Design of MA-loaded core experiments using J-PARC

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Abstract

Research and development (R&D) for minor actinide (MA) transmutation technologies by using Fast Reactor (FR) and Accelerator Driven System (ADS) have been performed at Japan Atomic Energy Agency (JAEA). Improvement on the neutronic design accuracy of the MA-loaded core is one of the most important issues in the MA transmutation technology.

Uncertainties of the current MA nuclear data are larger than those of other major nuclides. Therefore, analyzed neutronic properties of MA-loaded FR and ADS have much larger design margins in comparison with those of conventional FR. To improve the reliability, safety and economical efficiency of these systems, it is required to increase the accuracy of the nuclear data of MA by the experimental data taken by adequate experimental conditions.

JAEA plans a construction of "TEF-P" (Transmutation Physics Experimental Facility) in the second phase of the "J-PARC" (Japan Proton Accelerator Research Complex) project. TEF-P is a plate-type fuelled critical assembly which is able to accept a proton beam (400MeV, 10W) delivered from a LINAC of J-PARC. Various experiments are available in a critical condition or a sub-critical state driven by spallation neutrons. Furthermore, the experiments using pin-type MA fuel, which must be handled with remote devices, are planned to simulate the MA-loaded systems.

In this study, sensitivity and error analyses were performed to specify the effects caused from the error of the MA nuclear data to the neutronic properties of MA-loaded FR and ADS. The sensitivity analysis result of SAGEP code with JENDL-3.3 library clarified that Np-237 and Am-241 give specific sensitivity to criticality, coolant void reactivity and Doppler reactivity. Using these sensitivity results, the error analyses were also performed based on the cross-section adjustment procedure. These analysis results showed that the errors caused by the nuclear data were improved by considering existing 233 integral data and 7 hypothetical results simulating TEF-P experiments. As a typical result, the errors (the confidence level is 1σ) for the coolant void reactivity were improved from 2.4% to 1.4% for MA-loaded FR and from 5.8% to 3.0% for ADS designed by JAEA.