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RESEARCH ARTICLE

RADIATION EFFECT ON UNSTEADY MHD FREE CONVECTION FLOW PAST A VERTICAL POROUS PLATE WITH THERMAL DIFFUSION AND CHEMICAL REACTION

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ABSTRACT

An analysis of radiation effects on unsteady MHD free convection flow past a vertical porous plate with thermal diffusion and chemical reaction have been discussed. The dimensionless governing equations are linear and coupled. These equations are solved analytically by using perturbation technique. The expressions for velocity, temperature and concentration are obtained and discussed their variations under several parameters through graphs. The skin-friction, rate of heat transfer in the form of Nusselt number and the rate of mass transfer in the form of Sherwood number are also derived and discussed through tables.

Key words: Hall current, Chemical reaction, MHD, Radiation, Thermal diffusion, Porous plate.

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INTRODUCTION

Natural Convection flow over vertical surfaces in porous medium has attached paramount importance because of its potential applications in geo-hydrology, soil physics and filtration of solids from liquids, chemical engineering and biological systems. The study of fluid flowing porous medium is based on the empirically determined Darcy's law. Such flows are considered to be useful in diminishing the free convection, which would otherwise occur intensely on a vertical heated surface. In many transport processes existing in nature and in industrial application, heat and mass transfer has a consequence of buoyancy effects caused by diffusing of heat and chemical species. The study of such process is useful to improve a number of chemical technologies, such as polymer production, enhanced oil recovery, underground energy transport, manufacturing of ceramic and food processing. In the literature, extensive research work is available to examine the effect of natural convection on flow past a plate. Examples of this include Vedhanayagam *et al.* (1980), Kolar *et al.* (1988) and Li *et al.* (2001). Transient free convection flow past an isothermal vertical plate was first reported by Siegel (1958) using an integral method. The experimental conformation of these results was discussed by Gold stein *et al.* (1960). A review of transient natural convection presented by Raith by *et al.* (1985) where a large number of papers on this topic heat transfer fundamentals were reviewed. Cramer and Pai (1973) have taken transverse applied magnetic field and magnetic Reynolds numbers which are assumed to be very small, so the introduced magnetic field is negligible. Muthucumaraswamy *et al.* (2006) have studied the effects of homogenous chemical reaction of first order and free convection the oscillating infinite vertical plate with variable temperature and mass diffusion. Sharma (2005) investigated the effect of periodic heat and mass transfer on the unsteady free convection flow past a vertical flat plate in slip flow regime when suction velocity oscillates in time. Anjalidevi *et al.* (2000) studied the effects of chemical reaction on MHD micro polar fluid flow past a vertical plate in slip flow regime. Chaudhary and Jha *et al.* (2008) have examined the effect of chemical reaction on MHD micropolar fluid flow past a vertical plate in slip-flow regime. Alam *et al.* (2005) have presented the Soret and Dufour effects on unsteady MHD free convective and mass transfer flow past a porous vertical plate, in porous medium. Thermal radiation and chemical reaction effects on mass and heat transfer flow of MHD micro polar fluid in rotating frame of reference was analyzed by Das (2005). The exact solution of MHD viscous flow over a shrinking sheet in closed-form was studied by Fang and Zhang (2009). Guria (2007) investigated an oscillatory flow due to eccentrically porous disk and a fluid at infinity. Mackinder (2005) discussed the free convective flow with mass transfer and thermal radiation past a moving porous vertical plate. The leads of thermal radiation on unsteady mixed convective flow and heat transfer over a stretching porous surface in porous medium was noticed by Mukhopadhyay (2009). The influence of a magnetic field on mass and heat transfer from vertical surfaces by natural convection in porous media by considering Dufour and Soret effects were identified by Postelnicu (2004).

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The effects of varying viscosity and thermal conductivity on steady MHD free convective flow and heat transfer along the isothermal plate with internal heat generation was examined by Sharma and Singh (2009).Unsteady effect on MHD free convective and mass transfer flow through porous medium with constant suction and constant heat flux in rotating system studied by Sharma (2004). Jha and Singh (1990) presented an analytical study for free convection and mass transfer flow past an infinite vertical plate moving impulsively in its own plane taking Soret effects into account. However, Gebhart and Millender (1969) have shown that when the temperature difference is small or in high Prandtlnumber fluids or when the gravitational field is of high intensity, viscous dissipative heat should be taken into account in free convection flow past a semi-infinite vertical plate. Anand Rao and Shivaiah (2006) studied the Chemical reaction effects on an unsteady MHD free convection flow past an infinite vertical porous plate with constant suction. Glora (2016) examined Radiation and chemical reaction effects on MHD flow along a moving vertical porous plate. Jewel and Rubel discussed about thermal radiation and mass transfer effects on unsteady MHD free convection flow past a vertical oscillating. The purpose of this present investigation is to analyze the Detour, radiation and chemical reaction effects on MHD free convective flow past an oscillating plate embedded in porous medium. The consequences for various values of several arguments involved in this flow such as the concentration, temperature, velocity fields and their gradients are studied. As a step towards the eventual development in the study of transient MHD free convective chemically reacting fluid in a slip flow regime in the present investigation, it is proposed to obtain the analytical solution for the unsteady MHD free convection flow over a infinite vertical play moving porous plate including the effects of heat absorption, thermo diffusion and chemical reaction thermal radiation with heat source on heat generating fluid past subjected to a variable suction. The governing equations of the flow field are solved for the velocity, temperature, concentration distribution, skin friction, the rate heat transfer and the rate of mass transfer and the effects of various flow parameters on the flow field have been studied and the results are presented graphically and discussed quantitatively.

