Application of Molten Salts in Metals Production

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Abstract

Molten salt pyrochemical and electrolytic processing provides a unique opportunity to process and produce metals where gas-based pyro-reduction, metallothermic reduction, hydrometallurgical methods or aqueous electrochemical techniques are not feasible due to thermodynamic or kinetic limitations. Production of aluminum and magnesium by molten salt electrolysis are well known commercial processes. Several other reactive metals, such as lanthanides and actinides, as well as beryllium and calcium, make use of molten salt processing for extraction and refining.

This presentation describes the science of molten salt electrochemistry for pyrometallurgical reduction and electrowinning and electrorefining of metals. Material issues in design of molten salt reactors will be discussed. Case studies described in the presentation include (i) recovery of calcium metal from molten salt waste forms, (ii) proposed process for direct production of beryllium-aluminum alloy and a (iii) proposed scheme to produce silicon metal from lunar anorthite. It has been shown that reactive metals, such as calcium can be produced at a commercially acceptable rate using a porous ceramic diaphragm around the anode that prevents the back reactions in the cell. The production of beryllium using a liquid aluminum cathode is a viable process that uses low melting electrolytes. These processes will have tremendous potential if inert anodes can be applied in these cells. Experimental data will be included to justify the suitability as well as limitations of these specific processes. A novel scheme will be described to produce metals by pyrometallurgical reduction using the metal produced electrolytically within the same reactor. Anodic oxygen is the only by-product of this process that can produce metals having low solubility in the salt.