Group 16

Educational Alkaline Membrane Fuel Cell Kit

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Demonstrational Fuel Cell Kit

- “Deliver a functioning educational alkaline membrane fuel cell kit that demonstrates the effects of flow configurations on the fuel cell’s performance by the end of spring 2017 semester”

How an Alkaline Membrane Fuel Cell Operates

- Electrodes
  - Anode
  - Cathode
- Electrolyte Soaked Membrane
  - Potassium Hydroxide (KOH)
- Fuel
  - Hydrogen
  - $2H_2 + 4OH^- \rightarrow 4H_2O + 4e^-$
- Oxidizer
  - $O_2 + 2H_2O + 4e^- \rightarrow 4OH^-$

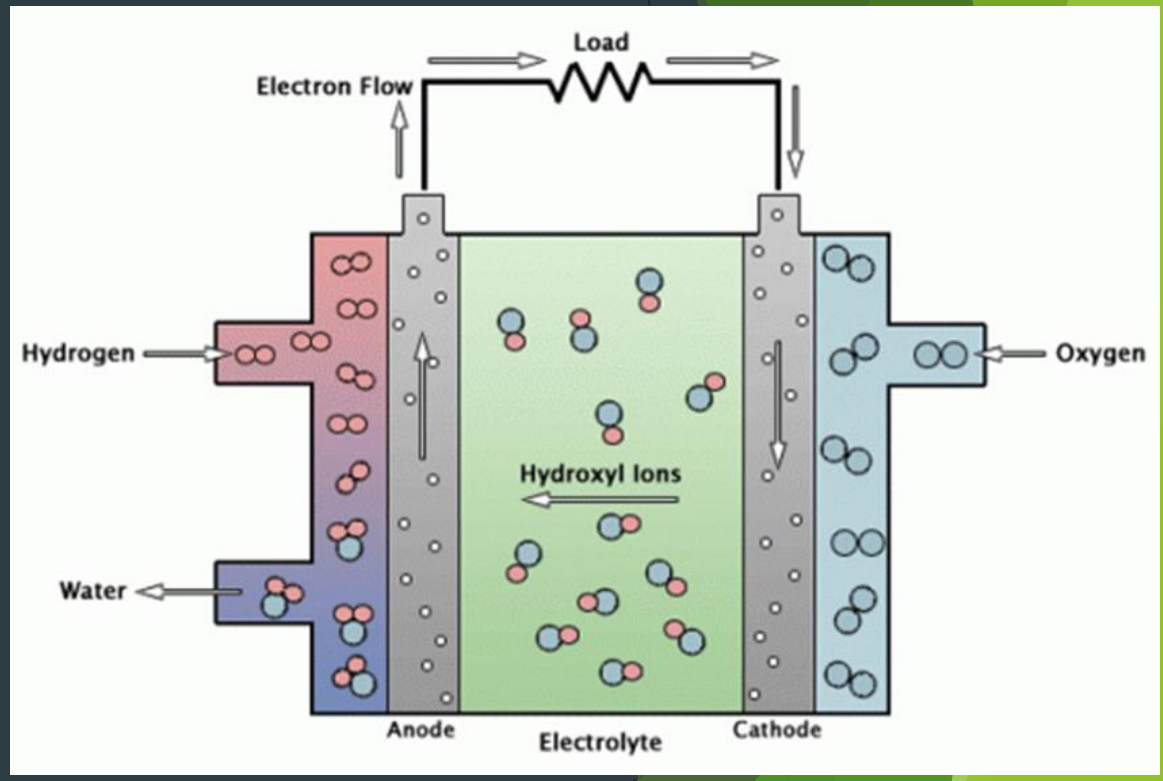

Figure 1. Fuel Cell Operation

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Advantages

- Compared to other Energy Sources
  - No greenhouse gas emissions
  - No moving parts
  - Quiet operation
  - Highly efficient
- Compared to other types of fuel cells
  - Ideal operating temperature
  - Less expensive catalysts can be used
  - More efficient

Figure 2. Advantages of fuel cell demonstrate clean energy

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Disadvantages

- Carbon dioxide poisoning
- Compressed gases required
- Alkaline solution is corrosive and cause acute toxicity
- Lack of development has prevented large scale use and manufacturing

