Quest for Grid Energy Storage: Case for the Performance of Iron-Ion/Hydrogen Redox Flow Battery Mixed Electrolytes

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RFB PRACTICAL APPLICATIONS

Iron-Ion/Hydrogen Redox Flow Battery

Flow batteries are just one technology that can store electricity but they could be amongst the cheapest and most versatile for large scale storage

CATCHING THE WIND

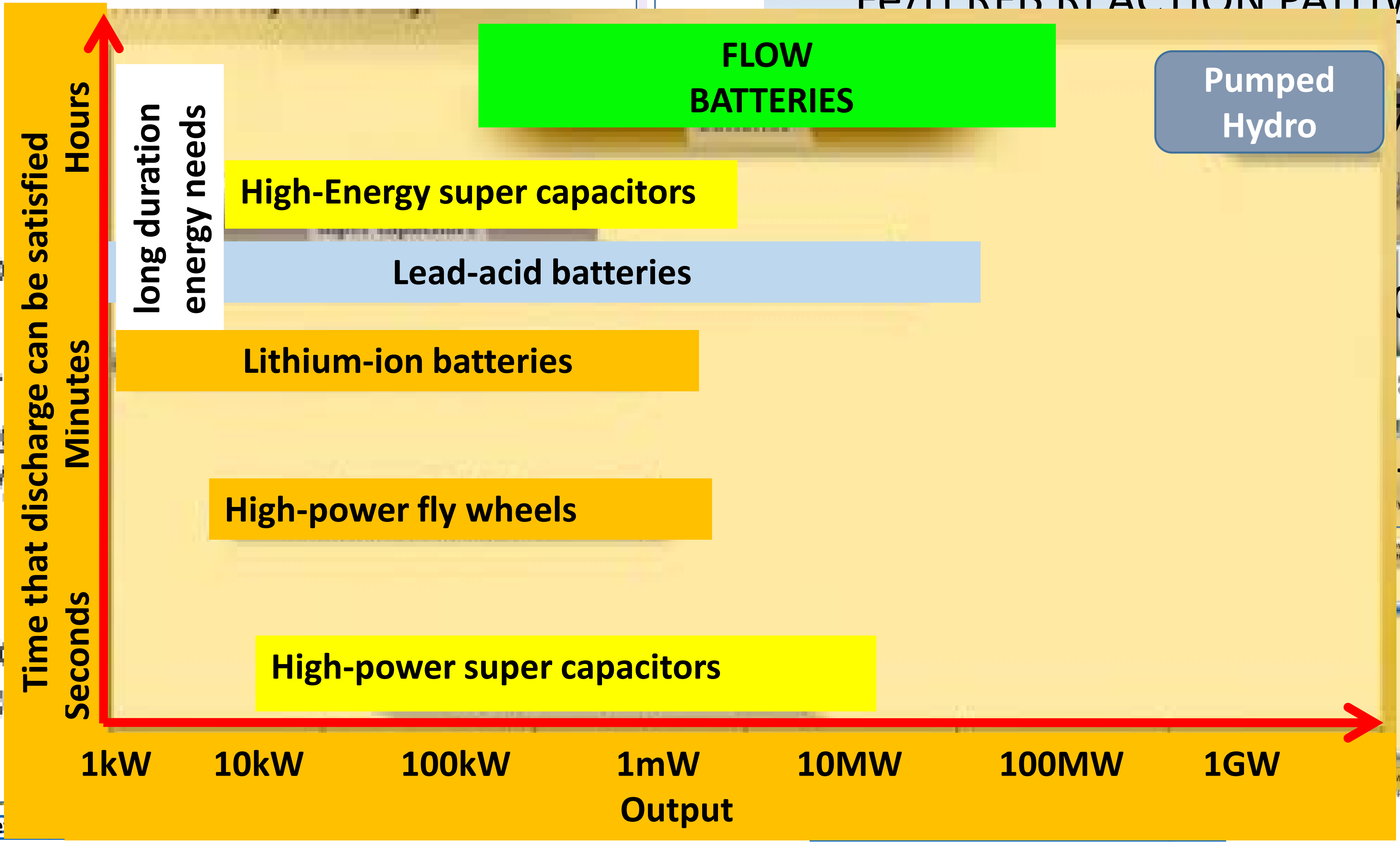
Fe/H RFB REACTION PATHWAY

Storage Energy (MWh)

Key factors:
H$_2$ pressure
Fe concentratio
OCV
Tank size

Consumption/Pro
Power (MW

Key factors:
Flow rate
Reaction kineti
Electrode desig
OCV
Cell size



77 V vs. SHE

00 V vs. SHE

77 V

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OBJECTIVE

•Determine the influence of electrolyte on Iron-Ion/Hydrogen Redox Flow Battery using Cyclic voltammetry (CV) techniques

