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Magneto-convective and radiation absorption fluid flow with variable temperature and concentration in the presence of thermal diffusion

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Abstract - In this paper, we have investigated an unsteady, magneto hydrodynamic, convection flow of a fluid past an infinite permeable plate in the presence of thermal diffusion. A transverse magnetic field of uniform strength is applied perpendicular to the plate along the direction of the flow. The non-dimensional governing equations have been solved by using finite difference method subject to the corresponding boundary conditions. The effects of various physical parameters on flow quantities such as velocity, temperature and concentration are studied through graphs. The expressions for local skin friction, Nusselt number and Sherwood number are derived and discussed with the help of tables.

Key words: MHD, Radiation, Soret number, Finite difference method, Thermal diffusion.

I. INTRODUCTION

MHD is an important branch of fluid dynamics. The studies on MHD are concerned with the association of electromagnetic fluids and electrically conducting fluids. When a conducting fluid moves through a magnetic field, an electric field and consequently current may be induced and, in turn the current interacts with the magnetic field to produce a body force. MHD interactions occur both in nature and new man-made devices. MHD flow occurs in the sun, interior of the earth, the ionosphere, the stars and their atmosphere, to mention a few. MHD is directly utilized in laboratory in making new devices such as propulsion units and power generators or which involve fluid –electromagnetic field interactions, such as electron beam dynamics, travelling wave tubes, electrical discharges and many others. Afify [1] analyzed MHD free convective flow and mass transfer over a stretching sheet with chemical reaction. Chamkha and Ahmed [2] studied similarity solution for unsteady MHD flow near a stagnation point of a three dimensional porous body with heat and mass transfer, heat generation/ absorption and chemical reaction. Das and Mitra [4] deliberated unsteady mixed convective MHD flow and mass transfer past an accelerated infinite vertical plate with suction. Harinath Reddy et al. [5] studied unsteady MHD free convection flow of a Kuvshinski fluid past a vertical porous plate in the presence of chemical reaction and heat source/sink. Hayat and Mehmood [6] considered slip effects on MHD flow of third order fluid in a planar channel. Kim [8] studied unsteady MHD convective heat transfer past a semi – infinite vertical porous moving plate with variable suction. Makinde and Mhone [9] found heat transfer to MHD oscillatory flow in a channel filled with porous medium. Sharma and Singh [23] analyzed effects of variable thermal conductivity and heat source/sink on MHD flow near a stagnation point on a linearly stretching sheet. Umamaheswar et al. [26] analyzed unsteady MHD free convective visco-elastic fluid flow bounded by an infinite inclined porous plate in the presence of heat source, viscous dissipation and Ohmic heating.

Radiation is the processes by which heat energy is transmitted from one place to another without the aid of any material medium. When a body is hot, the energy of vibration of the atoms and molecules is sent out from it in the form of radiant heat waves. These waves when falling on another body induce the molecules to vibrate there and hence the body is heated up. In the case of conduction and convection the intervening medium takes an active part in the process. But in the case of radiation the intervening medium has no such function. For example the radiation from the sun travels through vacuum and then through the atmosphere and reaches us. So even without the aid of any material medium heat energy is transmitted. Radiation from hot bodies consists of electromagnetic waves of higher wavelengths, radiation energy is also found beyond the violet and it is called ultraviolet. When infrared radiation falls on the skin, it gives the sensation of warmth. Ultraviolet radiation is absorbed by human skin and causes sun-burn; it stimulates the formation of vitamin D which is necessary for the assimilation of calcium and the prevention of rickets. Green plants produce carbohydrates from water and carbon dioxide by using absorbed ultraviolet radiation. This process is called photosynthesis. Radiation travels in a straight line with the speed of light. It is reflected and

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refracted according to laws which are as those of light. A protect black body is a good radiator as well as. Muthucumaraswamy [10] studied radiative heat and mass transfer effects on moving isothermal vertical plate in the presence of chemical reaction. Raju et al. [13] studied radiation and mass transfer effects on a free convection flow through a porous medium bounded by a vertical surface. Raptis et al. [14] analyzed effects of radiation in an optically thin gray gas flowing past a vertical infinite plate in the presence of a magnetic field. Ravikumar et al. [15] analyzed magnetic field and radiation effects on a double diffusive free convective flow bounded by two infinite impermeable plates in the presence of chemical reaction. Reddy et al. [16] deliberated chemical reaction and radiation effects on MHD free convection flow through a porous medium bounded by a vertical surface with constant heat and mass flux. Seddeek [17] considered thermal radiation and buoyancy effects on MHD free convective heat generating flow over an accelerating permeable surface with temperature dependent viscosity. Seddeek et al. [19] considered effects of chemical reaction and variable viscosity on hydromagnetic mixed convection heat and mass transfer for Hiemenz flow through porous media with radiation. Seth et al. [22] analyzed effects of thermal radiation and rotation on unsteady hydromagnetic free convection flow past an impulsively moving vertical Plate with ramped temperature in a porous medium. Seth [20] studied magnetohydrodynamics flow over a permeable non-linearly stretching surface with effects of viscous dissipation and thermal radiation. Seth et al. [19] analyzed effects of Hall current and rotation on unsteady MHD natural convection flow with heat and mass transfer past an impulsively moving vertical plate in the presence of radiation and chemical reaction.

