IOSR Journal of Mathematics (IOSR-JM)
e-ISSN: 2278-5728, p-ISSN: 2319-765X. Volume 12, Issue 2 Ver. I (Mar. - Apr. 2016), PP 109-120
www.iosrjournals.org

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 And Dufour Effects

M. Umamheswar[1], S. V. K. Varma[2], M. C. Raju[1]

[1]Department of Humanities and Sciences, Annamacharya Institute of Technology and Sciences Rajampet (Autonomous), Andhra Pradesh - 516126 India.
2 Department Mathematics, S. V. University, Tirupati, Andhra Pradesh -517502 India.

Abstract: *A numerical analysis is carried out for an unsteady free convective, radiative, chemically reactive, radiation absorption, viscous, incompressible and electrically conducting fluid past an exponentially accelerated vertical porous plate in the presence of sink and Soret and Dufour effects. The set of non-dimensional governing equations along with boundary conditions are solved numerically. The effect of various physical parameters on flow quantities are studied with the help of graphs. For the physical interest, the variations in skin friction, Nusselt number and Sherwood number are also studied through tables. The novelty of this study is the consideration of exponentially varying temperature and as well as concentration along with the exponentially accelerated vertical plate.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, Dufour number and Soret number*

Key words: *Numerical study; MHD; Radiation; radiation absorption; Chemical reaction; Thermal diffusion and Diffusion thermo effect.*

I. Introduction

The MHD continues to attract the interest of engineering science and applied Mathematics researches outstanding to extensive applications of such flows in the context of aerodynamics, engineering, geophysics and aeronautics.Seth and Ansari [1] considered MHD natural convection flow past an impulsively movingvertical plate with ramped wall temperature in the presence of thermal diffusion with heatabsorption. Afify [2] analyzed MHD free convective flow and mass transfer over a stretching sheet with chemical reaction. Das and Mitra [3] deliberated unsteady mixed convective MHD flow and mass transfer past an accelerated infinite vertical plate with suction.Kim [4] studied unsteady MHD convective heat transfer past a semi – infinite vertical porous moving plate with variable suction. Makinde and Mhone [5] found heat transfer to MHD oscillatory flow in a channel filled with porous medium. Sharma and Singh [6] analyzed effects of variable thermal conductivity and heat source/sink on MHD flow near a stagnation point on a linearly stretching sheet. Chamkha and Ahmed [7] 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. Hayat and Mehmood [8] considered slip effects on MHD flow of third order fluid in a planar channel.Umamaheswar et al. [9] 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. Harinath Reddy et al. [10] 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.

Radiation effects on heat and mass transfer are of greaterimportance in many processes and have, therefore, receiveda considerable amount of attention in recent time. It isapplied in engineering fields and physiology such astranspiration, cooling gaseous diffusion and blood flow inarteries. Radiative heat and mass transfer play importantroles in the design of spacecraft, filtrations processes, thedrying of porous material in textiles industries solar energycollector and nuclear reactors.Seddeek [11] considered thermal radiation and buoyancy effects on MHD free convective heat generating flow over an accelerating permeable surface with temperature dependent viscosity.Muthucumaraswamy[12] studied radiative heat and mass transfer effects on moving isothermal vertical plate in the presence of chemical reaction. Ravikumar et al. [13] 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. [14] 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.Raju et al. [15] studied radiation and mass transfer effects on a free convection flow through a porous medium bounded by a vertical surface.Seth et al. [16] 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 [17] studied magneto hydrodynamic flow over a permeable non-linearly stretching surface with effects of viscous dissipation and thermal radiation. Seth et al. [18] 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. 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. Raptis et al. [20] analyzed effects of radiation in an optically thin gray gas flowing past a vertical infinite plate in the presence of a magnetic field.Ibrahim et al. [21] studied effect of the chemical reaction and radiation absorption on the unsteady MHD free convection flow past a semi infinite vertical permeable moving plate with heat source and suction.

