A Transition Cycle Strategy to Enhance Minor Actinide Burning Potential in the Pan-Shape LMR Core

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Abstract

This study summarizes the neutronic performances and fuel cycle behaviors of the pan-shape transuranic (TRU) burner core from the initial core through the end of a core life. The cycle-by-cycle evolution of isotopic compositions and neutronics characteristics are compared with those calculated from the analysis of an assumed equilibrium cycle. The amount of burnt TRU per cycle after Cycle 8 turned out to be comparable to that of the equilibrium cycle, while the isotopic compositions and the resulting neutronics performances up to about Cycle 20 have shown considerable deviations from those of the equilibrium cycle. The reference core in this analysis has been designed to meet a target sodium void reactivity at the end of the equilibrium cycle by reducing the active core height. Since the core isotopic loading approaches that of the equilibrium cycle after many cycles of operation, significant margins to the target sodium void reactivity are noted in the early cycles. This finding has led to the loading of concentrated minor actinides (MA) relative to the Pu isotopes in the first three cycles. Thereafter, they are homogeneously self-recycled with the external feed TRU makeup composed of typical LWR discharge TRU compositions. The transition cycle analysis with the higher MA loading reveals that the total MA consumed through 50 cycles of operation is 1.89 times larger than the case for the constant external feed makeup TRU with a typical LWR discharge compositions, without exceeding the sodium void reactivity observed in the equilibrium cycle.