When heat and mass transfer occur simultaneously in a moving fluid, the relations between the driving potentials and fluxes are of more significant. It has been observed that energy flux can be generated by temperature gradients and also concentration gradients. The energy flux which is generated by a concentration gradient is termed the diffusion-thermo (Dufour) effect. On the other hand, mass flux can also be caused by temperature gradients and this embodies the thermal-diffusion (Soret) effect. In several studies belonging to heat and mass transfer phenomena, Soret and Dufour effects are neglected on the basis that they are of a smaller order of magnitude than the effects described by Fourier's and Fick's laws. But these effects may become significant when they are considered as second order phenomena and in the areas of petrology, hydrology, geosciences, etc. The Soret effect has been utilized for isotope separation and in mixture between gases with very less molecular weight and of average molecular weight. The Dufour effect was found of considerable magnitude so that it cannot be neglected. Soret and Dufour effects are important for studying intermediate molecular weight gases in coupled heat and mass transfer in binary systems of the fluid, often encountered in chemical engineering process. Chandra Reddy et al. [3] considered Thermal and solutal buoyancy effect on MHD boundary layer flow of a visco-elastic fluid past a porous plate with varying suction and heat source in the presence of thermal diffusion. Hayat and Nawaz [7] analyzed Soret and Dufour effects on the mixed convection flow of a second grade fluid subject to Hall and ion-slip currents. Narayana and Murthy [11] studied Soret and Dufour effects in a doubly stratified Darcy porous medium. Patil et al. [12] considered double diffusive mixed convection flow over a moving vertical plate in the presence of internal heat generation and a chemical reaction. Seddeek [18] considered thermal-diffusion and diffusion-thermo effects on mixed free forced convective flow and mass transfer over accelerating surface with a heat source in the presence of suction and blowing in the case of variable viscosity. Seth et al. [21] analyzed MHD natural convection flow with radiative heat transfer past an impulsively moving vertical plate with ramped temperature in the Presence of Hall Current and thermal diffusion. Srinivasacharya and Upendar [24] analyzed Soret and Dufour effects on MHD free convection in a micro-polar fluid. Srinivasacharya and Kaladhar [25] studied Soret and Dufour effects on mixed convection flow of couple stress fluid in a non-Darcy porous medium with heat and mass fluxes.

II. FORMULATION OF THE PROBLEM

We consider a viscous incompressible, electrically conducting, heat absorbing/generating and chemically reacting Newtonian fluid flow past an infinite vertical porous. A magnetic field of uniform strength is applied perpendicular to the plate. Let x^*-axis is taken along the plate in the vertically upward direction and the y^*-axis is taken perpendicular to the plate. At time $t^* \leq 0$, the plate is maintained at the temperature higher than ambient temperature T_∞^* and the fluid is at rest. At time $t^* > 0$, the plate is linearly accelerated with increasing time in its own plane and also at time $t^* > 0$ the temperature and Concentration of the plate $y^* = 0$ is raised to $T_\infty^* + \left(T_w^* - T_\infty^*\right)e^{a^* t^*}$ *and* $C_\infty^* + \left(C_w^* - C_\infty^*\right)e^{a^* t^*}$ with time t and thereafter remains constant and that of $y^* \to \infty$ is lowered to T_∞^* and C_∞^*. It is assumed that the effect of viscous dissipation is negligible. By usual Boussineq's and boundary layer approximation, the unsteady flow is governed by the following equations:

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$$\frac{\partial u^*}{\partial t^*}=\nu\frac{\partial^2 u^*}{\partial y^{*2}}+g\beta\left(T^*-T^*_\infty\right)+g\beta^*\left(C^*-C^*_\infty\right)-\frac{\sigma B_0^2 u^*}{\rho}-\frac{\nu}{K_p^*}u^* \quad (1)$$

$$\rho C_p\frac{\partial T^*}{\partial t^*}=k\frac{\partial^2 T^*}{\partial y^{*2}}-\frac{\partial q_r^*}{\partial y^*}-Q^*\left(T^*-T^*_\infty\right)+Q_1\left(C^*-C^*_\infty\right) \quad (2)$$

$$\frac{\partial C^*}{\partial t^*}=D\frac{\partial^2 C^*}{\partial y^{*2}}-K_r^*\left(C^*-C^*_\infty\right)+D_1\frac{\partial^2 T^*}{\partial y^{*2}} \quad (3)$$

