A Proliferation-Resistant Lead-Cooled Reactor for Transmutation of TRU and LLFP

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Abstract

The transmutation of TRU and LLFP (Tc-99 and I-129) in a 900 MWth lead-cooled reactor has been studied based on a proliferation-resistant, practical fuel cycle. For a high-performance fast reactor core, we introduce a new fuel assembly design concept, where B4C burnable absorbers and neutron streaming tubes are adopted. It is shown that with the new fuel assembly design both the burnup reactivity swing and peak fast neutron fluence can be substantially reduced. In addition, the reactor core can be designed with single fuel enrichment. To investigate the thermal-hydraulic behavior of the fuel assembly, a subchannel analysis is performed for the peak power assembly. Also, a sensitivity study is performed for the uranium removal rate to identify its impacts on the TRU transmutation capability and core characteristics. Tc-99 and I-129 are transmuted in moderated assemblies loaded into the reflector zone. For an efficient transmutation of Tc-99 and I-129, a double-annular LLFP target enclosing a ZrH1.78 moderator is used. A balanced transmutation of TRU and LLFP can be done in a core and the transmutation rates of Tc-99 and I-129 are found out to be ~6.9 %/year and ~6.0%/year, respectively.