1 plus 1 Dimensional Model of a technical PE Fuel Cell

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Normally a fuel cell is characterized by a current voltage curve and the majority of previous modelling approaches had the goal to reproduce or predict this characteristic.

A simple current voltage curve however, although describing the true performance of the cell, is due to its shapeless form, very insensitive in distinguishing the different loss mechanisms in the cell. Therefore a current voltage curve is problematic to be used for model validation. This is even more evident in cells of technical size, bcause here lateral effects and inhomogieties are more pronounced than in laboratory cells, but these phenomena are poorly reflected in a simple I/E curve.

However in order to optimise technical cells, models are needed which focus on the effects of inhomogeniety in the cell.

Based on a literature approach for the cell water distribution, a full cell model realized in a 1+1 dimensional approach was developed to get a deeper insight into the behaviour of the cell. The model can describe the co- and counter-flow regimes in a cell. A combination of these regimes was used to describe the water management of the given technical cell flow field (see Figure 1).

Typical Results are shown in Figure 2 for current density, membrane resistance and transport over voltage for a case when the cell is fed with dry hydrogen. Calculations of current density are in good agreement with measurements of the local current density in this cell geometry [1]. Calculations and experimental results for other interesting operation parameters will be shown.

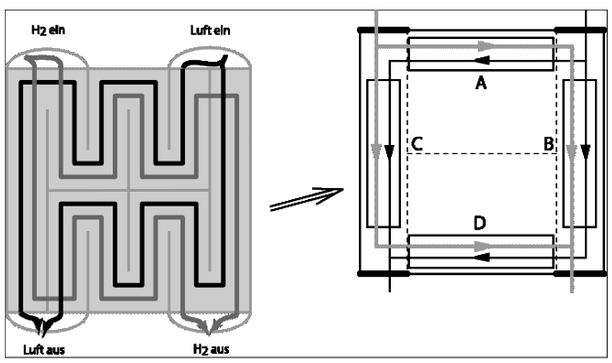
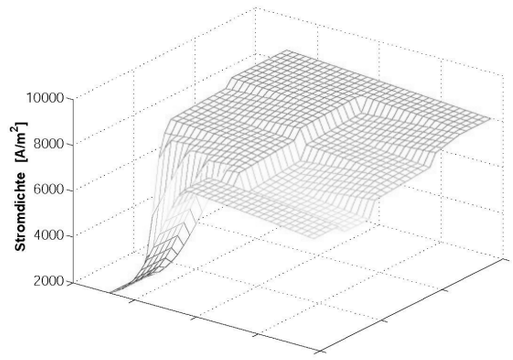
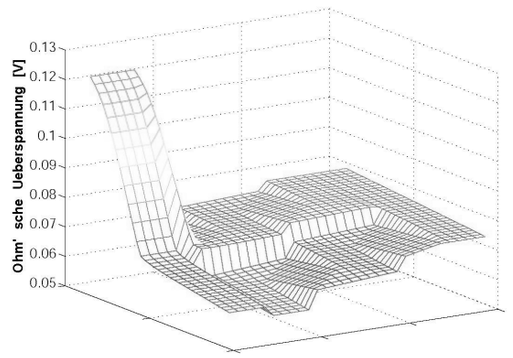


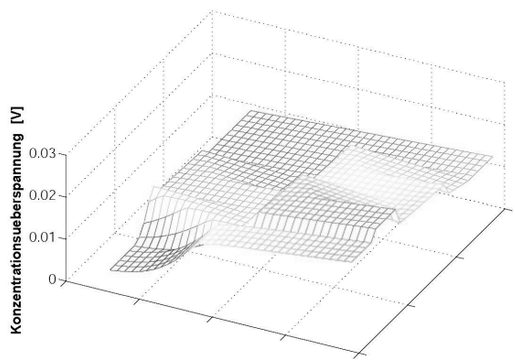
Figure 1: Abstraction of real flow field (left) by two co-flow sections (B, C) and two counter-flow sections (A, D) with given gas connections (right).



(a)



(b)



(c)

Figure 2: Calculated (a) Current density, (b) ohmic overvoltage and (c) concentration overvoltage, displayed for the real cell geometry for a cell operated on dry hydrogen and humidified air.

[1] F. N. Büchi, R.P. Neto, 201st Meeting of the Electrochemical Society, May 12-17, 2002, Meeting Abstracts volume 2002-1, Abstract No. 821