The corresponding initial and boundary conditions are

$$\left.\begin{array}{ll} u^*=0, T^*=T^*_\infty, C^*=C^*_\infty & \text{for all } y^*, t^*\le 0 \\ t^*>0: u^*=U_0\,e^{a^*t^*}, T^*=T^*_\infty+\left(T^*_w-T^*_\infty\right)e^{a^*t^*}, & \\ C^*=C^*_\infty+\left(C^*_w-C^*_\infty\right)e^{a^*t^*} & \text{at } y^*=0 \\ u^*\to 0, T^*\to T^*_\infty, C^*\to C^*_\infty & \text{as } y^*\to\infty \end{array}\right\} \quad (4)$$

Where $a=\frac{a^*\nu}{U_0^2}$

The non-dimensional quantities are as follows:

$$u=\frac{u^*}{U_0}, t=\frac{t^*U_0^2}{\nu}, y=\frac{y^*U_0}{\nu}, \theta=\frac{T^*-T^*_\infty}{T^*_w-T^*_\infty}, C=\frac{C^*-C^*_\infty}{C^*_w-C^*_\infty}, Gr=\frac{\nu g\beta\left(T^*_w-T^*_\infty\right)}{U_0^3},$$

$$Gm=\frac{\nu g\beta^*\left(C^*_w-C^*_\infty\right)}{U_0^3}, M=\frac{\sigma B_0^2\nu}{\rho U_0^2}, K=\frac{K_p^* U_0^2}{\nu^2}, \Pr=\frac{\rho\nu C_p}{k}, Q=\frac{Q^*\nu}{\rho C_p U_0^2},$$

$$\frac{\partial q_r^*}{\partial y^*}=4\left(T^*-T^*_\infty\right)I^*, R=\frac{4\nu I^*}{\rho C_p U_0^2}, \chi=\frac{Q_1\nu\left(C^*_w-C^*_\infty\right)}{\rho C_p U_0^2\left(T^*_w-T^*_\infty\right)},$$

$$Sc=\frac{\nu}{D}, Kr=\frac{K_r^*\nu}{U_0^2}, S_0=\frac{D_1\left(T^*_w-T^*_\infty\right)}{\nu\left(C^*_w-C^*_\infty\right)}$$

After introducing the non-dimensional quantities into the equations (1)-(3), these equations reduces to

$$\frac{\partial u}{\partial t}=\frac{\partial^2 u}{\partial y^2}+Gr\,\theta+Gm\,C-M\,u-\frac{1}{K}u \quad (5)$$

$$\frac{\partial \theta}{\partial t}=\frac{1}{\Pr}\frac{\partial^2\theta}{\partial y^2}-R\theta-Q\theta+\chi C \quad (6)$$

$$\frac{\partial C}{\partial t}=\frac{1}{Sc}\frac{\partial^2 C}{\partial y^2}-Kr\,C+S_0\frac{\partial^2\theta}{\partial y^2} \quad (7)$$

The corresponding initial and boundary conditions are

$$\left.\begin{array}{ll} u=0, \theta=0, C=0 & \text{for all } y, t\le 0 \\ t>0: u=e^{at}, \theta=e^{at}, C=e^{at} & \text{at } y=0 \\ u\to 0, \theta\to 0, C\to 0 & \text{as } y\to\infty \end{array}\right\} \quad (8)$$

III. METHOD OF SOLUTION

Equations (5)-(7) are linear partial differential equations and are to be solved by using the initial and boundary conditions (8). However exact solution is not possible for this set of equations and hence we solve these equations by finite-difference method. The equivalent finite difference schemes of equations for (5)-(7) are as follows:

$$\frac{u_{i,j+1}-u_{i,j}}{\Delta t}=Gr\,\theta_{i,j}+Gm\,C_{i,j}+\frac{u_{i-1,j}-2u_{i,j}+u_{i+1,j}}{\left(\Delta y\right)^2}-M\,u_{i,j}-\frac{1}{K}u_{i,j} \quad (9)$$