When heat and mass transfer occur simultaneously in a moving fluid, the relationsbetween the driving potentials and fluxes are of more significant. It has been observed that energyflux can be generated by temperature gradients and also concentration gradients. The energy fluxwhich is generated by a concentration gradient is termed the diffusion-thermo (Dufour) effect. Onthe other hand, mass flux can also be caused by temperature gradients and this embodies thethermal-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 magnitudethan the effects described by Fourier's and Fick's laws. But these effects may become significantwhen 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 betweengases with very less molecular weight and of average molecular weight. The Dufour effect wasfound of considerable magnitude so that it cannot be neglected. Soret and Dufour effects areimportant for studying intermediate molecular weight gases in coupled heat and mass transfer inbinary systems of the fluid, often encountered in chemical engineering process.Seth et al. [22] 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. Chandra Reddy et al. [23] 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. Srinivasacharya and Kaladhar [24] studied Soret and Dufour effects on mixed convection flow of couple stress fluid in a non-Darcy porous medium with heat and mass fluxes. Srinivasacharya and Upendar [25] analyzed Soret and Dufour effects on MHD free convection in a micro polar fluid. Seddeek [26] 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.Narayana and Murthy [27] studied Soret and Dufour effects in a doubly stratified Darcy porous medium. Hayat and Nawaz [28] analyzed Soret and Dufour effects on the mixed convection flow of a second grade fluid subject to Hall and ion-slip currents. Patil et al. [29] considered double diffusive mixed convection flow over a moving vertical plate in the presence of internal heat generation and a chemical reaction.

Nomenclature

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

Greek symbols

β Volumetric coefficient of thermal expansion — μ Coefficient of viscosity
β^* Volumetric coefficient of expansion with species concentration
ν Kinematic viscosity ρ Density of the fluid
τ skin friction σ Electrical conductivity

Subscripts

s surface of the plate
∞ Conditions in the free stream

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 $t \le 0$, 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:

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

$$\rho C_p \frac{\partial T^*}{\partial t^*} = k_T \frac{\partial^2 T^*}{\partial y^{*2}} - \frac{\partial q^*}{\partial y^*} - Q^*\left(T^* - T_\infty^*\right) + Q_l\left(C^* - C_\infty^*\right) + \left(\frac{D_m k_T \rho}{C_s}\right)\frac{\partial^2 C^*}{\partial y^{*2}} \tag{2}$$

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

The corresponding initial and boundary conditions are

$$\left.\begin{aligned} &u^* = 0, T^* = T_\infty^*, C^* = C_\infty^* && \text{for all } y^*, t^* \le 0 \\ &t^* > 0 : u^* = u_0 e^{a^*t^*}, T^* = T_\infty^* + \left(T_w^* - T_\infty^*\right)e^{a^*t^*}, && \\ &\quad C^* = C_\infty^* + \left(C_w^* - C_\infty^*\right)e^{a^*t^*} && \text{at } y^* = 0 \\ &\quad u^* \to 0, T^* \to T_\infty^*, C^* \to C_\infty^* && \text{as } y^* \to \infty \end{aligned}\right\} \tag{4}$$

Where $a = \frac{a^*\nu}{u_0^2}$

The non-dimensional quantities are as follows:

$$u = \frac{u^*}{u_0}, t = \frac{t^* u_0^2}{\nu}, y = \frac{y^* u_0}{\nu}, \theta = \frac{T^* - T_\infty^*}{T_w^* - T_\infty^*}, C = \frac{C^* - C_\infty^*}{C_w^* - C_\infty^*}, Gr = \frac{\nu g\beta\left(T_w^* - T_\infty^*\right)}{u_0^3},$$

$$Gm = \frac{\nu g\beta^*\left(C_w^* - C_\infty^*\right)}{u_0^3}, M = \frac{\sigma B_0^2 \nu}{\rho u_0^2}, K = \frac{k_p^* u_0^2}{\nu^2}, \Pr = \frac{\rho\nu C_p}{k_T}, Q = \frac{Q^*\nu}{\rho C_p u_0^2},$$

$$\frac{\partial q^*}{\partial y^*} = 4\left(T^* - T_\infty^*\right)I^*, R = \frac{4\nu I^*}{\rho C_p u_0^2}, \chi = \frac{Q_l \nu\left(C_w^* - C_\infty^*\right)}{\rho C_p u_0^2\left(T_w^* - T_\infty^*\right)}, Df = \frac{D_m k_T\left(T_w^* - T_\infty^*\right)}{\nu C_s C_p\left(C_w^* - C_\infty^*\right)},$$

$$Sc = \frac{\nu}{D}, Kr = \frac{K_r^*\nu}{u_0^2}, S_0 = \frac{D_1\left(T_w^* - T_\infty^*\right)}{\nu\left(C_w^* - C_\infty^*\right)}$$

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

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

$$\frac{\partial \theta}{\partial t}=\frac{1}{\Pr}\frac{\partial^2 \theta}{\partial y^2}-R\,\theta-Q\,\theta+\chi\,C+Df\left(\frac{\partial^2 C}{\partial^2 y}\right) \tag{6}$$

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

The corresponding initial and boundary conditions are

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

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:

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

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

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

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:

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

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

$$\begin{aligned}&u(0,j)=e^{at},\theta(0,j)=e^{at},C(0,j)=e^{at} \ \text{for all } j\\ &u(i_{max},j)=0,\theta(i_{max},j)=0,C(i_{max},j)=0 \ \text{for all } j\end{aligned} \tag{13}$$

(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.

