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A strategy for lowering cross-contamination of aqueous redox flow batteries using metal-ligand complexes as redox couple

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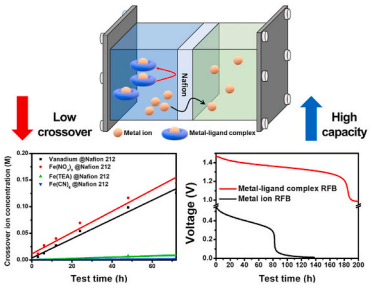
HIGHLIGHTS

- Single metal ions and metal-ligand complexes are considered as active materials.
- Permeability of active materials for Nafion membranes is investigated.
- Permeability of metal-ligand complexes is 1.6–6.6% of that of single metal ions.
- Capacity decay rate of ARFB using metal-ligand complexes is 0.1% per cycle.

GRAPHICAL ABSTRACT



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ABSTRACT

Membrane that is the core component of aqueous redox flow battery (ARFB) plays an important role in preventing cross contamination of active materials and transmitting charge balance ions selectively. However, single ions such as iron and vanadium, which are usually used in ARFB, penetrate conventionally used Nafion membrane relatively easily, and affect significantly the reduction in efficiency and capacity of ARFB. To overcome the easy crossover issue of single ions, metal-ligand complexes instead of metal ions are suggested as active materials, and their effects on the performance and stability of ARFB are evaluated. Initially, their permeability tests to Nafion membranes are performed using H-type stationary cell. As a result, it is confirmed that the permeability of metal complexes (0.068 and 0.018 mM $cm^{-2}h^{-1}$) is far lower than that of single ions (1.02 and 1.13 mM $cm^{-2}h^{-1}$) irrespective of that thickness of Nafion membrane, while the optimal thickness of Nafion membrane is determined when the metal-ligand complexes are used as active materials for ARFB. These evaluations for cross-contamination of active materials can give appropriate protocol for the use of metal-ligand complexes as active materials of ARFB and the limitations related to the cross-contamination of active materials of present systems can be considerably alleviated.

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