ALPHA-RAY IRRADIATION ON ADSORBENTS OF EXTRACTION CHROMATOGRAPHY FOR MINOR ACTINIDE RECOVERY

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Abstract

Extraction chromatography technology is one of the promising methods to recover minor actinides (MA; Am and Cm) from spent FBR fuel, and Japan Atomic Energy Agency has been conducting R&D study for the implementation. In order to design operational condition and frequency of adsorbents exchange, durability of the adsorbents is indispensable information. Although effects of γ-ray irradiation and exposure to acid on adsorption/elution performances of the adsorbents have been investigated so far, resistance against α-ray irradiation has not been reported yet. In this study, α-ray irradiation experiments on the representative adsorbents for the extraction chromatography process (CMPO/SiO_2-P, TODGA/SiO_2-P, HDEHP/SiO_2-P and isoHex-BTP/SiO_2-P) were carried out and influences of alpha-ray irradiation on fundamental characteristics of the adsorbents were investigated.

Nitric acid solutions containing ^{241}Am with 1.0 ~ 10 mM was prepared as α-ray sources. 0.5 g of the adsorbent was contacted with 10 mL of the source solution and was shaken for 3 hours to adsorb ^{241}Am onto the adsorbents. The ^{241}Am bearing particles were left for a certain period to irradiate with the α-ray. After the irradiation, ^{241}Am was desorbed by contacting the adsorbent with eluents. Batch adsorption/elution experiments using the irradiated adsorbents were carried out to evaluate influences of α-ray irradiation on distribution coefficients and desorption ratio. DG/DTA analysis on the α-ray irradiated adsorbents was also carried out to examine a possibility of hazardous reaction due to the formation of radiolysis products.

For all adsorbents, distribution coefficients and desorption ratios of ^{241}Am decreased with increasing the radiation dose, where the radiation dose was calculated from the amount of ^{241}Am adsorbed with an assumption of that α-ray energy from ^{241}Am (E = 5.5 MeV, Half life = 432.2 y) is completely transferred to the adsorbent. Those decreases in the performances must be corresponding to degradations of extractants impregnated in the adsorbents and of polymers supporting the extractants. Comparing the influences of α-ray with γ-ray on those properties under the same radiation doses condition, radiation damages suffer from the α-ray irradiations are less significant for all the adsorbents. Difference between a charged particle and γ-ray is considered to cause the different interaction between the system (adsorbents with nitric acid) and the radiations. Detailed mechanisms of the radiolytic degradations will be discussed in the presentation.

Distinct exothermic peaks were not observed at under 100°C in the DTA curves. In the extraction chromatography system, temperature of the system is controlled at less than 100°C to prevent from boiling the mobile phase. Therefore, degradation which is suspected to lead abnormal events such as fire or explosion will not be anticipated for the use of the adsorbents.