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*Stack level computational models of polymer electrolyte membrane hydrogen fuel cells*

A model of steady state operation of Polymer Electrolyte Membrane Fuel Cell (PEMFC) stacks with straight gas channels is presented. The model is based on a decoupling of transport in the down-channel direction from transport in the cross-channel plane. Further, cross-channel transport is approximated heuristically using one-dimensional processes. The model takes into account the consumption of reactants down the channel, two-phase transport in the Gas Diffusion Electrodes (GDE), the effect of membrane hydration on its conductivity, water crossover through the membrane, the electrochemistry of the oxygen reduction reaction, thermal transport within the Membrane Electrode Assembly (MEA) and bipolar plates to the coolant, heat due to reaction and condensation and membrane resistance, electrical interaction between unit cells due to in-plane currents in the bipolar plates, and thermal coupling of unit cells through shared bipolar plates. The model is a nonstandard system of non-smooth boundary value Differential Algebraic Equations (DAEs) with strong, nonlocal coupling. A discretization of the system and a successful iterative strategy are described. Representative computational results, validation against existing experimental data and a numerical convergence study are shown.