In- and ex-situ monitoring of extremely low MgOHCl in molten chloride salt for next-generation CSP

Qing Gong[1, *], Wenjin Ding[1], Alexander Bonk[1], Thomas Bauer[2]

[1] Institute of Engineering Thermodynamics, German Aerospace Center (DLR), Stuttgart, Germany
[2] Institute of Engineering Thermodynamics, German Aerospace Center (DLR), Cologne, Germany
[*]Corresponding author, Underline: presenting author

Molten chloride salt ($MgCl_2$-KCl-NaCl) is seen as a promising thermal energy storage medium for next-generation concentrating solar power (CSP) plant, due to its advantages of relatively low melting point (~385 °C), high thermal stability (stable at >800 °C), low vapor pressure (~ 1 kPa at 800 °C) and low cost (0.22 USD/kg) [1, 2]. However, molten $MgCl_2$-KCl-NaCl is strongly corrosive to Fe-Cr-Ni alloys even under protective inert gas atmospheres, attributing to hygroscopicity and corrosive hydrolysis products [3]. MgOHCl ($MgOH^+$) is the main corrosive hydrolysis product, which is soluble in $MgCl_2$-containing molten salt [4]. Hence, monitoring of MgOHCl is essential to evaluate the redox potential (i.e. corrosivity) of $MgCl_2$-KCl-NaCl. In other words, monitoring of MgOHCl is a prerequisite for quantitative control of corrosion. In previous work, the MgOHCl concentration was in-situ measured with cyclic voltammeter (CV) and was ex-situ measured with acid-base back titration (BT). The ex-situ BT results were used to calibrate the in-situ CV results. With this approach, concentration of MgOHCl in molten chloride can be converted into electrical signal, which has been used for lab-scale to understand purification methods[5, 6]. In addition, CV could be a potential method for automatic corrosion control system (CCS) in molten salt loops.

However, when the concentration of MgOHCl was measured by BT, the results were interfered with MgO mixed in chloride salts. This makes the measure limit of MgOHCl concentration above 0.1 wt.%, which is not sufficiently low to study the acceptable impurity level in molten chlorides. In this work, a more accurate ex-situ measurement, direct titration (DT), was adopted and will be reported. With the post calibration by DT, it is demonstrated that the extremely low (~0.02 wt.%, 39 ppm O) MgOHCl is quantifiably detectable in-situ by CV at 700 °C.

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