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

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

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 thedimensionless velocity field, temperature field, concentration field,skin friction, Nusselt number and Sherwood number.The effects of various physical parameters such asthe 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), Dufour number (Df), Schmidt number (Sc),chemical reaction parameter (Kr) and Soret number (S_0) on velocity, temperature and concentration are exhibited in the figures 1-12 and studied by choosing arbitrary values.Theinfluence 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 differentparameters.In Fig.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 Fig.2, in the presence of modified Grashof number, which also increases fluid velocity. Ravikumar et al. [30] also got similar results. 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*). Fig.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.

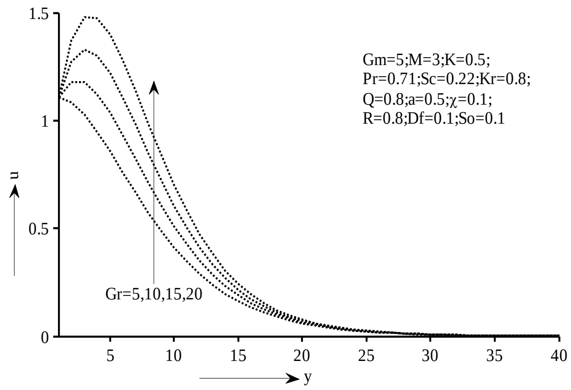

Fig.1: Effect of Grashof number on velocity

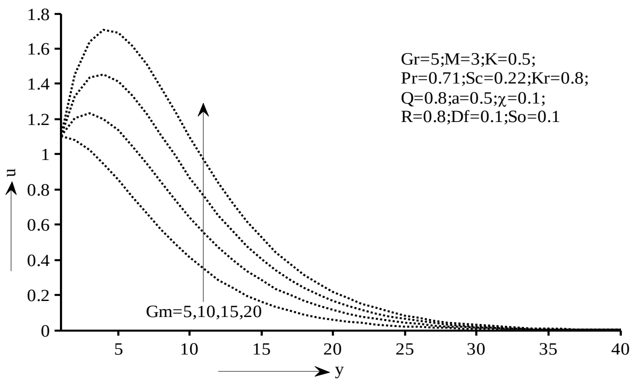

Fig.2: Effect of modified Grashof number on velocity

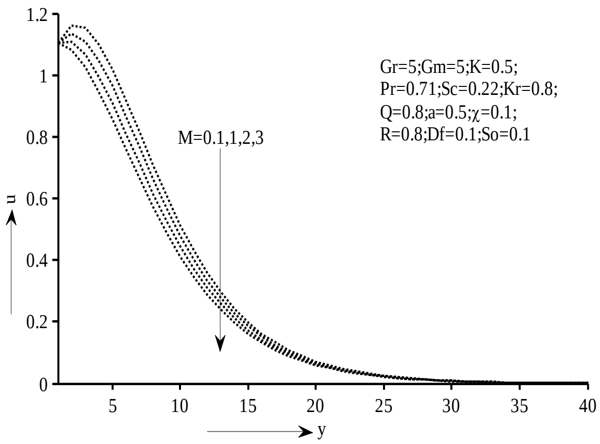

Fig.3: Effect of magnetic parameter on velocity

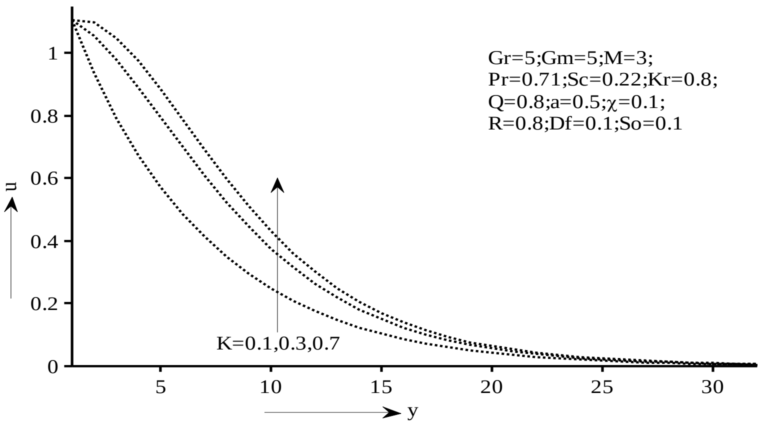

Fig.4: Effect of permeability parameter on velocity

Figures 5-9 display the variations of the fluid temperature under the effects of differentparameters.Fig.5 indicates that a rise in Prsubstantially reduces the temperature in the viscous fluid. It can be found from Fig.5 that the thickness of thermal boundary layer decreases on increasing Pr. Fig.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.Fig.7 shows the effect of radiation parameter on temperaturedistribution. It shows that the temperature reduces with increasing values of radiation parameter.The effect of radiation absorption parameter on temperature is demonstrated in fig.8. It is observed that temperature increases as an increase in radiation absorption parameter. The effect of Dufour number on temperature is shown in fig.9. The temperature increases with increasing values of Dufour number.

