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Experience and advantages in implementation of educational program in network form at Department «Closed nuclear fuel cycle Technologies» of National Research Nuclear University «MEPhI»

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Experience and advantages in implementation of educational program in network form at Department «Closed nuclear fuel cycle Technologies» of National Research Nuclear University «MEPhI»

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Abstract. The experience of implementation of the basic educational program of magistracy on direction «Nuclear Physics and Technologies» in a network form is presented. Examples of joint implementation of the educational process with employers organizations, other universities and intranet mobility of students are given.

1. Introduction

The interaction with key employers, requiring a high and multidisciplinary level of training of graduating students, is an important component of the educational process. For students training usually it takes a form of attracting the external specialists and concluding the agreements on student research work, practice and final qualifying works at the enterprises of industry.

The evolution of educational standards of higher education has been steadily moving in the direction of an increasing account of requirements of professional industry standards, and of employers' requirements. The Federal Law «On Education in the Russian Federation» (№ 273 - FZ of December 29, 2012) [1] has introduced the possibility of implementing the educational programs in a network form. The requirements for the educational program, which is realized in a network form, are provided with a set of resources granted by the organizations involved in its implementation. Such organizations may be geographically distributed units of the University (the intranet mobility), other educational organizations, as well as other (non-educational) organizations.

The ability to consolidate resources of various organizations in implementation of the educational program allows us to expand the range of educational services and to train personnel in accordance



with the programs of development of enterprises and industries, as well as in accordance with international educational cooperation programs.

2. Educational Master Program «Nuclear physics and technologies», program name «Nuclear technologies of new generation»

The department «Closed nuclear fuel cycle technologies» of National Research Nuclear University «MEPhI» (MEPhI) was founded in 2014. The main purpose of foundation of the department and its educational program is a target training for the organizations of the «Proryv project» in the framework of the Federal target program «Nuclear power technologies of a new generation for 2010-2015 and for the future till 2020» [2] and the «Innovation Development Program of Rosatom» [3]. The objects of professional activity include nuclear power technologies of new generation based on fast neutron reactors (BN, BREST) with closed nuclear fuel cycle for nuclear power plants to ensure the country's needs for energy and more efficient use of natural uranium and spent nuclear fuel.

In accordance with the objective of training the following system of courses was developed:

- the basic courses of educational standard and some classic courses of MEPhI;
- the special general courses on closed nuclear fuel cycle technologies (CNFC), that are further being developed in special courses with the deepening on directions of CNFC;
- teaching in the sites of practical training in accordance with the themes of master's works and with specialization of responsibility centers of the «Proryv project».

To read the special courses the Department actively engages external specialists of such organizations as the A.A. Bochvar All-Russia Scientific Research Institute of Inorganic Materials (VNIINM), Leading Research Institute of Chemical Technology (VNIKhT), State Research Center of Russian Federation - Institute of Physics and Power Engineering (IPPE), Innovation and Technology Center for Proryv Project, Nuclear Safety Institute of the Russian Academy of Sciences, National Research Center «Kurchatov Institute», State Atomic Energy Corporation ROSATOM.

However, for effective implementation of the educational program it was necessary to attract not only the staff, but also the material resources of partner organizations. For that the relevant agreements on the network implementation of the educational program have been concluded. As an example, consider a block of disciplines that for convenience can be called «Radiochemistry and nuclear fuel cycle» (Fig. 1).

Implementation of the block of disciplines lasts for three semesters with the increase of amount. The course «Radiochemistry» is given in MEPhI by lecturers of D. Mendeleev University of Chemical

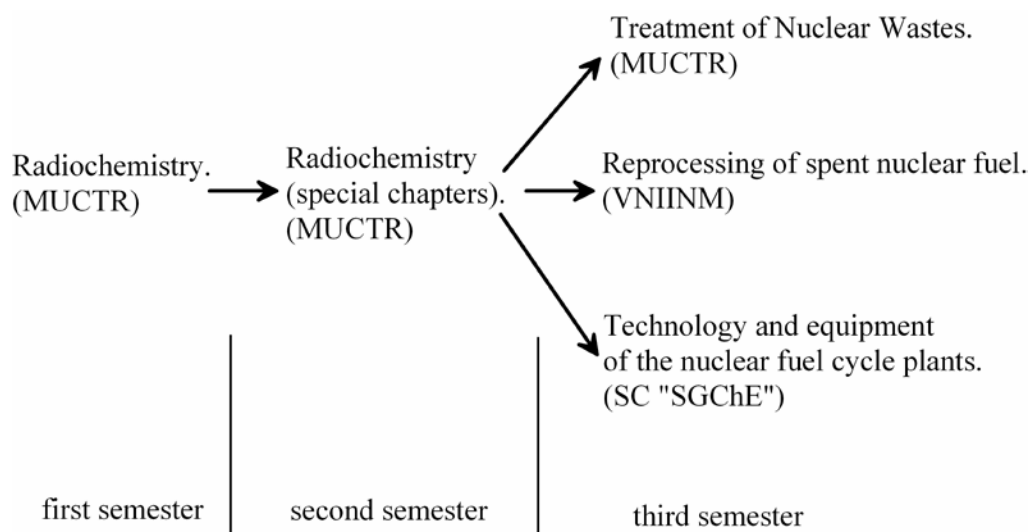


Figure 1. The structure of the block of disciplines «Radiochemistry and nuclear fuel cycle».

