A Preliminary Experiment on the Disposal Compatibility of the Polymer Solidification Incorporating Pellets

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1. Introduction

To reduce the volume of powdered radioactive wastes and solidify them by using the high-volume-reduction forming device based on the Roll Compaction System to pelletize and granulate them, they can be filled with liquid solidifying materials like epoxy to convert them into a disposable shape. But to deliver then to the disposal facility, Waste Acceptance Criteria (WAC) must be satisfied, and to assess the disposal fitness of solidifications, the Waste Acceptance Criteria testing method and judgment criteria are presented[1]. In this study, a preliminary experiment to measure compressive strength will be conducted according to the KS F-2405 test standard to check if the polymer solidification incorporating pellets, introduced above, satisfy the Waste Acceptance Criteria.

2. Experiment

2.1 Preparing samples

The high-volume-reduction forming device was used to pelletize particulate powder into rectangular pellets, and they were incorporated to make the polymer solidification samples. They are 50 mm in diameter, and 100 mm high. The shape of the sample is shown in Fig. 1. Surface processing was done to measure compressive strength, and the details of the samples are shown in Table 1.

Fig. 1. Produced pellets (L) and polymer solidification samples (R).

Table 1. Technical specifications by type – before the experiment

Sample No.	Curing temperature	Sample Size (mm)	Weight(g) powder	Weight(g) Epoxy	Weight(g) Total	Sample volume (cm^3)
A1	Room temperature	H=97.59 D=49.87	215.27	93.7	308.98	190.57
A2	Room temperature	H=97.58 D=49.99	215.54	94.14	309.68	191.44
B1	50℃	H=97.66 D=49.79	215.7	89.55	305.25	177.62
B2	50℃	H=98.59 D=48.13	215.4	91.49	306.89	191.87
C1	75℃	H=98.26 D=49.97	232.8	90.16	322.96	192.66
C2	75℃	H=100.03 D=49.90	242.96	91.2	334.16	195.58

Also, as thermocouples are inserted when temperature is measured, only the diameter and height of the samples used for measuring temperature were changed to 100 mm and 150 mm respectively, but the pellet incorporation ratio and the epoxy resin mixing ratio are the same, i.e. YD-128-epoxy/G1034-hardener/LGE-diluent = 57.5/31/11.5 (Weight %) respectively[2].

2.2 The heat-generating temperature of the solidification *depending on the curing temperature*

To examine the internal temperature of the solidification during curing, the center and diameter of the samples were trisected, and a total of three thermocouples were installed at 1/3 and 2/3 height from the floor, and the Data Logger was used to measure the temperature, and the forced convection oven, made by Company I, was used to vary the temperature.

Fig. 2. Measuring the heat-generating temperature of the solidification depending on the curing temperature– Room temperature (L), 50℃ atmosphere (R).

2.3 Measuring compressive strength

To measure compressive strength, the DTU-900HC Series (DT&T, Capacity: 50 ton) equipment, owned by the Korea Atomic Energy Research Institute was used. As illustrated in Fig. 3, the curing temperature was varied, and the compressive strength of the 3 manufactured samples was measured.

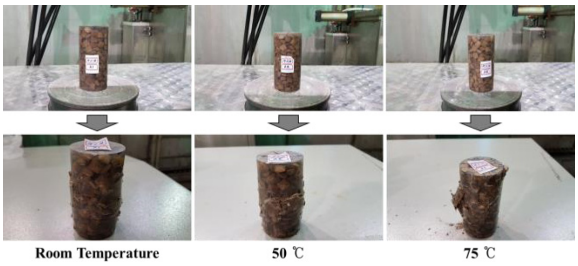

Fig. 3. Measuring the compressive strength of the solidification.

3. Results and discussion

The result of measuring the heat-generating temperature of the solidification by the curing temperature showed that as the ambient temperature rises, curing is accelerated, and as the difference between the ambient temperature and the curing temperature is small, the polymer solidification did not have any crack. Compared to the data in Fig. 4-5, it can be inferred that the curing time at 50℃ is 1/2 shorter than the curing time at room temperature, and accordingly it can be said that the curing at 50℃ is more advantageous in terms of working time.

