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Slowing down fission chain reaction in fast reactor to improve nuclear safety

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The basis for the safe operation of any energy-producing plant is correspondence between the rate of energy generation and the rate of its transfer and removing from the place where the energy is generated. Slowing down the rate of Fission Chain Reaction (FCR) to the rates of thermal-physical and thermal-hydraulic processes eliminates the explosive nature of FCR development, and increases safety of nuclear reactors. We propose a method for FCR slowing down in a fast reactor by surrounding its core with a reflector made of materials of weakly absorbing neutrons and heavy atomic weight. It has been shown that the safety of this fast reactor is substantially improved, and that the achievement of a significant lifetime of neutrons from the reflector and their contribution into the FCR devalue the role of fraction of delayed neutrons as the maximum permissible reactivity for the reactor safety. The consideration was performed on the basis of the multipoint model of nuclear reactor kinetics. The asymptotic nature of FCR development (in-hour equation) was analyzed. We propose a new interpretation, according to which the components of in-hour equation characterize the barriers and the resistibility of FCR in reactor against rapid runaways, which are dangerous because they can lead to serious accidents. Traditionally, the reactors are characterized by the presence of barriers based on delayed and fast neutrons. A new barrier based on neutrons from physically thick reflector was proposed. The in-hour equation taking into account neutrons from the reflector was obtained and analyzed. The importance of neutrons of the reflector to improve resistibility of fast reactor against rapid runaways was demonstrated. Note that this result was obtained on the basis of consideration of FCR resistibility without taking into account of feedbacks. Thus, method of improving the safety of fast reactors at level of fundamental principle of reactors operation- the FCR resistibility without considering the peculiarities of fast reactors was proposed.

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