1–7 Estimation of the Amount of Radioactivity in Water-Treatment Waste
— Calculation of Radionuclide Concentration in Contaminated Water —

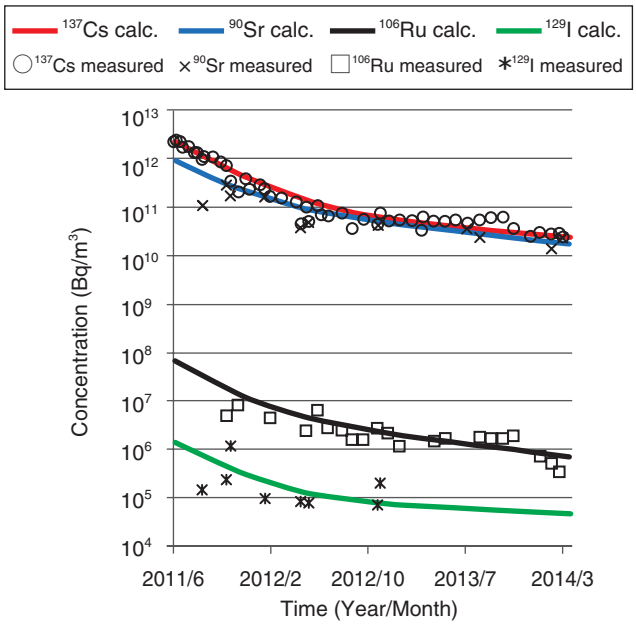

Fig.1-13 Time dependence of the radionuclide concentration in contaminated water
The high initial concentration of radioactivity decreased due to dilution by a continuous cooling water supply. Since middle of 2012, this decrease in concentration has slowed down, suggesting that radionuclides are released from the fuel debris continuously. Lines indicate calculation results with the analytical data.

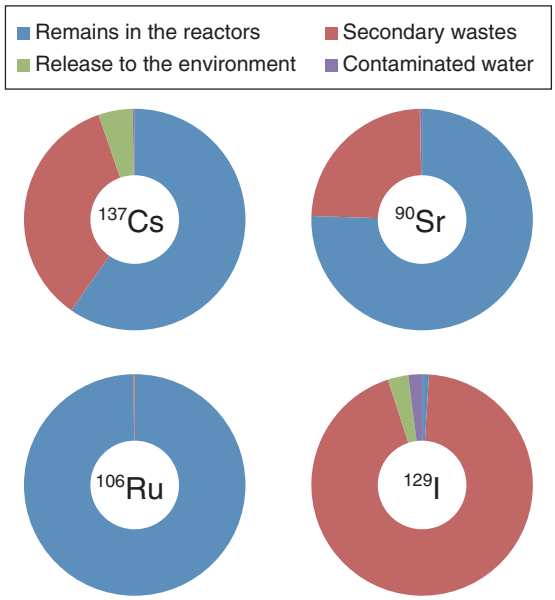

Fig.1-14 Estimated fractions of the inventory of ^{137}Cs, ^{90}Sr, ^{106}Ru, and ^{129}I on 13 March 2014, when water-treatment-system operation commenced
When the total radioactive inventories of the three reactors just before the accident were at 100%, the inventories of secondary wastes from the water-treatment systems were at approximately 35% for ^{137}Cs, approximately 24% for ^{90}Sr, less than 1% for ^{106}Ru, and approximately 94% for ^{129}I. This indicates some differences between radionuclides.

At the TEPCO's Fukushima Daiichi NPS (1F), a water-treatment system consisting of cesium (Cs)-adsorption devices and other components is being operated to remove radionuclides from the contaminated water. Some secondary wastes, such as sludge and spent adsorbents, are generated from water treatment. These wastes have never been generated in normal operation of the NPS; therefore, investigating new methodologies for their storage, processing, and disposal is necessary. To establish such methodologies, waste composition and radioactive inventory are essential information.

The cooling water for the damaged fuels in 1F1, 1F2, and 1F3 is routed from the reactor buildings by way of turbine buildings to the Centralized Radiation Waste Treatment Facility, and fed to the water-treatment system. The radionuclide concentration in this contaminated water, as fed to Cs-adsorption devices, is useful for estimating the total amount of radioactivity in the waste from the water-treatment system.

^{134}Cs and ^{137}Cs concentrations in the contaminated water are so high that it is rather easy to estimate the ^{134}Cs and ^{137}Cs inventories. On the contrary, few data are available for the other radionuclides due to low concentrations of radioactivity or a lot of time and effort being necessary for analysis. A calculation model has therefore been developed to estimate the concentrations of various nuclides in the contaminated water.

Since the ^{137}Cs concentration initially decreased at a constant rate with this decrease slowing after the middle of 2012, the calculation model assumes two source terms for radionuclides; the initial release and the continuous release of radioactivity to the cooling water. The concentrations of some nuclides including ^{90}Sr, ^{106}Ru, and ^{129}I were calculated by an equation derived from fitting with the analytical data (Fig.1-13).

Differences in radionuclide behavior were observed; for example, the initial concentration of ^{90}Sr was lower than that of ^{137}Cs, although the concentrations of both nuclides became gradually closer owing to similar continuous release rates. The ^{106}Ru concentration remained at a low value because both the initial concentration and continuous release of ^{106}Ru are relatively low.

The radionuclide inventories in the secondary wastes from the water-treatment system and the inventories of remains in the reactors were estimated with the calculated concentrations (Fig.1-14). The fractions of ^{137}Cs and ^{129}I, which are volatile and water-soluble, were indicated to be greater in the secondary wastes. Conversely, insoluble elements like Ru were suggested to mostly remain in the reactors.

Reference
Shibata, A. et al., Estimation of the Inventory of the Radioactive Wastes in Fukushima Daiichi NPS with a Radionuclide Transport Model in the Contaminated Water, Journal of Nuclear Science and Technology, vol.53, issue 12, 2016, p.1933–1942.