

USE OF INNOVATIVE TECHNOLOGIES IN TEACHING THE SUBJECT OF NUCLEAR FUEL PROCESSING

A. Kh. Ramazanov^a, E.Kh. Bozorov^{a,b}, A.A.Kenjayeve^c

^aNational University of Uzbekistan named after Mirzo Ulugbek, Tashkent, Uzbekistan,

^bInstitute of Nuclear Physics Academy of Sciences of the Republic of Uzbekistan, Tashkent, Uzbekistan

E-mail: asrorkhramazanov@gmail.com

^cUzbek State world Language University Tashkent, Uzbekistan

E-mail: adolatkenjaeva@gmail.com

Annotation: In this paper, based on pedagogical analysis, it is shown that it is possible to achieve effective learning outcomes using computer technology programs in studying the features and processes of nuclear fuel reprocessing. It has also been proven that teaching the topic "Nuclear Fuel" in the context of demonstrating technical achievements contributes to the formation of the worldview of students in accordance with the times.

Key words: nuclear fuel, neutron reactor, colloids, plutonium nitrate, radioactive waste, radiation safety.

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Introduction: Today, all nuclear power plants (NPPs) are developing measures for the reprocessing of spent nuclear fuel. To this end, students are introduced to many modern methods and modern methods of teaching the features and basic processes of processing nuclear fuel used at nuclear power plants. Radiochemical reprocessing of irradiated nuclear fuel is a relatively young developing industry that depends on the development of nuclear energy. Reprocessing technology faces new challenges facing nuclear power. Today, 192 nuclear power plants with 451 power units with a total capacity of 394,836 MW operate in 31 countries of the world. The process of a closed nuclear fuel cycle (NFC) with processing of plutonium and uranium is used on an industrial scale in France at the plants UP2-500 and UP3. Therefore, the problem of increasing the scale of production of mixed uranium and plutonium oxides for the production of fuel elements and mixed fuel has become an urgent problem in the radiochemical industry, which previously processed only irradiated uranium fuel. New methods for solving individual problems of irradiated nuclear fuel reprocessing technology have been proposed and new types of equipment have been developed. Practical implementation has been achieved through automated remote monitoring and control systems for the technological process. In the modern socio-economic development of our society, the level of knowledge of the population, the level of development of educational and scientific infrastructures are of great importance. In this sense, the nuclear fuel cycle, considered one of the important factors in the development of society, and the influence of enterprises have a significant place in the choice of each subject of science. "Production of nuclear fuel, fuel elements and fuel units", "Closed and open nuclear fuel cycle", "Types and features of the impact of nuclear fuel cycle enterprises on the environment" Enriching education with today's scientific and practical achievements is becoming a requirement of the time. In recent years, there has

been an increase in the number of books devoted to personal topics. In this article, we will provide information about new issues and changes in the technical area.

Actuality of the research topic: It is known that nuclear energy plays a very important role in shaping the scientific worldview of students in order to have a modern understanding of the methods of processing nuclear fuel. At the same time, the topics of nuclear energy are of paramount importance in the Department of Quantum Physics, and the process of studying them requires complex explanatory work and a certain level of abstraction skills. From the analysis of textbooks and methodological literature on the processing of nuclear fuel used at operating nuclear power plants, it can be seen that some of the proposed thematic materials in this area are insufficient to update the basic knowledge of students.

From the points of the training materials "Scheme of nuclear fuel cycles", "Natural uranium mining", "Production of nuclear fuel, fuel elements and fuel units", "Closed and based on a detailed study of the topics, the following can be said. such as "open nuclear fuel cycle", "types and features of the impact of NFC enterprises on the environment". Issues such as new generations of nuclear power plants, the possibility of a scientific assessment of the level of safety and the formation of a positive attitude towards it were somewhat left behind. However, the creation of a system of continuous education based on innovative technologies, the creation of a national education system capable of withstanding today's fierce competition on a global scale, the improvement of textbooks and teaching aids based on the requirements of the time, although the need to address such issues as the creation of their new generation, the optimization of educational programs and standards, the content of the currently studied educational topics lags far behind in reflecting the content of the principles of operation of modern devices operating in real life. In particular, the lack of

information about the processing of spent nuclear fuel at nuclear power plants in the nuclear power industry cannot give a modern idea about them. The elimination of such a difference by improving the methods of teaching nuclear fuel processing using computer technology based on innovative technologies is considered one of the urgent problems of our time.

Scope of research work: There are many scientific papers and dissertations devoted to the introduction of innovative technologies in the educational process, most of them are devoted to virtual methods for performing physical laboratories [1,2]. Also, enough models and computer programs have been created that display the sequence of physical phenomena. In teaching nuclear fuel reprocessing, nuclear models and the methods based on them for explaining various nuclear processes are traditional methods, and now it is necessary to pay enough attention to the methods of teaching nuclear fuel reprocessing using new innovative computer technologies. In particular, it is necessary to further improve the work devoted to teaching topics related to the development of time with the help of ICT [3].