Figure 3. Compressed Gases can be hazardous

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Educational Kit of AMFC

Challenges to Overcome

- Collecting and using pure hydrogen and oxygen
- Power output
- Operating temperatures
- Fuel cell corrosion caused by concentrated potassium hydroxide electrolyte solution
- Kit must be safe and relatively easy to operate

Project Scope

- “The current AMFC setup does not effectively allow students to test the effects of flow configurations on fuel cell performance.”
  - Conduct a series of experiments
  - Develop multiple flow configurations in kit
- Develop a model for commercialization

Figure 4. Multiple Fuel Cells

Prototype Design

- All required components needed to assemble and test fuel cell included in transportable case
- Kit must include an effective method for either collecting or storing pure hydrogen and oxygen
- Will contain more than one configuration of flow channels in order to allow for experimentation
- Fuel cell components must be noncorrosive
- Gas lines and fuel cell must be airtight

Current Design

Figure 5a. Case with Component slots

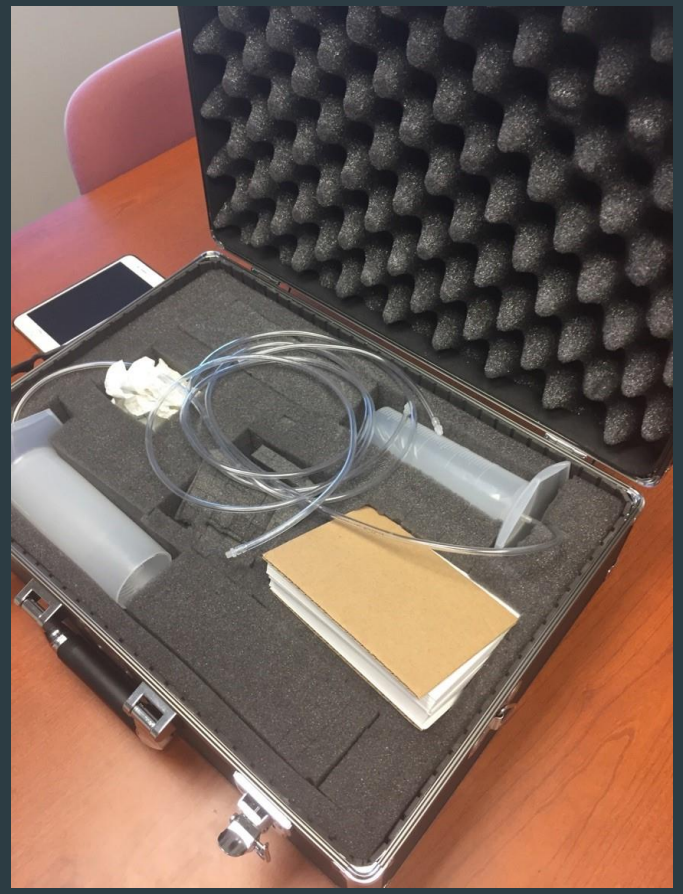

Figure 5b. Fuel Cell

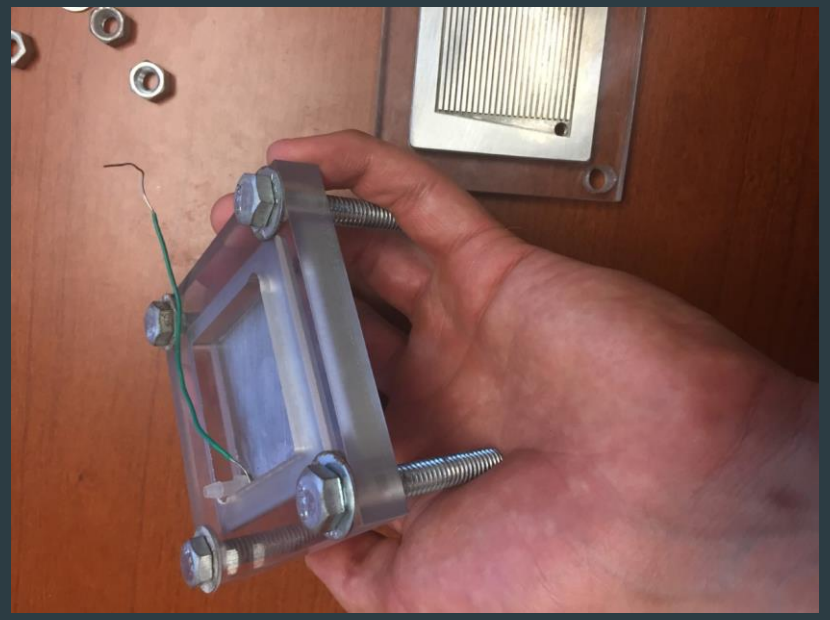

Figure 5c. Flow Configuration

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Designing New Configurations

