Numerical investigation on forced convection in rectangular cross section microchannels with nanofluids

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Heat transfer of fluids is very important to many industrial heating or cooling equipments. Convective heat transfer can be enhanced passively by changing flow geometry, boundary conditions or by enhancing the thermal conductivity of the working fluid. An innovative way of improving the thermal conductivity of base fluids is to introduce suspended small solid nanoparticles. In this paper a numerical investigation on laminar forced convection flow of a water–Al_2O_3 nanofluid in a rectangular microchannel is accomplished. A constant and uniform heat flux on the external surfaces has been applied and a single-phase model approach has been employed. The analysis has been performed in steady state regime for particle size in nanofluids equal to 38 nm.

The CFD commercial code Fluent has been employed in order to solve the 3-D numerical model. The geometrical configuration under consideration consists in a duct with a rectangular shaped crossing area. A steady laminar flow and different nanoparticle volume fractions have been considered. The base fluid is water and nanoparticles are made up of alumina (Al_2O_3). The length the edge and height of the duct are 0.030 m, 1.7 $x10^{-7}$ and 1.1 $x10^{-7}$ m, respectively. Results are presented in terms of temperature and velocity distributions, surface shear stress and heat transfer convective coefficient, Nusselt number and required pumping power profiles. Comparison with results related to the fluid dynamic and thermal behaviors are carried out in order to evaluate the enhancement due to the presence of nanoparticles in terms of volumetric concentration.

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