Development of Plasma Melter for Melting & Volume Reduction

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1. Introduction

KHNP-CRI has been developed the plasma melter to reduce disposal costs and safely dispose of radioactive waste, which is instrument to treat the combustible and non-combustible waste as large-capacity plasma melting system with 1.5MW torch power. This melter which can efficiently treat various types of waste in large amounts was developed for treating 200 L drum, directly. The appearance of the melter comprises an inclined upper surface having a slope with respect to the horizontal upper surface, a pouring portion formed through a bottom surface of the melter for discharging molten material there through, and an 200 L drum input apparatus having a slope for pushing waste into the melter, and plasma torch installed on the inclined upper surface with a slope for generating melting heat in the melter.

2. Melt and Volume Reduction

2.1 Treatment of Target Waste

Plasma melter is typically used to dispose of radioactive waste generated from nuclear power plants. In general, the medium and low level wastes generated in nuclear power plants are stored in a closed 200 L drum container. The wastes stored in drums are collected and stored in various forms, and the wastes comprise a variety of components having characteristic such as flammable, inorganic, etc. Therefore, it is difficult to separate and treat the radioactive waste stored in the 200 L drum separately because of the concern on secondary contamination. Therefore, it is very important that a series of stabilization treatments such as waste input, crushing, combustion and melting, etc. should be continuously made in a melter. The plasma melter has advantage to melt non-combustible materials such as metals, concrete, and so on, thereby reducing the volume.

2.2 Status of Operation on Commercial Facility

Recently, the plasma torch melter facility in the Kozloduy Nuclear Power Plant on Bulgaria was finished the pre-operation test on July, 2018 and commercial operation from August started for volume reduction of radioactive waste generated during NPP operation. This melter is discharging molten material with a method by tilting like as plasma facility on Zwilag in Switzerland. In case of Tsuruga nuclear power plant, the pouring of molten is using heating method with an induction heating device on around an outlet of the melter. An induction heating tool is an outlet positioned at the center of the bottom of the cone type.

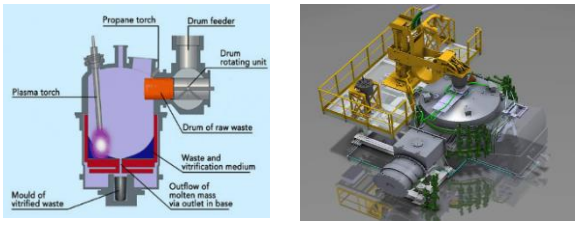

Fig. 1. (a) Tilting Type Plasma Melter of Zwilag, (b) Bulgaria Plasma Melter System.

3. Status of KHNP

KHNP-CRI through the present research developed a large-capacity melter to treat combustible and non-combustible wastes. A large-sized melter for directly processing a 200 L drum scale is used to increase the throughput of a target material, and a megawatt(MW) scale plasma torch is applied in consideration of the heat loss in the melter and the torch. In a plasma melter developed from present research, the upper surface on which the plasma torch is installed is provided with a constant inclined surface. Accordingly, the torch in melter is smoothly operated, and plasma heat source generated by the torch can easily keep balanced up to the upper

portion of the melter. The waste input on upper portion of melter is provided by a small-diameter (approximately 20 cm) inlet pipe and non-drum-shaped combustible waste can be input. The large-scale inlet apparatus is installed at the lateral inlet formed through the side of melter such that the waste drum of 200 L is directly inputted. The drum waiting portion is provided to have a gentle slope in a range of approximately 20 to 45 degrees so that the waste drum is inputted along the inclined bottom surface. Accordingly, the waste drum is input into the melter along a gently inclined surface, thereby minimizing the impact that may be applied to the melter body. The drum waiting portion comprises a slide gate provided on the upper portion which is sliding openable; and an input gate for spatially separating the drum waiting portion and the guide support and being vertically openable.

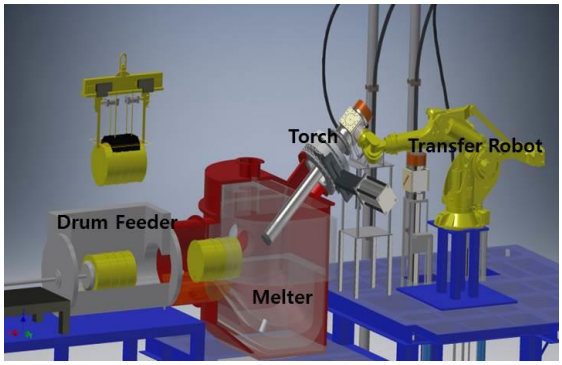

Fig. 2. KHNP Plasma Torch Melter Outline.


Fig. 3. Large-capacity KHNP Plasma Melter.

4. Result and Conclusion

The plasma melter comprises a discharge portion formed through a lower portion of inside body and at least two lateral discharge gates provided on the side of the melter at different heights for discharging the molten material. The melter body was made using a material with a high thermal stability such as heat-resistant bricks, and a cooling channel is formed in the inside of the melter.

The refractories inside melter were comprised with B-5, alumina brick, SAL/WMCT-10CR(Al_2O_3-Cr_2O_3 brick), MgO-C brick(YGM-15S1), MgO-C ramming (MgO-C) and so on. There are used with B-5 as an insulating material, MgO-C and MgO-Cr_2O_3 bricks as fireproof, MgO-C plastic as filling material around electrode inserted on melter bottom and castable of HACT-170. Accordingly, the outer surface of the melter can be cooled and maintained at a proper temperature below 60 degree by circulation of cooling water. The plasma torch is installed at the upper end of the melter which is operated with transferred or non-transferred mode. Electrodes for transferred operation were provided at the lower portion of inside melter.

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