Mathematical Formulation

Consider an unsteady, two-dimensional, hydromagnatic, laminar, incompressible, viscous, electrically conducting, chemically reacting and radiating fluid flow past an infinite vertical moving porous plate embedded in a porous medium in the presence of heat source. Assuming variable suction at the porous plate, nearly approximate solutions are obtained for velocity, temperature, species concentration. According system, the coordinate system, the x^*-axis is taken along the plate in upward direction and y^*-axis in normal to the plate. Since the plate is infinite in length, therefore all physical quantities are functions of y^* and t^* only.

By use of boundary layer approximation, the governing equations for unsteady flow of a vicious incompressible fluid through a porous medium are:

Momentum equation

$$\frac{\partial u^*}{\partial t^*} - V_0^*(1+\varepsilon A e^{i\omega^* t^*})\frac{\partial u^*}{\partial y^*} = g\beta(T^* - T_\infty^*) + g\beta^*(C^* - C_\infty^*) + \vartheta\frac{\partial^2 u^*}{\partial y^{*2}} - \frac{\sigma\beta_0^2}{\rho}u^* - \frac{\vartheta}{k^*}u^* \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

Energy equation

$$\rho C_p\left[\frac{\partial T^*}{\partial t^*} - V_0^*(1+\varepsilon A e^{i\omega^* t^*})\frac{\partial T^*}{\partial y^*}\right] = \frac{k}{\rho c_p}\frac{\partial^2 T^*}{\partial y^{*2}} + \frac{1}{\rho c_p}\frac{\partial q_r}{\partial y^*} - \frac{Q_0}{\rho c_p}(T^* - T_\infty^*) \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (2)$$

Diffusion equation

$$\frac{\partial C^*}{\partial t^*} - V_0^*(1+\varepsilon A e^{i\omega^* t^*})\frac{\partial C^*}{\partial y^*} = D_M\frac{\partial^2 C^*}{\partial y^{*2}} + D_T\frac{\partial^2 T^*}{\partial y^{*2}} - K_1(C^* - C_\infty^*) \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (3)$$

The boundary conditions for the velocity, temperature and concentration fields are

$$u^* = L^*\left(\frac{\partial u^*}{\partial y^*}\right),\ T^* = T_w^* + \varepsilon(T_w^* - T_\infty^*)e^{i\omega^* t^*},\quad C^* = C_w^* + \varepsilon(C_w^* - C_\infty^*)e^{i\omega^* t^*},\ at\ \ y^* = 0$$

$$u^* \to 0, \qquad T^* \to T_\infty^*, \qquad C^* = C_\infty^* \qquad as\ y^* \to \infty \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots (4)$$

We now introduce the following non-dimensional quantities into equations (1) to (4)

$$y = \frac{y^* V_0^*}{\vartheta},\ t = \frac{t^* V_0^*}{4\vartheta},\ u = \frac{u^*}{V_0^*},\ \omega = \frac{4\vartheta\omega^*}{V_0^{*2}},\ \theta = \frac{T^* - T_\infty^*}{T_w^* - T_\infty^*},\ C = \frac{C^* - C_\infty^*}{C_w^* - C_\infty^*},\ Gr = \frac{g\beta\vartheta(T_w^* - T_\infty^*)}{V_0^{*3}},$$

$$So=\frac{D_1(T_w^*-T_\infty^*)}{\vartheta(C_w^*-C_\infty^*)}Gc=\frac{g\beta^*\vartheta(C_w^*-C_\infty^*)}{V_0^{*3}},\Pr=\frac{\mu C_p}{k}=\frac{\vartheta\rho C_p}{k},Sc=\frac{\vartheta}{D},\ \gamma=\frac{k_1\vartheta}{V_0^{*2}},$$

$$K=\frac{k^*V_0^{*2}}{\vartheta^2},M=\frac{\sigma\beta_0^2\vartheta}{\rho V_0^{*2}},h=\frac{V_0^*L^*}{\vartheta},\frac{\partial q}{\partial y^*}=4T(T_w^*-T_\infty^*)I^*\ ,R=\frac{4\vartheta I^*}{\rho C_P V_0^{*2}}\ ,F=\frac{Q_0\vartheta}{\rho C_P V_0^{*2}}$$

Those the non-dimensional form of the governing equation (1), (2) and (3) are respectively as follows:

$$\frac{1}{4}\frac{\partial u}{\partial t}-(1+\varepsilon Ae^{i\omega t})\frac{\partial u}{\partial y}=Gr\theta+GcC+\frac{\partial^2 u}{\partial y^2}-Mu-\frac{u}{K} \qquad (5)$$

$$\frac{1}{4}\frac{\partial \theta}{\partial t}-(1+\varepsilon Ae^{i\omega t})\frac{\partial \theta}{\partial y}=\frac{1}{\Pr}\frac{\partial^2 \theta}{\partial y^2}-(R+F)\theta \qquad (6)$$

$$\frac{1}{4}\frac{\partial C}{\partial t}-(1+\varepsilon Ae^{i\omega t})\frac{\partial C}{\partial y}=\frac{1}{Sc}\frac{\partial^2 C}{\partial y^2}+So\frac{\partial^2 \theta}{\partial y^2}-\gamma C \qquad (7)$$

The boundary conditions to the problem in the dimensionless form are

$$u=h(\frac{\partial u}{\partial y}),\theta=\ 1+\varepsilon Ae^{i\omega t}\ ,C=1+\varepsilon Ae^{i\omega t}\ \ at\ y=0$$
$$u\to 0,\qquad \theta\to 0,\qquad C\to 0\qquad as\ \ y\to\infty \qquad (8)$$

