CHEMICAL REACTION AND THERMAL DIFFUSION EFFECTS ON UNSTEADY MHD FREE CONVECTION WITH EXPONENTIALLY ACCELERATED INCLINED PLATE

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Abstract : In this paper an analytical to study the influence chemical reaction and thermal diffusion on unsteady free convection with exponentially accelerated inclined plate in the real life application of food processing, energy utilization and the drag experimented at the cooled or heated and inclined surface in a seepage flow. A geometric model is employed for magnetic field of inclined plate regime. The normalized governing equations are reduced with dimensionless equations. The dimensionless governing equations involved in the present study are solved by using Laplace-transform technique. The influence of velocity, temperature, concentration, Sherwood number and Nusselt number are developed and physically interpreted through graphical illustrations like, Prandtl number, thermal Grashof number, magnetic field parameter, rotation parameter and thermal radiation parameter.

Key Words: Thermal Radiation, Chemical reactions, Inclined plate, Thermal diffusion

1. INTRODUCTION

In engineering and many industrial applications for the study of MHD with Heat and mass transfer plays an important role in, filtration processes, saturation of porous materials by chemicals, drying, in manufacturing industries for the design fins, steel, rolling, nuclear power plants, nuclear reactors, solar energy collectors, gas turbines and various propulsion devices for aircraft, missiles, satellites, material processing, food processing, energy utilization, remote sensing for astronomy and space exploration [1-5].

Muthucumaraswamy et al. [3] have studied MHD Flow past an Accelerated Vertical Plate with Variable Heat and Mass Diffusion in the Presence of Rotation. Rajput and Gaurav Kumar [4] have investigated the Radiation effect on unsteady MHD flow through porous medium past an oscillating inclined plate with variable temperature and mass diffusion in the presence of Hall current. The Natural convective magneto- nano fluid flow and radioactive heat transfer past a moving vertical plate have studied by Das and Jana [5]. Radiation Effect on MHD Flow Past an Inclined Plate with Variable Temperature and Mass Diffusion has studied by Rajput and Gaurav Kumar [6]. Swetha Ravi et al. [7] have derived the Effects of Thermal Radiation, and Radiation Absorption on Flow Past an Impulsively Started Infinite Vertical Plate with Newtonian Heating and Chemical Reaction. Harish Babu. Isah Bala Yabo et al. [8] have studied Effects of Thermal Diffusion and diffusion-Thermo Effects on Transient MHD Natural Convection and Mass Transfer Flow in a Vertical Channel with Thermal Radiation. Seth et al. [9] have analyzed the 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. The Effects of rotation and chemical reaction in MHD flow past an inclined plate with variable wall temperature and mass diffusion have examined by Rajput and Gaurav Kumar [10].Ram Prakash Sharma et al. [11] have worked on Rotational Impact on Unsteady MHD Double Diffusive Boundary Layer Flow over an Impulsively Emerged Vertical Porous Plate. The combined effects of radiation and chemical reaction in MHD flow past a moving plate with Hall current have discussed by Uday Singh Rajput and Gaurav Kumar [12]. Analytical investigations of diffusion thermo effects of unsteady free convection flow past an accelerated vertical plate have studied by Kumaresan, et al.[13]. Venkateswarlu et al. [14] have studied Thermal Diffusion and Radiation Effects on Unsteady MHD Free Convection Heat and Mass Transfer Flow Past a Linearly Accelerated Vertical Porous Plate with Variable Temperature and Mass Diffusion. Swetha Ravi et al. [15] have investigated Effects of Thermal Radiation, and Radiation Absorption on Flow Past an Impulsively Started Infinite Vertical Plate with Newtonian Heating and Chemical Reaction G. Silvia and Jayarami Reddy have examined the porous plate with hall current. Radiation and mass transfer effects on MHD flow through porous medium past an exponentially accelerated inclined plate with variable temperature has been developed by Jyotsna Rani Pattnaik et al.[16].Heat and mass transfer of unsteady Hydro magnetic free convection flow through Porous medium past a vertical plate with uniform Surface heat flux have presented by Mohamed Abdel-aziz and Yahya [17]. Swetha et al. [18] have worked on Diffusion-thermo and radiation effects on the MHD free convection flow of chemically reacting fluid past an oscillating plate embedded in a porous medium. Ananda Reddy et al. [19] has investigated on analytical study of MHD free convective, dissipative boundary layer flow past a porous vertical surface in the presence of thermal radiation, chemical reaction and constant suction. They have used regular perturbation technique to solve the governing equations. They found that temperature and velocity of the fluid near the plate diminish with the increase in radiation parameter.

