

## Engineering Supporting Electrolytes to Unlock Stable Two-Electron Energy Storage in Aqueous Organic Redox Flow Batteries

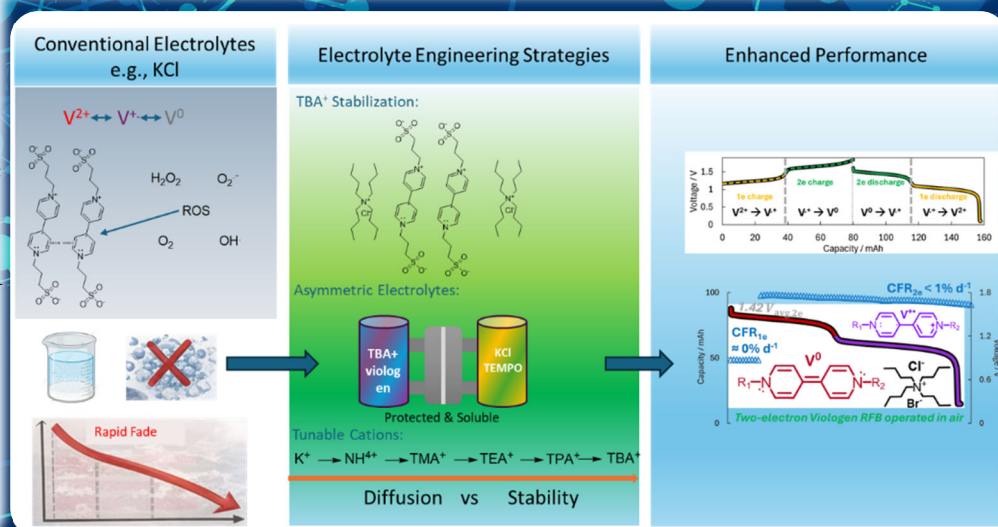
**Shahriar Hasan**

**Department of Chemistry, New Mexico Tech**



Aqueous organic redox flow batteries (AORFBs) are promising for grid-scale energy storage but are fundamentally limited by low energy density and capacity fade. This work demonstrates that supporting electrolyte engineering is a powerful and underexplored strategy to unlock stable two-electron storage in viologen-based systems. We first show that tetrabutylammonium chloride (TBACl) enables oxygen-tolerant two-electron cycling with dramatically reduced capacity fading compared to conventional KCl systems. Building on this, an asymmetric supporting electrolyte strategy is introduced, pairing TBA-supported viologen anolytes with KCl-supported TEMPO catholytes to simultaneously optimize stability, kinetics, and voltage efficiency. A systematic investigation of alkylammonium cations reveals how chain length governs transport, kinetics, and overall battery performance. To address oxygen-induced degradation,  $\text{MnO}_2$  is incorporated as a functional additive to modulate peroxide chemistry and eliminate parasitic redox features. Finally, a newly

designed asymmetric viologen and alternative electrolytes, including choline chloride, are newly demonstrated to enhance solubility and stability. Together, these results establish electrolyte-molecule interactions as a key design feature for advancing high-energy, durable AORFBs.



April 10<sup>th</sup> @2 pm – Lopez 106