Evaluation of Cesium Trapping Characteristic With SA Filter

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1. Introduction

An accumulation of spent fuel has brought a considerable interest due to its energy and environmental issue. Pyroprocessing has been investigated in Korea Atomic Energy Research Institute (KAERI) which reduces the accumulated spent fuel and increases the efficiency of fuel cycle. In head-end process of pyroprocessing, UO_2 pellets are produced from a fuel bundle and various radioactive gases from a spent fuel are released during thermal treatment. Within these gases, Cs-137 is a semi-volatile gas which had very high radioactivity, and therefore it is important to trap Cs.

It is well known that Cs highly reacts with aluminosilicate to form $CsAlSi_2O_6$ or $CsAlSiO_4$, and these structures are very stable in storing for long period. KAERI had developed a silica-alumina (SA) filters from kaolinite and had confirmed that it is effective in trapping Cs [1]. It is advantageous to fabricate SA filters because the size, shape, and porosity can be easily controlled by using suitable support material. In this study, SA filters were fabricated and the capture characteristic was investigated by using highly developed trapping system with SA filters.

2. Experimental Section

The silica-alumina (SA) based filters were prepared from kaolinite. Kaolinite ($Al_2Si_2O_5(OH)_4$) solution was mixed with 2wt% PVA solution and sprayed to polyurethane sponge and for several times and then calcined at 1200°C for overnight in air. The fabricated SA filters were placed in horizontal alumina tube and reduced at 1000°C for overnight using 4%-H_2 based Ar gas.

The Cs trapping system was consisted of two high temperature regions; vaporization and adsorption zones.

Cs_2CO_3 was placed in the alumina boat in the center of the vaporization zone and temperature fixed to 1100°C. In the adsorption zone, a horizontal Inconel cartridge was filled with cylindrical SA filters as shown in Fig. 1. The temperature of adsorption zone is operated at 1000°C for Cs to react SA filters. For the untrapped gas, Cs particles might be condensed on the condensation zone at low temperature, and the water scrubbers were installed at the end of the system for aqueous absorption. The trapping atmosphere was ~1.5 bar in alumina tube caused by four water scrubbers and the flow rate was 1 L min^{-1}.

3. Cs Trapping Characteristic

Cs trapping efficiency was calculated based on the mass increased on the SA filters after Cs_2CO_3 vaporization. In addition, Cs concentration of water in scrubbers can be used chemically analyzed to evaluate the trapping characteristic.

4. Conclusion

Trapping process was designed for Cs capture using trapping system with SA filters. Cs trapping performance was investigated and it was confirmed that most of Cs vaporized were effectively captured in the trapping system using SA filters.

Fig. 1. SA filters and SA filter cartridge.

REFERENCES

[1] Jae Hwan Yang et al., “A kaolinite-based filter to capture gaseous cesium compounds in off-gas released during the pyroprocessing head-end process”, Annals of Nuclear Energy (2017), Volume 103, page 29–35.