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Analysis of Hydro Magnetic Flow of Visco Elastic Fluid in a Vertical Channel

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ABSTRACT

In the present paper we have Analysis of hydro magnetic flow of visco elastic fluid. Hydro magnetic visco elastic fluid flow between two horizontal infinite parallel porous plates with time varying sinusoidal pressure gradient and magnetic field has been discussed in the present study. The visco elasticity in an effective approach to modeling the dissipative mechanism. Some interesting observations are low-frequency oscillating pressure gradient Prevents back flow, significant reduction in skin frictions is observed by embedding the channel in porous medium and magnetic field and elasticity decelerate the fluid flow and also in this paper a Theoretical Analysis is carried out of study the visco elastic effects on hydro magnetic heat & mass transfer in a vertical channel. The two vertical plates are in porous medium and non-uniform wall temperatures. A magnetic field of uniform strength is applied in the direction perpendicular to the plates.

The visco elastic fluid flow is characterized by second order fluid. The effects of different flow parameters on skin friction are analyzed and illustrated graphically.

Keywords : Visco Elastic, Skin-Frication, Heat & Mass Transfer Oscillatory Flow

I. INTRODUCTION

Sugunammaet. al. [8] has analysed a fully developed free convective flow through a porous medium in a vertical channel using brink man's model taking into account of both viscous &darcy dissipation using finite element method and some parameters of viscous flow e.g. velocity temperature &nuselt numbers are calculated and the phenomenon of oscillatory flow along with heat and mass transfer of a conducting fluid has attracted the attention of many researchers due to its importance in many areas such as biological and industrial processes. Jain Purushuttam& Singh [2] considered heat transfer in free convection flow of a viscous in compressible fluid through a vertical channel bounded by a naturally permeable material using Brinkman model & obtained important factors of fluid flow. Agarwal& Kishore [1] studied thermal mass diffusion of M.H.D. natural convection flow between infinite vertical moving & osculating porous parallel plates, here we are interested in considering buoyancy effects of thermal & mass diffusion on elastics viscous fluids under magneto hydro dynamic effect confined between two vertical parallel plates moving in opposite direction. One plate is excluding osculation about a constant mean. Here we obtained terms of velocity, skin fraction etc.

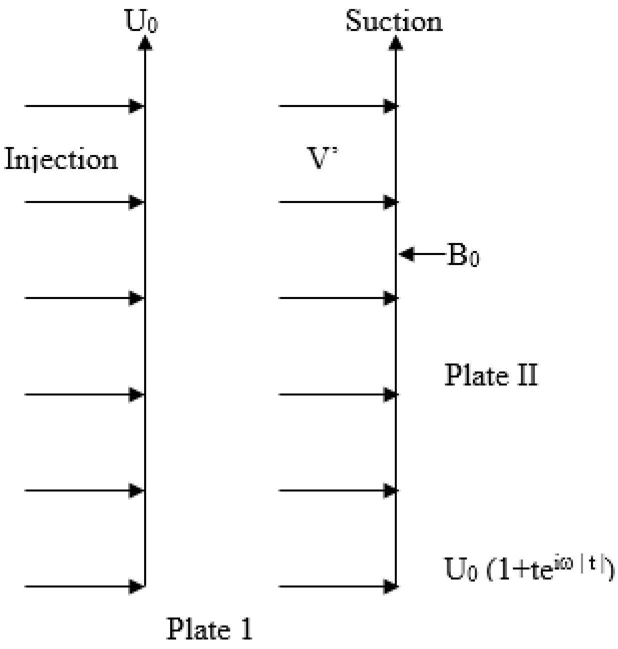
In this study, an attempt has been made to extend the problem studied by Kumari et.al. [23] to the case of visco-elastic fluid characterized by second order fluid. The constitutive equation for the incompressible second-order fluid is of the form.

$$\sigma = - PI + \mu_1 A_1 + \mu_2 A_2 + \mu_3 (A_1)^2$$

Where, σ is the stress tensor. A_n(n = 1, 2, 3) are the Kinematics Rivlin - Ericlcsen tensor; μ_1, μ_2,μ_3 are the material coefficients describing the visco-elasticity and cross viscosity respectively.