All above studies revealed that the application of material processing, food processing, energy utilization, remote sensing for astronomy and space exploration. However, none of the above studies is not carried out on of chemical reaction and thermal diffusion effects on unsteady free convection with exponentially accelerated inclined plate. In the present study to analyze the influence of MHD unsteady free convection with accelerated inclined plate in presence of thermal radiation and chemical reaction parameters. The close form solution is obtained for the solution of dimensionless governing equations using Laplace transform technique and the results are expressed in terms of complementary error functions and exponential. The effects of the flow parameters on the dimensionless axial and transverse velocities, temperature, concentration, Sherwood number and Nusselt number are explored through most appropriate graphs.

2. MATHEMATICAL ANALYSIS

The x-axis is taken along the plate in vertically upward direction and y-axis is taken normal to it in the direction of the applied transverse magnetic field. Initially, it is assumed that the plate and surrounding fluid are at the same temperature and concentration in a stationary condition of all the points in the entire flow region. At the time, the plate was given an impulsive motion with constant velocity. At the same time, the plate temperature is raised linearly with time t and the concentration levels near the plate are raised to C_w . A magnetic field of uniform strength B_0 is assumed to be applied normal to the flow. We assumed that the magnetic Reynolds number is very small and the induced magnetic field is negligible in comparison to the transverse magnetic field. It is also assumed that the effect of viscous dissipation is negligible in the energy equation and the level of species concentration is very low so the Soret and Dufour effects are negligible. As the plate is infinite in extent, so the derivatives of all the flow variables with respect to x vanish and they can be assumed to be functions of y and t only. Thus the motion is one dimensional with only non-zero vertical velocity component u , varying with y and t only. Due to one dimensional nature, the equation of continuity is trivially satisfied. The dimensionless governing equations are solved using Laplace transform technique and the solutions are expressed in terms of complementary error and exponential functions.

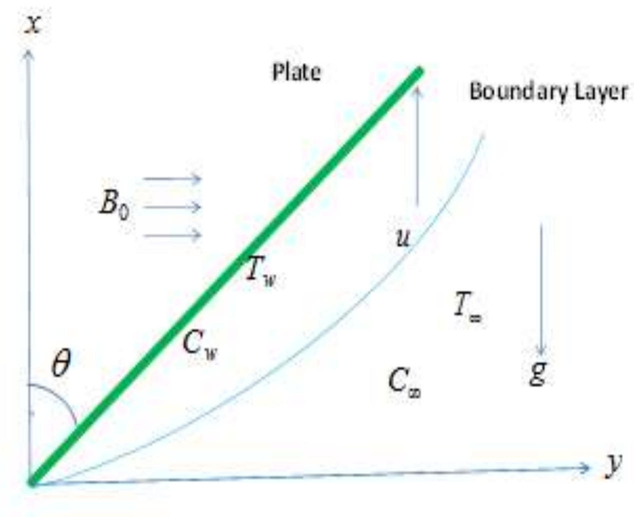

Figure 1 Proposed Physical model of the problem

Then the flow model is defined as follows

$$\frac{\partial u}{\partial t} = v\frac{\partial^2 u}{\partial t^2} - \frac{\sigma B^2{}_0 u}{\rho} + g\beta(T - T_\infty)\cos\alpha + g\beta^*(C - C_\infty)\cos\alpha, \tag{1}$$

$$\rho c_p \frac{\partial T}{\partial t} = k\frac{\partial^2 T}{\partial t^2} - \frac{\partial q_r}{\partial y} - Q(T - T_\infty) + \frac{D_m k_T \rho}{C_s} + \frac{\partial^2 C}{\partial y^2}, \tag{2}$$

$$\frac{\partial C}{\partial t} = D\frac{\partial^2 C}{\partial y^2} - k_v(C - C_\infty), \tag{3}$$

and the boundary conditions for the flow are given by

$$t \le 0: u = 0,\ T = T_\infty, C = C_\infty \quad \text{for all } y,$$

$$t \ge 0: u = u_0 \exp(a_0 t),\ T = T_\infty + (T_w - T_\infty)\frac{u_0^2}{v}t,\ C = C_\infty + (C_w - C_\infty)\frac{u_0^2}{v}t \text{ at } y = 0,$$

$$u \to 0,\ T \to T_\infty,\ C \to C_\infty, \quad as\ y \to \infty. \tag{4}$$

The local gradient for the case of an optically thin gas is expressed as follows

$$\frac{\partial q_r}{\partial t} = -4a^*\sigma(T_\infty^4 - T^4), \tag{5}$$

We assumed that the temperature differences within the flow are sufficiently small and that T^4 T^4may be expressed as a linear function of the temperature. This is obtained by expanding T^4 in a Taylor series about T_∞ T_∞ and neglecting the higher order terms, thus, we have

$$T^4 = 4T_\infty^3 T - 3T_\infty^4, \tag{6}$$

Substituting equations (5) and (6) in (2) we get

$$\rho c_p \frac{\partial T}{\partial t} = k\frac{\partial^2 T}{\partial t^2} + 16a^*\sigma T^3(T_\infty - T) + \frac{D_m k_t \rho}{c_s}\frac{\partial^2 C}{\partial y^2}. \tag{7}$$

