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Review article

Recent developments in organic redox flow batteries: A critical review

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HIGHLIGHTS

- Future opportunities for organic redox flow batteries are reviewed.
- Advantages, disadvantages and challenges are discussed.
- Organic redox couples are classified (aqueous & non-aqueous chemistries).
- The performance of systems are discussed against benchmarks.
- Critical areas requiring further R & D are highlighted.

GRAPHICAL ABSTRACT

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ABSTRACT

Redox flow batteries (RFBs) have emerged as prime candidates for energy storage on the medium and large scales, particularly at the grid scale. The demand for versatile energy storage continues to increase as more electrical energy is generated from intermittent renewable sources. A major barrier in the way of broad deployment and deep market penetration is the use of expensive metals as the active species in the electrolytes. The use of organic redox couples in aqueous or non-aqueous electrolytes is a promising approach to reducing the overall cost in long-term, since these materials can be low-cost and abundant. The performance of such redox couples can be tuned by modifying their chemical structure. In recent years, significant developments in organic redox flow batteries has taken place, with the introduction of new groups of highly soluble organic molecules, capable of providing a cell voltage and charge capacity comparable to conventional metal-based systems. This review summarises the fundamental developments and characterization of organic redox flow batteries from both the chemistry and materials perspectives. The latest advances, future challenges and opportunities for further development are discussed.