Factors Influence Performance of PEM Fuel Cell – A Review

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***Abstract*--The review paper includes introduction of the PEM fuel cell and Description of water management problem in PEM fuel cell. The consideration are based on exclusion of water management problem by proper design of fuel cell. The paper shows a variety of types of efficiency, divergence characteristics and power characteristics. It also describes the various parameters (pressure, temperature and humidity) which affect the performance of fuel cell, its optimum range in which fuel cell function safely and efficiently. This paper shows the recent work done for improvement of the performance of PEM fuel cell. Fuel cell performance is improved by proper water management on the membrane. Basic parameter which performs the fuel cell performance is Relative humidity, Flow field design, Temperature. With the help of this studies, we observe that the fuel cell performance develop by Increasing the relative humidity, temperature, pressure and using the serpentine flow field. The aim of this study is to explore the factors influence performance of PEM fuel cell.**

***Keywords*--Water management, Water flood & dry out, Flow parameter.**

INTRODUCTION

Fuel cell is the device in which electro chemical reaction takes place where chemical energy in the fuels is directly converted into electrical energy. The fuel cells can be operated for energy conversion with higher efficiency; they are not limited by the thermodynamic barrier of conventional power systems, like Carnot efficiency. Additionally they have low environment effect as ignition process and no pollutants are generated. The fuel cells are currently under quick development and challenging economically possible commercial power source in many applications, mainly for transportation, portable, stationary and automobile applications, as of their high energy density at low operating temperatures and zero emissions.

A typical fuel cell power system comprises of different components:

- Single cells, where electrochemical reactions occur. Single unit cells are the core of a fuel cell. They convert chemical energy into electrical energy.
- Stacks, consisting of the necessary number of cells and they are connected to provide the required power capacity.

In a PEM fuel cell, hydrogen is continuously supplied to the anode and an oxidant, often oxygen or air, is also continuously supplied to the cathode. Electrochemical reactions occur at the electrodes, generating an electric current through the electrolyte thus driving the equivalent electric current that performs the electric work on the load.

WATER MANAGEMENT

AtillaBiyiokoglu[1] presented complete computational model for fuel cell including its all phenomena together, This would be very useful to conduct analytical/numerical studies on fuel cells. In his study governing equations and assumptions were briefly reviewed and presented.

Aysu[2] discussed in his study about the water formation in a fuel cell when using parallel and serpentine type flow channels in the fuel cell. In his study parameters like rate of water injected rate, flow field type, electrode size, velocity and temperature of humidified gas and temperature of the model were considered. As per his study the serpentine flow filed type showed better performance than normal parallel flow type.

Biao Zhou wenbohuang and Andrzejsobiesisk[3] developed a steady state two-dimensional statistical model with pressure and phase change effects and illustrated inlet humidification and pressure effects on PEM fuel cell performance using this model. This was used to predict the following parameters along the fuel cell channels: mole no of liquid model and water vapour, pressure, temperature, density, viscosity, vapor mole fraction, volume flow rate, required pumping power and current density.

GalipH.Guvelioglu and Harvey G.Stenger[4] analyzed the performance at various hydrogen and air flow rates and humidification levels. They showed that hydrogen and air flow rates and their relative humidity were crucial to membrane dry out, current density and electrode flooding.

Uniform current densities along the channels are known to be crucial for thermal management and fuel cell life.

Mengbo Ji and Zidong Wei[5] The major problem impacting the performance and robustness of PEM fuel cells, namely the water management, has been methodically reviewed. Water management strategies must be represent with due consideration to the entire system design, to maintain the entire system simplicity and decrease the system parasitic power loss, thereby decreasing the costs and increasing reliability. All approach against water flooding, material and structures of the **Membrane Electrode Assembly** should be given more attention since the initial drop of water is formed within, and there is almost no any major parasitic power loss and on subordinate equipment is required by varying materials and structures of the **Membrane Electrode Assembly**. The separate channels for reactant gases transport and water, specifically, in a permeable electrode would be a promising way for the final solution of water flooding harassing PEMFCs.

M. Grujicic and K.M. Chittajallu[6] The performance of PEM fuel cells is studied using a single-phase 2D electrochemical model. The model is joined with a nonlinear constrained optimization algorithm to establish an optimal design of the fuel cell with esteem to the process and the geometrical factor of cathode such as the air inlet pressure, the cathode thickness and the width and length of shoulders in the interdigitated air distributor. However, the best possible design of the cathode side of the fuel cell is found not to be influence by the uncertainties in the model parameters such as the stability cathode/membrane potential difference. The results obtained are simplified in terms of the cause of the fuel cell design on the air flow fields and the opposition between the rate of species carry to and from the cathode active layer and the kinetics of the oxygen reduction half reaction.

