Water management in direct methanol fuel cells

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Abstract

Direct methanol fuel cell (DMFC) are a promising power source for micro and portable applications due to their high energy density and inherent simplicity of operation with methanol as the liquid fuel. Present state-of-the-art optimised operating conditions are elevated cell temperatures to improve the anode reaction, high air stoichiometries to prevent cathode flooding and dilute methanol solutions to mitigate methanol crossover. These very dilute fuel solutions require the presence of a high amount of water leading to a reduction of the energy density of the system. More concentrated methanol solutions would be preferable in order to achieve energy densities needed for portable power applications. However, the possibility of using highly concentrated methanol solutions at the anode is limited by the significant water loss from the anode to cathode occurring in the DMFC due to electro-osmotic drag and molecular diffusion through the membrane. So, low crossover of both methanol and water through a polymer membrane in a DMFC is essential for using high concentration methanol in portable power applications. In this work, the results of a simulation study using a previous developed model for DMFC´s are presented. Particular attention is paid to the water distribution across the cell. The influence of different parameters (such as methanol concentration, membrane thickness and gas diffusion media) over the water transport and on the cell performance is studied. The model used to predict the water transport was validated with recent published data.

Keywords: Direct methanol fuel cell, methanol concentration, methanol crossover, water transport