- Uniform current density
  - Result in a better thermal management
- Reactant distribution over large area
  - Reactant Concentration decreases as it flows along channels
- Minimize head loss
  - Minor losses
  - Frictional effects

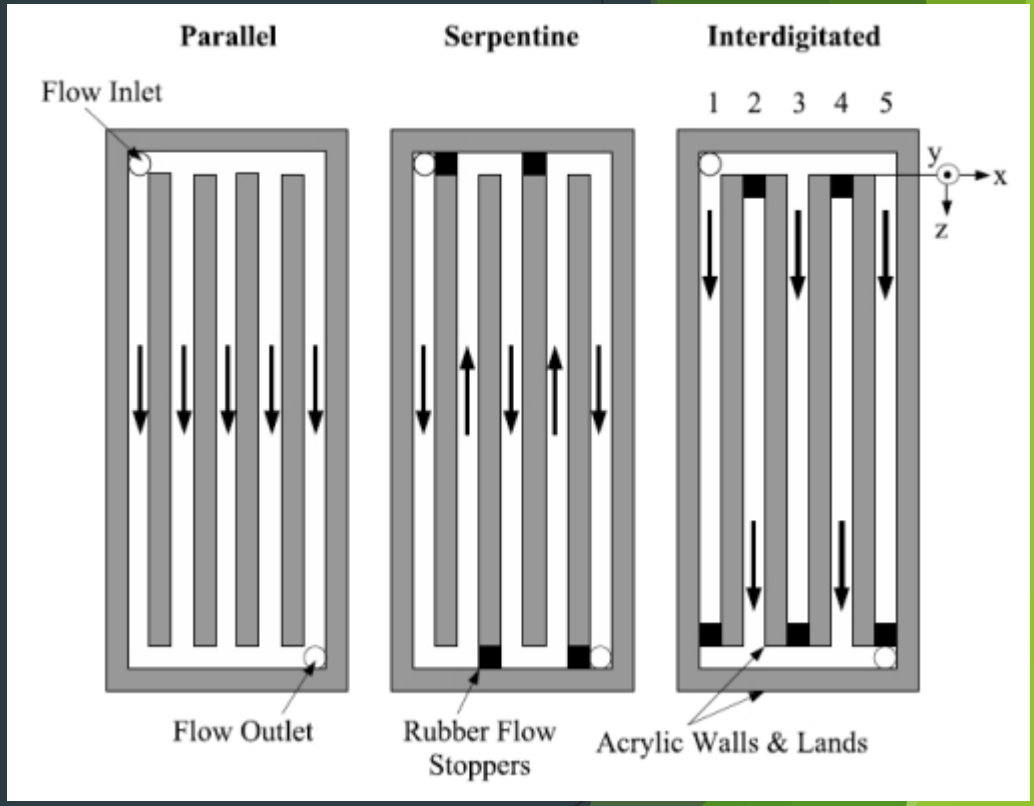


Figure 6. Fuel Cell Flow Configurations

Testing

- Construction of 2 new bipolar plates will be added
  - Serpentine and Interdigitated design
- Test power output
  - Voltmeter
- Test head loss
  - Efficiency
  - Water removal
- Test current density
  - Thermal imaging

