Pulse-Inverted Electrolyzer – Capstone Team 3

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The Problem is

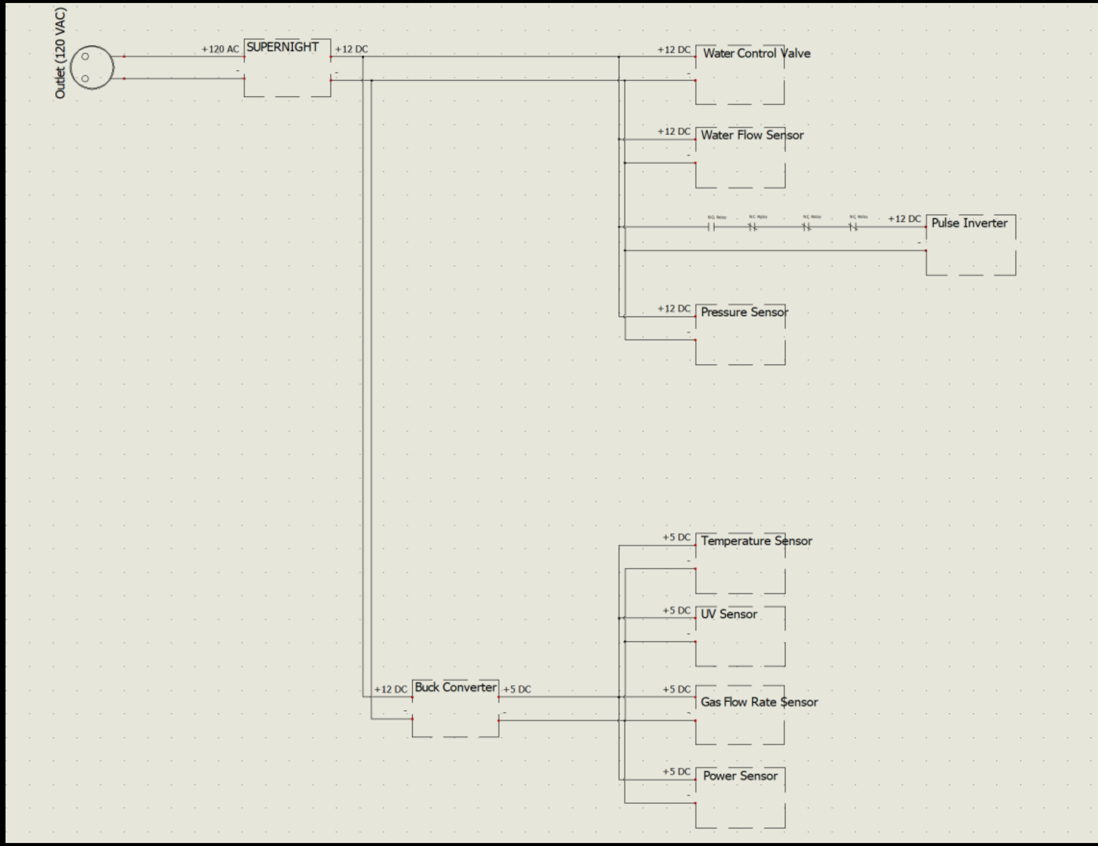
- The goal of the project was to create a water electrolysis system with modifications intended to boost its energy efficiency.
- Modifications were also made to the base system to properly address public health risks associated with the project and comply with various safety standards.

