Analysis of an “Air Cathode” for a Micro Fuel Cell

a Finite Element Analysis (FEA)

using flexPDE

Craig E. Nelson - Consultant Engineer

Nelson Research, Inc. 2142 – N. 88th St. Seattle, WA. 98103 USA 206-498-9447 Craigmail @ aol.com

Purpose of the Analysis:

An electrochemical reaction in a long rectangular fuel cell cathode channel is studied. The work shown here is a "reverse engineered – independently formulated" version of a journal paper presentation:

J. Yi and T. Nguyen, J. Electrochem. Soc., 146(1), 38 (1999).

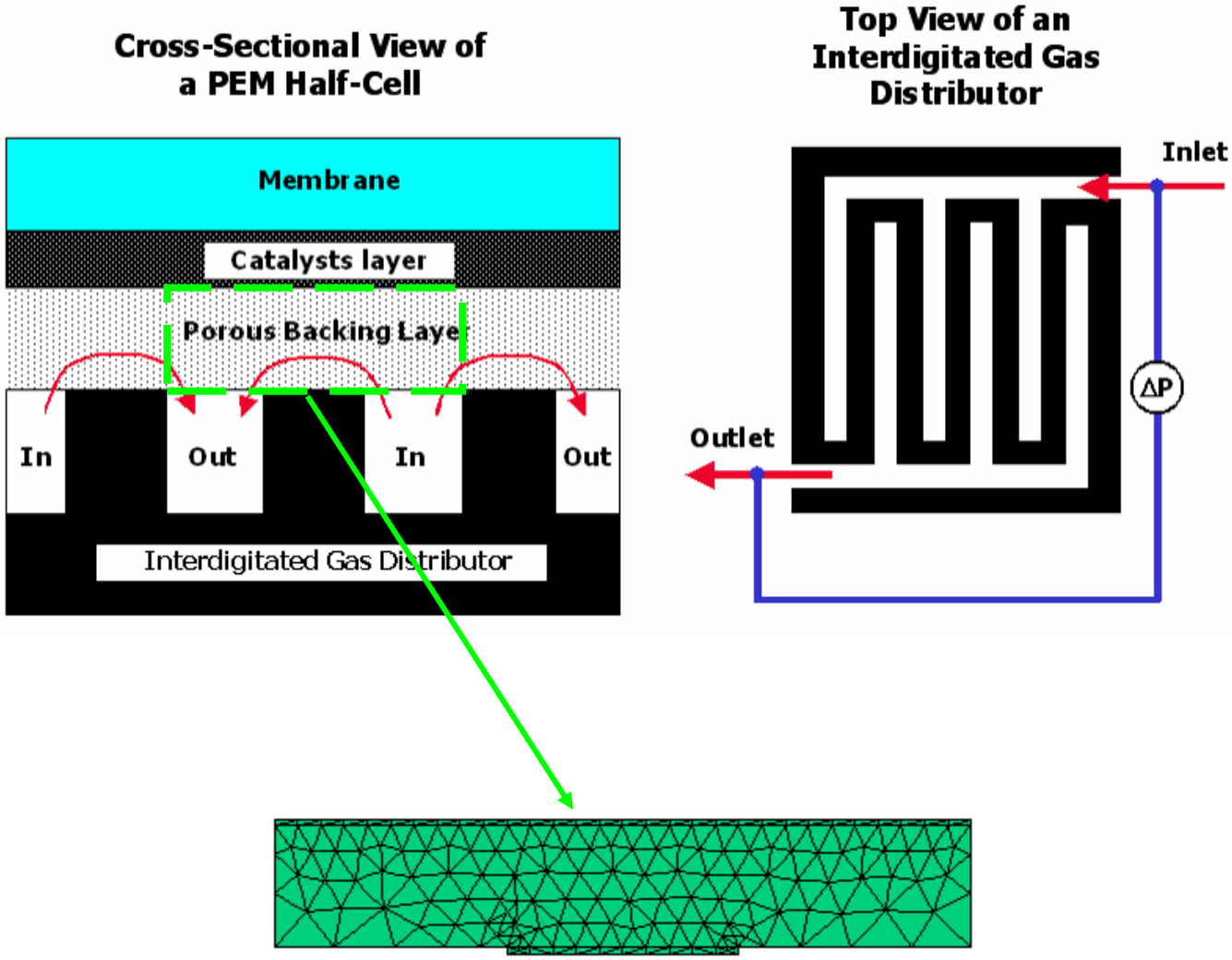
The purpose for this analysis was to check my model formulation methodology for a complex, multi-component, reactive-fluidic physical chemistry model, using a previously solved example as my guide and sanity check.

The results presented here agree very closely with those reported in the refereed journal paper.

Nelson Research, Inc. 2142 – N. 88th St. Seattle, WA. 98103 USA 206-498-9447 Craigmail @ aol.com

