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Research paper

Unsteady MHD Free Convective Two Immiscible Fluid Flows in a Vertical Permeable Plate with Heat and Mass Transfer under Chemical Reaction and Heat Source

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Abstract

In this article , the nonlinear Unsteady MHD Free convective Two Immiscible Fluid Flows in a vertical Permeable plate with Heat and Mass Transfer under chemical reaction and Heat source have been studied here. The conservation equations are solved analytically under the boundary conditions by using perturbation technique. The influence of various non dimensional parameters namely, Magnetic parameter, Prandtl number, chemical reaction,, Thermal radiation parameter and Schmidt number are examined on the velocity, Temperature, Concentration fields in detail. It is noted that the velocity is decreased with increasing Heat source under chemical reaction parameter. But increasing suction parameter decreases the velocity

Keywords: *Chemical reaction; Heat Transfer; Heat source; MHD; Mass Transfer*

1. Introduction

Due to various increasing applications in mechanical chemical engineering and material process engineering the fluids in a porous channel problems became popular. Such type of fluids are paints, cosmetic products grease clay coating oil slurries. The boundary layer behavior of viscoelastic fluid has numerous applications in engineering in paper production aerodynamics extrusion of plastic sheets etc. Also the applications of MHD in acc elerators, power generation systems, plasmas has a vital role in this modern age. Specially to control the direction by using this boundary layer problems.

Chemical reaction effect with Heat and Mass transfer in geometric with porous and without porous medium were analyzed by many authors .Chamkha [1] in 2004 discussed about the unsteady nature MHD convective Heat and Mass transfer in a moving vertical plate under thermal radiation. Oscillating plate temperature effects on a vertical porous plate with constant suction were discussed by Jaiswal [2]and Soundalgekar. SahinAhamed et al [3] investigated the combined Heat and mass transfer by mixed convection MHD flow along a porous plate under Heat source with Chemical reaction. Umavathi et al[4] also studied in 2010 about the unsteady flow in a porous medium sandwiched between viscous fluids.

In a nuclear power plants, gas turbines, missiles, satellites and various propulsion devices like space vehicles Radiative heat transfer flow is important. Radiation and mass transfer effects on MHD oscillatory flow in a channel with porous medium under chemical reaction is analyzed by Mohammed Ibrahim[5].sivakami.L et al [6] also discussed about the Effect of heat and mass transfer on the Unsteady Free Convective immiscible Fluid Flow in a Horizontal Channel under the influence of magnetic field and Chemical Reaction. Govindarjan et al [7] also analysed about the Chemical reaction effects on unsteady MHD convective flow in a rotating porous medium with mass transfer. Initially in 1981 Vafai et al [8] who initiated to study about the Boundary and Inertia Effects on Flow and Heat Transfer in Porous Media.Also Sivakami. L et al studied about the Dufour Effects on Unsteady MHD Free convective Flow of Two Immiscible Fluid in a Horizontal Channel under Chemical Reaction and Heat Source.

This paper is based on the concept of venkateswarluMalapati and Padma Polarapu (2015).Here we have made an attempt to convert the Unsteady MHD Free convective Heat and Mass Transfer in a Boundary Layer Flow past a vertical Permeable plate paper into a Two immiscible layered problem with Thermal Radiation and Chemical Reaction under Heat source.

2. Mathematical Formulation:

The unsteady two dimensional nonlinear MHD free convective two immiscible fluid flows of a viscous incompressible and electrically conducting fluid past an infinite heated vertical porous plate embedded in a porous medium under the influence of thermal and concentration buoyancy effects. Let the x* axis be taken in vertically upward direction along the plate and y* axis is normal to the plate.In the Region I densityis ρ_1, the viscosity is μ_1, thermal conductivity k_1, thermal diffusivity D_1. In Region-II i density is (ρ_2,) viscosity (μ_2,) thermal conductivity (k_2,) thermal diffusivity (D_2). A uniform magnetic field is applied in the direction perpendicular to the plate. The viscous dissipation and the Joule heating effects are assumed to be negligible in the energy equation. The magnetic Reynolds number and the transverse applied magnetic field are assumed to be very small, so that the produced magnetic field is insignificant. Also it is supposed that there is no applied voltage, so that the electric field is vanished. Under the above assumption as well as Boussinesq's approximation ,the governing equations of the fluid flow for the different regions are as follows.

