

Melt-Crystallization Monitoring System for the Purification of LiCl Salt Waste

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1. Introduction

Korea Atomic Energy Research Institute (KAERI) is developing pyrochemical process for the recycling of PWR spent nuclear fuels using electrochemical method to achieve the volume reduction of radioactive waste [1-3]. During the process, LiCl salt wastes are planned to be recycled using melt-crystallization process. In this study, modified crystallization monitoring system has been developed to prevent over-growing of LiCl crystal on the crystallization plate during melt-crystallization process.

2. Experimental

Melt-crystallization tests were conducted using engineering-scale melt-crystallization system capable of 20kg/batch treatment. In this study, the tests were conducted using 10 kg of surrogate LiCl salt waste. The surrogate LiCl salt waste having 0.03wt% CsCl, 1.11wt% SrCl₂ and 2.31wt% BaCl₂ were charged in the crystallization vessel and melted at 700 °C in the crystallization furnace. Then, crystallizer having 6 crystallization plates were immersed in the molten LiCl salt waste and the LiCl crystals were recovered on the 6 crystallization plates by cooling the plates using Ar coolant gas. Melt-crystallization process was terminated using modified crystallization monitoring system by measuring temperatures at each characteristic points. Nuclide separation efficiencies (%) were calculated by the relationship

of $(C_{before}-C_{after})/C_{before} \times 100$, where C_{before} and C_{after} are nuclides concentration in the LiCl salt waste before and after crystallization process. Concentration of cesium nuclide was measured using an Inductively Coupled Plasma Mass Spectrometer (ICP-mass) with a Thermo Elemental (Xseries X5) and concentrations of strontium/barium nuclides were measured by Inductively Coupled Plasma Atomic Emission Spectrometer (ICP-AES) with a Perkin Elmer (Optima 4300DV).

3. Results and Discussion

Fig. 1 shows the recovered LiCl crystal on the crystallization plates after melt-crystallization test. As shown in the Fig. 1 (a), when used previous monitoring system, over-grown LiCl crystal was found at the center part of crystallization plate owing to the temperature gradients. Meanwhile, modified crystallization monitoring system has been developed in consideration of temperature gradients within the reaction vessel, where the crystallization process of center part of crystallization plate is first terminated owing to the relatively high temperature. Therefore, as shown in the Fig. 1 (a), when used the modified crystallization monitoring system, we could obtain pure LiCl crystals on the crystallization plates with uniform distribution in terms of LiCl quantity. Also, the nuclide separation efficiencies were found to be enhanced as over 90% relative to that of purified LiCl crystal recovered using previous monitoring system.

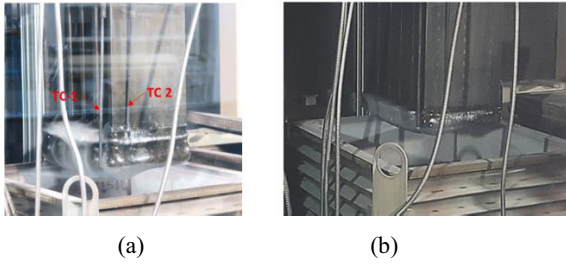


Fig. 1. (a) Over-grown crystal grown by previous monitoring system, (b) Recovered LiCl crystal without over-growing using modified crystallization monitoring system.

4. Conclusion

In the present study, melt-crystallization monitoring system has been modified to prevent over-growing of LiCl salt on the crystallization plates by considering temperature gradient within the reaction vessel. Using the modified crystallization monitoring system, high nuclide separation efficiency was obtained with uniform distribution of LiCl salt on the crystallization plates.

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