A Study on the Characterization of Polymer Waste Form Incorporating Cs-contaminated Soil Pellet Generated After Soil Washing

[1]Jun-Yeol An, [1]Sun-Il Kim, [2]Ki-Tae Yang, [3]Ki-Hong Kim, [2]Jong-Soon Song*
[1]Radioactive waste Technology department, Korea Research Institute of Decommissioning
[2]Chosun University, 309 Pilmun-Daero, Dong-Gu, Gwangju, Republic of Korea
[3]Radin, 5, Sinildong-ro 17beon-gil, Daedeok-gu, Daejeon, Republic of Korea
*jssong@chosun.ac.kr

Introduction

An accident in a nuclear power plant and its decommissioning process can cause heavy contamination of a large area of land due to release of a huge amount of radioactive materials. In such cases, the soil needs to be decontaminated as soon as possible and the site should be restored. To this end, a soil washing method featuring a fast decontamination process, and a phyllite-based flocculating agent to increase the efficiency of decontamination had been employed. Following this washing process, micro soil contamination in sludge state is generated as a secondary waste, and this is not easy to decontaminate. In this study has characterized this secondary waste so that proper disposal methods can be performed. Therefore, the soil with micro contamination in the sludge state was powdered and pelletized using a roll compaction technology. Subsequently, the polymer waste forms were fabricated by incorporating the pellets, and the characteristics of the waste forms were tested to confirm if they meet the Waste Acceptance Criteria(WAC) of the domestic nuclear material disposal sites.

Experiments

◆Materials

➢ **Powdered waste**

- **Simulated waste –** Mixed with below materials (Fig. 1)
  - ✓ Less than 38 μm soil, J-AF (Flocculating agent), Cs aqueous solution
- **Mixed rate**
  - ✓ Cs aqueous solution : 0.1 mmol/L, Soil : J-AF = 10 : 1

◆Preparation for manufacturing polymer waste form

➢ **Manufactured Pellet**

- **Equipment** - Roll compactor
- **Roll pocket Size** - H 6.5 · W 9.4 mm
- **Optimal conditions**
  - ✓ Hydraulic pressure: 28.44 MPa, Roll speed: 1.5 rpm, Feeding rate: 25 rpm

➢ **Polymer waste form**

- **Manufacturing method**
  - ✓ Pellets were placed in a specimen container, and then polymer was injected. Surface was polished (Fig. 2)
- **Incorporated pellets in polymer waste form**
  - ✓ About 60 wt.%

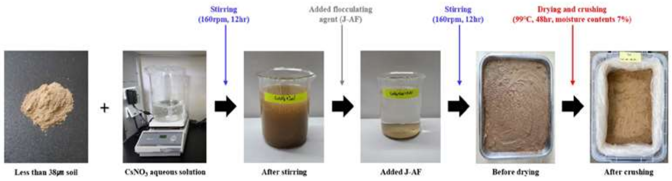

Fig. 1. Process of manufacturing the simulated powdered waste.

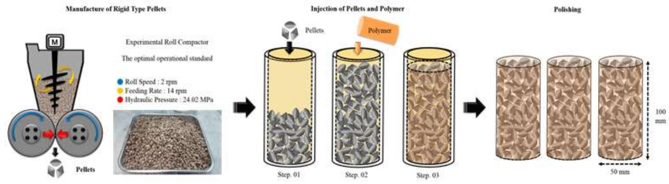

Fig. 2. Manufacturing process of polymer waste form.

Table 1. Compressive strength of pellets according to operating conditions.

Components of pellets	Device operating conditions[a] RS (rpm)	FS (rpm)	HP (MPa)	Compressive strength (MPa)
Contaminated soil	1.5	20	27.45	10.12
		25	27.45	10.48
		25	28.44	13.37

[a]Operating conditions (Roll speed; RS, Hydraulic pressure; HP, Feeding speed; FS)

Table 2. Mixing ratio of the epoxy resin

Sample No.	Epoxy / Hardner (Total 100 wt.%)				Added Diluent (w.t.%)	
Polymer waste form	YD-128	65	G-1034	35	LGE	10

Table 3. Incorporate rate of pellet/powder and epoxy of waste form

Sample No.	Quantity of injected wastes / epoxy (Total 100 wt.%) Pellets	Powder	Epoxy
Polymer waste form	60	-	40
	60	-	40

Results

◆Characteristic evaluation for polymer waste form

➢ **Compressive strength test**

- **Standard** - KS F 2405
- **Criteria** - ≥ 3.44 Mpa (500 psig)
- Compressive strength: 29.3 MPa - 31.2 MPa

➢ **Thermal cycling test**

- **Standard** - ASTM B553
- **Conditions** - 30 cycles, -30 ℃ - 60 ℃
- Compressive strength: 27.0 MPa - 28.8 MPa

➢ **Irradiation test**

- **Standard** - NRC
- **Conditions** - 9.091 × 10^3 Gy/hr, During 200 hr
- Compressive strength: 23.1 MPa - 29.3 MPa

➢ **Immersion test**

- **Standard** - NRC
- **Conditions** - Perform in demi. water for 90 days
- Compressive strength: 28.4 MPa - 31.9 MPa

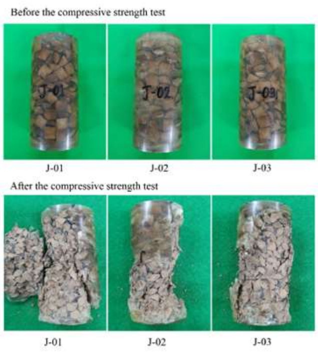

Fig. 3. Images of polymer waste form. Before compressive strength test, After compressive strength test.

Fig. 4. Images of polymer waste form. Before compressive strength test, After compressive strength test.

Fig. 5. Images of polymer waste form. Before compressive strength test, After compressive strength test.

Fig. 6. Images of polymer waste form. Before compressive strength test, After compressive strength test.

Conclusions

A study was conducted to treat/dispose the secondary waste generated after soil washing with a view to decontaminating the contaminated soil waste from a large area.
The contaminated soil powder was pelletized via roll compaction technology under optimized conditions, followed by mixing the pellets with polymer mix to form the polymer waste forms. Tests were conducted to evaluate the characteristics of the waste forms and confirm whether they meet the waste acceptance criteria of domestic nuclear waste disposal sites. All the compressive strength values after each characteristic test were above 3.44 MPa. Therefore, the evaluation results showed that all the specimens fabricated in this study satisfied WAC and confirmed their structural integrity.

Acknowledgements

This work was supported by the Korea Institute of Energy Technology Evaluation and Planning(KETEP) grant funded by the Korea government(MOTIE). (RS-2023-00247323 and 20214000000070)