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Research paper

Simulation of Fuel Cell Technology Using Matlab

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Abstract

This paper represents a mathematical model for proton exchange membrane fuel cell(PEMFC)system. Proton exchange membrane fuel cell (also called polymer Electrolyte Membrane fuel cells(PEM)) provides a continuous electrical energy supply from fuel at high levels of efficiency and power density. PEMs provide a solid, corrosion free electrolyte, a low running temperature, and fast response to power.

Keywords: *Fuel cell, matlab, efficiency.*

1. Introduction

They are many parameters must be considered when designing and modeling fuel cells. The calculations involved with designing fuel cell stacks are very basic, but sometimes are unknown to newcomers in the field. The most commonly used stack configuration is the bipolar configuration, which is very similar to how batteries are designed. There are also many alternative stack configurations, however, the materials, designs, and methods of fabricating the components are similar. When considering the design of a fuel cell stack, usually several limitations should be considered. Some of these limitations may include the following:

- Size, weight, and volume at the desired power
- Cost
- Water management
- Fuel and oxidant distribution

Fuel Cell Stack Sizing

The sizing of a fuel cell stack is very simple; there are two independent variables that must be considered~voltage and current. The known requirements are the maximum power, voltage, and/or current. Recall that power output is a product of stack voltage and current:

W_{FC} =Vst.I

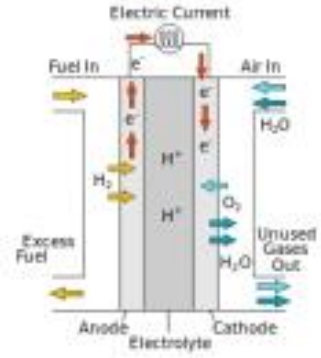

Figure 1: Schematic of a PEM fuel cell

Consideration can be help in designing a fuel cell stack are current and poer densities. These are often unavailable initially, and can be calculated from the desired power output, stack voltage, efficiency, and volume and weight limitations. The current is a product of the current density and the cell active area:

As mentioned previously, the cell potential and the current density are related by the polarization curve:

Vcell=f(i)

Most fuel cell develops by using a nominal voltage of 0.6 to 0.7 V at nominal power. Fuel cell systems can easily be designed at nominal voltages of 0.8 V per cell or higher if the correct design, materials, operating conditions, balance-of-plant, and electronics are selected.

2. Simulation

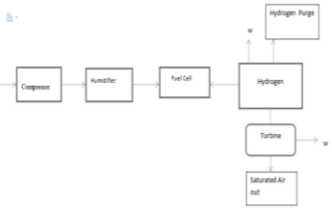

Figure 2: Block diagram for fuel cell system

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Compressors are used to compress air, which allows oxygen per volume per unit time an it increases the fuel cell efficiency. This enables the drop off in voltage due to mass transport to be delayed until higher current densities. If the pressure is high lower volume metric flow rate can be used for the constant flow rate and humidification needs less water for saturation (per mole of air). The compression can be isothemal or adiabatic. Isothermal compression allows temperature equilibration with the environment and adiabatic uses compression without heat exchange with environment[1].

The most common type of compressor is the centrifugal compressor. It uses kinetic energy to create a pressure increase. The centrifugal compressor can be operated with high efficiencies through a high range of flow rates by changing both the flow rate and the pressure. This compressor type is commonly found on engine turbo charging systems. The efficiency of the compressor is important for the overall efficiency of the fuel cell system. The efficiency is found by using the ratio of actual work done to raise the pressure from PI to P2.

$$\frac{T_2}{T_1} = \left(\frac{P_2}{P_1}\right)^{(\gamma-1)/\gamma}$$

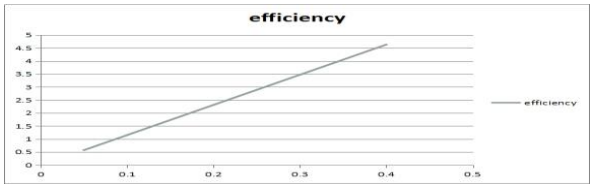
A humidifier may be a device that will increase humidity (moisture) in a very single area or a whole building. In home humidifiers are commonly used to humidify a single room, while whole-house or humidifiers, that connect with a home's HVAC system, provide humidity to the entire house Medical ventilators usually embrace humidifiers for hyperbolic patient comfort. massive humidifiers area unit utilized in industrial, institutional, and industrial.

Pumps, like blowers, compressors, and fans, are among the for most components in the fuel cell plant system. These parts are needed to move fuels, gases, and atmospheric phenomenon through the system and are important factors within the fuel cell system efficiency. Small to medium-sized PEM fuel cells for portable applications have a back pressure of about 10 kPa or I m of water[2]. This is too high for most axial or centrifugal fans[3]

Choosing the proper pump for the fuel cell application is very important. As in fans, blowers, and compressors, factors to consider are efficiency, potency, responsibility, corrosion-free materials, and also the ability to work with the specific temperatures, pressures, and flow rates for the particular fuel cell system. The appropriate matching of a high-efficiency pump with the appropriate motor speed/torque curve may allow more efficient fuel cell stack and system. The equations that describe pump performance characteristics are similar because the fan performance characteristics.[11][12] In pressurized fuel cell systems, the outlet gas is typically warm and pressurized (though lower than the inlet pressure). This hot gas from fuel cells can be turned into mechanical work through the use of turbines. This energy can be used to generate work that may offset the work needed to compress the air. An example of a turbo compressor system. The efficiency of the turbine determines whether it should be incorporated into the fuel cell system.

3. Output

Fan Efficiency



If the value of pressure increases then the efficiency increases. The output of the graph is linear.

S. No	Pressure Drop of Water	Humidifier Status
1	10020	No Humidification Required
2	22240	No Humidification Required
3	12140	No Humidification Required
4	33340	No Humidification Required
5	47390	No Humidification Required
6	55570	No Humidification Required
7	73333	Humidification Required
8	74550	Humidification Required
9	77890	Humidification Required
10	83335	Humidification Required
11	99900	Humidification Required
12	100200	Humidification Required

4. System Design

When the pressure drop of water is low then the humidifier status shows that the humidification is not required, if the value of pressure drop of water is high it shows humidification is required.

5. Conclusion

A fuel cell system can be very efficient with a simple plant and electrical subsystem-or a very complex one. The larger the fuel cell stack, the more complex the fuel cell plant subsystem will be. They are number of ways to design and optimize the fuel cell plant and electrical subsystems are endless. The plant components reviewed it include humidifiers, fans, blowers, compressors, turbines, and pumps. A series of quick models can aid the fuel cell stack designer to make the best design decisions. The efficiency and system design which describe the humidifier has been simulated by using MATLAB

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