Methods of Solution

In order to reduce the above system of ordinary differential equations in dimensionless form let the small amplitude oscillations ($\varepsilon << 1$), we can represent the velocity u, temperature θ and concentration C, near the plate as follows:

$$u(y,t)=u_0(y)+\varepsilon u_1(y)e^{i\omega t} \qquad (9)$$

$$\theta(y,t)=\theta_0(y)+\varepsilon\theta_1(y)e^{i\omega t} \qquad (10)$$

$$C(y,t)=C_0(y)+\varepsilon C_1(y)e^{i\omega t} \qquad (11)$$

Substituting (9) to (11) in (5) to (7), equating the coefficients of harmonic and non harmonic terms, neglecting the coefficient of

ε^2 we get $u_0^{11}(y)+u_0^1(y)-\left(M+\frac{1}{k}\right)u_0(y)=Gr\theta_0(y)-GcC_0(y)$ (12)

$$u_1^{11}(y)+u_1^{1}(y)-(M+\frac{1}{K}+\frac{i\omega}{4})u_1(y)=-G_r\theta_1(y)-GcC_1(y)-Au_0^1(y) \qquad (13)$$

$$\theta_0^{11}(y)+\Pr\theta_0^{1}(y)-F_1\theta_0(y)=0 \qquad (14)$$

$$\theta_1^{11}(y)+\Pr\theta_1^{1}(y)-\frac{\Pr i\omega}{4}\theta_1(y)=-A\Pr\theta_0^{1}(y) \qquad (15)$$

$$C_0^{11}(y)+ScC_0^{1}(y)-\gamma ScC_0(y)=-ScS0\ \theta_0^{11}(y) \qquad (16)$$

$$C_1^{11}(y)+ScC_1^{1}(y)-(\frac{i\omega Sc}{4}+\gamma Sc)C_1(y)=-AScC_0^{1}(y)-ScSo\ \theta_1^{11}(y) \qquad (17)$$

The corresponding boundary conditions reduce to

$$u_0 = h(\frac{\partial u_0}{\partial y}), u_1 = h(\frac{\partial u_1}{\partial y}), \theta_0 = 1, \theta_1 = 1, C_0 = 1, C_1 = 1 \quad at \quad y = 0$$

$$u_0 = 0, \quad u_1 = 1, \theta_0 = 0, \theta_1 = 0, C_0 = 0, C_1 = 0 \quad as \quad y \to \infty \quad \text{.......... (18)}$$

While primes denote the differentiation with respect to y.

Solving the equations (12) to (17) under the boundary conditions and then put these values in equations (9) to (11), we get

$$u = (n_{23} + \varepsilon e^{i\omega t} n_{33}) e^{-n_{17} y} - (n_{22} + \varepsilon n_{39} e^{i\omega t}) e^{-n_1 y} - (n_{20} + \varepsilon e^{i\omega t} n_{38}) e^{-n_6 y} + \varepsilon e^{i\omega t} (n_{40} e^{-n_{24} y} + e^{n_{25} y} + n_{36} e^{-n_3 y} + n_{37} e^{-\Pr y} - n_{28} e^{-n_{10} y} \quad \text{.......... (19)}$$

$$\theta = (1 - \varepsilon n_5 e^{i\omega t}) e^{-\Pr y} + \varepsilon (1 + n_5) e^{-n_3 y} e^{i\omega t} \quad \text{.......... (20)}$$

$$C = (n_9 + \varepsilon n_{22} e^{i\omega t}) e^{-n_6 y} + (n_8 + \varepsilon n_{13} e^{i\omega t}) e^{-n_1 y} + \varepsilon ((1 + n_{16}) e^{-n_{10} y} - n_{14} e^{-n_3 y} + n_{15} e^{-\Pr y}) e^{i\omega t} \quad \text{.......... (21)}$$

Now to calculate the Skin friction, the rate of heat transfer (Nusselt number) and the rate of mass transfer (Sherwood Number).

$$\tau = \left(\frac{\partial u}{\partial y} \right)_{y=0} = -n_{17} \left(n_{23} + \varepsilon n_{33} e^{i\omega t} \right) + n_{14} \left(n_{22} + \varepsilon n_{39} e^{i\omega t} \right) + n_6 \left(n_{20} + \varepsilon n_{38} e^{i\omega t} \right) + \varepsilon e^{i\omega t} (-n_{24} n_{40} + n_{25} - n_3 n_{36} - \Pr n_{37} + n_{10} n_{28}) \quad \text{.......... (22)}$$

$$Nu = -\left(\frac{\partial \theta}{\partial y} \right)_{y=0} = \Pr (1 - \varepsilon n_5 e^{i\omega t}) + \varepsilon n_3 e^{i\omega t} (1 + n_5) \quad \text{.......... (23)}$$

$$Sh = -\left(\frac{\partial C}{\partial y} \right)_{y=0} = -n_6 \left(n_9 + \varepsilon n_{12} e^{i\omega t} \right) + n_1 \left(n_8 + \varepsilon n_{13} e^{i\omega t} \right) - \varepsilon e^{i\omega t} (-n_{10} (1 + n_{16}) + n_3 n_{14} - \Pr n_{15}) \quad \text{.......... (24)}$$

