8–2 Radioactivity-Confirmation Method for the Disposal of Low-Level Waste

— Evaluation Method to Determine the Radioactivity Concentration in Radioactive Waste Generated from Post-Irradiation Examination Facilities —

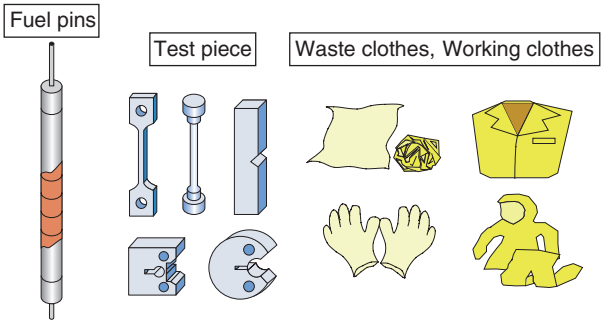

Fig.8-6 Example of waste generated from post-irradiation examination facilities
Irradiation fuel, materials irradiated in a nuclear reactor, waste, and working clothes used in examinations were selected as sample materials.

Fig.8-7 Sample of combustible wastes
Rubber gloves were gathered as a waste sample from waste housed in containers.

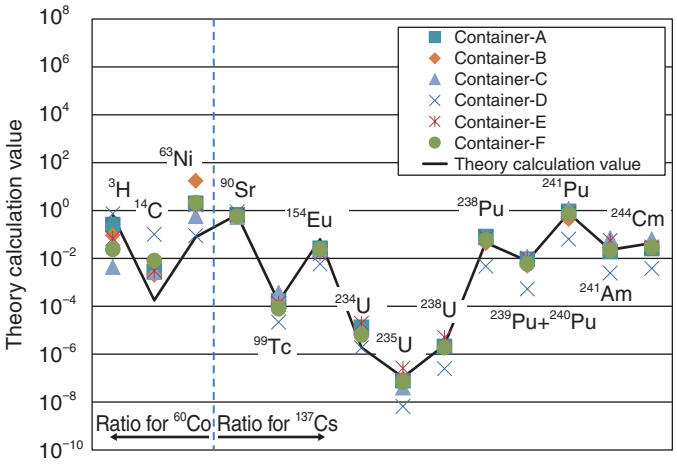

Fig.8-8 Comparison of the nuclide-composition ratios of analytical and theoretically calculated values
For ^{90}Sr, ^{99}Tc, ^{154}Eu, ^{234}U, ^{235}U, ^{238}U, ^{238}Pu, ^{239}Pu+^{240}Pu, ^{241}Pu, ^{241}Am, and ^{244}Cm, the analytical value of the nuclide-composition ratio accorded with that obtained by theory. Differences were seen in the ratios of ^{14}C and ^{63}Ni; this suggests that considering the contribution of radioactive cladding in a refrigerant and the influence of different elementary compositions of materials is necessary. Each waste sample taken from a container A–F comprised polluted waste from one type of irradiation fuel or irradiated material. The theoretical nuclide-composition ratio was determined by burn-up calculation.

A technique for evaluating the radioactivity concentration must be developed to enable the disposal of waste products generated from research, industrial, and medical facilities. The waste generated from post-irradiation-examination (PIE) facilities (Fig.8-6) includes a large number of radionuclides from irradiation fuel and materials irradiated in a nuclear reactor. Therefore, establishing methods to reasonably confirm these nuclides is necessary. We calculated the radioactivity-concentration ratio (nuclide-composition ratio) of nuclides in irradiation fuel and irradiated materials based on burn-up calculations; we also devised a method for evaluating the radioactivity of waste using this nuclide-composition ratio. In this study, the analytical nuclide-composition-ratio value was considered against the value theoretically calculated.

Seventeen nuclides (^{3}H, ^{14}C, ^{60}Co, ^{63}Ni, ^{90}Sr, ^{99}Tc, ^{137}Cs, ^{154}Eu, ^{234}U, ^{235}U, ^{238}U, ^{238}Pu, ^{239}Pu, ^{240}Pu, ^{241}Pu, ^{241}Am, and ^{244}Cm) were selected as evaluation-target-candidate nuclides for the burial disposal of radioactive waste of PIE facilities in this study. For such nuclides, the nuclide-composition ratio for ^{60}Co or ^{137}Cs was calculated based on the result of chemical analysis of a sample of combustible wastes (Fig.8-7) generated from PIE facilities. On the other hand, the theoretical nuclide-composition ratio using the burn-up calculation was determined based on the irradiation condition of the materials in question.

It was observed that the theoretical nuclide-composition ratios of ^{90}Sr, ^{99}Tc, ^{154}Eu, ^{234}U, ^{235}U, ^{238}U, ^{238}Pu, ^{239}Pu+^{240}Pu, ^{241}Pu, ^{241}Am, and ^{244}Cm occurring in the fuel agreed well with their analytical values (Fig.8-8). On the contrary, for ^{14}C and ^{63}Ni, which were corrosion products of materials, a difference was seen between the analytical and experimental nuclide-composition ratios. We believe that this result suggests the necessity of considering the contribution of radioactive cladding in a refrigerant and the influence of differences in the elementary compositions of materials.

We are presently examining the influence of the above factors upon the nuclide composition of irradiation fuel and irradiated materials with the aim of improving this method.

Reference

Tsuji, T. et al., Study on the Evaluation Method to Determine the Radioactivity Concentration in Radioactive Waste Generated from Post-Irradiation Examination Facilities – Part 2 –, JAEA-Technology 2017-010, 2017, 75p. (in Japanese).