

# PEM FUEL CELL STACK: THERMAL MANAGEMENT

The operation of proton exchange membrane fuel cell (PEMFC) stack requires careful thermal and water management for optimal performance.

## 1. MODEL VALIDATION

A two-phase model accounting for the conservation of mass, momentum, energy, charge, species, a phenomenological membrane and an agglomerate model for catalyst layer, is developed and validated against experimental data, both in terms of local as well as global current density.

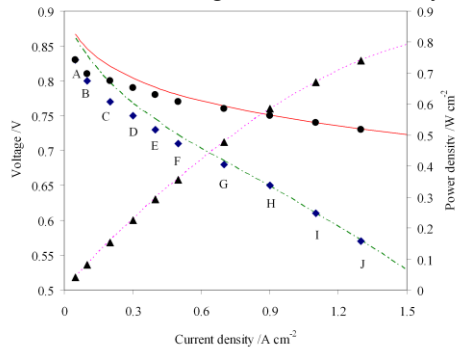


Figure 1: Global validation

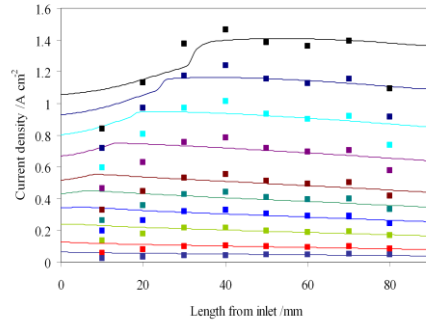


Figure 2: Local validation

## 2. WATER COOLING PEMFC STACK

The validated model is then employed as a building block for stack modeling. Four repetitive computational units are then identified for number of single cells placed in between coolant plates: (a) one cell; (b) two cells; (c) three cells; (d) four cells. The result show that there is strong correlation between stack performance and the placement of the coolant plates

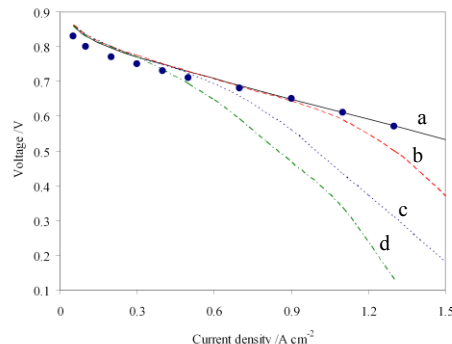
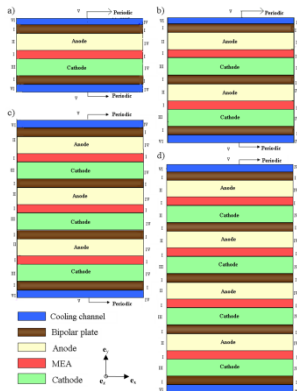


Figure 4: polarization curve for various coolant channel placement

## 3. FORCED CONVECTION AIR COOLING FOR PEMFC STACK

In order to reduced the complexity of the cooling system for PEMFC stack, while maintaining the stack at high performance, forced convection air powered by fans can be used to cool down the stack as well as to feed in air into the cathode. However, it requires careful consideration of the air flow rate at the cathode. Here, we investigate five different fan power: 4.5W; 12.2W; 19.5W; 30W; 60W

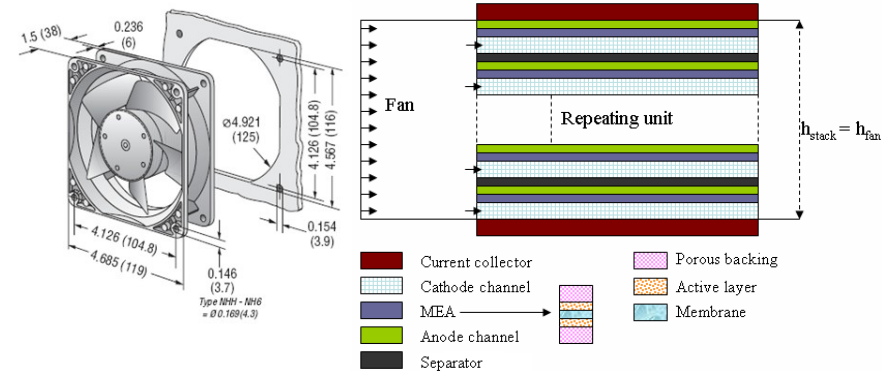


Figure 5: Schematic of PEMFC stack with fan cooling

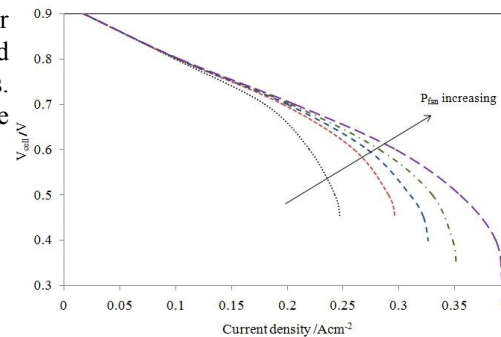


Figure 6: Polarization curve for different fan power

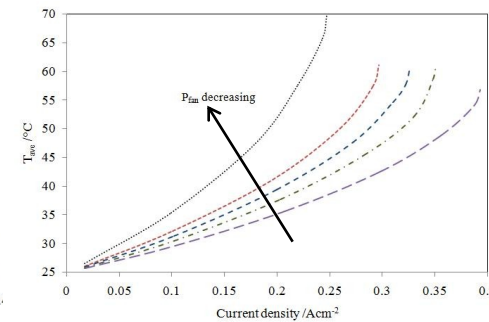


Figure 7: T average for different fan power

Agus Pulung Sasmito, Ph.D. Student, Mechanical Engineering Department, NUS  
 Dr. Erik Birgersson, Assistant Professor, Chemical Bio-molecular Department, NUS  
 Prof. Arun S Mujumdar, Professor, Mechanical Engineering Department & M3TC, NUS  
 Contact: mpeasm@nus.edu.sg

Figure 3: Various coolant channel placement