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UNSTEADY MAGNETO HYDRO DYNAMIC FLOW, HEAT AND MASS TRANSMIT THROUGH AN ACCELERATE VERTICAL POROUS PLATE IN THE PRESSURE OF VISCOUS DEBAUCHERY HEAT SUPPLY AND VARIABLE SUCTION.

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ABSTRACT

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By the Solving Analytically & numerically using Runge-Kutta fourth order method unsteady MHD flow, temp and mass transmit with an accelerate vertical porous plate in the effect of viscous debauchery, temp and suction when the plate accelerates in own plate is analyzed. Disclosed numerically values of physical parameters and the result of this paper have significant relevance in the field of geophysical & astrophysical studies.

KEYWORDS:. Nusselt number, porous MHD, skin friction, mass transfer

INTRODUCTION:

The study of effects of porous boundaries on flow and temp transfer with mass transfer is important many engineering design applications in the field of chemical and geophysical sciences. Permeable porous plates are used in the filtration processes and also for a heated body to keep its temperature constant and to make the heat in solution of the surface more effective. The study of stellar structure on solar surface is connected with the mass transfer phenomena. The aim of the paper is to investigate unsteady Magneto Hydro Dynamic flow, mass transfer and heat transfer past an accelerated vertical porous plate in the influence of viscous debauchery, temp source and variable suction when the plate accelerates in its own plate. The governing equations are solved both analytically and numerically using Runge-kutta forth order technique with shooting technique. The effect of the parameters on the velocity, temperature and the concentration distributions of the flow filled are discussed and represented by graphs and tables. Result of the paper have significant relevance to geophysical and astrophysical studies.

The study about magneto hydrodynamic flow of an electrically conducting fluid in metallurgical and metal and cored of planets of the size of larger than the earth. It is interesting to investigate this phenomenon and to study in particular, the case of mass transfer on the free convection flow. Hasimoto

(1957) discussed the boundary layer growth on a temp plate with suction or injection. Mishra and Dash (1974) worked under free convection of non- permeability fluid between parallel walls. Vajravalu (1979) worked under natural convection at a heated semi- infinite vertical plate with internal heat generation. Pop and soundalgekar (1980) worked under free convection flow past on accelerated infinite plate. Singh (1983) analyzed the MHD free convective flow past an accelerated vertical porous plate by finite difference method. Rapits et al. (1987) worked under the unsteady free convective flow through a porous medium adjacent to a semi-infinite vertical plate using finite difference scheme.

Singh and Dikshit (1988) studied hydro magnetic flow past a continuously moving semi-infinite plate at biggest suction. Singh and Soundalgekar (1990) of transient free convection in cold water past an infinite vertical porous plate. Sattar (1994) no rued free convection and mass transfer flow through a porous medium past an infinite vertical porous plate with time dependent temperature and concentration. Acharya et al. (1995) the effect of chemical and thermal diffusion with Hall current on unsteady hydro magnetic flow near an infinite vertical porous plate. Khandelwal (2013) worked under the Heat & mass transfer in vertical porous plate influence of viscous dissertation. Chandran et al. (1998) discussed the unsteady free convection flow with heat flow and accelerated motion. Jha (1998) reported the effects of applied magnetic field on transient convective flow in a vertical path. Dash and Das (1999) analyzed the effect of Hall current MHD free convection flow along an accelerated porous heated plate with mass transfer and internal heat generation. Soundalgekar et al. (1999) workout transient free convection flow of a viscous dissipative fluid past a semi-infinite vertical plate. Cookey et al. (2000) workout the influence of viscous dissipation and radiation on unsteady MHD free convection flow past an infinite heated vertical plate in a porous medium with time dependent suction. Kim (2000) investigated unsteady MHD convective heat transfer past a semi-infinite vertical porous moving plate with variable suction. Sharma and Mishra (2002) analyzed the effect of mass transfer in unsteady MHD flow and heat transfer past an infinite porous vertical moving plate. Panda et al. (2003) discussed unsteady free convective flow and mass transfer of a rotating elastico - viscous liquid through porous media past a vertical porous plate.

Das, Sahoo and Dash (2006) worked out unsteady free convection and mass transfer boundary layer flow past an accelerated infinite vertical porous plate with suction. Sharma and Singh (2008) worked out unsteady MHD free convective flow and heat transfer along a vertical porous plate with variable suction and internal heat development.

MATHEMATICAL FORMULATION OF THE PROBLEM

Consider the unsteady flow of an incompressible viscous fluid past an accelerating vertical plate. Let the X-axis be directed in up- word and the y-axis is normal to the plate. Let u and v be the velocity components along the x and y- axes, respectively. The fluid pressure is constant and induced magnetic field is small in comparison to the applied magnetic flied, so neglected.

