UNIVERSITI TEKNOLOGI MARA

TECHNICAL REPORT

NUMERICAL STUDY OF MIXED CONVECTION FLOW OF A NANOFLUID WITH SORET AND DUFOUR EFFECTS OVER A PERMEABLE STRETCHING SHEET

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IN THE NAME OF ALLAH, THE MOST GRACIOUS, THE MOST MERCIFUL

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ABSTRACT

The problem of mixed convection flow of a nanofluid over a permeable stretching has been studied by many researchers. The Buongiorno model has been employed in much research before. The effects of Soret and Dufour on mixed convection flow of a nanofluid over a permeable stretching sheet is studied numerically by developing Tiwari and Das (2007) model to examine the behaviour of nanofluid. Two different types of nanoparticles, copper, and alumina are used in this study while the base fluid is water. Firstly, the governing steady boundary layer equations are developed. The thermal expansion coefficient of nanofluid by Oztop and Abu-Nada (2008) and the effective thermal conductivity of the nanofluid by Ho et al. (2010) is employed. Next, the governing equations are transformed into non-linear ordinary differential equations by using similarity transformation method. The similarity variables which are stream function ψ, dimensionless distance normal to the surface η, dimensionless temperature $\theta(\eta)$and dimensionless concentration $\phi(\eta)$ are introduced. Then, the ordinary differential equations are transformed into a BVP4C function in MATLAB by using finite difference method to obtain numerical solutions. Besides, the shear stress, heat flux and mass flux from the surface of the sheet are derived. Several physical parameters such as mixed convection parameter, stretching or shrinking parameter, Brownian motion parameter, Lewis number and Prandtl number are analysed and discussed in term of their effects on the skin friction coefficient, heat and mass transfer rates at the surface as well as the velocity, temperature, and concentration profiles. Results for the skin friction coefficient, surface temperature gradient, dimensionless concentration gradient and velocity profiles are presented graphically. Besides, the numerical values of surface temperature gradient with some values of Prandtl number are compared with few papers which are Grubka and Bobba (1985), Ishak et al. (2006) and Yacob et al. (2013) and it shows a good agreement. The study proves that the dual solutions exist for different values of Soret number and Dufour number. The surface temperature gradient is shown to increase for both Alumina and Cuprum nanoparticles when the Soret number increases while the Dufour number decreases. However, the skin friction coefficient and dimensionless concentration of Alumina and Cuprum are decreasing.