ELECTRON EFFICIENCY

$$Electron\ efficiency\ (\eta) = \left(\frac{Number\ of\ electrons\ from\ Randles - Sevcik\ Eqn.}{Number\ of\ electrons\ in\ balanced\ Redox\ Eqn.} \right)$$

- **Randles-Sevcik equation at room conditions:**

$$I_p = 2686000 N^{3/2} A D^{1/2} C v^{1/2} \longrightarrow N = \left(\frac{I_p}{2686000 A D^{1/2} C v^{1/2}} \right)^{2/3}$$

Where;

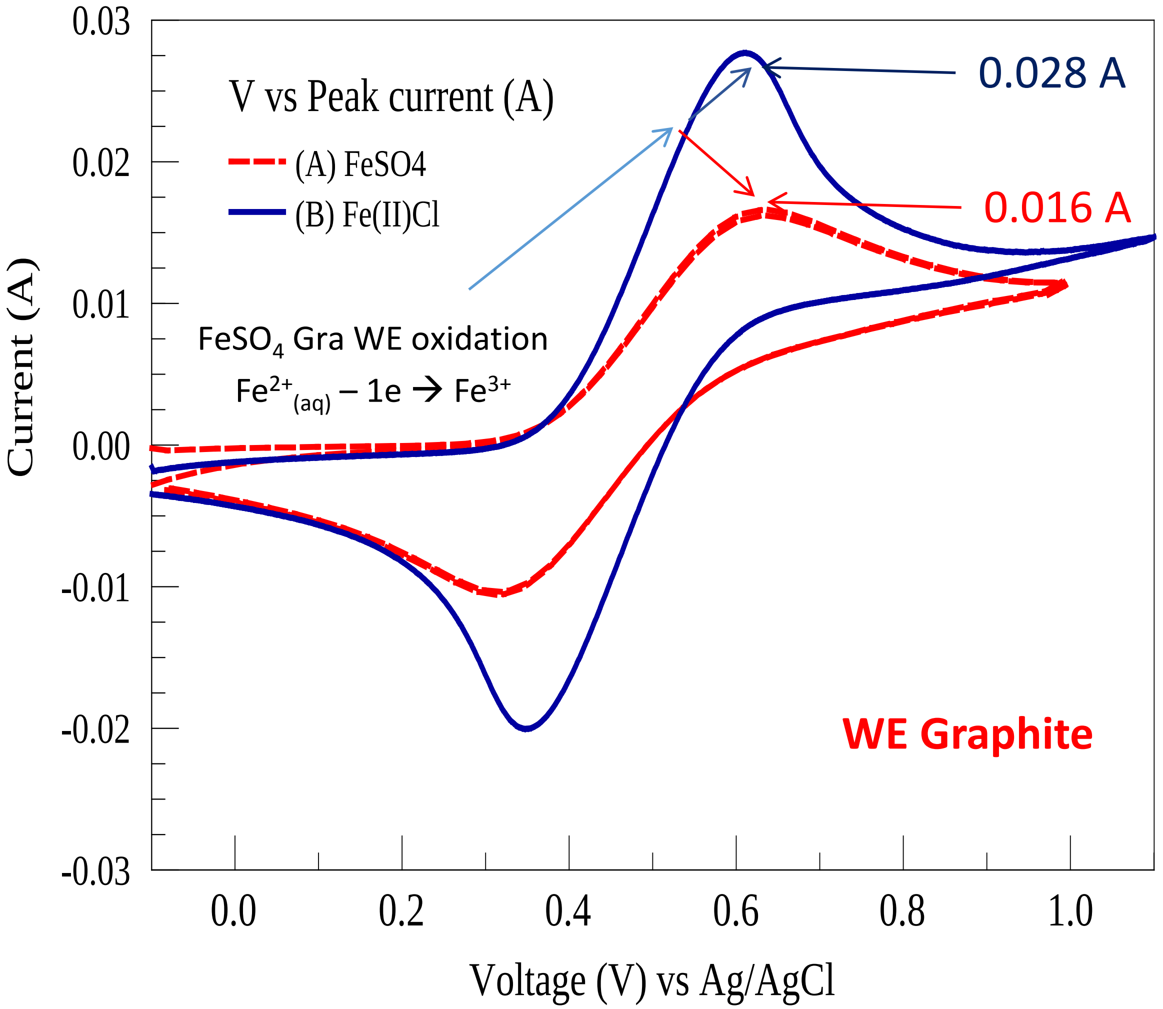
- **N = Number of electron**
- **A = Area of electrode (cm^2)**
- **C = Species concentration (mol/cm^3)**
- **D = Diffusion coefficient (cm^2/s)**
- **V = Scan rate (V/s)**

