Proton Exchange Membrane Fuel Cell

Design, Fabrication, Testing, and Optimization

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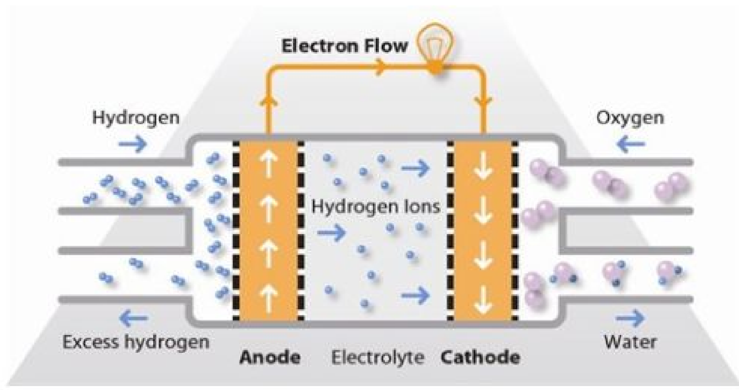
Background

Due to the growing concerns on the depletion of petroleum-based energy resources and climate change, fuel cell technologies have received much attention in recent years. A fuel cell is an electrochemical device that converts chemical energy from a fuel into electricity through a chemical reaction involving an oxidizing agent such as oxygen. The electrochemical reactions that occur are: $H_2 \rightarrow 2H^+ + 2e^-$ in the anode and $O_2 + 4H^+ \rightarrow 4H_2O + heat$ in the cathode. In order to speed up the chemical reactions, Proton Exchange Membrane Fuel Cells (PEMFC) utilize a catalyst. The best catalyst researched to date is platinum.



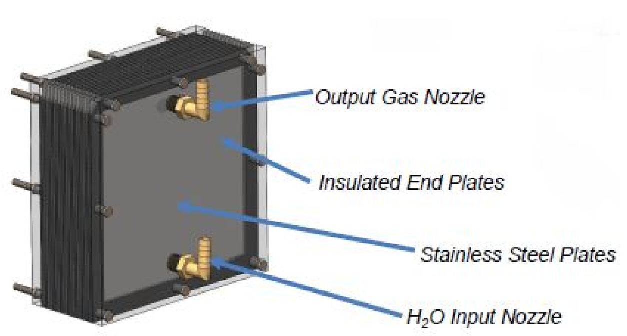
Schematic of PEMFC

Goal and Objective

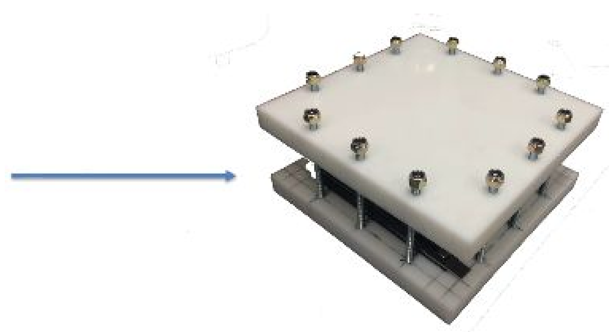
The goal of the project is to create a low cost fuel cell battery. The system will use a Photovoltaic Panel to power an electrolyzer to generate hydrogen, which will then be used as fuel. The electrolyzer will be made with nickel, which recent research suggests is more efficient than rare metals like platinum and is more cost efficient. Testing will be conducted and compared with last years model.

Electrolyzer

An electrolyzer is an electrochemical apparatus designed to perform electrolysis by splitting a solution the atoms of which it's made by passing an electric current through it. Last year's produced electrolyzer will be used as a model and will supply hydrogen gas to test the PEMFC.