RESULTS AND DISCUSSION

The linear coupled equations (12)-(17) subject to the boundary conditions (18), which illustrate the radiation effects on unsteady MHD free conviction flow past a vertical porous plate with thermal diffusion and the chemical reactions have been discussed. In order to get a physical insight of the problem, the above physical quantities are computed numerically for different values of the governing parameters. The velocity profile for different values of thermal Grashof number (Gr), Solutalgrash of number (Gc), Prandtl number (Pr), Magnetic parameter (M), Schmidt number (Sc), Sorret number (So), Porosity parameter (k), Radiation parameter (R), chemical reaction parameter (γ), Heat source parameter (F) are shown in the figures (1) to (11) respectively. Fig(1) & (2) shows the effective of thermal grashof number & Solutal grashof number on velocity distribution. It is observed that the velocity increases with increasing values of both the numbers. This is due to the fact that the buoyancy which is acting on the fluid particals due to gravitational forces that enhances the fluid velocity. Fig (3) shows the effect of Magnetic parameter on velocity distribution. It is seen that the velocity decreases with increasing values of Magnetic parameter. It is known fact that the application transfers Magnetic field which is applied normal to the flow, result in a flow resistive force called the Lorentz force which acts in the opposite direction of the flow. This force has the effect of slowing the motion of the fluid. Fig (4) displays the effect of Prandtl number on velocity distribution. It is observed that the velocity decreases with increasing values of Prandtl number. It is due to the fact that fluids with high Prandtl number will have high viscosity and hence fluid moves slowly. Fig (5) shows the effect of porous permeability parameter on velocity. It is seen that as the porosity parameter values increases the velocity also increases. Physically an increase in the permeability of porous medium leads the rise in the flow of fluid through it. When the holes of the medium become large, the resistance of the medium may be neglected. Fig (6) displays the effect of radiation parameter on velocity distribution. It is observed that the velocity increases with increasing values of radiation parameter.

