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Feasibility of MA Transmutation by (MA, Zr)Hx in Radial Blanket Region of Fast Reactor and Plan of Technology Development

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This paper shows a feasibility study of transmuting minor-actinide (MA) by MA-zirconium hydride, (MA, Zr)Hx in radial blanket region of a fast reactor and a plan of technology development for the MA target. The feature of this concept is that it has a great potential of transmutation and can be used in proven fast reactors, but naturally requires research and development.

The proposed (MA, Zr)Hx subassembly concept can be realized that the ratio of hydrogen to MA is enough for neutron energy spectrum shift and the loaded weight of MA is also enough for enhancing the transmutation because it densely contains both of MA and hydrogen. Preliminarily the MA transmutation rates were compared about four types of MA target: MA-Zr alloy pin; (MA, Zr)Hx one; lightly and heavily moderated combinations of (MA, Zr)O2 and ZrH1.6 ones. It was assumed that they are loaded around an active core in a 280 MWe sodium-cooled reactor; 54 MA target assemblies are respectively arranged in the radial blanket zone. It was followed that the MA transmutation of (MA, Zr)Hx doubles or triples, compared with the other types.

One of the other issues is optimizing the irradiation condition and specification. Shorter terms from irradiation to acceptable decay heat for spent fuel storage, smaller power distortion of neighbor subassemblies, higher ratio of transmutation, and greater mass transmutation are preferable, but they are near incompatible. Therefore, the feasibility study is optimizing the irradiation condition and specification of the (MA, Zr)Hx target so as to harmonize the requirements.

We started to research and develop key technologies of this concept toward an innovative actinide fuel cycle, conducted as the nuclear system research and development program under the contract with MEXT and supported by Nuclear Safety Research Association in Japan. The items of R&D contains measurements of the physical properties of (MA, Zr)Hx, fabrication testing, and laboratory-scale reprocessing test of (MA, Zr)Hx samples. Pellets of MA hydride target will be fabricated by hydrogenating of MA-Zr alloys in a Sieverts system to produce homogenous mixed pellet without a crack. In the next phase, sample of (MA, Zr)H pellet will be irradiated in a fast reactor and their irradiation behavior are measured by post-irradiation tests. These R&Ds would create a practicable and effective strategy of MA transmutation.

Country/Int. Organization

Japan

Primary author: Dr IKEDA, Kazumi (Mitsubishi FBR Systems, Inc.)

Co-authors: Dr MIZUSAKO, Fumiki (Nippon Nuclear Fuel Development Co. Ltd.); Prof. MUTA, Hiroaki (Division of Sustainable Energy and Environmental Engineering, Graduate School of Engineering, Osaka University); Mr IKEDA, Kazuo (Nuclear Development Corporation); Prof. KUROSAKI, Ken (Division of Sustainable Energy and

Environmental Engineering, Graduate School of Engineering, Osaka University); Prof. KONASHI, Kenji (Institute for Materials Research, Tohoku University); Mr ITO, Kunihiro (Nuclear Development Corporation); Dr HIRAI, Mutsumi (Nippon Nuclear Fuel Development Co. Ltd.)

Presenter: Dr IKEDA, Kazumi (Mitsubishi FBR Systems, Inc.)

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