Study on Solidification of Spent-Ion Exchange Resin Using Epoxy

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1. Introduction

Spent-ion exchange resins(IER), which are a type of wastes from nuclear power plants and chemically unstable and have the relatively high specific activity, have been stored in a high integrity container(HIC) and disposed.

The treatment of spent resins mainly consists of the solidification process by mixing with suitable materials, such as cement, asphalt, polymers and etc. and the volume reduction process by de-watering and by other means.

In this paper, we study the properties of materials used for solidification and discuss the spent resin treatment system that can simultaneously achieve solidification and volume reduction.

2. Solidification and volume reduction

2.1 Solidification

Cement solidification is the oldest solidification method with excellent durability, but it has a disadvantage that its radiation shielding capability is weak and solidification volume increases. Solidification using asphalt has a low durability in terms of compressive strength and there is a risk of fire during manufacturing process [1-3].

Polymers generally have high compressive strength and they have various physical properties depending on their type, so using polymers suitable for solidification may compensate for the disadvantages of cement or asphalt [4]. Resin solidified with epoxy(epoxy resin) has excellent compressive strength and it has high water resistance and good adhesion with IER made of stylene copolymer. Thus the imbedded material is not released when it is put water for long time. It is important to select epoxy that do not have too high viscosity to make solidification with IER. When viscosity is not high it is easy to mix with IER and to remove air bubbles that can degrade the properties of solidification. In addition, the injection time can be shortened if viscosity is not high, reducing the time to manufacture a solidification when used in the actual field. It is also easy to reduce the condensation heat occurs when epoxy resin is made. The viscosity of the epoxy depends on the molecular weight.

In this study, solidification was prepared by using bisphenol A type epoxy having viscosity suitable for solidification and amide type hardener.

2.2 Volume reduction

IER is a spherical shape having a three-dimensional structure. By crushing using a ball mill, it is possible to reduce the volume and widen the surface area of IER that can be bonded with the epoxy resin, so that more IER can be homogeneously combined with the epoxy resin.

Therefore, in this study, IER was crushed using a ball mill and then combined with an epoxy resin to prepare a solidification.

3. Experimental methods

3.1 Materials

Bisphenol A type epoxy was investigated as a solidification binder and amide is used as hardener. The MB-106 (mixed bed, WatchwaterKorea) resin was used as spent IER. $CoCl_2$ and $CsCl{\cdot}6H_2O$ are used to absorb Co and Cs to IER.

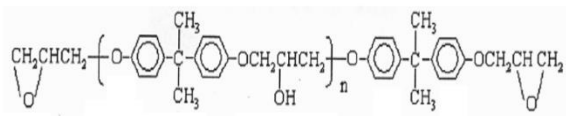

Fig. 1. Bisphenol A type Epoxy.

3.2 pre-processing of resin sample

The MB-106 was washed using distilled water then mixed with solution of $CoCl_2$ and $CsCl{\cdot}6H_2O$. After 3 hours it is washed using distilled water then dried at 90℃ for overnight.

3.3 Crushing using ball mill

The dried IER is crushed using ball mill and mixed with epoxy resin to form solidifications. Ball mill used is a ProPM2L model with a rotational speed of 0 to 580 r/min and discharge size of minimum of up to 0.1㎛.

4. Results

Adsorption results of Co and Cs on IER were confirmed by using inductively coupled plasma mass spectrometry (ICP-MS). Compressive strength of produced solidification was tested, which met the acceptance criteria. Fig. 2 shows the change in color after adsorbing Co and Cs to the IER.

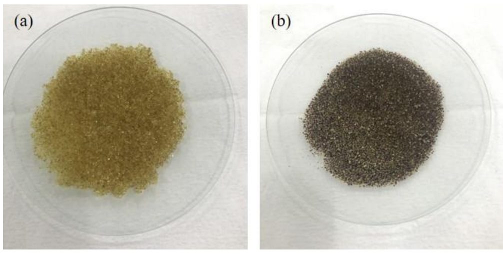

Fig. 2. The pictures of (a) non-treated IER, (b) Co and Cs adsorbed IER.

Table 1. The characteristics of MB-106

Resin	T-46	A-33
Interacting ion	H^+	OH^-
Ion exchange capacity	>1.8 eq/L (H^+)	>1.0 eq/L (OH^-)
Average diameter	0.3-1.2 mm (95%)	0.3-1.2 mm (95%)
Water contents	52%	60%
Volume ratio	1	2

In the compressive strength test of solidifications according to the KS-F-2351 test method, the epoxy resin met the acceptance criteria(ASTM C39, D1074, ≥0.34 MPa).

A leaching test of Co and Cs is currently in progress according to the ANSI/ANS-16.1 test method.

Fig. 3 shows a schematic diagram of the continuous treatment system of spent resins using mechano-chemistry process, which is the combination of the mechanical volume reduction process using ball mill and solidification process using chemical binders.

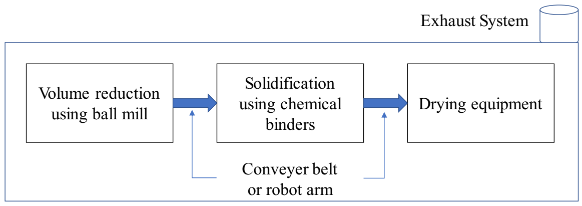

Fig. 3. schematic diagram of continuous mechano-chemistry treatment system.

5. Conclusion

Bisphenol A type epoxy was used to produce a solidified resin. In the compressive strength test, the epoxy resin met the acceptance criteria. A leaching test of Co and Cs is currently in progress.

For the treatment of spent resins, the mechano-chemistry processing system is the first attempt at home and abroad, and will be a way to reduce the treatment cost and to prove the chemically unstable characteristic of spent resins.

ACKNOWLEDGEMEMT

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