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$$\frac{\theta_{i,j+1}-\theta_{i,j}}{\Delta t}=\frac{1}{\Pr}\frac{\theta_{i-1,j}-2\theta_{i,j}+\theta_{i+1,j}}{(\Delta y)^2}-R\theta_{i,j}-Q\theta_{i,j}+\chi C_{i,j}+Df\frac{C_{i-1,j}-2C_{i,j}+C_{i+1,j}}{(\Delta y)^2} \quad (10)$$

$$\frac{C_{i,j+1}-C_{i,j}}{\Delta t}=\frac{1}{Sc}\frac{C_{i-1,j}-2C_{i,j}+C_{i+1,j}}{(\Delta y)^2}-Kr\,C_{i,j}+S_0\frac{\theta_{i-1,j}-2\theta_{i,j}+\theta_{i+1,j}}{(\Delta y)^2} \quad (11)$$

Here, the suffix i refer to y and j to time. The mesh system is divided by taking $\Delta y = 0.1$. From the initial condition in (8), we have the following equivalent:

$$u(i,0)=0,\ \theta(i,0)=0, C(i,0)=0 \text{ for all } i \quad (12)$$

The boundary conditions from (8) are expressed in finite-difference form as follows

$$u(0,j)=e^{at}, \theta(0,j)=e^{at}, C(0,j)=e^{at} \text{ for all } j$$
$$u(i_{max},j)=0, \theta(i_{max},j)=0, C(i_{max},j)=0 \text{ for all } j \quad (13)$$

(Here i_{max} was taken as 200)

First the velocity at the end of time step viz, u (i, j+1) (i=1,200) is computed from (9) in terms of velocity, temperature and concentration at points on the earlier time-step. Then θ (i, j +1) is computed from (10) and C (i, j +1) is computed from (11). The procedure is repeated until t = 0.5 (i.e. j = 500). During computation Δt was chosen as 0.001.

The finite difference schemes are inserted in MATLAB program and graphs are plotted.

Skin-friction:

The skin-friction in non-dimensional form is given by

$$\tau=\left(\frac{\partial u}{\partial y}\right)_{y=0}, \textit{where } \tau=\frac{\tau^1}{\rho u_0^2}$$

Rate of heat transfer:

The dimensionless rate of heat transfer is given by

$$Nu=\left(\frac{\partial \theta}{\partial y}\right)_{y=0}$$

Rate of mass transfer:

The dimensionless rate of mass transfer is given by

$$Sh=\left(\frac{\partial C}{\partial y}\right)_{y=0}$$

IV. RESULT AND DISCUSSION

In order to reveal the effects of various parameters on the dimensionless velocity field, temperature field, concentration field, skin friction, Nusselt number and Sherwood number. The effects of various physical parameters such as the thermal Grashof number (Gr), the modified Grashof number (Gm), magnetic parameter (M), permeability parameter, Prandtl number (Pr), heat sink (Q), radiation parameter (R), radiation absorption parameter (χ), Schmidt number (Sc), chemical reaction parameter (Kr) and Soret number (S_0) on velocity, temperature and concentration are exhibited in the figures 1-11 and studied by choosing arbitrary values. The influence of these parameters on skin friction, Nusselt number and Sherwood number are also shown in Tables 1–3.

Figures 1-4 demonstrate the variations of the fluid velocity under the effects of different parameters. In Figure 1, effect of thermal Grashof number on velocity is presented. As Gr increases, velocity also increases. This is due to the buoyancy which is acting on the fluid particles due to gravitational force that enhances the fluid velocity. A similar effect is noticed from Figure 2, in the presence of modified Grashof number, which also increases fluid velocity. In figure 3, velocity profiles are displayed with the variation in magnetic parameter. From this figure it is noticed that velocity gets reduced by the increase of magnetic parameter. When an electrically conducting fluid moves in the presence of an applied magnetic field, a magnetic force, called Lorentz force, is generated in the flow field whose tendency is to resist the fluid motion. Due to this reason fluid velocity is getting retarded on increasing magnetic parameter (*M*). Figure 4 depicts the variations in velocity profiles for different values of Permeability parameter. From this figure it is noticed that, velocity increases as K increases.

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Figures 5-8 display the variations of the fluid temperature under the effects of different parameters. Figure 5 indicates that a rise in Pr substantially reduces the temperature in the viscous fluid. It can be found from Figure 5 that the thickness of thermal boundary layer decreases on increasing Pr. Figure 6 depicts the effect of heat absorption on temperature. It is noticed that the temperature decreases as an increase in the heat absorption parameter. The central reason behind this effect is that the heat absorption causes a decrease in the kinetic energy as well as thermal energy of the fluid. The momentum and thermal boundary layers get thinner in case of heat absorbing fluids. It shows reverse effect in the case of heat generation parameter. Figure 7 shows the effect of radiation parameter on temperature distribution. It shows that the temperature reduces with increasing values of radiation parameter. The effect of radiation absorption parameter on temperature is demonstrated in figure 8. It is observed that temperature increases as an increase in radiation absorption parameter.

