Separation Characteristics of Fission Products in LiCl-KCl Waste Salt by Layer-melt Crystallization

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1. Introduction

The wastes arising from pyrochemical process after sufficient use of chloride salts as molten state electrolytes are LiCl waste salt from the electrolytic reduction process, and LiCl-KCl eutectic waste salt from the electrorefining and electrowinning processes. In particular, the waste salts have highly heat generative group II fission product such as Sr and Ba nuclides and highly radioactive generative rare earth fission products. Therefore, the fission products within the waste salt should be separated and concentrated in small volume to reduce the volume of final waste [1].

In this study, layer melt crystallization process was tested for separation Group Ⅰ & II and rare earth nuclide from the LiCl-KCl molten salt.

2. Experimental

Layer melt crystallization process was carried out in a 2 Kg/batch lab-scale apparatus. LiCl-KCl crystals were recovered by layer-melt crystallization, where crystallization plate is rectangular shape with thickness of 15 mm, 60 mm wide, and 200 mm height. Module of crystallizer consisted of three thermocouples, three crystallization plates [2]. Crystallization process was controlled by temperature monitoring of around crystallizer module: outer surface of crystallization plate (Crystallizer TC), center of two crystallization plate (Center TC) and molten salt (Salt TC), as shown in Fig. 1. All the parts are located in a glove box which was kept in Ar atmosphere. 2 kg LiCl-KCl having impurities of 1wt.% Group Ⅰ & Ⅱ nuclides and 0.5wt.% rare earth nuclide respectively were melted at 440°C in a furnace. For the growth of LiCl-KCl crystal on the crystallization plates which were cooled by Ar gas with stepwise flow rate of 5 L/min to 1min and 20 L/min to 300min. After crystallization process, concentration of impurities in purified LiCl-KCl salt was analyzed using an Inductively Coupled Plasma Spectrometer.

3. Results

Solid-liquid phase diagram was identified to determine temperature condition of crystallization process and separation possibility. Fig. 2 is the solid-liquid phase diagram for the LiCl-KCl-$SrCl_2$ system drawn using the FactSage software. As shown it showed not solid solutions at 330-350°C. Therefore, it thought that separation of Group I and II nuclides and recovery of purified LiCl-KCl salt can possible in this temperature conditions of crystallization process. The purified LiCl-KCl crystals are obtained below its melting temperature of around 350°C on the crystallization plates which is cooled by Ar coolant. Solid-liquid phase diagram of LiCl-KCl-$LaCl_3$ system is shown in Fig. 3. The temperature of solid state of only LiCl-KCl eutectic is none. The phase diagram shown that this system exist temperature zone of formation of K_2LaCl_5.

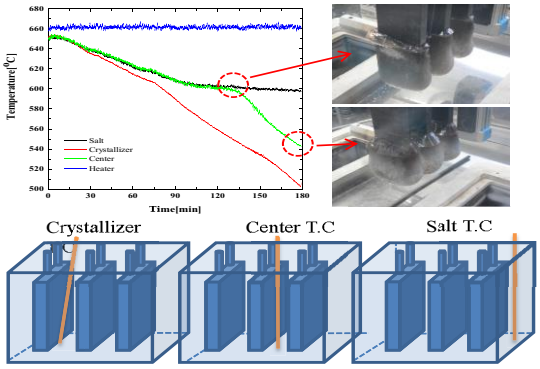

Fig. 1. Scheme of crystallizer module and temperature monitoring.

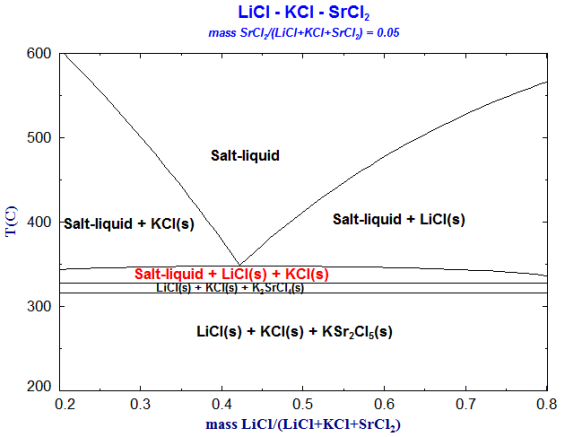

Fig. 2. Phase diagram of LiCl-KCl-$SrCl_2$ system.

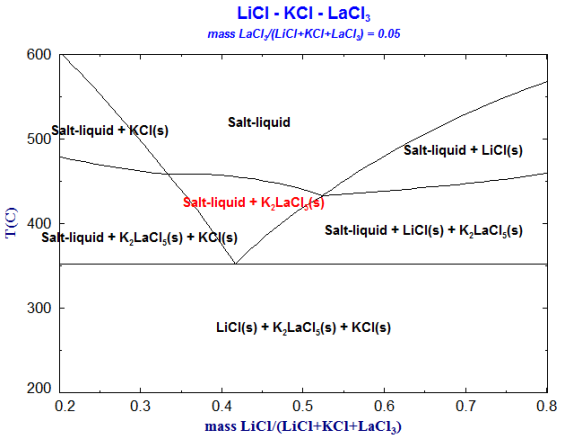

Fig. 3. Phase diagram of LiCl-KCl-$LaCl_3$ system.

REFERENCES

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[2] Y. Z. Cho, G. H. Park, H. S. Lee, I. T. Kim and D. S. Han, " Concentration of cesium and strontium elements involved in a licl waste salt by melt crystallization process", Nucl. Technol., 171, 325 (2010).