Study on Vitrification of Slag From Metal Melting Process

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1. Introduction

More than 90% of the wastes generated during nuclear dismantling are metal waste. Most of radioactive metal waste is carbon steel and stainless steel. Since these metal wastes are bulky, effective volume reduction techniques are required. One of the effective methods is melt decontamination [1], [2]. However, slag, which is a secondary waste, is generated during the melting decontamination process. And it has high melting temperature and is difficult to handle. In this study, vitrification using iron phosphate glass was studied to lower the melting point of slag and effectively treat it.

2. Experiment

2.1 Carbon Steel Melting Test

The sample used in the experiment is carbon steel. The melting point of carbon steel is 1430℃. Alumina crucibles were used to melt the samples in the furnace. The temperature of furnace was increased to 1550℃ with 10℃/min.

2.2 Slag Analysis Method

XRD and SEM/EDS analysis were performed to analyze the chemical composition and crystallinity of the slag.

2.3 Vitrification of Slag Using Iron Phosphate Glass

Alumina crucibles were used to melt the raw chemical ($FeO:P_2O_5$ = 0.5:0.5) in the furnace The temperature of furnace was increased to 1150℃ with 10℃/min. After melting for two hours, glass was mixed using quartz rod. After that was poured the glass into the graphite mold.

3. Result

3.1 Carbon Steel Melting Test Result

Fig. 1 shows of carbon steel before and slag after melting.

Fig. 1. Carbon steel before melting(left) and slag after melting(right).

3.2 Slag Analysis Result

The SEM/EDS analysis of slag is shown in Fig. 2. Fig. 2 indicates that the slag is consisted of FeO and Al_2O_3. It seems that Al_2O_3 is diffused from the crucible.

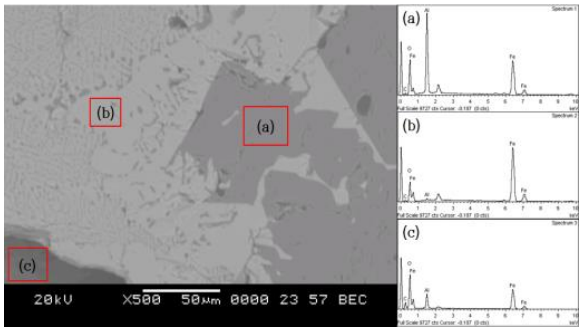

Fig. 2. SEM/EDS image of slag.

The XRD analysis shown in Fig. 3 indicated that the slag is consisted of 90% of FeO and 10% of Fe_3O_4. Since the physical properties, such as melting temperature, structure, etc., strongly depends on the oxidic state of Fe, accurate analysis of chemical species of Iron oxide is important.

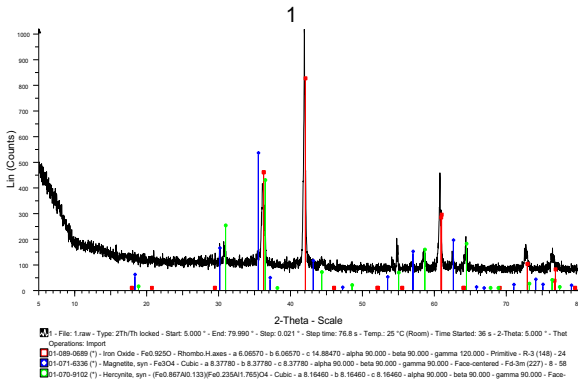

Fig. 3. X-Ray Diffraction of slag.

3.3 Characterization of Iron Phosphate Glass

Discharge was fair when the glass was poured into the graphite mold as shown in Fig. 4 (a), and the raw chemical was fairly dissolved in visual appearance as shown in Fig. 4 (b). The prepared glass was visually smooth on the surface and homogeneous as shown in Fig. 4 (c).

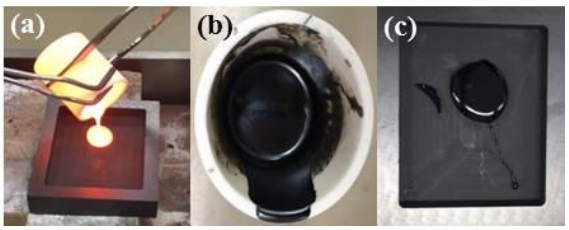

Fig. 4. (a) Glass pouring, (b) Crucible, and (c) Fabricated glass.

According to the evaluation of surface homogeneity through SEM/EDS analysis of Iron phosphate glass, a very homogeneous glass phase was analyzed as shown in Fig. 5. A homogeneous glass phase with Fe and P as the main composition was observed according to Fig. 5.

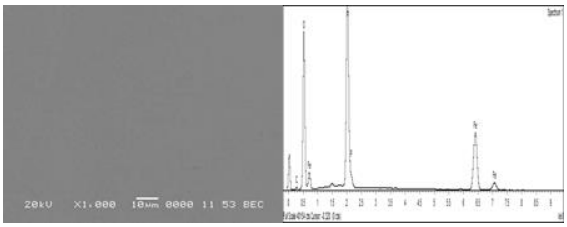

Fig. 5. SEM/EDS image of Iron phosphate glass.

4. Conclusion

When dismantling nuclear power plants, a large amount of carbon steel waste is generated. The main component of the slag generated during the carbon steel melt decontamination is FeO. Since the primary chemical species of slag was FeO, the Iron phosphate, which enables high waste loading, was studied for the vitrification of slag. As a result of the production of the iron phosphate glass to vitrify the slag, the experiment was successfully carried out. The physical and chemical properties of the resulting glass will be examined and a vitrification feasibility study will be conducted.

REFERENCES

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[2] Nieves, A. and Tilbrook, R. W. (1996) Potential radioactive scrap metal quantities from Nuclear power plants worldwide, Radwaste, Vol. 3, No. 1, pp. 45-53.