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Effects of Electrolyte pH and Water Transfer on the Performance of a Zinc-Bromine Flow Battery

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Extended Abstract

A zinc bromine flow battery (ZBB) provides the advantages of giving long cycle life, low cost of maintenance, flexible design and high efficiency for energy storage system [1]. Electrolyte of the ZBB is primarily composed of an aqueous zinc-bromide salt dissolved in water and is stored in external two tanks. During charging, the zinc bromide salt is split into zinc metal and elemental bromine. On discharging, the metallic zinc plated on the negative electrodes dissolves in the electrolyte and is available to be plated again at the next charge cycle. The ZBB is an attractive and useful technology for large-scale energy storage due to its higher energy density, but during cell charging and discharging its distinctive-electrochemical (electrolyte) property causes a lot of the following problems such as zinc growth on the anode, water transfer to a zinc half-cell, bromine aggregation by a complex agent, bromine absolution on a separator surface, reaction rate unbalance due to metallic and liquid phase transitions and etc.

This paper analyzes the electrochemical property of electrolyte through real-time measurements of "pH values of negative electrolyte and positive electrolyte" and "water transfer across membrane" during charge/discharge-cycle operation of a ZBB cell. For this purpose, experiments of a miniature cell and cyclic voltammetry are carried out and five zinc-bromide electrolytes with initial pH of 1 to 5 are compared. During cyclic charging and discharging operation of the cell, the real-time variations of pHs in the anolyte and catholyte are measured as functions of time and the amount of water transfer across membrane is also real-time measured at the same time. Then, their effects on the current efficiency and stability of electrolyte in the ZBB cell are analyzed. Experimental results show that the initial pH of electrolyte plays significant role in the electrochemical reactions of zinc bromide salt and the water transfer has a most strong influence on the electrolytic cell cycle life and long term durability of the ZBB cell. This study gives a new insight into improving energy efficiency of ZBB.

References

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