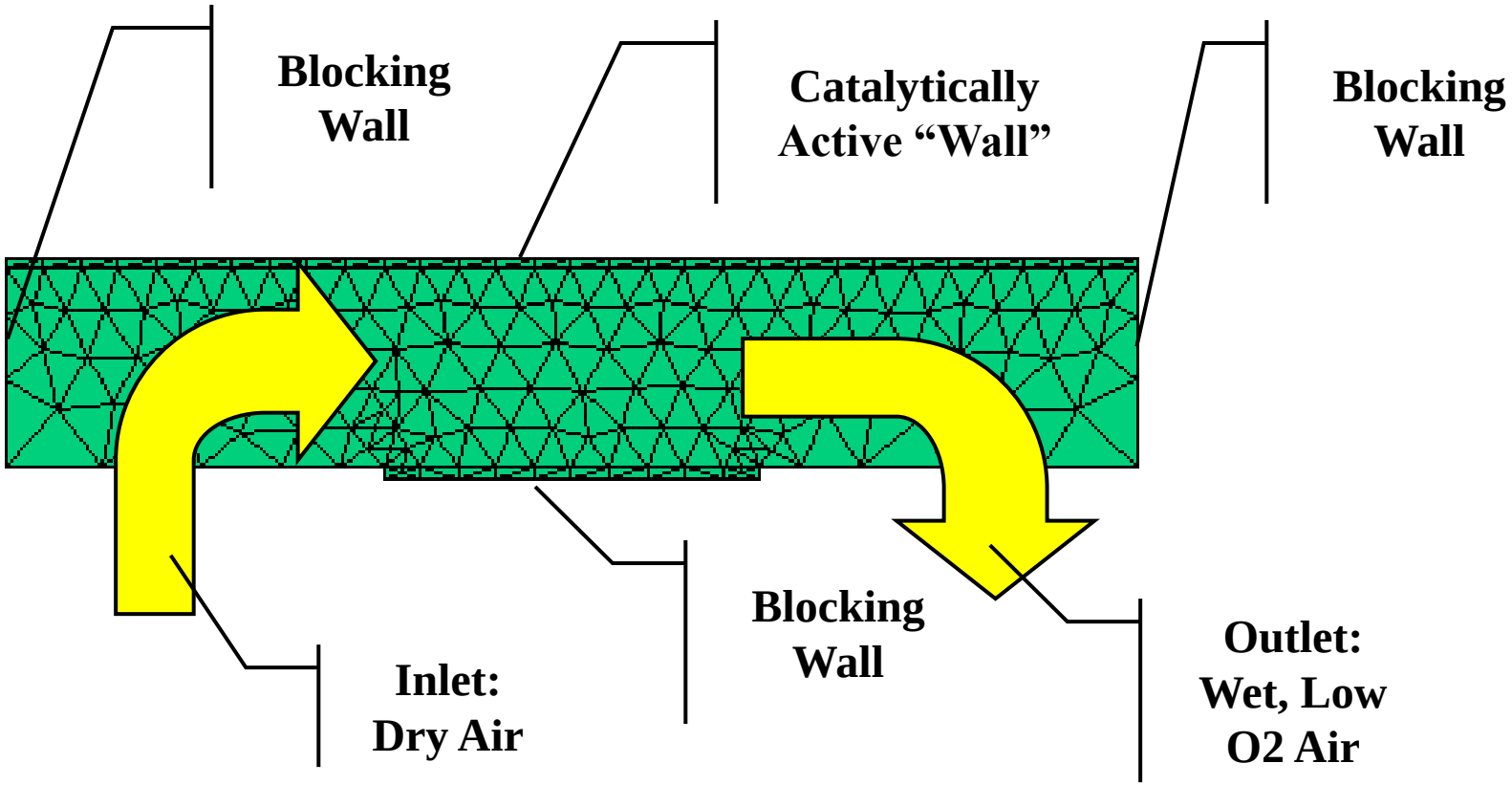
Analysis Geometry

Nelson Research, Inc. 2142 – N. 88th St. Seattle, WA. 98103 USA 206-498-9447 Craigmail @ aol.com



Solution Domain

Nelson Research, Inc. 2142 – N. 88th St. Seattle, WA. 98103 USA 206-498-9447 Craigmail @ aol.com

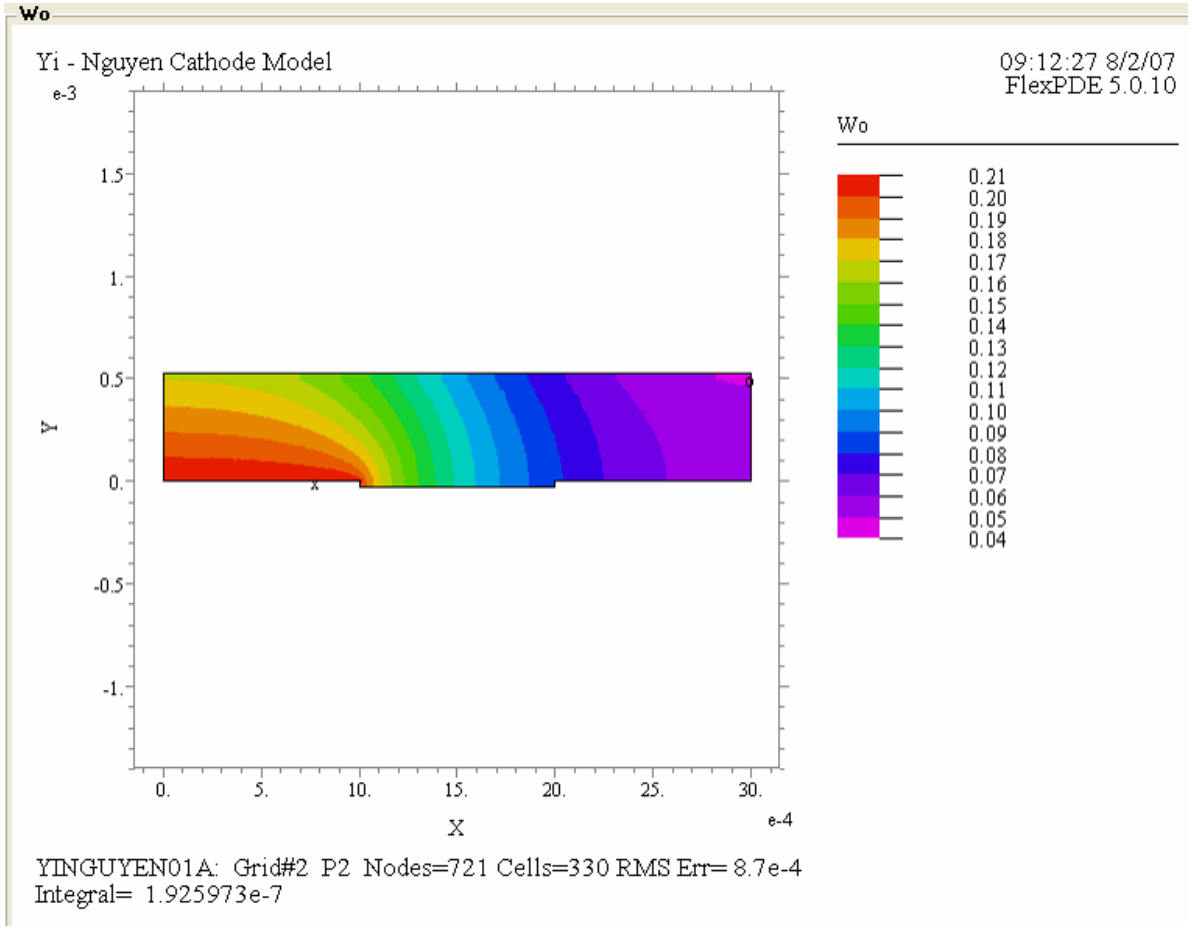


Solution Domain

Nelson Research, Inc. 2142 – N. 88th St. Seattle, WA. 98103 USA 206-498-9447 Craigmail @ aol.com