Shawn Litster et al.[7] Proton exchange membrane PEM fuel cells need humidified gases to sustain proper membrane humidification, but this often results in a problematic gathering of liquid water. Typically, too much air flow rates and serpentine channel designs are used to moderate flooding at the cost of system efficiency. The system also employs an external electro-osmotic _EO_ pump that actively removes surplus water from the channels and gas distribution layer. For a 25 cm2 fuel cell with 23 parallel air channels, we show a 60% enlarge in highest power density over a standard graphite plate with a low air stoichiometry of 1.3. Experimental and modeling results show that simple passive water transport through the porous carbon alone can stop flooding at definite operating conditions and flow field dimensions.

T.Henriques,B.Cesar and P.J.CoostaBranco[8] developed a 3D model of the original PEM fuel cell with parallel plus a transversal floe channel design using Comsol Multi physics. By means of this model the effects of different channel geometries andrespective cathode flow rates on the fuel cell's performance were studied. This model gives improvement in fuel cell efficiency up to 26.4%.

Ruy Sousa Jr and Ernesto R.gonzalez[9] discussed the possibilities of methanol in fuel cell instead of Hydrogen. They had developed mathematical modeling of polymer electrolyte fuel cells for discussing electro catalysis of the reactions and water management schemes to cope with membrane dehydration.

Y.M.Ferng, Y.C.Tzang ,B.S.pei, C.C.Sun and A.Su[10] described in their study the effects of operating temperature and pressure on fuel cell performance. The predicted performance at elevated temperature.

REVIEW ON PERFORMANCE

Lucia Salemme et al. [11] studied the fuel processor Energy efficiency. From this investigation the comparison between the steam reforming based systems showed that the employment of a membrane reactor can increase system efficiency from 48.0% to values above 52.0%. Such an efficiency increase requires almost no addition of sweep gas due to the endothermic nature of the process. Limit on temperature imposed to the system with membrane development reactor is more tighten energy efficiency results to be as high as the value reached in the system with membrane WGS reactor that operates at high SR temperature. The global energy efficiency of these systems strictly depends on fuel processor configuration and on operating situation; therefore a broad simulative analysis of fuel processors coupled with a PEMFC can contribute to recognize the conditions that exploit system performance.

M. ElSayed Youssef et al. [12] Analyzed the Development and Performance of PEMFC Stack based on bipolar plates fabricated employing different designs. A single, 2 cells, six cells and 11 cells LT-PEMFC stack was examine with cell vigorous area 114 cm2, Nafion membrane 112 and catalyst loading 0.4 mg/cm2 working at 25^{o} C and atmospheric pressure using air and hydrogen as a fuel and oxidant, respectively. The power output that is attain from each stack is existing and the overall power output is compared with friendless cell stack. The test was bring out with H_2 at anode and air at cathode side with stoichiometric ratios 2 and 1.2, in that order. Stacks were experienced at room Temperature.

The stack has a maximum power of 71 W at 170mA/cm^2 with 11 cells stack rature.

M. Perez-Page and V. Perez-Herranz [13] studied the Performance of a PEM Fuel Cell Stack on Dead-End method by the result of function and Humidification Temperatures. From this study the performance of PEM fuel cells is influenced by several factors such as humidification and process temperature. To monitor and control a 300W fuel cell stack a test bench was urbanized. The tafel slope minimize with the operating temperature for a given humidification temperature. Owing to the membrane conductivity and development of the gas diffusivity at higher temperatures the resistance decreases with the function temperature, when the film is very well humidified. Therefore, while the process temperature is high, humidification temperatures required are higher.

Conclusion

In PEM fuel cell water management is the severe problem which effects the performance of the fuel cell, various investigate have done on this type of fuel cell, the water management is depend upon the relative humidity, flow field and wetting property of gas diffusion layer. Serpentine flow field with increase the cross flow as well as dropping the gathering of liquid because of this the trouble of flooding at cathode decrease. Relative humidity of anode and cathode side also result the performance of fuel cell for obtain the excellent performance of the fuel cell the reactant gases must be humid. By use of the serpentine flow channel and external humidifier the concert of the fuel cell get better. The performance of fuel cell also gets better by selecting the proper range of operating parameter (temperature, pressure and relative humidity).

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BIOGRAPHIES

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