Accepted Manuscript

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PII: S0997-7546(18)30056-6
DOI: https://doi.org/10.1016/j.euromechflu.2018.04.005
Reference: EJMFLU 3286

To appear in: *European Journal of Mechanics / B Fluids*

Received date : 23 January 2018
Revised date : 6 April 2018
Accepted date : 6 April 2018

Chemical reaction and Newtonian heating effects on steady convection flow of a micropolar fluid with second order slip at the boundary

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Abstract

In this paper, asymptotic analysis of the chemical reaction and the Newtonian heating parameters is carried out. A mathematical model of a convective micropolar fluid flow over a permeable stretching/shrinking sheet is taken into account in the presence of the slip flow regime. A nonlinear system of transformed equations is solved by a semi-analytical technique called Homotopy Analysis Method (HAM). The current investigation is in a good agreement with the already published analytical and the numerical results with the help of tabular and graphical representations. In comparison with the stretching sheet, it is observed that the shrinking sheet produces a wider concentration boundary layer thickness by a small change in the chemical reaction parameter. In contrast to the stretching sheet, the Newtonian heating parameter raises the thermal boundary layer thickness by 39.93% for the shrinking sheet. The chemical reaction with the Newtonian heating effect is an important consideration in the solidification process of the liquid crystals and the polymeric suspensions.

Keywords: micropolar fluid; stretching/shrinking sheet; slip flow condition; Newtonian heating; chemical reaction

Nomenclature

- A constant coefficient for mean free path, m
- B square of constant coefficient for mean free path, m^2
- c_p specific heat at constant pressure, $JK^{-1}Kg^{-1}$
- C_f local skin friction coefficient
- C concentration of the species
- C_m dimensionless Chemical reaction parameter
- D_m mass diffusivity
- d mean free path, m
- f dimensionless velocity
- f_w dimensionless suction/injuction parameter
- g gravitational acceleration, ms^{-2}
- Gr_x dimensionless local Grashof number
- h_s surface heat transfer coefficient, $Wm^{-2}K^{-1}$
- h dimensionless micro rotational velocity
- j microinertia per unit mass,
- K dimensionless material parameter
- ξ first order homogeneous constant reaction rate
- k thermal conductivity, $Wm^{-1}K^{-1}$
- k_n Knudsen number

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