Modelling Performance Degradation of a Polymer Electrolyte Fuel Cell

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In this work a degradation model for polymer electrolyte membrane fuel cells (PEMFC) is developed. The model predicts the fuel cell performance by taking into account the influence of operating conditions (temperature, relative humidity, pressure) on degradation processes in the materials (gas diffusion layer, catalyst layer and proton exchange membrane).The model consists of two main modes. The first mode is a semi-empirical model calculating the following fuel cell parameters after a certain operating duration: membrane thickness, ionic conductivity, acid group concentration, diffusion coefficients of H_2, O_2 and N_2 in the membrane, electro-active surface of the catalyst layers as well as thickness and contact angle of the gas diffusion layer. The second mode is the CFD code AVL FIRE®. The material characteristics calculated in the semi-empirical model are used as input parameters for the CFD code AVL FIRE® in order to simulate the fuel cell performance at certain points in time. The description of the changes in the material characteristics is based on the experimental data published in the scientific papers [1-8]. A justification of the proposed model shows that the simulated polarization curves are in qualitative agreement with experiments. The simulation results indicate an increase of the PEMFC degradation with decreasing relative humidity and increasing pressure gradient of the feeding gases.

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