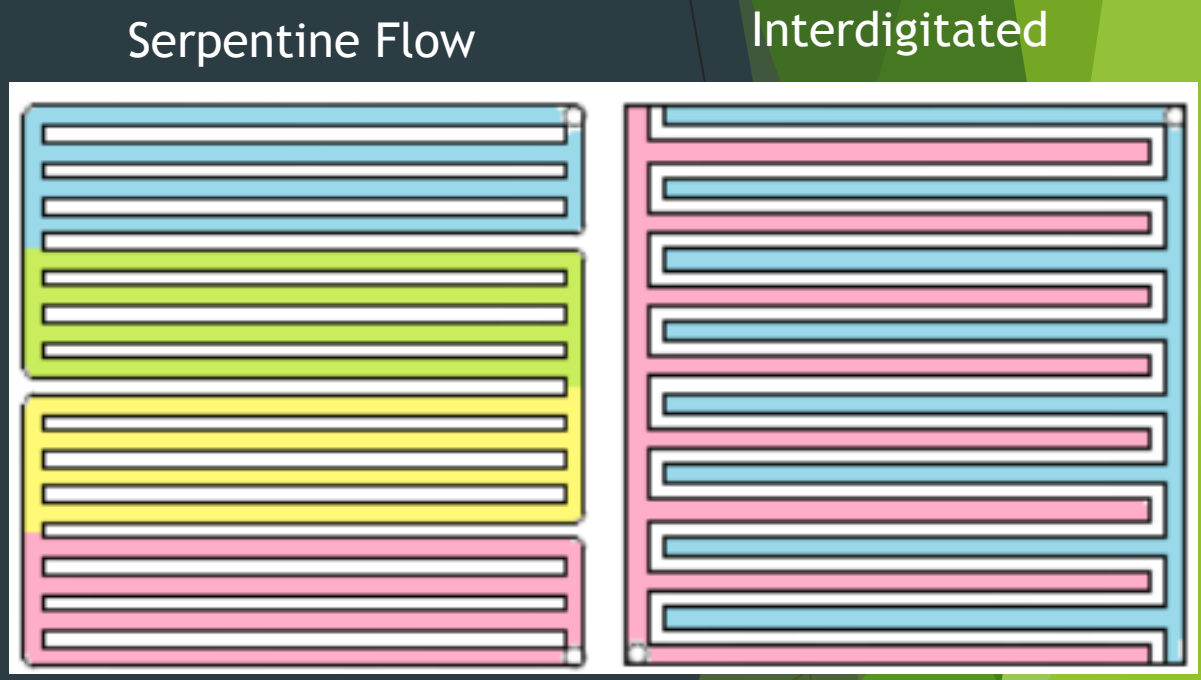


Figure 7. Fuel Cell Configurations

Design

- Collected data from testing
  - Develop new customized flow configuration
  - Optimized in all aspects that depend on fuel cell efficiency