Standards

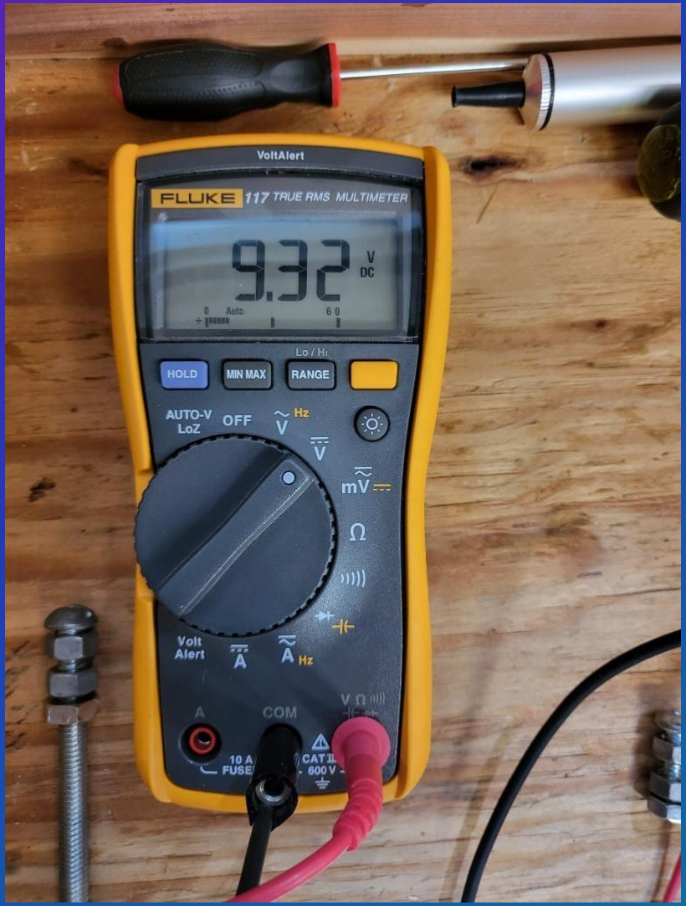
- 1910.103 OSHA – Storage, handling, and transportation
- NFPA 2 – Hydrogen Technolgies Code
- NFPA 54 – National Fuel Gas Code
- NFPA 70 – National Electrical Code
- ANSI Z21.1 - American National Standards Institute

Design - Power

- What needs power?
- The biggest power draw is the electrolysis cell itself.
- When DC, it will draw around 240 watts.
- To draw the 5 volts needed, a buck converter was used.



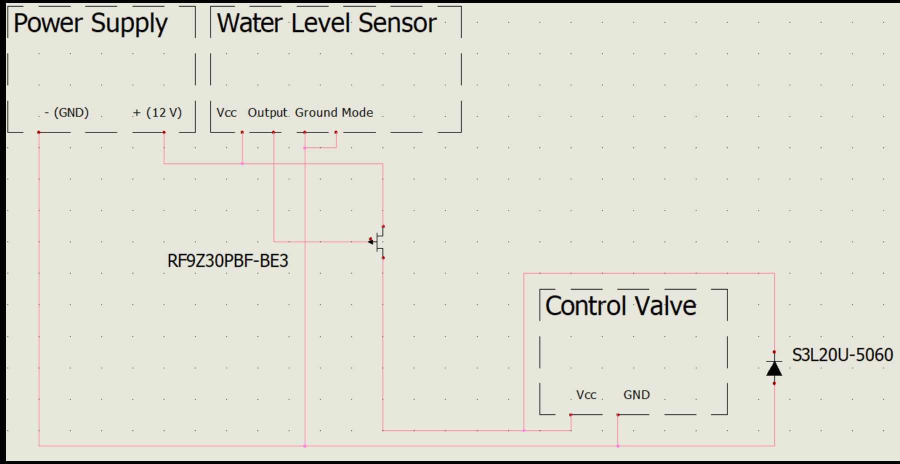
Implementation - Power



- Implementation is straightforward – just use a bus-bar.
- The biggest challenge was finding wire sizes for DC testing.
- The DC cell draws so much power it starts to lower the output of the supply.