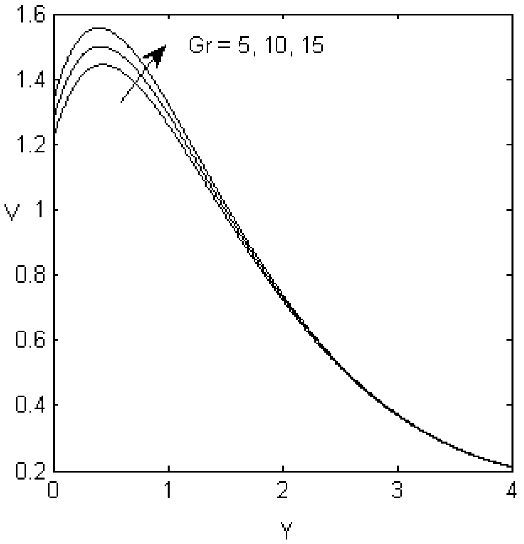

Fig. 1. Velocity profile under the influence of Gr Grash of number

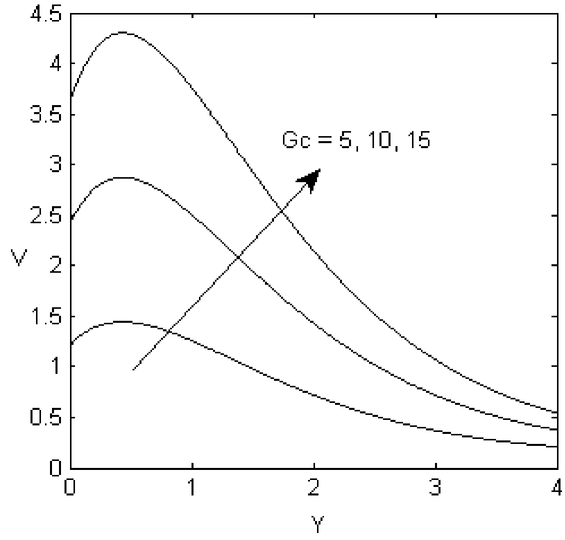

Fig. 2. Velocity profile under the influence of Solutal zrash of number Gc

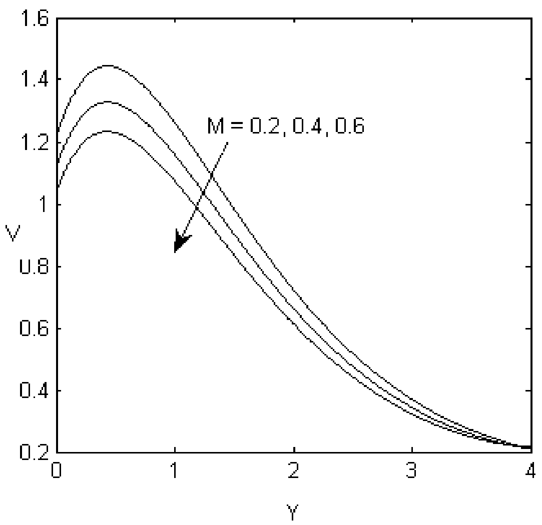

Fig. 3. Velocity profile under the influence of magnatic parameter

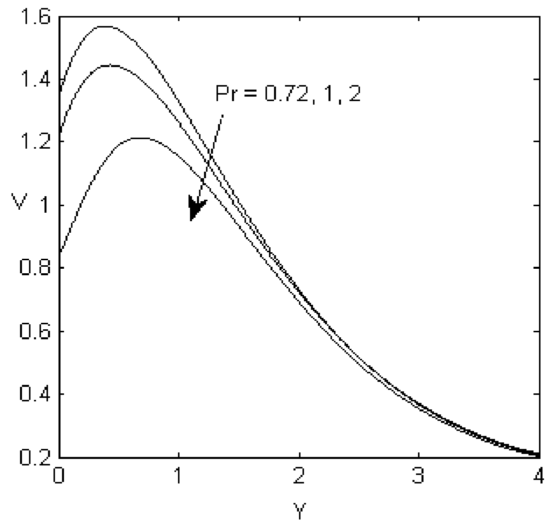

Fig. 4. Velocity profile under the influence of M Prandtl number Pr

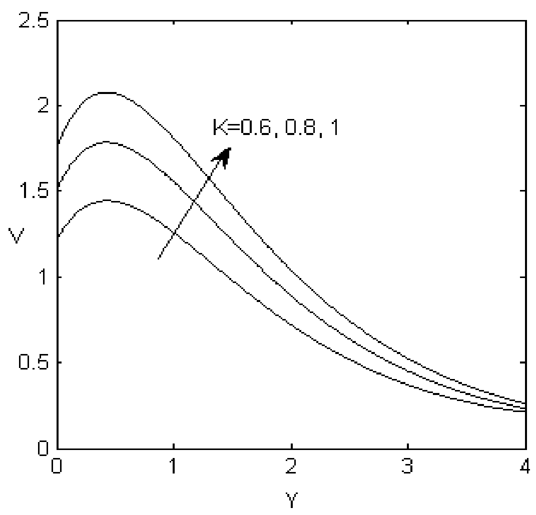

Fig. 5. Velocity profile under the influence of Porosity parameter K

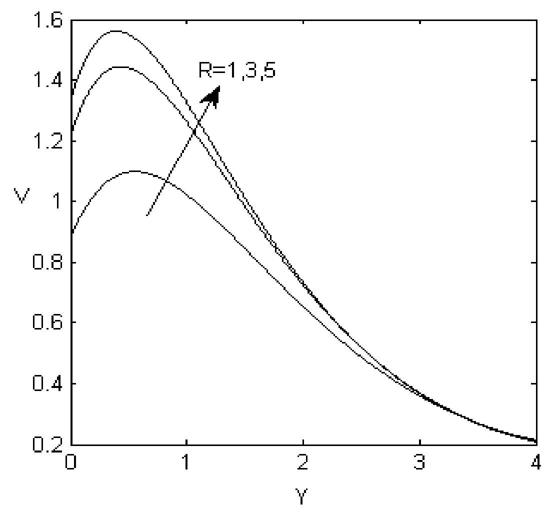

Fig. 6. Velocity profile under the influence of Radiation parameter R

