Mixing Treatment of Radioactive Wastes and Structural Stability Evaluation of Solid Waste Form From the FMPP

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1. Introduction

KJRR (Kijang Research Reactor) will include the Fission Moly Production Process (FMPP) and the Radioactive Wastes Treatment Facility (RWTF). In KJRR's FMPP, solid waste such as spent uranium cake, aluminum cake (Al_2O_3 residue) and Intermediate level liquid waste (ILLW) are generated. The ILLW of FMPP requires a minimum of two years storage period to allow short half-life radionuclides generated from FMPP to decay naturally. RWTF is designed to store ILLW for 5 years and the nuclide affecting the radioactivity concentration after storage is Cs-137 (half-life 30.17 years) [1].

The amount of generated waste such as spent uranium cake (precipitates), aluminum cake and ILLW is 220 L/year, 3,200L/year and 3,000 L/year, respectively. The purpose of this study is to evaluate both the effective mixing process of the wastes from FMPP and the structural stability of the solid waste by acceptance criteria of disposal facilities.

2. Experimental Methods

2.1 Characteristics of Wastes from FMPP

The main chemical composition of ILLW is NaCl and Na_2SO_4, and the salt concentration is 170.81 g/L. Therefore, at room temperature (20 °C), there is no precipitates in a completely dissolved state. The nuclide with the highest radioactivity concentration is Cs-137, so, ILLW is classified as intermediate-level according to Korea's Atomic Energy Act [3]. Aluminum cake is easily dissolved in water due to having 1.23 wt. % water. The radioactivity concentrations of Cs-137 and Co-60 in aluminum cake are estimated to be low-level according to the Korean Atomic Energy Act [2, 3].

2.2 Experimental Methods and Evaluation

The cement used for solidification was portland cement (type I). The wastes used in the experiment were the liquid waste and aluminum cake generated from the simulation of FMPP. The range of operation was based on 30 wt. % of aluminum cake and the mixing ratio of portland cement and liquid waste was varied from 0.45 to 0.75 w/c.

Specimens for the acceptance test were prepared with optimum conditions (Aluminum cake 30 wt. %, w/c ratio 0.6) derived from the operating range experiment. Three solid specimens were prepared for each test items and mean values were used for the evaluation. Test items, methods and procedures according to acceptance criteria of disposal facilities are applied for the structural stability evaluation of cement solidification [4].

3. Results and discussion

3.1 Operating Range and Optimum Condition

In this study, the w/c ratio is defined as the liquid waste/cement ratio. Fig. 2 shows that the operating range is between 0.50 and 0.60 w/c ratio, and the salt

content (salt/cement weight ratio) of solid wastes is 8.54 ~ 10.25 wt. %. The optimal operating condition considering the economic efficiency is 0.60 w/c ratio, and in this case, the salt content of solid wastes is 10.25 wt. %.

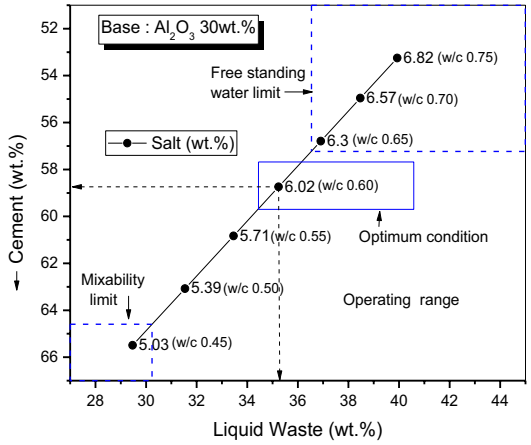

Fig. 1. The operating range and optimum conditions for cement solidification of liquid waste and aluminum cake.

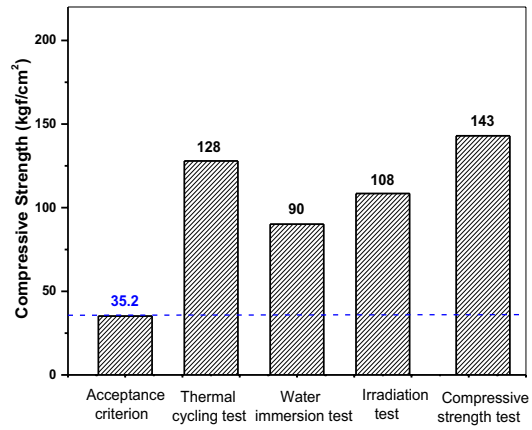

Fig. 2. Structural stability evaluation according to acceptance criteria of disposal facilities.

3.2 Structural Stability Evaluation of Solid Wastes

The solidified specimens for the structural stability evaluation were fabricated with the optimum operating condition, w/c ratio 0.60. Compressive strength on the solidified specimens was measured at ambient and after thermal cycling test, water immersion test, and irradiation test were completed. The specimens were also broken and subjected to free standing water test. After each test, the compressive strength is 90 ~ 143 kgf/cm^2, satisfying the acceptance criteria of 35.2 kgf/cm^2 (3.44 MPa). Fig. 2 shows the results of the acceptance criteria evaluation for the cement waste of mixed wastes from FMPP.

4. Conclusions

The main results of this study are summarized as follows;

1. The operating range is between 0.50 and 0.60 w / c ratio, in which case the solids content (salt / cement weight percentage) is 8.54 ~ 10.25 wt. %.

2. Optimum condition considering economic efficiency is w / c ratio 0.60. In this case, the solid waste content is 40.25 wt. % (salt 10.25 wt. % + aluminum cake 30 wt. %).

3. The structural stability of solid bodies satisfies the criteria for acceptance of repositories.

4. Mixing treatment of waste liquid (intermediate-level) and aluminum cake (low level, 30 wt. %) is considered to be an efficient method due to the dispersion effect of bulkiness and mid-range nuclides.

REFERENCES

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