UNSTEADY COMPRESSIBLE FLOW ABOUT A STAGNATION POINTON A STRETCHING SHEET

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Extended Abstract

Research Aim

The aim of this work is to analyze the unsteady two dimensional flow of a viscous compressible fluid about a stagnation point on a stretching sheet in the presence of time dependent free stream. The effect of the governing parameters on velocity and temperature distributions is discussed. The computed results are compared with previous reported works.

Literature survey

The behavior of boundary layer flow near the moving surface interests many researchers for the past few decades because of its occurrence in several engineering processes. The various aspects of the problem were investigated after the pioneering work by Sakiadis. An extension to this problem was that of a stretching sheet whose velocity is proportional to the distance from the slit which was considered by Crane[1].Several authors[2]-[8] have considered the various aspects of this problem and have made an analysis especially with regard to the temperature and velocity profiles.Subhasini and Nath [9] have shown that a self similar solution is possible when free stream velocity varies inversely with time.

Formulation of the problem

Let us consider an unsteady viscous compressible two dimensional flow near stagnation point on a stretching sheet in the presence of time dependent free stream. Let the temperature of stretching sheet be T_w, velocity $u_w(x,t)$ and free stream velocity is U(x ,t).Let the stretching sheet be placed in the plane y=0.Let us assume the x-axis along the stretching sheet and let u and v be velocity components along x and y axes respectively.

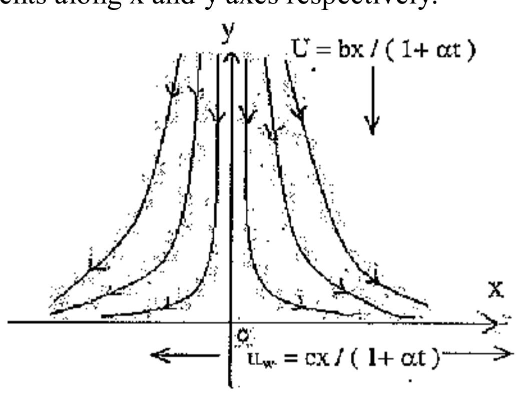

Fig 1. Physical model.

Neglecting the viscous dissipation term the governing equations are

Continuity: $\frac{\partial \rho}{\partial t} + \rho\left[\frac{\partial u}{\partial x} + \frac{\partial v}{\partial y}\right] = 0$

Momentum: $\rho\left[\frac{\partial u}{\partial t} + u\frac{\partial u}{\partial x} + v\frac{\partial u}{\partial y}\right] = \rho_e\left[\frac{\partial U}{\partial t} + U\frac{\partial U}{\partial x}\right] + \mu\frac{\partial^2 u}{\partial y^2}$

Energy: $\rho c_p\left[\frac{\partial T}{\partial t} + u\frac{\partial T}{\partial x} + v\frac{\partial T}{\partial y}\right] = \frac{\partial}{\partial y}\left(\lambda\frac{\partial T}{\partial y}\right) + \beta T\left(\frac{\partial p}{\partial t} + u\frac{\partial p}{\partial x}\right) + \mu\left(\frac{\partial u}{\partial y}\right)^2$

The boundary conditions are

$$y = 0, u = u_w(x,t) = \frac{cx}{1+\alpha t}, v = 0, T = T_w$$

$$y = \infty, u = U(x,t) = \frac{bx}{1+\alpha t}, T = T_\infty$$

where b, c are positive consants and α is also a consant.

Solution Methodology

The Governing equations of motion and energy are transformed into non-linear differential equations using a suitable similarity transformation. The reduced non –linear equations are solved using implicit finite difference scheme in combination with quasilinearisation technique. The difference equations were then reduced to a system of linear algebraic equations with tridiagonal structure, which is solved using Thomas algorithm.

Conclusion

The velocity and temperature profiles for different parameters were considered and the results were compared with results of P.R.Sharma's [5].Nusselt number and skin friction coefficient is also calculated for different parameters and the analysis is made.

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