Abstract

In this paper, laminar developing forced convection flow of a non-Newtonian nanofluid inside a circular tube, subjected to a constant heat flux at the wall, is analytically and numerically investigated. The nanofluid is composed of CuO nanoparticles and the non-Newtonian base fluid of 0.5 wt % aqueous solution of Carboxymethyl Cellulose (CMC). By taking into account the effect of viscous dissipation, a methodology based on a variational Ritz approach combined with Laplace transform technique is presented for a non-Newtonian fluid described by the power-law model. The effects of Brinkman numbers (*Br*), power low index (*n*) and nanoparticle concentrations (φ) on the developing temperature fields and the local Nusselt number were examined. The exact solution obtained was validated with the results obtained numerically by the Control Volume Method and with the particular cases of conventional fluids ($\varphi = 0$) and non-viscous dissipation effect ($Br = 0$) available in literature. The results obtained are given graphically in term of Nusselt number showing the effects of Brinkman, Peclet number, nanoparticles concentration (φ) and power low index (*n*). It is shown that in the fully developed region, Nusselt number has a fixed asymptotic value depending of *Br* number. At a fixed Brinckman number, the asymptotic Nusselt number increases substantially as the flow index decreases. Besides, it is seen that the incrusting of nanoparticle concentration has a positive effect on heat transfer that the Nusselt number distributions are enhanced by increasing the volume fraction of CuO due to the augmentation of thermal conductivity of the resulting fluid and an asymptotic value is independent of Peclet number.