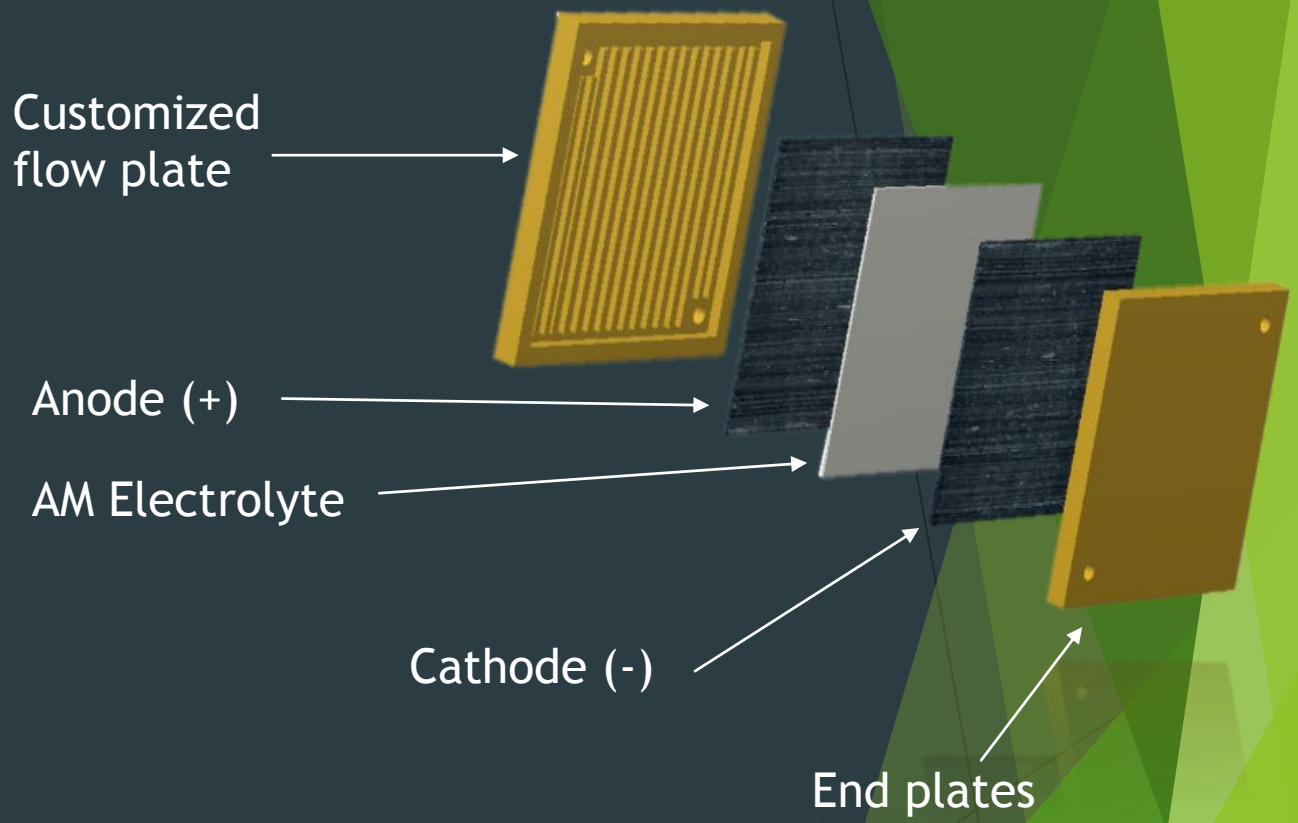


Figure 8. Exploded View of Fuel Cell

Marketing

- Hands on Learning
- Demonstrational Easy to Use Kit
- Compactable all necessary parts inclusive
- Targeted Consumers
  - High Schools
  - Universities
  - Science Centers

