# Redesign of a Vanadium Redox Flow Battery for Reduced Pressure Loss Using an Interdigitated Flow Field

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Low pressure drops are desired for flow battery operation to achieve high system efficiency. Flow battery designs with a porous flow-through electrode can experience large pressure drops across the cell. Increased reactant flow rates for higher current density operations or physically larger cell dimensions can further increase the flow resistance and associated pumping losses for the system. However, the pressure drop and pumping losses can be partially mitigated through the use of an appropriately designed interdigitated flow field.

A 1.1 kW flow-through vanadium redox flow battery (VRFB) was recently demonstrated by Pacific Northwest National Laboratory to achieve high system efficiency of 82% [1]. To further improve the system efficiency by reducing pumping losses, redesign of the cell with an interdigitated flow field (Figure 1) was considered and analyzed using numerical modeling. Computational fluid dynamics and electrochemical models were used for analysis of the interdigitated flow field concept.

Inlet/outlet channel dimensions were first optimized to achieve a nearly constant pressure drop across the porous electrode and ensure reactant flow uniformity along the entire cell. The effects of channel pitch and dimensions on reactant flow velocity ratio ($V_{max}/V_{min}$) were identified (Figure 2), and relatively uniform electrode flow rates could be achieved with significantly reduced pressure drops. The cell electrochemical performance was then evaluated to determine the influence of the channel flow velocity variations on uniformity of the current density. Preliminary numerical results indicated that local current density variations beneath the channels and along the cell were acceptable, so construction and experimental testing of a small interdigitated concept cell was initiated.

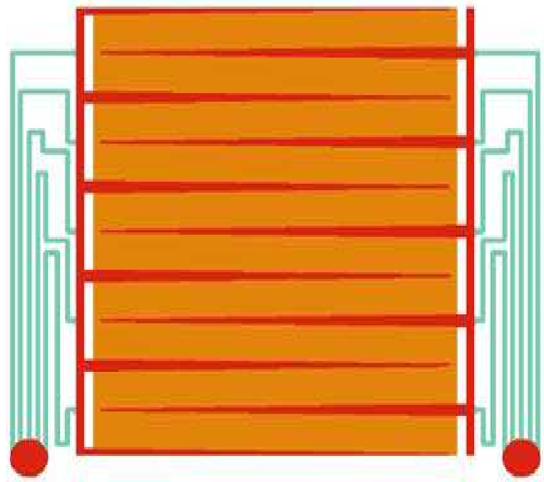

Figure 1. Interdigitated design concept for VRFB.

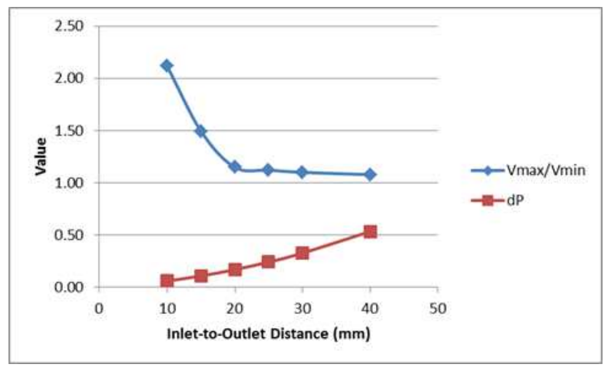


Figure 2. Effect of inlet-outlet channel pitch on reactant velocity ratio and pressure drop.

References:

1. Kim, S, E Thomsen, G Xia, Z Nie, J Bao, K Recknagle, W Wang, V Viswanathan, Q Luo, X Wei, A Crawford, G Coffey, G Maupin, and V Sprenkle. 2013. “1 kW/1 kWh Advanced Redox Flow Battery Utilizing Mixed Acid Electrolytes,” *J Power Sources* 237:300-309.