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Publication date: 2007

Document Version
Accepted author manuscript, peer reviewed version

Link to publication from Aalborg University

Citation for published version (APA):
Initial experiments with a Pt based heat exchanger methanol reformer for a HTPEM fuel cell system

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Motivation

The use of a liquid reformer hydro-carbon 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).

A standard industrial catalyst coated plate heat exchanger has been designed for the production of hydrogen rich gas for a HTPEM fuel cell stack. The advantages of the heat exchanger is contained in the design ensuring good heat transfer and compactness.

Methanol Reformer Test

The heat exchanger reformer consists of two separate flow branches, operating in co-flow. One side is the reformer side, where a mixture of evaporated water and methanol is presented and steam-reformed to a hydrogen rich gas. The steam reforming process is exothermic and is supplied with heat from the second flow branch, which is a catalytic burner, where hydrogen and air is mixed, and combusted over a catalyst. For the initial test, the evaporation of the fuel water/methanol mixture is done by electrical heaters, but could be integrated with the burner side of the heat exchanger.

"Methanol and water is steam reformed to a hydrogen rich gas"

The start-up of the reformer is fast due to the low mass of the heat exchanger, but the temperatures can easily reach critical levels if the combustion process of hydrogen is not carefully controlled. As soon as the fuel is introduced, hydrogen is produced and the burner heat should be balanced to match to inlet fuel flow. Temperature measurements directly on the heat exchanger reveals a temperature gradient thorough the length of the reformer, which at low fuel flows could result in performance losses.

"Rapid reformer start-up due to low thermal mass"

When controlling the temperature of the evaporator with a standard PI feedback control, initial experiments point towards the presence of a significant dead time, which requires a more complex control strategy for precise temperature control. In other of the control areas in the system, this phenomena occurs and must be compensated for steady control of the temperatures.

"A model based control strategy can compensate for dead-time occurrence"

Different tests with fuel flow changes are made to reveal the dominating reformer dynamics, including the effects on the outlet gas composition.

Conclusions

The construction of the methanol reformer system illustrated in figure 3, has resulted an initial test and verification of using a catalyst coated heat exchanger as a methanol reformer.

The following conclusions were made while experimenting with the system, and fueling it in different ways:

• Fast start-up with catalytically combusted hydrogen.
• Complicated temperature control due to dead-time.
• High CO content in reformate gas (5-6%)