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Chemical reaction and variable viscosity effects on flow and mass transfer of a non-Newtonian visco-elastic fluid past a stretching surface embedded in a porous medium

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Abstract This work deals with the study of the boundary layer flow and mass transfer of a visco-elastic fluid immersed in a porous medium over a stretching surface in the presence of surface slip, chemical reaction and variable viscosity. The partial differential equations governing the flow have been transformed by similarity transformation into a system of coupled nonlinear ordinary differential equations which is solved numerically by means of the fourth order Runge-Kutta integration scheme coupled with the shooting technique. The effects of various involved interesting parameters on the velocity fields and concentration fields are shown graphically and investigated. In addition, tabulated results for the local skin-friction coefficient and the local Sherwood number are presented and discussed.

Keywords Visco-elastic fluid · Slip velocity · Variable viscosity · Porous medium · Chemically reactive species

1 Introduction

In recent years, the study of the boundary layer flow of viscoelastic fluid over a stretching surface has gained considerable interest because of its extensive industrial applications in the manufactures of foods, glass-fiber and paper production, cooling of metallic sheets or electronic chips, the aerodynamic of extrusion of plastic sheets, the boundary layer along a liquid film in condension processes and many others. Rajagopal et al. [1] examined the boundary layer flow of visco-elastic fluid over a stretching sheet. Siddappa and Abel [2] investigated the problem of a visco-elastic fluid flow over a stretching sheet. Boundary layer flow and heat transfer of visco-elastic fluid over a permeable stretching sheet has been studied by Siddappa and Abel [3]. Bujurke et al. [4] studied second-order fluid flow past a stretching sheet with heat transfer. Flow and heat transfer in a visco-elastic fluid flow over a stretching sheet has been studied by Dandapat and Gupta [5]. Rollins and Vajravelu [6] investigated second-order fluid over a stretching surface with internal heat generation or absorption. Lawrence and Rao [7] examined the problem of heat transfer in the visco-elastic fluid flow over a stretching sheet. Soundalgekar and Murty [8] analyzed heat transfer characteristic of an elastico-viscous fluid past a semi-infinite plate with variable temperature. Bhatnagar et al. [9] studied flow of an Oldroyed-B fluid over a stretching sheet in the presence of a free stream velocity. Pontrelli [10] studied the steady boundary layer flow of a homogeneous incompressible fluid of second-grade over a stretching sheet numerically by a collection method. Vajravelu and Roper [11] investigated the flow and heat transfer characteristic in

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