Effects of variable properties on MHD heat and mass transfer flow near a stagnation point towards a stretching sheet in porous medium with thermal radiation.

Abd-El Aziz M. Salem

Abstract.

The effect of variable viscosity and thermal conductivity on steady magnetohydrodynamic heat and mass transfer flow of viscous and incompressible fluid near a stagnation point towards a permeable stretching sheet embedded in a porous medium are presented here, taking into account thermal radiation and internal heat genberation/absorbtion. The stretching velocity and the ambient fluid velocity are assumed to vary linearly with the distance from the stagnation point. The Rosseland approximation is used to describe the radiative heat flux in the energy equation. The governing fundamental equations are first transformed into a system of ordinary differential equations using a scaling group of transformations and are solved numerically by using the fourth-order Rung-Kutta method with shooting technique. A comparison with previously published work has been carried out and the results found to be in good agreement. The results are analyzed for the effect of different physical parameters, such as variable viscosity and thermal conductivity parameter, the ratio of free stream velocity and stretching velocity parameter, the magnetic field parameter, porosity parameter, radiation parameter, magnetic field parameter and suction/injection parameter on the flow, heat and mass transfer characteristics. The results indicate that the inclusion of variable viscosity and thermal conductivity into the fluids with light and medium molecular weight is cable to change the boundary-layer behavior for all the values of the velocity ratio parameter λ except $\lambda = 1$. Also, the imposition of fluid suction is to increase both the rate of heat and mass transfer, whereas fluid injection shows the opposite effects.

Keywords: *Variable properties; MHD heat and mass transfer; Stagnation point towards*
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Emerald Article: On the effectiveness of variable properties and thermophoresis on steadyMHD heat and mass transfer over a porous flat surface

Abdel Aziz Salem

Abstract.

In this article, we studied the influence of thermophoresis on an steady two-dimensional, laminar, hydromagnetic flow with heat and mass transfer over a semi-infinite, permeable flat surface in the presence of viscous dissipation and thermal radiation. The fluid viscosity and thermal conductivity are assumed to vary as a function of temperature. The boundary layer equations are transformed to non-linear ordinary differential equations using scaling group of transformations and these equations are solved numerically by using the fourth order Runge-Kutta method with shooting technique for some values of physical parameters. Comparisons with previously published work are performed and the results are found to be in very good agreement. Many results are obtained and a representative set is displayed graphically to illustrate the influence of the various parameters on the dimensionless velocity, temperature and concentration profiles as well as the local skin-friction coefficient, wall heat transfer, particle deposition rate and wall thermophoretic deposition velocity. The results show that the particle deposition rates were strongly influenced by Hartmann number and radiation parameter, particularly for the fluid with variable viscosity inside the boundary layer. The results also show that the skin-friction coefficient, wall heat transfer and particle deposition rate are higher for the fluids of constant viscosity than those of variable viscosity.

Keywords: *Variable properties ; Thermophoresis; MHD heat and mass transfer ; Porous plate*

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Effect of variable viscosity and suction/injection on thermal boundary layer of a non-Newtonian-power law fluids past a power-law stretching surface

Abdel Aziz Salem

Abstract

The analysis of laminar boundary layer flow and heat transfer of non-Newtonian fluids over a continuous stretched surface with suction or injection has been presented. The velocity and temperature of the sheet were assumed to vary in a power-law form, that is, $u = U_0 x^m$ and $T_w(x) = T_\infty + Cx^b$. The viscosity of the fluid is assumed to be inverse linear function of temperature. The resulting governing boundary-layer equations are highly non-linear and coupled form of partial differential equations and they have been solved numerically by using the Runge-Kutta method and Shooting technique. Velocity and temperature distributions as well as the Nusselt number where studied for two thermal boundary conditions: uniform surface temperature (b=0) and cooled surface temperature (b=-1), for different parameters; variable viscosity parameter θ_r, temperature exponent b, blowing parameter d and Prandtl number Pr. The obtained results show that the flow and heat transfer characteristics are significantly influenced by these parameters.