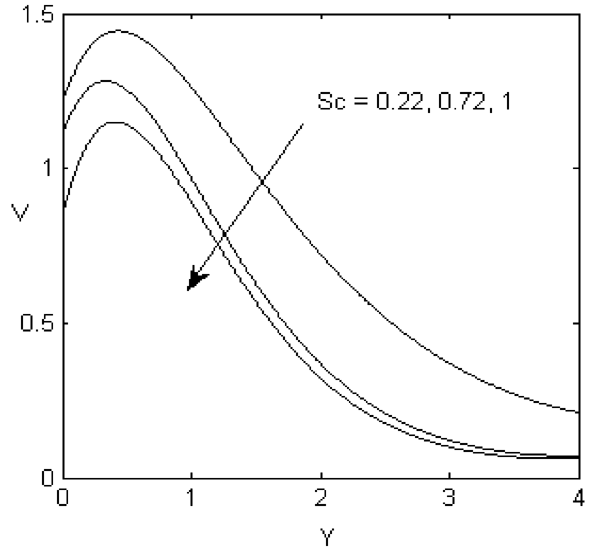

Fig. 7. Velocity profile under the influence of heat source parameter F

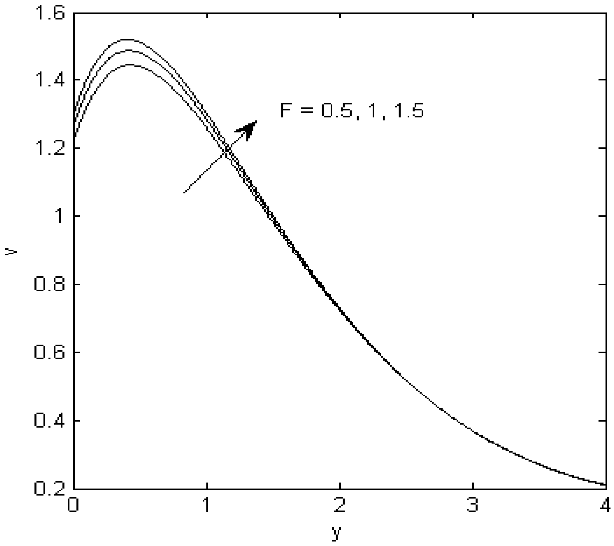

Fig. 8. Velocity profile under the influence of Schmidt number Sc

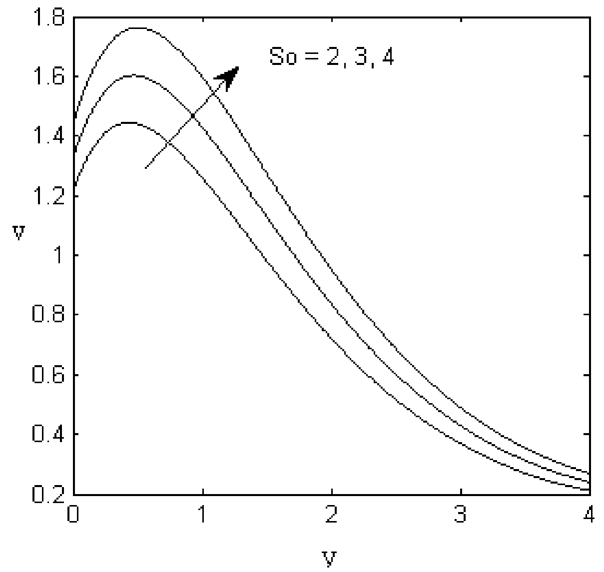

Fig. 9. Velocity profile under the influence of Soret Number So

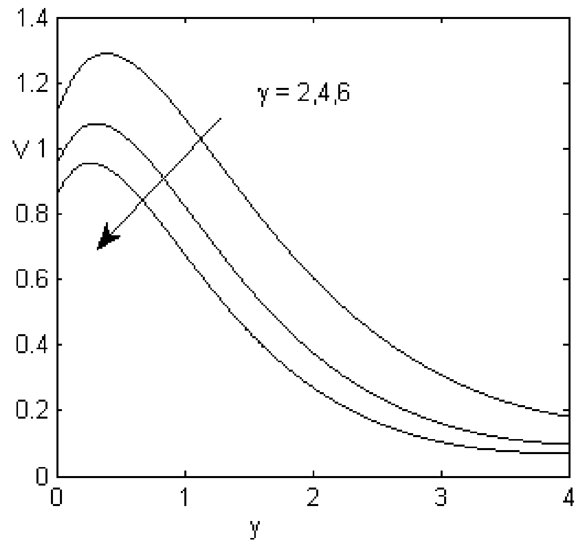

Fig. 10. Velocity profile under the influence of chemical reaction parameter γ

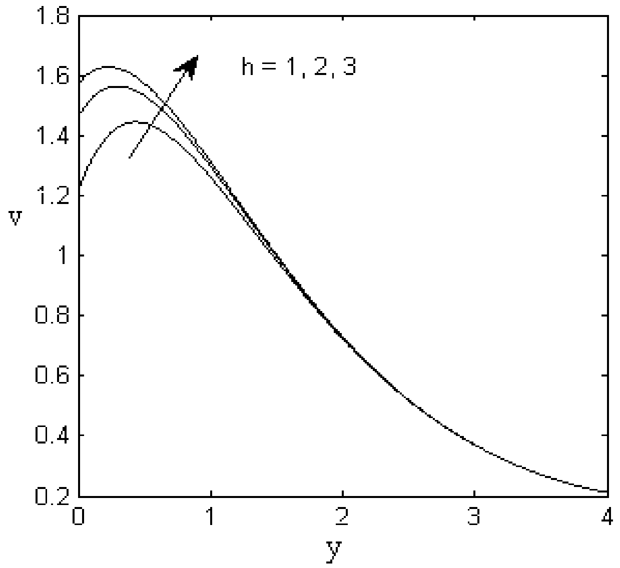

Fig. 11. Velocity profile under the influence of Rarefaction parameter h

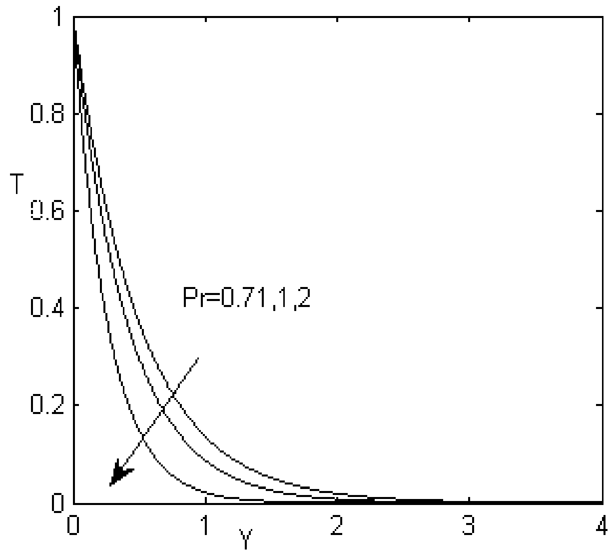

Fig. 12. Temperature profile under the influence of Prandtl number Pr

