Einflussgrößen auf den Wasser- und Methanoltransport einer größeren Direkt-Methanol Brennstoffzelle

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Abstract

In the present work factors which influence the water and methanol transport of a bigger direct methanol fuel cell (P_{el} > 1 kW) were investigated. Background is the importance of water-closed operation mode of a direct methanol fuel cell system.

During the electrochemical reaction on the anode less water is consumed than produced on the cathode. This difference must be removed from the fuel cell by the volume flow rate air on the cathode. All other water on the cathode must be condensed and returned to the anode. With increasing ambient temperature it is necessary to reduce the volume flow rate because otherwise more water than necessary for the water-closed mode is carried out of the fuel cell system. Furthermore, low volume flow rates on the cathode leads to instable cell voltage. As a conclusion the amount of water on the cathode side should be reduced.

The water permeation through the membrane-electrode-assembly (MEA) at volume flow rates, which are necessary to reach a water-closed mode is mainly influenced by the intake capacity and the residence time of the air and only slightly affected by the material used as gas diffusion layer on the cathode. The water permeation decreases with decreasing concentration gradient up to zero. Beside the water permeation another transport mechanism for water, the so-called electro osmotic drag (EOD), exists. Hereby the water transport is coupled by the transport of protons through the proton-conducting Nafion®-membrane. The protons are generated by the electrochemical reaction on the anode. This mechanism allows an active transport of water to the cathode also without a concentration gradient.

It can be shown that the EOD can be reduced by the use of a more dense material for water for the gas diffusion layer on the anode. Hereby the amount of water which reaches the membrane is reduced. In contrast to this, a change on the cathode did not affect the water- or methanol transport.

Furthermore, it can be shown that the electrochemical performance of the investigated membrane-electrode-assemblies is robust against the kind of preparation of the used catalyst dispersion, parameter variation of the hot-pressing process for the assembly of MEAs, the thickness of the used membrane and hereby the induced different level of methanol permeation. An influence of the amount of water on the cathode to the cell voltage can’t be observed. In contrast to this, the influence of different types of catalysts is clearly identifiable and mainly affects the electrochemical performance of the MEA.

The cell voltage stability is strongly influenced by the type of flow-field structure which is used. If a single serpentine flow-field type is used it is possible to operate a direct methanol fuel cell with low volume flow rates air on the cathode which are necessary to reach water-closed operation mode. To minimize the methanol permeation, it is necessary to control the methanol concentration on the anode side in dependency on the current density.