Technology of Russia (MUCTR). The discipline «Radiochemistry» is dedicated to acquaint students with the peculiarities of behaviour of radioactive isotopes in ultra small concentrations in solution, gas and solid phase, their distribution between the phases in the co-precipitation process, adsorption, ion and isotope exchange, electrochemistry, which is associated with the processing technology of spent nuclear fuel, radioactive waste and analysis of the quality of coolant in nuclear power plants. The discipline is levelling the incoming students, the account of the course is a two hour lecture per week.

The knowledge gained by students in the study of the course «Radiochemistry» is in demand later for the course «Radiochemistry (special chapters)», which is delivered on the basis of MUCTR in the amount of five classroom hours per week, including laboratory work. Obtained in the performance labs the ability and skills of radioactive drugs, the safety basis for work with open sources of radiation are the basic and necessary in the future to prevent a variety of emergency situations involving possible radioactive contamination of the atmosphere laboratory, clothing, skin, equipment at work at nuclear facilities. Complex laboratory works included in the curriculum will allow students to practice to get acquainted with the specifics of work in the radiochemical laboratory, learn radioactive drugs and radiometric equipment to determine the entire spectrum of radiation, and experimental reinforce the knowledge gained in lectures, in qualitative and quantitative radiochemical analysis, and use of radioactive tracers to solve various analytical problems [4]. The purpose of discipline «Radiochemistry (special chapters)» is the study of behaviour radioactive isotopes in the technologies of the nuclear fuel cycle, the methods of analysis, concentration and separation [5].

Three disciplines are already given in the block «Radiochemistry and nuclear fuel cycle» during the third semester. The course «Treatment of Nuclear Wastes» [6] is lectured on the basis of MUCTR in the amount of five classroom hours per week. The purpose of the discipline is to introduce students to technologies of management with radioactive waste, formed as a result of working with radio-nuclides. At present the possibility of practical training in the framework of the course on the basis of VNIKhT is under consideration.

The course «Reprocessing of spent nuclear fuel» is given by leading experts of VNIINM on the basis of this organization in the amount of four classroom hours per week. The purpose of the discipline is to prepare students for the engineering and chemical-technological problems related to development of reprocessing technologies of spent nuclear fuel and equipment for their implementation [7, 8].

The skills, obtained in the first two semesters, are developed during mastering the course «Technology and equipment of enterprises of nuclear fuel cycle» [9, 10]. At present the course is developed as follows. Students leave for Seversk (Seversk Technological Institute of MEPhI) where they undergo theoretical training for the first week six hours per day. The second week is devoted to a familiarization practice at Stock Company «Siberian Group of Chemical Enterprises» (SC «SGChE») with a visit to the radiochemical plant, sublimation plant, isotope separation plant, industrial reactor and chemical-metallurgical plant. Construction of a pilot demonstrational power complex is being carried out just at the site of SC «SGChE». The complex consists of a fast reactor installation «BREST-OD-300» with in-situ closed nuclear fuel cycle, including the production of uranium-plutonium nitride fuel (fuel fabrication), as well as the processing of irradiated nuclear fuel to produce a secondary uranium-plutonium nitride fuel (re-fabrication of fuel). Students can get acquainted with the construction process and, at the moment, with the technology of fuel production and the fuel assemblies from nitride fuel. It is planned to move the course to a remote platform CLP4NET in the amount of four hours per week with a weekly full-time practice at the SC «SGChE».

3. Conclusion

Various forms of network implementation of the educational program are applied for the realization of block of disciplines «Radiochemistry and nuclear fuel cycle» of the basic educational program of Master's in the direction «Nuclear Physics and Technology» on the profile «Nuclear power technologies of new generation». National Research Nuclear University «MEPhI» is a basic educational organization, D. Mendeleev University of Chemical Technology of Russia is an

educational organization and a partner, A.A. Bochvar All-Russia Scientific Research Institute of Inorganic Materials and Stock Company «Siberian Group of Chemical Enterprises» are not educational organizations, but they are partners, Seversk Technological Institute of MEPhI is a division of MEPhI (intranet mobility). These joint actions have allowed these organizations to form a unique block of disciplines, aimed at the comprehensive training of graduating students, that it would be impossible to implement on the basis of a single organization.

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