

Optically accessible cell for the investigation of two-phase flows in membrane electrolysis

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Motivation

During operation of a membrane electrolyser (PEM or AEM), a two-phase flow is created in the electrode chamber, consisting of liquid water and product gas. The secondary phase (gas phase) resulting as a product of the reactants can have a performance-reducing effect on the operation of the electrolyser. First, the gas bubbles adhere tightly to the surface of the porous transport layer (PTL) and form a growing volume. This can lead to partial or almost complete blockage of the supply channel. Significant pressure fluctuations and unstable operation can result. The interaction between water supply, formation or removal of reaction products and achievable power density is highly complex and requires detailed analysis. An optically accessible electrolysis cell was designed, constructed, manufactured and iteratively optimized as part of an IGF-funded research project. This allows the simultaneous fluid mechanical and electrochemical investigation of test specimens during operation.

Consortium

Test cell

- Electrochemical in-situ investigation of cell components
- Optically accessible flow field for in-situ evaluation of the two phase flow
- Modular cell design
- Approx. 25 cm² active area
- Use of PTL/current collectors with different thickness possible
- Contact pressure on PTL or CCM (Catalyst Coated Membrane) variable

Results

- FF1: 1 x 0,5 mm²
- FF2: 1 x 1 mm²
- FF3: 2 x 0,5 mm²
- FF4: 2 x 1 mm²

Land width: constant

- FF2 shows best performance for non-ohmic corrected polarization curves
- FF4 shows best performance for ohmic corrected polarization curves

➢ Cell performance is a trade off between good electrical contact (smaller channel width) and small anode water flow velocity (larger channel diameter)

➢ Validation of flow map presented in: "ITO, H., et al. Effect of flow regime of circulating water on a proton exchange membrane electrolyzer [1]"

References:

[1] H. Ito, T. Maeda, A. Nakano, Y. Hasegawa, N. Yokoi, C.M. Hwang, M. Ishida, A. Kato und T. Yoshida, „Effect of flow regime of circulating water on a proton exchange membrane electrolyzer,” International Journal of Hydrogen Energy, pp. 1-11, 2010

Funding

Thanks for the funding by

ALLIANZ INDUSTRIE FORSCHUNG

The research project IGF 19526 BG is funded by the AiF in the program for promoting the „Industrial Joint Research (IGF)” from the Federal Ministry for Economic Affairs and Energy.

Gefördert durch:

aufgrund eines Beschlusses des Deutschen Bundestages

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