II. MATHEMATICAL FORMATION

Here we consider two Dimensional flows of an incompressible viscous fluid between two Porous parallel plate moving in opposites direction. Let X' axis chosen along an infinite flate plate moving vertically upwards & Y' axis normal to it, B_0 is constant magnetic field in transverse direction. So that induced magnetic field is negligible.



III. MATHEMATICAL SOLUTION

The governing equations are as follows [1] & [6]:

3.1 a) $\frac{\partial u^{|}}{\partial t^{|}} + \nu^{|}\frac{\partial u^{|}}{\partial y^{|}} = g\,\beta^{|}\,(T^{|} - TS^{|}) + g\,\beta^{|}\,(C^{|} - C^{|}_{S}) + \nu\frac{\partial^2 u^{|}}{\partial Y^{|2}} - \frac{\sigma B_0^2 u^{|}}{\rho^{|}} - \frac{SV^2}{4V_0^2}\left(\frac{\partial^3 u^{|}}{\partial Y^{|2}\,\partial t^{|}} - \frac{V_0}{V}\frac{\partial^2 u^{|}}{\partial Y^{|2}}\right)$

b) $\frac{\partial V^{|}}{\partial t^{|}} = - \frac{\partial P^{|}}{\partial Y^{|}}$

c) $\frac{\partial T^{|}}{\partial t^{|}} + \nu^{|}\frac{\partial T^{|}}{\partial y^{|}} = \frac{K}{\rho^{|} Cp^{|}}\frac{\partial^2 T}{\partial y^{|2}}$

d) $\frac{\partial c^{|}}{\partial t^{|}} + \nu^{|}\frac{\partial c|}{\partial y^{|}} = D\,\frac{\partial^2 c^{|}}{\partial y^{|2}}$

e) $\frac{\partial V^{|}}{\partial y^{|}} = 0$

The Boundary conditions are:

3.2 a) $u^{|} = U_0$, $\nu^{|} = \nu^{|}$, $T^{|} = T^{|}_{\omega}$, $C^{|} = C^{|}_{\omega}$ at $y^{|} = 0$

b) $u = - U(t) = -U_0 (1+ t\, e^{i\omega|t|})$, $\nu^1 = \nu^1$

c) $T^{|} = T^{|}_{s}$, $C^{|} = C^{|}_{s}$ at $y^{|} = d$

Here the prime densities dimensional quantities &t is a very small perturbation parameter.

The continuity equation gives.

3.3 $\nu^{|} = \nu_0$

Introducing non dimensional quantities defined as follows:

$\eta = \frac{y^{|}\nu_0}{\nu}$, $m = \frac{d\nu_0}{\nu}$, $t = \frac{\nu_0^2 t^{|}}{4\nu}$

$\omega = \frac{4\nu\omega^{|}}{\nu_0^2}$, $u = \frac{u^{|}}{U_0}$, $\nu = \frac{\nu^{|}}{\nu_0}$,

$\theta = \frac{T^{|} - T^{|}s}{T^{|}\omega - T^{1}s}$, $\theta^* = \frac{C^{|} - C^{|}s}{C^{|}\omega - C^{|}s}$, $P_r = \frac{\mu C_P^{|}}{k^{|}}$

3.4 $S_c = \frac{\nu}{D}$ $E = \frac{U_0^{|}}{C_P^{|}(T^{|}\omega - T^{|}s)}$ $G_r = \frac{\nu g\beta^{|}(T^{|}\omega - T^{|}s)}{U_0 \nu_0^2}$

