A Mixed Acid Based Vanadium–Cerium Redox Flow Battery with a Zero-Gap Serpentine Architecture

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ABSTRACT

This paper presents the performance of a vanadium–cerium redox flow battery using conventional and zero-gap serpentine architectures. Mixed-acid solutions based on methanesulfonate-sulfate anions (molar ratio 3:1) are used to enhance the solubilities of the vanadium (>2.0 mol dm^{-3}) and cerium species (>0.8 mol dm^{-3}), thus achieving an energy density (*c.a.* 28 Wh dm^{-3}) comparable to that of conventional all-vanadium redox flow batteries (20–30 Wh dm^{-3}). Electrochemical studies, including cyclic voltammetry and galvanostatic cycling, show that both vanadium and cerium active species are suitable for energy storage applications in these electrolytes. To take advantage of the high open-circuit voltage (1.78 V), improved mass transport and reduced internal resistance are facilitated by the use of zero-gap flow field architecture, which yields a power density output of the battery of up to 370 mW cm^{-2} at a state-of-charge of 50%. In a charge–discharge cycle at 200 mA cm^{-2}, the vanadium–cerium redox flow battery with the zero-gap architecture is observed to discharge at a cell voltage of *c.a.* 1.35 V with a coulombic efficiency of up to 78%.

KEYWORDS: Flow battery; Cerium; Vanadium; Zero gap architecture; Mixed acid

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