DEFN-14-*[group #]*

PROJECT DEFINITION

APPROVALS			
ROLE	**NAME**	**SIGNATURE**	**DATE**
Team Leader	*Danyal Khafajizad*		
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PEM Fuel Cell Battery

Revision History

REV	DESCRIPTION	DATE	APPROVED BY
-	Initial Release	*[mm/dd/yy]*	*[an approver]*
[A]	*[enter description]*	*[mm/dd/yy]*	*[an approver]*

Table of Contents

1 PROJECT OVERVIEW

1.1 Executive Summary

Due to the growing concerns on the depletion of petroleum-based energy resources and climate change, fuel cell technologies have received much attention in recent years owing to their high efficiencies and low emissions. Factors such as durability and cost still remain as the major barriers to fuel cell commercialization. [Y. Wang, Ken S. Chen, Jeffrey Mishler, Sung Chan Cho, Xavier Cordobes Adroher, A Review of Polymer Electrolyte Membrane Fuel Cells: Technology, Applications, and Needs on Fundamental Research, Applied Energy 88 (2011) 981-1007].

Our research team consists of undergraduate Mechanical and Aerospace Engineering seniors and will be working on the study of proton exchange membrane (PEM) fuel cells. A fuel cell is an electrochemical device that converts chemical energy from a fuel into electricity through a chemical reaction involving an oxidizing agent such as oxygen.

The PEM fuel cell generates electricity by electrochemical reactions in the anode as well as the cathode. In order to speed up the chemical reactions, PEM fuel cells utilize a catalyst. The best catalyst researched to date is platinum. When the protons reach the cathode, they react with the oxygen and electrons to produce water, which is the only waste product produced by the fuel cell. Meanwhile, the electrons generated in the anode travel in an external circuit, creating the electrical output of the fuel cell. There are no harmful emissions as there is no combustion of the fuels.

A PEM hydrogen fuel cell has a practical efficiency of up to 60%, which leads to as little as 40% of the energy inputted becoming excess heat. However, fuel cells are negatively affected by variations in temperature. This research will look into a way of keeping the PEM fuel cells a consistent temperature, as well as utilizing the waste heat in a portable system. Two main ways of cooling, with air and with water, will be focused on. During this time, investigation will begin on which type of medium best cools the PEM fuel cells, as well as finding the best operating temperature for cells to achieve maximum efficiency. After this is done, research will be carried out to determine how much heat is removed from each fuel cell and whether or not this heat can be viably used for other purposes.

Another focus of this design project will be to maintain the water that is discharged from the fuel cell. Preliminary testing will be done on the fuel cells to determine the quantity of the discharged water as well as its temperature under various conditions. There are two cases that will be looked into regarding the temperature of the waste water: 1) low temperature waste water and 2) medium temperature waste water. Since the fuel cells that will be used are considered low temperature fuel cells, it is highly unlikely that the water will be discharged at a high temperature. For case 1, the low temperature waste water will be utilized for potential cooling for various systems. As for case 2, the focus of the medium temperature waste water will be on potential heating for smaller systems that do not require high temperatures. Depending on the amount of water discharged from the fuel cell will determine whether or not a third case will be introduced. The possible third case may be investigated will be to use the water to spin a rotor to generate additional electricity if there is a significant amount of discharged water from the fuel cell.

2 PROJECT DETAIL

2.1 Project Objective(s)

Objective 1 – *Design and Fabricate Flow Designs*
Different flow fields influence the performance of the PEM fuel cell in different ways. This quarter we would like to create two different fuel cell, each with its own flow field design in order to prepare for testing next quarter.

Objective 2 – *Design and Fabricate Electrolyzer*
There is already a commercial electrolyzer available for use however it is a HHO cell which has only one outlet for the outputs. This means that the hydrogen gas and the oxygen will be exiting mixed together. The presence of the oxygen will decrease the efficiency of the fuel cell. In order to combat this, we would like to create a hydrogen separating cell which has two separate outlet channels.

Objective 3 – *Create Test Stations*
Stable and permanent test stations will be needed for next quarter in order to properly collect and analyze data.

2.2 Scope Details

This quarter will be mostly focusing on design and fabrication in order to set everything up for testing next quarter. There will be preliminary testing performed this quarter but they will not be as in depth as we hope to go in the spring. Creating an original electrolyzer and fuel cell itself will be time consuming and a lot of time and effort will have to be put forward.

