

Study of Burnup Reactivity and Isotopic Inventories in REBUS Program

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Abstract

The REBUS program has a unique feature, that is, direct determination of the burnup reactivity of UO₂ and MOX fuel bundles, which were fabricated from irradiated fuel assemblies discharged from LWRs in Europe. The program consists of core physics experiment at a LWR critical test facility VENUS, nondestructive measurement of the burnups of irradiated fuel rods by gamma-ray spectroscopy, and radiochemical isotopic analysis of pellet samples. In the critical experiment, a core tank was loaded with a 27x27 square lattice core that consists of a 7x7 cell test bundle in the core center, and 3.3 and 4.0 wt% enriched UO₂ fuel rods surrounding the test bundle as a driver region. Five types of test bundles were included in the experiment: (1) fresh BR3 (PWR) MOX fuel, (2) irradiated BR3 MOX fuel, (3) irradiated BWR MOX fuel, (4) fresh PWR UO₂ fuel, and (5) irradiated PWR UO₂ fuel. While measured burnup reactivity values were well reproduced by core calculations, discrepancies between the calculated and measured inventories were observed for both irradiated UO₂ and MOX fuel. The present authors have indicated that the biases in inventory and reactivity calculations compensate each other, which makes the total biases of the burnup reactivity small for the BR3 MOX fuel. In the present study, the ratios of calculated to measured inventories (C/Es) for each nuclide were utilized to estimate probable inventories for the PWR UO₂ and BWR MOX fuel bundles, and burnup reactivity was analyzed with the probable inventories. From the results, the biases in inventory and reactivity calculations for burnup reactivity were discussed.