Figures 9-11 exhibit the variations of the fluid concentration under the effects of different parameters. Influence of Schmidt number on concentration is shown in figure 9, from this figure it is noticed that concentration decreases with an increase in Schmidt number. Because, Schmidt number is a dimensionless number defined as the ratio of momentum diffusivity and mass diffusivity, and is used to characterize fluid flows in which there are simultaneous momentum and mass diffusion convection processes. Therefore concentration boundary layer decreases with an increase in Schmidt number. From Figure 10, we observe that the concentration(C) decreases as chemical reaction (Kr) increases. The effect of Soret number on concentration is displayed in figure 11. The concentration increases with increasing values of Soret number.

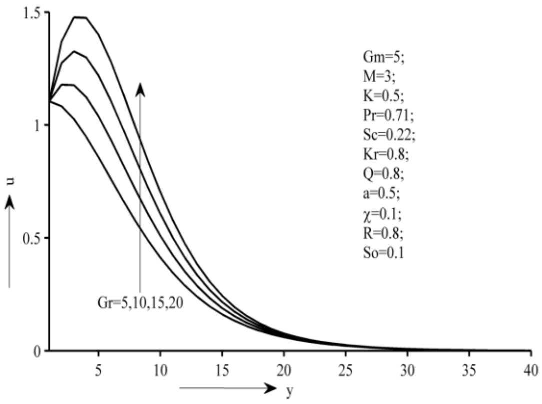

Figure1: Effect of Grashof number on velocity

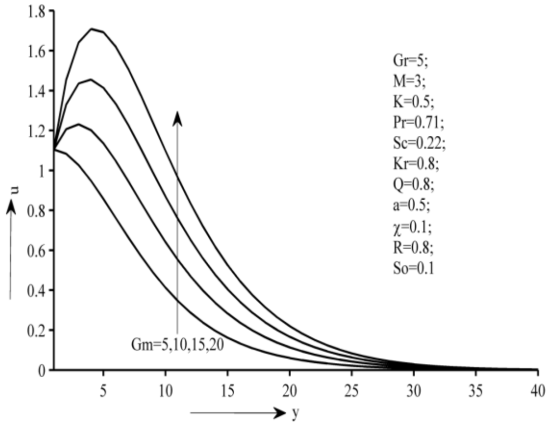

Figure2: Effect of modified Grashof number on velocity

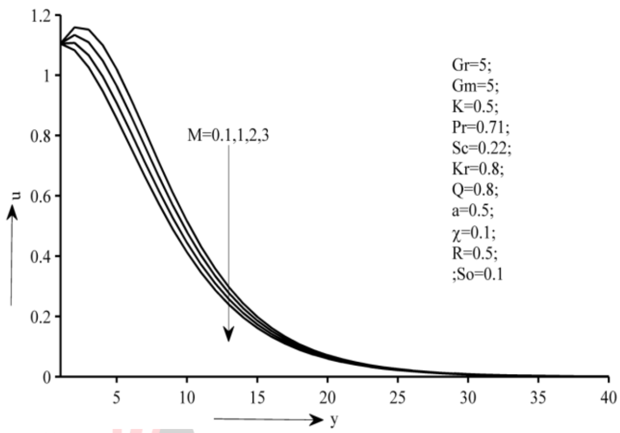

Figure3: Effect of magnetic parameter (M) on velocity

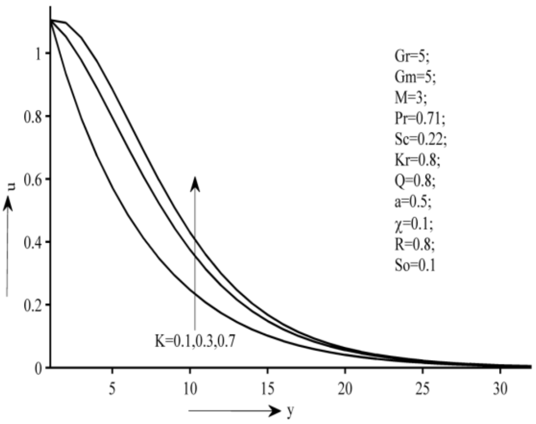

Figure4: Effect of Permeability parameter (K) on velocity

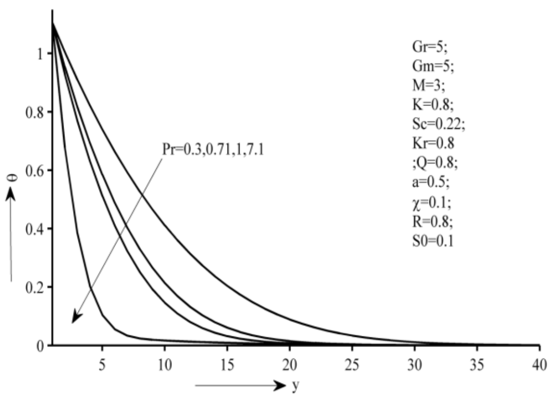

figure5: Effect of Prandtl number (Pr) on temperature

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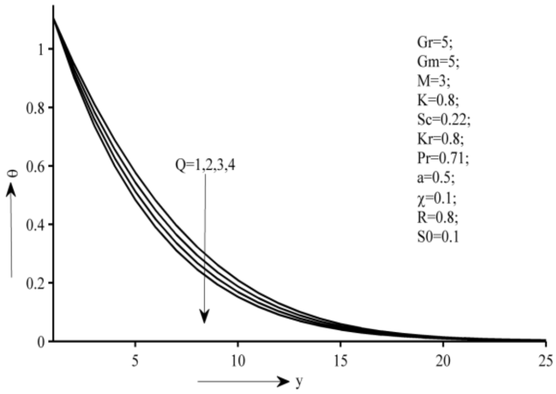