2.3 Project Milestones

Milestone Name	Target Date	Comments
Finish CAD designs of flow fields	1/31/2015	
Finish collecting information of electrolyzer	1/27/2015	
Begin testing electorlyzer	1/31/2015	
Procure material for electrolyzer test station	2/1/2015	
Begin collecting research on original electrolyzer	1/31/2015	
Finish list of materials for electrolyzer	2/1/2015	
Begin flow field fabrication	2/15/2015	
Begin construction of electrolzyer	2/15/2015	
Mix solutions with different concentrations	2/21/2015	
Connect solar panel setup to electrolyzer	2/27/2015	
Connect electrolyzer and fuel cell effectively	3/1/2015	
Put together test stations	3/1/2015	

2.4 Project Team

#	Name	Project Role	Email	Phone	Standing	Units
1	Jahangir Ashraf	Team Lead A	ashrafj@uci.edu	(424) 241-8732	Sr	4
2	Danyal Khafajizad	Project Lead	khafajid@uci.edu	(818) 272-5955	Sr	4
	Charles Parra	Team Lead B	Cparra1@uci.edu	(562) 331-9788	Sr	4

	Guillermo Jimenez	Member	guillerj@uci.edu	(562) 277-6691	Sr	1
	Stephen Hebert	Member	shebert@uci.edu	9093737283	Sr	2
	David Rowker	Member	drowker@uci.edu	(310) 987-3986	Sr	2
	Subat Hayrat	Member	shayrat@uci.edu	(661)993-1205	Sr	2
	Alexander Cuenca	Member	aacuenca@uci.edu	(562) 331-9788	Sr	2
	Michael Morey	Member	mamorey@uci.edu	(626) 353-3554	Sr	2
	Harjot Purewal	Member	hpurewal@uci.edu	(805) 760-4116	Sr	2
	Brian muraoka	Member	bmuraoka@uci.edu	661 210 9814	Sr	2
	Zoree Karibyan	Member	zkaribya@uci.edu	(818) 983-7923	Sr	4
	joseph sanchez	Member	josepas2@uci.edu	(818) 462-1099	Sr	4

[#: Enter the sequential number. This is to help keep track of the number of people on the project team.
Name: Enter the name of the person on the project team.
Project Role: Enter the role that corresponds with the name (e.g., Team Leader, Project Manager, Chief Engineer, etc.).
Email: Enter the email address.
Phone: Enter the phone number.
Standing: Enter the University standing for the person on the team (e.g., Senior, Junior, Sophomore, Freshman, Graduate).
Units: Enter the number of units the team member is taking for the project.]

2.5 Steering Team

#	Name	Title	Steering Role	Email	Phone
1					(XXX)-XXX-XXXX
2					

[#: Enter the sequential number. This is to help keep track of the number of people on the steering team.
Name: Enter the name of the person on the steering team.
Title: Enter the title that corresponds with the name (e.g., Professor, Engineering Manager, etc.).
Steering Role: Enter the steering role (e.g., advisor, project analyst, etc.)
Email: Enter the email address.
Phone: Enter the phone number.]

2.6 Project Costs Estimation

Project Expense	Comments	Est. Amount ($)
Electrolyzer Material		$500
Fuel Cell Material		$900
Testing material		$250
Station building material		$250
	Total	*$1900*

2.7 Resource Estimation

Name	Est. Hours	Rate ($/hr)	Est. Total ($)
Total	*[Sum total]*		*[Sum Total]*

[Estimate the number of hours from number of credits plus expected additional time as necessary. Estimate the hourly rate base on project role and steering role.]

3 Project Risks and Communication

3.1 Risk Mitigation Plan

Risk	Severity	Probability	Mitigation
Lack of Communication	High	High	Maintain constant contacts through email and text as well as weekly check ins
Lack of Accountability	High	High	Assign due dates and assignments to every member and hold each individual accountable
Shipping Problems	Low	Medium	Order at least a week and a half before materials are needed
Material Problems	Low	Low	Find multiple sources to order from in case one is not a viable option

[Risk: Identify the uncertain events or conditions that, if it occurs, has a negative effect on a project's objectives.
Severity: High, Medium, Low.
Probability: High, Medium Low.
Mitigation: Create options and actions to reduce threats to project's objectives.]

3.2 Communication Plan

Communication Type	Audience	Frequency	Responsibility
Weekly Meetings	Everyone	Once a week	Project Leader
Weekly Team Meetings A	Team A Members	Once a week	Team Leader A
Weekly Team Meetings B	Team B Members	Once a week	Team Leader B
Professor Meetings	Professor, Team Leads	Once every two weeks	Project Lead

[Communication Type: Weekly Meetings, Steering Meeting, All Hands Meeting, Design Review Meeting, etc.
Audience: Everyone, Team Leaders, Design Engineers, etc.
Frequency: How often does this communication occur? Identify date(s).
Responsibility: Who is the owner of the communication ensuring that the communication takes place and records minutes.]

4 Additional Project Details

http://app.knovel.com/web/toc.v/cid:kpFCSEE002/viewerType:toc/root_slug:fuel-cell-systems-explained-2nd-edition/url_slug:fuel-cell-systems-explained?b-q=fuel%20cells&b-group-by=true

Fuel Cell Handbook

http://www.fuelcelltoday.com/about-fuel-cells/technologies/pemfc

No. 10, in *An EPRI/GRI Fuel Cell Workshop on TechnologyResearch and Development, *April 13-14, 1993, Stonehart Associates, Madison, Connecticut, 1993.

S. Gottesfeld, “Polymer Electrolyte Fuel Cells: Transportation and Stationary Application,”