2021 DOE OE Energy Storage Peer Review

Redox Flow Batteries

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Redox flow batteries session speakers

Technical advantages

➢ High safety
➢ Environmentally friendly active materials preparation and recycling
➢ Modular design

Application: long-duration energy storage

➢ Decoupled energy (duration) and power (rate)
➢ Low self-discharge
➢ Potentially low-cost active materials
Redox flow battery session speakers

Dr. Jagjit Nanda
Oak Ridge National Laboratory

Dr. Cy Fujimoto
Sandia National Laboratory

Dr. Ruozhu Feng
Pacific Northwest National Laboratory

Professor Michael Aziz
Harvard University

Professor Sri Narayan
University of Southern California

Dr. Rangachary Mukundan
Los Alamos National Laboratory
Low-cost aqueous organic redox flow batteries (AORFBs)

Challenge in cycling stability
- Long-term cycling
- Cycling in non-demanding environment
- Cycling at elevated temperatures

Wu et al., Chem6, 1432–1442
Breakthrough in the development of stable AORFBs

Stable fluorenone derivatives

Capacity restoration approach

**Talk:** Reversible ketone hydrogenation and dehydrogenation for aqueous organic redox flow batteries

**Talk:** Long Lifetime Aqueous Soluble Organic Flow Battery Development
Mechanistic understanding of the degradation mechanism

Impact of substitution type on the stability

Impact of substitution pattern on the stability

Talk: Understanding the stability of positive electrode materials for aqueous organic redox flow batteries

Poster: Decomposition pathways and mitigation strategies for highly-stable hydroxyphenazine flow battery anolytes
Membrane and catholyte development

Flow Battery Membranes

High potential, high solubility organic iron complex catholyte


Talk: Sandia’s Flow Battery Membrane Development
Development of non-aqueous systems
Fe/pyridine ligand systems

**Modified Fe-bipyridines**

- Fe(bpyCF)₂(BF₄)₂
- Fe(bpyCO₂Me)₂(BF₄)₂
- Fe(bpy)₂(BF₄)₂
- Fe(bpy'Bu)₂(BF₄)₂
- Fe(bpyMe)₂(BF₄)₂
- Fe(bpyOMe)₂(BF₄)₂

**Fe-aminopyridines**

High Solubility
(~1.5 M in MeCN)

Poster: Metal Coordination Complexes for Symmetric, Non-aqueous Flow Batteries

Talk: Non-Aqueous Redox Flow Battery: Materials Development
Hybrid flow battery systems

Ambient Temperature Polysulfide-Based RFBs

**Full Cell: Cycling Insoluble Phases**

\[ \text{Na}_2\text{S}_8 \leftrightarrow \text{S}_8 \ (Q_{\text{theoretical}} = 209 \text{ mAh/g}_\text{S}) \]

**Talk:** Development of Sodium Polysulfide as Catholyte for Ambient Temperature Redox Flow Batteries

**Poster:** Mediated Lithium-Sulfur Flow Batteries

Mediated Li-S RFB

- **Anode:** Li-metal
- **Cathode:** Sulfur
- **Ion-Selective Separator:** None
- **Enabling Technology:** Redox Mediators in Electrolyte
In FY21, the research teams supported by the Department of Energy Office of Electricity’s Energy Storage Program made significant contributions through concerted efforts to the advancement of redox flow technology.

These advancements enable redox flow battery technology to better support long-duration energy storage applications and use cases in support of the nation’s decarbonization efforts.
Thank you