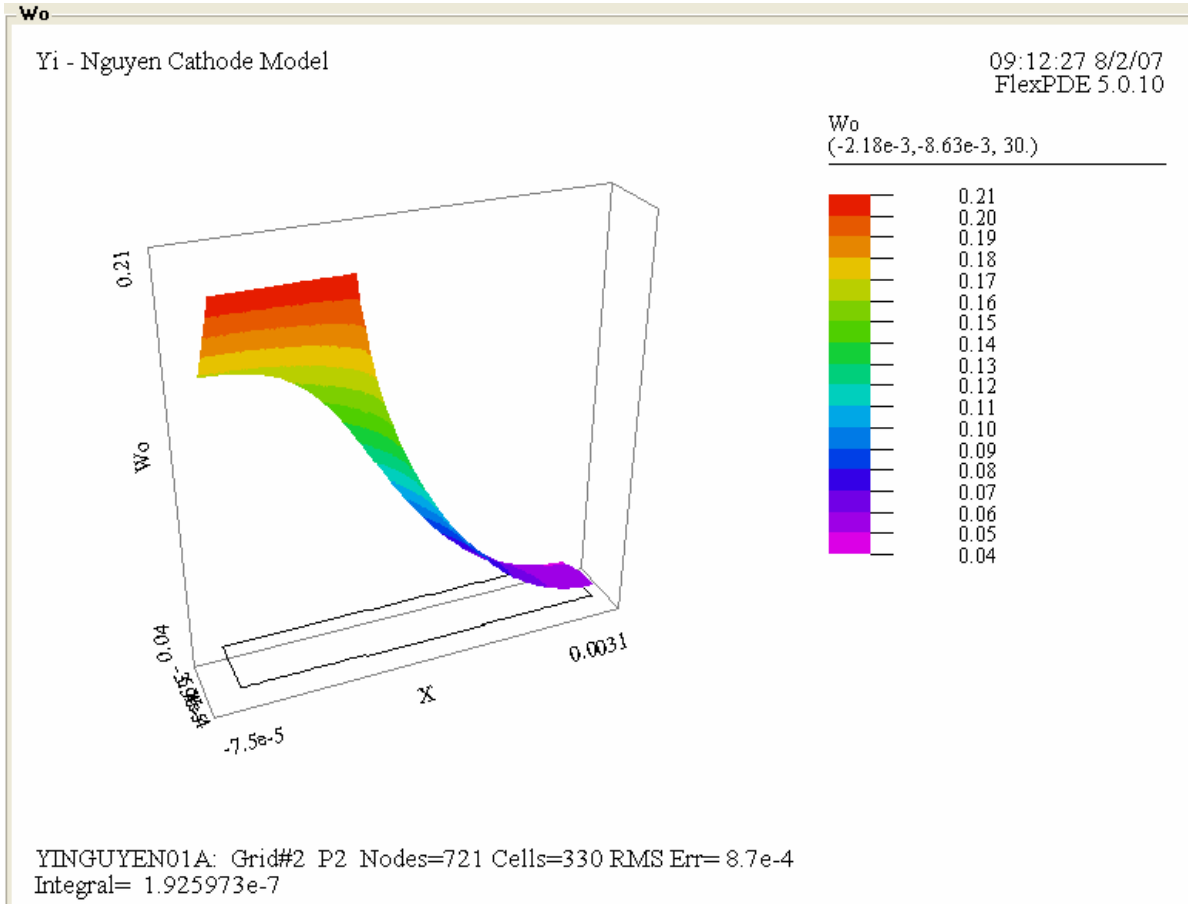
Numerical Experiment Results

Nelson Research, Inc. 2142 – N. 88th St. Seattle, WA. 98103 USA 206-498-9447 Craigmail @ aol.com