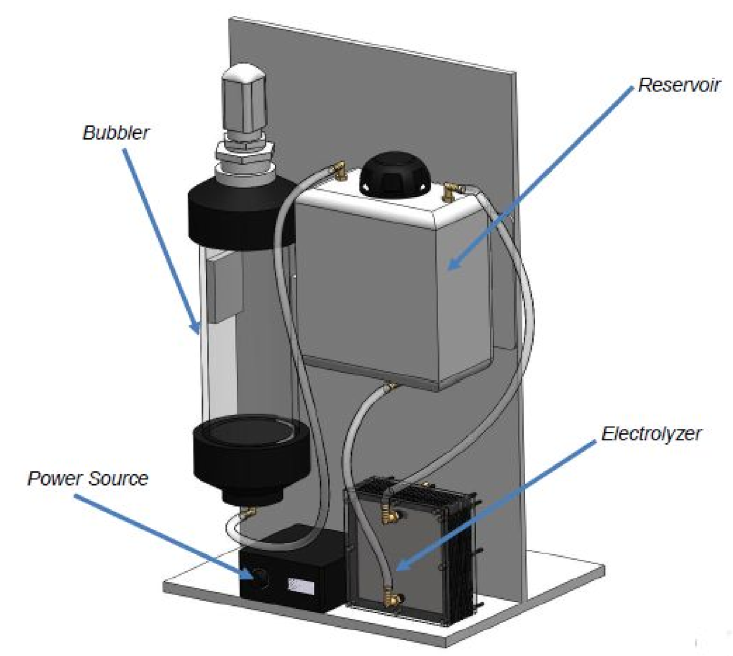
SW design of Electrolyzer



Hydrogen separating cell

A hydrogen separating cell, created during the 2015 winter quarter, is able to output hydrogen gas and oxygen from two separate channels. By separating the two gases we are able to provide the PEMFC with a more refined input so that the cell itself becomes more efficient.

Testing Station



Electrolyzer Testing Station

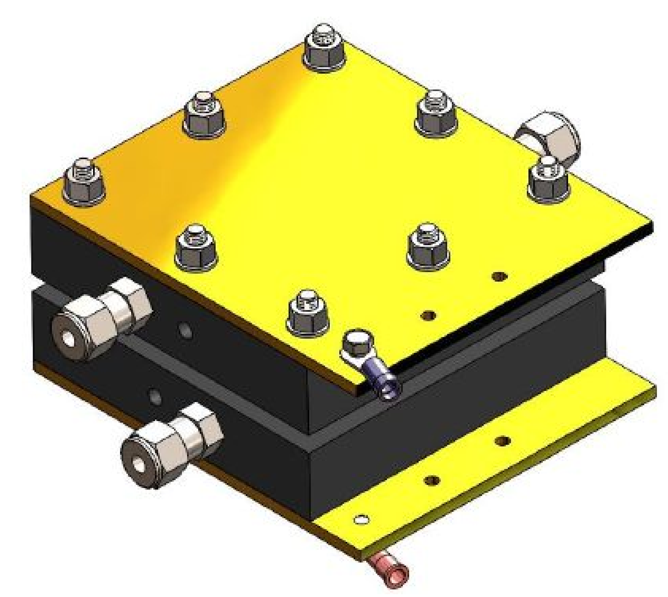
Hydrogen Dehumidifier

Cart

This is the resulting testing station from the previous year.

Proton Exchange Membrane Fuel Cell

The PEMFC consists of a Membrane Electrode Assembly with two bipolar plates. There are two inlets: one for hydrogen and one for oxygen. There's also two outlets: one for the excess hydrogen and one for water.

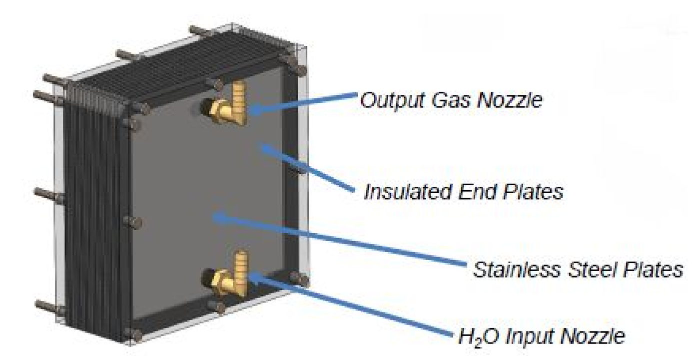


SW Design of PEMFC

The SW design shown above was created last Winter quarter. It included two layouts: triangular and rectangular. The channel design plays a vital role in the production for a fuel cell. Throughout the channels, the formation of slugs decreases power production by limiting contact area.

Nickel-Iron Electrolyzer

Recent studies have shown that nickel is a viable alternative for manufacturing electrolyzers. Nickel is not only cheaper than stainless steel, but it performs electrolysis at 4V and is resistant to corrosion.



SW design of Electrolyzer

After testing this electrolyzer, we would like to produce it using nickel and then test it. It would allow for better comparing data since we'll be able to calculate the efficiency of both.

Next Steps

- Produce PEMFC
- Test last years model
- Design an electrolyzer made with nickel and iron
- Purchase nickel
- Produce nickel-iron electrolyzer
- Test nickel-iron electrolyzer
- Compare results

Group Organization

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