On introducing the following non dimensional quantities

$$\left.\begin{array}{l}\bar{y}=\dfrac{yu_0}{v},\bar{u}=\dfrac{u}{u_0},\bar{t}=\dfrac{tu_0^2}{v},\ \bar{a}_0=\dfrac{va_0}{u_0^2},\ \theta=\dfrac{T-T_\infty}{T_w-T_\infty},\bar{C}=\dfrac{C-C_\infty}{C_w-C_\infty}\\ G_r=\dfrac{g\beta v(T_w-T_\infty)}{u_0^3},G_m=\dfrac{g\beta^* v(C_w-C_\infty)}{u_0^3},P_r=\dfrac{\mu c_p}{k},\mu=\rho v\\ S_c=\dfrac{v}{D},\ M=\dfrac{\sigma B_0^2 v}{\rho u_0^2},\ R=\dfrac{16a^*\sigma v^2\sigma T_\infty^3}{ku_0^2},\ k_v=\dfrac{vk}{u_0^2},\ Du=\dfrac{D_m k_t(C_w-C_\infty)}{c_s c_p v(T_w-T_\infty)}\\ Q_0=\dfrac{Qv}{\rho c_p u_0^2}.\end{array}\right] \quad (8)$$

We have the following governing equation which is dimensionless form

$$\frac{\partial\bar{u}}{\partial\bar{t}}=\frac{\partial^2\bar{u}}{\partial\bar{y}^2}-M\bar{u}+G_r\cos\alpha\theta+G_m\cos\alpha\bar{C}, \quad (9)$$

$$\frac{\partial\theta}{\partial\bar{t}}=\frac{1}{P_r}\frac{\partial^2\theta}{\partial\bar{y}^2}-\left(\frac{R}{P_r}+Q_0\right)\theta+D_u\frac{\partial^2\bar{C}}{\partial\bar{y}^2}, \quad (10)$$

$$\frac{\partial\bar{C}}{\partial\bar{t}}=\frac{1}{S_c}\frac{\partial^2\bar{C}}{\partial\bar{y}^2}-k\bar{C}, \quad (11)$$

The corresponding boundary becomes

$$\left.\begin{array}{l}\bar{t}\le 0:\bar{u}=0,\ \theta=0,\ \bar{C}=0 \qquad \text{for all } \bar{y}\\ \bar{t}>0:\bar{u}=\exp(\bar{a}_0\bar{t}),\ \theta=\bar{t},\ \bar{C}=1 \text{ at } \bar{y}=0\\ \bar{u}\to 0,\ \theta\to 0,\ \bar{C}\to 0,\ as\ \bar{y}\to\infty\end{array}\right] \quad (12)$$

The above equation dropping bars we get

$$\frac{\partial u}{\partial t}=\frac{\partial^2 u}{\partial y^2}-Mu+G_r\cos\alpha\theta+G_m\cos\alpha C, \quad (13)$$

$$\frac{\partial\theta}{\partial t}=\frac{1}{P_r}\frac{\partial^2\theta}{\partial y^2}-\left(\frac{R}{P_r}+Q_0\right)\theta+D_u\frac{\partial^2 C}{\partial y^2}, \quad (14)$$

$$\frac{\partial C}{\partial t}=\frac{1}{S_c}\frac{\partial^2 C}{\partial y^2}-kC, \quad (15)$$

The corresponding boundary

$$\begin{array}{l}t\le 0: u=0,\ \theta=0, C=0 \quad \text{for all } y\\ t>0: u=\exp(a_0 t),\theta=t, C=1 \ \text{ at } y=0\\ u\to 0,\ \theta\to 0, C\to 0,\ \ as\ \ y\to\infty\end{array} \quad (16)$$

