SUB-GROUP TEAMS:

Fuel Analysis:

-Researched different method of obtaining and storing hydrogen, methanol reformation and fuels such as JP-5, 8.

Impurities:

-Researched what most commonly poisons a cell and how to prevent such poisoning

Unmanned Air Vehicles:

-Researched the feasibility of using fuel cell in Unmanned Air Vehicles (UAV)

PBI Fuel Cell Design:

-Researched the PBI fuel cell and designed a cell to produce enough energy to power a small aircraft motor and pump

Electronics:

-Designed the power system in terms of what components would be needed to supply power to the motor and other accessories .

Fuel Tank Design:

-Designed system to store, transport, and reform the fuel.

CHALLENGES:

This IPRO was especially difficult because we were researching a topic that is still in its infant stages. Fuel cells are only now being put into small scale production and we were attempting to make the huge leap into commercial and military applications.

RECOMMENDATION:

Fuel cell technology has come a long way and many obstacles that discouraged their use before have been overcome by innovations like the PBI/phosphoric acid based membrane fuel cell. Even with all these advances, fuel cell technology is still not ready to compete on a commercial basis with the current internal combustion engines and battery technology. Other technological hurdles still need to be overcome: how to dissipate and decrease the amount of heat produced by the cell, weight of the fuel cell system, cost of the catalyst and corrosion of the cell's bipolar plates.

CONCLUSION:

A PBI/phosphoric acid fuel cell system was designed for a two-passenger unmanned aircraft in place of an internal combustion engine. Replacing the cell's graphite bipolar plates with metal, a more corrosive material, met weight standards but the system still produced more heat than could be efficiently dissipated.

SPECIAL THANKS TO…

- Vijay Ramani for being an excellent advisor
- The MMAE 436 (Screech Owl) design team

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Fuel Cells for the Future

Business or Bust?

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PEM/PBI Fuel Cell

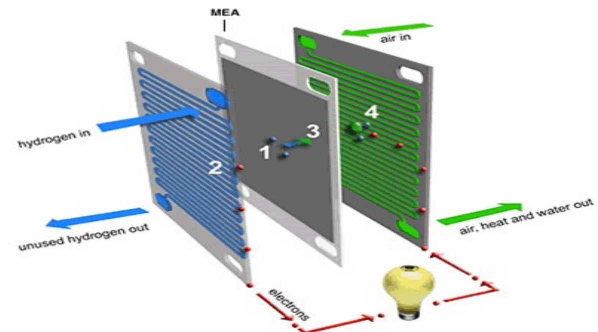
Problem Statement:

The goal of this IPRO is to evaluate the feasibility of fuel cells in commercial applications (including military and defense, automotive, and aerospace) by drafting a design that incorporates a fuel cell system.

Objective:

- Evaluate the feasibility of current PEM fuel cell technology for use in commercial applications
- Compare and contrast the performance of PEM fuel cells to PBI/phosphoric acid fuel cells
- Assess the feasibility of PBI/phosphoric acid fuels cells for use in UAV and UUV military applications
- Design a fuel cell system to power a light aircraft
- Compare the cost, benefit, and commercial feasibility of the newly designed fuel cell system

BASIC FUEL CELL



WHAT is a PEM FUEL CELL?

Proton Exchange Membrane (PEM) fuel cells work with a polymer electrolyte in the form of a thin, permeable sheet. The solid, flexible electrolyte will not leak or crack. A typical fuel cell's operating temperature is about 80°C.

Polybenzimidazole (PBI) is a type of PEM fuel cell with a sol-gel based, high-temperature (<200 °C) proton conducting membrane with unprecedented characteristics. Using a PBI/H_3PO_4 composite membrane can eliminate auxiliaries to control water because it does not require humidification and is less sensitive to carbon monoxide poisoning

What are PEM fuel cells used for?

- Transportation applications
- Some stationary applications

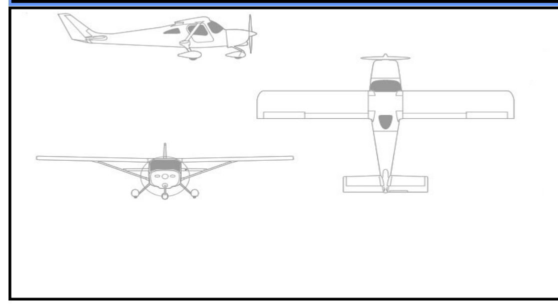
OUR PROCESS

Our first approach to this problem was to research the technical aspects of fuel cells from which it was determined that polybenzimidazole (PBI) fuel cells were the most promising.Next, we investigated possible applications for our fuel cell system. Commercial automobiles were determined not to be feasible with current technology. Then unmanned air vehicles (UAV) and unmanned underwater vehicles (UUV)

OUR PROCESS (Cont.)

were compared. UAV were chosen as the best option. First, we looked into the possibility of using an original IIT design by MMAE senior students, which was determined to be too small to carry the fuel cell it would require. Then, we looked at several models on the market only to find the same difficulty as with the student-made design. Finally, we decided that the best possible choice was converting a two-passenger airplane into a UAV because the space and weight originally designed for two people could be easily adapted and used for the space and weight of a fuel cell power system.

AIRCRAFT DESIGN



- Cessna Skycatcher two-passenger aircraft gives enough space to fit the fuel cell and all components into previous passenger space
- Fuel cell dimensions based cockpit size
- Electronics and supporting systems fit into the storage areas

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