Perspective of the Accelerator-Driven System with High-Energy Protons in the Kyoto University Critical Assembly

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Abstract

At the Kyoto University Research Reactor Institute, the experimental study on the accelerator-driven system (ADS) is being conducted with the use of the Kyoto University Critical Assembly (KUCA) and the fixed-field alternating gradient (FFAG) accelerator. The spallation neutrons generated by 100 MeV proton beams from the FFAG accelerator have been successfully injected into not only the uranium-loaded core but also the thorium-loaded core. A series of the thorium-loaded ADS experiments has been carried out by varying the external neutron source (14 MeV neutrons and 100 MeV protons) and the neutron spectrum of the core with the combined use of fuel (highly-enriched uranium: HEU, natural uranium: NU and thorium: Th) and moderator (polyethylene, graphite, beryllium and aluminum). In the thorium-loaded ADS experiments, the reactor physics parameters have been successfully obtained, including the reaction rate distribution, the neutron decay constants, the neutron multiplication and the subcriticality, with the use of the thorium capture reactions in subcritical systems.

The reactor physics parameters in the subcritical systems, including the neutron multiplication M ($M=(F+S)/S$, F: fission neutrons and S: source neutrons) and the subcritical multiplication factor k_s ($k_s=F/(F+S)$), could be evaluated successively by the experimental and numerical (MCNPX) reaction rates of the indium wire and foil obtained in the core and the target, respectively, as well as in previous study on the Th-loaded ADS, with the variation of the subcriticality, the external neutron source and the neutron spectrum. Further, the benchmark experiments on the Th-loaded ADS are planned to be carried out to conduct the conversion analysis of ^{232}Th capture and ^{233}U fission reactions with the use of capture and fission ratio: ^{232}Th/^{238}U (NU) and ^{233}U/^{235}U (HEU), respectively, in case of the variation of the subcriticality, the external neutron source and the neutron spectrum.

The U-loaded ADS experiments could be also conducted in the subcritical core with harder spectrum than previous cores to examine the feasibility of the nuclear transmutation with the use of ADS, including the minor actinides (MAs: ^{237}Np and ^{241}Am). Additionally, as well as shown in the Th-loaded ADS experiments, another conversion analysis of ^{237}Np/^{238}U and ^{241}Am/^{235}U is expected to be carried out to investigate the MAs characteristics when the subcriticality, the neutron spectrum and the external neutron source are varied in the subcritical system.