IMPROVEMENT OF NEUTRON-PHYSICAL CHARACTERISTICS OF FAST REACTOR BY USING 208PB REFLECTOR

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As a rule materials of small atomic weight (light and heavy water, graphite and so on) are used as neutron moderators and reflectors. A new very heavy atomic weight moderator is proposed – radiogenic lead consisting mainly of isotope ^{208}Pb. It is characterized by extremely small neutron radiative capture cross-section (~0.5 mbarn for thermal neutrons, i.e. less than that for graphite and deuterium) and highest albedo of thermal neutrons.

It is evaluated that the use of radiogenic lead makes it possible to slow down the chain fission reaction on prompt neutrons in a fast reactor. This can improve safety of fast reactor

In this work the chain fission reaction slowed down by prolonging mean lifetime of prompt neutrons. The use thick (3-4 m) ^{208}Pb reflector in fast reactors can considerably prolong mean lifetime of prompt neutrons (on three orders of magnitude) that can substantially improve nuclear safety even if positive reactivity above $1 is inserted into the reactor core;

Such a drastic extension of mean prompt neutron lifetime is caused by the following effect. Fast neutrons from the reactor core penetrated deeply into ^{208}Pb reflector, multiple neutron-nucleus collisions slowed down these neutrons and they came back to the reactor core after an essential time delay (due to small absorption and effective albedo of ^{208}Pb). Since these returning neutrons, in the terms of their origin, are prompt neutrons, it can be spoken about the slowed progression of chain fission reaction on prompt neutrons.

This means, in its turn, that application of such a thick neutron reflector gives a new quality to the reactor – the larger fraction of delayed neutrons and, as a consequence, slowing down of chain fission reaction.

One else important circumstance consists in the following fact. The larger fraction of delayed neutrons depends mainly on neutron leakage from the reactor core and, thus, may be chosen as a developer wills, while fraction of nuclei-emitters of delayed neutrons may be chosen only within very stringent constraints. Evidently, generation rate of these "delayed" neutrons substantially depends on leakage rate of fast and resonance neutrons from the reactor core. That is why application of thick neutron reflector is a reasonable option not only for fast reactors but also for the reactors with resonance and even thermal spectra, i.e. for the reactors with significant leakage of fast and resonance neutrons from the reactor core.

Also studied affect of reflector with different isotope composition on fast reactor's neutron-physical behavior.

Obtained Dependencies of asymptotic power excursion period in the fast reactor with thick reflector on the inserted positive reactivity

Thereby use thick 208Pb reflector in fast reactors can improve safety of fast reactor.