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Thermochemical Modeling of a Hydrolysis Moving Bed Reactor in the Cu-Cl Cycle of Hydrogen Production

Jenna M. Broders[1], Kelly A. Hawboldt[2], Kevin Pope[3], Greg F. Naterer[4]
[1, 3, 4] Department of Mechanical Engineering, Memorial University of Newfoundland and Labrador, St. John's, Canada
[2] Department of Process Engineering, Memorial University of Newfoundland and Labrador, St. John's, Canada

ABSTRACT

This study focuses on simulating the hydrolysis step of the Copper-Chlorine (Cu-Cl) Cycle in a moving bed reactor (MBR). The hydrolysis reaction is one of three reactions in the Cu-Cl cycle for hydrogen production. Several recent studies have highlighted fluidized bed reactors as a promising reactor for this reaction, with lab scale studies ongoing. However, a potential alternative reactor system, to decrease associated costs and energy requirements of high steam to copper ratios, is an MBR. Alternative heterogeneous MBRs have been successful in reducing steam requirements in steam gasification of coal and biomass. These operations demonstrate comparable reaction models to the hydrolysis reaction, which indicate the potential of moving bed reactors as an attractive alternative for the process. Simulation of MBRs can be used as a tool to establish the feasibility and design of a lab scale and scaled up MBR, however, there are no current models for this reaction system. This reactor model uses the Shrinking Core Model (SCM) for heterogenous reactions, reaction kinetics, and mass and energy balances, to represent the system. The resulting simulation is first validated by established reaction system / data and then applied to the Cu-Cl system. The model is then used to investigate whether a series of MBRs could improve the steam to copper ratio and conversion of the hydrolysis reaction, as well as the overall cycle efficiency.

Keywords: Hydrogen Production, Hydrolysis, Copper-Chlorine Cycle, Moving Bed Reactor, Modeling