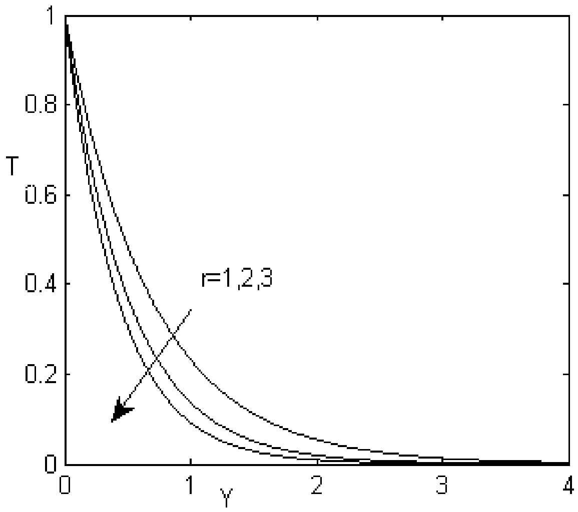

Fig 13. Temperature profile under the influence of radiation parameter R

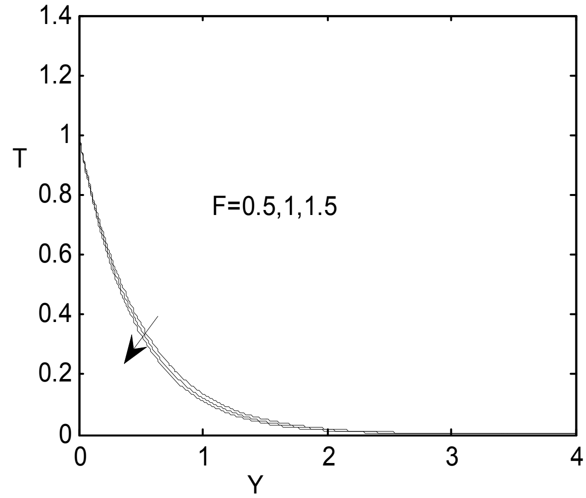

Fig 14. Temperature profile under the influence of heat source parameter F

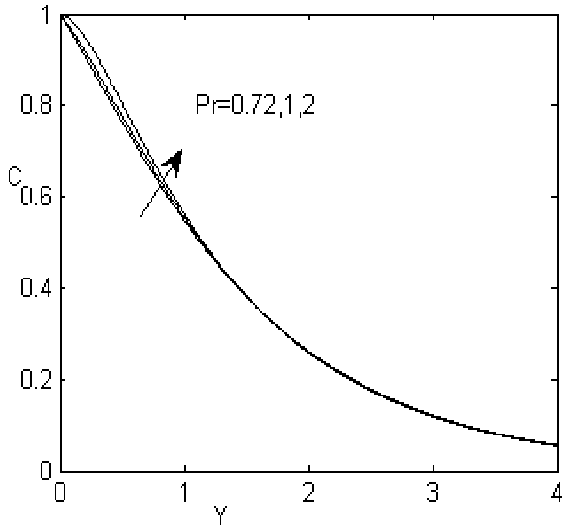

Fig. 15. Concentration profile under the influence of Prandtl number Pr

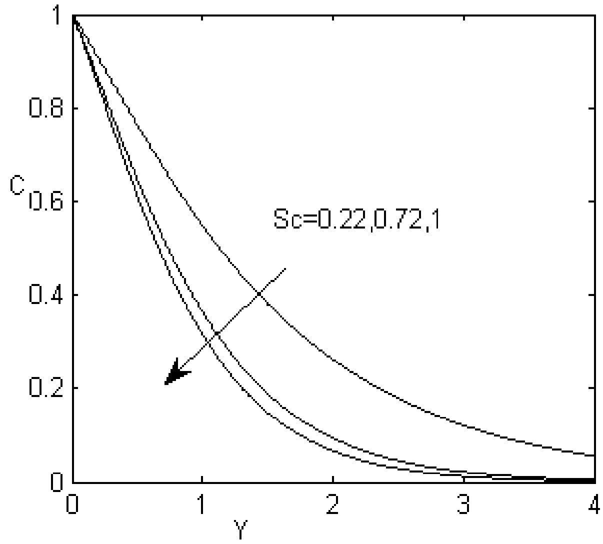

Fig. 16. Concentration profile under the influence of Schmidt number Sc

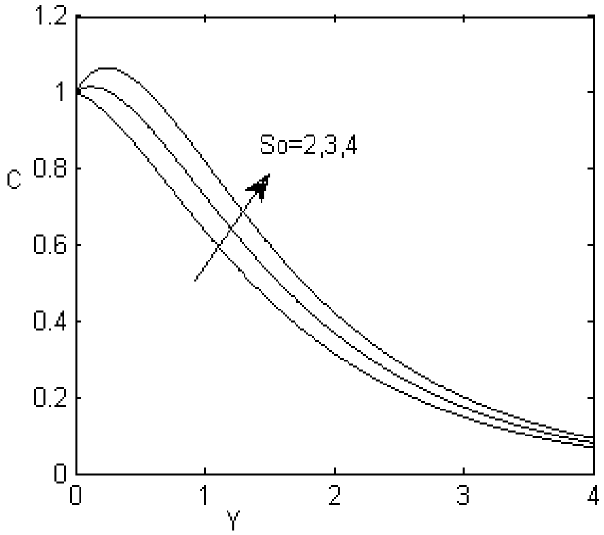

Fig. 17. Concentration profile under the influence of Soret number So

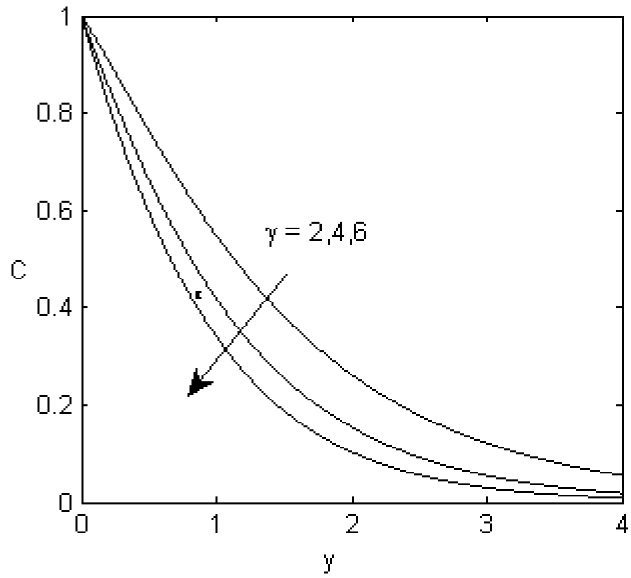

Fig. 18. Concentration profile under the influence of chemical reaction parameter γ