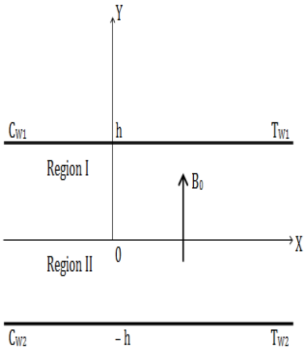

Figure 1:-Physical Configuration of the Problem

Here the fluid properties for the fully developed flow l are constants. The value of the Reynolds number is very small. The following are the governing equations of the fluids for two different regions

REGION I: Porous Region

$$\frac{\partial v_1^{'}}{\partial y^{'}} = 0$$

$$\left(\frac{\partial u_1^{'}}{\partial t^{'}} + V_1^{'}\frac{\partial u_1^{'}}{\partial y^{'}}\right) = \nu_1\frac{\partial^2 u_1^*}{\partial y^{*2}} - \sigma B_0^2\frac{U_1^{*'}}{\rho_1} + \beta_1 g_1(T_1^* - T_\infty^*) + \beta^*{}_1 g(C_1^* - C_\infty^*) + U_1^*\frac{\nu_1^{'}}{k_1^*}$$

$$\rho_1 C_{p1}\left(\frac{\partial T_1^{*'}}{\partial t^{*'}} + V_1^{'}\frac{\partial T_1^{*'}}{\partial y^{*'}}\right) = \alpha_1\frac{\partial^2 T_1^*}{\partial y^{*2}} - \frac{\partial q_{r1}{}^*}{\partial y^{*'}} - Q_1^*(T_1^* - T_\infty^*)$$

$$\left(\frac{\partial C_1^{*'}}{\partial t^{*'}} + V_1^{'}\frac{\partial C_1^{*'}}{\partial y^{*'}}\right) = D_1\frac{\partial^2 C_1^*}{\partial y^{*2}} - \frac{\partial q_{r1}{}^*}{\partial y^{*'}} - K_{r1}(C_1^* - C_\infty^*)$$

EGION II: Clear Region

$$\frac{\partial v_2^{'}}{\partial y^{'}} = 0$$

$$\left(\frac{\partial u_1^{*}}{\partial t^{'}} + V_2^{'}\frac{\partial u_2^{'}}{\partial y^{'}}\right) = \nu_2\frac{\partial^2 u_2^*}{\partial y^{*2}} - \sigma B_0^2\frac{U_2^{*'}}{\rho_2} + \beta_2 g_2(T_2^* - T_\infty^*) + \beta^*{}_2 g(C_2^* - C_\infty^*) + U_2^*\frac{\nu_2^{'}}{k_2^*}$$

$$\rho_2 C_{p2}\left(\frac{\partial T_2^{*'}}{\partial t^{*'}} + V_2^{'}\frac{\partial T_2^{*'}}{\partial y^{*'}}\right) = \alpha_2\frac{\partial^2 T_2^*}{\partial y^{*2}} - \frac{\partial q_{r2}{}^*}{\partial y^{*'}} - Q_2^*(T_2^* - T_\infty^*)$$

$$\left(\frac{\partial C_2^{*'}}{\partial t^{*'}} + V_2^{'}\frac{\partial C_2^{*'}}{\partial y^{*'}}\right) = D_2\frac{\partial^2 C_2^*}{\partial y^{*2}} - \frac{\partial q_{r2}{}^*}{\partial y^{*'}} - K_{r2}(C_2^* - C_\infty^*)$$

Therefore, interface and the boundary conditions on the velocity, Temperature, Concentration for both fluids are:

$$U_1^*(h) = 0, U_2^*(-h) = 0, U_1^*(0) = U_1^*(h), \nu_1\frac{\partial U_1^*}{\partial y^*} = \nu_2\frac{\partial U_2^*}{\partial y^*}$$

$$T_1^*(h) = T_{w1}{}^*, T_2^*(-h) = T_{w2}{}^*, T_1^*(0) = T_2^*(0), \alpha_1\frac{\partial T_1^*}{\partial y^*} = \alpha_2\frac{\partial U_2^*}{\partial y^*}$$

$$C_1^*(h) = C_{w1}{}^*, C_2^*(-h) = C_{w2}{}^*, C_1^*(0) = C_2{}^*(0), D_1\frac{\partial C_1^*}{\partial y^*} = D_2\frac{\partial C_2^*}{\partial y^*}$$

