Modeling of Lead-acid Flow Battery

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Abstract

Failure of conventional lead-acid battery is attributed to degradation of solid active mass (PbO2 and PbSO4). A number of research efforts are underway worldwide to overcome degradation of active mass to improve the cycle life of lead-acid batteries. Soluble lead-acid flow battery (SLFB) is a new kind of lead-acid flow battery in which products of discharge remain in dissolved state. SLFB contains mixture of lead (II)-methanesulfonate as the electroactive material dissolved in methanesulfonic acid. During charging, P bO2 and P b are formed at anode and cathode respectively. During discharge, lead (II)-methanesulfonate is regenerated at both electrodes. The flow battery thus has potentials to overcome a number of drawbacks of the conventional lead-acid batteries, associated with solid discharge products. In experimental studies elsewhere, it has been observed that the voltage-time curve for charge-discharge cycles of SLFB at constant current follows a specific pattern, which impacts the efficiency and capacity of the battery. A simple mathematical model based on diffusive and convective transport of ionic species in the system and their reaction on the electrode surfaces is developed in the present work. The model is used to predict the charge-discharge

characteristics of SLFB along with energy efficiency and charge efficiency during the cycling. The model can also be used to predict the cycle life of a SLFB. Electrochemistry module with moving interface available in COMSOL Multiphysics has been used to solve the model.

Reference

A. A. Shah et al., Mathematical model for the soluble lead-acid flow battery, Journal of Electrochemical society, 157(5), A589 - A599 (2010)