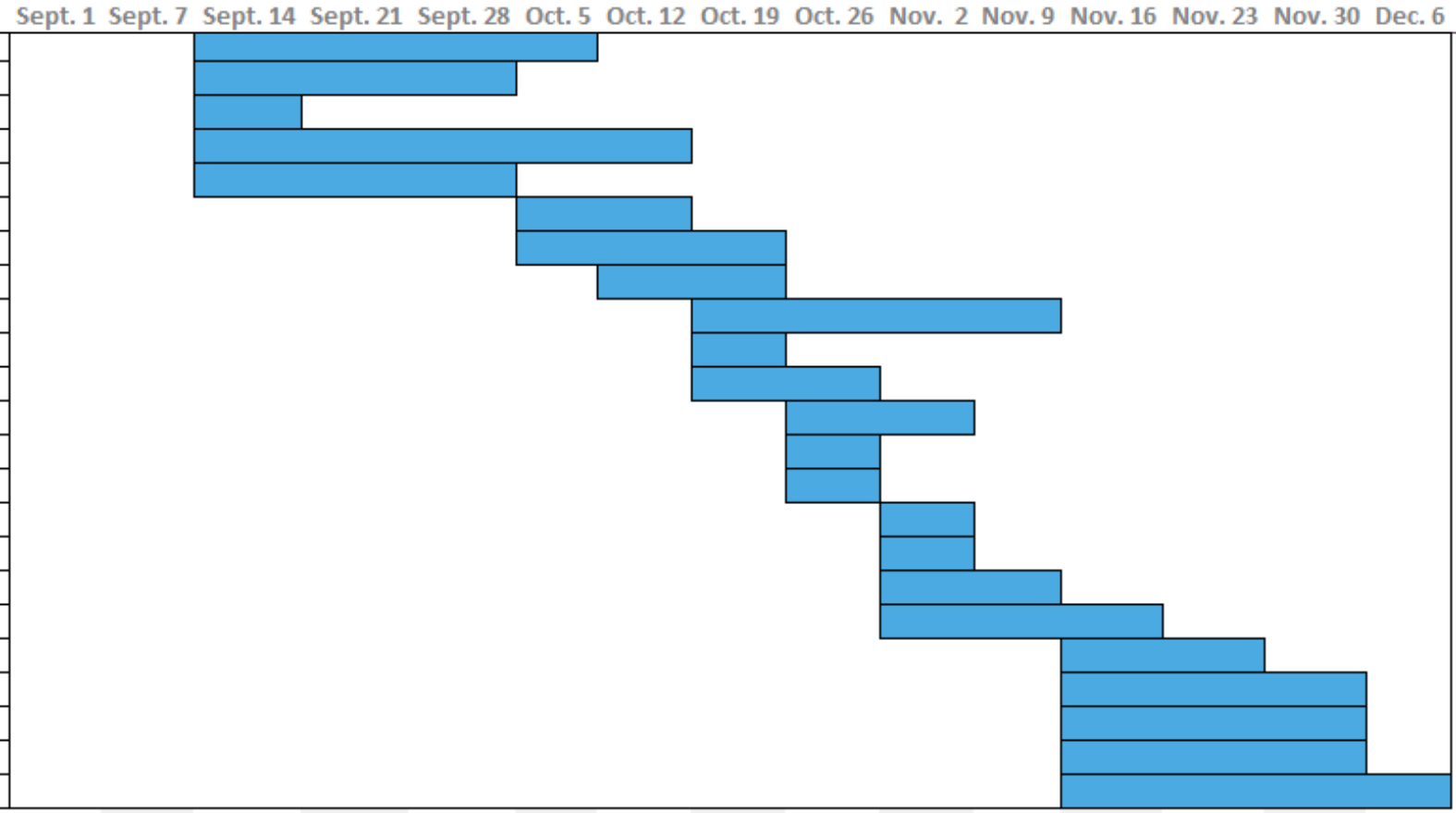
Figure 9b. Science Center

Figure 9a. High School Students in Lab

Project Plans

Table 1. Gantt Chart for Project Planning

ACTIVITY	DATE START	END DATE	DURATION
Meet with Advisor/Sponsor	9/14/2016	10/5/2016	21 days
Background Research	9/14/2016	9/30/2016	16 days
Code of Conduct Report	9/14/2016	9/16/2016	2 days
Discuss Design Ideas	9/14/2016	10/10/2016	26 days
Needs Assesment Draft Report	9/16/2016	9/30/2016	14 days
Midterm 1 Presentation	10/5/2016	10/11/2016	11 days
Midterm 1 Report	10/5/2016	10/21/2016	21 days
Gain Access to CAPS Laboratory	10/10/2016	10/19/2016	9 days
Communicating with Machine Shop	10/17/2016	11/12/2016	26 days
Web Design	10/18/2016	10/21/2016	3 days
Begin Testing of Existing Design	10/19/2016	10/24/2016	5 days
Construct CAD Drawings	10/21/2016	10/31/2016	10 days
Purchase Components	10/24/2016	10/31/2016	7 days
Machine new Flow Channels	10/24/2016	10/31/2016	7 days
Optimize Gas Delivery System	10/26/2016	11/2/2016	7 days
Optimize Electrolyte Membrane	10/26/2016	11/4/2016	9 days
Test Flow Configurations	11/1/2016	11/10/2016	9 days
Conduct Mathematical Analysis	11/1/2016	11/10/2016	9 days
Midterm 2 Presentation	11/10/2016	11/15/2016	5 days
Final Web Design	11/16/2016	11/22/2016	6 days
Finalize Protype Kit	11/16/2016	12/1/2016	15 days
Poster Presentation	11/16/2016	12/1/2016	15 days
Final Report	11/16/2016	12/5/2016	19 days



References

1. [4] Sommer, E.M., L.S. Martins, J.V.C. Vargas, J.E.F.C. Gardolinkski, J.C. Ordonez, and C.E.B. Marino. "Alkaline Membrane Fuel Cell (AMFC) Modeling and Experimental Validation." Journal of Power Sowers (2012): n. pag. Web. 25 Sept. 2016.
2. Paulino, Andre L.R., Eric Robalinho, Edgar F. Cunha, Rainmundo R. Passos, and Elisabete I. Santiago. "Current Distribution on PEM Fuel Cells with Different Flow Channel Patterns." (n.d.): n. pag. Https://www.comsol.com/paper/download/181391/paulino_paper.pdf. CAPES (Coordenação De Aperfeiçoamento De Pessoal De N ível Superior) and CNPq (Conselho Nacional De Desenvolvimento Científico E Tecnológico, 2013. Web. 2016.
3. Anderson, Bryan, and James Richardson. "Educational Kit for Alkaline Membrane Fuel Cell (AMFC)." Senior Design Presentation. Famu FSu College of Engineering, Tallahassee. 2016. Lecture.

Questions