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Heat and Mass Transfer in Stagnation-Point Flow Towards a Vertical Stretching Sheet Embedded in a Porous Medium with Variable Fluid Properties and Surface Slip Velocity

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The purpose of this study is to examine the effects of variable fluid properties on heat and mass transfer in stagnation-point flow towards a vertical stretching sheet immersed in a highly porous medium in the presence of surface slip. The governing conservation equations of mass, momentum, energy, and mass diffusion are converted into a system of nonlinear ordinary differential equations using similarity transformation. This system is solved numerically using the Chebyshev spectral method. The effects of the stretching parameter, the slip parameter, the porosity parameter, the viscosity parameter, and the thermal conductivity parameter on the velocity, temperature, and concentration profiles are discussed in detail. Also, the numerical values of the local skin-friction coefficient, the local Nusselt number, and the local Sherwood number are illustrated in tabular form and discussed for both cases of assisting and opposing flows.

Keywords Heat and mass transfer; Porous medium; Slip velocity; Stagnation point; Variable viscosity; Variable thermal conductivity

Introduction

In recent years, the study of mixed convection heat and mass transfer over a vertical surface immersed in porous media has attracted considerable attention several researchers in view of its important applications in engineering processes such as enhanced oil recovery, packed bed reactors, thermal energy storage, casting and welding in manufacturing processing, cooling of nuclear reactors, from ultrafiltration. Comprehensive reviews concerning the subject of porous media can be found in the books by Ingham and Pop (2001), Pop and Ingham (2005), and Nield and Bejan (2006).

The problem of boundary layer flow and heat and mass transfer over a stretching surface is important in many industrial applications such as paper production, hot rolling and wire drawing, glass blowing, continuous casting, spinning of fibers, aerodynamic extrusion of plastic sheets, metal spinning, and drawing plastic films. Crane (1970) studied the boundary layer flow over a linearly stretched surface.

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