Non-isobaric Marangoni boundary layer flow for Cu, Al2O3, and TiO2 nanoparticles in a water based fluid.

ABSTRACT

In this paper, a non-isobaric Marangoni boundary layer flow that can be formed along the interface of immiscible nanofluids in surface driven flows due to an imposed temperature gradient, is considered. The solution is determined using a similarity solution for both the momentum and energy equations and assuming developing boundary layer flow along the interface of the immiscible nanofluids. The resulting system of nonlinear ordinary differential equations is solved numerically using the shooting method along with the Runge-Kutta-Fehlberg method. Numerical results are obtained for the interface velocity, the surface temperature gradient as well as the velocity and temperature profiles for some values of the governing parameters, namely the nanoparticle volume fraction φ ($0 \leq \varphi \leq 0.2$) and the constant exponent β. Three different types of nanoparticles, namely Cu, Al2O3 and TiO2 are considered by using water-based fluid with Prandtl number Pr = 6.2. It was found that nanoparticles with low thermal conductivity, TiO2, have better enhancement on heat transfer compared to Al2O3 and Cu. The results also indicate that dual solutions exist when $\beta < 0.5$. The paper complements also the work by Golia and Viviani (Meccanica 21:200–204, 1986) concerning the dual solutions in the case of adverse pressure gradient.

Keyword: Marangoni convection; Boundary layer; Nanofluid; Dual solutions; Numerical solutions.