MODELING THE INTRUSION OF A GAS DIFFUSION LAYER INTO FLOW CHANNELS OF A PROTON EXCHANGE MEMBRANE FUEL CELL.

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In a proton exchange membrane fuel cell (PEMFC) stack, a compression force is required to hold all components together and to seal the reactant gases in the cell. As a result of this compression force, the gas diffusion layer (GDL) can deform into the adjacent anode or cathode channels. The GDL is a carbon fiber paper which provides support for the catalyst coated membrane (CCM) as well as electrical conductivity. The amount of GDL that extends into the channel is defined as intrusion, and this intrusion is equivalent to a partial channel blockage. Intrusion is an undesired effect of compression to fuel cell performance and leads to increased pressure drop losses which can affect the current density as well as diminish the water management abilities of the cell. In the present work, the intrusion has been modeled numerically. A commercially available finite element software, ANSYS, has been used to analyze various geometries and loading conditions. The amount of intrusion into the gas channels as well as the magnitude of shear stress experienced by the GDL from the force of the current collecting plates is the main focus of this analysis. With only a few published values available for the elasticity of a carbon fiber paper, a value of 17.9 MPa was determined from literature. Analyses were performed assuming a Poisson's Ratio of zero, which was determined to yield results with deviations of less than 5%. It was found that increasing the compression force on the GDL increased the amount of intrusion as well as the shear stress. Introducing edge effects such as rounds to the corner of a channel wall has been found to relieve stresses, but as a consequence, facilitates an increase in intrusion height. From this work, insight has been obtained for intrusion and its characteristics, which could be applied to channel design.