Water-in-salt electrolytes for redox flow batteries

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**The Problem**
Achieving net zero carbon emission necessitates generating energy from renewable sources, but these do not always produce energy when it is needed by consumers.

**The Solution**
Use grid-scale energy storage systems (ESS) to store energy generated during off-peak periods and discharge energy during peak periods.

**Project Aim**
To develop a membrane free redox flow battery (RFB), using water-in-salt electrolytes and organic molecules.

**Redox Flow Batteries**
- Tanks store electrolyte containing redox active materials
- Electrons generated via redox reactions at electrodes

Voltage of the RFB is the difference between redox potentials of the materials in the anolyte and catholyte.

**This Work**
- Investigating the redox behaviour of organic molecules in WiSEs
- Lithium bis(trifluoromethanesulfonyl)imide (LiTFSI) WiSE forms an ABS with lithium chloride (LiCl) WiSE
  - Anthraquinone (AQ) is soluble in LiTFSI but not LiCl
- Cyclic voltammetry of AQ in basic LiTFSI shows one-step two-electron, suggesting lithium ion could be involved in the reaction

**Water-in-salt Electrolytes**
What is a Water-in-salt electrolyte (WiSE)? Water-based (aqueous) electrolyte solutions containing more salt than water molecules

Why are WiSEs interesting?
1. They can increase the electrochemical stability window (ESW) of water
2. Some WiSEs can form aqueous biphasic systems (ABS), in which the liquids are two distinct layers

How can WiSEs be used in RFBs?
Have two separate electrolyte phases of WiSEs which will not mix in the battery. No longer need an expensive membrane.

**Key Terms**
- Ion: Particle with positive or negative charge
- Electrolyte: Solution containing a substance that is separated into positively and negatively ions, which can conduct electric current
- Electrode: A conductor that carries electrons to and from the liquid system
- Redox: Oxidation-reduction reaction which involves electron transfer between molecules or particles

**Ideal ESS should be...**
- Safe
  - No flammable components
- Environmentally friendly
  - No metals hazardous to the environment
- Cheap
  - Water is the cheapest solvent
  - Redox-active organic molecules are abundant and cheap

**Future Work**
1. Test the anthraquinone in LiTFSI with a positive redox material in a static battery system
2. Test the battery system under flow

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