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Flow-sheet study of MA recovery by extraction chromatography for SmART cycle project

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Abstract

Optimization in a flow-sheet of the extraction chromatography process for minor actinides (MA(III); Am and Cm) recovery from high level liquid waste (HLLW) were carried out through batch-wise adsorption/elution experiments on diluted HLLW and column separation experiments on genuine HLLW. Separation experiments using CMPO/SiO_2-P and HDEHP/SiO_2-P adsorbent columns with an improved flow-sheet successfully achieved more than 70 % recovery yields of MA(III) with decontamination factors of Ln(III) > 10^3, and a modified flow-sheet for less contamination with fission products was proposed consequently. These results will contribute to MA(III) recovery operations for SmART Cycle project in Japan Atomic Energy Agency which is planned to demonstrate FR fuel cycle with more than 1g of Am.

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Keywords: Extraction chromatography; minor actinides; CMPO; HDEHP

1. Introduction

Japan Atomic Energy Agency is conducting the SmART (Small Amount of Reuse Fuel Test) Cycle project, which consists of recovering all actinides from MOX irradiated fuel, fabrication of MA (minor-actinices: Np, Am, Cm) -bearing MOX fuel and irradiation experiments, to demonstrate FR fuel cycle as shown in Fig. 1[1]. In this project, MA(III) (Am and Cm) are planned to be recovered by the extraction chromatography technology from the

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raffinate generated in U/Pu/Np co-extraction process. In the technology, MA(III) are recovered through extraction/back-extraction reactions inside the packed column with adsorbents. The adsorbent is prepared by impregnating an extractant into the support of porous silica particle coated with styrene-divinylbenzene polymer (referred as SiO_2-P)[2]. The project targets more than 1 g of Am recovery from the 4 Joyo irradiated fuel pins, and MOX fuel containing 5% Am will be fabricated.

MA(III) recovery and denitration of a product solution containing U, Pu, Np, Am and Cm will be carried out at Chemical Processing Facility (CPF) of Japan Atomic Energy Agency. The extraction chromatography experiments on genuine HLLW have been carried out in hot cells of CPF in our previous study[3], and a flow-sheet employing CMPO/SiO_2-P adsorbent for MA(III) + Ln(III) recovery and HDEHP/SiO_2-P adsorbent for MA(III)/Ln(III) separation must be promising though it requires some modifications to enhance the MA(III) recovery performance. In those experiments, MA(III) + Ln(III) recovery by the 1st column was successfully achieved, however MA(III) selective stripping from the 2nd column was poorer than expected. Consequently, selection of an appropriate eluent for MA(III) from HDEHP/SiO_2-P was revealed to be a main necessary improvements in the flow-sheet. Based on the previous data, optimization in pH of the current eluent is expected to enhance the selective MA(III) elution performance.

A microwave denitration apparatus is installed inside a glove box in CPF, and high decontamination factors of fission products are required to transport the product solution from hot cell to the glove box in the respect of radioactivity restriction of the glove box. Fission products such as ^{137}Cs and ^{90}Sr are easily decontaminated satisfactory by the 1st column, however decontamination of Ln(III) is one of the most difficult tasks. Amounts of Ln(III) have to be reduced to at least one-hundredth according to the radioactivity restriction, thus the eluent for the 2nd column should be attentively selected to accomplish the Ln(III) decontamination. At present, target decontamination factors for all fission products are set at 100 tentatively. The required recovery yields of Am for the SmART cycle project is more than 30 % considering losses at reprocessing and denitration processes, therefore targeted recovery yields of MA(III) in the extraction chromatography process are set at 50 %.

In this study, in advance with the actual MA (III) recovery operation, optimization in the flow-sheet of the extraction chromatography process through batch-wise adsorption/elution experiments and MA(III) recovery trials on the genuine HLLW using the modified flow-sheet were carried out to estimate the MA(III) recovery yield for the SmART cycle.

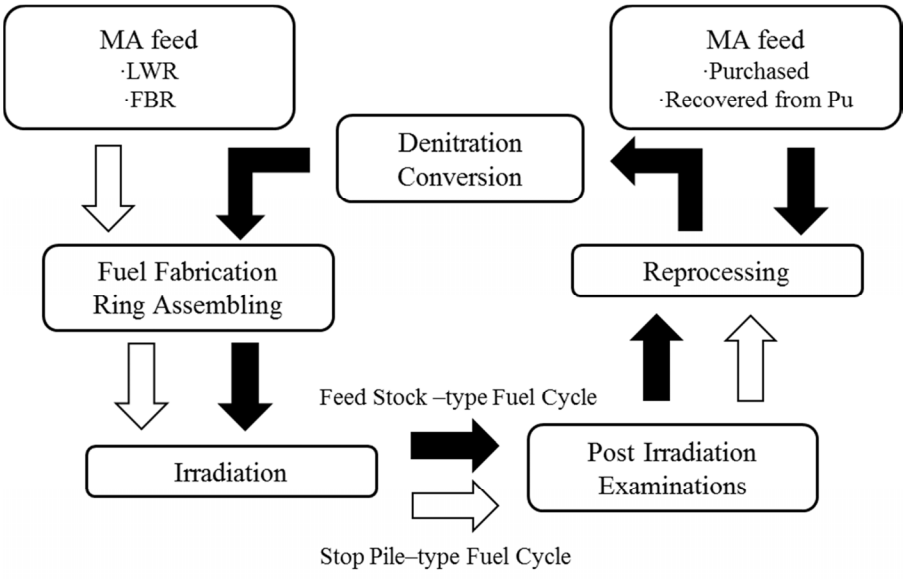

Fig. 1 Concept of the SmART Cycle project