Fuel Your Sol: Design of a Unitized Hydrogen Fuel Cell

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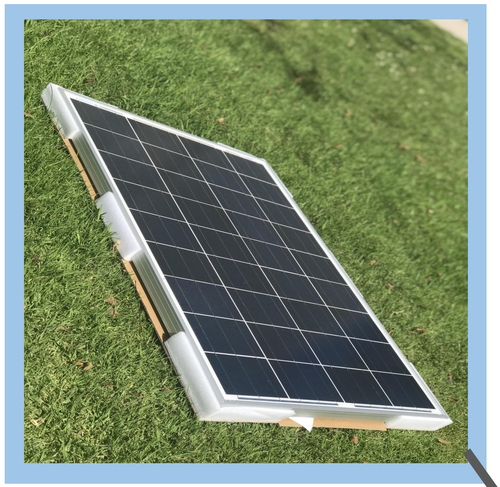
Solar Power



Background:
Building off of the success of previous AIChE Project teams, notably the Campus Renewable Energy's solar umbrella, we chose to take a different path and focus on energy storage.

We begin with a solar panel, which takes solar energy and converts it into electrical energy to be utilized. We plan to have two alternate paths for the energy to take: if a phone is plugged in, the solar panel will ideally directly charge the phone to increase efficiency, while if not it will power the electrolysis reaction to produce hydrogen.

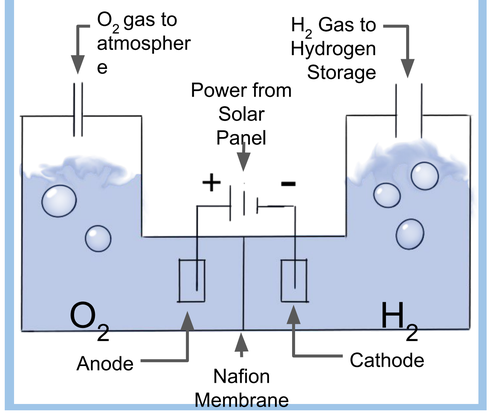
H_2 Generation

Our current design also includes a separate component for the hydrogen generation. We will be making an electrolytic cell, that will make use of Potassium Hydroxide (KOH) as the electrolyte, which will create hydrogen and oxygen gas.
A nafion membrane will be present to separate the products.

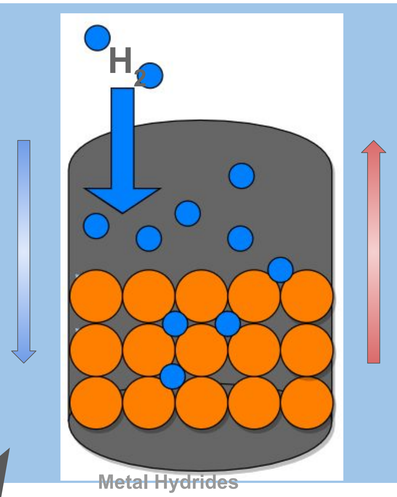
Electrical Current will be introduced to the two electrodes then into the alkaline solution which will then initiate the decomposition of water.

Anode: $2H_2O \rightarrow O_2 + 4H^+ + 4e^-$
Cathode: $4H^+ + 4e^- \rightarrow 2H^2$

Electrolytic Cell Design:



H_2 Storage



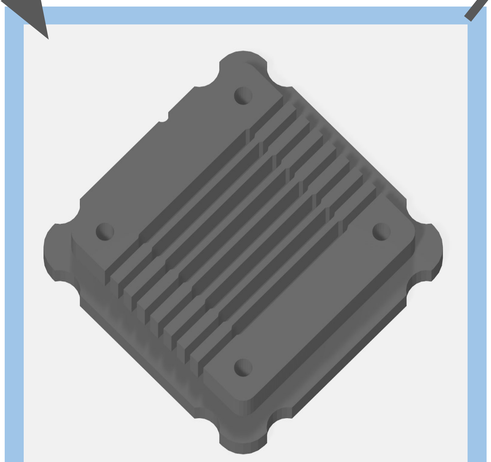
Hydrogen Storage:
Once the hydrogen is separated it is to be stored for later use. Conventionally, hydrogen may be stored as compressed gas or as a cold liquid. For our purpose of implementation, these methods may not be safe since those components are volatile and flammable, thus requiring a sturdy container.

We want to use metal hydrides, such as $LaNi_5$, to store our hydrogen since the method is reversible and can be operated at a reasonable temperature and pressure.

Fuel Cell

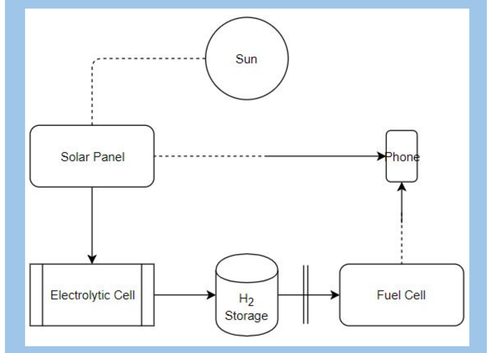
Fuel Cell Design:
The design of the fuel cell is what's known as a bipolar plate which allows for the stacking of each cell in series so as to increase the output voltage. The top half as shown below is designed to permit a uniform flow of oxygen across the cell while the bottom half consists of a winding channel for the hydrogen gas to pass through.

Contact between the two gases occurs across a polymer electrolyte membrane which facilitates the reaction to produce electricity and water vapor.



Overall

**not drawn to scale



Fuel Your Sol aims to utilize solar energy and hydrogen fuel cell technology to address the modern day concerns of sustainable energy sources.
These fuel cells can serve as an alternative to fossil fuels making them efficient and environmental friendly.

The design is still under development, but we hope that it will serve as an accessible phone charger to the students and faculty on campus.

Progress:

Over the last year, our research has shown that a reversible fuel cell is both less efficient and more prone to corrosion. As such, we have decided to shift to a larger design more focused on overall sustainability: we plan to include a hydrogen fuel cell simply for energy generation, and an electrolytic cell in order to create the hydrogen that will then be stored for later use. Furthermore, the solar umbrella has been taken down but we have a solar panel that can be used as our new power source: the power will be used either to charge a phone or to run the electrolytic cell, which will generate hydrogen gas that can be used to power the fuel cell's reaction if we need to charge a phone when the solar cell is not in operation. As such, our plan for the future is to keep the overall objective of our team (creating a renewable sustainable energy storage unit) but shift implementation to include the electrolytic cell and the solar panel, which can likely be set up via a covered bench or other, similar setup.