Radioactive waste from activated reactor core internals is classified as relatively higher radioactive waste, which is a category of low-level waste. As these wastes contain long-lived radionuclides and must be kept away from the biosphere long-term, it is planned to be disposed of underground in Japan. Safety assessments of radioactive waste disposal must analyze the migration of radionuclides from the solid phase to that in solution; the higher the ratio of the concentration of Nb adsorbed on the solid phase to that in solution, the higher the sorption property.

**Niobium-94** ($^{94}$Nb) is a long-lived radionuclide (half-life: 20,300 y) contained in the wastes of reactor core internals and important in the safety assessment of waste disposal because of its contribution to radiation doses. However, a reliable model must be developed to estimate the sorption properties of radionuclides onto rock-forming minerals.

Niobium-94 ($^{94}$Nb) is expected to be slowed by sorption onto rock-forming minerals. This process is affected by coexisting ions in groundwater, the compositions which may change according to the long-term disposal environment. Therefore, a reliable model must be developed to estimate the sorption properties of radionuclides onto rock-forming minerals.

The proposed sorption model includes the aqueous species (CaNb(OH)$_6$), which was confirmed to form in the solubility experiments in addition to aqueous Nb(OH)$_5^-$, aqueous Nb(OH)$_5^-$, and surface COaNb(OH)$_6$ (surf_OCaNb(OH)$_6$).

This divergence was resolved by assuming the existence of Nb complexes with OH$^-$ and Ca$^{2+}$ (Ca-Nb-OH complex), which had not been considered before. In order to confirm the formation of aqueous Ca-Nb-OH complexes, solubility experiments of Nb were performed under various Ca concentrations and pH. The experimental results showed that CaNb(OH)$_5^-$ was formed as the dominant aqueous species, in addition to Nb(OH)$_5^-$ and Nb(OH)$_7^{2-}$. Additionally, Ca-Nb-OH complexes containing surface OH groups (surf_OH) were assumed to be formed and followed the sorption reaction: surf_O$^-$ + CaNb(OH)$_5^-$ = surf_OCaNb(OH)$_6$.

The proposed model deals with Ca-Nb-OH complexes, which can be explained by the previous model, as shown in Fig.2-18. The sorption distribution coefficient is the ratio of the concentration of Nb adsorbed on the solid phase to that in solution; the higher the value, the higher the sorption property.

The results of this study will be used as a scientific basis for highly reliable evaluation of the sorption property of $^{94}$Nb to rock in the future disposal of the wastes from reactor core internals.

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**Reference**