An Inexpensive Metal-free Organic Redox Flow Battery (ORBAT) for Grid-Scale Energy Storage

Awardee: *University of Southern California, Loker Hydrocarbon Research Institute*

Sub Awardee: *ITN Energy Systems Inc.*

ARPA-E Open FOA Program (Program Director: Dr. John Lemmon/ Grigorii Soloveichik)

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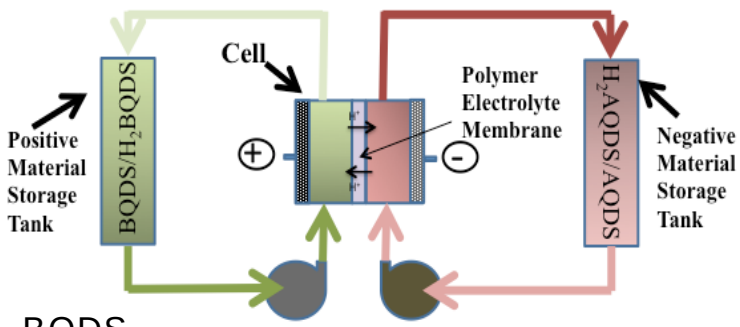
Advantages of ORBAT:

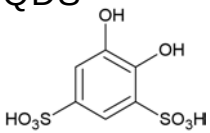
- Extremely Low Materials Cost: $10-20/kWh
- Low System Cost < $100/kWh
- No toxic metals or organic solvents

Targets:

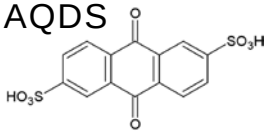
- 80% Roundtrip Efficiency
- 5 kW/20 kWh system for Telecom and distributed energy storage
- 1700 cycles ;0.5 V at 300 mA/cm^2



BQDS



AQDS



Positive Electrode Reaction

$$BQDS + 2H^+ + 2e^- \rightleftharpoons H_2BQDS$$

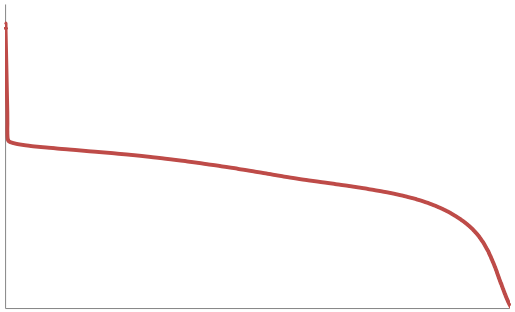
BQDS= 1,2-benzoquinone-3,5-disulfonic acid
H_2BQDS = 1,2-dihydrobenzoquinone-3,5-disulfonic acid

Negative Electrode Reaction

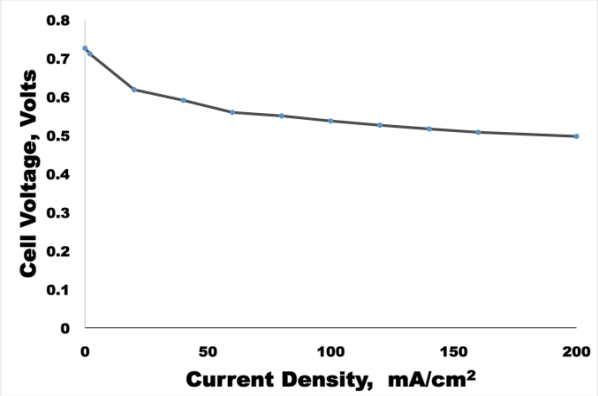
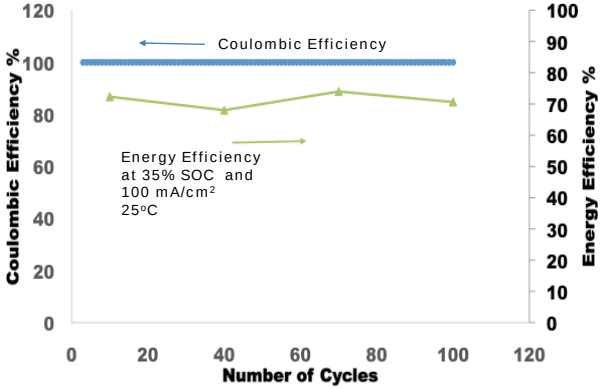
$$AQDS + 2H^+ + 2e^- \rightleftharpoons H_2AQDS$$

AQDS = 9,10-anthraquinone-2,6-disulfonic acid
H_2AQDS=9,10-dihydroanthraquinone-2,6-disulfonic acid

Discharge Curve at 100mA/cm^2
1M BQDS/1M AQDS



Discharge Performance of ORBAT,1M BQDS/AQDS



Coulombic and Energy Efficiency of ORBAT, 1M BQDS/AQDS