# Electrical Conductivity & Viscosity of Multi-Component LiCl-KCl Molten Salt Systems Comprising Uranium and Lanthanides

Sang-Heon Lee, Jong-Yun Kim, Dae-Hyeon Kim, Sang-Eun Bae, Tae-Hong Park

*Nuclear Chemistry Research Division, Korea Atomic Energy Research Institute*
*111, Daedeok-daero 989beon-gil, Yuseong-gu, Daejeon, 34057, Korea*
*kjy@kaeri.re.kr*

## I. PHYSICAL PROPERTY MEASUREMENT TECHNIQUE

Many physical properties of high-temperature molten salt such as the electrical conductivity, viscosity, phase transition and temperature are very critical in designing and operating the pyroprocess. Such properties also provide important information with regard to the process operation and nuclear material accountancy. Among the many valuable physical properties, the electrical conductivity and viscosity are essential physical properties providing information of monovalent and trivalent ions in molten salts used in the pyroprocess. However, not all commercially available measurement systems are adequate for measuring the electrical conductivity and viscosity of high-temperature corrosive molten salts. Recently, we developed new electrical conductivity and viscosity measurement systems installed inside a glove box, and controlled using custom-made software based on LabView and the C# program.

### I.A. Electrical Conductivity

The electrical conductivity measurements of LiCl-KCl molten salts with various compositions of $UCl_3$, $LaCl_3$, $CeCl_3$, and $NdCl_3$ were performed in a glove box under an argon atmosphere equipped with a high-temperature furnace. An in-house designed capillary cell and measurement system were used for an accurate determination of the relatively higher electrical conductivities of molten salts. In our present study, a short time interval, multiple-potential step, chronoamperometry technique was used to minimize the measurement errors owing to the polarization. In the short time interval, multiple-potential step, chronoamperometry technique, the potential is applied for a very short period of time (on the order of microseconds) to minimize the influence of the polarization of the electrode. With a series of standard solutions with known conductivities, the cell constant was determined from the slope of a peak current at each time interval versus the potential curve. Subsequently, the same procedure and the same capillary cell were followed for the determination of the electrical conductivities with a test sample solution containing 0 to 9 mol% $UCl_3$ at various temperatures (300 ℃ to 620 ℃). The measurements of the electrical conductivity showed that one or two phase transition temperatures of multi-component LiCl-KCl molten salt systems comprising uranium and lanthanides were observed by reducing the temperature from 620 ℃ to 300 ℃. The electrical conductivity measurement technique is applicable to the determination of the liquidus and solidus temperatures of multi-component LiCl-KCl molten salt systems comprising uranium and lanthanide elements.

### I.B. Viscosity

For the viscosity, the measurements of LiCl-KCl molten salts with various compositions of $UCl_3$, $LaCl_3$, $CeCl_3$, and $NdCl_3$ were also conducted in a glove box under similar conditions with the electrical conductivity measurements using a viscosity measurement system for molten salt by modifying a commercial Brookfield viscometer. The precision (RSD) of the viscosity measurement was less than 10 % within the range of 1-5 cP. The viscosity measurements of multi-component LiCl-KCl molten salt systems comprising 0 to 9 wt% $UCl_3$ were conducted at 500 ℃.

## II. CONCLUSIONS

In conclusion, a physical property measurement technique, such as for the electrical conductivity and viscosity, under development will be useful for a safe and efficient process operation. In addition, such fundamental physical properties provide the basis for understanding and predicting the macroscopic behavior of the actinides and lanthanides in the molten salts in the scaled-up pyroprocess.

## ACKNOWLEDGMENTS

This work was supported by a National Research Foundation of Korea (NRF) Grant, funded by the Korean government (MSIP).