International Journal of Pure and Applied Mathematics
Volume 119 No. 14 2018, 1819-1824
ISSN: 1314-3395 (on-line version)
url: http://www.ijpam.eu
Special Issue
ijpam.eu

EXPERIMENTAL STUDY AND PARAMETRIC ANALYSIS OF PROTON EXCHANGE MEMBRANE FUEL CELL

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ABSTRACT

The proton exchange membrane fuel cell (PEMFC) is a developing technology as analternative energy source with less emission due to the power density, operating temperatures are low, reduced local emissions, quiet operation and fast start up-shutdown. In order to identify fuel cell as dischargeable Power supply performance identification of less quantity of cells is needed.

In this project, PEMFC consis.ting of single cell with a surface area of 25 cm2 per cell have been made and it was tested in varying of gas flow rate. The experimental results were displayed as polarization and power output curves that show the effects of changing number of cells and H2/O2 flow-rates on the hydrogen fuel cell performance. The result from this experiment shows that the gas flow rate and temperature will affect the overall performance of the cell

INTRODUCTION

Due to the awareness of the environmental issues, many of the researchers explores for clean energy source to replace the conventional energy. In that case, hydrogen is found, the alternative sustainable renewable energy source for future. With respect to the electrical vitality utilization, a framework named power device is represented as a zero toxin electrical vitality source .The power device utilizes hydrogen gas and oxygen taken from the encompassing to deliver power by the compound response that oxidation decrease. The procedure of a power device is like the procedure of electrolysis where the utilization of two cathodes to isolate the electron to deliver power.

The reaction will also produce heat from the separation of electron in the oxygen atom where the separation of the electron will need a certain amount of heat to successfully remove the electron from the atom and combine with the hydrogen to produces water. The PEM fuel cell is a fuel cell that utilizes hydrogen as an electrolyte and a quick developing in the green innovation to supplant the current sustainable power sources issues. The current sustainable power resources are excessively subject to the environment and did not deliver much vitality that will satisfy the requirements of a certain process. Theneeds in controlling the contamination of utilizing fuel that discharging carbon monoxide that are dirtying the air greatly.

The examination for energy component research and applications has been expanding quickly from the most recent ten years and came to more than 1.5 billion USD in the year 2007 where the energy unit has been effectively connected on the territories that requires autonomous power supplies and an essential vitality sources.In Malaysia, numbers of economic corridors planned in the future and forthe present growth energy consumption where the needs for an independent power supplies would be a heavy demand especially when the development today are more on alternative energy resources. Hydrogen could be an important energy carrier in the future where an energy carrier moves and delivers energy in a useable form towards the consumers. Producing energy using hydrogen which is can be stored and transport to other locations when needed will results in a high demand for hydrogen in the future technology.

The technology can be applied to the industrial production by changing the current machinery supplies and also opens up new market of a renewable energy which leads towards more job opportunity and more experts in the future. The PEM fuel cell can operate up to 200c temperature and normally operates at 80c and this was caused by the electric current productions where the higher amount of power produced will lead to a higher amount of heat. Contrasted and alternate kinds of energy units, a proton exchange membrane fuel cell (PEMFC) demonstrates promising outcomes with its favorable circumstances, for example, low temperature, high power thickness, quick reaction, and zero discharge on the off chance that it is keep running with unadulterated hydrogen, and it is reasonable for use in versatile power supply, vehicles, and private and circulated control plants The challenges in acquiring a precise PEMFC dynamic model are getting the parameters of the model to be utilized as a part of displaying model.

Execution of PEM energy components is known to be impacted by numerous parameters, for example, working temperature, weight and humidification of the gas streams. Keeping in mind the end goal to enhance power device exhibitions, it is fundamental to comprehend these parametric consequences for energy component activities. Energy unit organizations and research foundations may have done different efficient exploratory investigations here for various particular purposes, however a large portion of the information would be restrictive in nature and extremely constrained information are accessible in the open writing.

However efficient test information are extremely significant for energy component engineers to improve their power device working conditions as indicated by their particular energy unit plans and task prerequisites, and to quicken their power device outline and advancement. Such information are likewise fundamental for power device display designers to approve and enhance their models.