Design - Water

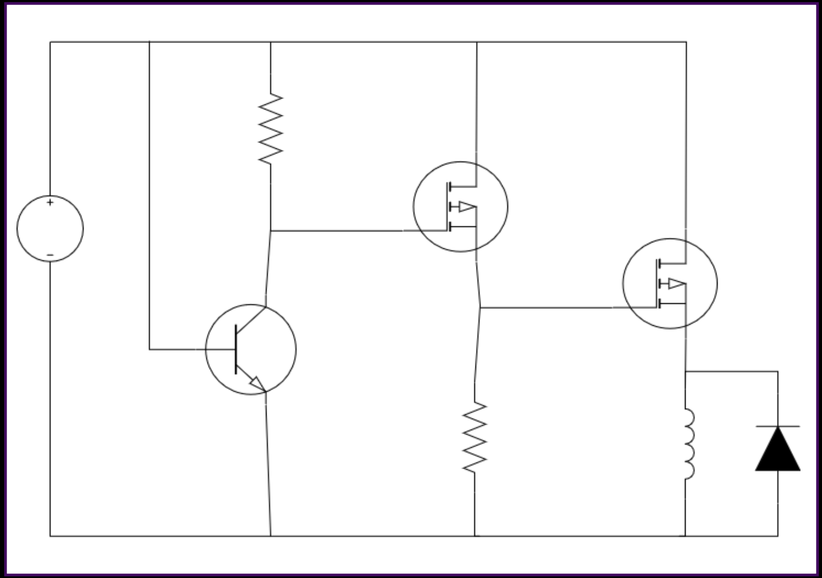
- Needed a way to sense the level of the Water level without being in the cell
- Had to ensure the was no backflow to make sure we would not contaminate the water supply
- Had make sure the water would stay at an appropriate level

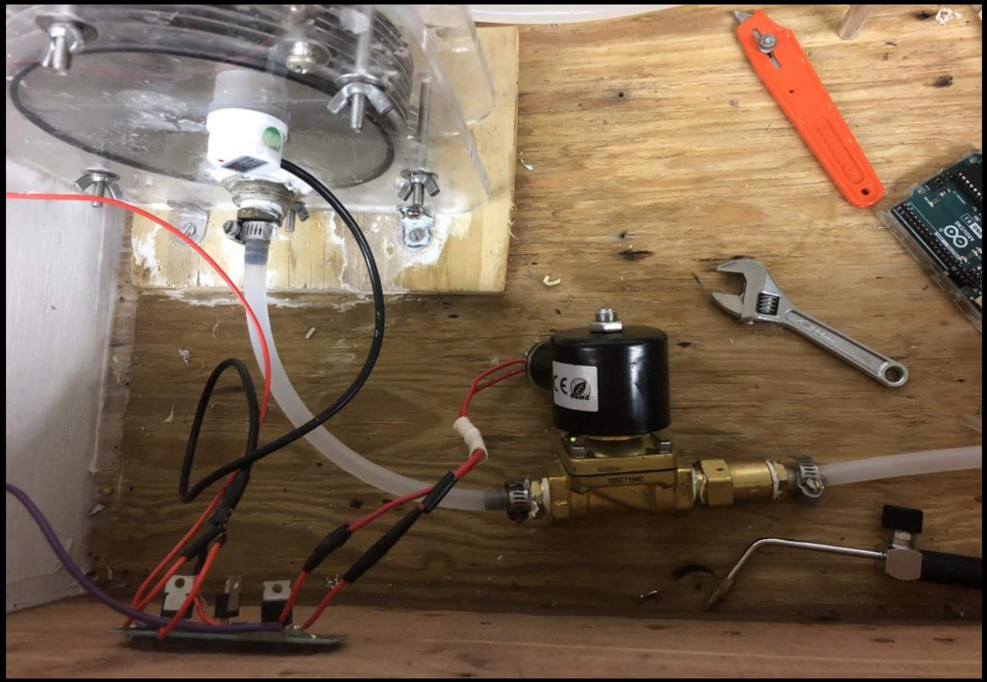


Implementation - Water

- Original Design did not work
- Needed to invert the signal from the sensor
- Could have used a micro-controller but went with an analog circuit