Let us assume that the plate is accelerating with a velocity $u = Ut$ in its own plane at time $t \geq 0$. Then the unsteady boundary layer equations of motion, energy and mass transfer in the presence of heat generation and viscous dissipation, Brinkman's empirical modification of Darcy's law are

$$\frac{\partial v}{\partial y} = 0 \qquad v = v(t), \tag{1}$$

$$\rho\left(\frac{\partial u}{\partial t} + v\frac{\partial u}{\partial y}\right) = \mu\frac{\partial^2 u}{\partial y^2} + g\beta(T - T_\infty) + g\beta^*(C - C_\infty) - \sigma B_0^2 u - \frac{v}{K^*}u, \tag{2}$$

$$\rho C_p\left(\frac{\partial t}{\partial t} + v\frac{\partial t}{\partial y}\right) = k\frac{\partial^2 T}{\partial_{y^2}} + Q(T - T\infty) + \mu\left(\frac{\partial u}{\partial y}\right)^2, \tag{3}$$

$$\frac{\partial c}{\partial t} + v\frac{\partial c}{\partial y} = D\frac{\partial^2 c}{\partial y^2} \tag{4}$$

Where t = time, ρ = density, T = temperature, C = concentration of spices in the fluid, $T\infty$ and $C\infty$ = temperature and concentration of the fluid in the free stream, g = acceleration due to gravity. β = coefficient of volume expansion, β^* = coefficient of concentration expansion, v = kinematics viscosity, σ = electric conductivity, $B_\circ$ = magnetic induction, Q = heat generation sink parameter, C_p = specific heat at constant pressure, D = mass diffusion coefficient, K^* = permeability parameter, μ = coefficient of viscosity and K = thermal conductivity.

The boundary conditions when t ≥ 0 are

$$y = 0: \; u = Ut, T = T_{w,} \; C = C_w \tag{5}$$

$$y \to \infty: \; u \to 0, T \to T\infty, C \to C\infty$$

Following Hasimoti (1957), Sing and Soundalgekar (1990), we choose

$$v = -V_\circ\left(\frac{v}{t}\right)^{½} \tag{6}$$

where $V_0 > 0$ the suction parameter.

Introducing the similarity variables and dimensionless quantities

$$\boldsymbol{\eta} = \frac{y}{2\sqrt{vt}}, u = Utf(\boldsymbol{\eta}), Q = \frac{T - T\infty}{T_w - T_\infty}, C = \frac{C - C_\infty}{C_w - C_\infty}, K = \frac{4vt}{K^*}, S = \frac{4Qt}{\rho C_p}, Pr = \frac{\mu C_p}{K}, Sc = \frac{v}{D} \tag{7}$$

$$Gr = 4g\beta\frac{T_w - T_\infty}{U}, Gc = 4g\beta^*\frac{(C_w - C_\infty)}{U}, M = \sqrt{\frac{4\sigma t}{\rho}}, Ec = \frac{U^2 - t^2}{C_p(T_w - T_\infty)}$$

into the equations(2) to (4), we get

$$f'' + 2(\boldsymbol{\eta} + V_0)f - (M + K)f = Gr\theta - GcC, \tag{8}$$

$$\theta'' + 2(\boldsymbol{\eta} + V_0)Pr\theta - S\,\mathrm{Pr}\theta = -Ec\,\mathrm{Pr}\;f^2, \tag{9}$$

$C" + 2(\boldsymbol{\eta} + V_0)ScC = 0,$ (10)

The corresponding boundary conditions are

$f(0) = 1, \theta(0) = 1, C(0) = 1, f(\infty) = 0, \theta(\infty) = 0, C(\infty) = 0.$ (11)

Where pr = prandtl number , Gr = Grashof number for heat transfer, Gm = modified Grashof number of mass transfer, M = Hartmann number, Ec = Eckert number, S =heat source parameter, Sc = Schmidt number and K = porosity parameter.