$$Fe^{2+}_{(aq)} - 1e^- \rightarrow Fe^{3+}\ Oxidation - Charging$$

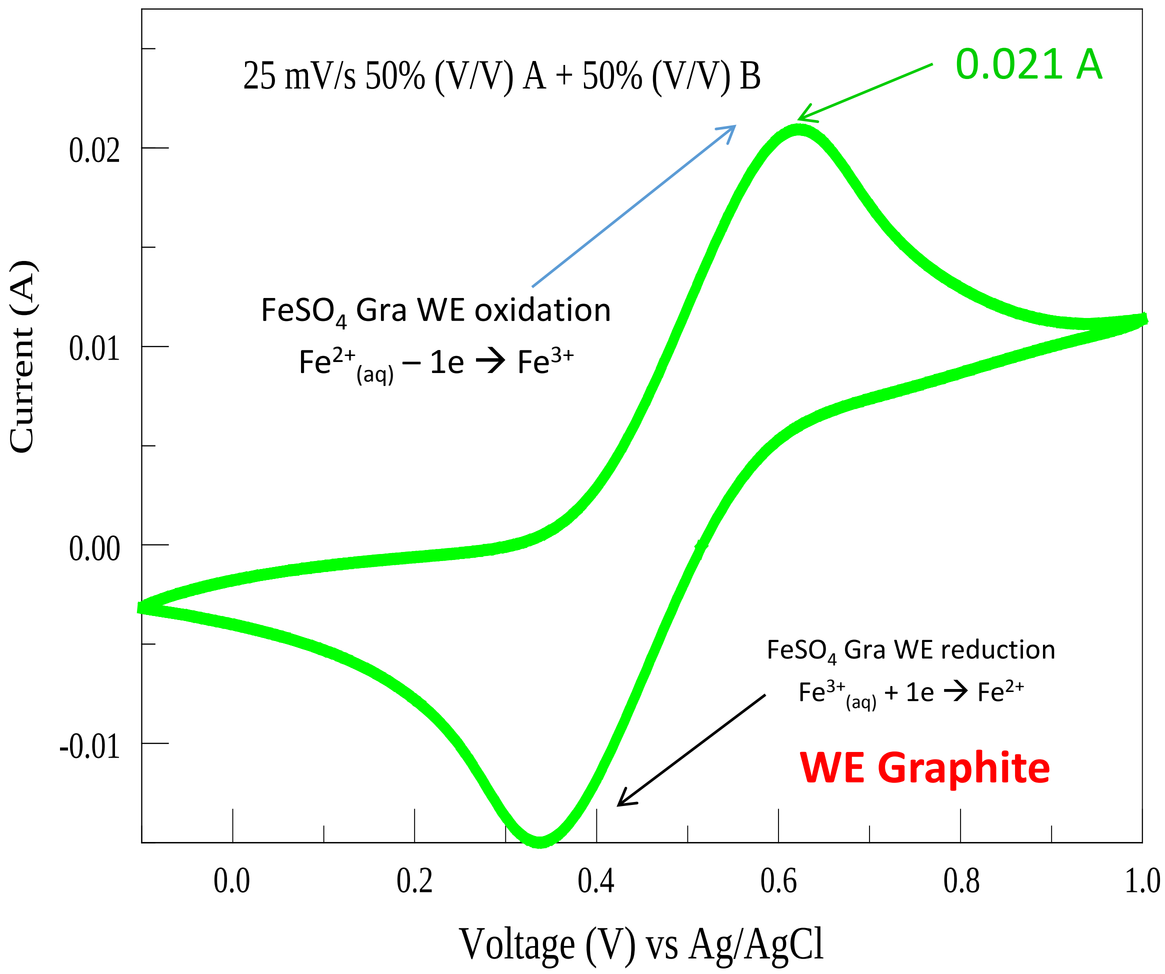
$$Fe^{3+}_{(aq)} + 1e^- \rightarrow Fe^{2+}\ \ Reduction - Discharging$$

Mixed Electrolyte:
Improve charge/discharge of Fe-H RFB electrolyte

BEFORE MIXING



AFTER MIXING



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Influence of Mixed Electrolyte on the Performance of Iron-Ion/Hydrogen Redox Flow Battery

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Improved charge/discharge performance of Iron-ion/Hydrogen redox flow battery (RFB) electrolyte with a mixed $FeSO_4$ and $FeCl_2$ is reported. Addition of Cl^- ions into a sulfate electrolyte changes the charge/discharge behavior of the sulfate electrolyte leading to a reduction in charging potential for a mixed $FeSO_4$ and $FeCl_2$ electrolyte system. This suggests that a sulfate/chloride electrolyte system can lead to improved charge/discharge of the Fe-ion/H_2 RFB. Reverse addition of $FeSO_4$ to $FeCl_2$ showed a decrease in the mixed electron transfer efficiency (experimental current relative to theoretical) equivalent to a decrease in electrolyte performance. We deduce that 0.8 M $FeCl_2$ corrosive electrolyte can be replaced by less corrosive mixture of 46 mol % Cl^- in 0.8 M FeSO4 to achieve the same performance that can be obtained using an all chloride system.

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