Treatment and Disposability of Intermediate Level Liquid Radwastes Generated by Fission Moly Production

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1. Introduction

The intermediate level liquid radwastes (ILLW) will be generated during Mo-99 production at KIJANG research reactor which is planning by KAERI. Currently, the KIJANG research reactor is on the construction regulation phase, and it require ILLW storage capability at least 20 years.

All radwastes treatment processes of KIJANG research reactor should be certified, and all treated radwastes can shift to final disposal site. Furthermore, the treatment processes have to fit for the radwastes from the research reactor because, the radwastes of research reactor differ from that of nuclear power plants.

In this study, we developed the treatment method for ILLW, and evaluated the disposability

2. Experiments

2.1 Characteristics of ILLW

The ILLW will be generated 3.0 m^3/yr and, and chemical characteristics are shown in Table 1.

Table 1. Chemical characteristics of ILLW

Chemical Composition	Concentration [g/L]	Solubility (water, 20°C) [g/L]	Density [g/cm^3]
NaCl	64.28	359.00	2.165
Na_2SO_4	106.53	139.00	2.664
Sum	170.81		

The radioactivity of ILLW is dramatically decrease for 2years, and after 5years most nuclide with short half-life are naturally decayed. Table 2 summarized activity of ILLW after 5yeasrs.

Table 2. Activity of ILLW after 5years

Nuclide	Half-life [day]	Activity [Bq/ml]
Ag-110m	2.504E+02	1.921E+00
Co-60	1.924E+03	1.316E+03
Cs-134	7.526E+02	7.351E+03
Cs-137	1.095E+04	6.531E+06
Fe-59	4.460E+01	1.381E-08
I-129	5.731E+09	1.106E-02
Ru-103	3.935E+01	7.873E-07
Te-125m	5.800E+01	6.090E-09
Te-127m	1.090E+02	1.106E-01
Te-129m	3.360E+01	4.129E-12

As shown in Table 2, our target nuclide is Cs-137 which has highest activity after 5years [1].

2.2 Materials

Portland cement (type1) was used for solidification, and chemically simulated liquid wastes were used.

2.3 Method and evaluation

The mixture of cement and liquid wastes were mixed following “Testing method for mechanical mixing of hydraulic cement pastes and mortars of plastic consistency” (KS-L-5109). The operation range were determined using mixability, free standing water test and water immersion test (90days). The workability was adopted from “cement test flow table” (KS-L-511, KS).

In order to evaluate the disposability of cementation, we decided test contents and method

following the acceptance criteria of Gyeongju disposal site [2].

We prepared 3 cementation samples and averaged 3 results per each case.

3. Results and Discussion

Amount of salt in the cementation proportional to liquid wastes mixed with cement. That is, it proportional to w/c (water/cement) ratio. Over the 0.65 w/c ratio, there is free standing water, and there is no mixability under 0.35. Thus, the operating range is 0.40 ~ 0.60 w/c ration. In this case, the salts contents in the cements is 6.83 ~ 10.25wt.%. Considering safety and economics such as scale up factor, human error and so on, the optimum condition would be 0.50 ~ 0.55, and in this case the salts contents would be 8.54 ~ 9.39wt.%. Fig. 1 shows operation range and optimum condition for cementation.

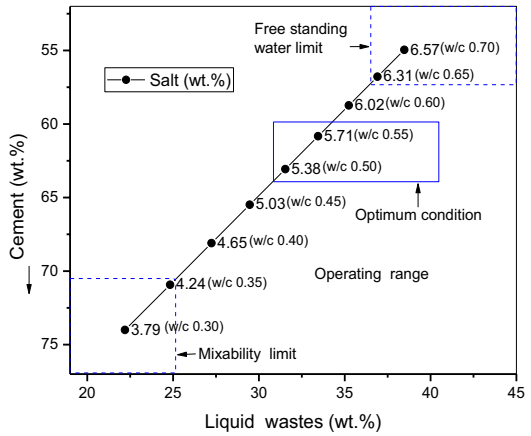

Fig. 3. Optimum condition of cementation for liquid radwastes.

3.1 Evaluation for Disposability

We performed compressive strength test and re-measured compressive strength after thermal cycling test, water immersion test and irradiation test using samples solidified with 0.50 w/c ratio. Also we performed free standing water test using crushed sample. The result of compressive strength (188~276 kg_f/cm^2) after all test is higher than acceptance criteria of Gyeongju disposal site (35.2 kg_f/cm^2). Fig. 2 shows the evaluation for acceptance criteria of FM radwastes for final disposal.

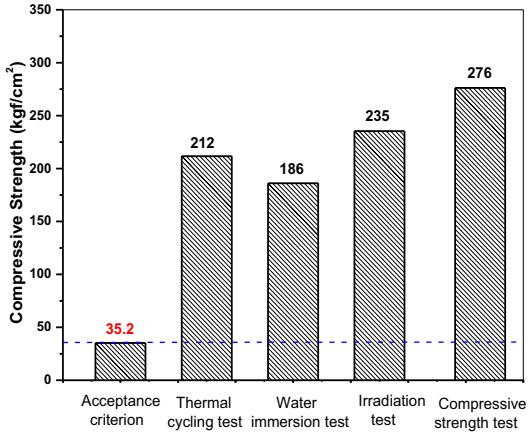

Fig. 4. Evaluation for acceptance criteria of FM radwastes for final disposal.

4. Conclusion

4.1 Cementation is a certified technology, and the activity of solidification is 3.01E+06 Bg/g. Thus, it classified as intermediate level wastes by atomic energy act. And can be disposed to Gyeongju disposal site.

4.2 The operation range is 0.40 ~ 0.60 of w/c ratio, and the salts contents are 6.83 ~ 10.25wt.%.

4.3 Optimum condition is 0.50 ~ 0.55 of w/c ratio, and the physical and chemical properties of cementation meet the acceptance criteria of Gyeongju disposal site.

REFERENCES

[1] Martin W. A. Stewart, “Immobilisation of higher activity wastes from nuclear reactor production of 99Mo”, Australian Nuclear Science and Technology Organization (ANSTO), 2013.

[2] Korea Radioactive Wastes Agency, “Safety analysis report of Low-and intermediate-Level Radioactive Waste Disposal Facility”, 2008.