Fig (7) shows the effect of heat source parameter on velocity distribution. It is observed that the velocity increases with increasing values of heat source parameter. Fig (8) displays the effect of Schmidt number on velocity distribution. It is observed that the velocity decreases with increasing values of Schmidt number. Physically this is true as Schmidt number increasing velocity of the fluid also increases that results decreasing velocity. Fig (9) shows the effect of Sorret number and velocity distribution. It is seen that the velocity increases with increasing values of Sorret number. Fig (10) displays the effect of chemical reaction parameter on velocity distribution. It is observed that the velocity decreases with increasing values of chemical reaction. Fig (11) shows the effect of constant parameter h on velocity distribution. It is observed that the velocity increases with increasing values of constant parameter h. Figures (12) to (14) show that the temperature profiles for different values of Prandtl number (Pr), Radiation parameter (R) and heat source parameter (F). Fig (12) shows the effect of Prandtl number on temperature distribution. It is observed that the temperature decrease with increasing values of Prandtl number. This occurs because reduced to velocity would mean that, is not conversed readily and hence surface temperature decreases. Fig (13) shows the effect of radiation parameter on temperature distribution. It is observed that the temperature decreases with increasing values of radiation parameter. Fig (14) displays the effect of heat source parameter on temperature distribution. It is observed that the temperature decreases with increasing values of heat source parameter. The concentration profiles for different values of Prandtl number (Pr), Schmidt number (Sc), Sorret number(So) and chemical reaction parameter (γ) are shown in figures (15)to(18).Fig(15) shows the effect of Prandtl number and concentration distribution. It is observed that the concentration increases with increasing values of Prandtl number. Fig(16) displays the effect Schmidt number (Sc) on concentration distribution. It is noticed that as the Schmidt number increases there is a decreasing trend in the concentration field. Not much of significant contribution of Schmidt number is observed for away from the plate. Fig(17)displays the effect of Sorret number on concentration distribution. It is observed that the concentration increases with increasing values of Sorret number. Fig(18) shows the effect of chemical reaction parameter on concentration distribution .It is observed that the concentration decreases with increasing values of chemical reaction. From Table 1 it is noticed that an increasing in thermal Grashaf number(Gr), solutable Grashof number (Gc), porosity parameter(k), Prandtl number(Pr), radiation parameter(R), heat source parameter(F)and Nusselt number (So) results on increasing skin friction, while it decreases with an increase in magnetic parameter(M), Schmidt number (Sc) and chemical reaction parameter(γ)respectively. Table 2 shows the effects of Prandtl number (Pr), radiation parameter(R) and heat source parameter (F), and Soret number (So) results on increasing skin friction while it decreases with an increase in magnetic parameter (M), Schmidt number(Sc)and chemical reaction parameter(γ)respectively. Table 2 shows the effects of Prandtl number (Pr), radiation parameter(R), heat source parameter(F)numerically on rate of heat transfer Nu. It is noticed that the rate of heat transfer decreases with increasing values of Prandtl number (Pr), radiation parameter (R) and heat source parameter r(F) respectively. Table 3 shows the effects of Prandtl number (Pr), radiation parameter (R), heat source parameter (F), Schmidt number (Sc), Soret number (So) and chemical reaction parameter (γ) on rate of mass transfer (Sh) numerically. It is observed that the rate of mass tr1ansfer increases with increasing values of radiation parameter(R), heat source parameter (F), Schmidt number (Sc), and chemical reaction parameter (γ), while it decreases in the case of Prandtl number (Pr) and Soret number(So) respectively.

Table 1. Skin friction τ for different values of M, Pr, $Sc, So, \gamma, Gr, Gc, k$ with fixed values h, ε, ω, t.

M	Gr	Gc	k	Pr	R	F	Sc	So	γ	τ
0.2	5	5	0.6	0.72	3	0.5	0.22	1	2	1.1026
0.4	5	5	0.6	0.72	3	0.5	0.22	1	2	1.0112
0.2	10	5	0.6	0.72	3	0.5	0.22	1	2	1.1631
0.2	5	10	0.6	0.72	3	0.5	0.22	1	2	2.1919
0.2	5	5	0.8	0.72	3	0.5	0.22	1	2	1.3701
0.2	5	5	0.6	1.0	3	0.5	0.22	1	2	1.2155
0.2	5	5	0.6	0.72	5	0.5	0.22	1	2	1.2807
0.2	5	5	0.6	0.72	3	1	0.22	1	2	1.1416
0.2	5	5	0.6	0.72	3	1	0.3	1	2	1.0448
0.2	5	5	0.6	0.72	3	1	0.3	2	2	1.2145
0.2	5	5	0.6	0.72	3	1	0.22	1	3	1.0106

Table 2. Nusselt number Nu for different values 0f Pr,r,f with fixed values ε, ω, t

Pr	R	F	Nu
0.72	3	0.5	0.7211
1	3	0.5	0.3477
1	5	0.5	0.6004
1	3	1	0.6319

Table 3. Sherwood number Sh for different values of Pr, r, f, Sc, So with fixed values ω, t, ε

Pr	R	F	Sc	So	γ	Sh
0.72	3	0.5	0.22	1	2	0.4424
1	3	0.5	0.22	1	2	0.3471
0.72	5	0.5	0.22	1	2	0.6004
0.72	3	1	0.22	1	2	0.5907
0.72	3	0.5	0.3	1	2	0.701
0.72	3	0.5	0.22	2	2	0.4176
0.72	3	0.5	0.22	1	3	0.762

Conclusion

Heat and mass transfer of MHD radiating fluid flow past a moving vertical porous plate with variable suction in the presence of heat source and chemical reaction.The set of linear coupled partial differential equations ae solved analytically and the results are presented and discussed through MATLAB software. The results are as follows.

- The velocity decreases with an increase in magnatic field parameterM, Schmidt number Sc, Chemical reaction parameter γ, Prandtl number Pr. But the velocity increases with an increase in radiation parameter R, heat source parameter F, soret number So, solutal grashoff number Gc, porocity parameter K, rarefaction parameter h.
- The temperature decreases with an increase in heat source parameter F, radiation parameter R, Prandtl number Pr.
- The concentration increases with an increase in Prandtl number Pr, soret number So.But the concentration decreases with an increase in Schmidt number Sc, Chemical reaction parameter γ.
- The skin friction increase of grashof number Gr, solutal grashof number Gc, porocity parameter K, Prandtl number Pr, radiation parameter R, heat source parameter F, soret number So. But the skin friction τdecreases with an increase in magnatic field parameterM, Schmidt number Sc, Chemical reaction parameter γ.
- The Nusselt number(Nu) decreases with the increase of Prandtl number Pr, radiation parameter R, heat source parameter F.
- The Sherwood number(Sh) decreases with the increase of Prandtl number Pr, soret number So.But the Sherwood nunber increases with the increase of Chemical reaction parameter γ, heat source parameter F, radiation parameter R, Schmidt number Sc.

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