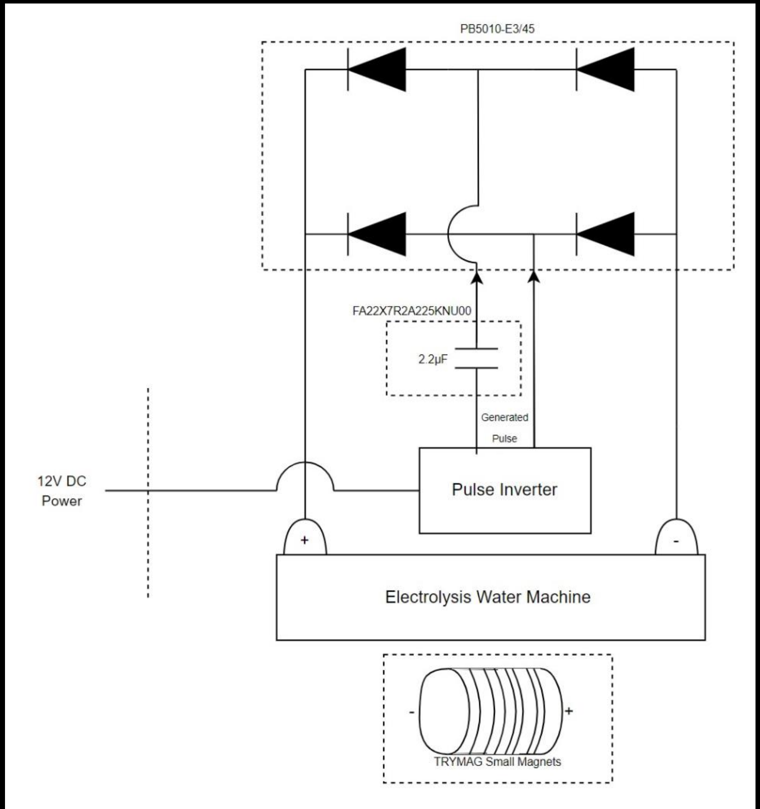
Implementation - Water





Design - Electrolysis

- Needs to include the electrolytic cell and the tools for efficiency boosting
  - Pulse inverter
  - Rectifier
  - Magnets
  - Coupling capacitor



Implementation - Electrolysis

- Everything was incorporated successfully.
  - The expected AC pulses were produced from the pulse inverter.
  - The AC voltage was then rectified properly.
  - Magnets were attached to the outside of the cell.
- The auxiliary capacitors were replaced to adjust the duty cycle of the pulses.

