# Design and Development of Optimized Flow Channels for an Alkaline Membrane Fuel Cell (AMFC) Educational Kit

## PROJECT GOAL

The goal of the fuel cell project is to investigate the performance of a proposed alkaline fuel cell membrane (AMFC) and optimize it for an education kit for high school and college level laboratory fuel cell functional demonstration. This investigation involves improving the design of the current fuel cell kit and finding new ways of improving the performance of the fuel cell. An understanding of how flow channels affect performance will contribute a key factor in the new design of the fuel and oxidant delivery components.

## BACKGROUND

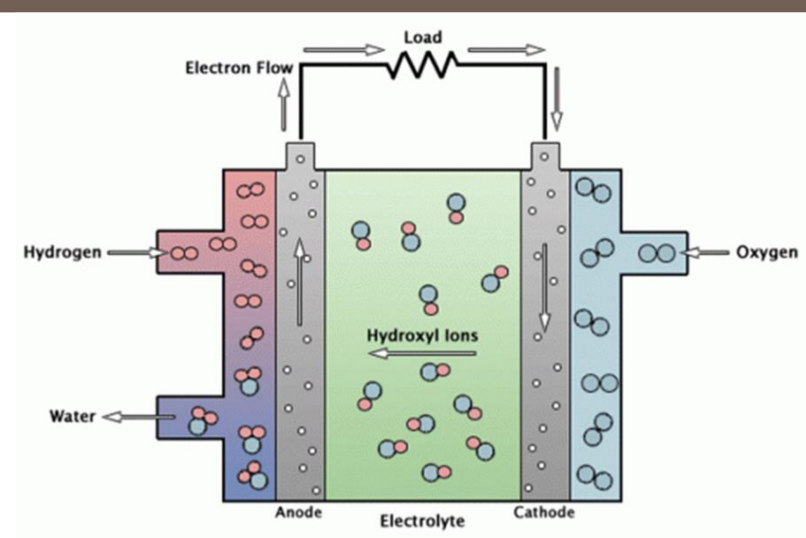


Figure 1: Basic Fuel Operation

- Converts chemical energy into electric potential energy
- Requires an electrolyte solution, hydrogen gas, and oxygen gas for operation
- Generates pure water and electricity

## OBJECTIVES

- Improve the overall safety of the fuel cell's previous design.
- Conduct thermal fluid systems analysis to correlate with fuel cell performance
- Include multiple flow configurations to compare performances
- Include operation procedure and a product specification sheet
- Design experimental procedures for optimal learning experience
- Develop a model for commercialization of the kit.

## ACKNOWLEDGEMENTS


Team 16 would like to first thank Dr. Shih for hosting senior design, providing feedback and guidance. Our advisor and sponsor Dr. Juan Ordonez has given us a lead on our project as well as insight on thermal fluids research. Mr. Larson has helped the team with his advice in the machine shop to ensure that production is done correctly and efficiently.


