Sandia National Laboratories

Energy, Climate & Infrastructure Security

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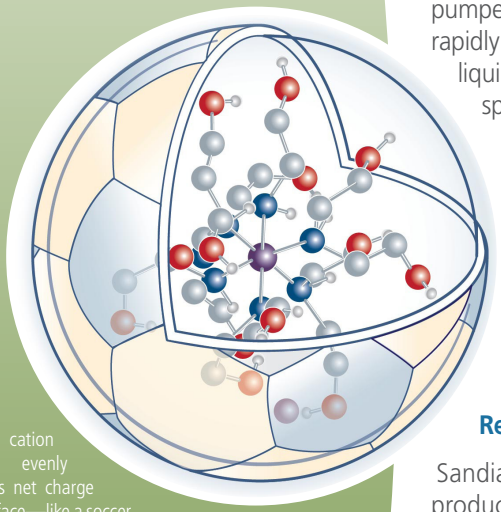
MetILs: Metal Ionic Liquids for Flow Batteries

MetILs may lead to a lower cost, higher performing redox flow system and thus make flow batteries more economically feasible for grid storage.

Sandia has created a family of liquid salt electrolytes, known as MetILs, that allow for higher energy density by incorporating an electro-active element (such as a transition metal) into the solvent's molecular formula.



The MetIL's cation complex evenly distributes its net charge across its surface—like a soccer ball has evenly spaced white/black panels. Because of this symmetrical charge distribution, no two complexes can come close enough to each other to initiate ion pairing/solid formation, but they can easily capture, release, and exchange electrons.

Flow Battery Technology

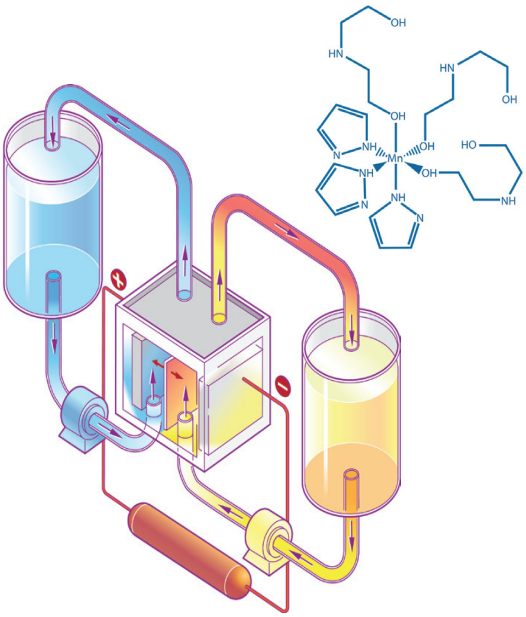
A flow battery is a rechargeable battery in which electrolyte containing one or more electro-active species flows through a cell that converts chemical energy to electricity. Additional electrolyte is stored in tanks and pumped through the cell. Flow batteries can be rapidly recharged by replacing the electrolyte liquid while simultaneously recovering the spent material for re-energization.

Flow batteries work well in large-scale, stationary storage applications to mitigate the variability of wind/solar power generation (load leveling), minimize the electrical loads during peak demand (peak shaving), or act as an uninterruptable power supply during power outages.

Reduction-Oxidation Ionic Liquids

Sandia has developed a method to produce reduction-oxidation (redox) active ionic liquids for redox flow batteries using inexpensive, non-toxic, and highly abundant precursors. MetILs are based on readily available, inexpensive, non-toxic materials such as iron, copper and manganese. In addition, the electrochemical efficiency, or ability to reverse charge, is far better than any ionic liquid system reported to date.

By incorporating the redox active species into the ionic liquid's molecular formula, we increase metal concentration and energy density well beyond the saturation point of most metals in both aqueous and non-aqueous systems. As ionic liquids, MetILs have negligible vapor pressures and thus ameliorate cell pressurization issues that can lead to membrane rupture and cell leakage. As a non-aqueous system, we can improve efficiency by operating at higher voltages (well beyond the 1.5 V limit associated with the hydrolysis of water).



Lower Cost Flow Batteries

MetILs have 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 higher safety as a result on using environmentally benign ionic liquids.

Commercialization Path

Sandia looks forward to collaborating with partners to scale up materials for MetILs. Opportunities for research and development partnerships are available through Sandia's Corporate Research and Development Agreement (CRADA) process. Please contact us to discuss company needs and collaboration goals.

For more information please contact:

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U.S. DEPARTMENT OF ENERGY

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