

The Effect of Structural Interaction of Radionuclides and Sodium Alkalinized Metakaolin-Based Geopolymer

*Anil Can YILDIRIM¹, Kanako TODA¹ Takumi SAITO¹

¹The University of Tokyo

Geopolymer (GP) is a group of newly derived inorganic barrier materials for the stabilization of radioactive wastes. In this study, the leaching behaviors of different metal ions from the sodium alkalinized metakaolin based geopolymer (Na-MKGP) have been studied under different aquatic conditions, and the results are discussed through the structural participation of metal ions in the Na-MKGP matrix.

Keywords: Metakaolin, Geopolymer, Leaching, Seawater, Metal Ions

1. Introduction

Geopolymers (GP) consisting of networks of inorganic chains take attention at the nuclear industry by their superior properties on metal ion immobilization [1]. Therefore, leaching studies also become an interest of study, where cumulative leaching and leaching fractions of radionuclides are investigated and compared with other binder materials such as cement. However, effects of the metal ions to the structures of GPs and their relation to leaching remain unclear. Therefore, in this study, the leaching of various ions from Na-MKGP are studied as a function of time and aqueous phase conditions and leaching behaviors discussed in terms of the structural changes of Na-MKGP

2. Experimental

To create the metal bearing Na-MKGP specimens, firstly alkaline solutions were created by mixing adequate amounts of NaOH, Sodium Silicate (*Kishida Chem.*) together with for 2 to 3 hours. Later, measured amounts of metakaolin (*Imerys, Agrical M1000*) were added to the alkaline solutions, which were mixed sufficiently for 10 minutes by hand. After that, 10 gr of viscous GP were transferred to plastic flasks by weighting, then quickly aqueous metal ion solutions were added individually and mixed another 10 min to provide homogeneity. Followingly, ion bearing GPs were moved to the PFA molds and cured under humidified environment for a week. Finally, the specimens were put into distilled water system (DWS), artificial ground water system (GWS) and sea water system (SWS) to conduct the leaching experiment through the IAEA standard [2]. Liquid samples have been taken for a month period and measured with an inductively coupled plasma mass spectrometer (ICP-MS, Agilent 7500cx) or ion chromatography (930 IC Flex, Metrohm), while characterizations of the solid specimens have been conducted through Fourier transformed infrared spectroscopy (Model 6600, Jasco) and X-Ray diffraction (XRD, SmartLab, Rigaku).

3. Conclusion

The obtained results pointed out the different leaching reactions take place for each metal ion. For instance, the leaching of Cs⁺ was direct cation exchange where either structurally entrapped or used Cs⁺ (to neutralize AlO₄⁻ tetrahedra) replaced with the cations at the SWS. Apart of the Cs⁺, high pH of the GP together with carbonate, influenced UO₂²⁺ speciation that dissolved and leached out as a function of time at the DWS more than SWS. Furthermore, although the GP was originally loaded with I⁻, IO₃⁻ leaching was observed instead of the I⁻, suggesting the oxidation of I⁻ during the geopolymerization process. In the presentation, we will discuss how structural changes of the GPs induced by the ion uptake affect the leaching itself.

References

- [1] Tatranský, P.; Pražská, M.; Harvan, D. Solidification of Spent Ion Exchange Resins into the SIAL® Matrix at the Dukovany NPP, Czech Republic. 2013.
- [2] E.D. Hespe, Leach testing of immobilized radioactive waste solids, *At. Energy Rev.* 9 (1971) 195–207.