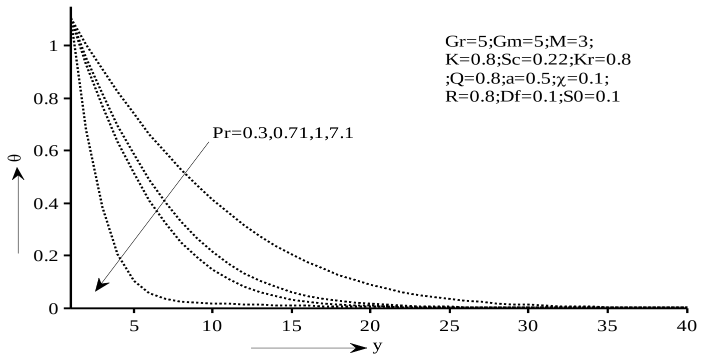

Fig.5: Effect of Prandtl number on temperature

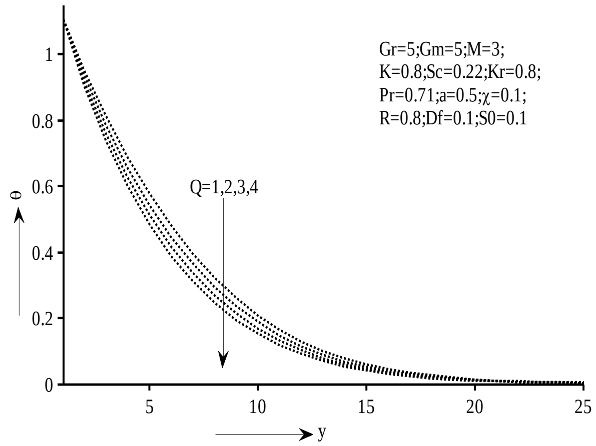

Fig.6: Effect of heat sink on temperature

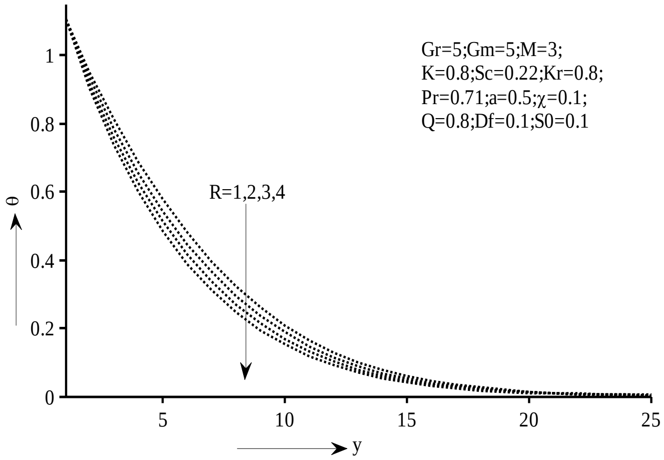

Fig.7: Effect of radiation parameter on temperature

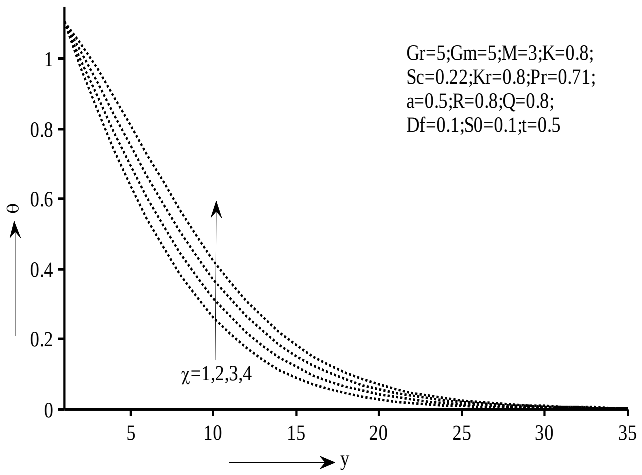

Fig.8: Effect of radiation absorption parameter on temperature

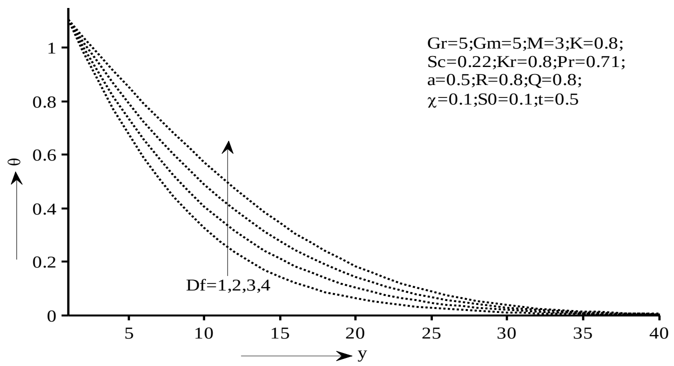

Fig.9: Effect of Dufour number on temperature

Figures 10-12 exhibit the variations of the fluid concentration under the effects of differentparameters. Influence of Schmidt number on concentration is shown in fig.10, 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 Fig.11, we observe that the concentration(C) decreases as chemical reaction (Kr) increases. The effect of Soret number on concentration is displayed in fig.12. The concentration increases withincreasing values of Soret number.

