Immobilization of Radioactive Waste Generated From Primary System Decontamination Using Geopolymer Waste Form

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1. Introduction

The decontamination of nuclear power plant (NPP) is a great concern as old NPPs are decommissioned. Among several decontamination processes for NPP's primary system, hydrazine based reductive metal ion decontamination (HYBRID) process with sulfuric acid is newly developed as an attractive method for achieving acceptable decontamination factor and lowering the damage of base metals. Despite of these advantages, high sulfate contents of HYBRID process lead to serious deterioration of general cement waste form due to the potential formation of ettringite [1].

Therefore, the new solidification method is needed to develop and evaluate the geopolymer waste form with high mechanical performance and even high sulfate resistance.

2. Geopolymer synthesis and results

This study used industrial byproducts (red mud and fly ash) as geopolymer precursors. All paste samples were cast in polypropylene vials (Φ23 x 46mm) with sealing material. The sealed samples were placed in the oven at 20°C for 7 days.

2.1 Geopolymer precursors

Industrial wastes (red mud and fly ash) were obtained from Daejoo KC and Sungshin industry, respectively. The chemical analysis of red mud and fly ash using X-ray fluorescence (XRF) is shown in Table 1. As water content of red mud is about 20%, red mud sample was dried in the 110 °C oven for 24 hr before use.

Table 1. Chemical compositions of red mud and fly ash (wt%)

	SiO_2	Al_2O_3	CaO	Fe_2O_3	Na_2O	LOI*
Red mud	20.0	25.0	2.35	29.3	14.5	3.01
Fly ash	42.1	18.6	23.6	4.20	1.66	4.60

*LOI: loss of ignition

2.2 Identification of simulated HYBRID sludge waste

The properties of simulated HYBRID sludge waste were identified by XRF and XRD (Table 2 and Fig. 1). Sludge waste contains high amount of SO_3 (13.8%) which corresponds to XRD patterns of barite peak (PDF#24-1035).

Table 2. Chemical properties (%) of simulated HYBRID sludge waste

SiO_2	**BaO**	SO_3	Na_2O	Al_2O_3	MnO	LOI*
45.8	**28.9**	13.8	2.58	2.04	2.04	4.49

*LOI: loss of ignition

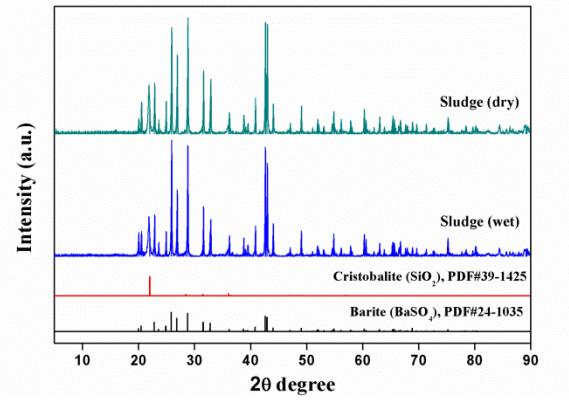

Fig. 1. XRD patterns of simulated HYBRID sludge waste.

2.3 Geopolymer synthesis

Geopolymer waste forms were successively formulated with a desired ratio of Si/Al (0.8-1.3) and H_2O/Al (13-17) using calculated matrix [2]. Geopolymer waste forms were successfully synthesized using red mud and fly ash to meet the waste form acceptance criteria (>3.45 MPa).

3. Conclusions

The immobilization of simulated HYBRID sludge waste using geopolymer waste form prepared with red mud and fly ash was tested and investigated. The results revealed that the mechanical stability of the geopolymer waste forms was better than that of cement waste forms. These results suggest the potential use of geopolymer based on industrial byproducts for radioactive waste solidification.

ACKNOWLEDGEMENT

This work was supported by the Korea Atomic Energy Research Institute (KAERI) granted financial resource (No. 1711049170).

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