Electrical and Thermal Modeling of a Molten Salt Electro-Refiner

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Abstract

A common pyrometallurgical route for the recovery of numerous metals and rare earths is high-temperature molten salt electrolysis. This process involves an electrolyte made of a molten salt in which the metal to be recovered, most commonly present in its oxide form, is dissolved. When a current is applied between the cathode and anode, the metal is deposited as a solid or a liquid at the cathode, while some gas (generally a carbon oxide, such as CO or CO2) evolves at the carbon-based anode, as depicted in the figure below.

Numerical simulation can be advantageously employed to predict the main cell features (e.g., the reaction rate distribution on the electrodes, the cell voltage, or the electrolyte temperature) in order to optimize the design and operational conditions of the process.

In this poster, we describe two complementary computational approaches applied to a molten salt electro-refiner for predicting (1) the current distributions at the surface of the electrodes and (2) the temperature throughout the cell. The electrical model relies on the secondary current theory, i.e. with activation-based overpotentials. The thermal model accounts for the three transport modes (conduction, convection and radiation) of the heat that is generated by the current flow and the overpotentials, both simulated with the electrical model.

Figures used in the abstract

Figure 1

Figure 2

Figure 3

Figure 4