The appeared physical parameters are defind in the nomenclature

3.THE METHOD OF SOLUTION

The dimensionless governing equations from (13) to (14) using boundary condition (16) and solved by using Laplace transform method. Thus using Abramowitz and Stegum [1] and Hetnarski's algorithm [2] for inverse Laplace transform, we obtain the solutions as follows:

$$C=\tfrac{1}{2}\left[\exp(y\sqrt{kS_c})\,erfc(\eta\sqrt{S_c}+\sqrt{kt})+\exp(-y\sqrt{kS_c})\,erfc(\eta\sqrt{S_c}-\sqrt{kt})\right], \tag{17}$$

$$\theta(y,t)=\left[\begin{array}{l}\left(\frac{t}{2}+\frac{yp_r}{4\sqrt{(R+Q_0p_r)}}\right)\exp(y\sqrt{R})\,erfc\left(\eta\sqrt{p_r}+\sqrt{\left(\frac{Rt}{p_r}+Q_0\right)t}\right)\\ +\left(\frac{t}{2}-\frac{yp_r}{4\sqrt{(R+Q_0p_r)}}\right)\exp(-y\sqrt{R})\,erfc\left(\eta\sqrt{p_r}-\sqrt{\left(\frac{Rt}{p_r}+Q_0\right)t}\right)\end{array}\right]$$

$$-\tfrac{A_4}{2}\left[\begin{array}{l}\exp(y\sqrt{(R+Q_0p_r)})\,erfc(\eta\sqrt{p_r}+\sqrt{(Rt+Q_0p_r)})\\ +\exp(y\sqrt{(R-Q_0p_r)})\,erfc(-\eta\sqrt{p_r}+\sqrt{(Rt-Q_0p_r)})\end{array}\right]$$

$$+\tfrac{(A_4-A_3)}{2}\exp(-A_2t)\left[\begin{array}{l}\exp(y\sqrt{R+(Q_0-A_2)p_r})\,erfc(\eta\sqrt{p_r}+\sqrt{\left(\frac{Rt}{p_r}+Q_0-A_2\right)t})\\ +\exp(-y\sqrt{R+(Q_0-A_2)p_r})\,erfc(\eta\sqrt{p_r}-\sqrt{\left(\frac{Rt}{p_r}+Q_0-A_2\right)t})\end{array}\right]$$

$$\begin{aligned}&+\tfrac{A_4}{2}[\exp(y\sqrt{kS_c})\,erfc(\eta\sqrt{S_c}+\sqrt{kt})+\exp(-y\sqrt{kS_c})\,erfc(\eta\sqrt{S_c}-\sqrt{kt})]\\&+\tfrac{(A_3-A_4)}{2}\exp(-A_2t)[\exp(y\sqrt{(k-A_2)S_c})\,erfc(\eta\sqrt{S_c}+\sqrt{(k-A_2)t})\\&+\exp(-y\sqrt{(k-A_2)S_c})\,erfc(\eta\sqrt{S_c}-\sqrt{(k-A_2)t})],\end{aligned} \tag{18}$$

$$\begin{aligned}u(y,t)=&\tfrac{\exp(a_0t)}{2}[\exp(y\sqrt{(M+A_0)})\,erfc(\eta+\sqrt{(M+A_0)t})+\exp(-y\sqrt{(M+A_0)})\,erfc(\eta-\sqrt{(M+A_0)t})]\\&+\tfrac{B_1}{2}[\exp(y\sqrt{M})\,erfc(\eta+\sqrt{Mt})+\exp(-y\sqrt{M})\,erfc(\eta-\sqrt{Mt})]\\&+\tfrac{B_2}{2}[(\tfrac{t}{2}+\tfrac{y}{4\sqrt{M}})\exp(y\sqrt{M})\,erfc(\eta+\sqrt{Mt})+(\tfrac{t}{2}-\tfrac{y}{4\sqrt{M}})\exp(-y\sqrt{M})\,erfc(\eta-\sqrt{Mt})]\\&+\tfrac{B_3}{2}\exp(A_6t)[\exp(y\sqrt{(M-A_6)})\,erfc(\eta+\sqrt{(M-A_2)t})+\exp(-y\sqrt{(M-A_6)})\,erfc(\eta-\sqrt{(M-A_2)t})]\\&+\tfrac{B_4}{2}\exp(-A_2t)[\exp(y\sqrt{M-A_2})\,erfc(\eta+\sqrt{(M-A_2)t})+\exp(-y\sqrt{M-A_2})\,erfc(\eta-\sqrt{(M-A_2)t})]\\&+\tfrac{B_5}{2}\exp(-A_8t)[\exp(y\sqrt{M-A_8})\,erfc(\eta+\sqrt{(M-A_8)t})+\exp(-y\sqrt{M-A_8})\,erfc(\eta-\sqrt{(M-A_8)t})]\end{aligned}$$