Figure6: Effect of heat absorption parameter (Q) on temperature

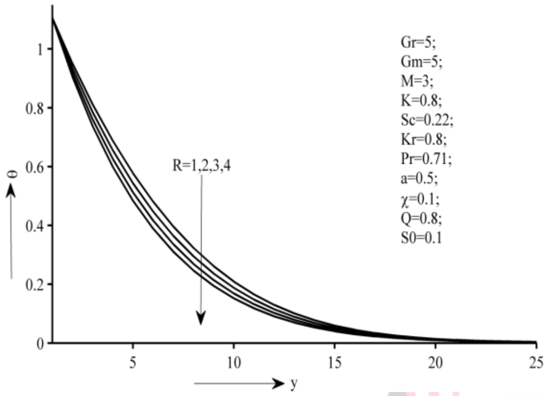

Figure7: Effect of radiation parameter (R) on temperature

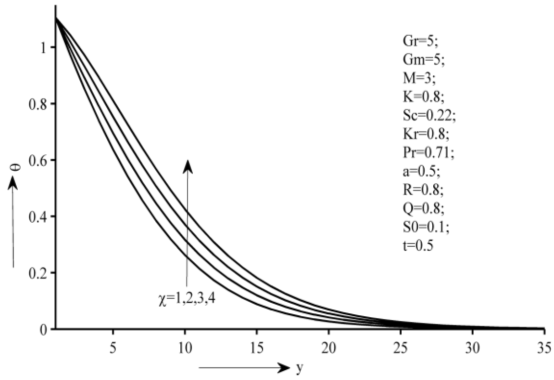

Figure8: Effect of radiation absorption parameter (χ) on temperature

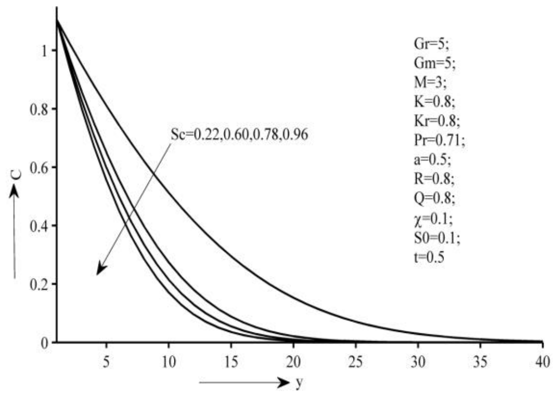

Figure9: Effect of Schmidt number (Sc) on concentration

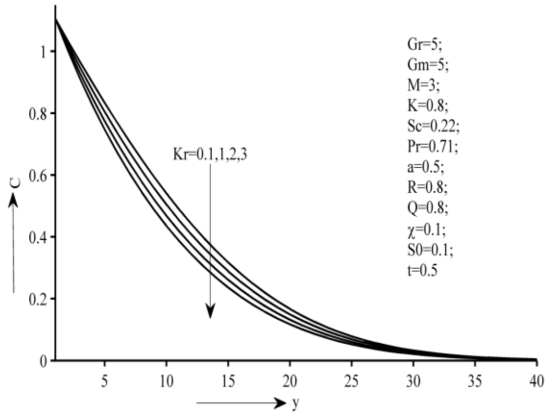

Figure10: Effect of chemical reaction parameter on concentration

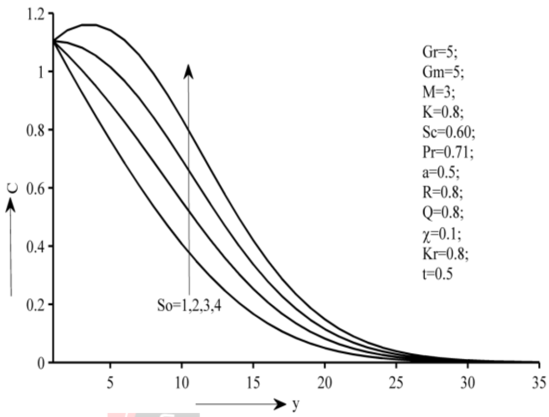

Figure11: Effect of Sorret number on concentration

Table 1 show numerical values of skin-friction for various of Grashof number (Gr), modified Grashof number (Gm), magnetic parameter (M), permeability parameter (K), Prandtl number (Pr), heat sink (Q), radiation parameter (R), radiation absorption parameter (χ),Schmidt number (Sc), chemical reaction parameter (Kr) and Soret number (S_0). From table 1, we observed that the skin-friction increases with an increase in magnetic parameter, Prandtl number, heat sink, radiation parameter, Schmidt number and chemical reaction parameter whereas it decreases under the influence of Grashof number, modified Grashof number, permeability parameter, radiation absorption parameter and Soret number.

Table 2 demonstrate numerical values of Nusselt number (Nu) for different values of Prandtl number (Pr), heat sink (Q), radiation parameter (R) and radiation absorption parameter (χ). From table 2, we noticed that the Nusselt number increases with an increase in Prandtl number, heat sink and radiation parameter whereas it decreases under the influence of radiation absorption parameter and Dufour number.

Table 3 show numerical values of Sherwood (Sh) for distinct values of Schmidt number (Sc), chemical reaction