The continuity equations (1) and (5) implies that V_1' and V_2' are independent of y', they can be at most a function of time alone. Hence we can write

$$V^{'} = V_0(1 + \varepsilon A e^{i\omega t}) \qquad (12)$$

Assuming that $V_1^{'} = V_2^{'} = V^{'}$. ε is a very small .Here velocity V' varies periodically with time about a non-zero constant mean velocity V_0. The following are the dimensionless quantities:

$$U = \frac{u^*}{V_0}, v = \frac{v^*}{v_0}, y = \frac{y^* v_0}{\nu}, t = \frac{t^* v_0{}^2}{4\nu}, w = \frac{w^*\nu}{\nu^2{}_0},$$

$$\alpha_1 = \frac{\nu_2}{\nu_1}, \beta_1 = \frac{\alpha_2}{\alpha_1}, \phi_1 = \frac{Qh^2}{k_1}, \gamma_1 = \frac{D_2}{D_1}, h = \frac{L^* v_0}{\nu},$$

$$Sc = \frac{\nu}{D}, M = \frac{\sigma\nu B_0{}^2}{\rho v_0{}^2}, Q = \frac{Q_0\nu}{\rho C_p v_0^2}, k = \frac{k^* v_0{}^2}{\nu^2},$$

$$\zeta_1 = \frac{1}{\tau_1} = \frac{\rho_1}{\rho_2} \quad \Pr = \frac{\nu\rho C_p}{k} + \frac{\nu}{\alpha}$$

$$\zeta_1 = \frac{1}{\tau_1} = \frac{\rho_1}{\rho_2}, Gr = \frac{(T_{w2}^{'} - T_{w1}^{'})g\nu\beta^{*'}}{V_0^3},$$

$$Gc = \frac{(C_{w2}^{'} - C_{w1}^{'})g\nu\beta^{*'}}{V_0^3}, \quad R = \frac{a^* k}{4\sigma^*\nu^2 T_\infty^{*3}},$$

$$q_r = \frac{-16T_\infty^3\sigma_0}{9k^*}\frac{\partial^2 T}{\partial y^2}, \quad T_w^{*4} = 4T_\infty^{*3}T_w^* - 3T_\infty^{*4}$$

i=1,2,3,4 equations (2), (3), (4), (6), (7)and (8) become

REGION: I The following are the equations 13,14,15

$$\frac{1}{4}\frac{\partial U_1}{\partial t} - (1 + \varepsilon A e^{i\omega t})\frac{\partial U_1}{\partial t} = \frac{\partial^2 U_1}{\partial y^2} + Gr\theta_1 + Gc\phi_1 - [M + \frac{1}{k}]u_1$$

$$\frac{1}{4}\frac{\partial\theta_1}{\partial t} - (1 + \varepsilon A e^{i\omega t})\frac{\partial\theta_1}{\partial t} = \frac{\partial^2\theta_1}{\partial y^2}\frac{1}{PR}[1 + \frac{4}{3r}] - Q_1\theta_1$$

$$\frac{1}{4}\frac{\partial\phi_1}{\partial t} - (1 + \varepsilon A e^{i\omega t})\frac{\partial\phi_1}{\partial t} = \frac{\partial^2\phi_1}{\partial y^2}\frac{1}{SC} - K_R\phi_1$$

REGION:II The following are the equations 16,17,18

$$\frac{1}{4}\frac{\partial U_2}{\partial t} - (1 + \varepsilon A e^{i\omega t})\frac{\partial U_2}{\partial t} = \frac{\partial^2 U_2}{\partial y^2} + Gr\theta_2 + Gc\phi_2 - [M + \frac{1}{k}]u_2$$

$$\frac{1}{4}\frac{\partial\theta_2}{\partial t} - (1 + \varepsilon A e^{i\omega t})\frac{\partial\theta_2}{\partial t} = \frac{\partial^2\theta_2}{\partial y^2}\frac{1}{PR}[1 + \frac{4}{3r}] - Q_2\theta_2$$

$$\frac{1}{4}\frac{\partial\phi_2}{\partial t}(1 + \varepsilon A e^{i\omega t})\frac{\partial\phi_2}{\partial t} = \frac{\partial^2\phi_2}{\partial y^2}\frac{1}{SC} - K_R\phi_2$$

