Development of Treatment Technology Using Plasma Torch Melting Facility for Heat Insulation Material

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1. Introduction

Heat insulation materials such as glass fiber wool are expected to be generated during operation and dismantling of nuclear power plants as the radioactive waste. The glass fiber wool is easily crushed in powder form due to long-term degradation. Therefore, the disposal of the glass fiber wool should be considered for treatment such as packaging or melting to prevent the dispersion of particle. To treat the waste, plasma torch melting is being considered as a promising treatment technology for the glass fiber wool generated from nuclear power plants. According to IAEA TECDOC-1527(2006), the treatment technology is known to be able to apply to various radioactive wastes regardless of its types such as both combustible and non-combustible wastes [1, 2]. In KHNP CRI, plasma torch melting facility was successfully developed to evaluate the applicability of the treatment technology. In this study, a demonstration test with glass fiber wool as a simulant was carried out using the developed 100kW class plasma torch melting facility.

2. Experimental

2.1 Plasma torch melting facility of KHNP CRI

The facility is mainly made of feeding system, melting chamber, pyrolysis chamber, discharge device, and off-gas treatment system as shown in the Fig. 1.

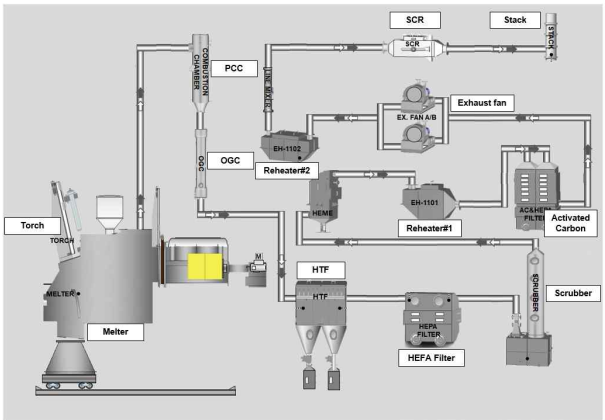

Fig. 1. Schematic diagram of plasma torch melting facility.

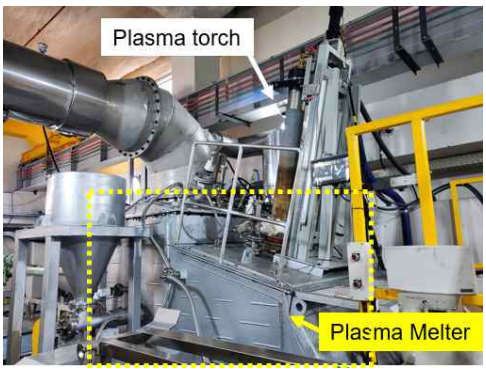

Fig. 2. Picture of plasma torch melting facility.

2.2 Target waste

The glass fiber wool, which is predicted to be generated during nuclear power plant of operation and dismantling, was selected as the target waste. For the demonstration test, glass fiber wool was drummed into 200L drum without the pre-treatment.

Fig. 3. Picture of target waste with 200L drum.

3. Results and discussion

3.1 Development of melt composition

To treat the glass fiber wool waste in plasma torch melting system, various factors could be considered like the slag of electric conductivity, viscosity and melting temperature. Especially, the viscosity of the glass melt is very critical factor for easy discharging.

The viscosity for plasma melting was calculated using the GlassPro Plus program. As shown in Fig. 4, the viscosity was calculated according to the amount of additive. From the calculated results, the composition

was determined to be 70wt.% of glass fiber wool and 30 wt.% of additives.

As the result, the glass fiber wool was mixed with additive, and then the melting test using electric box furnace was performed to check the viscosity with the naked eye. The simulant were melted at 1,400℃ for 2 hours as shown in Fig. 4. Melted glass fiber wool have a high viscosity. On the other hand, when an additive was added a enough low viscosity for melt discharge was shown.

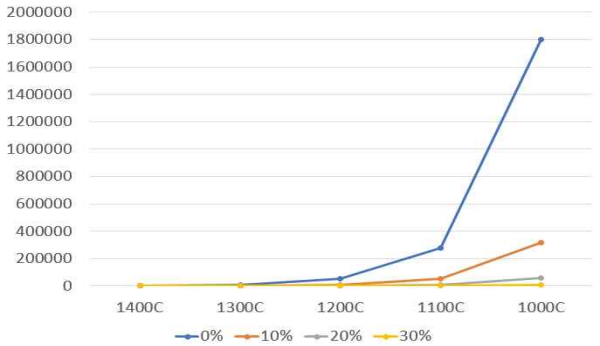

Fig. 3. Results of simulation of the viscosity of target waste.

Fig. 4. Picture of melted glass fiber wool: (upper) only glass fiber wool (bottom) glass fiber wool with additive.

3.2 Demonstration test

In this study, demonstration test was successfully carried out with developed composition and plasma torch melting facility. As shown in Table I, during the operation of plasma torch, the power was maintained about 360kW. The total amount of treated wastes is 74kg (10 drum) except for drum weight.

Table I: Results of the demonstration tests

Plasma torch	About 360kW
Melting chamber	About 1,600℃
Amount of treated waste	74kg (except for drum)
Operation time	10 hours

4. Conclusion

To treat the various types of radioactive wastes, plasma torch melting facility was successfully developed in KHNP CRI. The applicability of plasma torch melting for glass fiber wool was successfully confirmed through development of melt composition and demonstration test.

REFERENCES

[1] IAEA, “Application of Thermal Technologies for Processing of Radioactive Waste”, IAEA TECDOC-1527, 2006.
[2] Eduardo S. P. Prado, et al., “Thermal plasma technology for radioactive waste treatment: a review”, Journal of Radioanalytical and Nuclear Chemistry, Vol. 325, p.331-342, 2020.