$G_c = \frac{\nu g\beta^{|}(C^{|}\omega - C^{|}s)}{U_0 \nu_0^2}$, $M = \frac{\sigma B_0^2 \nu}{\rho^{|} \nu_0^2}$, $S = \frac{4\nu_0^2}{\nu^2}$

Using (3.4), Then we get non -dimensional eq^nas follows:

3.5 a) $\frac{1}{4}\frac{\partial u}{\partial t} + \frac{\partial \mu}{\partial \eta} = G_r\theta + G_C\theta^1 + \frac{\partial^2 u}{\partial \eta^2} - M_u - S\left(\frac{1}{4}\frac{\partial^3 u}{\partial n^2 \partial t} - \frac{\partial^2 u}{\partial \eta^2}\right)$

b) $\frac{1}{4} P_r \frac{\partial \theta}{\partial t} + P_r \frac{\partial \theta}{\partial \eta} = \frac{\partial^2 \theta}{\partial \eta^2}$,

c) $\frac{S_c}{4}\frac{\partial \theta^{|}}{\partial t} + S_c \frac{\partial \theta^{|}}{\partial t} = \frac{\partial^2 \theta^{|}}{\partial \eta^2}$

B.C's are gives by

3.6 a) $u = 1$, $\theta = 1$, $\theta^{|} = 1$, at $\eta = 0$

b) $u = -(1 + te^{i\omega t})^{|}$, $\theta = 0$, $\theta^* = 0$ at $\eta = m$

If Let us take

3.7 a) $u(\eta) = u_0(\eta) + t\, u_1(\eta)\, e^{i\omega t}$

b) $\theta(\eta, t) = \theta_0(\eta) + t\, \theta_1(\eta)\, e^{i\omega t}$

c) $\theta^*(\eta, t) = \theta_0^*(\eta) + t\, \theta_1^*(\eta)\, e^{i\omega t}$ from (3.5), (3.6) & (3.7) we get -

3.8 $\theta^* = \frac{e^{scn} - e^{scm}}{1 - e^{scm}}$, $\theta = \frac{e^{Pr\eta} - e^{Pr\, m}}{1 - e^{Pr\, m}}$

from3.5(a) and 3.7(a), we get -

3.9 $\frac{d^2 u_0}{d\eta^2}(1 + S) - \frac{du_0}{d\eta} - Mu_0(\eta) = -G_r\theta_0(\eta) - G_c\theta_0^*(\eta)$

3.10 $\frac{d^2 u_1}{d\eta^2}\left(1 + S - \frac{Si\omega}{4}\right) - \frac{du_1}{d\eta} - \left(M + \frac{i\omega}{4}\right) u_1(\eta) = 0$

Solving above equations we get,

3.11 $u = C_1 e^{\frac{1+\sqrt{1+4M(1+S)}}{2}\eta} + C_2 e^{\frac{1-\sqrt{1+4M(1+S)}}{2}\eta} - \frac{G_r e^{SCm}}{(1-e^{SCm})(S_c^2(1+S) - S_c - M)} - \frac{G_r e^{SCm}}{M(1-e^{SCm})} - \frac{G_c e^{Pr\eta}}{(1-e^{Prn})(P_r^2(1+S) - P_r - M)} - \frac{G_c e^{Prm}}{M(1-e^{Prm})}$

$$+ \in e^{i\omega t}\left\{ d_1 e^{\frac{1+\sqrt{1+4\left(1+S-\frac{Si\omega}{4}\right)\left(M+\frac{i\omega}{4}\right)}\eta}{2}} + d_2 e^{\frac{1-\sqrt{1+4\left(1+S-\frac{Si\omega}{4}\right)\left(M+\frac{i\omega}{4}\right)}\eta}{2}} \right\}$$

IV. CONCLUSION

If we draw graph for Mi against η than it we will find that Mi decreases with increase of M more rapidly where as if increases that first up to η = 0.6 & then decreases. We also solve u decrease with the increase in magnetic Graphop No: Gc. We see that Pr&s on skin friction causes a decrease in t.

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