Proton Exchange Membrane Fuel Cells (PEMFC)

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Objective:

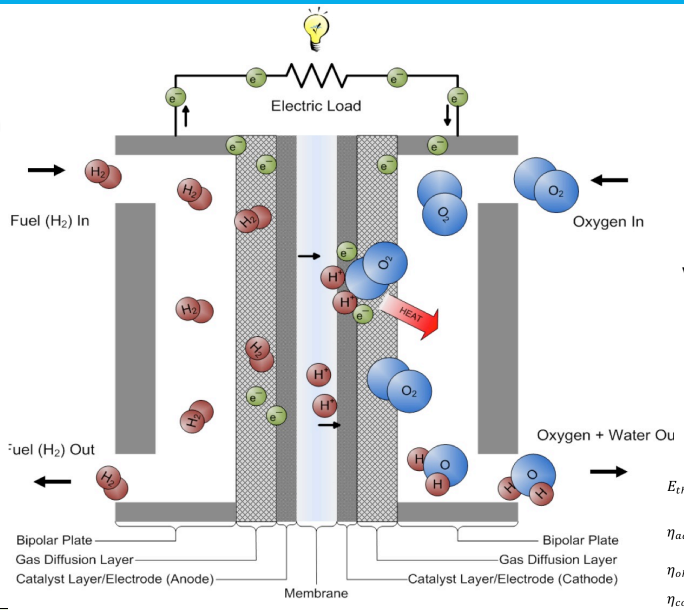
To study the operation and efficiency of a proton exchange membrane fuel cell.

Materials and Methods:

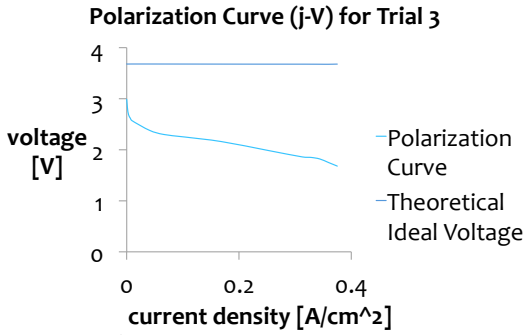
The materials used in this experiment include:

- 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:



$$E_{thermo} = E^o + \frac{\Delta \delta}{nF}(T - T^o)$$

$$\eta_{act} = -\frac{RT}{\alpha nF} ln j_o + \frac{RT}{\alpha nF} ln j$$

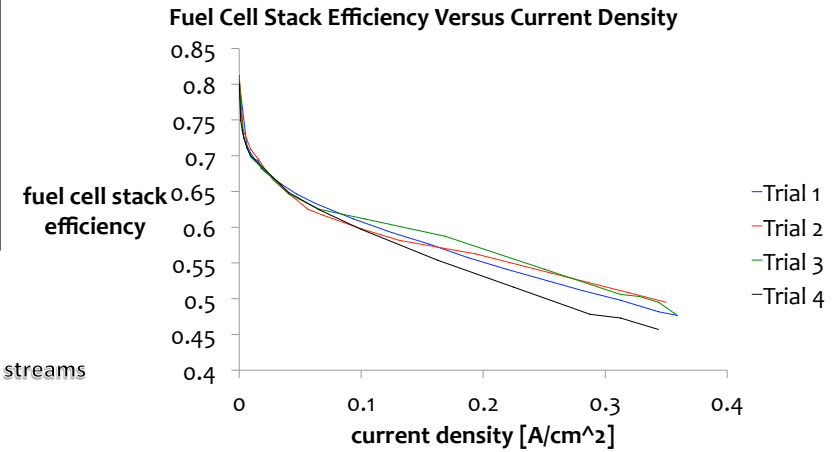
$$\eta_{ohmic} = j(ASR); \text{ ASR} = A_{fuel\ cell} R_\Omega$$

$$\eta_{conc} = c ln \frac{j_L}{j_L - j}$$

$$Efficiency = \frac{v}{E^0}$$

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:



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

References: Experiments conducted at Cleveland State University's undergraduate Chemical/Biomedical Engineering Laboratory under Dr. Orhan Talu.
O'Hayre, Ryan P. *Fuel Cell Fundamentals*. Hoboken, NJ: John Wiley & Sons, 2006. Print.