1-16 Development of Multi-Functional Reprocessing and Utilization of Separated Elements
—Establishment of Advanced Separation Process Using Pyridine Resin—

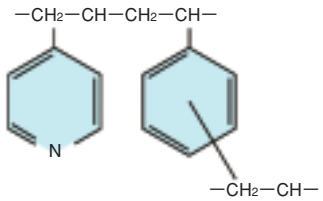

Fig.1-39 Basic structure of tertiary pyridine resin
Two types of resins, gelated-type by suspension polymerization and porous-type supported by silica beads (60 μm), were used in this study.

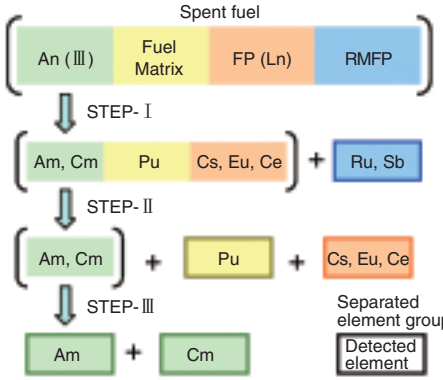

Fig.1-40 Outline of separation process
Three step separation process for each element group.

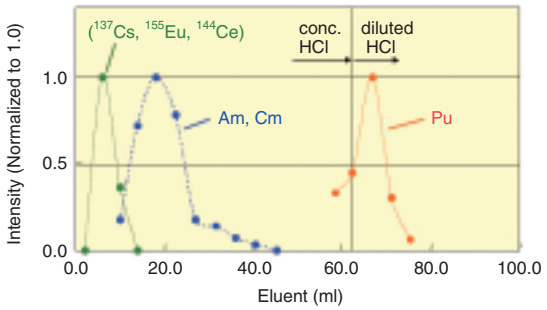

Fig.1-41 Chromatogram of STEP-Ⅱ separation process
Separation of FP(Ln), An(Ⅲ), and fuel (Pu) groups demonstrated.

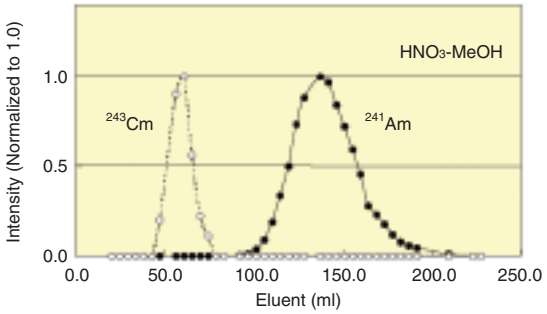

Fig.1-42 Chromatogram of STEP-Ⅲ separation process
Separation of Am and Cm demonstrated.

A separation process concept utilizing tertiary pyridine resin was applied to the separation of rare metal fission products (RMFP), trivalent lanthanides (Ln(Ⅲ)), trivalent actinides (An(Ⅲ)) and plutonium (Pu) in mixed oxide (MOX) fuel irradiated at "JOYO". Further, the mutual separation of americium (Am) and curium (Cm) was performed successfully. The study was carried out with Tokyo Institute of Technology.

The resin has the functions of a weakly basic anion-exchanger and a nitrogen soft donor ligand, and is a salt-free CHON compounds (Fig.1-39).

The separation process (Fig.1-40) can be divided as follows:

STEP-Ⅰ : Platinum group elements separation (pre-filtration)

STEP-Ⅱ : Separation of Ln(Ⅲ) and other FP, An(Ⅲ), and Pu

STEP-Ⅲ : Separation of Am and Cm

Firstly, a 85 μg HCl solution of MOX with high burnup of 140 GWd/MTM was introduced to the separation process.

STEP-Ⅰ Antimony-125 and RMFP, mainly ^{106}Ru in present experiment, were perfectly adsorbed in the resin. STEP-Ⅱ The solvent was changed to conc. HCl solution, and passed through the resin embedded in silica beads. The Ln (Ⅲ) including the other FP, such as ^{155}Eu, ^{144}Ce, and ^{137}Cs, were separated. Accordingly An(Ⅲ) were separated. After the removal of An(Ⅲ), the effluent was changed to diluted HCl to strip out Pu fraction from the resin. (Fig.1-41) STEP-Ⅲ An(Ⅲ) solution was changed to nitric acid-methanol mixed solution, and passed through the resin, separating Am and Cm. (Fig.1-42)

The recovery of ^{241}Am was more than 95% in this experiment. The Decontamination Factors (DFs) of ^{137}Cs and ^{155}Eu in the isolated Am-fraction exceeded 3.9×10^{4} and 1.0×10^{5}, respectively. The DF of ^{243}Cm from ^{241}Am was more than 2.2×10^{3}. This DF of An(Ⅲ) is higher than ever achieved. These results proved that a simplified separation process can be used in the advanced ORIENT multifunction cycle with enhanced separation, transmutation and utilization of spent fuel.

Reference

Koyama, S. et al., Development of Multi-functional Reprocessing Process based on Ion-exchange Method by Using Tertiary Pyridine-type Resin, Journal of Nuclear Science and Technology, vol.43, no.6, 2006, p.681-689.