Effect of water based nanofluids on laminar convective heat transfer in developing region of rectangular channel

ABSTRACT

Researches involving mixing very little amount of nano-sized solid additives to base fluid have gained popular interest to develop enhanced convective heat transfer techniques. The dispersion of solid particles in such nanofluids changes the thermo physical properties of the working fluid such as viscosity, thermal conductivity, density and specific heat. Therefore, nanofluids have enhancement potential in heat transfer performance compared to normal working fluids. Additionally, most of the researches regarding heat transfer enhancement by using nanofluids considered circular tube as the geometry conducted on developed region. However, in many industry or heat generated equipment, rectangular channels are generally used as a flow path for fluid flowing to conduct heat transfer application. Therefore, the analysis of heat transfer through the entire section of channel (both developing and developed region) is important to understand flow behavior along with heat transfer performance of the entire section for industrial operation. In this study, convective heat transfer of laminar nanofluids in developing region of a rectangular channel was numerically investigated using finite volume method and single-phase approach with ANSYS Fluent software. Four nanoparticles (Al_2O_3, CuO, SiC and TiO_2) with different volume fraction (1% - 5%) were used to mix with water to produce water based nanofluids. The heat transfer was analysed for a constant Reynolds numbers 700 with a constant heat flux 500 W/m2 applied on the channel wall. Results demonstrated 2% to 13.38% enhancement in heat transfer coefficient with the presence of 1 to 5% nanoparticles concentration, respectively, in comparison to pure water. Meanwhile, results in terms of Nusselt number showed an increase of 1.5% to 13.36% as compared to pure water for the same range of nanoparticles concentration, respectively. From these results, it can be deduced that higher nanoparticles volume fraction results in higher heat transfer coefficient and Nusselt number. Moreover, CuO-water nanofluid provides the highest enhancement in terms of both heat transfer coefficient and Nusselt number while Al2O3-water nanofluid provides lowest enhancement in terms of both heat transfer coefficient and Nusselt number among all nanofluids considered in this study. From this study, it can be concluded that water-based nanofluids provide enhancement of heat transfer coefficient and Nusselt number for laminar developing region of a rectangular channel.

Keyword: Nanofluids; Nusselt number; Heat transfer coefficient; Developing region