The boundary and interface conditions in dimensionless form are given as follows from (19) to (21) at y=0

$$U_1^*(1) = 0, U_2^*(-1) = 0, U_1^*(0) = U_1^*(0), \frac{\partial U_1^*}{\partial y^*} = \alpha_1\frac{\partial U_2^*}{\partial y^*}$$

$$\theta_1^*(1) = 1, \theta_2(-1) = 0, \theta_1(0) = \theta_2(0), \alpha_1\frac{\partial\theta_1}{\partial y^*} = \beta_1\frac{\partial\theta_2}{\partial y^*}$$

$$C_1(1) = C_2, C_2^*(-1) = 0, C_1(0) = C_2(0), \frac{\partial C_1}{\partial y^*} = \gamma_1\frac{\partial C_2}{\partial y^{'*}}$$

3. Solution of the Problem

To solve the equations (13) to (18) with the interface and boundary conditions (19) to (21), we have to expand

$U_{01}(y,t)$, $U_{02}(y,t)$, $\theta_{01}(y,t)$, $\theta_{02}(y,t)$, $C_{01}(y,t)$, $C_{02}(y,t)$ as a power of ϵ.

$$U_1(y,t) = U_{10}(y) + \varepsilon e^{i\omega t} U_{11}(y)$$
$$\theta_1(y,t) = \theta_{10}(y) + \varepsilon e^{i\omega t} \theta_{11}(y)$$
$$C_1(y,t) = C_{10}(y) + \varepsilon e^{i\omega t} C_{11}(y)$$
$$U_2(y,t) = U_{20}(y) + \varepsilon e^{i\omega t} U_{21}(y)$$
$$\theta_2(y,t) = \theta_{20}(y) + \varepsilon e^{i\omega t} \theta_{21}(y)$$
$$C_2(y,t) = C_{20}(y) + \varepsilon e^{i\omega t} C_{21}(y)$$

The results of the above equations are as follows in terms of equations (22)to (33))

REGION:I: Non – Periodic Terms:

$$\frac{\partial^2 U_{10}}{\partial y^2} + \frac{\partial U_{10}}{\partial y} - [M + \frac{1}{k}]U_{10} = -[Gr\theta_{10} + Gc\phi_{10}]$$

$$\frac{\partial^2 \theta_{10}}{\partial y^2} - \Pr[1 + \frac{4}{3R}]\frac{\partial \theta_{10}}{\partial y} - \Pr Q\theta_{10} = 0$$

$$\frac{\partial^2 \varphi_{10}}{\partial y^2} - Sc\frac{\partial \varphi_{10}}{\partial y} = S_r K_r \varphi_{10} = 0$$

Periodic Terms:

$$\frac{\partial^2 U_{11}}{\partial y^2} + \frac{\partial U_{11}}{\partial y} - [M + \frac{\omega i}{4} + \frac{1}{k}]U_{11} = -[Gr\theta_{11} + Gc\phi_{11} + AU'_{10}]$$

$$\frac{\partial^2 \theta_{11}}{\partial y^2} + \Pr[1 + \frac{4}{3R}]\frac{\partial \theta_{11}}{\partial y} - \frac{\Pr i\omega}{4}[1 + \frac{4}{3R}]\theta_{11} = -2A\Pr[1 + \frac{4}{3R}]\frac{\partial \theta_{10}}{\partial y} + \Pr Q\theta_{11}$$

$$\frac{\partial^2 \varphi_{11}}{\partial y^2} + Sc\frac{\partial \varphi_{11}}{\partial y} - [Kr + \frac{i\omega}{4}]S_c\varphi_{11} = -ASc\frac{\partial \varphi_{10}}{\partial y}$$

