Analysis and effects of Heat Transfer and Friction Factor on SOFC Performance Characteristics - DTU Orbit (27/10/2019)

Analysis and effects of Heat Transfer and Friction Factor on SOFC Performance Characteristics

Within a solid oxide fuel cell (SOFC) assembly, the dominant mode of heat transfer is convection between the solid parts of the cell and the flowing gases in the gas channels. Estimation of the convective heat transfer coefficients is usually based on a constant value of the Nusselt number, assuming laminar established flow in the fuel cell channels. In this work, the convective heat transfer between solids and gases in both air and fuel channels is under study. The entrance effects on gas flow and heat transfer for the channels are simulated by a three-dimensional computation code in terms of friction factor $f_{Re}$ (Pressure drop) and Nusselt number $Nu$, based on a thermal boundary condition with constant heat flux $q_w$ at one wall and with thermal insulation ($q=0$) at the other three walls. The new results from the heat transfer study are integrated into a mathematical model, developed for simulation of a planar SOFC with internal reforming. This in order to test if these results will have any significant impact on the performance estimation of the cell. The detailed two-dimensional SOFC model, developed earlier by one of the authors, describes a single cell plate operating behaviour, i.e., gas utilisation, power density, energy efficiency, current and temperature profiles for different operating conditions. The modelling comprises solving the governing equations of heat and mass transfer in the air and in the fuel channels and in the solid structure of the cell. It includes comprehensive representation of resistive cell losses, reaction kinetics for the reforming reaction and heat conduction through the solid part of the cell. The results from the heat transfer study are integrated into the cell model by means of a variable heat transfer coefficient along the fuel cell channels.

Keyword: SOFC, Heat transfer, Friction factor

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