Statement of the research problem: between the need to raise the quality of knowledge on nuclear fuel reprocessing to a high level, to form an understanding of nuclear processes and insufficient knowledge of the methodology for teaching nuclear fuel reprocessing based on innovative information technologies. gap is one of the problems in teaching atomic energy.

Aim of the research work: Master students of 1-2 courses are taught modern technological solutions, technical developments of the NPP SNF processing process for individual units of their technological scheme, as well as problems aimed at improving technological processes, taking into account the specifics of processing various types of SNF. fuel, lies in the development of an innovative educational methodology that allows you to achieve effective results that shape the modern imagination.

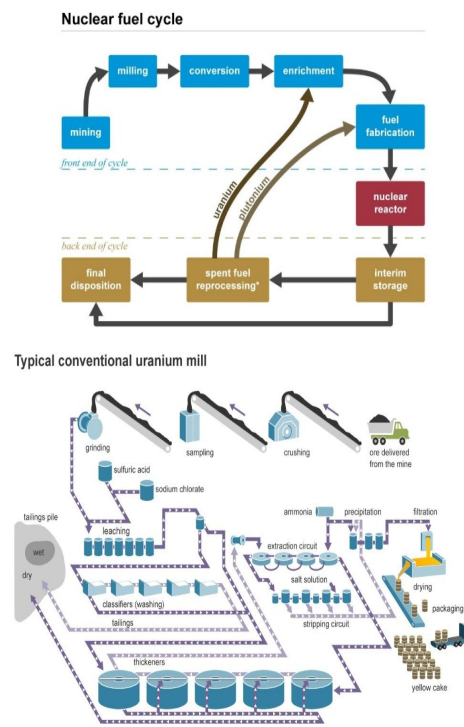
The task of the research work: To achieve the goal, it is important to complete the following tasks.

- analyze the state of students' training in nuclear fuel reprocessing methods and identify the main difficulties in teaching this section;
- studying the experience of using new information technologies in teaching physics and determining their capabilities in the study of nuclear energy;
- creation of computer programs and demonstration slides that improve the presentation of dynamic and static scenes in the study of nuclear fuel reprocessing processes;
- use of computer technologies to improve the methods of teaching nuclear fuel reprocessing, aimed at developing students' personal qualities, thinking, creativity, experimentation skills, and interest in learning.

Methods of the research work: Research methods include documents on educational tasks,

programs, methodological literature, audiovisual and technical teaching aids, information technology, computer programs, slides, aids for demonstration experiments, duplicates [4]. The basis of research methods is also being formed: the basic principles of didactics, student-centered teaching methods based on the modern concept of education, teachings on the methodology of pedagogical research and ideas about the use of information technology in the educational process. [5].

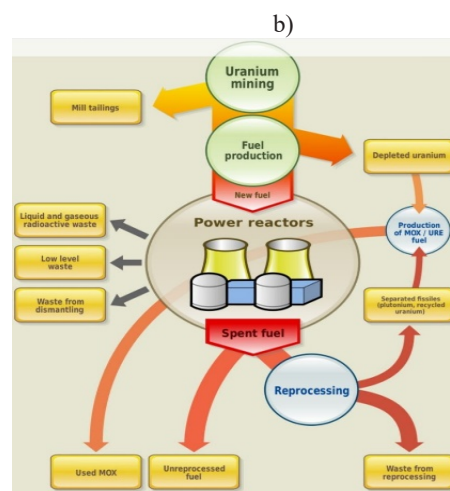
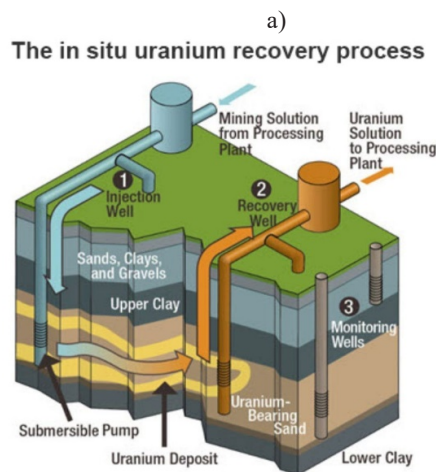
Main part: The resources of educational innovative technologies are used to model and animate the processes being studied, develop students' thinking skills in a figurative way, demonstrate educational information, conduct laboratory work in the conditions of computer experiments, and most importantly, create a real situation by simulating on a monitor, creates ample opportunities for improving interest in learning [6]. In order to improve the methods of teaching nuclear fuel processing using such opportunities, it is necessary to ensure that the content of educational subjects corresponds to the achievements of modern science and technology, to ensure the connection between theory and practice by showing areas, to pay attention to the environmental organizers of physical education and to perceive the physical essence of each concept, that is, a physical phenomenon. , physical quantity, model, idea, concepts such as theory, nuclear fuel, nuclear reactor, MOX fuel, uranium and plutonium, and processing must be provided in accordance with fundamental laws and scientific. The block structure of the content of logically related educational materials on nuclear fuel processing can be distinguished as follows (Fig. 1).



Rice. 1 Reprocessing of SNF at NPPs.