Region: II Non-periodic Terms:

$$\frac{\partial^2 U_{20}}{\partial y^2} + \frac{\partial U_{20}}{\partial y} - [M + \frac{1}{k}]U_{20} = -[Gr\theta_{20} + Gc\phi_{20}]$$

$$\frac{\partial^2 \theta_{20}}{\partial y^2} + \Pr[1 + \frac{4}{3R}]\frac{\partial \theta_{20}}{\partial y} - \Pr Q\theta_{20} = 0$$

$$\frac{\partial^2 \varphi_{20}}{\partial y^2} - Sc\frac{\partial \varphi_{20}}{\partial y} = ScKr\varphi_{20} = 0$$

Periodic Terms:

$$\frac{\partial^2 U_{21}}{\partial y^2} + \frac{\partial U_{21}}{\partial y} - [M + \frac{\omega i}{4} + \frac{1}{k}]U_{21} = -[Gr\theta_{21} + Gc\phi_{21} + A\frac{\partial U_{20}}{\partial y}]$$

$$\frac{\partial^2 \theta_{21}}{\partial y^2} - \Pr[1 + \frac{4}{3R}]\frac{\partial \theta_{21}}{\partial y} - \frac{\Pr i\omega}{4}[1 + \frac{4}{3R}]\theta_{21} = -2A\Pr[1 + \frac{4}{3R}]\frac{\partial \theta_{20}}{\partial y} + \Pr Q\theta_{21}$$

$$\frac{\partial^2 \varphi_{211}}{\partial y^2} + Sc\frac{\partial \varphi_{21}}{\partial y} - [Kr + \frac{i\omega}{4}]S_c\varphi_{21} = -ASc\frac{\partial \varphi_{20}}{\partial y}$$

By using the following interface and boundary conditions (34) to (39) the above equations are the solutions of the given problem.

Non- Periodic Terms

$$U_{10}(1) = 0, U_{20}(-1) = 0, U_{10}(0) = U_{20}(0), \frac{\partial U_{10}}{\partial y} = \alpha_1 \frac{\partial U_{20}}{\partial y}$$

$$\theta_{10}(1) = 1, \theta_{20}(-1) = 0, \theta_{10}(0) = \theta_{20}(0), \frac{\partial \theta_{10}}{\partial y} = \beta_1 \frac{\partial \theta_{20}}{\partial y}$$

$$\phi_{10}(1) = 1, \phi_{20}(-1) = 0, \phi_{10}(0) = \phi_{20}(0), \frac{\partial \phi_{10}}{\partial y} = \gamma_1 \frac{\partial \phi_{20}}{\partial y}$$

Periodic Terms:

$$U_{11}(1) = 0, U_{21}(-1) = 0, U_{11}(0) = U_{21}(0), \frac{\partial U_{10}}{\partial y} = \alpha_1 \frac{\partial U_{21}}{\partial y}$$

$$\theta_{11}(1) = 1, \theta_{21}(-1) = 0, \theta_{11}(0) = \theta_{21}(0), \frac{\partial \theta_{11}}{\partial y} = \beta_1 \frac{\partial \theta_{21}}{\partial y}$$

$$\phi_{11}(1) = 1, \phi_{21}(-1) = 0, \phi_{11}(0) = \phi_{21}(0), \frac{\partial \phi_{10}}{\partial y} = \gamma_1 \frac{\partial \phi_{21}}{\partial y}$$

The solutions of the differential equations (22) to (33) using the above boundary conditions (34) to (39) are

$$U_{10}(y) = C_5 e^{m5} y + C_6 e^{m6} y + K_1 e^{m3} y + K_2 e^{m4} y + K_3 e^{m1} y + K_4 e^{m2} y$$
$$U_{20}(y) = C_{17} e^{m17} y + C_{18} e^{m18} y + K_{23} e^{m15} y + K_{24} e^{m16} y + K_{25} e^{m13} y + K_{26} e^{m14} y$$
$$\theta_{10}(y) = C_3 e^{m3} y + C_4 e^{m4} y$$
$$\theta_{20}(y) = C_{15} e^{m15} y + C_{16} e^{m16} y$$
$$\phi_{10}(y) = C_1 e^{m1} y + C_2 e^{m2} y$$
$$\phi_{20}(y) = C_{13} e^{m13} y + C_{14} e^{m14} y$$
$$U_{11}(y) = C_{11} e^{m11} y + C_{12} e^{m12} y + K_9 e^{m9} y + K_{10} e^{m1} y + K_{11} e^{m3} y + K_{12} e^{m4} y +$$
$$K_{13} e^{m7} y + K_{14} e^{m8} y + K_{15} e^{m1} y + K_{16} e^{m2} y + K_{17} e^{m5} y + K_{18} e^{m6} y + K_{19} e^{m3} y + K_{20} e^{m4} y + K_{21} e^{m1} y + K_{22} e^{m2} y$$
$$\theta_{11}(y) = C_9 e^{m9} y + C_{10} e^{m10} y + K_7 e^{m3} y + K_8 e^{m4} y$$
$$\theta_{21}(y) = C_{21} e^{m21} y + C_{22} e^{m22} y + K_{29} e^{m15} y + K_{30} e^{m16} y$$
$$\phi_{11}(y) = C_7 e^{m7} y + C_8 e^{m8} y + K_5 e^{m1} y + K_6 e^{m2} y$$
$$\phi_{21}(y) = C_{19} e^{m19} y + C_{20} e^{m20} y + K_{27} e^{m13} y + K_{28} e^{m14} y$$

