Verluste des Unternehmens so gering wie möglich zu halten, muss es die Produktion auf null reduzieren, d. h. die Produktion einstellen.

Die Analyse des Modells des Unternehmensverhaltens auf dem Markt des vollkommenen Wettbewerbs ermöglichte es also, die Bedingungen und Besonderheiten des Gleichgewichts des Unternehmens in den kurz- und langfristigen Perioden zu ermitteln. Die Bedingungen des Gleichgewichts des Unternehmens auf dem Markt des vollkommenen Wettbewerbs und ihre Besonderheiten auf kurze und lange Sicht sind ermittelt. In der kurzfristigen Periode erreicht das Unternehmen, das seinen Gewinn maximiert, das Gleichgewicht, während in der langfristigen Periode das Unternehmen einen Gewinn von Null erzielen muss, um das Gleichgewicht zu erreichen.

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## **МОДЕЛЬ РЫНКА СОВЕРШЕННОЙ КОНКУРЕНЦИИ И УСЛОВИЯ РАВНОВЕСИЯ ФИРМЫ В КРАТКОСРОЧНОМ И ДОЛГОСРОЧНОМ ПЕРИОДАХ**

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**Аннотация:** Статья посвящена одной из важнейших тем микроэкономики – изучению и критическому анализу концепции совершенной конкуренции, а именно рыночной модели и условий краткосрочного и долгосрочного равновесия фирмы. В рамках изучения рыночной модели совершенной конкуренции в статье рассмотрены и представлены характеристики поведения фирмы в условиях совершенной конкуренции.

**Ключевые слова:** рынок, рыночные отношения, конкуренция, убытки, цена.

## CHARACTERISTICS AND CIRCUMSTANCES OF PREMEDITATED MURDERS

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### Abstract

The article discusses the types and circumstances of intentional crimes. The purpose of the article is to consider the main types and circumstances under which murder is committed. The author comes to the conclusion that the growth of premeditated murders depends on social tension, the standard of living of the population, personal problems and problems with education.

**Keywords:** circumstances of premeditated murders, premeditated murder, types of premeditated murders.

### Introduction

According to part 1 article 105 of the Criminal Code of the Russian Federation, a murder is an illegal purposely deprivation of life. This definition, adopted in our system of legislation, is the first and single. In ancient times only doctrinal concepts were using to define the serious crime which was considered the most dangerous.

Life is a fundamental and inalienable right of each person which is protected by criminal legislation. Within the framework of this legislation, the right to life is recognized and guaranteed for each individual apart from age, health, and life position, physical and moral characteristics from birth to death [2].

The right to life of every person is the direct object of this crime. According to the Act of the Russian Federation N 4180-1 titled 'Transplantation of human organs and (or) tissues' 22 of December 1992 the diagnostics of biological death is based on irreversible brain death. The definition of brain death allows you to distinguish biological death from clinical or inkomma. An attempt to cause clinical death, when the victim's body can subsequently be restored, is considered an attempted murder. Actions in relation to a deceased person (after physiological or biological death) mistaken for a living person, should be considered, taking into account the factual error, as an attempted murder.

A murder can be committed both by active and passive acts. The offender can use physical force (inflict wounds, poisoning, drown), psychological pressure (fright, dissemination of dangerous information, threats). If murder is committed using various means (for example, brass knuckles or a knife) of machinery (rifle, gun), then such action is classified as an active murder. The murder committed by inaction is possible if the person must prevent death. However, inflicting a fatal blow in case of self-defense is not considered as murder, because each person has the right to the necessary protection according to Article 37 of the Criminal Code of the Russian Federation. A murder considers as an intentional crime only if the offender realizes that his action or

inaction allow victim's death. The offender foresaw such an outcome and desired its occurrence (direct intent), or deliberately allowed the possibility of death (indirect intent) [1].

Premeditated murder is considered as one of the most serious violent crimes. The use of violence against human life is a major factor in such crimes.

Based on the research in the field of criminology, the following factors can be identified that influence the growth and increase in the public danger of violent crime:

- a profound revision of old values and moral principles, as the public consciousness increasingly began to attach special importance to money and material goods as the only measure of value;

- a human life that lost its value, if it is not accompanied by a high indicator of material prosperity;

- blurred boundaries between morally acceptable and unacceptable, between ethics and immorality;

- the increase of social contradictions in society due to the growth of socioeconomic inequality, the level of material well-being of citizens;

- significant changes in lifestyle and social status of majority of people, which leads to an increase in the level of aggression and switching to the use of any available means to achieve their goals [3].

We discuss the circumstances leading to premeditated murders. Unemployment, alcoholism, drug addiction, personal problems, debauch, negative moral qualities - avidity, greed and careless parenting, especially among youth.

Important to note that alcoholism plays a great role in numerous cases of premeditated murders. Alcohol intoxication causes various manifestations of aggression and leads to negative consequences closely related to upbringing, behavior, psychology and morality. That is why alcohol and alcoholism may be the direct cause of the murder.

Hooligan tendencies play an essential role in motivating murderers. The factors and conditions preceding hooliganism mainly coincide with those that lead to premeditated murders. The lawlessness of hooligans creates an environment in which they feel irresponsible and, ultimately, are capable of committing premeditated murder.

Also, the reason for committing murders can be a problematic situation in everyday life and depravity. Most often such crimes arise after systematic scandals, fights and threats between the accused and the victim. However, despite the fact that many relatives, neighbors and other people around are aware of such conflicts, they often do nothing to prevent such crimes. The lack of an adequate response to the wrong behavior of a person preceding a crime is one of the main factors contributing to premeditated murders.

The commission of murders may be motivated by selfish motives, such as greed and self-interest. Criminals who exhibit these negative qualities often commit murders for selfish reasons.

Insufficient educational work, especially among young people can cause intentional murders. This can lead to the spread of alcoholism, drug addiction and gambling, which, in turn, predispose to the commission of crimes, including murder.

Unemployment has a negative impact on the frequency of homicides. Every year the number of unemployed people increases and the lack of financial opportunities and a miserable existence can incline a human to commit premeditated murders.

When committing premeditated murders, there are also a number of factors that can be used as indicators of criminal intent. Such indicators can take the form of threats, insults, harassment of potential victims, or even preparation to commit a crime.

A drop in income, a decline in living standards, an increase in social stratification, unemployment, problems in personal life, and problems with upbringing— all these factors play an essential role in determining premeditated murders. The aggravation of contradictions among these factors causes an increase in social tension, a decline in traditional moral values, a sharp decrease in the level of law-abiding, a violation of the stability of public order.

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## ХАРАКТЕРИСТИКА И ОБСТОЯТЕЛЬСТВА УМЫШЛЕННЫХ УБИЙСТВ

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**Аннотация:** В статье рассматриваются виды и обстоятельства умышленных преступлений. Целью статьи является рассмотрение основных видов и обстоятельств, при которых совершается убийство. Автор приходит к выводу, что рост умышленных убийств зависит от социальной напряженности, уровня жизни населения, личных проблем и проблем с воспитанием.

**Ключевые слова:** виды умышленных убийств, обстоятельства умышленных убийств, умышленное убийство.

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