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Performance enhancement of PEM fuel cells using flow-field indentation of bipolar-plates

M. J. Kermani

Zentrum für Sonnenenergie- und Wasserstoff-Forschung (ZSW) Baden-Württemberg, Germany

Abstract

With global growths in energy-demands and pollution-creations, enthusiasm toward alternative clean-sources of power production via more efficient manners has recently greatly increased. In this contribution performance enhancement of fuel cells using a novel flow field design is described. A method called as flow-field indentation of bipolar-plates has been recently proposed by Kermani and colleagues, in which it is shown that placement of proper indents along the gas delivery channels built-in bipolarplates, the cell performance can enhance as much as 20%. In a systematic approach, the work has initially been assessed using computations of sole heat transfer problems that show up to 40% enhancement in heat exchange between the core flow and the channel wall, due to the presence of proper obstacles (indents) along the channel. This great amount of enhancement in heat transfer is due to local disturbances generated by channel indentations where at opening regions right above the indents (say throats), larger velocity gradients at the walls are achieved. Hence the wall-shear stress (local skin friction), and temperature gradients (local Nusselt number) in the case of sole heat transfer problems and larger wall-concentration gradients (in the case of fuel cells) are locally enhanced at the surface of the wall in throat regions. This promotes locally higher consumption of reacting species (oxygen in the case of PEM FC), generating locally and globally higher electrical current productions. In this presentation, reviews of our earlier works on various types of transport phenomena are first described, then a sample of three-dimensional computations of a parallel flow PEM fuel cell with various indent shapes and locations along the channel are presented. The performance enhancements of the cell due to the placement of indents are compared with those of a reference case (the case with no indent). The experimental part of the present study is also under the way, and is planned for near future using the laboratory facilities in ZSW-Ulm, Germany.

Biography

Mohammad Jafar Kermani completed his PhD from Carleton University in 2001, and postdoctoral studies from University of New Brunswick in 2003, Canada. He was the top rank student during his Master's program (Applied Math-Fluid Mechanics) from University of Manchester, UK, and the 2nd rank during his Bachelor program in Mech.Eng. from Shiraz University, Iran. Presently he is performing research on PEM fuel cells in Center for Solar Energy and Hydrogen Research in Ulm, Germany under a fellowship from Alexander von Humboldt Foundation, Germany. He is author of over 90 journal and conference papers and recipient of several prizes such as MITACS, Canada.