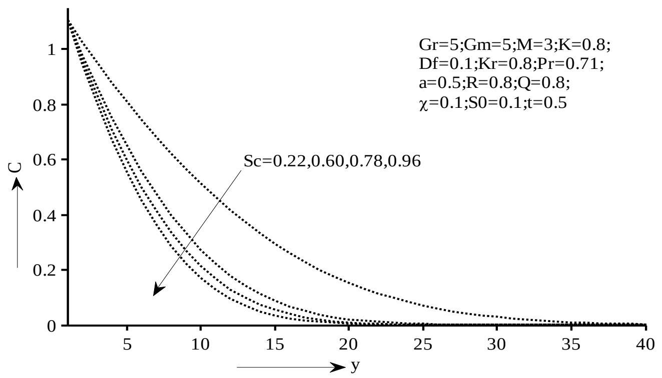

Fig.10: Effect of Schmidt number on concentration

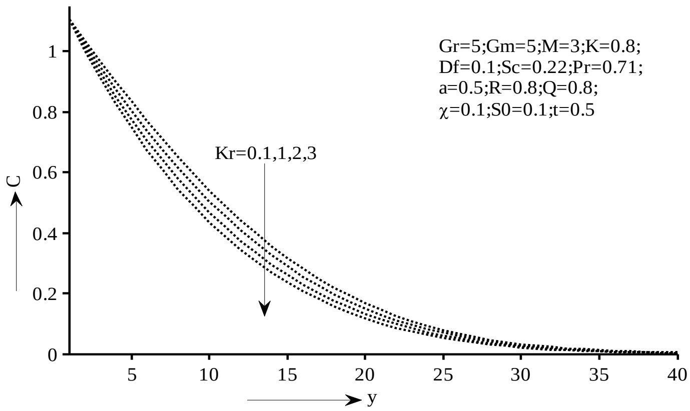

Fig.11: Effect of chemical reaction on concentration

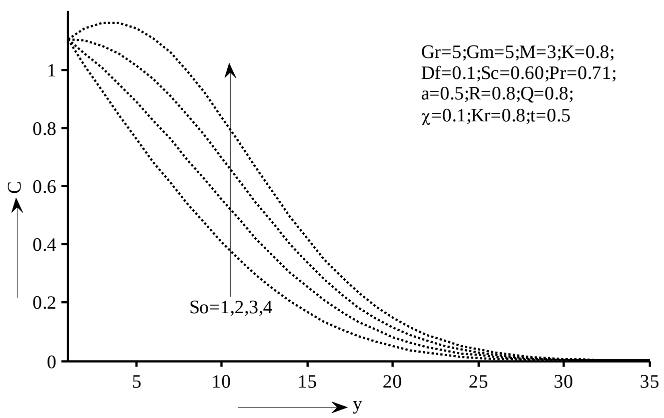

Fig.12: Effect of Soret number on concentration

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), Dufour number (Df), 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 inmagnetic parameter, Prandtl number, heat sink, radiation parameter, Schmidt number andchemical reaction parameter whereas it decreases under the influence of Grashof number, modified Grashof number, permeability parameter, radiation absorption parameter, Dufour number 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), radiation absorption parameter (χ) and Dufour number (Df). 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 parameter (Kr), Soret number and Dufour 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	Df	Sc	Kr	So	τ
5	5	3	0.8	0.71	0.8	0.8	0.8	0.1	0.22	0.8	0.1	6.4089
10	5	3	0.8	0.71	0.8	0.8	0.8	0.1	0.22	0.8	0.1	6.1769
15	5	3	0.8	0.71	0.8	0.8	0.8	0.1	0.22	0.8	0.1	5.9450
20	5	3	0.8	0.71	0.8	0.8	0.8	0.1	0.22	0.8	0.1	5.7131
5	10	3	0.8	0.71	0.8	0.8	0.8	0.1	0.22	0.8	0.1	6.0873
5	15	3	0.8	0.71	0.8	0.8	0.8	0.1	0.22	0.8	0.1	5.7657
5	20	3	0.8	0.71	0.8	0.8	0.8	0.1	0.22	0.8	0.1	5.4441
5	5	0.5	0.8	0.71	0.8	0.8	0.8	0.1	0.22	0.8	0.1	6.3082
5	5	1	0.8	0.71	0.8	0.8	0.8	0.1	0.22	0.8	0.1	6.3284
