11-3 Analytical Techniques for Radioactive Nuclides in Wastes Generated from Research Facilities

—Guidelines for a Simple and Rapid Determination Method for Waste Samples—

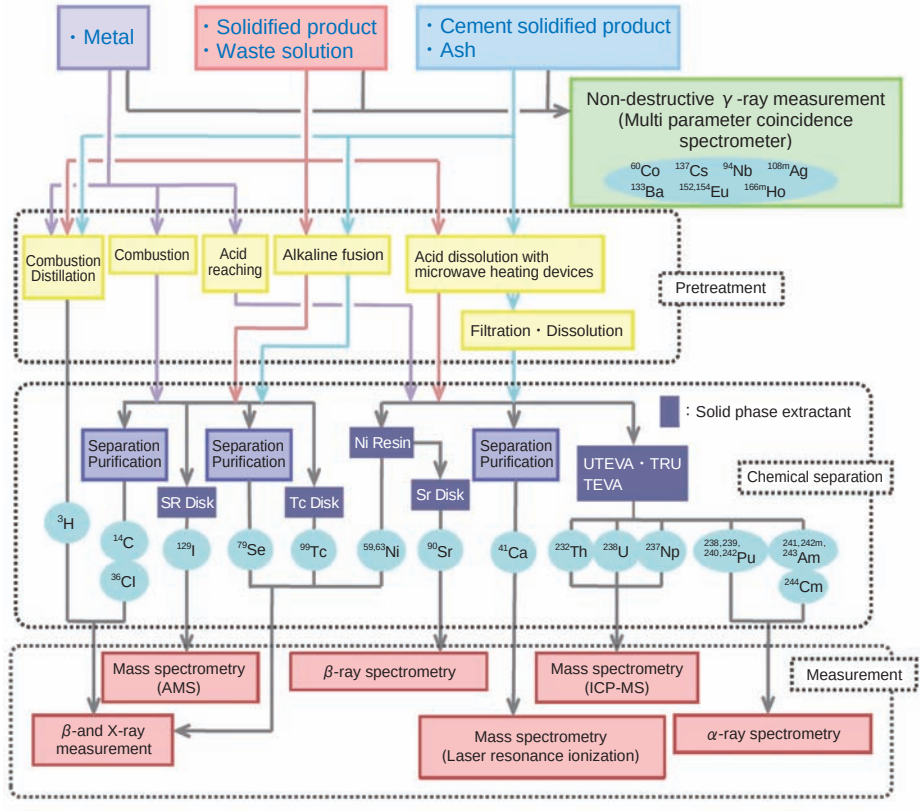

Fig.11-6 Basic radioactive waste sample analysis flow
First, the properties of radioactive waste samples are determined by a non-destructive γ-ray measurement. According to the properties of the radioactive nuclides, the samples are pre-treated by combustion, acid reaching, alkali fusion, or dissolution assisted by microwave heating. α- and β-ray emitting nuclides are separated by a Solid Phase Extraction (SPE) method and subsequently measured.

Fig.11-7 Multi parameter coincidence spectrometer
This spectrometer allows very low concentrations of nuclides in the presence of high concentrations of ^{60}Co to be detected by reducing background counts resulting from Compton scattering.

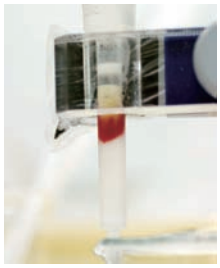

Fig.11-8 Separation of radioactive nuclides by SPE
To expedite the process of chemical separation and reduce secondary wastes, SPE resins are applied to the separation of $\alpha \cdot \beta \cdot$X-ray emitting nuclides. This picture shows that Ni is extracted by SPE resin in the red colored region.

For proper disposal of radioactive waste packages generated from various research facilities, an evaluation of radioactivity inventories in the waste packages is indispensable. In order to establish a practical and reliable estimation method for radioactivity inventories, we need to accumulate data concerning radioactivity concentrations in radioactive wastes. A total of twenty-nine nuclides (Fig.11-6) were selected as objects of analysis from preliminary safety assessment for disposal of the wastes. With conventional analytical methods, major problems in analyses of a large number of waste samples are that tedious and time-consuming pretreatment and chemical separation are needed. Therefore, we prepared a basic analytical flow and also developed constituent techniques which allow rapid analysis (Fig.11-6).

In nondestructive γ-ray measurement, a multi parameter coincidence spectrometer which consists of four Germanium detectors has been applied to increase counting efficiency. As a result, chemical separations for these γ-ray emitting nuclides are no longer needed (Fig.11-7). In order to dissolve a sample of solidified product, which is hard to dissolve by a conventional method, a new dissolution method using microwave heating devices and sealed vessels has been developed. Application of a Solid Phase Extraction (SPE) method for chemical separation of $\alpha \cdot \beta \cdot$X-ray emitting nuclides instead of solvent extraction has resulted in rapid separation and reduced secondary waste such as spent solvent (Fig.11-8). In addition to this, a new time of flight mass spectrometer based on resonance ionization and deflection by a rotating electric field has been also developed. Using these techniques, the time for the analysis of the objective nuclides has been shortened to less than one-third of conventional methods.

Based on these results, we expect that more radioactivity data for the wastes than is presently available will be effectively collected using these analytical techniques.

Reference

Kameo, Y. et al, Simple and Rapid Determination Methods for Low-Level Radioactive Wastes Generated from Nuclear Research Facilities (Guidelines for Determination of Radioactive Waste Samples), JAEA-Technology 2009-051, 2009, 81p. (in Japanese).