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Organometallic redox flow batteries using iron triethanolamine and cobalt triethanolamine complexes

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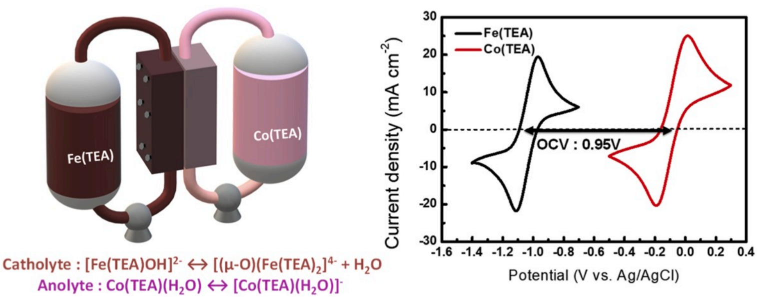
HIGHLIGHTS

- Fe (TEA) and Co(TEA) are proposed as redox couple of ARFB.
- Optimal ratio of Co ion and TEA ligand is determined for optimal Co(TEA).
- 4 M NaOH is required for optimizing 1:2.5 Fe (TEA) and 1:1 Co(TEA).
- ARFB using this redox couple shows excellent CE (99%) and power density (35 mW cm^{-2}).
- Electrolyte cost per capacity of ARFB is 43% lower than VRFB.

GRAPHICAL ABSTRACT



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ABSTRACT

Organometallic complexes consisting of iron- and cobalt-triethanolamine ligand (Fe (TEA) and Co(TEA)) are proposed as redox couple of aqueous redox flow battery (ARFB). Fe (TEA) and Co(TEA) are dissolved in sodium hydroxide (NaOH) electrolyte, while their chemical stability and electrochemical reactivity are quantitatively characterized. As a result, the chemical stability of Co(TEA) is degraded for multiple charge/discharge cycle test due to the deformation of unchelated TEAs by the chemical reaction with hydroxyl ion (OH^-) and the catalytic effect of Co(TEA). To address the issue, the ratio of Co to TEA and the concentration of NaOH are manipulated. When the ratio is 1:1, the redox reactivity of Co(TEA) is improved because the amount of unchelated TEAs that is a reason for lowering its redox reactivity is minimized, while 4 M NaOH is proper to supply enough amount of OH^-, preserving its chemical structure and reducing mass transfer retardation. Regarding Fe (TEA), with 1:2.5 ratio of Fe to TEA in 4 M NaOH, the stability and performance of Fe (TEA) are best. Performance of ARFB using 1:2.5 Fe (TEA) and 1:1 Co(TEA) shows excellent results of high charge and energy efficiencies of 99% and 62% at 40 mA cm^{-2}, and high power density of 35 mWcm^{-2}.

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