Leaching behavior of Cs from cement and geopolymer solidified forms of Cs adsorbent and fly ash

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Abstract — After the Fukushima Daiichi nuclear power plant accident, a great volume of incineration ash with radio-Cs (r-Cs) is produced and stored at the interim storage facility. Solidification of incineration ash or volume-reduced manners of r-Cs by adsorbents are candidate disposal forms. In this study, cement and geopolymer, stabilized zeolite and calcined ferrocyanide are considered as solidifying matrices and adsorbents, respectively. This research evaluates Cs leaching behaviors of various solidified forms.

***Keyword*:** geopolymer, cement, incineration ash, leaching, adsorbent, solidification, radioactive cesium

1. Introduction

After the Fukushima Daiichi nuclear power plant (FDNPP) accident, a wide region of northeastern Japan was contaminated with radio-Cs (r-Cs). Surface soils excavated by decontamination works have been stored in the interim storage facility (ISF). To reduce the volume of the collected materials, combustible materials are incinerated, resulting in formation of Cs bearing incineration fly ash (IA).

R-Cs presents the most serious risk and could be released to environments if incineration ash or secondary wastes produced from various treatments of incineration ash are not properly conditioned in the final disposal site by leaching from the waste forms. Various adsorbents are used to further reduce the large volume of IA for disposal. Therefore, the most important purpose is minimizing the leaching amount to ensure the safety of disposal by evaluating the Cs leaching behavior from adsorbents and IA with different solidification methods [1].

2. Leaching experiments

Leaching experiments were based on the ANS16.1 standard leaching test [2]. As a variable, the size of the specimens and loaded Cs concentration was examined in leaching test to see the effect. Different size of geopolymer specimens using a M_2O: SiO_2: H_2O =1:1:13 solution, where M stands for Na+ or K+ loaded with various concentrations of Cs were prepared. Specimens with diameters of 12 mm or 20 mm and heights from 15 mm to 35 mm were made and cured hermetically for 7 days. ICP-MS was used to determine the concentration of Cs in the leachates, and LR (Leaching rate) was calculated to evaluate the size effect on leaching. As a result, no regular trend on LR result of different sizes is found so the size of specimens may not play a significant role in leaching test.

Specimens with cement and geopolymer bearing model IA, Cs-loaded zeolite and calcined ferrocyanide are prepared and were taken to 7-days leaching test following ANS16.1 standard with the specimen size determined above. The maximum volumes of model IA and adsorbents mixed with matrices were determined by unconfined compressive strength test and slump flow tests that achieve strength and workability requirements for construction works. Ultra-pure water was used for leachate, which was exchanged at 2, 7 hours and each day after. Then, Cs concentration was measured for each collected leachate. The CLF (cumulative leach fraction) and LR was calculated to evaluate the leaching behaviors of Cs from the specimens.

3. Conclusion

The size effect on leaching behavior of Cs was evaluated. No significant effect was shown in the size leaching test with different sizes specimens within this study indicating sample sizes could be smaller than the actual wastes to determine the Cs leaching behavior from wastes with the same composition. The maximum volumes of IA and adsorbents mixed with matrices were decided by unconfined compressive strength tests and slump flow tests. Leaching behaviors of Cs from different immobilized waste matrices were evaluated and will be presented in the conference.

References

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[2] ANSI/ANS-16.1-2019, American National Standard Measurement of the Leachability of Solidified Low-Level Radioactive Wastes by a Short-Term Test Procedure