Proton Exchange Membrane Fuel Cell

Design, Fabrication, Testing, and Optimization

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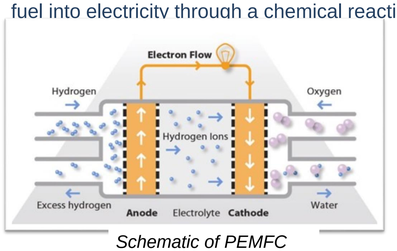
Background

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 $O_2 + 4e^- + 4H^+ \rightarrow 4H_2O + heat$ 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

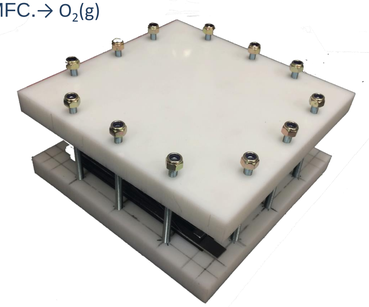
Goal and Objectives

The primary goal of this project is to experimentally measure the efficiency of a PEMFC under various conditions and its durability under accelerated stress testing. THE PEMFC will be supplied hydrogen gas from an electrolyzer; the electrolyzer will be supplied power from a Photovoltaic(PV) Panel. To meet this goal, the project was divided into three separate phases with distinct objectives to better achieve this goal.

Fall 2014	Winter 2015	Spring 2015
Test/design electrolyzer	Design channel layout	Test/Analyze PEMFC
Design permanent electrolyzer test station	Fabricate permanent electrolyzer test station	Optimization
Design PEMFC	Fabricate Electrolyzer	Fabricate PEMFC
Test PV Panel		

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. Our designed electrolyzer will be used to supply hydrogen gas to test the PEMFC.→ $O_2(g)$

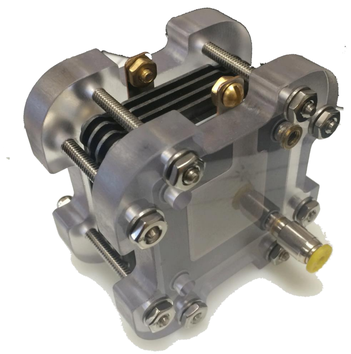


The electrolyzer pictured is a hydrogen separating cell. Created during the 2015 winter quarter, this cell is able to output hydrogen gas and oxygen from two separate channels. By separating the two gases we are able to provide the PEMFC with a more refined input so that the cell itself becomes more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

Innovation: Electrolyzer

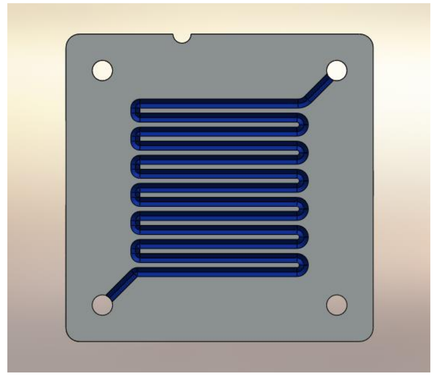
Previous quarters designs were implemented and an electrolyzer cell was fabricated. The designs proved to be problematic and unforeseen issues were encountered. In order to combat the flaws, the stacked electrolyzer cell was changed into a single cell. Further tests came with the conclusion that single cell was much more efficient than the original stacked design. One of the changes implemented was to place a plastic sheet within the separating chamber in order to divide the oxygen gas from the hydrogen gas. Once the gases were produced, they were verified by checking the volume. The gas which had double the volume than the other gas was determined to by hydrogen.

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: excess hydrogen and water. The commercial PEM fuel cell with a serpentine channel is shown above. Winter quarter 2015 consisted of creating an original channel design. This included two layouts: triangular and rectangular.

Innovation: Fuel Cell



The flow field pattern implemented in the PEM fuel cell battery was the serpentine flow field shown above. The fuel cell battery was used to power the 5V fan. The electrolyzer cell was fed directly into the PEM fuel cell battery in order to optimize the hydrogen gas produced.

Quarter Overview

The electrolyzer cell was tested and respectably changed in order to insure maximum output and efficiency. The test station concept introduced in the previous quarter was scrapped in order to provide the maximum amount of hydrogen gas produced to the PEM fuel cell. The electrolyzer cell was ultimately connected directly to the PEM fuel cell, thus hydrogen gas was fed straight from production. The excess oxygen gas was released into the atmosphere.

Group Organization

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