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Performance mapping of cation exchange membranes for hydrogen-bromine flow batteries for energy storage

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Abstract

Electricity storage is essential for the transition to sustainable energy sources. Hydrogen-bromine flow batteries (HBFBs) are promising cost-effective energy storage systems. In HBFB's, proton exchange membranes are required to separate the two reactive materials, enabling proton transport for charge balancing. In this paper, we present a comprehensive overview of the key properties and an experimental performance map of cation exchange membranes for HBFBs. Our study shows that membrane water uptake is an important property due to its strong correlation with membrane resistance and bromide species crossover. Long chain perfluorosulfonic acid (LC PFSA) membranes are shown to have a better power density–crossover tradeoff and a higher stability than other types of functionalized membranes. The good power density-crossover tradeoff of LC PFSA membranes is the result of the high level of separation of hydrophobic and hydrophilic domains in the membrane, leading to well-connected ionic pathways for proton transport. Reinforcement of long chain LC PFSA membranes further improves their tradeoff because it mechanically constrains the swelling (lower water uptake), resulting in a lower crossover but a similar peak power density. Consequently, reinforced LC PFSA membranes are the most promising option for HBFBs.

Keywords

Hydrogen bromine flow batteries, cation exchange membranes, water uptake, perfluorosulfonic acid membranes, reinforcement.