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Modeling of kW Proton Exchange Membrane Fuel Cell Power System

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Background

At present, proton exchange membrane fuel cell (PEMFC) is the most technology ready and versatile fuel cell system. It has been successfully demonstrated as a combined heat and power (CHP) unit for more than several thousands families in Japan PEMFC is also used as power source for electrical forklift, electrical vehicle, auxiliary power unit (APU), uninterrupted power supply (UPS) and many other applications. Depending on the application, the fuel cell power may range from few watts for portable devices to several kW for mobile and stationary applications. The size of individual components in the fuel cell system is depending on the power output need and applications.

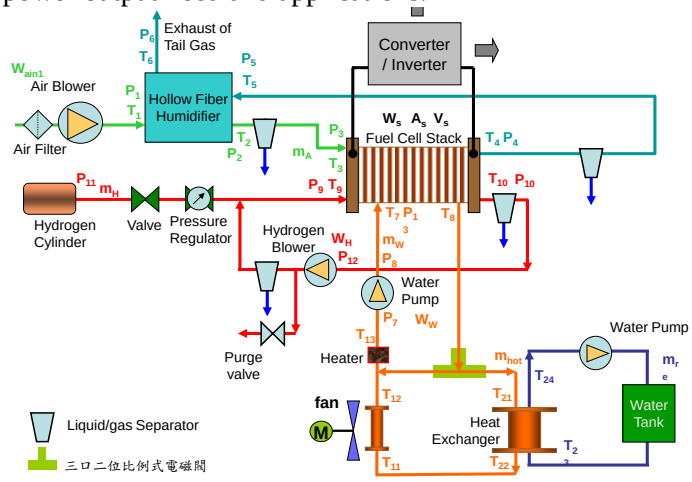

Fig. 1 Schematic diagram of a kW PEMFC power unit.

Scope of this work

Commercial computational fluid dynamic and mechanic software are used in modeling. MATLAB, ADVISORTM, GCTool, and Easy 5, are some of the commercial software used for the system level modeling of fuel cells. This study intends to build the computer model to evaluate a PEMFC power unit at various operating conditions. Component and flow chart of this power unit is depicted on Fig. 1. The power generated from fuel cell and power consumption by BOP (balance of plant) is calculated. Power controlling sub-systems, such as converter and inverter, are not considered in our modeling. A simplified model based on LabVIEW (from Laboratory Virtual Instrumentation Engineering Workbench) is under development.

Results and Discussion

Fig. 2 is the net power output from this power unit. Measured data are compared to the calculated result. Fig. 2 plots power consumed by individual components as a function of hydrogen flow rate. Ideally, power consumed by the BOP is only a small portion (~ 5%) of the power generated by the PEMFC system. Both power consumed by air blower and fan is depending on the hydrogen flow rate. The power consumed by hydrogen blower and water pump is almost constant over the entire range of hydrogen flow rate.

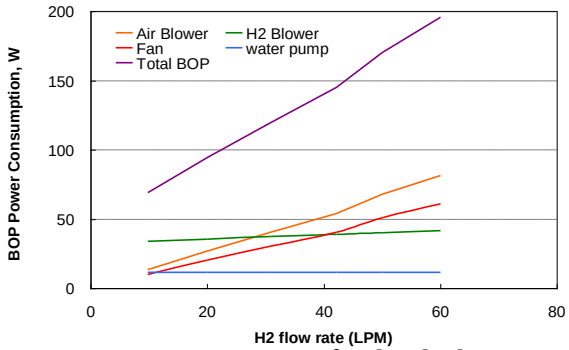

Fig. 2 Power consumption of individual components of a PEMFC unit.

Conclusion

At the present stage, this model is under development with LabVIEW. By modeling the system, we can easily observe the performance of each subsystem. After integration of all the subsystems, consisting of gas blowers, humidifier, stack, thermal and power managements, we can optimize the overall efficiency of entire system.

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