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Static Mixers for Enhanced Reactant Distribution in Redox Flow Cells

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Decarbonizing and modernizing our energy system will require flexible and reliable, grid-scale storage. Redox flow batteries (RFBs) are well positioned to provide deployable solutions. Commercialized vanadium redox flow battery technology (VRFB/VRB) in particular is scalable, safe and long-lasting, with continuous performance improvements being achieved through research and development. Mass transfer limitations are a significant focus area in efforts to increase efficiency and power density, as the significance of electrolyte flow and the associated effects has not yet been adequately addressed, especially for large scale systems. Multiphysics simulation with computer aided design (CAD) has been shown to be an effective means of exploring novel cell geometries to improve the local availability of reactants, with experimental studies demonstrating good agreement with modelling results[1,2,3].

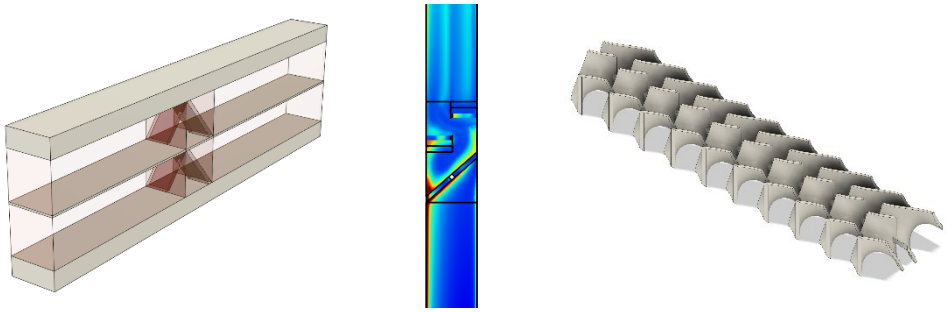

Figure - unit-width full-cell geometry with blade-style static mixer in both half-cells (left) concentration (mol m^{-3}) of V^{3+} in simulated half-cell (center) and computer aided design (CAD) render of helical mixers (right).

Recent research suggests that the innovative application of static mixers within VRB cells is a promising avenue of investigation. Static mixers are common in industrial chemical processes, and a variety of geometries have been developed for different applications, however research for their use in flow cells is very limited. This work investigates mixer architectures for VRBs to address concentration gradients within half-cells during operation. A blade-style, low-pressure drop (LPD) type mixer increased minimum V^{3+} concentration by 60% with an optimized location and number of elements. Other configurations such as helical geometries could improve mixing, and pairing mixers with other innovations such as wedge-shaped cells has the potential to deliver added benefits while also reducing parasitic energy losses.

References

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