Modeling, simulation and shape optimization of a proton exchange membrane fuel cell using computational fluid dynamics

Ivan Korkischko[1*], Elisabete Inácio Santiago[1], Bruno Souza Carmo[2], Fabio Coral Fonseca[1]

[1]IPEN-CNEN, CCCH, São Paulo, SP, Brazil

[2]RCGI, Department of Mechanical Engineering, Poli, University of São Paulo, SP, Brazil

[*] Corresponding author: ivan.korkischko@gmail.com

Abstract

This paper presents the modeling, simulation and optimization of a single channel proton exchange membrane fuel cell (PEMFC) using computational fluid dynamics methods. The shape optimization of the cross section of the flow channels was employed to improve the electrical performance of the fuel cell. The minimization of the standard deviation of the current density on the longitudinal mid-plane of the membrane was the objective function of the single-objective optimization problem, the upper and lower widths of the flow channels were the control variables and a cross-section area restriction was imposed. The optimized flow-channel PEMFC presented improved electrical performance, with higher current and power densities and a more uniform current density distribution than the rectangular flow channel. It is also expected that a more uniform current distribution improves the durability and water management of the fuel cell.

Keywords: PEMFC, Flow Field, Numerical Simulation, CFD, Shape Optimization