Factors Influence Performance of Direct Methanol Fuel Cell – A Review

J.Dinesh [a*], M.Easwaramoorthi[b], M.Muthukumar[c]
[a*]*PG Scholar, Department of Mechanical Engineering, Nandha Engineering College (Autonomous), Erode, India-638052*
[b,c]*Professor, Department of Mechanical Engineering, Nandha Engineering College (Autonomous), Erode, India-638052*
[a*]*bemechdinesh@gmail.com,* [b] *eswaramoorthi65@gmail.com,* [c]*muthupsgtech@gmail.com*

***Abstract*--The review paper includes introduction of the Direct Methanol fuel cell (DMFC) and Description of water management and methanol crossover problems in DM fuel cell. DM fuel cells are working at low temperature and atmospheric pressure. As DM fuel cell has high efficiency, they are widely used for mobile and stationary applications. The performance of DM fuel cell depends on temperature, pressure, humidity and transport phenomena inside the cell, membrane conductivity, water management, methanol crossover, flow field design parameters. There are several technical problems to be solved in order to achieve practicability and popularization. Especially, water management and methanol crossover inside a DM fuel cell is essential for high performance operation. This paper shows the recent work done for improvement of the performance of DM fuel cell. With the help of this studies, we observe that the fuel cell performance develop by Increasing the relative humidity, temperature, pressure and using the various flow fields. The aim of this study is to explore the factors influence performance of DM fuel cell.**

***Keywords*-- Water management, Methanol Crossover, Flow channel design, Flow parameters.**

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.

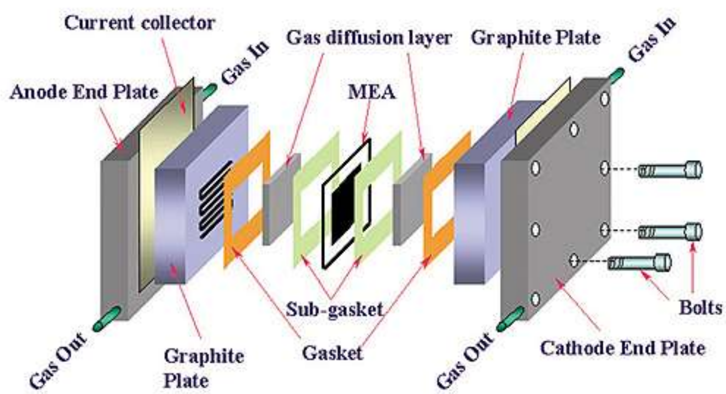

Fig 1: Direct Methanol Fuel Cell

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 DM fuel cell, methanol 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.

LITERATURE REVIEW

AarneHalme*et al.*[1]discussed about an alternative concept for DMFC Combined electrolyzer and H2 PEMFC. This paper presents a novel idea for producing electricity from methanol by using a combination of a PEM fuel cell and a PEM electrolyzer. In some situations the efficiency in making electricity from methanol could be fairly higher. This is owing to the reality that production of hydrogen can be done using very low electrolysis energy on the one case, and in the other way a PEM H2 fuel cell is more competent than a DMFC. In an PEM electrolyzer the cathode electrode is in a worse potential and no air is participated, which leads to prevent effectively forming of CO from the crossover methanol. According to author experience, the methanol concentration at the electrolyzer anode can be improved without the risk of poisoning the Pt catalyst to much advanced concentrations than in DMFC. From a practical overview, the possibility to work the system using higher methanol concentrations without water dilution is an vital aspect, because it shorten the technical construction.

Andrea Calabriso*et al.* [2] discussed in his study about the CO_2 bubble generation influence on direct methanol fuel cell performance. The presence of gaseous CO_2 produced in the anode channels is the major problem as it delays the free surface of the Gas Diffusion Layer (GDL) decreasing the energetic area and the methanol flux through the permeable media towards the catalyst layer. In this study the manipulation of gas phase fraction on the cell performance and the connection with the operating factors such as methanol-water solution flow rate, air flow rate and current density is explored. The bubbles shows a reduced in mean diameter when the flow rate rose up. The coalescence of bubbles can cause a shrink in generated power in particular when the flow rate is low and the current density is much high. He found that bubbles generation decreases the power also more than 40 %.