In this work, precise examinations have been directed on a solitary PEM power module to give major parametric trial information. Unadulterated hydrogen was utilized on the anode side and air was utilized on the cathode side. Arrangement of polarization bends with various energy component temperatures, humidification temperatures and backpressures were acquired.

These polarization bends demonstrate the pattern of the PEM energy component execution with various parameters

1. EXPERIMENTAL SYSTEM

A solitary PEM energy unit with dynamic surface region of 5*5 cm was utilized for all examinations in this investigation. The layer cathode get together (MEA) comprises of a Nafion film in blend with platinum anode. The gas dissemination layers are made of carbon fiber fabric.

The MEA situated between two graphite plates is squeezed between two gold-plated copper plates. The graphite plates are notched with serpentine gas channels. The energy component test station is produced by Fuel Cell Technologies Inc. furthermore, it can control the power device temperature, humidification temperatures and backpressures on both the anode and cathode sides through a PC.

In the test station, reactant gases are humidified by going through outer water tanks. Controlling the water temperature controls the humidification of the reactant gases. Energy unit temperatures and humidification temperatures are controlled by a microchip based temperature/process controller.

Backpressures are controlled by backpressure controllers. This station likewise incorporates a PC based control and information obtaining framework. The energy unit polarization bends are acquired from this program too by controlling Electronic Load, which measures the voltage versus current reaction of the power module.

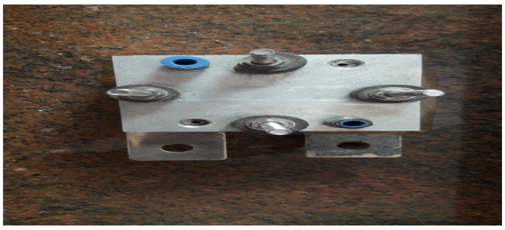


Figure 1:showing the top view of hydrogen fuel cell

Figure 2:showing the side view of the hydrogen fuel cell

Figure 3: showing the isometric view of hydrogen fuel cell

Figure: Showing different views of fabricated fuel cell.

2. EXPERIMENTAL PROCEDURE

The procedure for each experiment is as follows:

1. first switch on the fuel cell testing station and the valves of gas should be opened.
2. While starting we need to purge anode side by using nitrogen to clarify that there is no oxygen content in it
3. Set the experimental parameters of mass flowrate,fuelcell temperature, humidification temperature and backpressure.
4. Set the maximum voltage, minimum voltage and voltage
5. Set the delay between every two voltage vs. current data points in the test software interface.
6. Start the computer program to automatically control experiments and collect data.

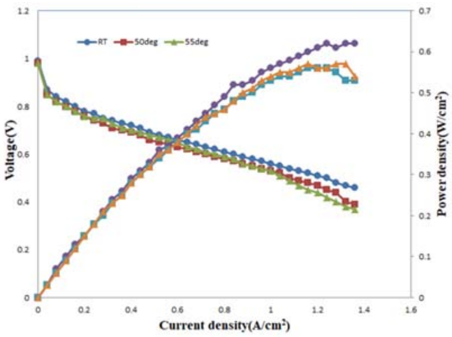
Figure4: The fuel cell test station loaded with fabricated fuel cell

3. EXPERIMENTAL RESULTS AND DISCUSSION

Effect of operating temperatures

Two types of experiments were performed to study the effect of fuel cell temperature on PEM fuel cell performance. First type of experiments consisted of varying the fuel cell temperature from room temperature to 55°c while the anode and the cathode humidification temperature kept same. The other set consisted of simultaneously by changing the fuel cellworking temperature and the mass flow rates of hydrogen and air.

Graph5.1 shows the graph plotted for current density vs voltage and power density maintained at a constant flow rate of 100mL/min and by varying temperatures like room temperature, 50°C and 55°C. In this graph for room temperature as the current density increases voltage also decreases and after a certain limit it shows a light deviation. If we notice the effect of power density it shows the gradual increase as current density increases. In this graph compared to the temperatures of 50oc and 55oc the power output at room temperature will be ahead slightly.

