Metal Ionic Liquids for Flow Batteries

Exceptional service in the national interest

U.S. DEPARTMENT OF ENERGY

Sandia National Laboratories

We have created a new family of ionic-liquid based electrolytes with accompanying non-aqueous compatible membranes and flow cell designs for higher energy density redox flow batteries targeted to support increasing demands for stationary energy storage.

Sandia National Laboratories has developed a method to produce reduction-oxidation (redox) active ionic liquids for redox flow batteries using inexpensive, non-toxic, and highly abundant precursors. By incorporating the redox active species into the ionic liquid's molecular formula, metal concentration and energy density are increased well beyond the saturation point of most metals in both aqueous and non-aqueous systems.

As ionic liquids, Sandia's liquids have negligible vapor pressures and thus ameliorate cell pressurization issues that can lead to membrane rupture and cell leakage. As a non-aqueous system, efficiency is improved by operating at higher voltages beyond the 1.5 V limit associated with the hydrolysis of water. All of these technical attributes contribute to a lower cost, higher performing redox flow system, thus making flow batteries more economically feasible for grid storage.

Lower Cost Flow Batteries

This project has three metrics that allow for lower cost flow batteries relative to the all-vanadium system:

(1) higher metal concentration
(2) lower cost precursors, and
(3) higher operating voltages.

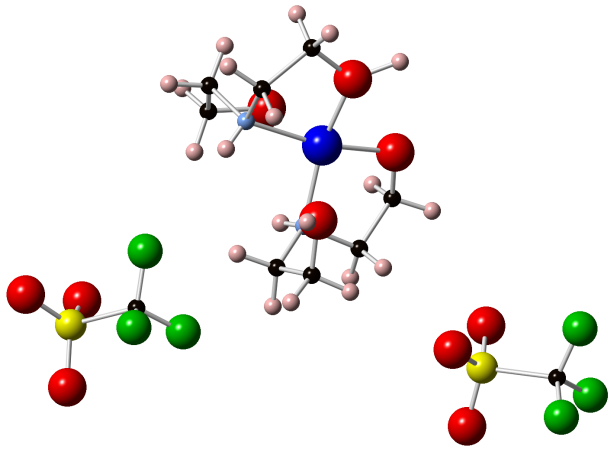
The higher energy density and thus lower cost make it competitive with zinc-bromine and related systems, with the added benefit of improved safety as a result of using environmentally benign ionic liquids.

New Membrane Technologies

The development of non-aqueous flow batteries has been limited by the fact that commercially available, ion selective membranes are not designed for non-aqueous use. As a result, Sandia technology membranes are now being tested because their detailed chemical structures are known, and therefore they can be fine-tuned for optimal compatibility with electrolytes. The results of this work are higher Coulombic efficiencies and reduced crossover.

Commercialization Path

We are presently identifying key materials for our batteries. We seek to partner with aqueous flow battery companies and utilize their infrastructure and expertise to help bring non-aqueous systems to demonstration and finally to market. We also seek chemical scalability capabilities to ensure appropriate quantities of our materials are available for testing and demonstration.



Ball-and-stick notation of a copper-based ionic liquid salt

For more information:
IP.sandia.gov

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