Basic Research for Nuclear Transmutation Techniques by Accelerator-Driven System (4) Deterministic Method (III): PNS Analysis using Source Iteration Scheme with Adjoint Fluxes

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Abstract: For analyzing reactor kinetics in accelerator-driven system (ADS) at KUCA, a source iteration scheme is developed. Based on the scheme, a detector response as time in the KUCA core with the pulsed neutron source (PNS) is evaluated, and the results are compared with those of the experimental and MCNP results.

Keywords: Forward Adjoint Flux, Pulsed Neutron Source Method, Kinetic Analysis, Accelerator-Driven System, KUCA

1. Introduction

The point kinetics approximation is a representative method for analyzing the reactor transient. It is superior to calculation efficiency; however, it cannot analyze space-dependent reactor characteristics such as PNS analysis at KUCA. In this study, a kinetics method is proposed for obtaining accurate result of PNS histogram at KUCA ADS.

2. Methodology

For the analysis, the sources were classified into fission, delayed and external neutron sources; the sources were linked to each other by time-dependent adjoint fluxes, which are defined as the contribution rate to producing the neutron sources or detector responses having distribution as time. For effective analyses of reactor kinetics, an accelerated simulation method, which is point-wise treatment on geometry with conserving a shape function of source distribution, were also proposed. With the balance equation of neutron sources, the time-dependent neutron transients at a detector were estimated with the time-dependent adjoint flux.

3. Result and Discussion

A simulation code was developed by C++ program language based on the proposed method. The KUCA core with ADS in the subcritical state was selected, and it was divided into 5 x 5 x 5 local regions. The space-time dependent adjoint fluxes at each region were estimated by the MCNP6 [1] code with the ENDF/B-VII.0 cross section library [2]. The adjoint simulation with the MCNP code is not available for high energy neutrons; the forward adjoint flux, which is a result with the forward simulation scheme to acquire the adjoint flux, was evaluated to link the external source and fission sources. The PNS results estimated by the proposed method were generally in good agreement with those of experiment and MCNP for the ADS problem with high computational efficiency. It is expected that the proposed method will contribute an effective and accurate PNS analysis on ADS.

References

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