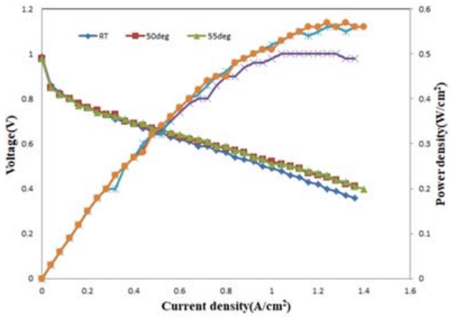


Graph1: polarisation curves for different temperatures at flow rate of 100mL/min

Table 1:operating characteristics of fuel cell at 100mL/min flow rate

s/no	Operating temperature	H2 flow rate	H2 line pressure	O2 flow rate	O2 line pres sure
1	Room temp	600	2	100	3.3
2	50	600	1.9	100	3.3
3	55	600	2	100	3.3

Graph5.2 shows the graph plotted for current density vs voltage and power density maintained at a constant flow rate of 110mL/min and by varying temperatures like room temperature, 50°C and 55°C. In this graph for room temperature as the current density increases power also increases and after a certain limit it shows a light deviation. In this graph the power output for the temperatures of 50oc and 55oc are comparatively equal and slightly greater than room temperature.

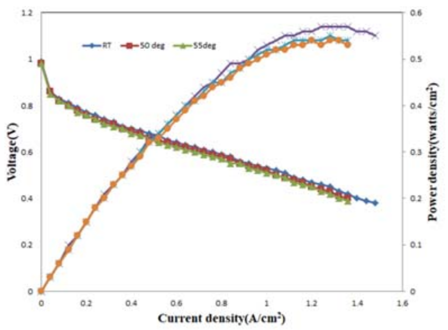


Graph2 :polarisation curves for different temperatures at flow rate of 110mL/min

Table 2:operating characteristics of fuel cell at 110mL/min flow rate

s/no	Operating temperature	H2 flow rate	H2 line pressure	O2 flow rate	O2 line pressure
1	Room temp	600	1.9	110	3.3
2	50	600	1.9	110	3.3
3	55	600	2.1	110	3.3

Graph5.3 shows the graph plotted for current density vs voltage and power density maintained at a constant flow rate of 120mL/min and by varying temperatures like room temperature, 50oc and 55oc. In this graph for room temperature as the current density increases power also increases and after a certain limit it shows a light deviation at the end. In this graph the power output at all the temperatures is largely equal but at room temperature there will be maximum compared to other.

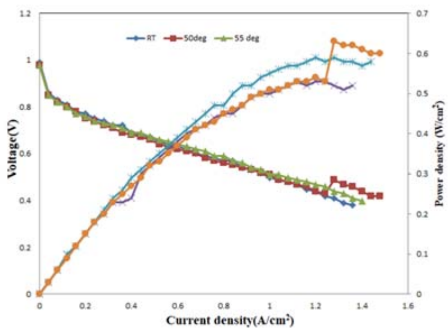


Graph3:polarisation curves for different temperatures at flow rate of 120mL/min

Table 3:operating characteristics of fuel cell at 120mL/min flow rate

s/no	Operating temperature	H2 flow rate	H2 line pressure	O2 flow rate	O2 line pressure
1	Room temp	600	2	120	3.3
2	50	600	1.9	120	3.3
3	55	600	2	120	3.3

Graph5.4 shows the graph plotted for current density vs voltage and power density maintained at a constant flow rate of 130mL/min and by varying temperatures like room temperature, 50oc and 55oc. In this graph for room temperature as the current density increases power also increases and after a certain limit it shows a light deviation at the end. In this graph



Graph4:polarisation curves different temperatures at flow rate of 130mL/min

Table 4:operating characteristics of fuel cell at 130mL/min flow rate

s/no	Operating temperature	H2 flow rate	H2 line pressure	O2 flow rate	O2 line pressure
1	Room temp	600	1.9	130	3.3
2	50	600	2	130	3.3
3	55	600	2.2	130	3.3

4. CONCLUSION:

At minimum flow rate and less temperature yields high power density. By observing the polarization curves the current density had influence on increasing temperatures. Based on this study we get to know that the operating temperatures of the fuel cell should be minimum and the fuel flow rate should be less and the oxygen flow rate should be kept constant in order to get high power density. In order to proceed to further developments, the implements can be made by varying all the parameters.

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