Improving the Sensoring of PEM Fuel Cell By Numerical Techniques

S. Skoda[1], E. Robalinho[2], E. F. Cunha[1], M. Linardi[1]

[1]Instituto de Pesquisas Energéticas e Nucleares - IPEN/CNEN-SP, São Paulo, SP, Brazil
[2]Universidade Nove de Julho - UNINOVE, São Paulo, SP, Brazil

Abstract

The use of numerical techniques in PEM fuel cell sensoring represents an advantage of project engineering, reducing the costs and accelerating the manufacturing of prototypes. In this work some numerical responses are shown, relating to numerical sensoring of water and oxygen mole fractions at cathode of a 5 cm² of geometric area PEM fuel cell. The use of COMSOL Multiphysics® software with CFD and Chemical Reaction Engineering modules allowed the implementation of the problem and its complex multiphysics. The model contains the Free and Porous Media Flow, the Transport of Concentrated Species and the Secondary Current Distribution physics interfaces. The boundary conditions were defined for each interface. The need to recognize a geometric figure of merit that meaning the region of sensoring, led us to define the lines localized in the center of the cell. Figures 1 shows one vertical line and Figure 2 shows eleven horizontal lines used in order to take the readings from the model. These lines are localized in the median plane of the central channel of the cell (inset of Figure 2). Using these detection lines, the numerical responses are much more interesting to the fuel cell researcher, that captures important average information of oxygen and water at cathode domain. Figure 3 presents the variation of the oxygen molar fraction along the lines (horizontal), in the range of 0.1V - 0.95V, at 308K. Figure 4 presents the variation of oxygen molar fraction along the vertical line, in the range of 0.1V - 0.95V, at 308K. These results allow to predict the behavior of the PEM fuel cell when it works in low temperatures, that is, condition in which the efficiency control is more difficult. Usually flooding problems are observed in this context. The study of phenomena and control conditions are very difficult task for researchers and the use of numerical evaluations is of great help, when allied to the experimental results.

Reference

[1] M. Linardi, Introdução à Ciência e Tecnologia de Células a Combustível, Art Lieber Editora, São Paulo, SP, 2010.

[2] F. Barbir, PEM Fuel Cells – Theory and Practice, Elsevier Academic Press, 2005.

[3] S.Skoda, E.Robalinho, A.L.R.Paulino, E.F.Cunha, M.Linardi, Modeling of Liquid Water Distribution at Cathode Gas Flow Channels in Proton Exchange Membrane Fuel Cell – PEMFC, Proceedings of the COMSOL Conference 2013, Rotterdam, ND, 2013.

[4] E. Robalinho, Desenvolvimento de um modelo numérico computacional aplicado a uma célula a combustível unitária de 144 cm² do tipo PEM. PhD Thesis, São Paulo, SP, Brazil, 2009.

Figures used in the abstract

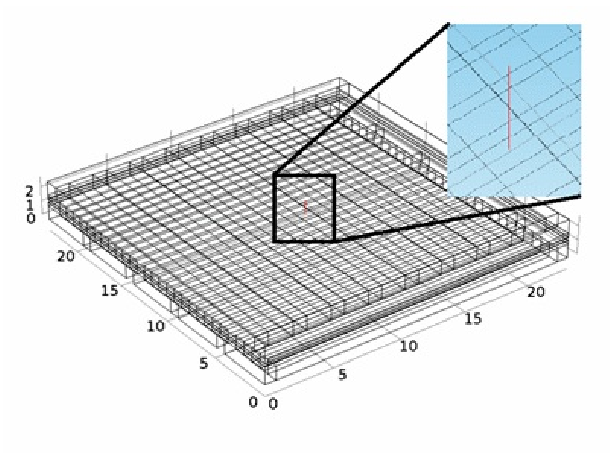

Figure 1: Vertical line used to taking readings of the model.

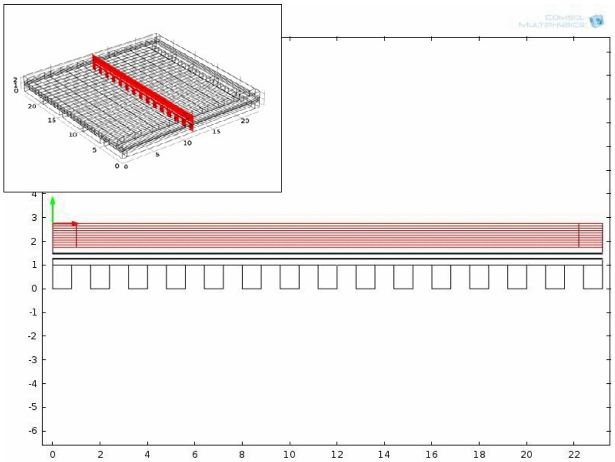

Figure 2: Horizontal lines used to taking readings of the model (inset: median plane of the central channel of the cell).

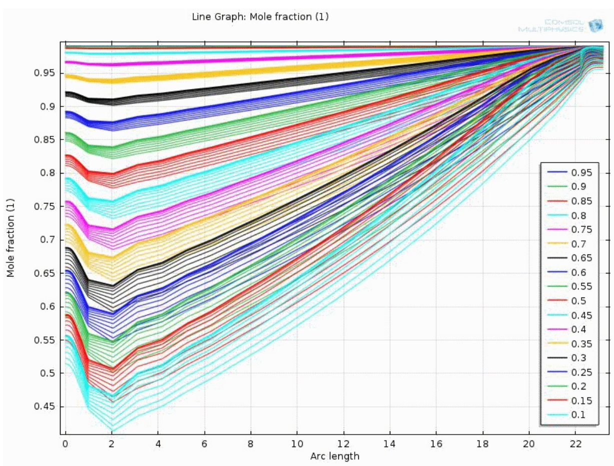

Figure 3: Oxygen molar fraction values along the horizontal lines, 0.1V – 0.95V, 308K.

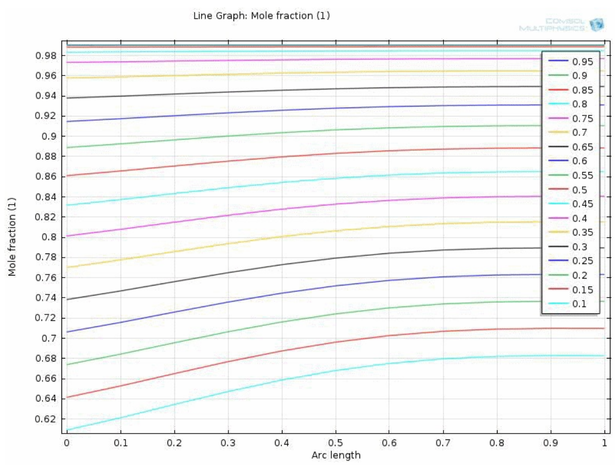

Figure 4: Oxygen molar fraction values along the vertical line, 0.1V – 0.95V, 308K.