BalaiahKuppan*et al.* [3]discussed the Platinum-supported ordered mesoporous carbon catalysts were prepared employing colloidal platinum decreased by 4 different reducing agents, viz., sodium borohydride, paraformaldehyde, hydrogen and ethylene glycol. Platinum nano particles settled over mesoporous CMK-3 carbon by paraformaldehyde reduction method is better than the other reduction methods. The paraformaldyde method is more right for the preparation of the high dispersed uniform seized platinum nano particles on the mesorporous support with an average size of the particle resulted in 4 nm. Thus the present paper deals that optimized reduction methods is the appropriate selection of carbon supports can offer major cost savings by lowering the catalyst loading.

ChunguangSuo*et al.*[4]defined about the Design of MEMS-based micro direct methanol fuel cell stack. The silicon-based DMFC stack was proposed as a "flip-flop" style and was manufactured using MEMS technology. Compared to the SS DMFC stack in planar connection, the flip flop connection way can majorly decrease the space of the connection resistance electric and connection. When fed 2M methanol solution and air as oxygen both the stainless steel stack and the silicon stack can power the LED with comparable output of 6.77mW and 6.75mW, correspondingly.

Chun-Chen Yang *et al.*[5]discussed the Preparation of a novel composite membrane and PtRu/Hollow carbon sphere (HCS) anode catalyst for alkaline DMFC. The alkaline composite anionic-exchange membrane is based on PVA/QASP/TAMPFS-PET composite electrolyte was manufactured by a solution casting method. An alkaline DMFC, comprising of the PVA/QASP/TAMPFS-PET composite polymer membrane, was systematically examined and assembled. The maximum power density of alkaline DMFC composing of the PVA/QASP/TAMPFS-PET composite polymer membrane. This membrane used for purpose in alkaline DMFCs.

HalimF.A *et al.*[6] enhanced overview on vapour feed direct methanol fuel cell. DMFC works in two basic behavior which are methanol can be fed in liquid or vapor phase. Due to methanol crossover issue faced by liquid feed DMFC operated at high methanol concentration, vapor feed DMFC is an another way to solve this trouble. Methanol obstacle layer used to increase the mass transfer resistance in the fuel cell hence decrease methanol crossover. Water management layer was added at the cathode to push large amount water backward from cathode to anode to hydrate the membrane for methanol oxidation reaction.

Jean Marcel R. Gallo *et al.*[7]developed Novel mesoporous carbon ceramics composites as electrodes for DMFC. MCC composites for electrodes planned to take the merits of the well orderedmesoporous silica structure and of the graphite which is having high conductivity, is presented for the first time. This behavior can be revealed by the more difficult diffusion of the liquid combustible if evaluated with the gas oxidant. The fuel can diffuse enhanced in the organized porous MCC structure than in the Vulcan XC-72R structure.

Joan M. Ogden *et al.*[8]discussed the study about a comparison of methanol, hydrogen and gasoline as fuels for fuel cell vehicles: implication for infrastructure development and vehicle design. Hydrogen can be stored directly or formed onboard the vehicle by reforming methanol. The vehicle design is easy with direct hydrogen storage. But it needs developing a more intricate refueling infrastructure. In this study, we present modeling results comparing or evaluating three leading choice for fuel storage on board fuel cell vehicles: (a) on board partial oxidation (POX) of hydrocarbon fuels derived from crude oil , (b) compressed gas hydrogen storage on board stearn reforming of methanol (c) Considering both vehicle and infrastructure issues. Feasible fuel strategies tends to the commercialization of fuel cell vehicles are formalized. Hydrogen is favor fuel for fuel cell vehicles, for reasons of cost, vehicle design and efficiency.

