

Transmutation efficiency of minor actinides in fast-and thermal-spectrum molten salt reactors

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Long-lived minor actinides (MA) like, Neptunium, Americium, and Curium are the major burden of nuclear power. Long-lived MAs have not yet been used as nuclear fuel. Therefore, the transmutation of long-lived MAs is introduced as an alternative to direct final disposal. In current work, we compare the performance of MA transmutation in a critical Single-fluid Double-zone Thorium-based Molten Salt Reactor (SD-TMSR) and a Small Molten Salt Fast Reactor (SMSFR). We study the dynamic of K_{eff} and core reactivity with different MA loads, shift of the neutron spectrum, time evolution of MA and basic nuclides inventory that affect the core stability, as well as the transmutation coefficient (TC). The TC of long-lived MA is calculated using the Monte Carlo code SERPENT-2. The total neutron flux in SD-TMSR and SMSFR can reach 4.1×10^{14} and 1.8×10^{15} n/cm²s, respectively. The results show that SD-TMSR consumes about 50% of the generated Pu isotopes in the fuel salt; however, SMSFR consumes about 86.5% of the generated Pu isotopes. During burnup, we apply online reprocessing and refueling, so the core remains critical, and the total mass of fuel in the core and blanket is practically constant. The results show that both reactors efficiently transmute ²³⁷Np, ²⁴¹Am, ²⁴³Am and ²⁴³Cm, while SMSFR has a higher TC than SD-TMSR. TC of total MA reaches 54.84% and 87.97% in SD-TMSR and SMSFR, respectively.

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