## PLATE CONFIGURATIONS AND DESIGN

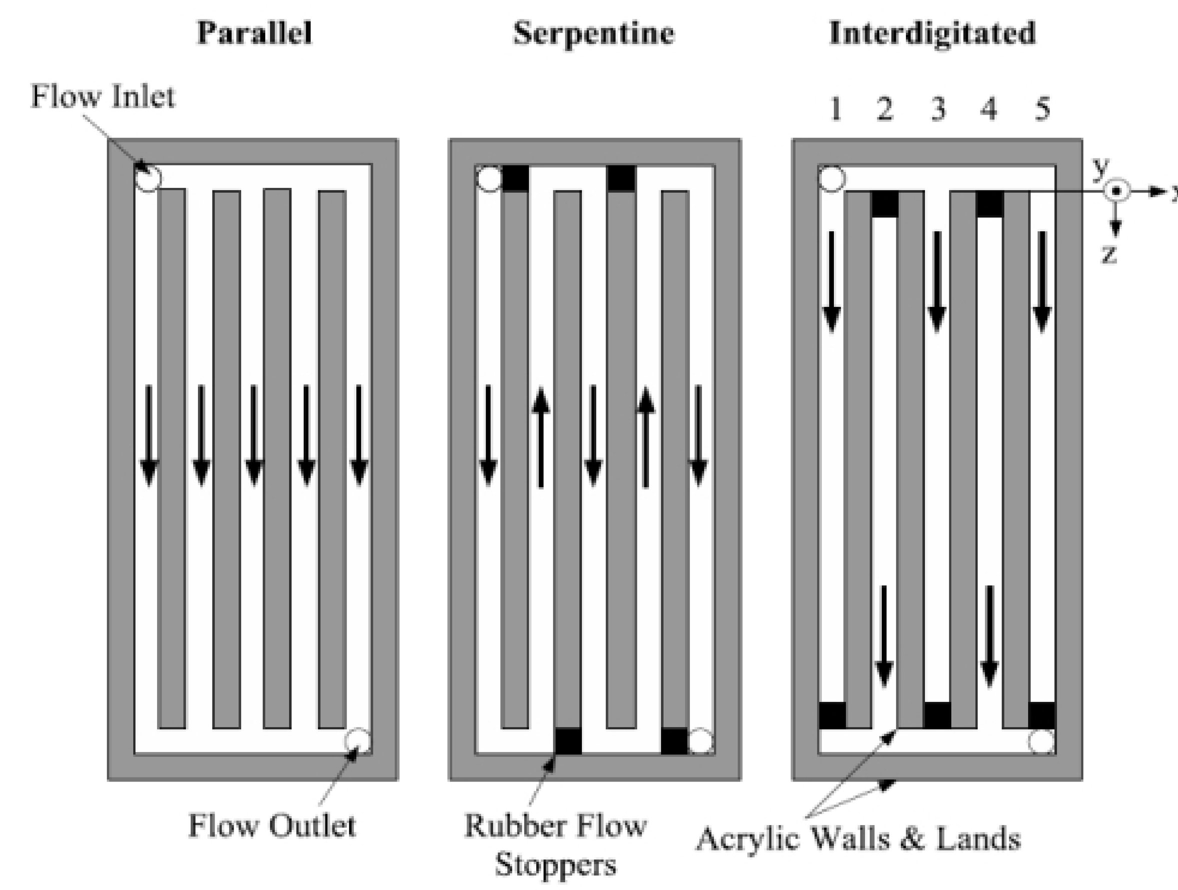


Figure 2: Flow Configuration Pathways

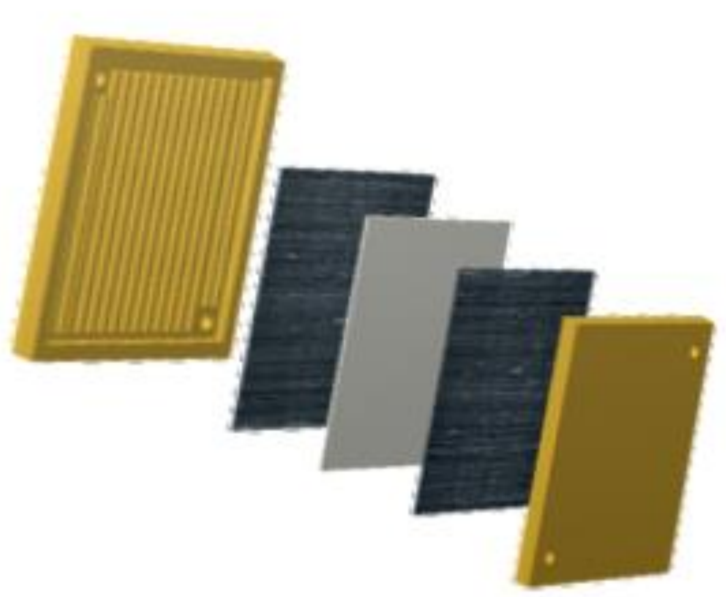

Figure 3: Exploded Cell View

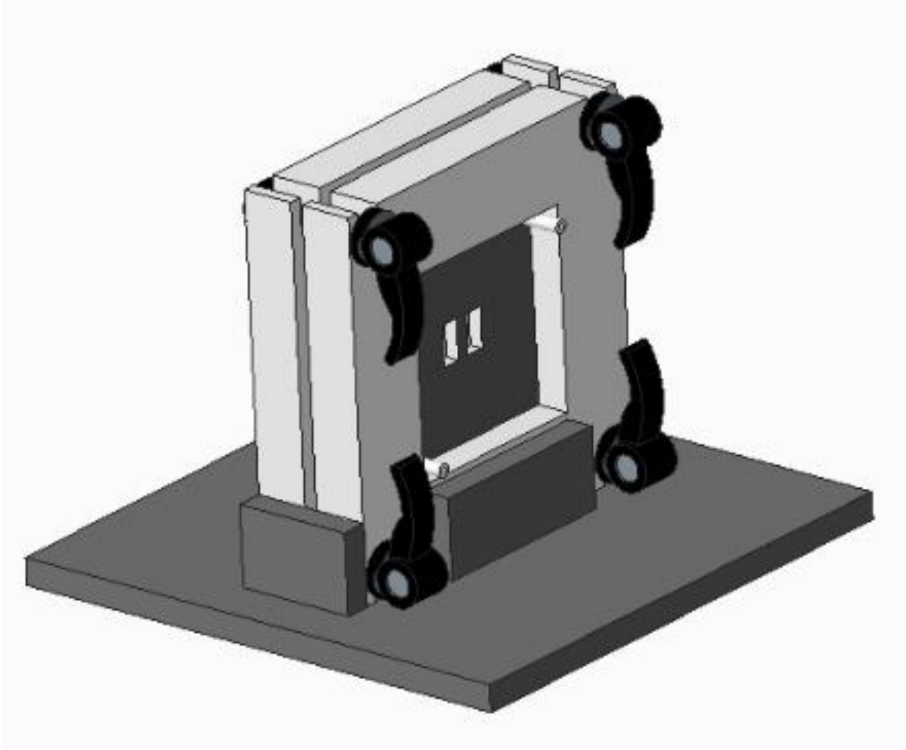

Figure 4: Assembled Cell View

Figure 2 demonstrates the various flow paths that will be made into cell plates. The plates will be easily interchangeable for effective experimental learning purposes. Figure 3 shows the configuration plates (2.5 X 2.5 X $^{1}/_{8}$ in) and components within the cell for functionality. Figure 4 is an assembled view of the cell during operation.

## DESIGN IMPROVEMENTS

- Baseplate included to improve stability (5 X 5 X 0.25 in)
- Quick release skewers to minimize components and eliminate unnecessary tools
- Incorporate the use of alligator clips to improve electrical connections
- Plexiglas housing to minimize hot surfaces (3.5 X 3.5 in)