The nuclear fuel cycle begins with the exploration of uranium and the operation of mines for the extraction of uranium ore. Various methods are used to detect uranium, including airborne radiometric surveys, chemical sampling of groundwater and soil, and exploratory drilling to understand the underlying geology. At the same time, the use of the necessary model to understand a particular process using models that represent the special properties of the nucleus, and the limits of application and capabilities of each model are demonstrated directly with the help of computer programs, to expand information about the properties and structure of the nucleus, and expand information about the universal structure of the nucleus, they will have information that the model has not been created[7].

It should be said that if the study of such information in the traditional way takes a lot of time, then the use of ICT not only saves time, but also facilitates the perception of the essence in a visual way. Also, one of the important issues in the processing of nuclear fuel is a radical way to get rid of excess accumulation of nuclear fuel, reduce radiotoxicity and the amount of waste to be destroyed, which consists in their processing with the release of uranium and plutonium and consists in the use of newly produced fuel (fuel processing). In this scenario, the bulk of uranium and plutonium (99.9%) is obtained from spent nuclear fuel, while a small part of it remains in high-level waste, which is sent for final storage in a geological repository. 8]. Another of the central issues is the formation of students' attitudes towards the reprocessing and safety of nuclear fuel by demonstrating a real picture of the types of nuclear fuel cycles [9]. For this, new nuclear energy devices have been created using the achievements of nanotechnology and various modern computer programs that help to teach based on scientific results: "TechSmith Camtasia", "MXSAFlash", "ActivePresenter", "EasyQuizzy" and "Used AutoPlay MediaStudio".



Rice. 2 Nuclear fuel reprocessing process

It is advisable to use such electronic programs as a) "Uranium extraction", b) "Uranium extraction", "Modern nuclear reactors and their working mechanisms", shown in Figure 2. These electronic programs are created using the programming languages "ActionScript", "JavaScript", "C#" using modern computer capabilities. Animation of thermonuclear reactions related to nuclear energy, animation of nuclear fission processes, presentation of the first and modern nuclear power plants - nuclear power plants, tables of criteria for assessing their safety level, animation of types of nuclear reactors, presentation of nuclear fission reactions and proton-neutron-nuclear reactions. Demonstration programs such as the models are included in the methodology of teaching nuclear energy and improved, as well as educational experiments for undergraduates of 1-2 courses of the Department of Nuclear Physics of the Faculty of Physics of the National University of Uzbekistan [8].

Experimental results and discussions:

Improving traditional teaching methods with the help of created electronic textbooks, virtual laboratories, videos and presentations, in order to determine the effectiveness of the results of nuclear energy training and the degree of formation of ideas about the physical laws underlying modern technical ones. First of all, the necessary conditions were determined, goals and objectives of the pedagogical experiment, the shortcomings identified in the process of many years of teaching the science of nuclear energy are taken into account. The main purpose of the pedagogical experiment is to identify the problems that arise in the formation of the modern scientific worldview of students when teaching nuclear energy subjects, and to test the effectiveness of an improved methodology for teaching the sciences of nuclear energy, based on the use of innovative technologies in their solution. Pedagogical experiments take place in three stages, the first stage is the need to use innovative technologies to solve problems identified on the basis of studying the methods of teaching nuclear energy, theoretical and experimental work at

the first stage in 2021-2022. They improved the methodology for teaching nuclear energy [10]. At the second stage (2021-2022), the experience of studying educational and methodological materials was carried out and the content of educational topics and teaching methods enriched with innovative technologies was brought to the attention of the teachers of the Tashkent State Technical University, based on the indicated methodological recommendations and seminars, students were tested to study nuclear physics.

In 2021-2022, the results of the improved teaching methodology were determined. At the third stage (2023-2024), a control experiment was carried out. The science of modern problems of nuclear energy was taught in the experimental and control groups, and the results of the pedagogical experiment were analyzed. The developed guidelines were statistically processed and introduced into the educational process. According to the results of general pedagogical experiments, the developed methodology for teaching nuclear energy turned out to be effective in the study of nuclear energy, while an increase in the quality of education by 15% was noted [11]. As a criterion for the effectiveness of training, such cases as logicity, systematicity, precise justification of answers, meaningfulness, and completeness of knowledge were identified.

Conclusion. Created using innovative technologies, the programs "TechSmith Camtasia", "MXSAFlash", "ActivePresenter", "EasyQuizzzy" and "AutoPlay MediaStudio" "Nuclear fuel", "Reprocessing stages", "Modern nuclear reactors and mechanisms of their work", "Renewable sources of Nuclear Fuel and Their Resources" with the help of additional electronic programs that combine the achievements of modern science with existing ones, a methodology for teaching the subject of science about nuclear energy "Nuclear fuel processing" has been developed.

In addition, the content of educational materials is at the center of the methodology for teaching nuclear energy based on computer technology, and the teacher is the organizer of the educational activities of students. And the computer performs the function of using information technology. It has been established that educational materials on nuclear energy are enriched with the achievements of scientific and technological development, and their teaching in a demonstrative form leads to an increase in the level of students' knowledge and activation of the educational process.

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