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Aqueous organic redox flow batteries for high-temperature operation

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Environmental concerns together with gradually increasing geopolitical tensions emphasizes the need for safer and more sustainable way of securing energetic needs of growing mankind. For the aimed transition from fossil-based towards more sustainable energetics, affordable, safe and eco-friendly energy storage options are urgently needed, both for mobile and stationary applications. Redox flow batteries (RFBs) offer valuable features of decoupled power and capacity and non-flammability. Moreover, use of aqueous electrolytes also simplifies heat management and, thus, can potentially enable heat storage applications of the battery. However, with std. vanadium electrolytes, this option is typically not fully deployed due to the limited thermal stability of posolyte active species at high SOC and temperatures above 40 °C. [1, 2] Thus, alternatives active species for flow battery electrolytes are intensively sought incl. organic redox species, some of them being reported for their excellent chemical stability in a broad temperature range. [3]

In our contribution, we study chemical and electrochemical stability of the selected aqueous RFBs electrolytes using phenazine- and alloxazine-based negolytes coupled with ferrocyanide-based posolyte. The stability of the redox couples at various supporting electrolytes (pH range 7-14) was systematically evaluated in a broad temperature range (20-80 °C) for both oxidation states of active species, incl. symmetric and asymmetric flow battery single-cell testing. The post mortem analysis of the electrolyte composition using UV-vis, potentiometric titrations, HPLC and RDE measurements enabled us to identify individual mechanisms of the electrolyte degradation and to assess their contribution to the overall capacity fade observed in flow battery testing.

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