

Evaluation of Structural Stability for Cement Waste Form of Lime Waste

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1. Introduction

Lime waste was generated in the AUM (Ammonium Uranyl Carbonate) process, which is a wet manufacturing process of UO_2 powder and storage in KAERI (435 drums, 200L drums). Lime waste is no longer generated because of the closure of the research facility. It is important to safely dispose [1] of low-and intermediate level radioactive waste from operation of the research facility. One of the efficient way to treat radioactive waste is cement solidification. The cement solidification method is cheap and simple than other solidification method. Portland cement (Type I) has been used for a long time as solidification material and has proven technically safer and more convenient. This Portland cement has an initial setting time of about 4 hours, which is advantageous in ensuring sufficient working time for fast curing speed and high calorific value [2]. The purpose of this study is to evaluate the simple process for permanent disposal and the structural stability of the Lime cement waste form. In addition, Lime cement waste form meets the waste acceptance or satisfy the waste acceptance criteria for final disposal facility in several tests such like compressive strength, immersion, leaching test, and thermal cycling test.

2. Methods and Results

2.1 Materials

Portland cement was purchased from SSangyong. The components of lime waste are deduced from NH_4NO_3 , $NaNO_3$, $Ca(NO_3)_2$, $CaCO_3$ and $Ca(OH)_2$ [3]. The real image of lime waste and XRD patterns are shown in Fig. 1.

As shows in Table 1, radionuclides concentration of lime waste. Lime waste is estimated to be extremely low level waste.

Table 1. Characterization of lime waste

Radioactive concentration [Bq/g]	Main component	pH
U-238 : 55.4	$CaCO_3$	8.2
Cs-137 < 0.200	$Ca(NO_3)_2$	

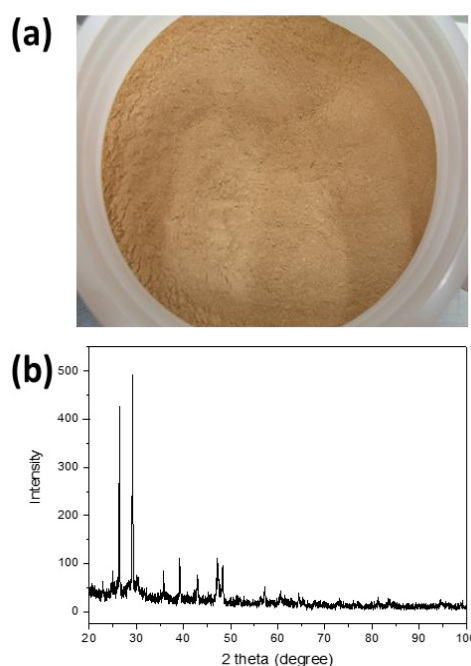


Fig. 1. (a) Real image of lime waste powder and (b) XRD patterns.

2.2 Manufacture of lime cement waste form

The Lime cement waste form were manufactured in accordance with the Korean Industrial Standard (KS-L-5109) [4]. The mechanical mixer was purchased from JI-206 (Jeil Precision, Korea). And Lime cement waste form solidified while under curing at room temperature with relative humidity of 40 to 60 % for 28 days. After 28 days, the uniformity of the Lime cement waste form was visually confirmed.

Lime cement waste form were made to find the optimal mixing rate (W/C, where W is water and C is cement) from 1.8 to 2.3. The operating range was

determined by workability, free-standing water test, and water immersion test (90 day).

2.3 Operation range of lime cement waste form

In preliminary tests, the maximum lime waste content of the cement waste is 80 wt.%. For stability and reliability, lime cement waste form of lime waste content was selected at 75 wt.%, the content of portland cement as 25 wt.%. Therefore, the volume increase of Lime cement waste form material is estimated to be less than 10% considering the density of cement (3.16 g/cm^3). When the W/C ratio is less than 1.80, the mixture (lime waste, cement, water) has no fluidity, but W/C ratio is higher than 2.40, the lime cement waste form has free-standing water. Therefore, the optimal mixing rate is 1.85 to 2.20. Fig. 2 shows the operating range the W/C ratio of the lime cement waste form.

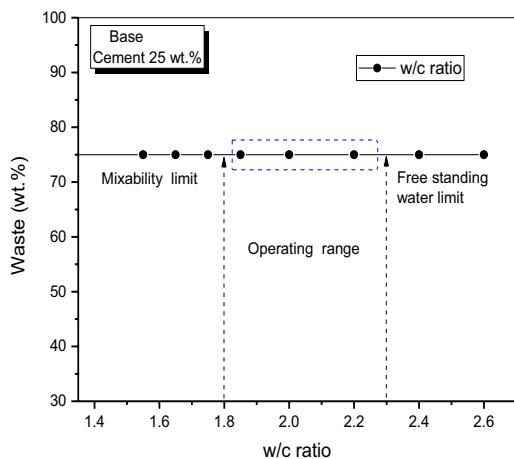


Fig. 2. Operating range of Lime cement waste form.

2.4 Stability evaluation of lime cement waste form

The stability evaluation of lime cement waste form was determined by the acceptance criteria such as compressive strength, thermal cycling test, immersion, and leaching test [1].

As shown in Fig.3, compressive strength result of the lime cement waste form. The compressive strength is 55 ~ 76.3 kgf/cm^2 , which satisfied the acceptance criteria of 35.2 kgf/cm^2 (3.44MPa). And, all experiment groups were satisfied with the final disposal facility.

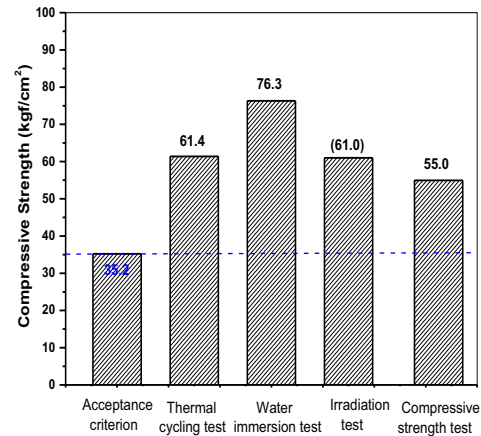


Fig. 3. Compressive strength test of Lime cement waste form.

3. Conclusions

1. Cement solidification method is a recognized technology, the lime waste content of lime cement waste form is 75 wt.% and volume increase is less than 10%.
2. The operating range of lime cement waste form is estimated to be between 1.80 and 2.30 W/C ratios.
3. Optimum condition is W/C ratio is 1.85 ~ 2.20 and lime cement waste form meets the waste acceptance and satisfy the waste acceptance criteria for final disposal facility.

REFERENCES

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