5	5	2	0.8	0.71	0.8	0.8	0.8	0.1	0.22	0.8	0.1	6.3687
5	5	3	0.1	0.71	0.8	0.8	0.8	0.1	0.22	0.8	0.1	6.7533
5	5	3	0.3	0.71	0.8	0.8	0.8	0.1	0.22	0.8	0.1	6.4920
5	5	3	0.5	0.71	0.8	0.8	0.8	0.1	0.22	0.8	0.1	6.4389
5	5	3	0.8	1	0.8	0.8	0.8	0.1	0.22	0.8	0.1	6.4414
5	5	3	0.8	3	0.8	0.8	0.8	0.1	0.22	0.8	0.1	6.5400
5	5	3	0.8	7.1	0.8	0.8	0.8	0.1	0.22	0.8	0.1	6.5870
5	5	3	0.8	0.71	0.5	0.8	0.8	0.1	0.22	0.8	0.1	6.4088
5	5	3	0.8	0.71	1	0.8	0.8	0.1	0.22	0.8	0.1	6.4090
5	5	3	0.8	0.71	2	0.8	0.8	0.1	0.22	0.8	0.1	6.4094
5	5	3	0.8	0.71	0.8	0.1	0.8	0.1	0.22	0.8	0.1	6.4086
5	5	3	0.8	0.71	0.8	0.5	0.8	0.1	0.22	0.8	0.1	6.4088
5	5	3	0.8	0.71	0.8	1	0.8	0.1	0.22	0.8	0.1	6.4090
5	5	3	0.8	0.71	0.8	0.8	0.5	0.1	0.22	0.8	0.1	6.4091
5	5	3	0.8	0.71	0.8	0.8	1	0.1	0.22	0.8	0.1	6.4087
5	5	3	0.8	0.71	0.8	0.8	2	0.1	0.22	0.8	0.1	6.4081
5	5	3	0.8	0.71	0.8	0.8	0.8	1	0.22	0.8	0.1	6.3844
5	5	3	0.8	0.71	0.8	0.8	0.8	2	0.22	0.8	0.1	6.3567
5	5	3	0.8	0.71	0.8	0.8	0.8	3	0.22	0.8	0.1	6.3284
5	5	3	0.8	0.71	0.8	0.8	0.8	0.1	0.60	0.8	0.1	6.4775

5	5	3	0.8	0.71	0.8	0.8	0.8	0.1	0.78	0.8	0.1	6.4999
5	5	3	0.8	0.71	0.8	0.8	0.8	0.1	0.96	0.8	0.1	6.5188
5	5	3	0.8	0.71	0.8	0.8	0.8	0.1	0.22	1	0.1	6.4089
5	5	3	0.8	0.71	0.8	0.8	0.8	0.1	0.22	2	0.1	6.4093
5	5	3	0.8	0.71	0.8	0.8	0.8	0.1	0.22	3	0.1	6.4096
5	5	3	0.8	0.71	0.8	0.8	0.8	0.1	0.22	0.8	1	6.3843
5	5	3	0.8	0.71	0.8	0.8	0.8	0.1	0.22	0.8	2	6.3565
5	5	3	0.8	0.71	0.8	0.8	0.8	0.1	0.22	0.8	3	6.3282

