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Highly stable aqueous organometallic redox flow batteries using cobalt triisopropanolamine and iron triisopropanolamine complexes

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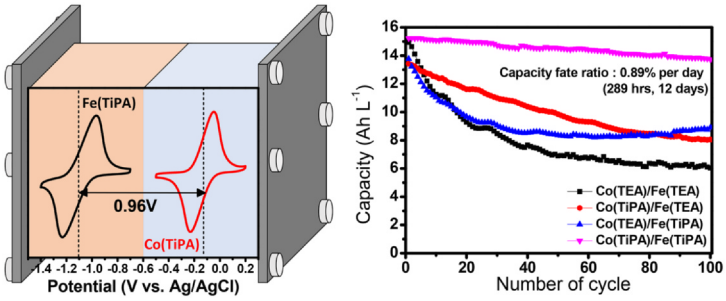
HIGHLIGHTS

- Co(TiPA) and Fe(TiPA) are suggested as redox couple of RFB.
- TiPA complexes have high stabilization constant.
- TiPA complexes has better long cycle stability than TEA complexes.
- Energy efficiency and power density of RFB using Co(TiPA) and Fe(TiPA) are high.
- RFB using Co(TiPA) and Fe(TiPA) shows excellent capacity retention for 298 h.

GRAPHICAL ABSTRACT



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ABSTRACT

Two metal-organic complexes consisting of new triisopropanolamine (TiPA) ligand and two transition cobalt (Co) and iron (Fe) metals (Co(TiPA) and Fe(TiPA)) are suggested and used as redox couple for redox flow battery (RFB) with potassium hydroxide (KOH) electrolyte. The redox reactivity of Co(TiPA) and Fe(TiPA) adopting TiPA ligand is measured and their reaction mechanism is compared with that of complexes containing triethanolamine (TEA) ligand (Co(TEA) and Fe(TEA)) that are conventionally considered. According to evaluations, the reaction rate of all complexes is controlled by their diffusion rate. In a comparison of the complexes, that of TEA complexes is faster than that of TiPA complexes. This means that the viscosity of TEA complexes is lower than that of TiPA complexes. However, regarding the stability in KOH, the stability of TiPA complexes is much better than that of TEA complexes, enabling the stable redox reactions over a long period. Considering the reduction potential of complexes and their stabilization constant, TiPA complexes have a higher stabilization constant than TEA complexes because the redox reaction of TiPA complexes is stably performed, whereas the Fe ions of Fe(TEA) are precipitated for charging process and the preciptation induces irreversible reaction in KOH. This is confirmed by the solidified Fe atoms observed onto carbon felt after RFB test. When the performance of RFB using Co(TiPA) and Fe(TiPA) is measured, its capacity retention is well maintained for 100 cycle (298 h), while this RFB shows superior energy efficiency (77% at 40 mA cm^{-2}) and power density (81.3 mW cm^{-2} at 160 mA cm^{-2}).

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