4. Skin Friction:

Knowing the velocity field, the skin-friction at the plate can be obtained, which in non-dimensional form is given by

$$C_f(U) = \left[\frac{\partial U_{10}}{\partial y}\right]_{y=1} + \varepsilon e^{i\omega t}\left[\frac{\partial U_{11}}{\partial y}\right]_{y=1}$$

$$C_f(L) = \left[\frac{\partial U_{20}}{\partial y}\right]_{y=-1} + \varepsilon e^{i\omega t}\left[\frac{\partial U_{21}}{\partial y}\right]_{y=-1}$$

5. Nusselt Number:

From the Temperature field, Nusselt number is given in non-dimensional form is

$$Nu(U) = \left[\frac{\partial \theta_{10}}{\partial y}\right]_{y=1} + \varepsilon e^{i\omega t}\left[\frac{\partial \theta_{11}}{\partial y}\right]_{y=1}$$

$$Nu(L) = \left[\frac{\partial \theta_{20}}{\partial y}\right]_{y=-1} + \varepsilon e^{i\omega t}\left[\frac{\partial \theta_{21}}{\partial y}\right]_{y=-1}$$

6. Shearwood Number

From Concentration field , Shearwood Number (rate of change of mass transfer) which is given in non-dimensional form is

$$Sh(U) = \left[\frac{\partial C_{10}}{\partial y}\right]_{y=1} + \varepsilon e^{i\omega t}\left[\frac{\partial C_{11}}{\partial y}\right]_{y=1}$$

$$Sh(L) = \left[\frac{\partial C_{20}}{\partial y}\right]_{y=-1} + \varepsilon e^{i\omega t}\left[\frac{\partial C_{21}}{\partial y}\right]_{y=-1}$$

7. Results and discussion:

To get the Physical significance of the problem, we have plotted velocity, Temperature, Concentration, for different values of the physical parameters like Magnetic parameter, thermal Grashof number Gr, Permeability parameter K, Solutal Grashof number Gc, Prandtl number Pr, Schmidt number Sc .Here the default parameter values are adopted for calculation: Gc=5,Gr=10, R=1,ωt=90, Sc=.60,K=10,Kr=.1,R=1, Pr=.71, M=1, A=.5,h=.2,$\varepsilon = .001$
Figure 2 and 3 represents the velocity profile effects for the distinct values of the Grashof number Gr and salutal Grashof number Gc for Heat and mass transfer due to buoyancy force . In the figure we can see that the velocity increases and attains its maximum in the porous region then decreases in the Clear region.
Figure 4 represents the effect of M the Magnetic parameter on the velocity field. we have drawn the figure for velocity against y for different M values. Here the velocity decreases in the upper region and increases in the lower region.
In Figure 5 the Schmidt number (Sc) on the velocity field is drawn for various values. An increase in the Schmidt number has no significance difference on the velocity field in the Region II. similarly in the velocity field of Region I an increasing effect is seen due to the domination of viscous diffusion rate over mass diffusion rate.
Figure 6 illustrates the velocity for various values of chemical reaction parameter Kr. It is clear from the figure that an increase in Kr leads to the decrease in both the values of velocity in the two different regions.
Figure 7 represents the Prandtl number effect on the velocity and Figure 8represents the effect on suction parameter and Figure 9 represents the effect of Pr on temperature. An increase in Pr leads to the decrease in both the values of velocity and temperature in region I and region II.