Table.2: Variations in Nusselt number

Pr	Q	R	χ	Df	Nu
0.71	0.8	0.8	0.8	0.1	5.3506
1	0.8	0.8	0.8	0.1	6.7109
3	0.8	0.8	0.8	0.1	12.8171
7.1	0.8	0.8	0.8	0.1	16.6389
0.71	0.1	0.8	0.8	0.1	5.3234
0.71	0.3	0.8	0.8	0.1	5.3312
0.71	0.5	0.8	0.8	0.1	5.3390
0.71	1	0.8	0.8	0.1	5.3583
0.71	0.8	0.5	0.8	0.1	5.3391
0.71	0.8	1	0.8	0.1	5.3584
0.71	0.8	2	0.8	0.1	5.3970
0.71	0.8	0.8	0.1	0.1	5.3882
0.71	0.8	0.8	0.5	0.1	5.3667
0.71	0.8	0.8	1	0.1	5.3398
0.71	0.8	0.8	0.8	1	4.7099
0.71	0.8	0.8	0.8	2	3.9897
0.71	0.8	0.8	0.8	3	3.2610
0.71	0.8	0.8	0.8	4	2.5243

Table.3: Variations in Sherwood number

Sc	Kr	S_0	Df	Sh
0.22	0.8	0.1	0.1	2.9641
0.60	0.8	0.1	0.1	4.7048
0.78	0.8	0.1	0.1	5.5240
0.96	0.8	0.1	0.1	6.3379
0.22	0.1	0.1	0.1	2.9460
0.22	0.3	0.1	0.1	2.9512
0.22	0.5	0.1	0.1	2.9563
0.22	0.9	0.1	0.1	2.9693
0.22	0.8	1	0.1	2.3060
0.22	0.8	2	0.1	1.5674
0.22	0.8	3	0.1	0.8215
0.22	0.8	4	0.1	0.0688
0.22	0.8	0.1	1	2.9969
0.22	0.8	0.1	2	3.0356
0.22	0.8	0.1	3	3.0769
0.22	0.8	0.1	4	3.1210

V. Conclusion

In this paper 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 and Dofour effects. 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 and Dufour number while decrease in the presence of Prandtl number,heat sink 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 parameterwhile it has reverse tendency forGrashof number, modified Grashof number, permeability parameter, radiation absorption parameter, Dufour number 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 ofradiation absorption parameter and Dufour number.
f. The rate of mass transfer increases with Schmidt number, chemical reaction parameterand Dufour number but it shows opposite effects in case of Soret number.

