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DETAILED NEUTRONIC CALCULATIONS FOR PULSED NUCLEAR RESEARCH REACTOR NEPTUNE

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The IBR-2M reactor plant, the complex of technological equipment and the reactor building will develop their final life depending on the operating mode in 2032-2037. One of the proposed options to replace the IBR-2M reactor is the NEPTUNE reactor (average power of 15 MW, pulse duration of 210 μs and an average neutron flux of 1,6 x 1014 n/cm2/s and at peak power of 3,8 x 1017 n/cm2/s), which will for the first time use fuel based on the isotope Np-237.

Nuclear reactors accumulate kilograms of neptunium as a result of irradiation of natural and enriched uranium fuel, and the use of these quantities will give a major boost towards closing the nuclear fuel cycle and reducing the risks of nuclear wastes. Np-237 is a threshold isotope with a fission threshold of 0.4 MeV, lower than the fission threshold of uranium-238 of 2 MeV, which gives it a significant advantage in terms of the possibility of using as a nuclear fuel in pulsed reactors to obtain a very short neutron pulses, have a low background power between pulses and using a new more effective reactivity modulator and control rods.

The report and presentation explain the principle of operation of the reactor, its most important properties, and some of the problems that were discovered during the developing stage, while presenting proposed solutions:
 the results of the development of a promising new generation reactor of the IBR type - “NEPTUNE”, are considered in detail. The report will provide an explanation of the components of the research station, clarify in details the components of the reactor core, explain the working principle of the reactor and show the most important characteristics of the reactor;
 the report will also illustrate the possibility of partially using low-enriched uranium fuel (with U-235 enrichment less than 20%) in the reactor with the aim of enhancing the safety of the reactor by increasing the generation life time of the neutron;
 also review the results of comparing the use of three materials, namely liquid para hydrogen, solid methane, and mesitylene, at temperatures of 20 K, in order to increase the percentage of cold neutrons extracted in the neutron channels.

Section

Energy and materials science (Section 2)

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