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Study of Laminar Convective Heat Transfer, Friction Factor, and Pumping Power Advantage of Aluminum Oxide-Water Nanofluid through a Channel

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Abstract : The numerical and simulative analysis of laminar heat exchange convection of aluminum oxide (Al_2O_3) - water nanofluid for the developed region through two parallel plates is presented in this present work. The second order single phase energy equation, mass and momentum equation are solved by using finite volume method with the ANSYS FLUENT 16 software. The distance between two parallel plates is 4 mm and length is 600 mm. Aluminum oxide (Al_2O_3) is used as nanoparticle and water is used as the base/working fluid for the investigation. At the time of simulation 1% to 5% volume concentrations of the Al_2O_3 nanoparticles are used for mixing with water to produce nanofluid and a wide range of interval of Reynolds number from 500 to 1100 at constant heat flux 500 W/m^2 at the channel wall has also been introduced. The result reveals that for increasing the Reynolds number the Nusselt number and heat transfer coefficient are increased linearly and friction factor decreased linearly in the developed region for both water and Al_2O_3-H_2O nanofluid. By increasing the volume fraction of Al_2O_3-H_2O nanofluid from 1% to 5% the value of Nusselt number increased rapidly from 0.7 to 7.32%, heat transfer coefficient increased 7.14% to 31.5% and friction factor increased very little from 0.1% to 4% for constant Reynolds number compared to pure water. At constant heat transfer coefficient 700 W/m2-K the pumping power advantages have been achieved 20% for 1% volume concentration and 62% for 3% volume concentration of nanofluid compared to pure water.

Keywords : convective heat transfer, pumping power, constant heat flux, nanofluid, nanoparticles, volume concentration, thermal conductivity
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