הטכניון - מכון טכנולוגי לישראל
TECHNION - ISRAEL INSTITUTE OF TECHNOLOGY

הפקולטה להנדסה כימית
ע"ש וולפסון
The Wolfson Department of Chemical Engineering

Wolfson Department of Chemical Engineering Seminar
Monday, August 28th, 2023 at 13:30
Room 1

Membraneless Zinc-Bromine Flow Batteries

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MSc Seminar

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To support the energy transition from fossil fuels to renewable energy sources, inexpensive grid-scale energy storage is required to mitigate the intermittency of renewables. Redox flow batteries (RFBs) have the potential to provide such storage; however high capital costs have hindered market penetration. To reduce costs, membraneless single-flow configurations have been explored to eliminate expensive battery components and reduce balance of plant.

In this study, we developed a unique membraneless single-flow zinc-bromine battery leveraging a unique multiphase electrolyte. The use of such emulsive electrolytes, containing a bromine-poor aqueous phase and bromine-rich polybromide phase, have allowed for effective reactant separation in single-flow architectures, although at the cost of low coulombic efficiency (CE). In this study, we show that significant improvements in CEs are possible when using strong-binding bromine complexing agents (BCAs) to form the polybromide phase. We compared battery performance when using a widespread but relatively weak-binding BCA, N-ethyl-N-methylpyrrolidinium bromide (MEP) and novel, stronger-binding BCA, 1-butyl-3-methylpyridinium bromide (MBP). We demonstrated that use of MBP significantly lowers zinc corrosion during cycling due to a reduced aqueous phase bromine concentration, enabling an up to 23% increase in CE than its counterpart MEP when cycling at 30 mA/cm^2.

Further, by decreasing the $ZnBr_2$ concentration and introducing the $ZnCl_2$ into the electrolyte containing MBP, aqueous bromine concentration was significantly reduced. In addition, cell geometry was modified to maximize the utilization of electroplated zinc during the discharge process. This synergistic effect of reduction in aqueous bromine concentration and redesigning the cell led to >90% CE. Furthermore, electrolyte flow rate, polybromide volume fraction, bromine concentration and cell cycling conditions were optimized to withdraw maximum energy efficiency. Finally, the cell was subjected to long-term cycling process (100 cycles) to assess the stability and capacity degradation under the optimized experimental conditions.

Refreshments will be served at 13:15