References

[1]. G. S. Seth and Md. S. Ansari, MHD natural convection flow past an impulsively movingvertical plate with ramped wall temperature in the presence of thermal diffusion with heatabsorption, Int. Jou. Appl. Mech. Eng., Vol. 15, pp. 199–215, 2010.
[2]. A.A. Afify, MHD free convective flow and mass transfer over a stretching sheet with chemical reaction, Heat Mass Transfer, Vol. 40, pp. 495-500, 2004.
[3]. S. S. Das, and M. Mitra, Unsteady mixed convective MHD flow and mass transfer past an accelerated infinite vertical plate with suction, Ind. J. Sci. Tech., Vol. 2 (5), pp.18 – 22, 2009.
[4]. Y. J. Kim, Unsteady MHD convective heat transfer past a semi – infinite vertical porous moving plate with variable suction, Int. J. Engg. Sci., Vol. 38, pp. 833 – 845, 2008.
[5]. O.D. Makinde and P. Y. Mhone, Heat transfer to MHD oscillatory flow in a channel filled with porous medium, Rom Journal of Physics, Vol. 50(10), pp.931-938, 2005.
[6]. P. R. Sharma and G. Singh, effects of variable thermal conductivity and heat source/sink on MHD flow near a stagnation point on a linearly stretching sheet , Journal of Applied Fluid Mechanics, Vol. 2(1),pp. 13-21, 2009.
[7]. A. J. Chamkha and S. E. Ahmed, 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 , Journal of Applied Fluid Mechanics, Vol. 4(2), pp. 87-94, 2011.
[8]. T. Hayat and O. U. Mehmood, Slip effects on MHD flow of third order fluid in a planar channel,Communications in Nonlinear Science and Numerical Simulation, Vol. 16(3), pp. 1363–1377, 2011.
[9]. M. Umamaheswar, S. V. K. Varma and M. C. Raju, 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, International journal of Advanced Science and Technology,Vol.61,pp.39-52,2013.
[10]. S.Harinath Reddy, M.C.Raju, E. Keshava Reddy, Unsteady MHD free convection flow of a Kuvshinski fluid past a vertical porous plate in the presence of chemical reaction and heat source/sink, International Journal of Engineering Research in Africa, Vol. 14, pp. 13-27, 2015.
[11]. M. A. Seddeek, Thermal radiation and buoyancy effects on MHD free convective heat generating flow over an accelerating permeable surface with temperature dependent viscosity, Canada Journal of Physics, Vol. 79, pp. 725-732, 2001.
[12]. R. Muthucumaraswamy, P. Chandrakala and S. A. Raj, Radiative heat and mass transfer effects on moving isothermal vertical plate in the presence of chemical reaction, International Journal of Applied Mechanics and Engineering, Vol. 11(3), pp. 639-646, 2006.
[13]. V. Ravikumar, M. C. Raju and G. S. S. Raju, Magnetic field and radiation effects on a double diffusive free convective flow bounded by two infinite impermeable plates in the presence of chemical reaction , IJSER, Vol. 4(7), pp. 1915-1923, , 2013.
[14]. T. S. Reddy, M. C. Raju and S. V. K. Varma, 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, Journal of computational and Applied research in Mechanical Engineering, Vol. 3(1), pp. 53-62, 2013.
[15]. M. C. Raju, S. V. K. Varma and N. A. Reddy,Radiation and mass transfer effects on a free convection flow through a porous medium bounded by a vertical surface, Journal of future Engineering and Technology, Vol. 7 (2), pp. 7-12, 2012.
[16]. G.S. Seth, R. Nandkeolyar and Md. S. Ansari, 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, J. Appl. Fluid Mech., Vol.6 (1), pp. 27-38, 2013.
[17]. G. S. Seth, B. Kumbhakar and S. Sarkar, Magneto hydrodynamic flow over a permeable non-linearly stretching surface with effects of viscous dissipation and thermal radiation, J. Nature Sci. and Sustainable Tech., Vol. 8(2), pp. 273-292, 2014.
[18]. G. S. Seth, S. M. Hussain and S. Sarkar, 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, Bulg. Chem. Comm., Vol. 46(4), pp. 704-718, 2014.
[19]. M. A. Seddeek, A. A. Darwish, and M. S. Abdelmeguid, Effects of chemical reaction and variable viscosity on hydromagnetic mixed convection heat and mass transfer for Hiemenz flow through porous media with radiation,Communications in Nonlinear Science and Numerical Simulation, Vol. 12(2), pp. 195–213, 2007.
[20]. A. Raptis, C. Perdikis, A. Leontitsis, Effects of radiation in an optically thin gray gas flowing past a vertical infinite plate in the presence of a magnetic field, Heat & Mass Transfer, Vol. 39, pp. 771–773, 2003.
[21]. F. S. Ibrahim, A. M. Elaiw, and A. A. Bakr, Effect of the chemical reaction and radiation absorption on the unsteady MHD free convection flow past a semi infinite vertical permeable moving plate with heat source and suction, Communications in Nonlinear Science and Numerical Simulation, Vol. 13(6), pp. 1056–1066, 2008.
[22]. G. S. Seth, G. K. Mahato and S. Sarkar, 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, Int. J. Appl. Mech. Eng., Vol. 18 (4), pp. 1201-1220, 2013.
[23]. P. Chandra Reddy, M.C. Raju and G.S.S. Raju, 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, Journal of Applied & Computational Mathematics, Vol.4(5),pp.1-7,2015.
[24]. D.Srinivasacharya and K. Kaladhar, Soret and Dufour effects on mixed convection flow of couple stress fluid in a non-Darcy porous medium with heat and mass fluxes, Journal of Porous Media, Vol 17 (2), pp.93-101, 2014.
[25]. D.Srinivasacharya and Mendu Upendar, Soret and Dufour effects on MHD free convection in a micro polar fluid, Afrika Mathematika, Vol. 25, pp. 693- 705, 2014.
[26]. M.A. Seddeek, 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, Acta Mech, Vol. 172, pp. 83–94,2004.
[27]. P.L. Narayana and P. Murthy, Soret and Dufour effects in a doubly stratified Darcy porous medium, Jou. Porous Media, Vol. 10, pp. 613–624, 2007.
[28]. T. Hayat and M. Nawaz, Soret and Dufour effects on the mixed convection flow of a second grade fluid subject to Hall and ion-slip currents,International Journal for Numerical Methods in Fluids, Vol. 67, no. 9, pp. 1073–1099, 2011.

[29]. P.M .Patil, S Roy, A.J. Chamkha, Double diffusive mixed convection flow over a moving vertical plate in the presence of internal heat generation and a chemical reaction,Turkish J. Eng. Env. Sci., Vol. 33, pp. 193-205,2009.
[30]. V. Ravikumar, M.C. Raju, G.S.S. Raju., MHD three dimensional Couette flow past a porous plate with heat transfer, IOSR Jour. Maths., Vol. 1, no.3, pp. 3-9, 2012.