Alkaline-activated metakaolin solidification of iodine sorbed by layered double hydroxides

TOSHIHIKO OHNUKI[1], NAOFUMI KOZAI[2], KAZUYA TANAKA[2], KOHEI TOKUNAGA[2], SATOSHI UTSUNOMIYA[3], RYOHEI IKEHARA[3], TATSUKI KOMIYA[3], AYAKA TAKEDA[3], DANIEL I. KAPLAN[4], PETER SANTSCHI[5]

[1]LANE, IIR, Tokyo Institute of Technology, Tokyo 152-8550, Japan (toshi.ohnuki@lane.iir.titech.ac.jp)
[2]Advanced Science Research Center, Japan Atomic Energy Agency, Tokai, Ibaraki, 319-1195, Japan.
[3] Department of Chemistry, Kyushu University, 744 Motooka, Nishi-ku, Fukuoka-shi, 819-0395 Japan
[4] Environmental Biogeochemistry & Technology, Savannah River National Laboratory, Aiken, SC, 29808, USA
[5] Laboratory for Oceanographic and Environmental Research, Texas A&M University, Galveston, TX 77553, USA

After the Fukushima nuclear power plant accident, radionuclides containing fission products were released from the fuel debris into the cooling water. Treatment of the contaminated cooling water by the Advanced Liquid Processing System (ALPS) facility removed most of the cationic fission products by sorption and/or co-precipitation. However, removal of anionic fission products from the cooling water remains a technical challenge. Especially problematic is iodine-129, which has a high toxicity and an extremely long half-life (16M years), and commonly exists as multiple species, iodide (I^-), iodate (IO_3^-), and/or organo-iodine (org-I). Thus, sorption and solidification of I-129 should be studied by controlling chemical species.

Here we report the sorption behaviors of IO_3^- and I^- on calcined hydrotalcite (CHT) and the solidification of the IO_3^- or I^- sorbed CHT with a geopolymer formed by alkaline-activation of metakaolin (AAMK). We measured distribution coefficients, $[I_{solid}]/[I_{aq}]$, by CHT, leaching behavior from the AAMK into a distilled water and into a sea water. We analyzed chemical species of I in CHT and AAMK by XANES using synchrotron X-ray, and position of I and chemical components present with I in CHT and AAMK were analyzed by SEM.

Sorption of IO_3^- and I^- by CHT showed the distribution coefficients for IO_3^- were higher than for I^-. XANES analysis showed that the CHT-sorbed IO_3^- and I^- did not change speciation after solidified with AAMK. SEM analysis of AAMK showed that the I was co-located with CHT. These results indicate that IO_3^- and I^- were recovered from the waste water by CHT and remained associated with the CHT after solidification within the AAMK geopolymer.