8–3 Developing Rapid Method to Analyze Radioactive Waste

— Developing Method to Analyze ^{242m}Am in Low-Level Radioactive Waste —

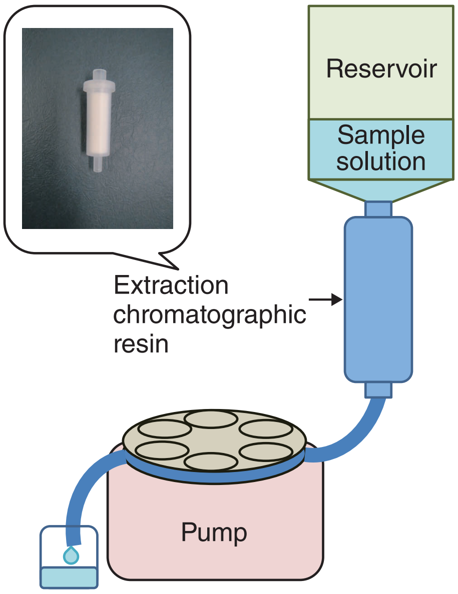

Fig.8-9 System of extraction chromatography
A cartridge-type of extraction chromatographic resin was used. Solution in a reservoir is pumped from downstream into the cartridge.

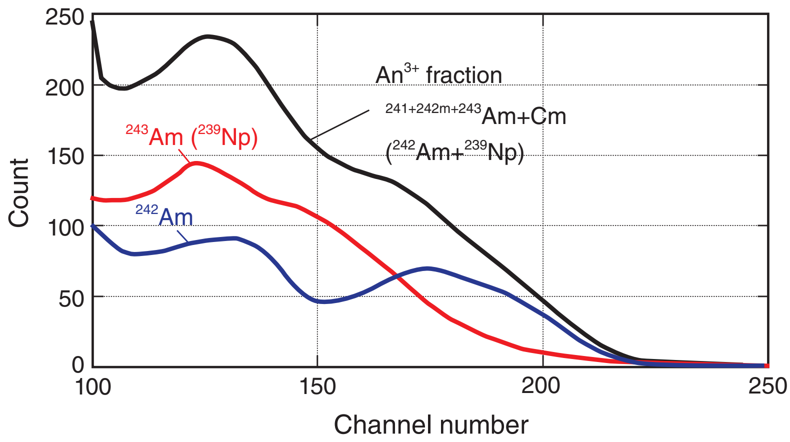

Fig.8-10 *β*-ray spectrum of ^{242}Am and so on
An^{3+} fraction contains $^{241+242m+243}$Am and Cm, and *β*-ray spectrum of ^{242}Am and ^{239}Np, which are progeny nuclides of ^{242m}Am and ^{243}Am, respectively is obtained. ^{243}Am source was prepared to estimate *β*-ray spectrum derived from ^{239}Np, which was subtracted from the spectrum of the An^{3+} fraction to obtain the *β*-ray spectrum of ^{242}Am.

The radioactive inventory of low-level radioactive waste (LLW) must be evaluated to dispose of LLW. However, some nuclides that are important for safety are difficult to analyze, such as americium-242m (^{242m}Am). Thermal ionization mass spectrometry (TIMS) is a conventional method to determine the content of ^{242m}Am. ^{242m}Am can also be analyzed by *α*-ray of curium-242 (^{242}Cm), which is the progeny nuclide of ^{242m}Am (^{242}Cm method). Although the TIMS measuring time is short, more sample is required than for ^{242}Cm method. However, less sample is available for the ^{242}Cm method, it takes several months to determine the ^{242m}Am content. In addition, both methods require separation of Am from Cm.

In the present study, we developed a new method to determine the ^{242m}Am content that involves measuring *β*-ray emission from ^{242}Am, which is the progeny nuclide of ^{242m}Am. To measure *β*-rays from ^{242}Am, Am must be separated from *β*-ray emitting nuclides in LLW. Therefore, we used a separation method based on extraction chromatography (Fig.8-9). First, trivalent actinides (An^{3+}) and lanthanides (Ln^{3+}) were separated from the major elements in LLW by using transuranic resin (Eichrom Technologies), which has selectivity for transuranic elements. Next, An^{3+} was separated from Ln^{3+}, which has similar chemical properties and contains some *β*-ray emitting nuclides, by using a tetravalent actinide resin (Eichrom Technologies). This An^{3+} fraction contains Cm, but the influence of Cm on the *β*-ray measurement can be subtracted because there is no *β*-ray emitting Cm in LLW. Conversely, *β*-rays from neptunium-239 (^{239}Np), which is a progeny nuclide of ^{243}Am, have to be detected and considered. Therefore, a ^{243}Am source was prepared to measure *β*-ray spectra of ^{239}Np, which were subtracted from those of An^{3+} to obtain the radioactivity of ^{242}Am (Fig.8-10). As a verification, the value obtained was compared with that determined by the ^{242}Cm method.

The separation step in the new method to determine the radioactivity of ^{242}Am is simpler than that for the TIMS and ^{242}Cm methods. Less sample is required by this new method than by the TIMS method and is comparable to that required by the ^{242}Cm method. The measuring time for this new method is considerably shorter than that for the ^{242}Cm method.

Reference

Shimada, A. et al., A New Method to Analyze ^{242m}Am in Low-Level Radioactive Waste Based on Extraction Chromatography and *β*-ray Spectrometry, Analytical Chemistry, vol.85, no.16, 2013, p.7726-7731.