

APPLICATION OF VIRTUAL SIMULATORS FOR TRAINING STUDENTS OF THE CHEMICAL TECHNOLOGY TYPE AND IMPROVEMENT OF PROFESSIONAL SKILLS OF CHEMICAL ENTERPRISES PERSONNEL *

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Abstract: The structure and contents of training and control system formed on the basis of LabVIEW programming environment are presented. The system can be used in training students of chemical technology type and chemical enterprises personnel.

In XX century numerous attempts to automate production processes in various industries were carried out. In 1980–1990s computers became available and widespread, which caused rapid development of automated management systems of technological processes. Nowadays such systems are widely applied at the automated assembly (automobile, electronic industry, etc.), and for the control of technological processes at chemical and power enterprises.

Modern chemical industry actively uses systems of automated control over technological processes, considerably improving the quality of products, as well as giving its employees convenient and simple in use tools to control technological processes and prevent extraordinary and extreme situations. No doubt, in order to use such systems the personnel should have certain training. Thus, it is necessary to create the simulators, intended to give students of chemical technology type and chemical enterprises employees an opportunity of practicing and improving their professional skills to use the systems of the automated control and management of technological processes.

Today there is plenty of software intended for training the personnel of industrial enterprises – simulators, programs for testing and so on. Introduction of such software packages at the enterprise raises the quality of personnel training and contributes to the formation of skills. It should be noted that computer-aided training involves the use of visual methods; besides, it is very convenient and easy to use. Simulators and training programs have become very popular in chemical and power industries since the employees at these kinds of enterprises quite often use remote controls in their work; these operations can be easily performed by means of programs-simulators.

Besides, application of programs-simulators seems to be quite promising in training students at higher educational institutions of chemical technology type. It is very important for the students to have both theoretical knowledge and practical skills necessary for the solution to certain industrial tasks. It can be achieved through application of

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systems simulating the work of particular technological lines. Thus, two goals are achieved: on the one hand, students have deeper understanding of the studied material as representation of devices performance in dynamics is frequently more informative than text descriptions and static illustrative materials; on the other hand, students have an opportunity to get practical skills necessary for their further work, without the necessity of using real equipment which is quite often unavailable, or its use is connected with some difficulties. It is obvious, that in such cases the use of simulators is, practically, a unique way to give students the necessary knowledge and skills.

A long-range direction in creation of computer-aided training systems for chemical enterprises employees and students of corresponding specialties is the use of SCADA-system as realization medium. With its help it is possible to create simulators, interaction with which completely simulates the work at a control panel at the real manufacturing enterprise equipped with a similar system. It allows the trainee to receive skills, in many respects similar to practical work at the plant. Another advantage of SCADA-systems for the creation of simulators is that nearly all the basic network reports are integrated into the systems of this class, including TCP/IP that enables to create training programs with the removed access through Internet.

The department "Computer-aided design of the process equipment" of Tambov State Technical University is engaged in the development of the automated system for control and training of the students of the specialization "Flexible automated systems in technology of machines and devices of chemical production" and the personnel of "Pigment" plc, Tambov. The given system is developed on the basis of *LabVIEW* programming media made by the company *National Instruments*.

The developed system includes the following components:

1. The virtual simulator of a workstation of the operator, controlling the work of pigment-making device.
2. The module of trainee testing, providing the knowledge check of simulated technological processes and chemical technologies as a whole.
3. The help system including the description of simulated production technology.

The training module represents a set of virtual tools created in *LabVIEW* system. It consists of two basic components: a simulator intended for practicing actions in case of emergency, and a simulator imitating the regular work of the technological circuit.

The simulator "PLAS-T" (fig. 1) represents the virtual tool intended for improvement of personnel actions in case of emergency, created on the basis of the existing Plan of Emergency Localization (PEL) of the plant specialized in production of monometylaniline at "Pigment" plc, Tambov. It represents a complex including the forward panel, the panel of preliminary adjustments, subsystems of answers' processing and those of testing results output.