$$-\tfrac{B_2}{2}\left[\begin{array}{l}(\tfrac{t}{2}+\tfrac{yP_r}{4\sqrt{R+Q_0P_r}})\exp(y\sqrt{(R+Q_0p_r)})\,erfc\left(\eta\sqrt{p_r}+\sqrt{\left(\frac{Rt}{p_r}+Q_0\right)t}\right)\\ +(\tfrac{t}{2}-\tfrac{yP_r}{4\sqrt{R+Q_0P_r}})\exp(-y\sqrt{(R+Q_0p_r)})\,erfc\left(\eta\sqrt{p_r}-\sqrt{\left(\frac{Rt}{p_r}+Q_0\right)t}\right)\end{array}\right]$$

$$+\tfrac{B_7}{2}\exp(-A_6t)\left[\begin{array}{l}\exp(y\sqrt{R+(Q_0-A_2)p_r})\,erfc(\eta\sqrt{p_r}+\sqrt{\left(\frac{Rt}{p_r}+Q_0-A_6\right)t})\\ +\exp(-y\sqrt{R+(Q_0-A_2)p_r})\,erfc(\eta\sqrt{p_r}-\sqrt{\left(\frac{Rt}{p_r}+Q_0-A_2\right)t}\end{array}\right]$$

$$+\tfrac{B_8}{2}\exp(-A_2 t)\left[\begin{array}{l}\exp(y\sqrt{R+(Q_0-A_2)p_r})\,erfc(\eta\sqrt{p_r}+\sqrt{\left(\frac{Rt}{p_r}+Q_0-A_2\right)t})\\ +\exp(-y\sqrt{R+(Q_0-A_6)p_r})\,erfc(\eta\sqrt{p_r}-\sqrt{\left(\frac{Rt}{p_r}+Q_0-A_6\right)t}\end{array}\right]$$

$$\begin{aligned}&+\tfrac{B_9}{2}[\exp(y\sqrt{kS_c})\,erfc(\eta\sqrt{S_c}+\sqrt{kt})+exp(-y\sqrt{kS_c})\,erfc(\eta\sqrt{S_c}-\sqrt{kt})]\\&+\tfrac{B_{10}}{2}\exp(-A_2t)[\exp(y\sqrt{(k-A_2)S_c})\,erfc(\eta\sqrt{S_c}+\sqrt{(k-A_2)t})\\&+\exp(-y\sqrt{(k-A_2)S_c})\,erfc(\eta\sqrt{S_c}-\sqrt{(k-A_2)t})]\\&+\tfrac{B_{11}}{2}\exp(-A_8t)[\exp(y\sqrt{(k-A_8)S_c})\,erfc(\eta\sqrt{S_c}+\sqrt{(k-A_8)t})\\&+\exp(-y\sqrt{(k-A_8)S_c})\,erfc(\eta\sqrt{S_c}-\sqrt{(k-A_8)t})].\end{aligned} \quad (19)$$

4. NUSSELT NUMBER

The Nusselt number obtained from temperature field and is given in non-dimensional form is given by $Nu=-\left[\frac{\partial\theta}{\partial y}\right]_{y=0}$,

$$\begin{aligned}Nu=&-\left[t\sqrt{(Q_0P_r+R)}\,erf\sqrt{(\tfrac{R}{P_r}+Q_0)t}-\sqrt{\tfrac{P_rt}{\pi}}\exp((\tfrac{-R}{P_r}+Q_0)t)-\tfrac{P_r}{2\sqrt{(Q_0P_r+R)}}\,erf\sqrt{(\tfrac{R}{P_r}+Q_0)t}\right]\\&-A_4\left[(-\exp((\tfrac{-R}{P_r}+Q_0)t)\sqrt{\tfrac{P_r}{\pi t}}-\sqrt{(Q_0P_r+R)}erf((\tfrac{R}{P_r}+Q_0)t)\right]\\&-(A_3-A_4)\exp(-A_2t)\left[(-\exp(-\tfrac{R}{P_r}+Q_0+A_2)t)\sqrt{\tfrac{P_r}{\pi t}}-\sqrt{R+(Q_0-A_2)P_r}\,erf\sqrt{(\tfrac{R}{P_r}+Q_0-A_2)t}\right]\\&+A_4\left[\sqrt{\tfrac{S_c}{\pi t}}\exp(-kt)+\sqrt{kS_c}\,erf(kt)\right]-(A_3-A_4)[-\exp(-kt+A_2t)\sqrt{\tfrac{S_c}{\pi t}}\\&-\sqrt{kS_c-A_2S_c}\,erf(\sqrt{kt-A_2t})].\end{aligned} \quad (20)$$

5. SHERWOOD NUMBER

The Sherwood number obtained by concentration field and is given in non-dimensional form as

$$Sh=\left(\tfrac{1}{2}\sqrt{\frac{S_c}{k}}+t\sqrt{S_ck}\right)(1-erf\sqrt{kt})+\exp(-kt)\sqrt{\frac{tS_c}{\pi}} \quad (21)$$

The utilized constant expressions are described in the Appendix section.

