Hydrogen Peroxide Redox Flow Batteries

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Problem Statement

- Solar and wind are two leading renewable energy sources currently on the market. However, these are **intermittent energy sources.** They are not always produced when energy demand is high, wasting them if not stored for later use.

- When this occurs, **power demand must be supplemented**, typically with non-renewable sources.

- This problem creates the **need for effective forms of energy storage**.

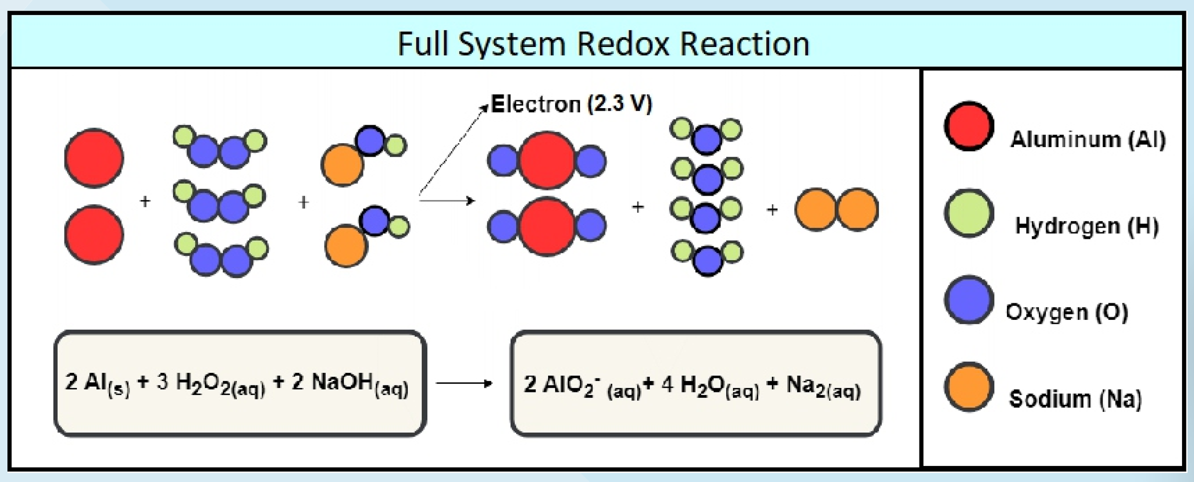
Design Outline

- **Objective:** Test the feasibility of a hydrogen peroxide redox flow battery via a prototype.

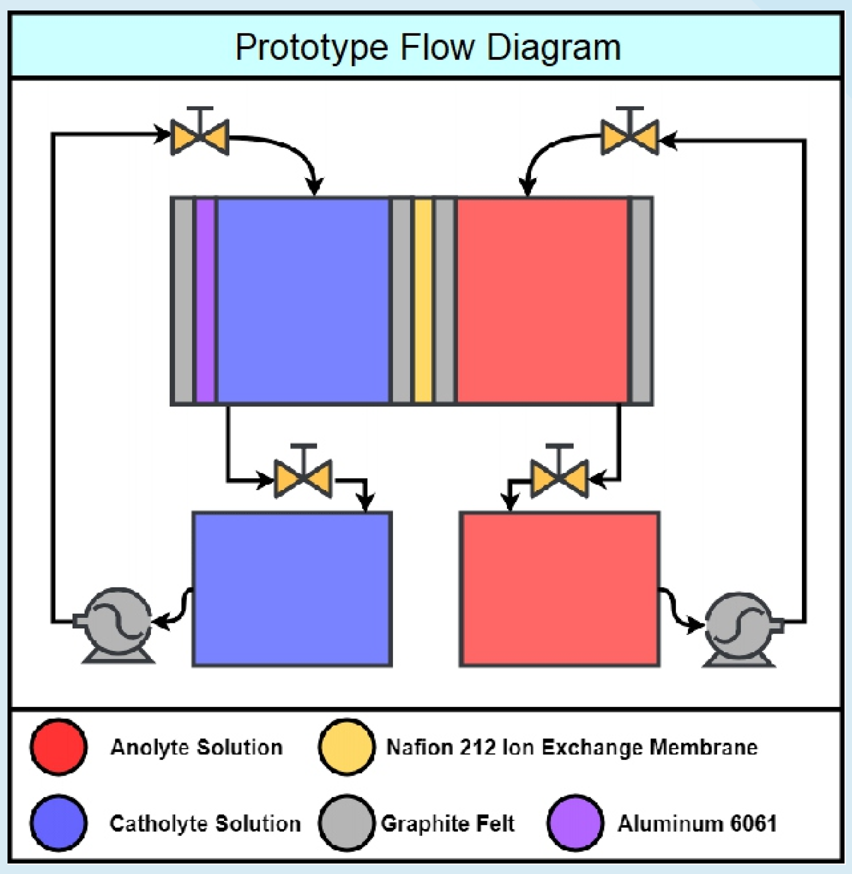
- **Redox Flow Battery (RBF):** Redox flow batteries are electrochemical energy conversion devices. Two electrolytes within the battery undergo redox reactions to produce a voltage across an electrode pair.

