

Chemical analysis and volume reduction of radioactive HEPA filter waste

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1. Introduction

According to the active operation of nuclide facilities at KAERI, many spent filters used in a ventilation system of the nuclear facilities have been generated as a spent filter wastes. These spent filter wastes have generally consisted of a HEPA filter after filtering of all the contaminants in the air stream generated during the operation of nuclide facilities [1]. Therefore, this study is conducted to investigate the radionuclide and heavy metals in HEPA filters, and the characteristics of the melting as a decontamination and volume reduction.

2. Materials and methods

2.1 Chemical analysis of HEPA filter

Five HEPA filter samples were collected in KAERI. The filters were weighed before and after the extraction using a microbalance with 1 μg sensitivity to obtain the net mass of collected dusts. The filters were equilibrated in desiccator with stabilized temperature (22-23°C) and relative humidity (45-50 %) for at least 24 hours before and after actual weighing. We followed the analytical procedure for determination of trace metals in filters shown in Work Assignment 5-03 [2] and SOP MLD061 [3]. The collected filters were extracted in Teflon centrifuge tubes with 25 mL of the 4% nitric acid followed by ultrasonic treatment for 3 hours using heated (69°C) sonication bath. After sonication, the samples were allowed to cool down at room temperature. Samples were filtered by Whatman 541 filter paper and the diluted with DI water having a final volume of 50 mL prior to use of inductively Coupled Plasma-Optical Emission Spectrometry (ICP-OES) to analysis of As, Cd, Co, Cr, Cs, Pb, Se, Sr, U, and Zn. The samples were stored in a refrigerator before analysis.

2.2 Volume reduction of radioactive HEPA filters

Melting has been known as one of the most effective technologies for volume reduction and recycling of metallic radioactive wastes [4,5]. TGA analysis of HEPA filter was conducted to investigate the characteristic of volume reduction by melting. A muffle furnace was used in the melting experiment to obtain basic data on the melting characteristics of the HEPA filter. The XRD and SEM analyses were conducted to investigate the crystalline and morphology of melted HEPA filters. HEPA filters contained the filter

separator of aluminum and filter media of glass fiber. The muffle furnace tests were conducted for separator HEPA filter of aluminum and glass fiber and mixed HEPA filter to investigate the possibility of separation during melting procedure.

3. Results and discussion

3.1 Heavy-metal concentration

The different HEPA filter samples were collected in five areas in KAERI. The heavy-metal concentrations in HEPA filters were analyzed using Work Assignment 5-03 [2] and SOP MLD061 [3]. The most abundant elements in the HEPA filter were Zn followed Sr, Pb, and Cr. The concentration of As, U, Se, Co, Cs, and Cd is low levels in HEPA filters.

3.2 Characteristics of melting in HEPA filters

The TGA analysis of HEPA filter was conducted to investigate the characteristic of volume reduction by high-temperature melting. The results of TGA analysis showed the HEPA filter was significantly shranked from 200 °C to 500 °C (Fig. 1). The reason is the dehydration of H₂O, volatilization of combustible binder, and the phase change to liquid of inorganic filter media. The soften point of HEPA filter media is 670 °C.

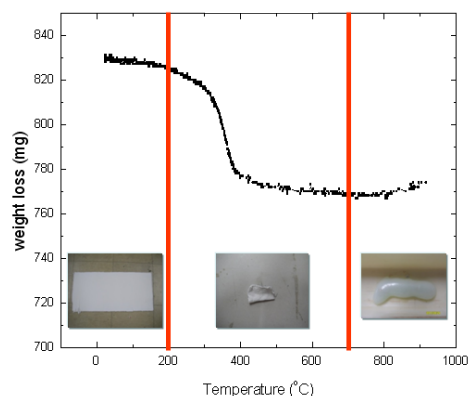


Fig. 1. The TGA analysis of HEPA filter media

The HEPA filter was changed to the volume-reduced and stable solid by vitrification of HEPA filter media. The ratio of volume reduction by melting is 34 (Fig. 2). This result indicated that the volume reduction ratio is significantly high, and HEPA filter media was transformed to stable and reduced solid form.

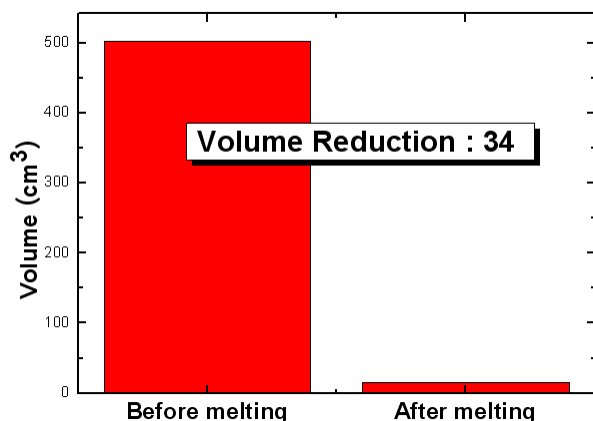


Fig. 2. The volume reduction in HEPA filter

The muffle furnace test was conducted for the possibility of separation between aluminum and glass fiber in HEPA filters. Results showed that the separated HEPA filter was isolated to the aluminum and filter media by melting. However, non-separated HEPA filter was melted to the mixed solid (Fig.3). Therefore, the development for conditioner is needed for separation between aluminum and glass fiber during melting.



Fig. 3. The volume reduction in HEPA filter

4. Conclusions

The most abundant heavy-metals in HEPA filter is Zn and the soften point of HEPA filter media is 670 °C. Based on the results, the ratio of volume reduction by melting is 34. The melting of HEPA filter was transformed to stable solid. Based on these results, the melting is one of the most effective technologies for volume reduction and recycling of HEPA filters.

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