6. NUMERICAL RESULTS AND DISCUSSION

The present analysis discussed in the thermos-diffusion and radiation effects of free convection flow past an accelerated infinite inclined plate with mass diffusion and variable temperature. The governing equations are highly nonlinear involving partial differential equations that are quite problematic to solve analytically. The nonlinear partial differential equations (13), (14), and (15) with boundary conditions (16) have been solved by usual Laplace transform method. The effects of the flow parameters on the dimensionless axial and transverse velocities, temperature, concentration, Sherwood number and Nusselt number are explored through most appropriate graphs. The results discussed of different parameters like $P_r = 0.71,\ Du = 0.03,\ S_c = 2.01,\ G_m = 5$ $G_r = 0.01\ a_0 = 0.5\ k = 0.5,\ t = 0.4,\ Q_0 = 0.005,\ M = 4,\ R = 4,\ \alpha = \frac{\pi}{3}$. on the velocity, the temperature, the species concentration, Nusselt number and Sherwood number are obtained.

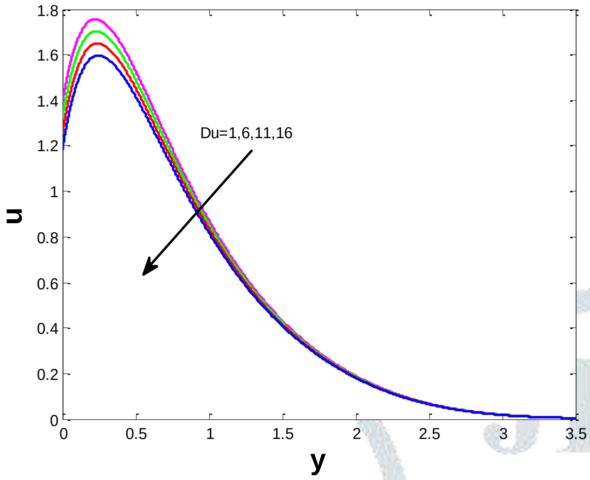

Figure 2 Velocity profiles for different values Du

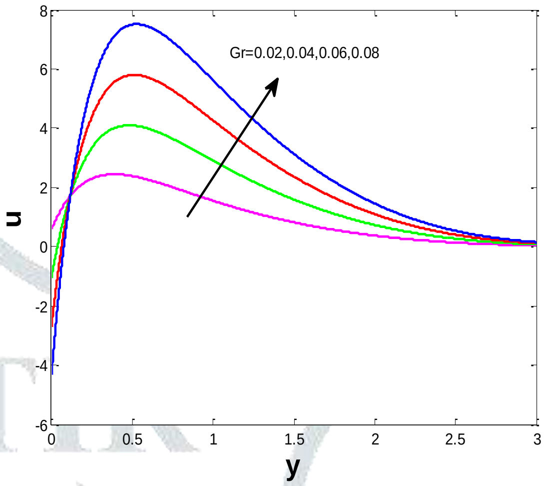

Figure 3 Velocity profiles for different values G_r

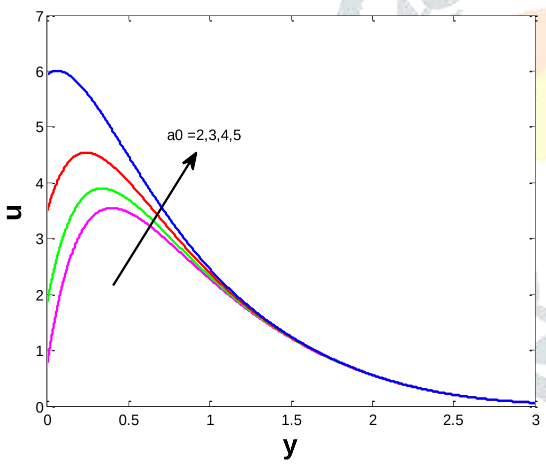

Figure 4 Velocity profiles for different values a_0

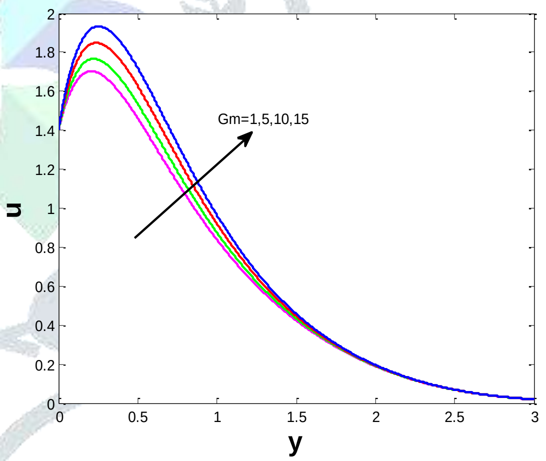

Figure 5 Velocity profiles for values G_m

6.1 Velocity profile

Figure 2 we see that the velocities of fluid decreasing with are increases values of Dufour effect. Figure 3 we conclude that the velocities of fluid increased with are increases values of Thermal Grashof number. Figure 4 we have the velocities of fluid increased with are increases values of Accelerated parameter. Figure 5 we observe that the velocities of fluid increased with are increases values of Mass Grashof number and Figure 6 we see that the velocities of fluid increased with are increases values of Mass Grashof number Magnetic field parameter.

