The Effect of Fuel and Oxidant Pumping on the Performance of a Membraneless Microfluidic Fuel Cell

A. F. Tayel[1], M. A. Fathallah[1], M. M. Elsayed[1]

[1]Department of Mechanical Engineering, Alexandria University, Alexandria, Egypt

Abstract

For the commercialization of membraneless microfluidic fuel cell, voltage and minimum power demand for various applications need a precise selection of fuel and oxidant flow rates to achieve the optimum cell performance. A numerical study on a membraneless microfluidic fuel cell was made to determine the effect of Peclet (Pe) number on the overall performance of the fuel cell. A model of 1 mm (wide) x 1 mm (height) x 30 mm (length) Y channel configuration was validated. Formic acid was used as a fuel, oxygen was used as an oxidant and Sulfuric acid was used as an electrolyte. Creeping Flow module was selected using incompressible Navier-Stokes equations for very low Reynolds number flow. Secondary Current Distribution module was used to model the electrochemical reaction and reaction rates using concentration dependent kinetics. Transport of Diluted Species module was used to account for the mass transfer between fuel and oxidant streams, in addition to species diffusion. Pumping power increased with the increase of Pe number. The output current density slightly increased, and the net power density remained constant when Pe number was increased at Voltage greater than 0.6 V. When Pe number was increased and voltage was less than 0.6 V, the change in the output current density increased significantly, the net power density increased, and the overall efficiency dramatically decreased. The highest efficiency was achieved at the smallest Pe number. With the increase of Pe number, the change in the polarization curve, net power curve, and efficiency curve were decreased. A trade-off must be made between the cell efficiency and its net power output to achieve the required power output with the maximum fuel utilization.

Figures used in the abstract

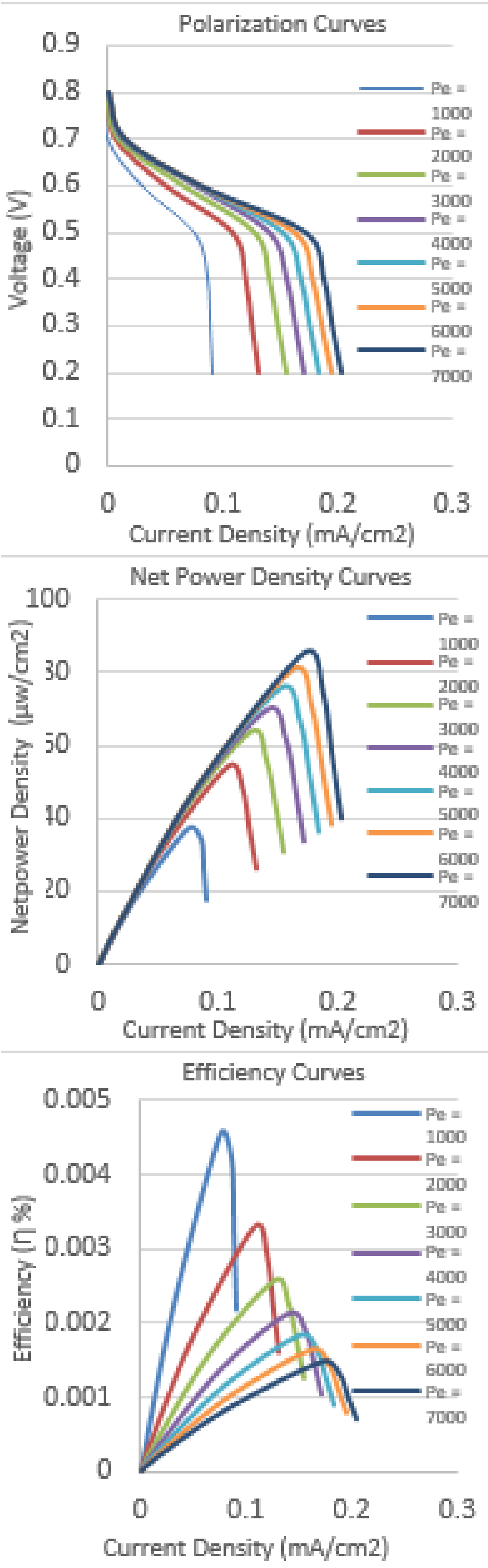

Figure 1: The performance of microfluidic fuel cell under different Peclet number

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