Optimizing Electrode Dissolution In Flow-through Electrochemical Reactors With Concentric Electrodes

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Abstract

Electrochemical reactors play a crucial role in various industrial processes, such as electroplating, water treatment, and energy conversion. In this study, we present a Multiphysics model developed to predict the optimal design of an electrochemical reactor with concentric electrodes, focusing on electrode dissolution. The model utilizes the Tertiary Current Distribution mathematical scheme and considers laminar flow, transport phenomena of chemical species, and the operation of the reactor under galvanostatic conditions with periodic polarity changes. To analyze and optimize reactor performance, a Multiphysics model was developed using COMSOL Multiphysics®. This model incorporates variations in electrolyte composition, ionic strength, solution resistance, and electrode kinetics. It also includes single-phase laminar fluid flow, the Nernst-Planck equation, electroneutrality approximation, and concentration-dependent overpotentials to simulate the electrolysis process of electrode dissolution. By using the developed model, the impact of different geometric sizes of the reactor and the frequency of current polarity changes on the overall performance of the system was investigated. The optimization process aimed to enhance the efficiency of the electrode dissolution process and improve the overall reactor design. The results of this study demonstrate the effectiveness of using the COMSOL Multiphysics® to predict reactor performance and optimize its design based on parameters such as geometric size and current polarity half cycles. The findings provide valuable insights into the complex interplay of factors affecting electrode dissolution in electrochemical reactors and highlight the importance of incorporating Multiphysics approaches in the design and analysis of such systems. Overall, this research contributes to the advancement of electrochemical reactor design and provides a framework for improving the efficiency and performance of electrode dissolution processes in various industrial applications.

Reference

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