学　位　論　文　内　容　の　要　旨

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学　位　論　文　題　名

Applicability and long-term safety assessment of geopolymer and cement disposal systems for spent titanate adsorbent from decontamination of wastewater at Fukushima Daiichi Nuclear Power Station
(福島第一原子力発電所における廃水処理で発生した使用済チタン酸塩吸着材のジオポリマーおよびセメント固化処分の適用性および長期安全評価)

Since the accident at Fukushima Daiichi Nuclear Power Station (FDNPS) in March 2011, the contaminated water with radionuclides is continuously produced by the cooling process of damaged nuclear fuel. Various radionuclides exist in wastewater, and 90Sr and 137Cs are main contaminants that have to decontaminate due to their long half-life and effect on human bodies. Therefore, ion-exchange methods for decontamination of these radionuclides in the wastewater were conducted using several kinds of absorbents. For instance, Simplified Active Water Retrieve and Recovery System (SARRY) and Advanced Liquid Processing System (ALPS) in FDNPS have used synthetic zeolites and hydrous sodium titanate as cation adsorbents for reduction of the radioactive Cs and Sr concentration, respectively. The both systems have produced spent zeolite and titanate adsorbents. They have been contemplated the way for safe storage and disposal of the adsorbents, and these come to be an urgent issue in FDNPS. Therefore, there are critical challenges to find out materials using for stabilizing those adsorbents to ensure long term safety storage and disposal. There are many reports on zeolite-embedded cement waste-form. However, there is a few studies on the titanate consolidation and applicability of alkali-activated materials, that is, geopolymers. In this context, applicability and long-term safety of K-based geopolymer and cement disposal systems for the spent titanate adsorbent were investigated in this study.

Chapter 1 refers to the background, objectives of this study.

Chapter 2reviews the literatures on geopolymer waste and the absorption of Sr and Cs by titanate. To catch up of the knowledge on fundamental mechanisms on geopolymer production and express the utility of geopolymer, as well as the comprehension of Sr and Cs' sorption mechanisms by titanate adsorbent.

In Chapter 3, leaching experiments and observations of Sr distribution of spent titanate adsorbent embedded in geopolymers, loaded with Sr at realistic concentrations, were conducted. The experimental results illustrate that only 0.75

Chapter 4 shows the adsorption behavior of Cs with titanate adsorbent as an optional method for removing Cs in contaminated water. Leaching experiments and observations of the Cs the distribution of spent titanate adsorbent embedded in geopolymers were also conducted. 6.92

Chapter 5 shows results of the safety assessment of geopolymer and cement waste with titanate adsorbent loaded Sr and Cs. The safety assessment system is used for evaluating the suitability of waste form for long-term storage and disposal in the different disposal types simulated form GoldSim software by

using the actual numerical value from a real situation and leaching rate (90 days leaching). The safety evaluation conducted here reveals that it is practical to utilize pit type disposal system for the solidified geopolymer with titanate adsorbent generated in the treatment of contaminated water processes. With the target radionuclides (Sr-90 and Cs-137), it was confirmed that the maximum annual exposure dose was below the limit of standard-dose in both examined cases as groundwater transfer scenario and land-use scenario. On the contrary, a disposal system for the solidified geopolymer with titanate adsorbent is not suitable to adopt the trench type.

Chapter 6 provides general conclusions and recommendations for future necessities and suggestions for research.