6.2 Temperature profile

Figure 7 represents of Temperature profiles at S_c, t, Du, P_r, k for different Prandtl number P_r. It is seen that the wall Temperature increases with decreasing values of Prandtl number .Figure 8 represents of Temperature profiles at S_c, t, Du, P_r, k for different values of Radiation parameter. It is seen that wall Temperature increases with decreasing values of Radiation parameter R and figure 9 represents of Temperature profiles at S_c, t, Du, P_r, k for different t. We have seen that the wall Temperature increases with increasing values of time.

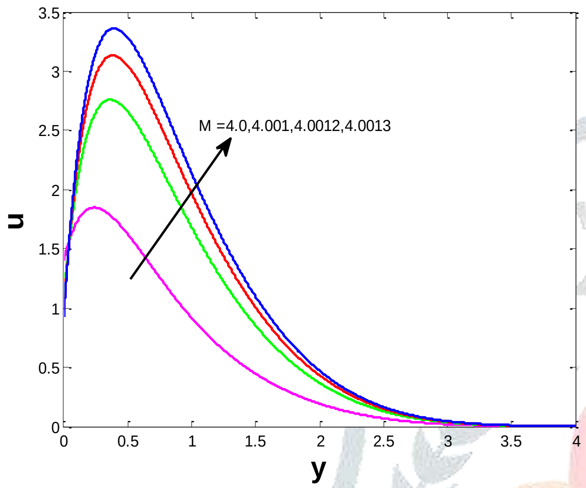

Figure 6 Velocity profiles for different Values M

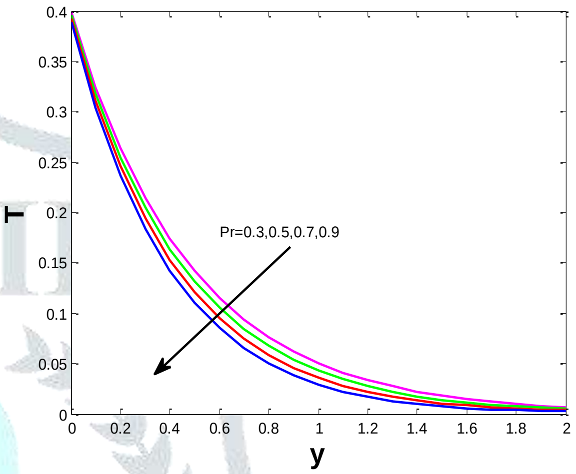

