PHYSICS STUDY ON LEAD-MAGNESIUM-EUTECTIC-COOLED FAST REACTOR FOR TRU TRANSMUTATION

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Abstract

Lead-bismuth eutectic has been extensively studied due to its low melting temperature and Russian experience with nuclear submarine. It is well known that the LBE coolant is subject to several challenging technical problems such as material corrosion and Po-210 production. Consequently, a pure lead coolant is being paid some attention as an alternative coolant. The lead, however, has also a crucial drawback, i.e., a relatively high melting temperature (about 327 C) although the corrosion problem is a little mitigated and the Po-210 issue might be adequately addressed. In this paper, a new lead-alloy, Pb-17Mg eutectic (LME), has been evaluated from the reactor physics point of view for a TRU-loaded core. The LME has a melting temperature of about 249 C. It is expected that the coolant freezing issue would be significantly relaxed in an LME-cooled reactor. We have briefly addressed the material compatibility of LME, relative to lead, using open literature information.

A 900 MWth LME-cooled reactor has been considered to investigate the core characteristics. The core is comprised of ductless hexagonal fuel assemblies and the fuel is a metallic alloy of U-TRU-Zr. TRU materials are assumed to come from PWR spent fuels. Fuel recycling is performed based on a simple proliferation-resistant pyroprocessing, in which all the TRU elements flow in a single stream without any separation. Core properties are evaluated for an equilibrium cycle in terms of safety-related parameters and TRU transmutation performances, and they are compared with those of a lead-cooled core. As a design measure to reduce the burnup reactivity swing, a B4C burnable absorber is utilized in the LME-cooled reactor. All the neutronic analyses have been done with the REBUS-3/DIF3D code system and the ENDF-B/VI cross section data.