Keywords: *Variable viscosity; Non-Newtonian power-law fluids; Power law stretching sheet*

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Effect of Thermal Radiation on MHD Mixed Convective Heat Transfer Adjacent to a Vertical Continuously Stretching Sheet in the Presence of Variable Viscosity

A. M. Salem* and Rania Fathy

Department of Mathematics, Faculty of Science, Zagazig University, Egypt.

Abstract

An analysis is presented to study the combined free-forced convective laminar boundary layer flow adjacent to a vertical continuously stretching sheet in the presence of a magnetic field with variable viscosity and thermal radiation. The velocity and the temperature of the sheet were assumed to vary in a power law form, that is, $u_w = Bx^m$ and $T_w(x) - T_\infty = Ax^n$. The governing equations for the problem were changed to dimensionless ordinary differential equations by using a similarity transformation. The transformed governing equations in the present study were solved numerically by using the Runge-Kutta and Shooting method. A comparison between the analytical and the numerical solutions has been included.. The effects of the variable viscosity parameter θ_r, the mixed convection parameter $G^* = \frac{Gr_x}{Re_x^2}$, the radiation parameter N and the magnetic field parameter M are discussed through graphs. Graphical results illustrating interesting features of the physics of the problem are presented and discussed.

Keywords: *Boundary layer heat low, Thermal radiation, Forced convection, Magnetohydrodynamics*

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Non-Darcy Free Convection Flow Past a Wedge with Variable Viscosity

A. M. Salem

Abstract

An analysis is presented to investigate the effect of temperature-dependent viscosity on free convection flow along a vertical wedge adjacent to a porous medium in the presence of heat generation or absorption. The governing fundamental equations are transformed into the system of ordinary differential equations using scaling group of transformations and are solved numerically by using the fifth-order Rung–Kutta method with shooting technique for various values of the physical parameters. The effects of variable viscosity parameter on the velocity, temperature and concentration are discussed. Numerical results for the problem considered are given and illustrated graphically.

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Further results on the variable viscosity with magnetic field on flow and heat transfer to a continuous moving flat plate

A. **M. Salem**

Abstract

The steady, laminar-boundary-layer flow along an isothermal, continuously moving, flat plate is studied taking into account the variation of viscosity with temperature in the presence of a magnetic field. The fluid viscosity is assumed to vary as a linear function of temperature. The resulting, governing equations are non-dimensionalized and are transformed using a similarity transformation and then solved numerically by the shooting method. Comparison with previously published work is performed and full agreement is obtained. A parametric study of all parameters involved is conducted, and a representative set of numerical results for the velocity and temperature profiles as well as the skin-friction parameter and the Nusselt number is illustrated graphically to show typical trends of the solutions. It is worth pointing out that, when the variation of viscosity with temperature is strong in the presence of the effect of a magnetic field, the results of the present work are completely different from those that studied the same problem in the absence of magnetic field.

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Laminar Mixed Convection Adjacent to Vertical Continuously Stretching Sheets With Variable Viscosity and Variable Thermal Diffusivity

A. M. Salem

Abstract

The paper presents a study of the laminar mixed convection adjacent to vertical continuously stretching sheets, taking into account the effects of variable viscosity and variable thermal diffusivity. The similarity solutions are reported for isothermal sheet moving with a velocity of the form $u_w = BX^{0.5}$ and a continuous linearly stretching sheet with a linear surface temperature distribution. The equations of conservation of mass, momentum and energy, which govern the flow and heat transfer, are solved numerically by using the shooting method. The numerical results obtained for the flow and heat transfer characteristics reveal many interesting behaviors. The numerical results show that, variable viscosity, variable thermal diffusivity, the velocity exponent parameter, the temperature exponent parameter and the buoyancy force parameter have significant influences on the velocity and temperature profiles, shear stress and Nusselt number in two cases air and water.

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