Leaching Test for Polymer Waste Form of Spent Ion-exchange Resins

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1. Introduction

Spent ion-exchange resin is generated through the purification of primary system of nuclear power plant. The proper solidification of spent resin is urgent issues and needs to be developed because spent resin is consisted of organics which can generate the gas. Spent ion-exchange resin is considered to be problematic waste so that, in many case, it requires special approaches and precaution during their solidification to meet the acceptance criteria for disposal. In this study, the polymer was used as a solidification material to improve the waste content and reduce the leachability in solidification. Despite this, the reference data for leaching test is still limited.

The objective of this study is to evaluate the polymer wasteform solidified spent ion-exchange resin waste. In fact, the leaching test (ANSI/ANS16.1) and compressive strength test are performed to meet the acceptance criteria for disposal facility.

2. Experimental section

2.1 Development of polymer waste form

Polymers vary in characteristics depending on chemical and physical structure and range of strength, durability required for the purpose of use. Therefore, physical properties can be enhanced by the selection of suitable polymers that meet the criteria of a polymer and by adding additives as needed. Polymer (Polyester Epoxy) was used as solidification ingredient and added with ion exchange resin (GRAVEX GR 3-16 N, mixed bed resin) to develop polymer waste form. The ion exchange resin was dried and crushed in advance, and added after removing air gap (Fig. 1).

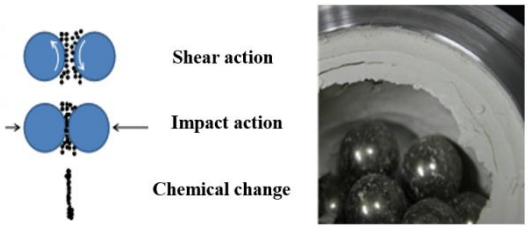

Fig. 1. Crushed ion exchange resin by ball mill.

In this study, the polymer solid waste form (Type A) was prepared as cylindrical. In comparison, polymer waste form (Type B) containing only Co without resin was prepared. The characteristics of polymer waste form A and B are shown in Table 1. The compressive strength of polymer waste form was analyzed by the universal testing machine (SALT model ST-1001).

Table 1. The characteristics of waste form A and B

Waste form type	A	B
Containing	Co adsorbed ion-exchange resin	Co chemicals
Average diameter	4.6 cm	4.6 cm
Average height	9.4 cm	9.4 cm
Surface area	169.1 cm^2	169.1 cm^2
Initial weight	218.1 g	219.0 g
Initial concentration	1569.7 μg/g	27983.2 μg/g

2.2 Leaching test

The leaching test was conducted according to ANSI/ANS16.1 method. A total sampling time was 10 times with 2 hr, 7 hr, 1 day, 2 days, 3 days, 4 days, 5 days, and 19 days. The 8 times out of 10 times. The sampling is scheduled for 49 days and 90 days. The reactor of leaching test is shown in Fig.2. Polymer waste form was soaked in deionized DIW (deionized water) with 9.0±1.0 ratio of total volume of DIW

waste to surface area of waste form. The whole of leachate was replaced at every sampling time.

Fig. 2. ANSI/ANS 16.1 test of 19 days.

After each sample collection, the leachate was analyzed by Inductively Coupled plasma-mass spectrometry (ICP-MS) to determine the leachability of the elements of interest. The leachability index (LI) was calculated by Eq. (1).

$$L_i = \frac{1}{n} \cdot \sum_1^n [log(\beta/Di)]_n \quad (1)$$

where L_i: The leachability index of a nuclide, i

n: Total sampling days

β: A defined constant (1.0 cm^2/s)

D_i: The effective diffusivity of nuclide

3. Results and discussion

The measured compressive strength was 65 Mpa (A) and 28 Mpa (B), respectively. It is higher than 3.44 Mpa which is the acceptance criteria for waste form in repository.

Effective diffusivity of Co is shown in Fig. 3.

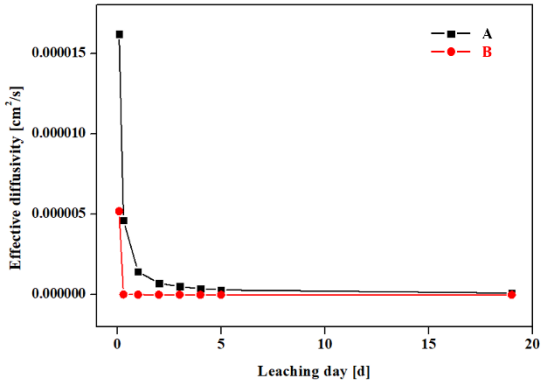

Fig. 3. Leaching test results of A and B.

The Leachability Index for A and B was calculated as 6.04 and 8.35, respectively. The leachability index of sample A and B ware appropriate to the radioactive waste criteria.

4. Conclusion

Polymer waste form was developed using polyester epoxy. The leaching test for two polymer waste form specimens were conducted by ANSI/ANS16.1 method. The leachability indexes of sample A and B were appropriated to be accepted for disposal. In order to optimize the solidification of resin waste for acceptance to repository, additional additives or formulation should be developed to increase the LI for acceptance to repository.

ACKNOWLEDGEMEMT

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REFERENCES

[1] ANS 16.1,″ Measurement of the Leachability of Solidified Low-Level Radioactive Wastes by a Short-Term Test Procedure″, 1986.