



# Proton Exchange Membrane Fuel Cells (PEMFC)



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## Objective:

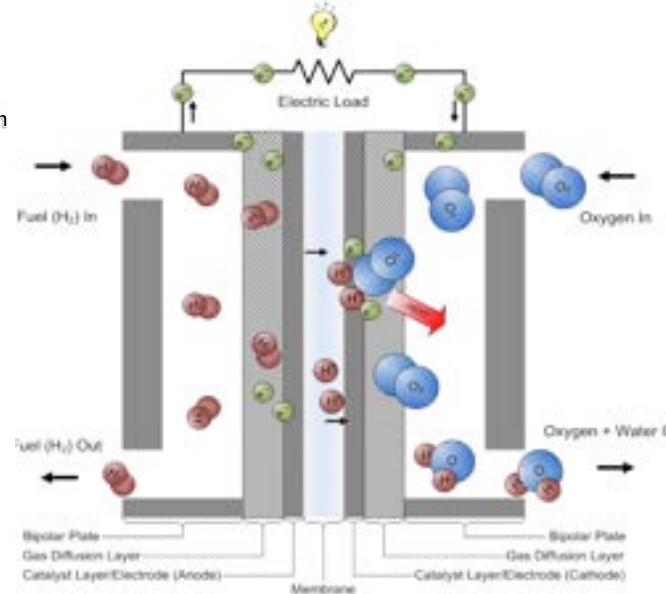
To study the operation and efficiency of a proton exchange membrane fuel cell.

## Materials and Methods:

The materials used in this experiment include:

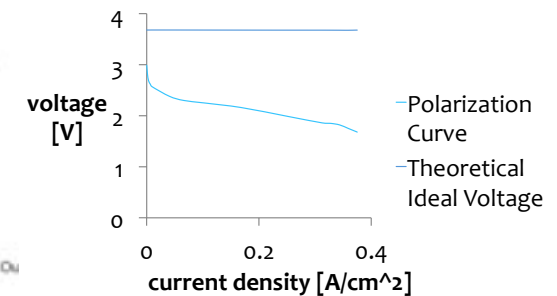
- PEMFC apparatus
- Hydrogen
- Air
- Data acquisition software

Four trials are conducted in order to test/observe the effect of varying gas flow rate, humidification, and fuel cell temperature.



## Polarization Curve:

Polarization Curve (j-V) for Trial 3



$$E_{\text{Nernst}} = E^{\circ} + \frac{\Delta E}{nF} (T - T^{\circ})$$

$$E_{\text{act}} = -\frac{RT}{\alpha n F} \ln j_0 + \frac{RT}{\alpha n F} \ln j$$

$$E_{\text{ohmic}} = j(\text{ASR}); \text{ASR} = A_{\text{fuel cell}} R_{\text{A}}$$

$$E_{\text{conc}} = c \ln \frac{j_0}{j_0 - j}$$

$$\text{Efficiency} = \frac{E}{E^{\circ}}$$

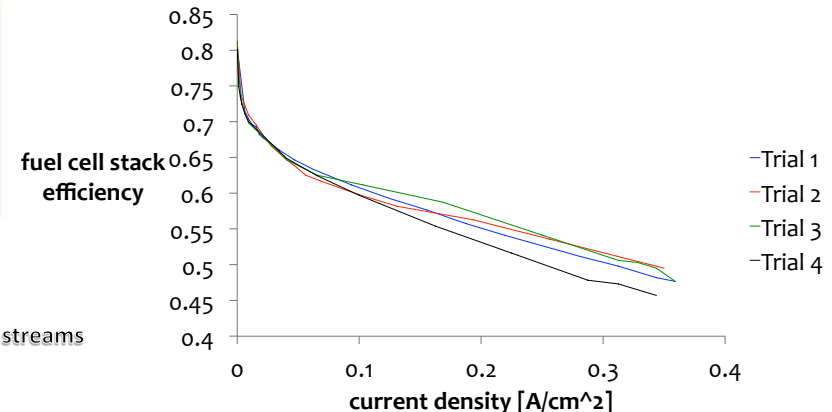
| Trial 1                        |      | Trial 2                        |      |
|--------------------------------|------|--------------------------------|------|
| Humidifier Temp (Hydrogen) [C] | 25   | Humidifier Temp (Hydrogen) [C] | 25   |
| Humidifier Temp (Air) [C]      | 25   | Humidifier Temp (Air) [C]      | 25   |
| Fuel Cell Temp [C]             | 36.3 | Fuel Cell Temp [C]             | 35.9 |
| Hydrogen Flow Rate [cc/min]    | 100  | Hydrogen Flow Rate [cc/min]    | 300  |
| Air Flow Rate [cc/min]         | 500  | Air Flow Rate [cc/min]         | 1500 |

| Trial 3                        |      | Trial 4                        |      |
|--------------------------------|------|--------------------------------|------|
| Humidifier Temp (Hydrogen) [C] | 31   | Humidifier Temp (Hydrogen) [C] | 31   |
| Humidifier Temp (Air) [C]      | 31   | Humidifier Temp (Air) [C]      | 31   |
| Fuel Cell Temp [C]             | 36.3 | Fuel Cell Temp [C]             | 21.1 |
| Hydrogen Flow Rate [cc/min]    | 100  | Hydrogen Flow Rate [cc/min]    | 100  |
| Air Flow Rate [cc/min]         | 500  | Air Flow Rate [cc/min]         | 500  |

## Results:

Fuel Cell Stack Efficiency Versus Current Density



## Conclusions:

- Fuel cell efficiency increases as a result of increasing fuel cell temperature
- Fuel cell efficiency increases as a result of increasing humidification of incoming gas streams
- Fuel cell efficiency increases as a result of increasing gas flow rates into the fuel cell
- Fuel cell temperature has the largest impact on fuel cell efficiency