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Property of fission chain reaction to resist quick runaways in fast and thermal nuclear reactors to improve nuclear safety

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It has been shown that the in-hour equation characterizes the barriers and resistibility of fission chain reaction (FCR) against quick runaways in nuclear reactors. Traditionally, nuclear reactors are characterized by the presence of barriers based on delayed and prompt neutrons. A new barrier based on the reflector neutrons that can occur when the fast reactor core is surrounded by a weakly absorbing neutron reflector with heavy atomic weight was proposed. It has been shown that the safety of this fast reactor is substantially improved, and considerable elongation of prompt neutron lifetime devalues the role of delayed neutron fraction as the maximum permissible reactivity for the reactor safety. The following main results were obtained: new interpretation was proposed for the terms of the in-hour equation. The summands in the right part should be considered as the contribution deficits into the FCR balance from prompt and delayed neutrons, respectively. The left part of the in-hour equation is the reactivity needed to compensate the contribution deficits caused by time delays of prompt and delayed neutrons and to provide the runaway with given asymptotic period. The FCR resistibility to quick runaways in fast reactors can be significantly strengthened by surrounding the reactor core with the neutron reflector made of weak neutron absorber with heavy atomic weight. The modified in-hour equation with accounting for neutrons from the reflector was derived and analyzed. Neutrons from the reflector can play a significant role in upgrading the FCR resistibility to quick runaways.

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