The basic features of system "PLAS-T" are:

- conformity of the skills formed via the simulator, to the skills obtained through working life (it is ensured by the fact that the simulator is based on the existing PEL which is the basic document regulating the behavior of people in charge if the emergency occurs) and, thus, it secures the identity between the actions which operator is obliged to take in case of real failure and those which he does while being trained on the simulator;
- inhibition of the skills giving a negative effect when put into real conditions as the trainee learns about the mistake or the wrong answer thus helping them to avoid a similar mistake in further testing;
- an opportunity to vary testing conditions; it is ensured by two time modes of testing and the opportunity to choose a stage of technological process, its conditions and type of emergency;

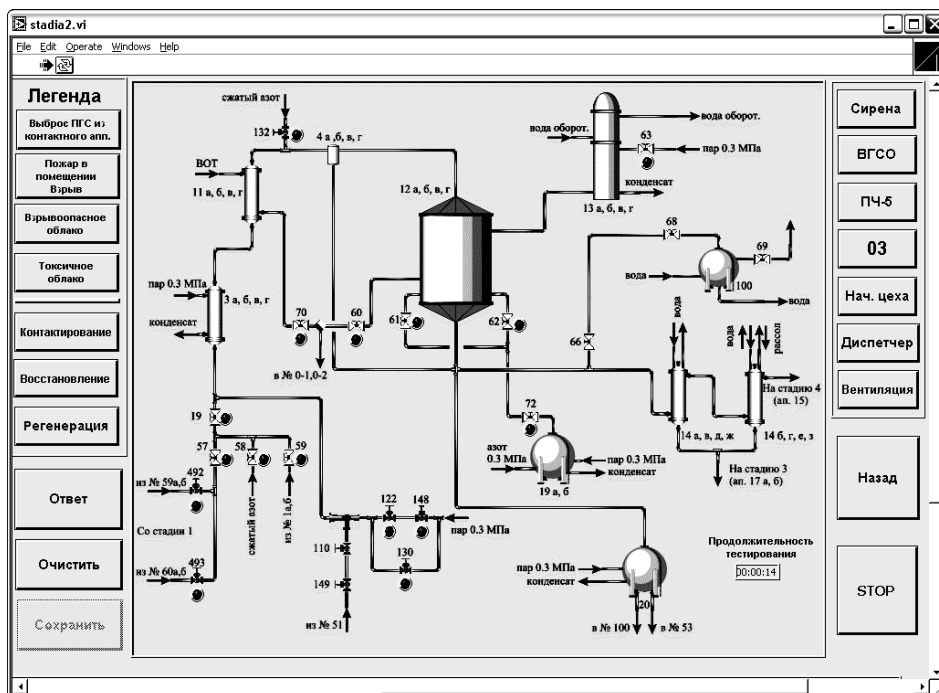


Fig. 1. Main panel of simulator "PLAS-T"

- registration of the results required for further analysis; these are presented inside the program in the form of a chart showing correct and incorrect answers, and as an external file containing complete information on testing;
- methodical purposefulness of the simulator covering all possible variants of emergency occurrence and development as stipulated in PEL and a set of the exercises for students.

The second component of the training module is the "Training-K" system simulating control panels of combined technological circuits (for example, production of a vinous pigment and a red G one) (fig. 2). The simulator is based on working modes of products manufacturing. The controls are located on the forward panel of the simulator, enabling to supervise the movement of working media along the circuit, the work of mixing devices drives, and also the indicators of medium level in the devices. With the help of this simulator the trainee has an opportunity to receive skills of control over real technological system without using the real equipment.

The important feature of the given simulator is the opportunity to do personnel training and testing remotely through Internet with the help of a usual Internet-browser without installation of the additional software. For this purpose the Internet-page is created; it has constantly updated image of the forward panel of the simulator on which the active zones corresponding to its controls are marked. Pressing these zones with the help of a cgi-script turns into signals, which influence the simulator.