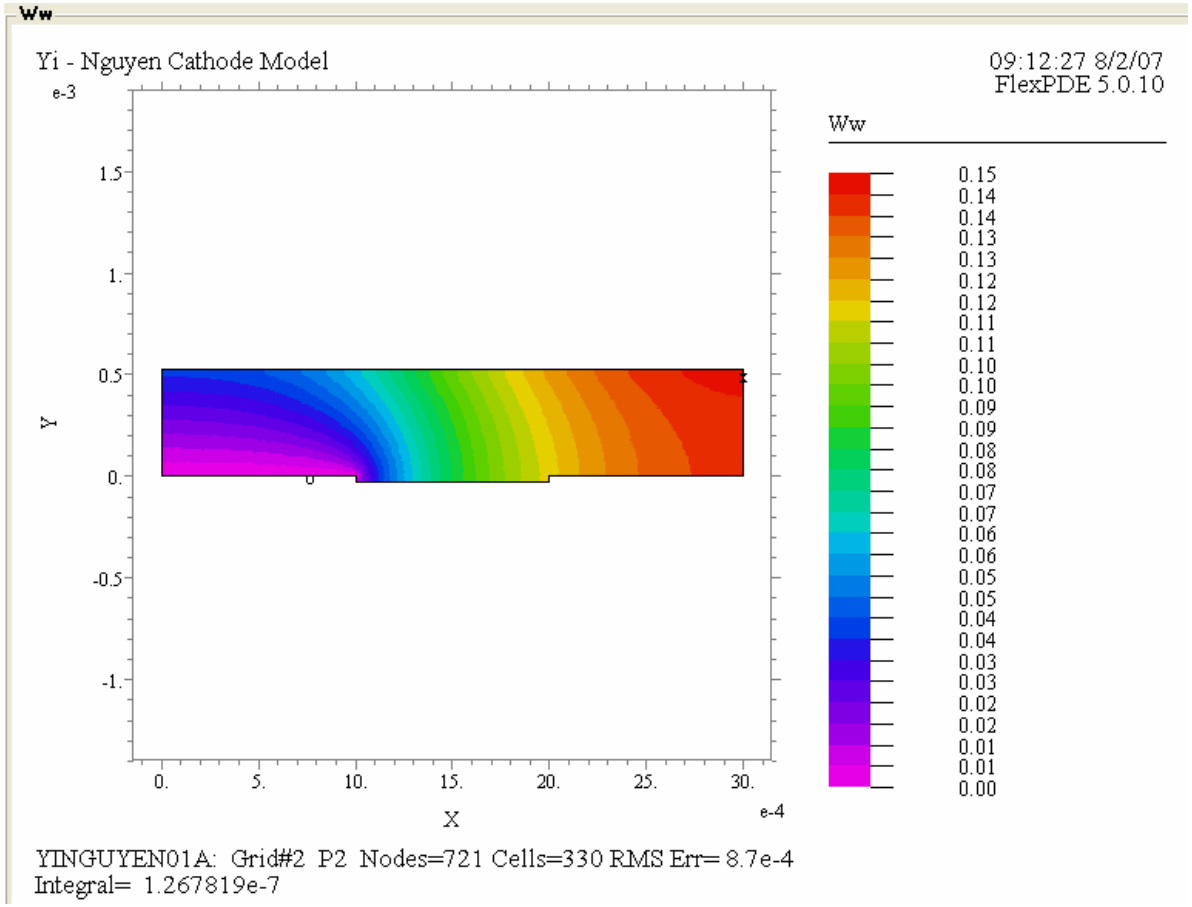
Mass Fraction – Oxygen – Contour Plot

Nelson Research, Inc. 2142 – N. 88th St. Seattle, WA. 98103 USA 206-498-9447 Craigmail @ aol.com



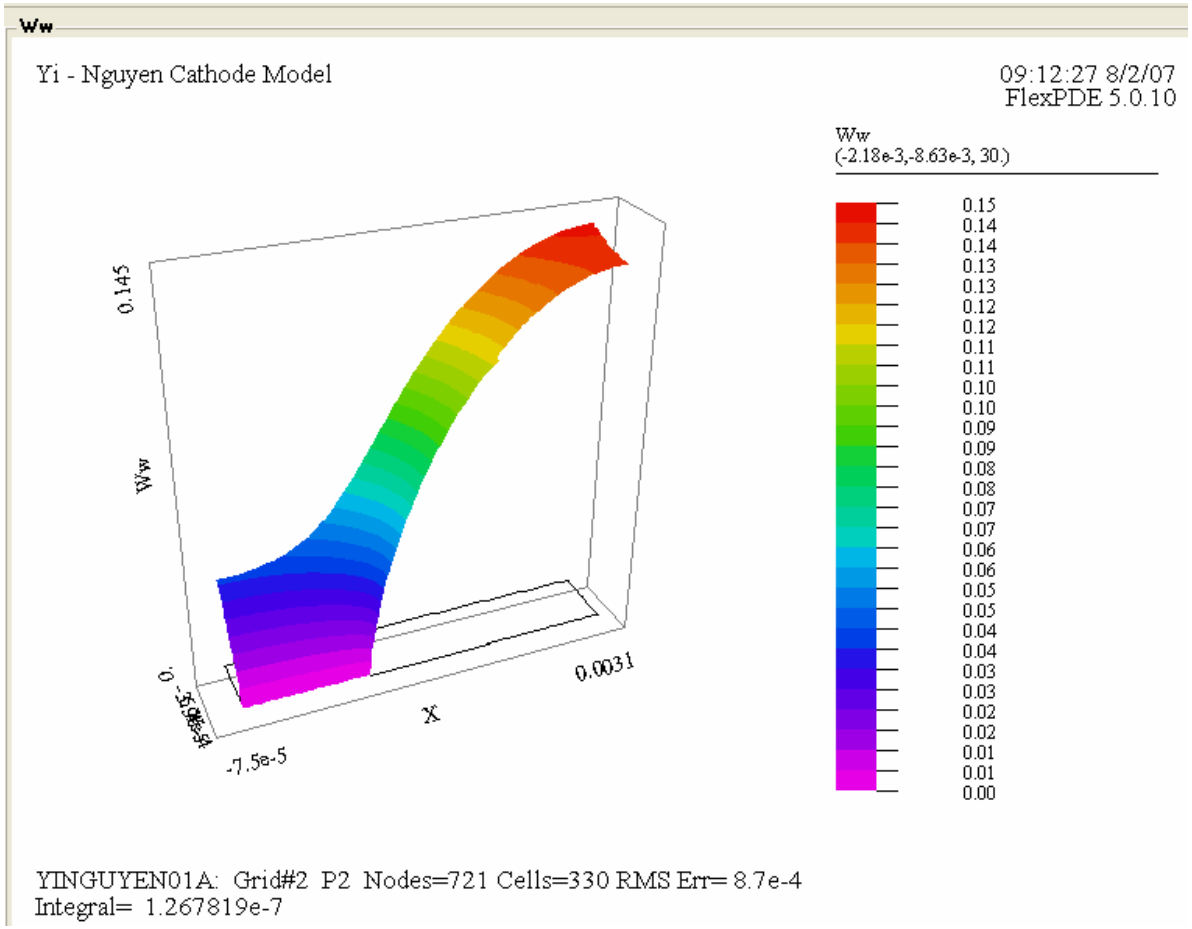
Mass Fraction – Oxygen – Surface Plot

Nelson Research, Inc. 2142 – N. 88th St. Seattle, WA. 98103 USA 206-498-9447 Craigmail @ aol.com



