Cycling Performance of Organic Electrolytes in Commercial Vanadium FB Hardware

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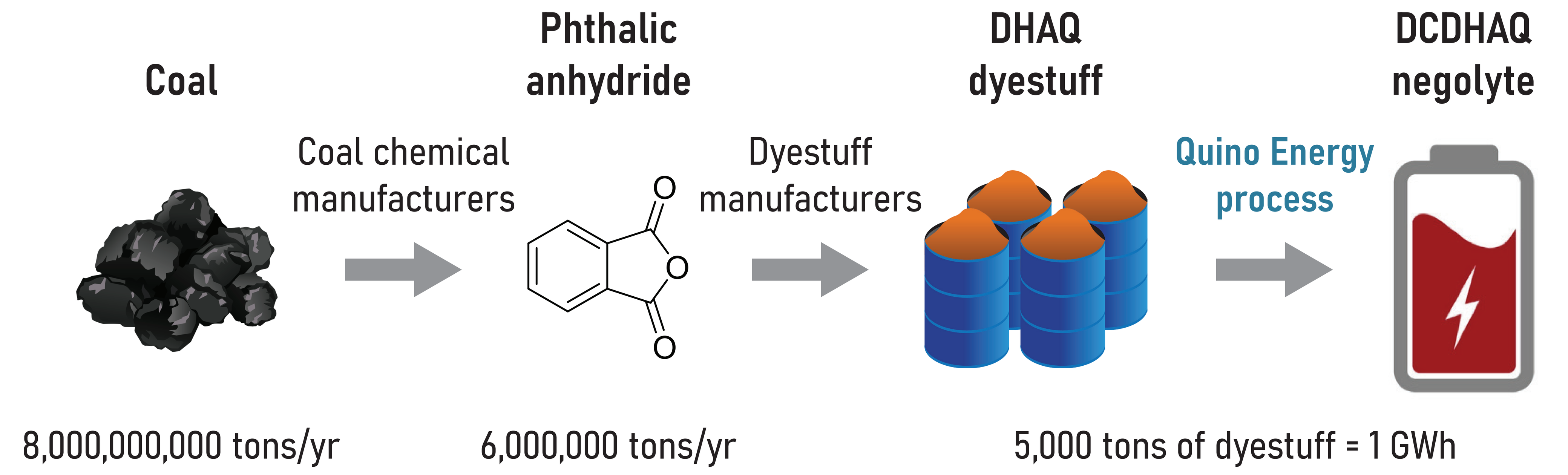
Why Organic Reactants?

- No critical materials in supply chain
- Abundant domestic supply
- $20-40/kWh energy CAPEX possible
- No hydrogen produced when charging
- Compatible with existing VFB hardware with minimal modification



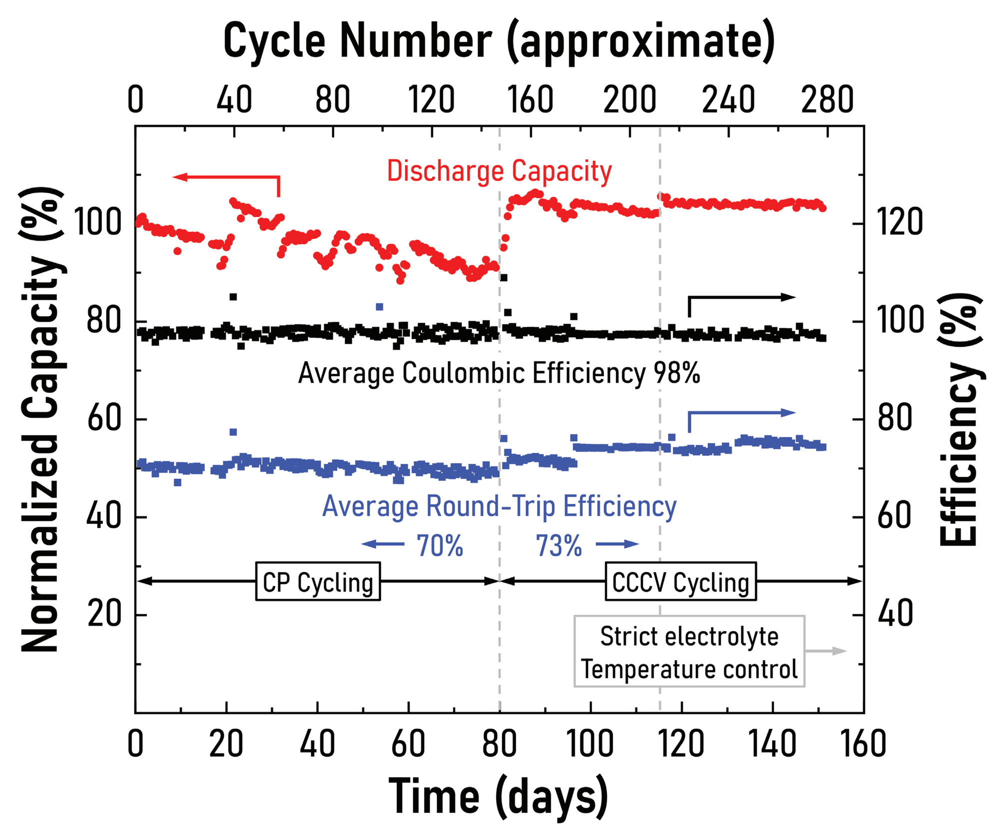
Performance of 1,5-DCDHAQ Negolyte vs. FeCN Posolyte in a Commercial 6 kWh System

