

Adsorption and co-precipitation behavior of Cs in calcium and potassium silicate hydrate and Cs leaching behavior during their alteration process

*Kazuma Kuroda¹, Kanako Toda¹, Yutaro Kobayashi¹, Tsutomu Sato², Tsubasa Otake²

1. Graduate school of Engineering, Hokkaido University, 2. Faculty of Engineering, Hokkaido University

After the accident at the Fukushima Daiichi Nuclear Power plant (FDNPP), contaminated water, containing radioactive cesium (Cs) and other radioactive nuclides, has been continuously generated. Zeolite is used as the adsorbent for Cs ion in contaminated water and spent zeolite is planned to be solidified for the safe disposal. Glass and cement have been proposed for solidifying binder, but they have some disadvantages. Recently, geopolymer is considered as the binder which has potentials to solve these disadvantages for the safe disposal for spent zeolite. Geopolymer has an advantage for solidifying binder that primary phases such as calcium silicate hydrate (C-S-H) and potassium silicate hydrate (K-S-H) as adsorbents of radioactive nuclides. We can target the desired primary phases by changing the type and/or ratio of the starting materials. However, there are only few data related to the alteration of the primary C-S-H and K-S-H, and Cs leaching during their alteration in disposal conditions. Further, the adsorption behavior of Cs by K-S-H has not been fully understood. In this context, the objective of this study is to clarify Cs adsorption and co-precipitation behavior by C-S-H and K-S-H, and Cs the leaching behavior during alteration of C-S-H and K-S-H.

In this study, C-S-H and K-S-H were synthesized prior to the experiments. Synthetic method for K-S-H is not clarify. Therefore, metakaolin, calcined kaolinite and water glass are reacted and use it as K-A-S-H because it includes aluminum from metakaolin. From adsorption and co-precipitation experiments, it is obtained that both of C-S-H and K-A-S-H have Cs sorption capacity. About C-S-H, sorption ratio is increased by the decreasing of Ca/Si ratio, and adsorption and co-precipitation ratio are almost same in each Ca/Si ratio. These results are consistent with the previous study. Comparing C-S-H and K-A-S-H, K-A-S-H can sorb high amounts of Cs than C-S-H. The reason of this is considered that the ionic radius of Cs is similar to K than Ca.

From alteration experiment, we can't see the alteration of C-S-H and K-A-S-H during the reaction period of this study from analysis of solid samples. However, from leaching experiment in deionized water and sea water, a part of adsorbed Cs leach within 1 months. This would be caused by ion exchanging. Comparing C-S-H and K-A-S-H, the leaching ratio of K-A-S-H is lower than it of C-S-H. However, the both of them are considered to not be able to keep Cs for long term because Cs are exchange with cation in solvent. However, C-S-H and K-A-S-H are metastable and they have possibility to incorporate Cs into the structure of stable mineral during alteration. It is therefore important to clarify behavior of Cs during the alteration.

Keywords: Geopolymer, Cesium, Adsorption, Co-precipitation, Leaching behavior