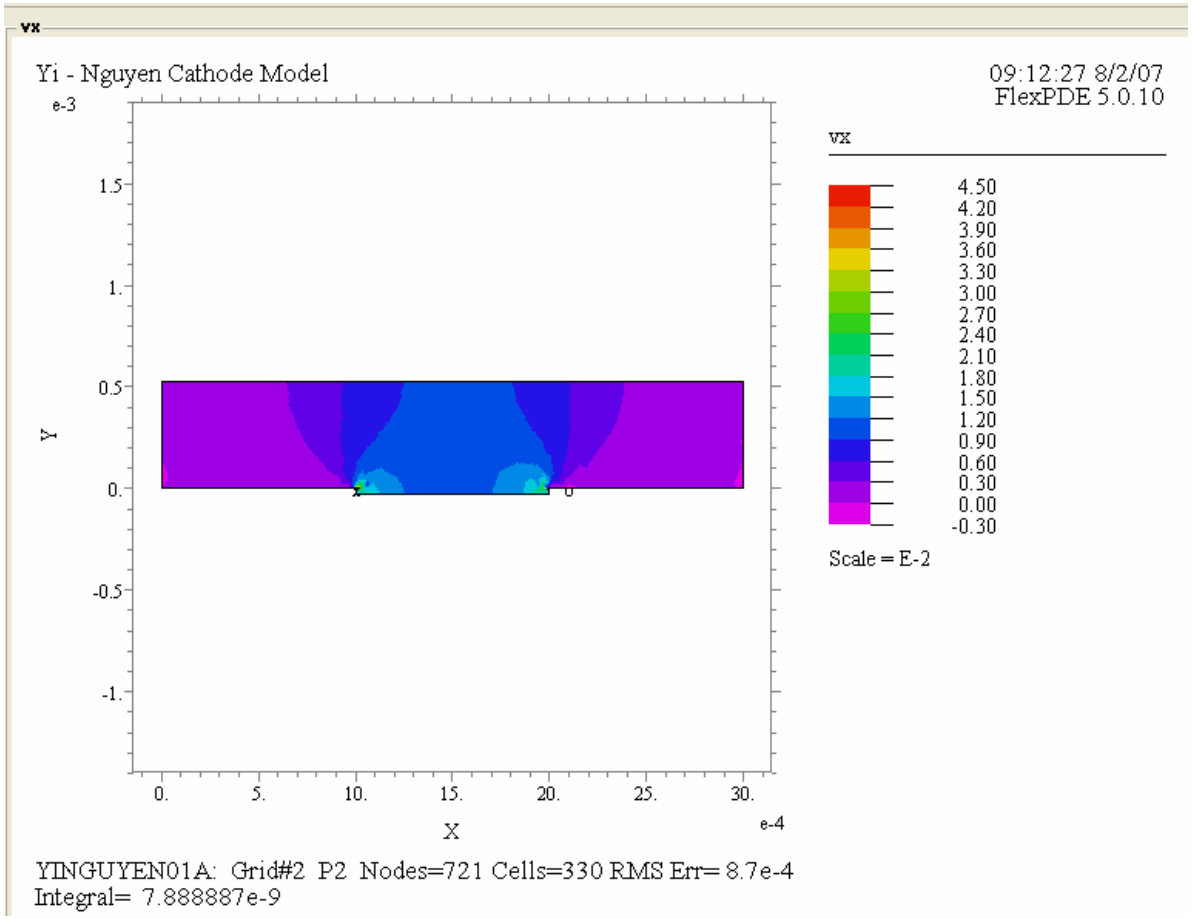
Mass Fraction – Water – Contour Plot

Nelson Research, Inc. 2142 – N. 88th St. Seattle, WA. 98103 USA 206-498-9447 Craigmail @ aol.com



