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Pyrochemical Extraction Analysis of an Immiscible Molten LiCl-KCl/Cd System

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Immiscible liquid contacting is one of the most common and important phenomena in the high temperature pyrochemical systems. Among these processes, an extraction system employing molten LiCl-KCl and liquid Cd metal has been proposed for the pyrochemical recovery of actinides in a waste salt treatment step. Understanding the complex interaction of immiscible fluid dynamics with mass transfer is a fundamental importance in a liquid-liquid extraction process. The use of a liquid cadmium electrode, which is the unique feature of the process, provides hydro-dynamically a free surface contacting with an immiscible molten-salt electrolyte. This free interface of immiscible liquids gives an interface for mass transfer and is inconstant depending on agitated conditions. A computational method to expect an effective area for the mass transfer in the molten-salt and liquid metal system is particularly interesting and challenging for an agitated operation frequently encountered in the pyrochemical system. Details of the calculation of the velocity fields and free surface profiles which evolve in time are given. Representative simulation results are presented to illustrate the capabilities of this method for the molten LiCl-KCl/Cd system.

In addition, this study also presents a new modeling approach for studying an analysis of a counter current multistage extraction in the immiscible molten streams. An operational analysis of a counter current multistage extraction was carried out by the model equations, composed of species material balance and distribution relationships between molten salt and cadmium phase. The solutions were determined by using the matrix-based numerical method and the parametric investigations were simulated for the effect of the operating variables on the decontamination factor. The decontamination performance and species concentration profiles could be obtained by considering the flow ratio of immiscible liquids and oxidant feed throughout the multistage extraction step in a given actinides concentration condition of the waste stream.

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