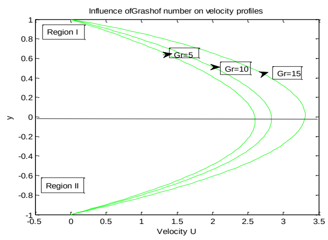

Figure 2: Influence of Velocity Profile on Gr

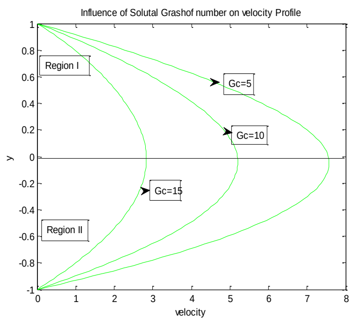

Figure3: Influence of Velocity Profile on Gc

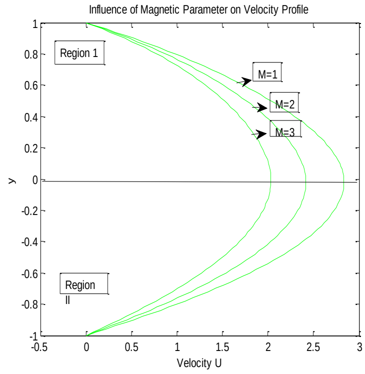

Figure4: Influence of Velocity Profile on M

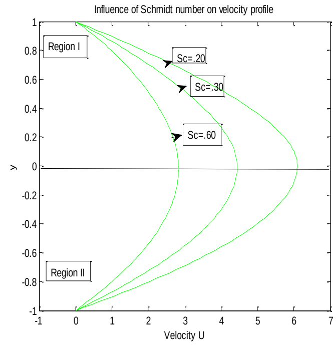

Figure5: Influence of Velocity Profile on Sc

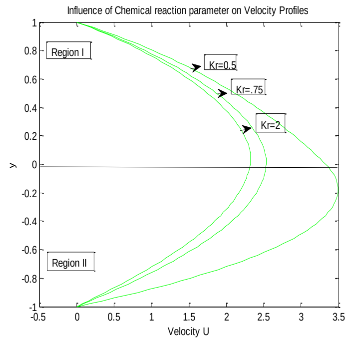

Figure 6: Influence of Velocity Profile on Kr

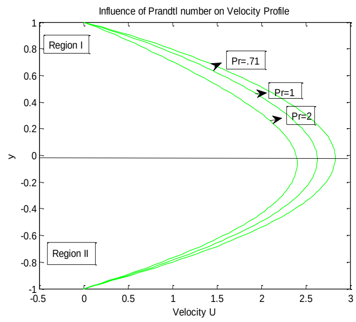

Figure7: Influence of Velocity Profile on Pr

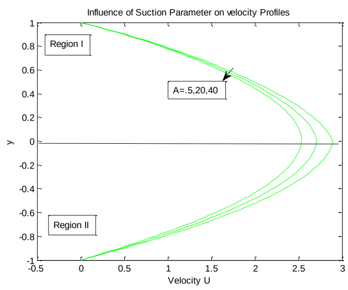

Figure 8: Influence of Suction Parameter on Velocity

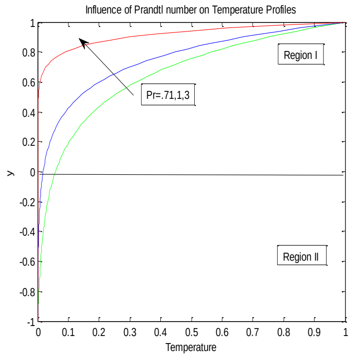

Figure 9: Influence of Temperature Profile on Pr

8. Conclusion:

In this study the following conclusions are made from the diagrams of velocity, temperature and concentration.
The Grashof number(Gr) for heat and mass transfer(Gc) hasten the velocity of the flow field in region I and II at all points. It is more significant for velocity field in presence of mass transfer.
If the radiation parameter and thermal conductivity are larger the velocity and concentration reduction are faster.
Due to diffusing particles the flow field suffers a greater reduction in the velocity.

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