

Appraising Nanofluid Cooled Microchannel Heat Sink Performance through Thermal Dispersion Model

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Over the last years, with continuous demand from different industrial sectors for astronomical heat flux accommodation, the need for special and innovative cooling techniques seems to be essential. Microchannel heat sink (MCHS) idea attracts a great deal of attention because of its anomalous potential for implementing in industrial application. Nevertheless, the poor thermal conductivity of working fluids is an obstacle for further improvement. As a remedy, using liquids with ultra fine metallic or nonmetallic (nanofluid) particle inclusions was proposed by S.U.S Choi. The aim of present work is to study on appraising MCHS performance, using a thermal dispersion model of nanoparticles and taking into account the impact of liquid nanolayering. Governing equations for fluid flow and heat transfer are based on a well established “porous medium model” and accordingly, the modified Darcy equation for fluid flow and two-equation model for conjugate heat transfer problem are employed. Velocity profile is obtained analytically and for heat transfer problem a combined analytical-numerical approach is used. Heat transfer analysis is based upon thermal dispersion model and the latest proposed model for effective thermal conductivity, which considers nanolayering effect, is integrated into the model. Despite two previous works in the field, interfacial Nusselt number is regarded as a function of only channel aspect ratio as in the case of pure fluid flow in MCHS and the impact of using nanofluid on interfacial heat transfer enhancement is modeled through using equivalent thermal conductivity of nanofluid in thermal dispersion model instead of static thermal conductivity in convective heat transfer coefficient calculation from Nusselt number value. The effects of dispersed particles concentration, thermal dispersion coefficient and Reynolds number are investigated on thermal fields and on thermal performance of a microchannel heat sink. Additionally, the impact of turbulent heat transfer on heat transfer enhancement is studied.