METHOD OF SOLUTION:

Equation (10) is an ordinary second order differential equation, solved under the boundary conditions 10 as given by

$$C = \frac{erfc((\eta+V_0)\sqrt{Sc})}{erfc(V_0\sqrt{Sc})} \quad (12)$$

In order to solve equation(8) and (9) we use Runge Kutta order method along with shooting technique. Now, the equations (8) and (9) are transformed into system of firdt order ordinary differential equation as given below

$$\frac{\partial\theta}{\partial\boldsymbol{\eta}} = f_1(\boldsymbol{\eta}, \theta, \omega) = \omega, \ \ \theta(0) = 1 \quad (13)$$

$$\frac{\partial w}{\partial\boldsymbol{\eta}} = f_2(\boldsymbol{\eta}, \theta, w) = -2(\boldsymbol{\eta} + V_0)Prw - S\,Pr\theta - EcPrz^2, w(0) = ?, \quad (14)$$

$$\frac{\partial f}{\partial\boldsymbol{\eta}} = g,(\boldsymbol{\eta}, f, z) = z, f(0) = 1, \quad (15)$$

$$\frac{\partial z}{\partial\eta} = g_2(\eta, f, z) = -2(\eta + v_0)z + (M + K)f - Gr\theta - GcC. \quad (16)$$

Here values of w (0) and z (0), are unknown and obtained using shooting technique.

Once the value of w(0) is known, the equations (13), (14) and (15), (16) become initial valued and then solved using Runge-Kutta forth order technique.

SKIN-FRICTION COEFICIENT

Skin friction coefficient at the plate is given by

$$C_f = \frac{2\tau}{\rho U\sqrt{Vt}} = -f'(0) \quad (17)$$

Where $\tau = \mu\left(\frac{\partial u}{\partial y}\right)_{y=0}$

NUSSELT NUMBER:

The local heat flux in terms of Nusselt number at the plate is given by

$$Nu = \frac{2q_{w\sqrt{vt}}}{K(T_w - T_\infty)} = -\theta'(0) \quad (18)$$

Where q_w = heat flux per unit area.

RESULTS AND DISCUSSIONS

Unsteady Magneto Hydro Dynamic flow, heat and mass transfer along an accelerated vertical porous plate with viscous dissipation, heat and suction source when the plate accelerates in its own plate is analyzed and solved numerically using Runge-kutta forth order method .The effect of the flow parameters on the velocity and temperature distributions are represented through figures, Numerical values skin-friction coefficient and Nusselt number at the plate are derived for different value of physical parameters and presented through Numerical table.

It observed from Figure 1 that fluid velocity decreases with the increase of Hartmann number (M) Porosity parameter(K) and suction velocity (V_0), while it increases with the increase in Grashof number (Gr) modified Grashof number(Gc).

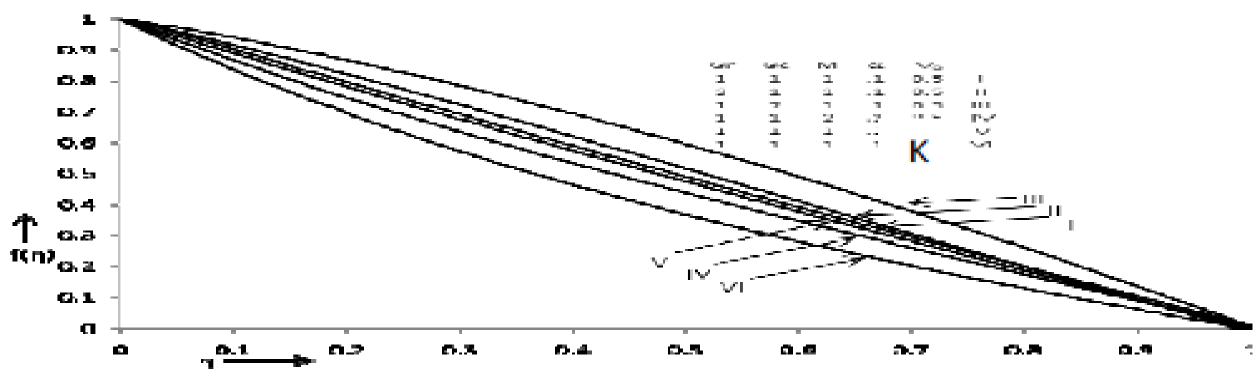

Figure 1: Velocity Profiles Versus η When Pr=0.71, Ec=2, S=1 and Sc=0.2

Figure 2 when temp. decreases with increase of Pr.

