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Heat and mass transfer effects in a Direct Methanol Fuel Cell: a 1D model

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Abstract: (Your abstract must use **Normal style** and must fit in this box. Your abstract should be no longer than 300 words. The box will 'expand' over 2 pages as you add text/diagrams into it.)

Models play an important role in fuel cell development since they facilitate a better understanding of parameters affecting the performance of fuel cells and fuel cells systems. In this work, a steady state, one-dimensional model accounting for coupled heat and mass transfer, along with the electrochemical reactions occurring in the DMFC is presented. The model accounts for the kinetics of the multi-step methanol oxidation at the anode while the kinetics of the cathodic oxygen reduction is modelled using the Tafel equation. Two-phase flow effects are neglected. The anode and cathode flow channels are treated using the continuous stirred tank reactor (CSTR) approach. The cell voltage expression incorporates the anodic and cathodic overpotentials as well as the ohmic losses across the membrane. The mixed potential of the cathode due to methanol crossover is also included. The reactions in the catalyst layers are considered homogeneous. Pressure gradients across the layers are assumed as negligible. Methanol and water transport through the membrane is assumed to be due to the combined effect of the concentration gradient and electro-osmotic force. Mass transport in the diffusion layers and membrane is described using effective Fick models. Local equilibrium at interfaces is represented by partition functions. The methanol flux in the cathode catalyst layer is considered as well as methanol crossover. The transport of heat through the gas diffusion layers is assumed to be a conduction-dominated process. The thermal conductivity for all the materials is assumed to be constant. Heat generation is considered in the catalyst layers. The analytical solutions for concentration and temperature across the cell are compared with recently data existing in literature and with in-house obtained results, for a wide range of operating conditions. The model shows very good agreement. This easily implemented simplified model is suitable for use in real-time DMFC simulations.