A number of training modules forming "The complex of virtual simulators for chemical technology systems operators" have been developed by students of department CDPE of TSTU on the basis of the technique developed during the creation of the described training modules, which you can find at <http://www.170514.tstu.ru/tren/index.html> (fig. 3) is developed.

The testing module is created on the basis of "Knowledge control system Knost 1.0.4." (www.scorp.ru), designed for the creation of electronic tests, testing and viewing of its results. The system consists of two modules: "Knowledge Control: Testing" (knosttester.exe) and "Knowledge Control: Administrator" (knostadmin.exe).

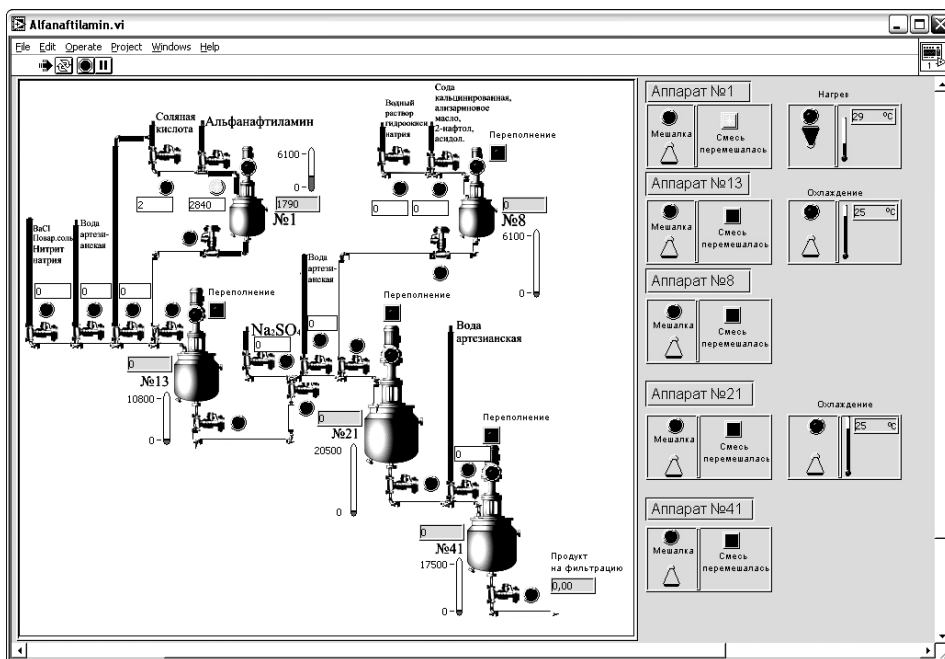


Fig. 2. Main panel of simulator "Training-K"

