Experimental Research on Decontamination of Co Containing Metal by Induction Melt

Beom-Kyu Kim, Hwa-Jeong Han, Jun-Hyeok Lee, Jae-Hong Yim, and Byung-Gi Park*
Soonchunhyang University, 22, Soonchunghyang-ro 22, Asan-si, ChungCheongnam-do, Republic of Korea
*qu@sch.ac.kr

1. Introduction

The dismantling of a nuclear power plant is the final finishing process for safely disposing and disposing of a nuclear power plant whose operating life has expired, it is imperative that the dismantling technology is uniquely established and internationally competitive. During a decommissioning of nuclear plants and facilities, large quantities of slightly contaminated steel wastes are generated. Radioactive metal wastes generated during nuclear dismantling process are primary targets for reduce volume and can be recycled if the radioactive contamination degree is reduced through the melting process.[1-2] Most of the radioactive contained in the metal contains Co-60, Co-58. In this study, we conducted an experimental study on the decontamination of radioactive metal waste using induction heating method for Cobalt, which is expected to be a major pollutant species, in the case of metal melt decontamination related to steam generator disassembly during disassembly process. Melting decontamination is accomplished by combining radioactive nuclides with oxygen or other elements to form a safer form of the compound when the metal contaminated with the radionuclide is melted. Therefore, in this melting experiment, the radionuclides in the contaminated metal are combined with oxygen in the air or the oxygen element in the slag to form the nuclide oxides, and the oxides of the radionuclides formed are in contact with the slag, it is moved to the slag phase by the difference or the like and is decontaminated.

2. Experimental

Since the actual radioactive element is not safe, the experiment is performed by replacing the simulated material. The simulated radioactive elements were Co3O4, 1.0 g (Alfa Aesar, 99.7%), and the decontamination flux was purchased from Sigma Aldrich as CaO, SiO2, Fe2O3 and Al2O3. The composition of the flux medium is CaO (40%) - SiO2 (30%) - Fe2O3 (20%) - Al2O3 (10%) / 100 g. The molten metal was carbon steel (2 kg). Experiments were carried out in the induction chamber in Figure 1. The melting time was 6 hours, frequency was 15 kHz, the maximum applied power was 7.5 kVA and the temperature was carried out at about 1800°C as the melting temperature of the carbon steel. In the experimental procedure, a carbon steel metal and a nuclide (cobalt) are added to a magnesia crucible and melted to make a simulated specimen. Flux was then added as a medium for decontamination according to the composition. Then Samples were aliquoted and sampled over time. The concentration of cobalt in the metal was measured by ICP and compared with time. In addition, we confirmed the distribution behavior of slag and ingot through SEM-EDS.

3. Result and Discussion

In this experiment, the ingot was sampled acquired according to time and the process is shown in Fig. 1 (a). It is the process of being sucked into the sampling tube through the pressure. In Fig. 1 (b), the sampled metal specimens were divided into 5 pieces, upper, middle and lower parts to perform ICP.

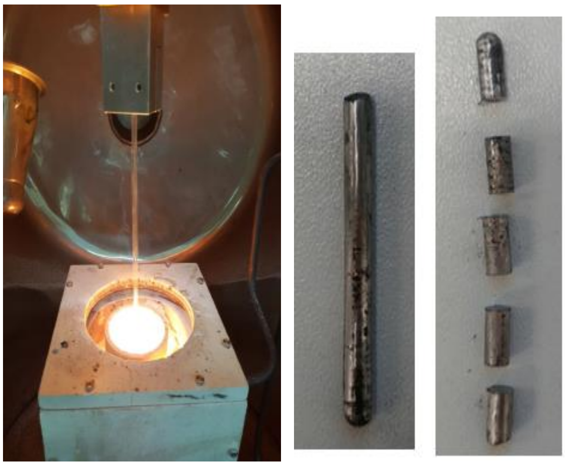

Fig.1. (a) Sampling process in the crucible inside the chamber (b) the sampled metal specimen.

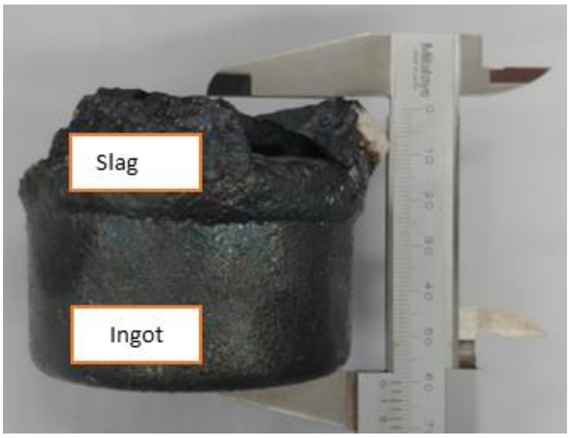

Fig. 2. The final solid metal and slag at room temperature.

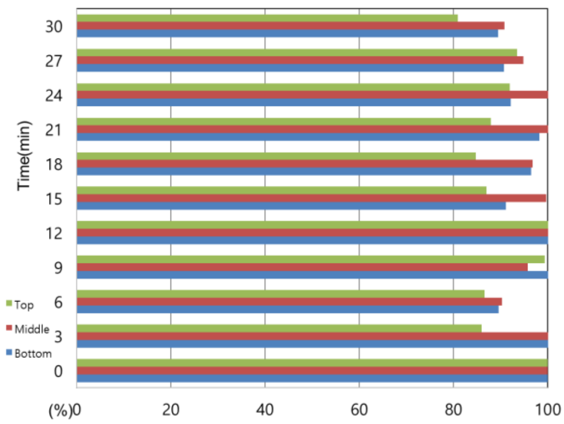

Fig. 3. Percentage (%) of late concentration/initial concentration over time as measured by ICP.

Figure 2 shows the ingot after melting. The change in metal mass before and after melting was changed from 2.0 kg before melting to 1.45 kg after melting. It can be seen that the metal-oxidized metal oxide has migrated to the slag. It was confirmed that the slag and the ingot were clearly separated. Fig. 3 shows the results of ICP analysis of the metal phase. It was confirmed that Co contained about 80% finally.

4. Conclusion

As a result of the experiment, the removal rate of Co was about 10 ~ 15%. The ionic bond of cobalt is easier to react with the slag during melting than the metal bond. The first step in melt decontamination is to form oxides of radionuclides. However, since cobalt is smaller than oxygen and affinity than metals formed in Flux such as Si, Ca, Al, and Fe, oxygen is difficult to form cobalt oxide by bonding with metal elements having high affinity first. Cobalt is assumed to be stabilized in the metal phase

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