Minoru Umeda*et al.*[9]discussed about novel Pt-C and Pt-Ru-C electrodes were made by a co-sputtering technique to increase the methanol oxidation reaction. An O_2-enhancing methanol oxidation at the Pt 0.56 C 0.44, which never occurs for the Pt, was obtained and compared to that for the Pt 0.61 Ru 0.34 C 0.05. The results exhibited that the addition of Ru to the Pt-C can improve the methanol oxidation current and tends to a negative shift in the onset potential (*E*onset) in mutually the N_2 and O_2 atmospheres. Based on these results showed, the O_2-enhancing methanol oxidation with a negative *E*onset is obviously achieved by the Pt-Ru-C sputtered electrode. This also points out the fact that the O_2-increasing methanol oxidation takes place under these situations. The DMFC power generation performance was then reviewed by changing the counter-electrode reactant from H_2 to O_2. By contrasting the results of the DMFC power generation performance and methanol oxidation voltammogram, the degraded DMFC power generation was resolved due to methanol crossover.

MullaiSudaroli.B*et al.*[10] explained about Heat and Mass Transfer Characteristics of Direct Methanol Fuel Cell. Temperature distribution and Methanol in the anode side are expected. Double channel flow field is used to explore the methanol distribution and its consequence on cell performance. Water crossovers and Methanol in the cell are the main controlling factors which control the cell performance. The model is also used to calculate the methanol crossover effect on Cell performance and the Fuel Utilization Efficiency (FUE). The cell efficiency had increased range from 7 to 13% with decreasing methanol concentration of 1 to 0.25 M. The cell efficiency also increases from 7 to 13% due to high FUE.

Phuttachart.T*et al.*[11]fabricates bipolar plates for direct methanol fuel cells (DMFC) to increase creep behavior and compressive strength. The composites consist of poly methyl methacrylate (PMMA), carbon black (CB) and polyurethane (PU) and were manufactured via bulk polymerization in a casting process. The composites were prepared in various weight ratios PMMA/PU/CB. The potential of using PMMA/PU/CB composites as original polymeric bipolar plates for DMFCs. PMMA/PU/CB composites were fabricated by bulk polymerization via casting process were victorious in further improving mechanical properties of the composites such as brittleness, creep behavior and compression strength. To know more characters of composites as a function of bipolar plate role, in-situ and ex-situ creep behavior tests should be examined as future work.

Vasco S. Silva *et al.*[12]examined the Membranes for direct methanol fuel cell applications and an outline of the research development regarding this DMFC module. Specific efforts are given over to research feature related with the characterization, membrane preparation, DMFC tests and modeling. Membranes with increased relation between barrier and electrolyte properties were made in comparison with that of Nafion.

Conclusion

In DM fuel cell water management and methanol crossoverare the severe problems which effects the performance of the fuel cell, various investigate have done on this type of fuel cell, the water management and methanol crossoverare 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

J.DINESHcompleted his Bachelor Degree in Mechanical Engineering from Nandha Engineering College, Erode. He is currently pursuing Master Degree in Engineering Design at Nandha Engineering College, Erode. His area of interest includes Automobile Engineering, Fuel cell.

M. Easwaramoorthi completed his B.E. degree in Mechanical Engineering Kongu Engineering College Under Bharathiyar University and M.E. Production & Industrial Engineering from PSG College of Tech Under Bharathiyar University. He completed the Ph.D. at PSG College of Technology under Anna University. His area of interest includes Manufacturing System Design, Lean Manufacturing, Automobile Engineering and Solar Thermal System.

M.MUTHUKUMAR completed his B.E. degree in Mechanical Engineering Under Bharathiar University and M.E. Engineering Design from Anna University. He completed the Ph.D. at PSG College of Technology under Anna University. His area of interest includes Theory of Machines, Design of Machine components, and Fuel cells.