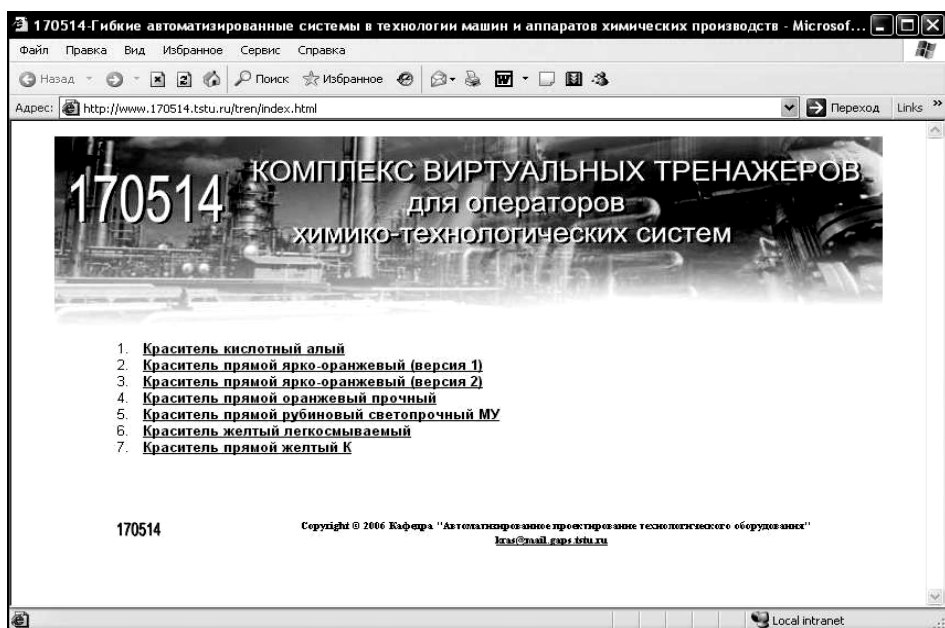


Fig. 3. A web-page of the complex of virtual simulators for chemical technology systems operators

With help of administrator module it is possible to create tests and carry out the remote testing on a local network. The test created in the system Knost, represents a set of questions and several variants of answers to each question. Each question may have an image in .bmp format, stored in a test file. Besides, each question has the so-called maximum point received for the correct answer. Thus, it is possible to identify the complexity of the question and its effect on the total score.

The set of questions together with the variants of the answers covering both general knowledge of chemical production technology and the particular production process presented in the module is stored in the test file. When the test is over the file is created; its name contains the initials of the student who has completed the test, and the title of the test itself. This file can be viewed only with the help of the program «Knowledge Control: Administrator». The score file contains the following information: the title of the test and the student's surname, the number of questions, correct and wrong answers, factor of knowledge and a mark given according to a five-point scale. Besides, the examiner can look through the answers given by the student.

In addition to training and testing modules the structure of information system for training chemical enterprises employees includes the help system. It contains the descriptions of technological processes used in the training module, and also the user's guide for training modules, created with the help of Macromedia Captivate system and representing interactive demonstration of simulator's opportunities, its controls and principles of work.

The result of the represented work is the complex system which contains the testing module for high schools students and chemical enterprises employees intended to identify the level of knowledge of technological processes and the training module which enables to increase considerably the quality of training and retraining of personnel, to achieve deeper understanding of work principles of the studied equipment. The application of the given system makes it possible to do practical classes teaching students skills required at chemical enterprises, thus pulling together university education and real production. The other important area of application of the given system is training and retraining of chemical enterprises personnel, revealing the degree of their readiness to various situations, including cases of emergency.

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Применение виртуальных тренажеров для обучения студентов химико-технологического профиля и повышения квалификации персонала химических предприятий

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Ключевые слова и фразы: виртуальный тренажер; дистанционное обучение.

Аннотация: Представлены структура и состав системы тренажа и проверки знаний на базе среды программирования LabVIEW. Данная система может быть использована в обучении студентов химико-технологического профиля и персонала химических предприятий.

**Anwendung der virtuellen Trainers für die Ausbildung der Studenten
des chemietechnologischen Profils und die Erhöhung der Qualifikation
des Personals der chemischen Unternehmen**

Zusammenfassung: Es sind die Struktur und den Bestand des Trainsystems und der Prüfung des Wissens auf der Basis des Programmierens LabVIEW vorgestellt. Das vorliegende System kann in der Ausbildung der Studenten des chemietechnologischen Profils und des Personals der chemischen Unternehmen verwendet sein.

**Application des home-trainers virtuels pour la formation des étudiants
du profil chimique et technologique et pour l'augmentation
de la qualification du personnel des entreprises chimiques**

Résumé: Est présentée la structure et la composition du système des home-trainers et du contrôle des connaissances à la base du milieu informatique LabVIEW. Le système donné peut être utilisé dans la formation des étudiants du profil chimique et technologique ainsi que du personnel des entreprises chimiques.
