A study of the compaction properties of potassium and metakaolin-based geopolymers for radioactive metals

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Abstract

After the decommissioning of JMTR, the geopolymer treatment method for difficult waste ion exchange was proposed. Geopolymers have been investigated for applications to nuclear waste treatments, however, compaction of radioactive aluminum ions has never been attempted. As geopolymers are used to compaction of radioactive aluminum ions, the stability of geopolymer after compact the radioactive Al metal ions is important.

Keywords: Geopolymer, metakaolin, radioactive, aluminum

Introduction

With the development of the nuclear industry, there are inevitable problems of nuclear power plant abandonment and nuclear waste disposal. The disposal of some radioactive metal ions has not yet been well solved. Geopolymers are inorganic polymers composed of AlO_4 and SiO_4 tetrahedral structural units and a three-dimensional network structure [1]. This structure is very conducive to dividing and enclosing metal ions and other toxic substances in the cavity, and the aluminum ions in the framework can adsorb metal ions [2]. As geopolymers are used to compaction of radioactive aluminum ions, the stability of geopolymer after compact the radioactive Al metal ions is important. This study will investigate the leaching performance of Al ions in water after mixed in geopolymer and cured for 14 days.

Experiment

Geopolymers were made of EFACO silica, metakaolin powder, potassium hydroxide and potassium silicate solution with molar ratios of Al: Si: K: H_2O =1: 2.1: 0.8: 8. 0.5wt% of Al powder, Al wire were added in the samples respectively. Then the samples were cured 60 degrees for 1 day and then kept at RT until the 14 days. After 2 weeks curing, geopolymer samples were leaching in water for (2h, 7h, 24h, 48h, 72h). ICP-MS was used for detecting the Al and Cs ions in the liquid.

Results and Discussion

Synthesized samples are shown in Fig.1. The samples added with Al powder appeared more cracks than added with Al wire. Hydrogen gas produced by the corrosion reaction of aluminum metal introduces voids into the paste mixture. The chemical reaction as shown in formula (1).

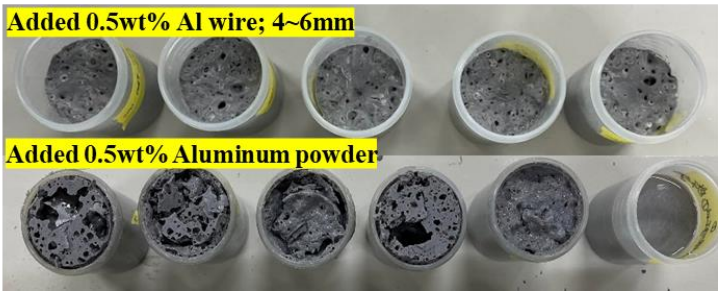

Fig 1. Geopolymer samples synthesized with 0.5wt% of Al powder, Al wire were demolded after 1 day.

$$2Al+6H_2O+2NaOH \rightarrow 2NaAl(OH)_4+3H_2 \quad (1)$$

The reaction contact area of aluminum wire was smaller than that of aluminum powder, so the rate of reaction to generate hydrogen was higher weaker than that of aluminum powder, and the damage to the sample was less than that of aluminum powder.

References

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