Modeling of Humidification Using COMSOL Multiphysics®

I. Wadgaonkar[1]

[1]Tata Motors Ltd., Pune, India

Abstract

Humidification is a complex phenomenon including multiphase flow along with heat and mass transfer. Further the presence of discontinuous phase in the form of water droplets poses even greater a challenge.
In the following study COMSOL Multiphysics® was used to simulate evaporation of water droplets in a stream of heated air. This was a precursor to the modeling of a humidifier, which is used to humidify the air supplied to fuel cell stack. Since the percentage of water droplets was relative low, particle tracing method was used for the simulation. Source terms were added to model evaporation of water droplets due to the heat transfer from surrounding air. COMSOL Multiphysics software solves particle tracing in Lagrangian frame and particle variables are solved in Eulerian frame. To remove the limitation on the overall time step of the simulation due to the source term in the energy equation, it was assumed that particle evaporation has no effect on the air temperature. Motion of water droplets in a heated air stream, across a straight channel along with evaporation was modeled and the motion of generated water vapor was tracked. Generated water vapor eventually converged to a parabolic profile as expected for a laminar flow through channel.

Reference

1. Christian Siegel,"Two-Dimensional, Non-Isothermal, Two-Phase Flow inside the Gas Diffusion Layer Unit of the Polymer-Electrolyte-Membrane Fuel Cell", Excerpt from the Proceedings of the COMSOL Users Conference 2006 Frankfurt.

Figures used in the abstract

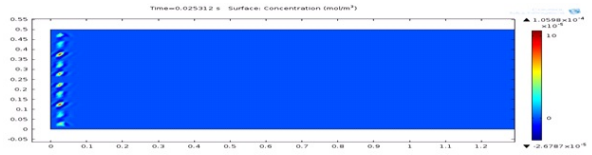

Figure 1: Fig.1: Contours of water vapor with source term for energy equation.

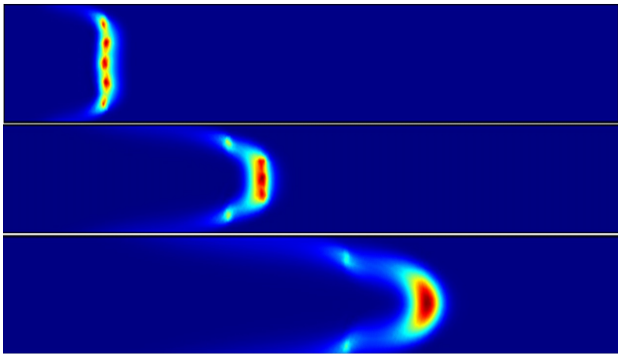

Figure 2: Fig.2: Contours of water vapor neglecting source term for energy equation.