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PERFORMANCE AND FABRICATION OF PROTON EXCHANGE MEMBRANE (PEM) FUEL CELL

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Abstract- ***Proton Exchange Membrane (PEM) fuel cell are increasingly being cited by governments as a possible pathway to the reduction of greenhouse gas emission. It is one of the prospective power sources for automotive applications, train appliances, stationary cogeneration systems, and mobile electronic devices. But the dryness of the membrane of a PEM fuel cell decreases the ionic conductivity, resulting in performance reduction. In this work, a two-dimensional model is used to analyze the main and interaction effects of five design factors, at three levels in a proton exchange membrane (PEM) fuel cell. Analysis is conducted for operating potentials of 0.7 and 0.6V and a range of current densities.A motor that gains its power from a hydrogen tank and a fuel cell Stored in a tank. The chemical energy from the hydrogen will be converted into electrical energy by the fuel cell to propel the train at up to maximum speed of 80km/hr. Train appliances like Fans, lighting may also run on PEM fuel cell. This new hydrogen train is thus perfect for shorter, quieter stretches of the network that electrification hasn't yet reached***

Keywords- ***Bubble-Type humidification method, Proton Exchange Membrane (PEM) fuel cell, Portable auxiliary power.***

1. INTRODUCTION

The performance of a Proton Exchange Membrane fuel cell (PEMFC) is influenced by its operating conditions, including temperature, pressure, and moisture content of the inlet gases. A fuel cell is an electrochemical energy conversion device which is typically two to three times more efficient than an internal combustion engine in converting fuel to power. In a fuel cell, fuel (e.g. hydrogen gas) and an oxidant (e.g., oxygen gas from the air) are used to generate electricity, while heat and water are typical byproducts of the fuel cell operation. A fuel cell typically works on the following principle as the hydrogen gas flows into the fuel cell on the anode side, a platinum catalyst facilitates oxidation of the hydrogen gas which produces protons (hydrogen ions) and electrons The hydrogen ions diffuse through a membrane (the center of the fuel cell which separates the anode and the cathode) and, again with the help of a platinum catalyst, combine with oxygen and electrons on the cathode side, producing water. The interest in Proton exchange membrane (PEM) fuel cells for transportation, portable and stationary applications is growing as energy prices increase and concern for environmental impacts of internal combustion engines grows. Even though PEM fuel cells are conceptually simple electrochemical conversion devices, the underlying physics that describe their operation is complex.

Due to their high-energy efficiency, a low temperature (60–80C) operation, a pollution-free character, and a relatively simple design the PEM fuel cells are currently being considered as an alternative source of power in the electric vehicles. However, further improvements in the efficiency and the cost are needed before the PEM fuel cells can begin to successfully compete with the traditional internal combustion engines. The development of the PEM fuel cells is generally quite costly. Fuel cells in the range of 1W-100kW range are being considered for near term service in several remote and mobile applications where they provide quiet operation, high reliability, potentially high energy density and ultra-low emissions. In recent years, research and development in fuel cells and fuel cell systems have accelerated, and although significant improvements in polymer electrolyte membrane fuel cell technology has been achieved over the past decade, the performance, stability, and reliability for today's fuel cell technology is not sufficient to replace internal combustion engines. On the other hand, the cost of fuel cell systems is still too high for them to become viable commercial products. In a PEM fuel cell stack, the cells are electrically connected in series and the polarization curves of the individual cells can be measured by measuring the current of the entire stack and the voltages of individual cells.

II. LITERATURE SURVEY

Integral coach factory, Chennai, is a premier production unit of Indian railways manufacturing railway passenger and other special coaches. W.E. Stewart et al. has investigated it comes to rail innovations, it's usually the fastest, longest and most expensive new connections or rolling stock that grab people's attention. Next year, however, Germany will buck that trend with something that's both ground-breaking and singularly modest. German rail's most innovative project for 2017 won't go especially fast, and you've probably never heard of the cities it will link. It will still revolutionize rail travel, quite possibly across the world, with one dramatic change. In December 2017, Germany will launch the first ever passenger rail service powered by hydrogen. M.S. Phadke et al.

Unveiled by French manufacturers Alstom, the new Coradia Lint will feature a motor that gains its power from a hydrogen tank and a fuel cell. Stored in a tank large enough to fuel a 497-mile journey, the hydrogen's chemical energy will be converted into electricity by the fuel cell, propelling the train at up to 87 miles per hour. Any energy not used immediately is stored in Lithium batteries attached to the car bottom. Producing nothing but steam as a by-product, the motor will run far more quietly and cleanly than a diesel engine. P.J. Ross et al. Recently developed a two dimensional across-the-channel CFD PEM fuel cell model in which the effects of channel and bipolar plate shoulder dimensions as well as thickness and properties of fuel cell components were studied. Even though the recent trend in PEM fuel cell modeling is 3D CFD models, the computational cost of accurate 3D modeling is large and not easily achievable. Typical anode and cathode catalyst layer thicknesses are on the order of 10–20cm and the height and width of a single cell in a stack are 10–20cm. These low conductivity electrode was used. [5] discussed about a system, GSM based AMR has low infrastructure cost and it reduces man power. The system is fully automatic, hence the probability of error is reduced. The data is highly secured and it not only solve the problem of traditional meter reading system but also provides additional features such as power disconnection, reconnection and the concept of power management.