Long-Term Cycling

1,5-DCDHAQ (0.6 M) was tested in a 6-kWh system demonstrating successful long-term cycling vs. the ferro/ferricyanide (FeCN) redox couple with two cycling protocols:

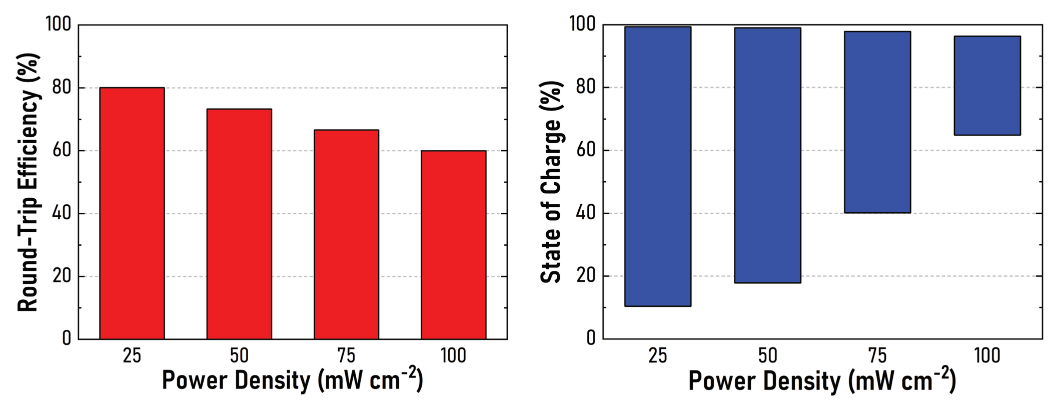
Constant power (CP) at a stack power density of 50 mW cm^{-2} (rated power)

Constant current-constant voltage (CCCV) between 0–80% SOC at 40 mA cm^{-2}



Utilization and RTE

From cycling three times at each power density at room temperature:



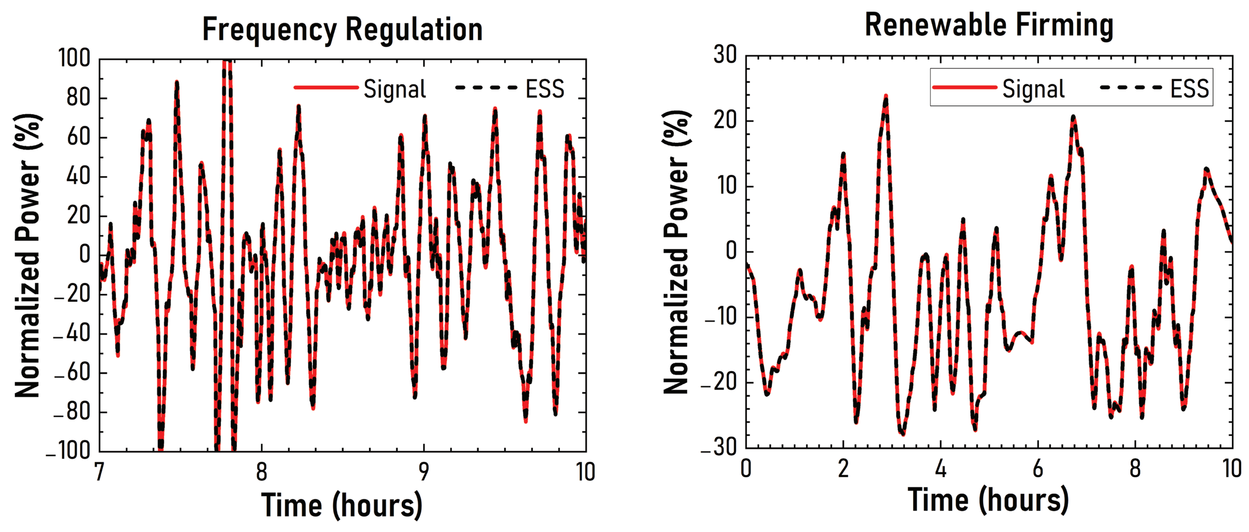
Application Duty Cycles

This study tested the 6 kWh battery (ESS on graphs) under ideal lab conditions using a programmable battery cycler. Two widely used application tests published by PNNL were used [See Reference]:

Frequency regulation (24-hour signal with 4-second resolution)

Renewable firming (10-hour signal with 1-second resolution)

The ESS achieved low root mean square error (RMSE), low mean absolute error (MAE), and high signal tracking percentage within ±2%, showing high responsiveness and therefore suitability for grid regulation tasks.



Duty Cycle	Normalized RMSE (%)	Normalized MAE (%)	% of time signal is tracked
Frequency Regulation	0.009	0.0074	99.27
Renewable Forming	0.008	0.0066	98.98

Conclusions

The as-synthesized 1,5-DCDHAQ negolyte was evaluated using various cycling protocols and real-world duty cycles in commercial FB systems originally designed for vanadium electrolytes.

Its strong cycling stability, high performance, and exceptional signal tracking capabilities demonstrate that quinone-based electrolytes are well-positioned for immediate integration into commercial flow battery applications.

Acknowledgments

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Reference

D. R. Conover et al., Protocol for Uniformly Measuring and Expressing the Performance of Energy Storage Systems. Report No. PNNL-22010 Rev. 2. Pacific Northwest National Lab, Richland, Washington, USA, 2016.