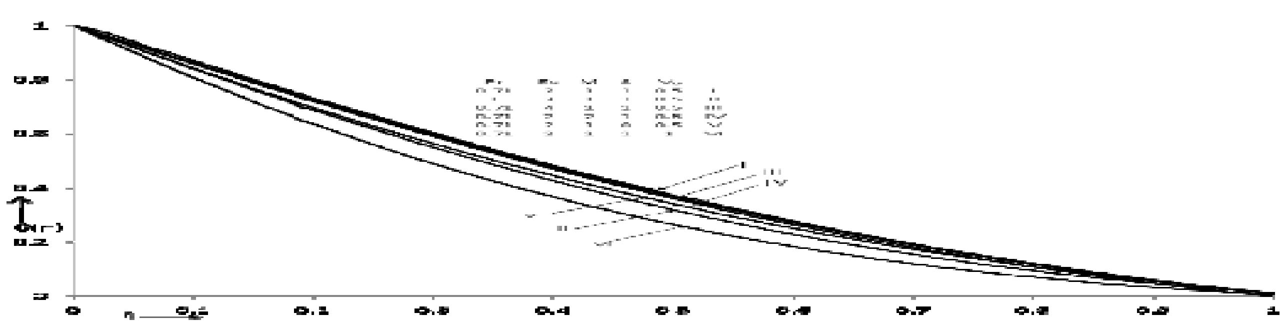

Figure 2: Temperature Profiles Versus η when Gr=1,Gc=1

It is observed from figure 3 that mass concentration increases with the increase in the Sc.

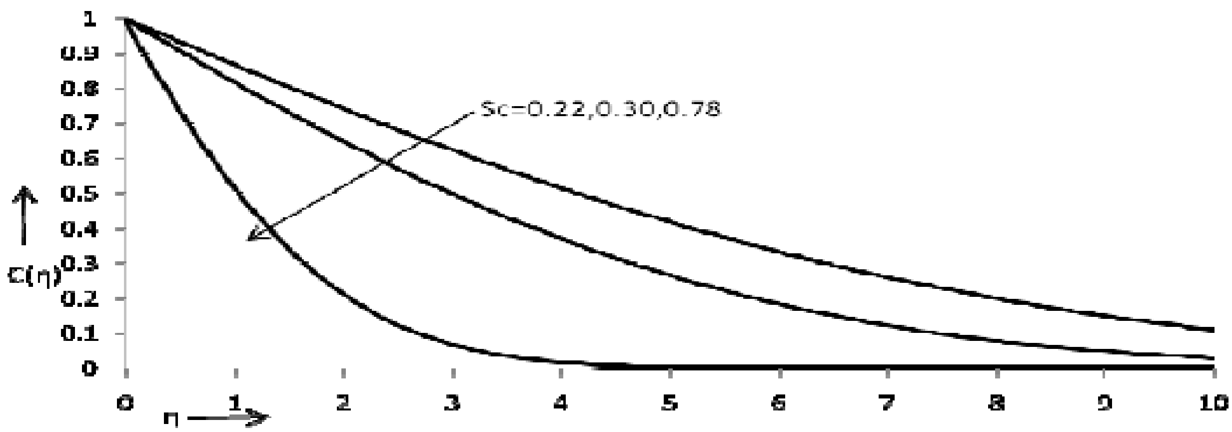

Figure 3: Concentration Profiles Versus η for Different Values of Sc with V_0 = 0.5

It is seen from Table 1 that the numerical values of skin-friction coefficient increases with the increase in Prandtl Pr, Schmidt number Sc, Eckert number Ec,Hartmann number M , suction velocity V_0 ,while it decreases with increases in Grashof number ,the modified Grashof number Gc.

The numerical values of Nusselt number increases with the increase in Prandtl (Pr) Schmidt number (Sc) the Grashof number (Gr) the modified Grashof number(Gc) suction velocity (V_0), while it decreases with the increase in the Hartmann number (M)the Eckert number (Ec) or heat source parameter(S.)

Table 1: Numerical Values of Nussult Number and Skin-Friction Coefficient at the Plate for Different Values of Parameters

Pr	Gr	Gc	Sc	Ec	M	K	S	V_0	Nu	C_r
0.71	1	1	0.22	2	1	0.1	1	0.5	1.456	1.0741
1	1	1	0.22	2	1	0.1	1	0.5	1.708	1.0791
0.71	2	1	0.22	2	1	0.1	1	0.5	1.464	0.8054
0.71	1	2	0.22	2	1	0.1	1	0.5	1.482	0.552
0.71	1	1	0.3	2	1	0.1	1	0.5	1.461	1.099
0.71	1	1	0.78	2	1	0.1	1	0.5	1.466	1.089
0.71	1	1	0.22	4	1	0.1	1	0.5	1.406	1.075
0.71	1	1	0.22	2	2	0.1	1	0.5	1.408	1.393
0.71	1	1	0.22	2	1	0.2	1	0.5	1.471	1.124
0.71	1	1	0.22	2	1	0.1	0	0.5	1.656	1.075
0.71	1	1	0.22	2	1	0.1	1	1	2.062	1.738

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