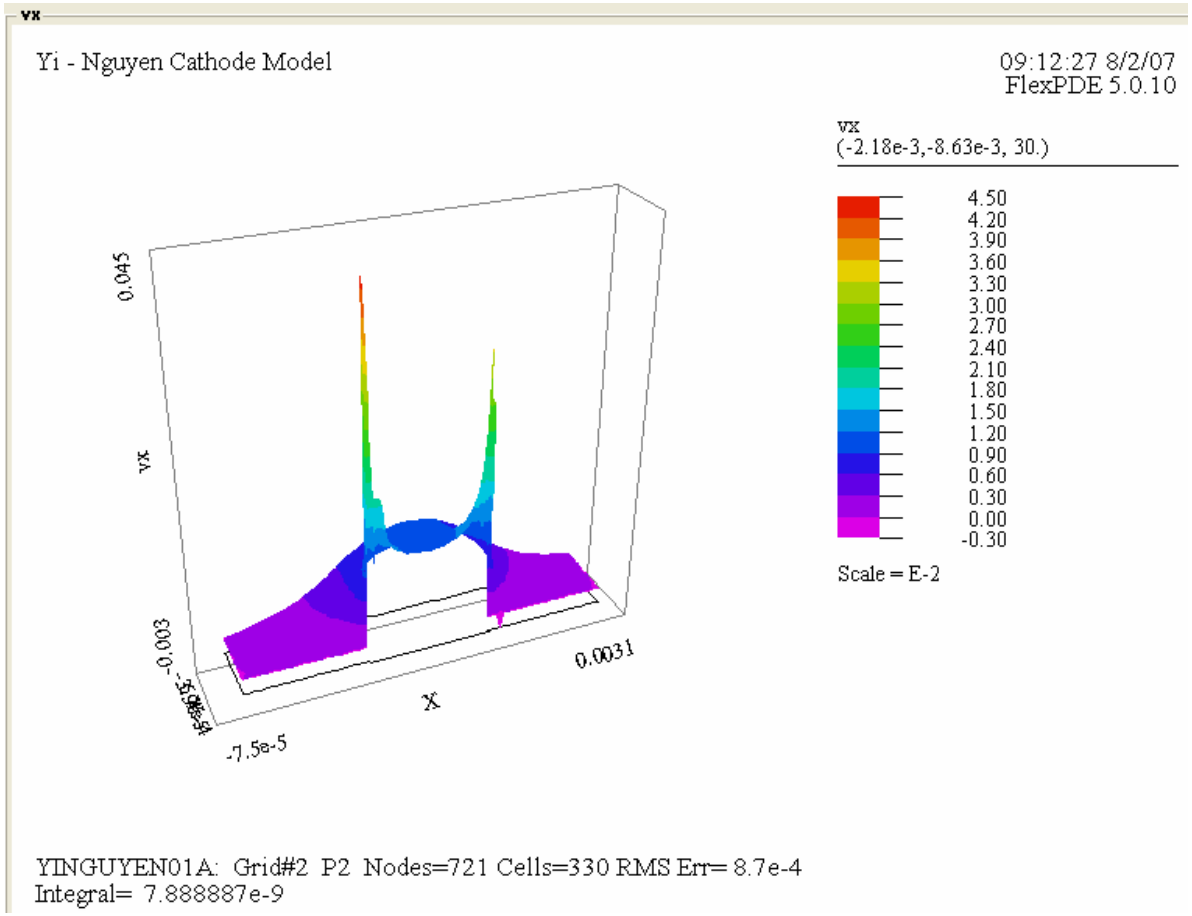
Mass Fraction – Water – Surface Plot

Nelson Research, Inc. 2142 – N. 88th St. Seattle, WA. 98103 USA 206-498-9447 Craigmail @ aol.com



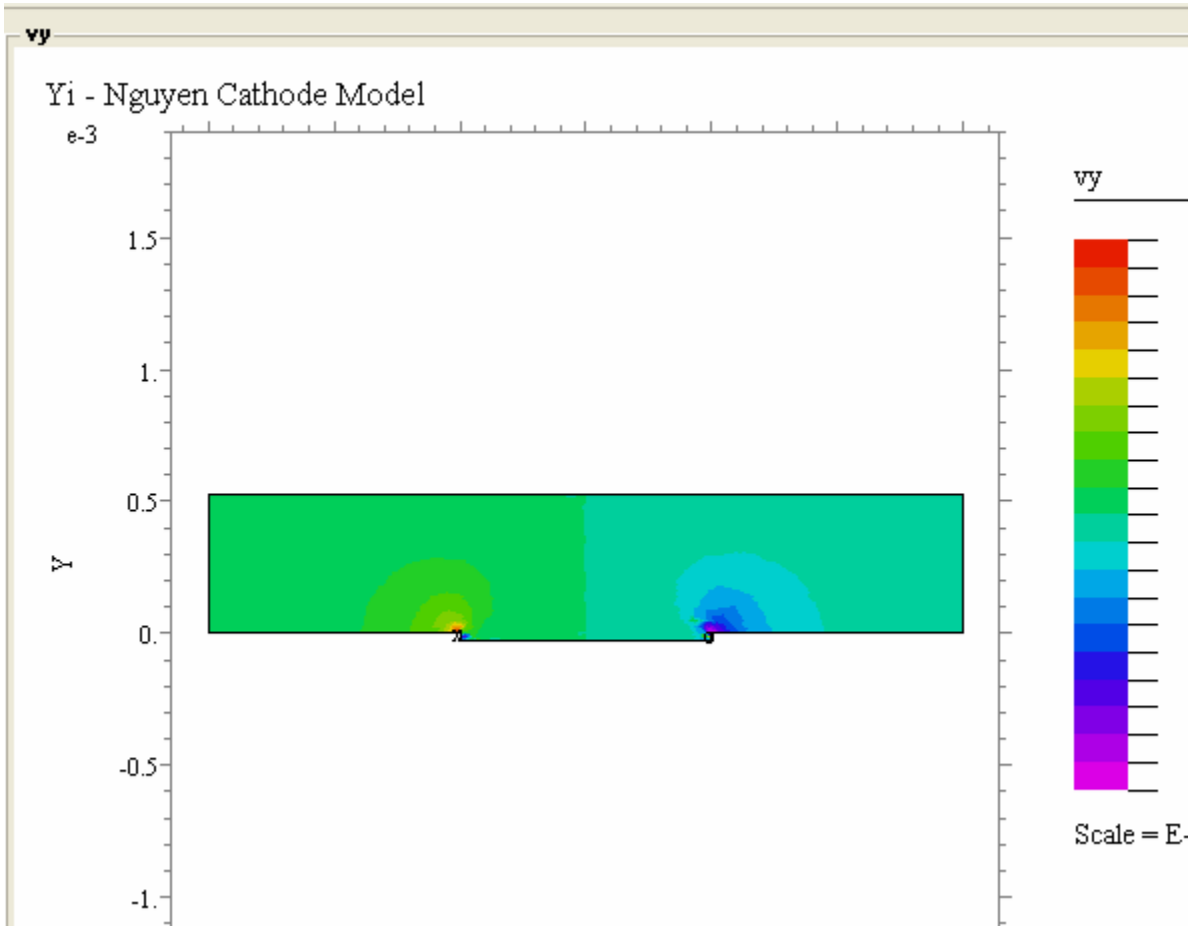
Air and Water Vapor Velocity – Horizontal Direction - Contour Plot

Nelson Research, Inc. 2142 – N. 88th St. Seattle, WA. 98103 USA 206-498-9447 Craigmail @ aol.com



