Peltier and Dufour Effects in the Polymer Electrolyte Membrane Fuel Cell

Marco Sauermoser [S] and Signe Kjelstrup [C]
PoreLab, Department of Chemistry, Norwegian University of Science and Technology, NTNU, Trondheim, Trøndelag, Norway
signe.kjelstrup@ntnu.no

Bruno G. Pollet
Department of Energy and Process Engineering, Norwegian University of Science and Technology, NTNU, Trondheim, Trøndelag, Norway

Local heat production inside a polymer electrolyte membrane fuel cell plays a critical role for safety issues [1], durability [2] and auxiliary equipment design (e.g. cooling equipment [3]) and, therefore, for the overall system efficiency. To accurately compute these heat effects, all coupling terms such as Peltier and Dufour effects need to be included when modelling the PEMFC. These effects, however, are often neglected.

We present a newly developed 1D non-equilibrium thermodynamic PEMFC model, where all coupling terms were included. The set of equations were solved in MATLAB 2019a, based on an open-source code by Vetter and Schumacher [4]. We show the various profiles inside the PEMFC, of temperature, heat flux and water molar fraction. We discuss in-depth the importance of coupling of fluxes of heat, mass and charge, and how they impact the cell profiles.

Recent results [5] show that Dufour and Peltier heats have significant contributions to the heat fluxes in the anode porous transport layer (PTL), the Nafion membrane and the cathode PTL, and they could not be neglected. Dufour effects in the membrane competed with Fourier type contributions to the heat flux. Peltier effects were also substantial. In addition, contributions to the water fluxes in the homogenous layers were analyzed. Thermal diffusion in the PTLs played an essential role in the computation of the water fluxes.

References

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