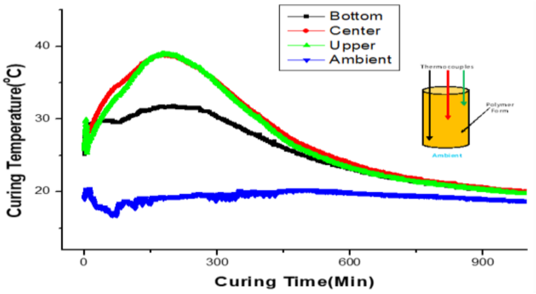

Fig. 4. The heat-generating temperature data by temperature – Room temperature.

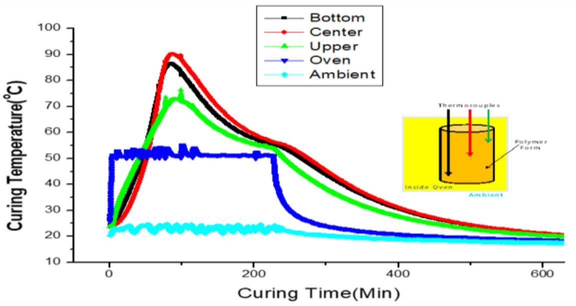

Fig. 5. The heat-generating temperature data by temperature –50℃ atmosphere.

Also, in the compressive strength measurement test, the failure mode showed a typical rigid type. The compressive strength was 200 kg_f/cm^2 or greater regardless of the curing temperature, and the measurement result at 50℃ was most excellent, and the details are shown in Table 2 and Fig. 6.

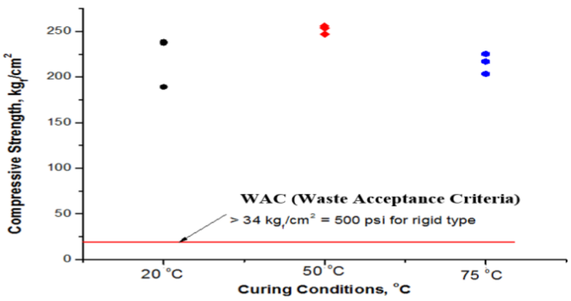

Fig. 6. Compressive strength of the solidification depending on the curing temperature.

Table 2. Technical specifications by type – after the experiment

Sample No.	Curing temperature	Sample size (mm)			Weight (kg_f)	Compressive strength (kg_f/cm^2)
		Diameter (mm)	Height (mm)	Cross-sectional area (cm^2)		
A1	Room temperature	4.99	9.76	19.53	4,660.71	238.64
B1	50℃	4.81	9.77	18.19	4,912.69	256.00
C1	75℃	4.97	9.82	19.61	4,419.97	225.39

4. Conclusion

The result of the preliminary experiment on the disposal suitability of the polymer solidification incorporating pellets far exceeds the Waste Acceptance Criteria (34 kg_f/cm^2) through the compressive strength KS F-2405 test standards. Accordingly, if additional experiments are conducted according to the strength depending on the moisture contents of the pellets, the epoxy mixing ratio and the solidification judgment criteria, and shortcomings are improved, it is believed that this technology can be applied to solving the problems of excessive wastes and saturation.

ACKNOWLEDGEMENT

This paper is a research project funded by Ministry of Commerce, Industry and Energy, which was conducted with the help of the Korea Institute of Energy Technology Evaluation and Planning. (No. 20171520101630) and supported by the National Research Foundation of Korea (NRF) funded by the Ministry of Science and ICT (The grant number: NRF-2018M2B2B1065636).

REFERENCES

[1] M.Y. J, S.H. L, J.S. S, et al., “Development of Treatment Technology of Non-Disposal Radwastes for the Increase of Their Volume at Disposal Site”, Proc. of KRWS 2017 Fall, pp. 171-2, 2017.

[2] J.S. S, M.Y. J, S.H. L, et al., “An Experimental Study on the Pelletization of Powdered Radioactive Waste Using the Roll Compaction System”, Proc. of KRWS 2018 Spring, pp. 190-1, 2018.

[3] Radwaste Acceptance Criteria, LILW –Operation-Radiation-028, Korea Radioactive Waste Agency.

[4] Solidification Radwaste structural soundness verification of examination, LILW-Operate-Radiation-048, Korea Radioactive Waste Agency.