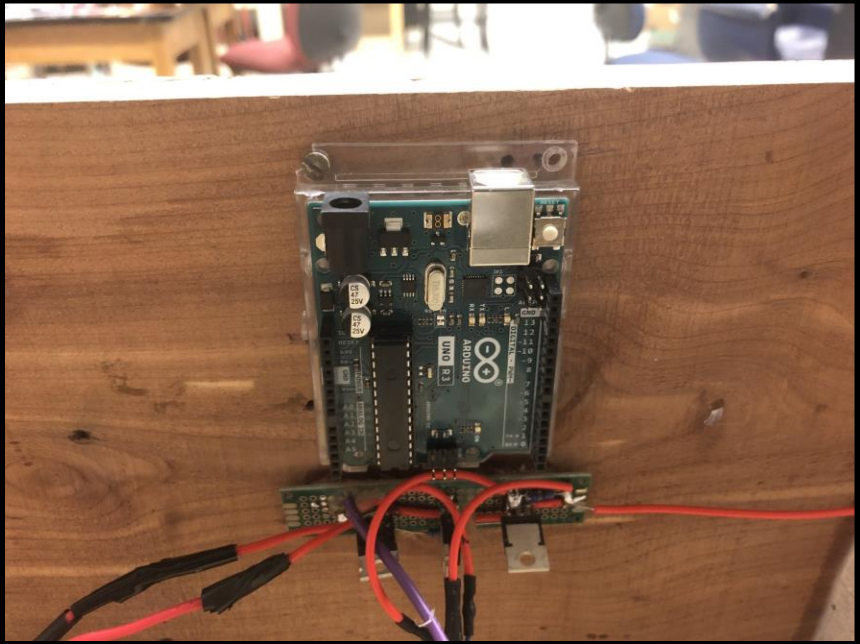
Design - Controller

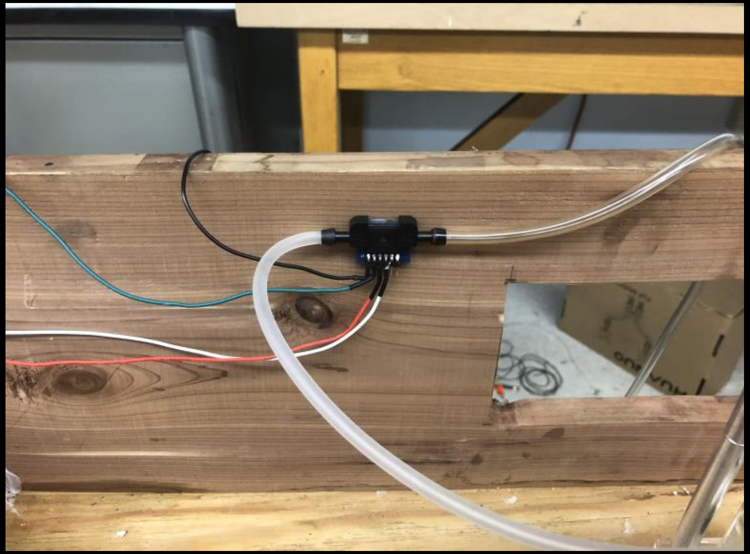
- Arduino Uno for sensor readings, efficiency calculations, and serial output.
- Originally planned on using the SFM3003 for gas flow rate readings but the gas tube was too small to fit around the sensor.
- Switched to FS1012 which is an analog gas flow rate sensor.
- Adafruit INA260 for power readings.

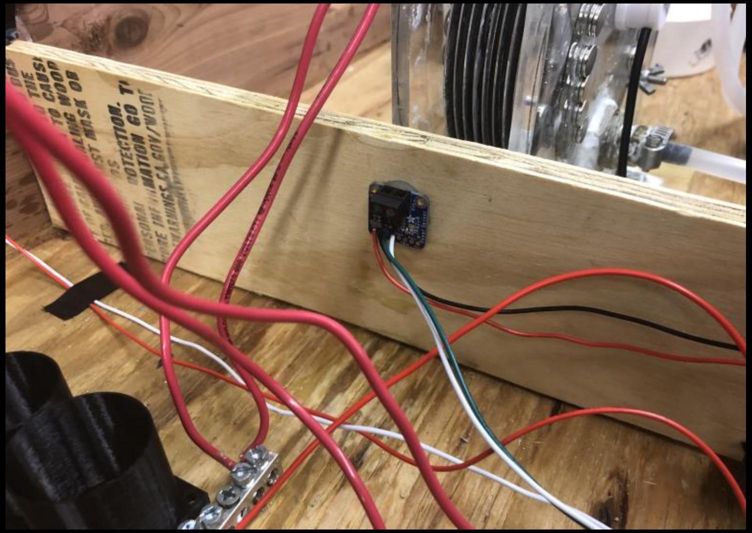
Implementation - Controller

- Accidentally desoldered resistors off the power sensor, new ones had to be ordered.
- The flowrate sensor originally was reading about 7.4 sccm while using 240 Watts but after trying to solder on wires and desolder the pins the sensor no longer behaved the same way.
- The power sensor was about 3-4 Watts off I think this was since the sensor was not grounded with the rest of the system.

Implementation - Controller







Design - Gas

- Handling gas once it is generated, there is no storage in the system.
- Gas Arrestor is used to prevent any combustion from going back into cell housing, this is used as a safety measure.
- Gas System prevents the backflow of flame from causing damage to the system

