



The characterization of a H_2 PEM fuel cell stack

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ABSTRACT

Fuel cell has been regarded as a promising technology for its use in renewable energy applications. This poster is focused on the characterization of a H_2 PEM fuel cell stack and the interpretation of the experimental results.

1. INTRODUCTION

Proton exchange membrane fuel cell use hydrogen as the fuel and oxygen as the oxidant to generate electric power via an electrochemical reaction.

This work is focused on the V-I curve and impedance spectrum of a PEM fuel cell stack. LabVIEW programs are developed for data acquisition and process control.

Some issues are discussed through the interpretation of the experimental data. An equivalent circuit of the PEM fuel cell is introduced for comparison between the theoretical and experimental results.

2. EXPERIMENTAL SETUP

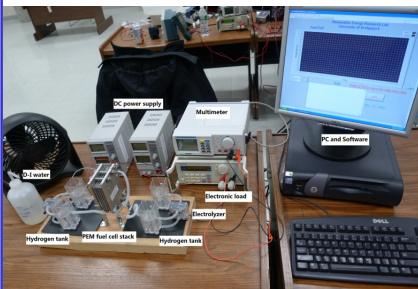


Figure 1 Experimental setup for V-I measurement

A 4-fuel-cell stack generate electricity with H_2 from two electrolyzers. A LabVIEW program is developed to control the load through a programmable DC electronic load. A digital multimeter is also used to monitor the output voltage of the fuel cell stack. All experimental data will be stored in our PC for data analysis.

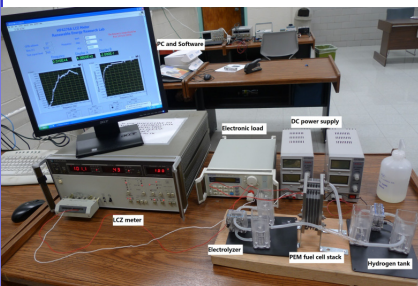


Figure 2 Experimental setup for impedance spectrum

An Hp LCZ meter is used to obtain the impedance spectrum and this meter is connect to a computer through a GPIB interface.

In this experiment, a programmable DC electronic load is connected to the output of the fuel cell stack as an external load to control current and output voltage as well.

A LabVIEW program is also developed for the instrument control and data acquisition.

3. RESULTS & DISCUSSION

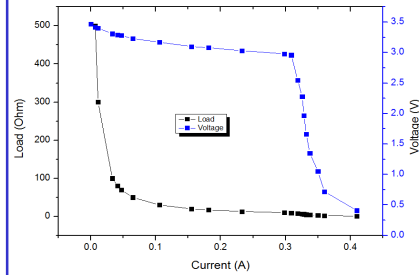


Figure 3 V-I curve of 4 stack PEM fuel cell

The V-I measurement are performed at room temperature and the pressure of the gas is 1 atm. All the data is gathered when the fuel cell stack runs in the stable state.

From Figure 3, there is a significant voltage drop as the load is around 6Ω . In order to determine the reason for such drop, the V-T is analyzed.

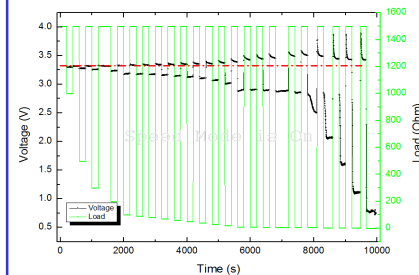


Figure 4 V-T curve of 4 stack PEM fuel cell

In Figure 4, there are some abnormal phenomena: Firstly, the overshooting of the open-circuit voltage increases as the external load decreases. Secondly, there is a significant voltage drop when the external load is less than 6Ω .

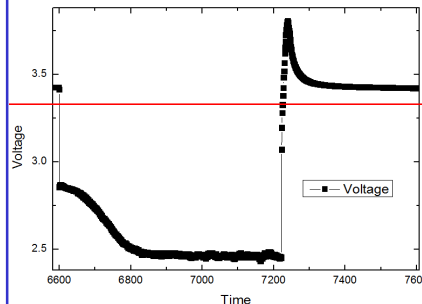


Figure 5 V-T curve as the load is 6Ω

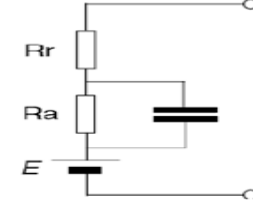


Figure 6 Equivalent circuit of PEM fuel cell

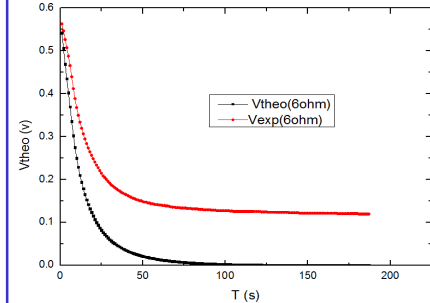


Figure 7 R-C circuit discharging voltage and experimental V-T curve

Through the comparison between our result and the equivalent circuit shown in Figure 6, all the abnormal phenomena is due to the voltage drop caused by the power consumption on ohmic load (R_r) and through the Figure 7, it is obvious that overshooting is caused by the activation loss, a process of charging and discharging of R-C circuit.

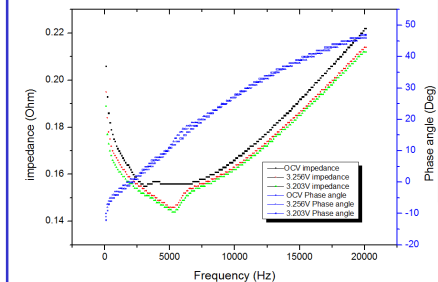


Figure 8 Impedance spectrum

From above curve, it is found that the impedance of PEM fuel cell increases as cell voltage increases.

4. CONCLUSION

Through this study, it is found:

- In PEM fuel cell stack, cell voltage is inversely proportional to current.
- Ohmic loss and activation loss have big impact on performance of PEM fuel and both of them can be calculated from the equivalent circuit.
- The impedance of PEM fuel cell is directly proportional with cell voltage and it related with both internal resistance and space-charge polarization regions (capacitor).