Project Information

Subject: Fuel Cell Heating Unit for Use in Domestic Energy Supplies

Applicant: E.ON Ruhrgas AG
Halterner Strasse 125
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Project term: 17 May 2001 to 31 Dec 2003

Project partner: Duisburg-Essen University
rhenag rhein. Energie AG
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Project Results:

Based on a steam reformer developed by Duisburg-Essen University, this reformer prototype was improved and combined with a membrane fuel cell under a project funded by the North Rhine-Westphalian State Initiative on Future Energies. The project partners were Duisburg-Essen University, AGEF e.V., RHENAG and E.ON Ruhrgas AG. The steam reformer was designed for the generation of hydrogen from natural gas for use in approx. 1 kW_e membrane fuel cells. In addition to optimisation of gas processor operating behaviour, the design and implementation of a selective gas purification oxidation stage was an important development step. Also important was the examination of anode waste gas recovery in the reformer burner during total system operation.

In order to be able to implement a total system with high electrical efficiencies and high energy utilisation, quite a number of technical questions must be solved. Aside from the selection of suitable peripheral components such as pumps, valves, burners, certain requirements for the fuel cell and the gas process must be defined. In domestic applications, quick starts and good load change behaviour are, among other things, important to the gas process working at approx. 700 °C to 800 °C. Reformate gas quality should change only slightly when load changes. CO concentrations are particularly critical in the case of membrane fuel cells. The fuel cell stack should always make efficient use of the fuel so that only a small amount of hydrogen remains in the anode waste gas. Anode waste gas return makes it possible to thermally exploit the remaining hydrogen energy content in the burner for heat supply to the steam reformer and thus to increase total system efficiency.

At nominal load (2.5 kW thermal hydrogen output from the gas processor, approx. 950 W electrical output from the fuel cell), the process chain achieves a gross efficiency of just under 30 %. Approx. 77 % of this gross efficiency are attributable to the hydrogen generation efficiency of the reformer. Fuel cell gas utilisation at full load is approx. 77 %, the electrical efficiency of the fuel cell approx. 50 %. The product of these three efficiencies corresponds to an overall efficiency (gross) of approx. 30 % for the combination of reformer and fuel cell.

Returning the fuel gas not used in the fuel cell considerably improves reformer and total system efficiencies. Initial measurements with anode waste gas return confirmed an electrical gross efficiency of approx. 34 % to 35 %. Anode waste gas return thus improves the electrical efficiency of the total system by 4 % to 5 %. There is even more potential for improvement, for example, through increased use of waste gas heat.

The development work has been very successful so far and will be continued at Duisburg-Essen University. In this context, the focus is on a comprehensive experimental characterisation of the total system, work on individual component and total system control as well as on start-up strategies.

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