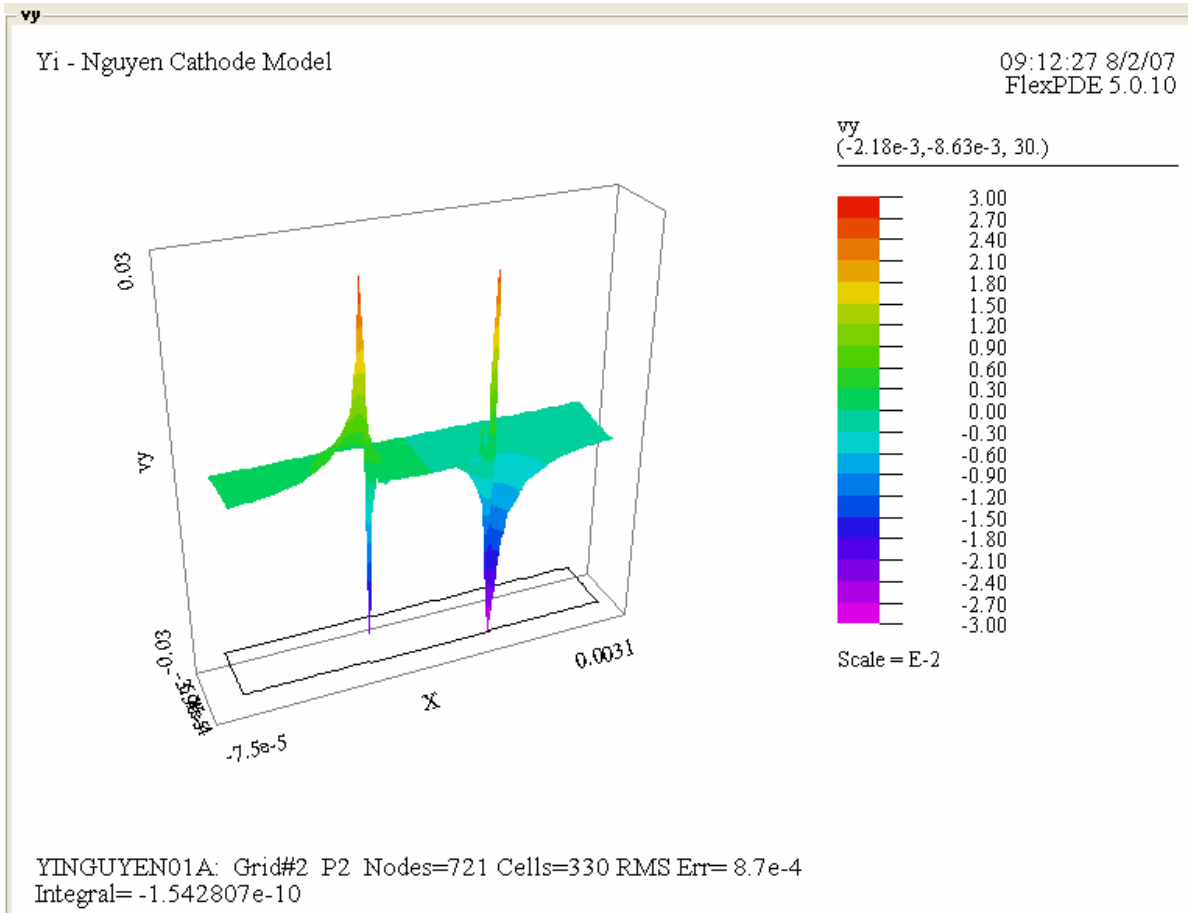
Air and Water Vapor Velocity – Horizontal Direction - Surface Plot

Nelson Research, Inc. 2142 – N. 88th St. Seattle, WA. 98103 USA 206-498-9447 Craigmail @ aol.com



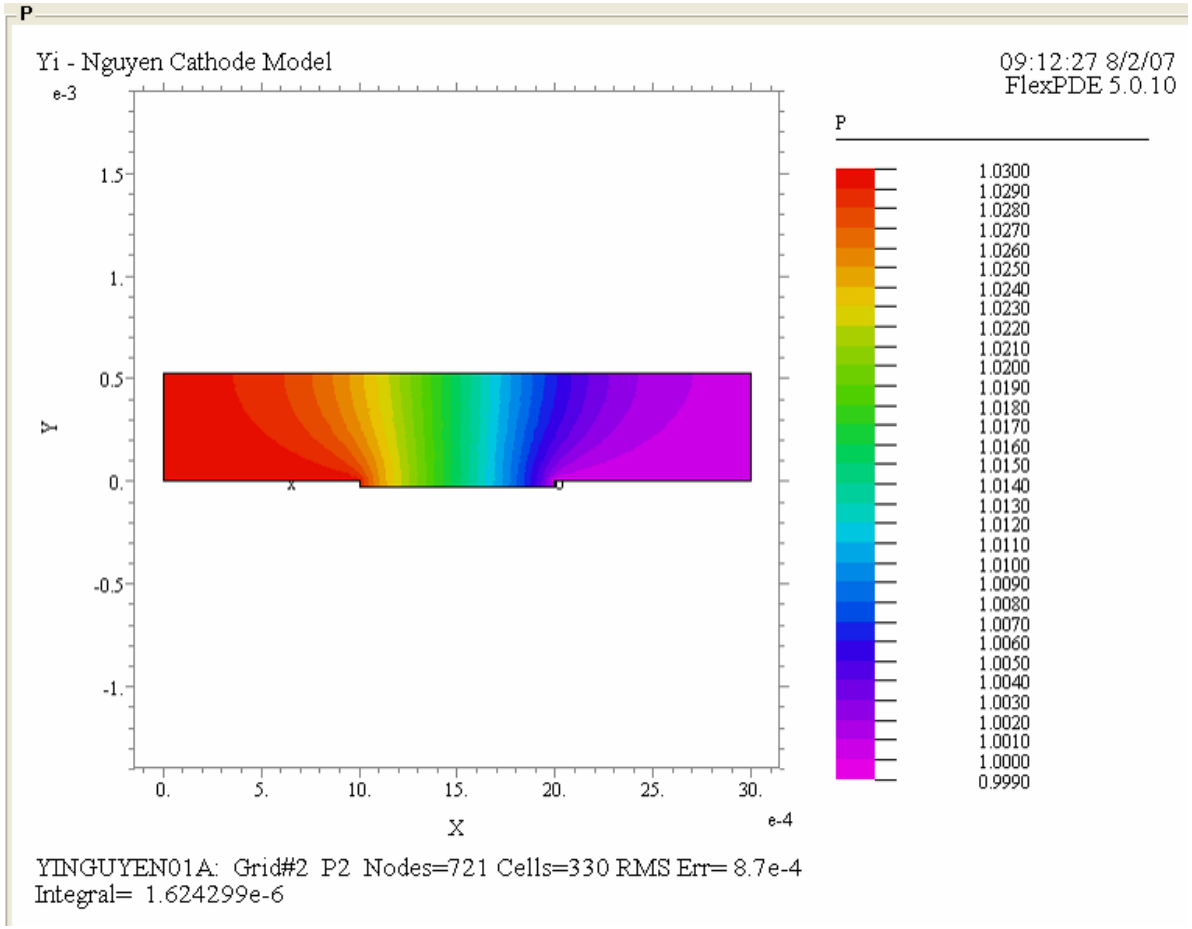
Air and Water Vapor Velocity – Vertical Direction - Contour Plot

