Development of a 400 W High Temperature PEM Fuel Cell Power Pack - Modelling and System Control

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Development of a 400 W High Temperature PEM Fuel Cell Power Pack: Fuel Cell Stack Test

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Motivation

The use of a liquid reformed hydrocarbon as fuel for fuel cells can reduce fuel storage volume considerably. The PBI membrane technology used in high temperature PEM (HTPEM) fuel cells has great advantages when using reformate fuel gas compared to low temperature PEM fuel cells (LTPEM).

Fuel Cell Stack Test

A simple system has been designed consisting of a prototype 30 cell HTPEM fuel cell stack, a pressure reduction valve and an axial blower. The stack is for initial tests supplied with pure hydrogen and is designed for cathode air cooling, which simplifies the system significantly.

"Simple and reliable HTPEM fuel cell system with cathode air cooling"

The experiences obtained operating the system are, that the cathode air cooling efficiently cools the stack, but the temperature profile of the stack changes with the airflow. Situations can occur at the inlet of the stack, where temperatures are quite low at high airflow. This results in a fuel cell voltage drop, and hereby a power loss because of the lower temperature.

"Temperature differences introduce problems for cathode air cooled stacks"

The design of the gas channels in the bipolar plates offer a very low pressure loss, which makes it possible to use small low power consuming blowers for air supply.

"Low pressure loss through stack makes it possible to use small blowers for air supply"

The general experience of running the HTPEM fuel cell system was positive. The primary drawback being the temperature gradient in the stack and a long start-up time because the system operates at 120°C-200°C to avoid liquid water. The first of these problems has been dealt with in the 2nd generation HTPEM fuel cell stack design.

Conclusions

The construction of the HTPEM fuel cell system illustrated in figure 3, has resulted in a very simple and reliable HTPEM fuel cell system.

The conclusions and experiences made during these experiments, have given much knowledge for improvement of the cathode air cooled HTPEM fuel cell stack design, and demonstrates the potential of using HTPEM fuel cells to make simple, and reliable fuel cell systems. Furthermore, the experiments results have given inputs to the further development and test of different controllers and control strategies.