Implementation - Gas

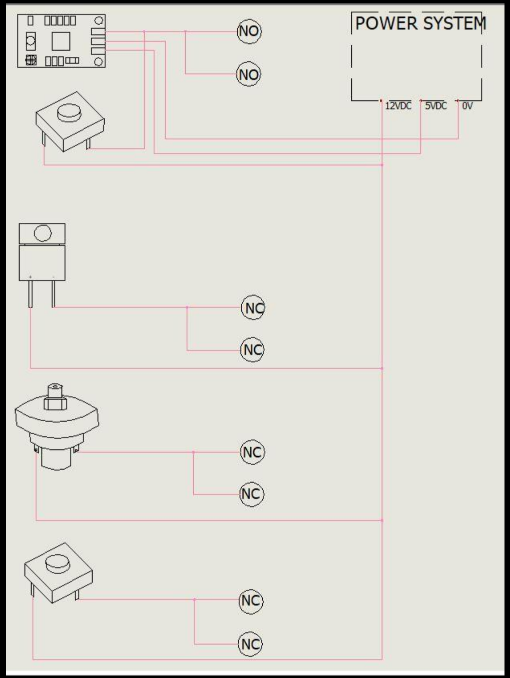
- The system was turned on, the torch was removed, and no flame was lit. After some time of gas producing the flame was then lit. This caused flame to be sent backwards towards the arrestor.

- The water in the arrestor expels the flame and preventing it from travelling towards the cell.

Implementation - Gas

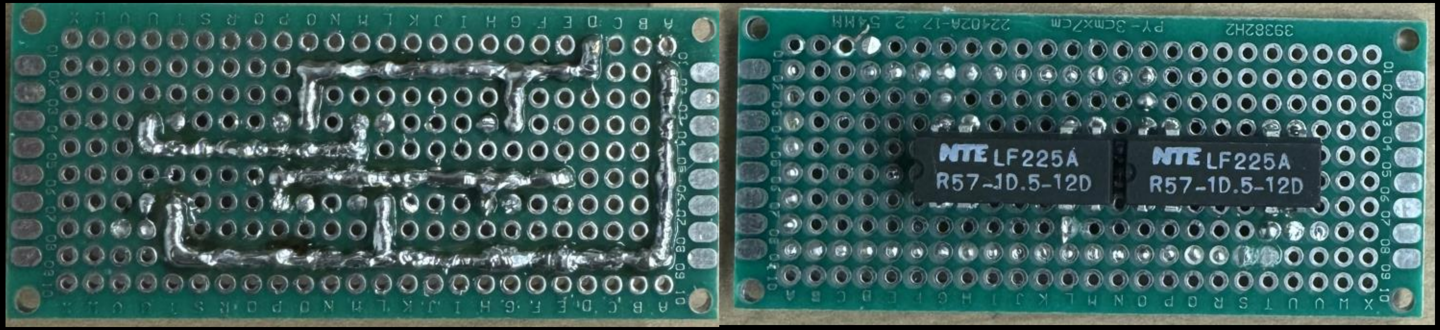
Design - Safety

- Cut off power to the pulse inverter if the system becomes unsafe
- "Safe" is defined by conditions in which browns gas could ignite
  - Temperature rises above 100 °C
  - Pressure builds above 15 psi
- Design also includes user inputs to start/stop the system
  - System is not producing a flame
  - User presses the emergency stop button



Implementation - Safety

- Original flame sensor was supposed to detect light between 200-370 nm - this was not the case. A second temperature sensor was used instead.
- All other components behaved as expected and implementations went smoothly.



Experimentation

- One of our measures of success was to improve the efficiency of electrolysis.
- The other measure of success we wanted to do was have a constant flame output.
- To be able to measure the input and output power of the system.
- The accuracy of the pulse generator outputs frequency voltage

What's Next?

- We would like to increase the auxiliary capacitor.
- Implement a closed-loop feedback system for the pulse inverter's controller.
- We would like to change both the power input sensor and the gas output sensor.
- We would like a high sensor and low sensor for the water system.
- Use a flame sensor instead of a temperature sensor to detect flame output.

Budget

Predicted

Components	Price($)
Electrodes	180
Pulse Generator	90
Mini Compressor	400
Hydrogen Sensor	65
Housing System	80
Gas System	260
Micro-controller	30
Total	925

Real

Components	Price($)
Controller	155.72
Electrolysis	120.9
Gas	157.42
Power	33.97
Safety	152.64
Total	620.65

Demonstration