Nelson Research, Inc. 2142 – N. 88th St. Seattle, WA. 98103 USA 206-498-9447 Craigmail @ aol.com



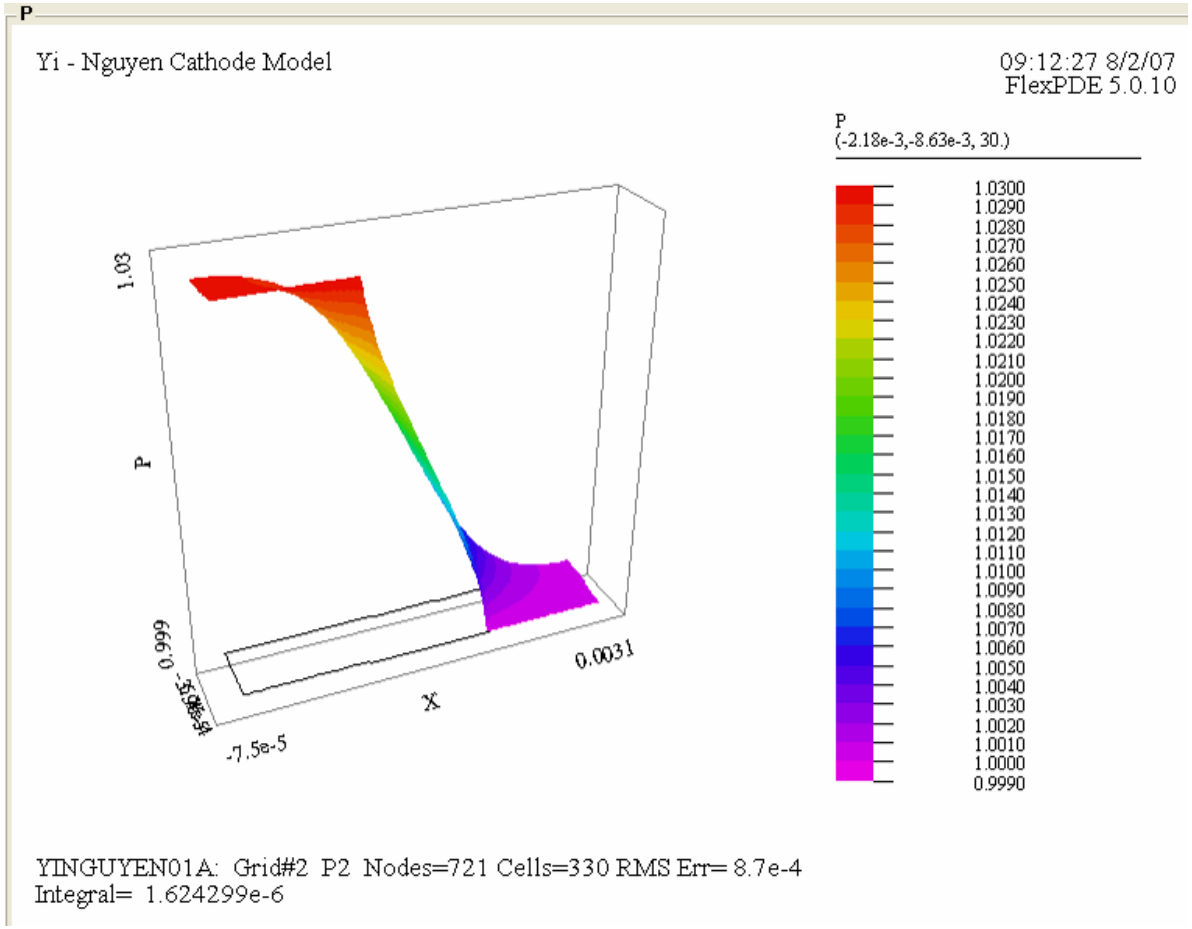
Air and Water Vapor Velocity – Vertical Direction - Surface Plot

Nelson Research, Inc. 2142 – N. 88th St. Seattle, WA. 98103 USA 206-498-9447 Craigmail @ aol.com



Pressure – Contour Plot

Nelson Research, Inc. 2142 – N. 88th St. Seattle, WA. 98103 USA 206-498-9447 Craigmail @ aol.com



Pressure – Contour Plot

Nelson Research, Inc. 2142 – N. 88th St. Seattle, WA. 98103 USA 206-498-9447 Craigmail @ aol.com

Summary and Conclusions

A fuel cell micro “air” cathode has been analyzed by means of the finite element method (FEA).

The results correctly demonstrate the “consumption” of oxygen and the “production” of water within a porous region bounded on one side by a catalytically active layer where heterogeneous chemical reactions occur.

The values produced by the model are essentially identical to those from a similar analysis reported in the literature. Therefore, I can trust my own methods of problem formulation and analysis in this complex “multiphysics” scenario.

Nelson Research, Inc. 2142 – N. 88th St. Seattle, WA. 98103 USA 206-498-9447 Craigmail @ aol.com