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parameter (Kr) and Soret number. It can be noticed from table 3, that the Sherwood enhances with rising values of Schmidt number, chemical reaction parameter, Dufour number. Increasing values of Soret number results in decreasing the Sherwood number.

Table 1: Variations in skin friction for different values of flow parameters

Gr	Gm	M	K	Pr	Q	R	χ	Sc	Kr	So	τ
5	5	3	0.8	0.71	0.8	0.8	0.8	0.22	0.8	0.1	6.4089
10	5	3	0.8	0.71	0.8	0.8	0.8	0.22	0.8	0.1	6.1769
15	5	3	0.8	0.71	0.8	0.8	0.8	0.22	0.8	0.1	5.9450
20	5	3	0.8	0.71	0.8	0.8	0.8	0.22	0.8	0.1	5.7131
5	10	3	0.8	0.71	0.8	0.8	0.8	0.22	0.8	0.1	6.0873
5	15	3	0.8	0.71	0.8	0.8	0.8	0.22	0.8	0.1	5.7657
5	20	3	0.8	0.71	0.8	0.8	0.8	0.22	0.8	0.1	5.4441
5	5	0.5	0.8	0.71	0.8	0.8	0.8	0.22	0.8	0.1	6.3082
5	5	1	0.8	0.71	0.8	0.8	0.8	0.22	0.8	0.1	6.3284
5	5	2	0.8	0.71	0.8	0.8	0.8	0.22	0.8	0.1	6.3687
5	5	3	0.1	0.71	0.8	0.8	0.8	0.22	0.8	0.1	6.7533
5	5	3	0.3	0.71	0.8	0.8	0.8	0.22	0.8	0.1	6.4920
5	5	3	0.5	0.71	0.8	0.8	0.8	0.22	0.8	0.1	6.4389
5	5	3	0.8	1	0.8	0.8	0.8	0.22	0.8	0.1	6.4414
5	5	3	0.8	3	0.8	0.8	0.8	0.22	0.8	0.1	6.5400
5	5	3	0.8	7.1	0.8	0.8	0.8	0.22	0.8	0.1	6.5870
5	5	3	0.8	0.71	0.5	0.8	0.8	0.22	0.8	0.1	6.4088
5	5	3	0.8	0.71	1	0.8	0.8	0.22	0.8	0.1	6.4090
5	5	3	0.8	0.71	2	0.8	0.8	0.22	0.8	0.1	6.4094
5	5	3	0.8	0.71	0.8	0.1	0.8	0.22	0.8	0.1	6.4086
5	5	3	0.8	0.71	0.8	0.5	0.8	0.22	0.8	0.1	6.4088
5	5	3	0.8	0.71	0.8	1	0.8	0.22	0.8	0.1	6.4090
5	5	3	0.8	0.71	0.8	0.8	0.5	0.22	0.8	0.1	6.4091
5	5	3	0.8	0.71	0.8	0.8	1	0.22	0.8	0.1	6.4087
5	5	3	0.8	0.71	0.8	0.8	2	0.22	0.8	0.1	6.4081
5	5	3	0.8	0.71	0.8	0.8	0.8	0.60	0.8	0.1	6.4775
5	5	3	0.8	0.71	0.8	0.8	0.8	0.78	0.8	0.1	6.4999
5	5	3	0.8	0.71	0.8	0.8	0.8	0.96	0.8	0.1	6.5188
5	5	3	0.8	0.71	0.8	0.8	0.8	0.22	1	0.1	6.4089
5	5	3	0.8	0.71	0.8	0.8	0.8	0.22	2	0.1	6.4093
5	5	3	0.8	0.71	0.8	0.8	0.8	0.22	3	0.1	6.4096
5	5	3	0.8	0.71	0.8	0.8	0.8	0.22	0.8	1	6.3843
5	5	3	0.8	0.71	0.8	0.8	0.8	0.22	0.8	2	6.3565
5	5	3	0.8	0.71	0.8	0.8	0.8	0.22	0.8	3	6.3282