## RESULTS

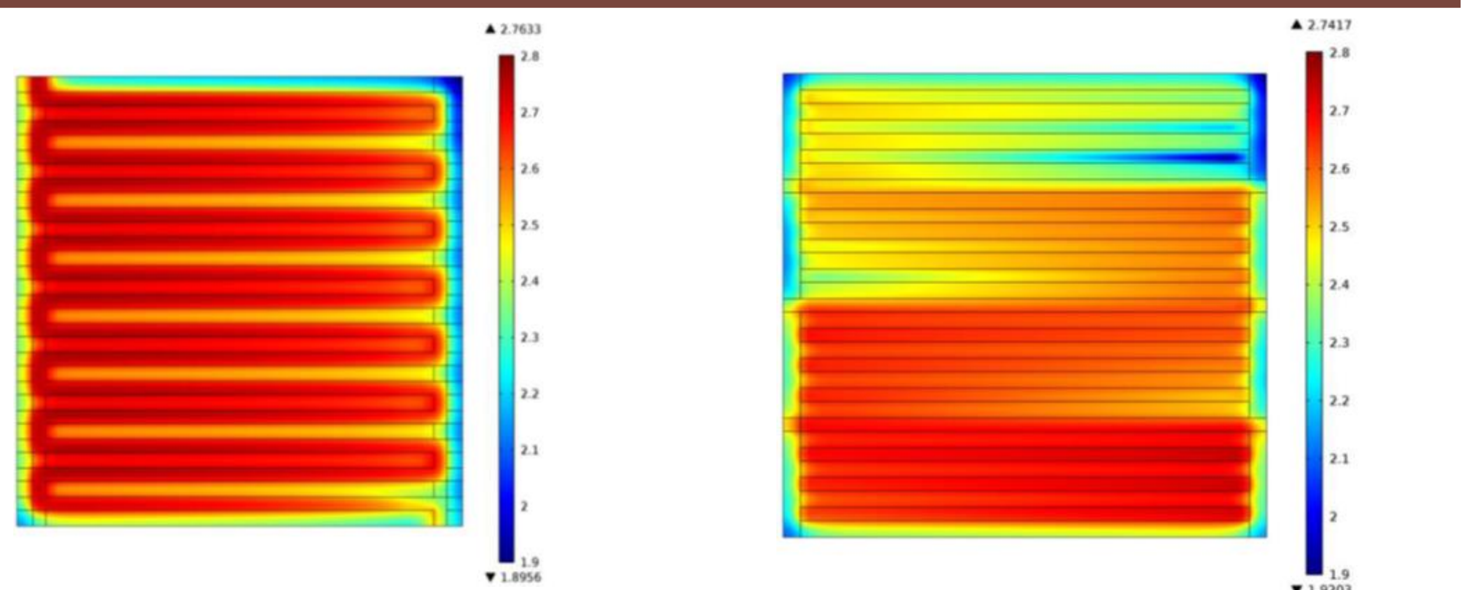

Figure 5: Thermal Imaging Interdigitated (left) Serpentine (Right)

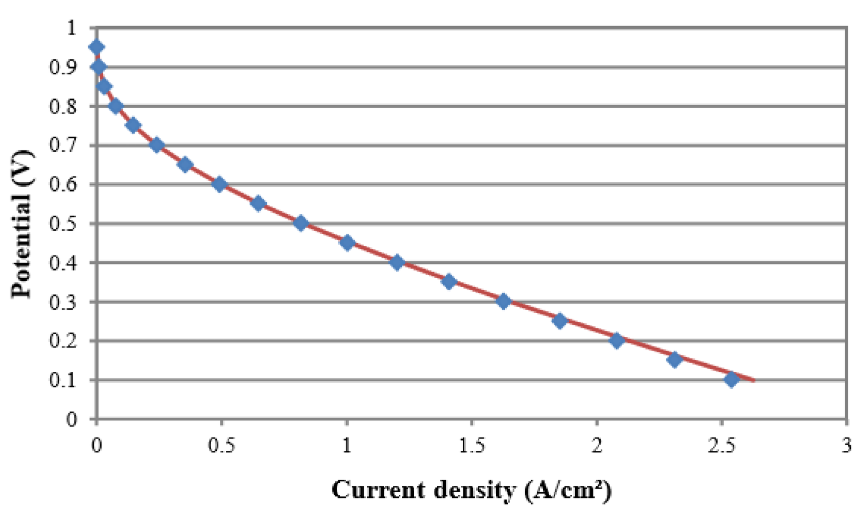


Figure 6: Theoretical values for Voltage vs. Current Density (Blue dots-Serpentine, Red line-Interdigitated)

## FUTURE PLAN

- Efficient gas delivery method with consistent flow rates
- Pressure gages to calculate experimental pressure drops
- Machine serpentine and interdigitated designs
- Test each design for voltage potential and water management and compare to pressure drop results
- Design new customized configuration that optimizes diffusion, contains a low pressure drop, and promotes good water management to optimize performance
- Order additional components

## REFERENCES


[1] 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.