- **RFB Components**: The electrolytes used are aqueous hydrogen peroxide and sodium hydroxide. An ion exchange membrane physically separates the two fluids into half-cells. The battery's electrodes are made from graphite felt. Aluminum sheeting is used as a reactant in the sodium hydroxide half-cell. Two tanks store excess electrolytic fluid to increase energy storage capacity.

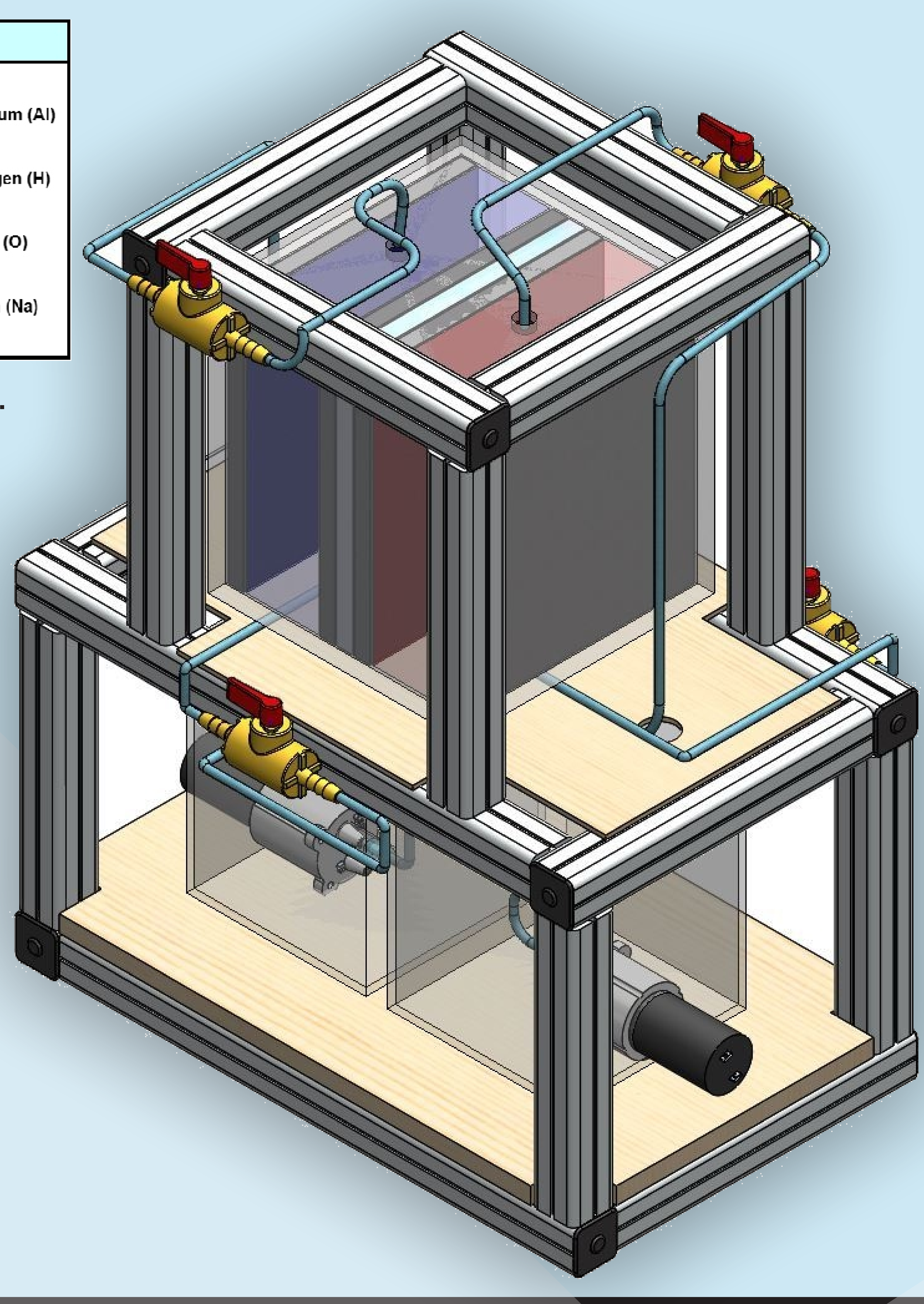
System Overview

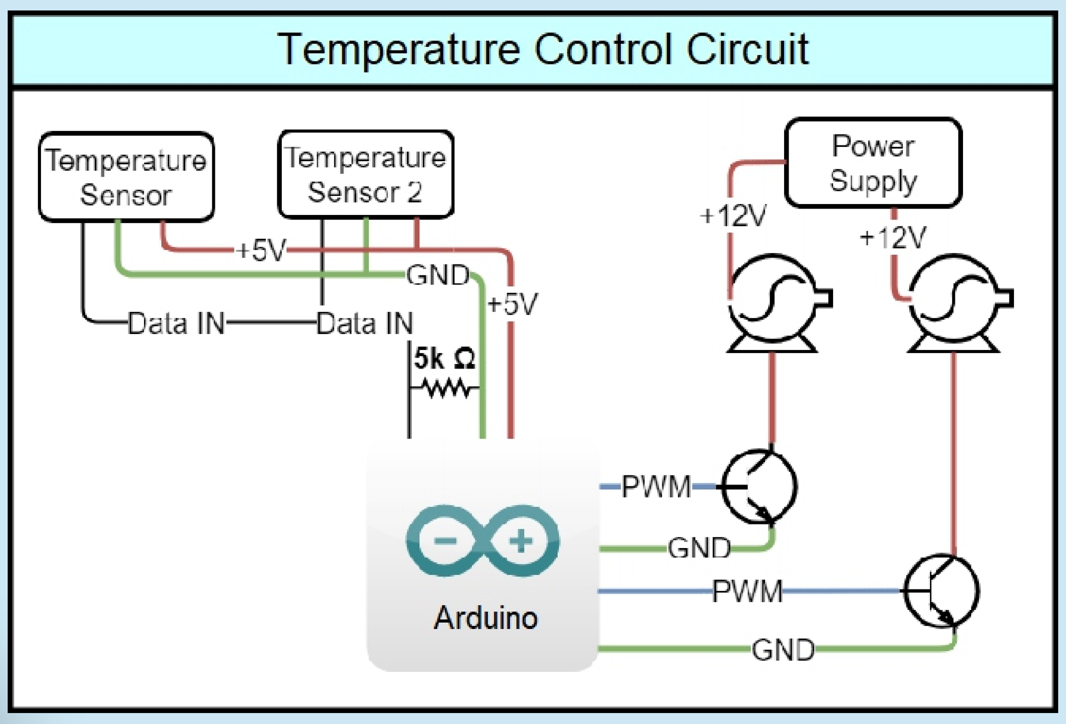


The battery is charged by the full redox reaction. The reverse reaction occurs in discharging.



Detachable cut-off valves are used to stop fluid flow, allowing the system to be flushed with new chemicals when needed.





Battery temperatures are determined by chemical reaction rates, which are in turn controlled by fluid flow rates. Temperature sensor input is fed to an Arduino microcontroller that uses pulse width modulation on two transistors acting as pump switches to determine flow rate.

Discussion

Flow batteries are a strong solution to the intermittent energy problem. They are a renewable energy source that easily scales to meet desired energy demands while having low environmental impact. Unlike most electrolytic cells, they can discharge fully and recharge conveniently as the chemical reactions involved are reversible. The major drawbacks of these batteries are their low energy density and sub-par power delivery.

Conclusions

The prototype provides an appropriate test apparatus. Cut-off valves yield great ease of use but are bulky. Graphite felt electrodes are easy to cut to size, but they are costly and have somewhat high resistivity. The implemented tanks are a nice proof-of-concept, but do not provide much extra storage capacity. A commercial application should strive for a volumetrically-optimized design with low-cost materials. Additionally, multiple cell stages should be connected in series to produce greater output voltage.

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