Engineering Net Water Balance Through Coupled Heat and Mass Transfer in Polymer Electrolyte Fuel Cells – Coupled Problems 2015

Jake M. LaManna*, and Matthew M. Mench,*, †

* Electrochemical Energy Storage and Conversion Laboratory
Department of Mechanical, Aerospace and Biomedical Engineering, University of Tennessee, Knoxville, TN, USA
e-mail: mmench@utk.edu, web page: http://ecpower.utk.edu

ABSTRACT

Properly engineering the water distribution in low temperature hydrogen polymer electrolyte fuel cells involves a complex combination of transport mechanisms including multi-phase transport in porous media and ion exchange membrane transport. The net drag and distribution of liquid water is often a determining factor in performance, stability and longevity of the system, and is a result of a variety of transport processes that involve a combined heat and mass transport. The motivation of this work is to understand the methods by which we can control the water transport in a PEFC via engineering of the components, operating conditions and architecture. Experimental and numerical models have been developed to measure and predict this, and various pathways for control of water storage and transport will be discussed. In particular, control of the micro and macroporous layer thermal and mass transport resistance, cell architecture, and micro-porous layer|catalyst layer interface will be shown to be capable of manipulating the net water storage and drag coefficient. The work presented will show a global pathway for control of water distribution in polymer electrolyte fuel cells using both thermal and mass transport engineering.