Table 2: Variations in Nusselt number

Pr	Q	R	χ	Nu
0.71	0.8	0.8	0.8	5.3506
1	0.8	0.8	0.8	6.7109
3	0.8	0.8	0.8	12.8171
7.1	0.8	0.8	0.8	16.6389
0.71	0.1	0.8	0.8	5.3234
0.71	0.3	0.8	0.8	5.3312
0.71	0.5	0.8	0.8	5.3390
0.71	1	0.8	0.8	5.3583
0.71	0.8	0.5	0.8	5.3391
0.71	0.8	1	0.8	5.3584
0.71	0.8	2	0.8	5.3970
0.71	0.8	0.8	0.1	5.3882
0.71	0.8	0.8	0.5	5.3667
0.71	0.8	0.8	1	5.3398

Table 3: Variations in Sherwood number

Sc	**Kr**	**S_0**	**Sh**
0.22	**0.8**	**0.1**	**2.9641**
0.60	**0.8**	**0.1**	**4.7048**
0.78	**0.8**	**0.1**	**5.5240**
0.96	**0.8**	**0.1**	**6.3379**
0.22	**0.1**	**0.1**	**2.9460**
0.22	**0.3**	**0.1**	**2.9512**
0.22	**0.5**	**0.1**	**2.9563**
0.22	**0.9**	**0.1**	**2.9693**
0.22	**0.8**	**1**	**2.3060**
0.22	**0.8**	**2**	**1.5674**
0.22	**0.8**	**3**	**0.8215**
0.22	**0.8**	**4**	**0.0688**

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V. Conclusion

In this chapter we have considered a numerical study of magneto-convective and radiation absorption fluid flow past an exponentially accelerated vertical porous plate with variable temperature and concentration in the presence of Soret effect. Explicit finite difference method is employed to solve the equations governing the flow. From the present numerical investigation, following conclusions have been drawn:

a. Velocity increases with an increase in Grashof number and as well as modified Grashof number and permeability of the porous medium while decrease in the existence of magnetic parameter.
b. Temperature increases in the presence of radiation absorption parameter while decrease in the presence of Prandtl number, heat sinks and radiation parameter.
c. Concentration increases with an increase in Soret number but it shows the reverse effects in case of Schmidt number and chemical reaction parameter.
d. A significance increase is seen in Skin friction for magnetic parameter, Prandtl number, heat sink, radiation parameter, Schmidt number and chemical reaction parameter while it has reverse tendency for Grashof number, modified Grashof number, permeability parameter, radiation absorption parameter and Soret number.
e. The rate of heat transfer increase with Prandtl number, heat sink and radiation parameter while it shows adverse effect in the case of radiation absorption parameter.
f. The rate of mass transfer increases with Schmidt number and chemical reaction parameter but it shows opposite effects in case of Soret number.

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Nomenclature

a	Constant
Cp	Specific heat at constant pressure
C	Concentration
Gr	Thermal Grashof number
Gm	modified Grashof number
g	Acceleration due to gravity
M	magnetic parameter
K_p^*	Permeability of the medium
k	Thermal diffusivity
Pr	Prandtl number
K	porosity parameter
Q	heat absorption parameter
R	radiation parameter
D	molecular diffusivity
Sc	Schmidt number
Kr	Chemical reaction parameter
Nu	Nusselt number
Sh	Sherwood number
D1	thermal diffusivity
S_0	Soret number
Df	Dufour number
u	Velocity of the fluid
t	Time
y	Coordinate axis normal to the plate

Greek symbols

β	Volumetric coefficient of thermal expansion
β^*	Volumetric coefficient of concentration expansion
θ	Temperature
μ	Coefficient of viscosity
ν	Kinematic viscosity
ρ	Density of the fluid
τ	skin friction
σ	Electrical conductivity
χ	Radiation absorption parameter

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