Characterization of MEMS Microchannel Using COMSOL Multiphysics

S. N. Das[1], G. Bose[2]

[1]Centurion University of Technology and Managment, Jatani, Bhubaneswar, Orissa, India
[2]Institute of Technical Education and Research, SOA University, Bhubaneswar, Orissa, India

Abstract

This paper describes the characteristics of MEMS micro channel and various issues of its designing. The major constraints are pressure drop and heat transfer rate as the hydraulic diameter decreases. Various structures are modeled by using multiphysics software and optimized to get a minimum pressure drop and maximum heat transfer rate. The simulation results provides the characterization for Mass flow rate, Temperature, Pressure drop, Reynolds number, Velocity profile of the fluid. Here the material used for designing is silicon and fluid used is water. The dimension of the model we designed is 10mm×8mm×1mm. and the diameters of the channels we are 200μm, 500μm, 1000μm. Using COMSOL Multiphysics the various structures of micro channels are modeled. In this paper we have modeled for cubical channel, circular channel as well as for staggered fin structure channel. Choosing proper boundary conditions for inlet pressure, outlet pressure and temperature, the physical design for different diameters are simulated. The inner profiles in different planes are studied with proper visualization. The result we obtained are for 200μm, 500μm, 1000μm diameter structures by taking cubical cylinder, circular cylinder and staggered fin comes as per our expected result. The results are compared for different structures and diameters. But when the diameter is decreased below 200μm we did not get the desired result which is the limitation of this model. We conclude that the staggered fin structures are optimised in term of pressure drop and heat transfer rate. Figure1, Figure2, Figure3 shows few simulated outputs.

Reference

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[2] Kandlikar, S. G., High Flux Heat Removal with Microchannels – A roadmap of Challenges and Opportunities, Heat Transfer Engineering, vol. 26, no.8, pp. 5- 14, 2005.

[3] Steinke, M. E., and Kandlikar, S. G., Single-phase Heat Transfer Enhancement Techniques in Microchannel and Minichannel Flows, Second International Conference on Microchannels and Minichannels, Rochester, NY, June 17–19, pp. 141–148, 2004.

Figures used in the abstract

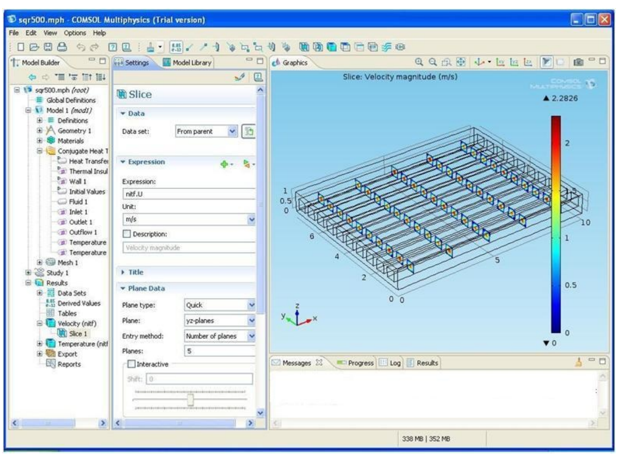

Figure 1: Figure [1] , 3D plot of Velocity variation in 500µm square channel

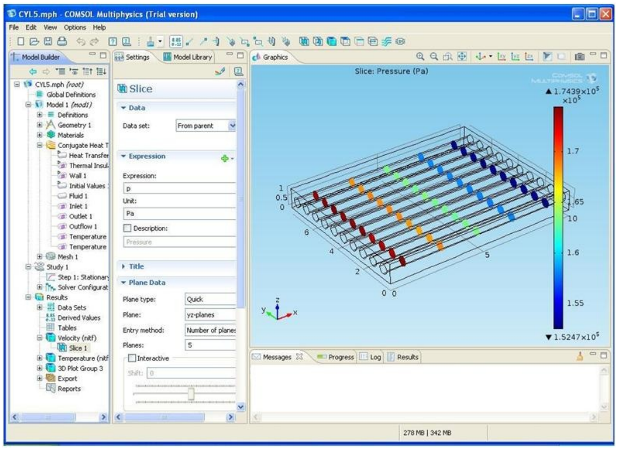

Figure 2: Figure [2] , 3D plot of Pressure magnitude variation in 500μm circular channel

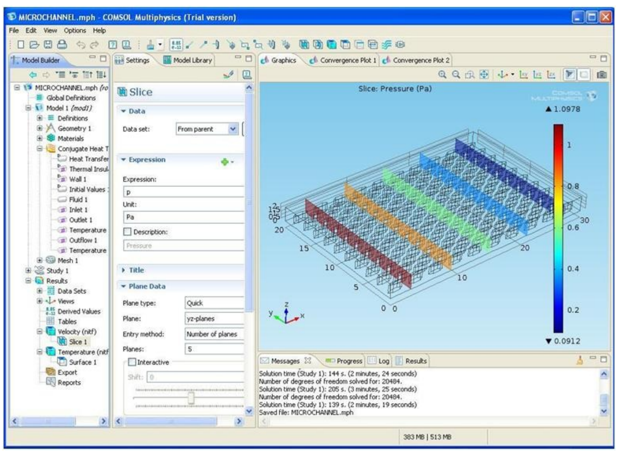

Figure 3: Figure [3], 3D plot of Pressure magnitude variation of staggered fin geometry