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Comparative analysis of minor actinides transmutation in a molten-salt burner reactor based on LiF-NaF-KF and LiF-BeF2 salts

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In Russia, research is actively underway to develop a specialized molten-salt burner reactor (MSR-burner) of minor actinides (MA) from spent nuclear fuel of power reactors. Two candidate fluoride salts, LiF-BeF2 [1] and LiF-NaF-KF, are considered as the solvent of the reactor fuel components.
The purpose of the present paper is to study MA transmutation in the MSR-burner based on selected salts in the equilibrium mode of reactor operation at different volumes of the core. The calculations were performed using PRIZMA+RISK software package developed at the "RFNC-VNIITF named after Academ. E.I. Zababakhin" [3,4].
The LiF-BeF2 salt has a low solubility limit of actinide fluorides, which leads to the need to feed the reactor with a significant amount of Pu and, consequently, to a low efficiency of MA transmutation. By reducing of volume of the active zone increases the consumption of Pu and reduces the efficiency of transmutation. In contrast to LiF-BeF2, LiF-NaF-KF eutectic is characterized by a relative high solubility of actinide fluorides. For a MSR-burner based on this salt, Pu is needed mainly for starting; in the equilibrium mode reactor consumes only MA. In this case, the maximum efficiency of MA transmutation can be achieved in a wide range of core volume: from 2 m3 to 30 m3 with a concentration of actinide fluorides from 17 to 10%, mol., respectively.

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[2] Lizin A.A., Tomilin S.V., Gnevashov O.E., et al. PuF3, AmF3, CeF3, and NdF3 solubility in LiF-NaF-KF melt. Atomic energy, 2013, v.115, No.1, p.11-16.
[3] Zatsepin O.V., Kandiev Ya.Z., Kashaeva E.A., et al. Calculation for the VVER-1000 core by the Monte-Carlo method implemented in the PRIZMA code. Voprosy atomnoy nauki i techniki. Serija: Jadernye konstanty, 2011, No.4, p.64-73.
[4] Modestov D.G. The RISK-2014 code to solve nuclear kinetics problems, RFNC-VNIITF preprint No.243, Snazhinsk, 2014.

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