III. RESEARCH METHODOLOGY

The basic idea is to power both light and heavy trains with hydrogen instead of diesel and overhead line electric.The relevant hydrogen manufacture and distribution infrastructure must be in place and people need to be made aware that it is a safe technology, while it must be shown to be economically viable.With the rapid development of battery technology and the existence of grids to deliver electricity, it is likely that light vehicles will mostly use electricity there will be little incentive to provide a new, universal fuel distribution grid for hydrogen.Local rail networks are particularly suited - hence the Hydrail concept, which could use hydrogen fuel cells or, in the short-term, converted diesel. It consists of a 300 W fuel cell stack with individual cells. Under optimal conditions with regard to pressure, humidity, reactants flow, and temperature, the electrical output capability of the stack is 300W. The supply of air to the cathode is handled by a compressor and the hydrogen is stored in a high-pressure tank at up to 200 bar. Using reduction valves, mass flow controllers, and an external humidifier, hydrogen and air are fed to the fuel cell stack. Purge valves were used to assist the removal of water droplets in the flow channels. The liquid cooling loop consists of a continuous-controlled pump and a heat exchanger. The temperatures are measured by thermocouples as shown in fig.1.

In this work, the fuel cell stack performance was evaluated at different fuel cell operation temperatures from 20 to 80ºC. Hydrogen was supplied to the fuel cell stack in the dead-end mode, at the exact rate at which is being consumed. In this mode of operation the measurements the hydrogen flow rate was only measured but not controlled as shown in fig 5.2, while air was supplied with a stoichiometric ratio of 5. The operation pressure was 1 bar.

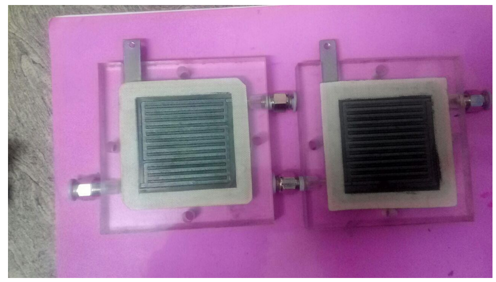

Fig.1. Proton Exchange Membrane Pattern(Serpentine)

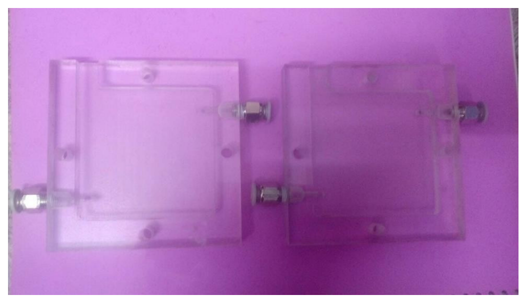

Fig.2. PEM Fuel Cell Cover and Connectors(Inlet and Outlet)

[6] discussed about a project, in this project an automatic meter reading system is designed using GSM Technology. The embedded micro controller is interfaced with the GSM Module. This setup is fitted in home. The energy meter is attached to the micro controller. This controller reads the data from the meter output and transfers that data to GSM Module through the serial port. The embedded micro controller has the knowledge of sending message to the system through the GSM module. Another system is placed in EB office, which is the authority office. When they send "unit request" to the microcontroller which is placed in home. Then the unit value is sent to the EB office PC through GSM module. According to the readings, the authority officer will send the information about the bill to the customer. If the customer doesn't pay bill on-time, the power supply to the corresponding home power unit is cut, by sending the command through to the microcontroller. Once the payment of bill is done the power supply is given to the customer. Power management concept

is introduced, in which during the restriction mode only limited amount of power supply can be used by the customer. The fuel cell stack performance was first evaluated from the polarization curves at operation temperatures from 20 to 60ºC in absence of humidification. The polarization curves indicate that the fuel cell stack performance was improved with increasing temperature from 20 to 40ºC, it remains almost constant between 40 and 50ºC, and finally decreases for temperatures above 50ºC. The increase in the fuel cell stack performance between 20 to 40ºC, in terms of the measured voltage, can be explained by the increase in the gas diffusivity and membrane conductivity at higher temperatures and to the increase of the exchange current density with the increase of the operation temperature, which reduces the activation losses. The gas diffusivity improves with increased fuel cell temperature.

IV. CONCLUSION

Proton Exchange Membrane (PEM) fuel cell are increasingly being cited by governments as a possible pathway to the reduction of greenhouse gas emission. It is one of the prospective power sources for automotive applications, train appliances, stationary cogeneration systems, and mobile electronic devices. But the dryness of the membrane of a PEM fuel cell decreases the ionic conductivity, resulting in performance reduction. In this work, a two-dimensional model is used to analyze the main and interaction effects of five design factors, at three levels in a proton exchange membrane (PEM) fuel cell. Analysis is conducted for operating potentials of 0.7 and 0.6V and a range of current densities.A motor that gains its power from a hydrogen tank and a fuel cell Stored in a tank. The chemical energy from the hydrogen will be converted into electrical energy by the fuel cell to propel the train at up to maximum speed of 80km/hr. Train appliances like Fans, lighting may also run on PEM fuel cell. This new hydrogen train is thus perfect for shorter, quieter stretches of the network that electrification hasn't yet reached

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