Figure 7 Temperature profiles for different values P_r

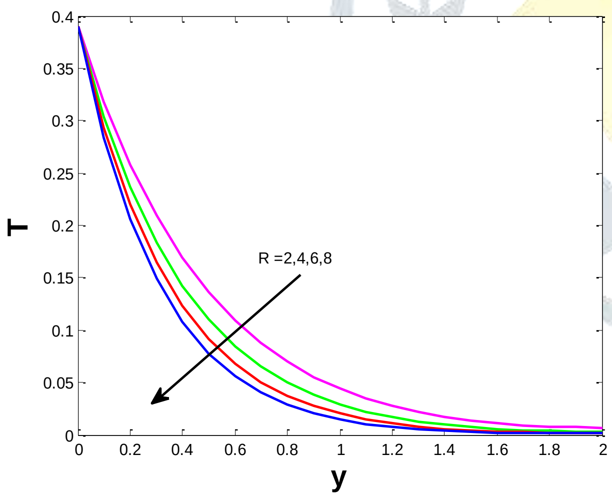

Figure 8 Temperature profiles for different values R

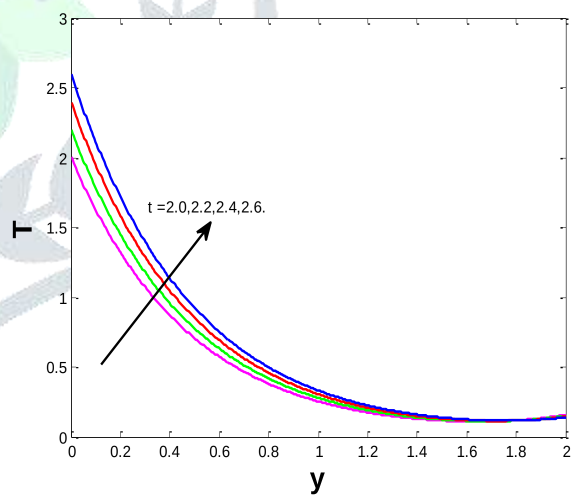

Figure 9 Temperature profiles for different values t

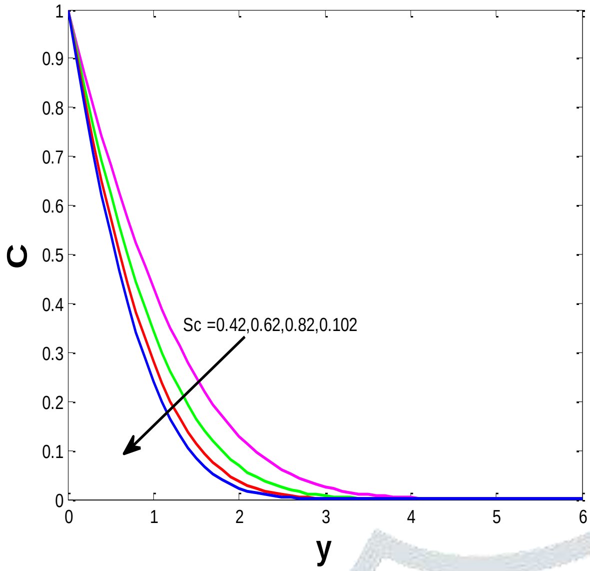

Figure 10 Concentration for different values S_c

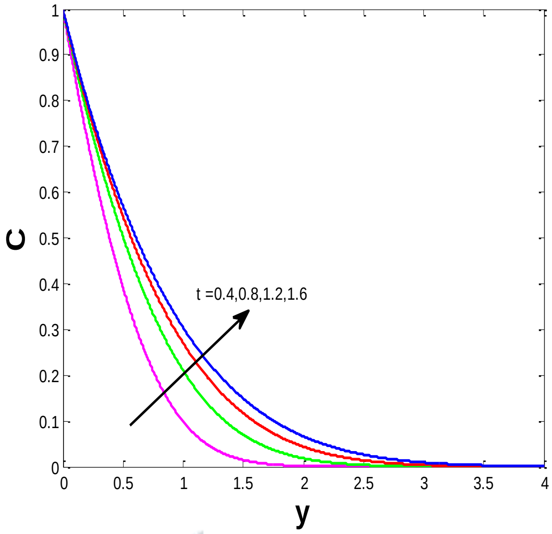

Figure 11 Concentration profiles for different values t

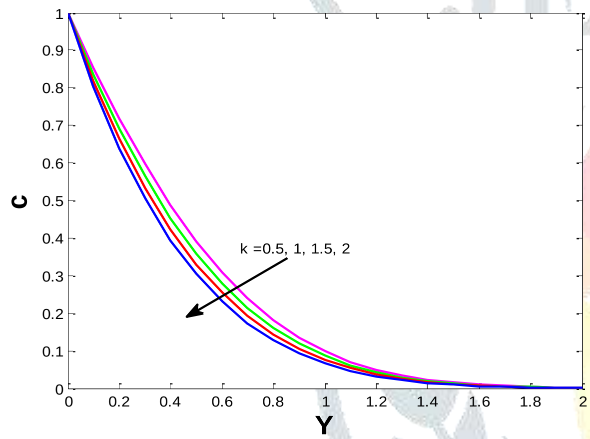

Figure 12 Concentration profiles for different values k

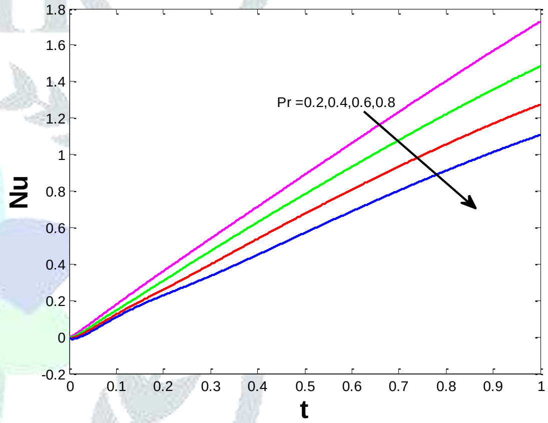

Figure 13 Nusselt number of different values P_r

6.3 Concentration profile

Figure 10 represents of concentration profiles at Thermal conductivity of the fluid k for a different Schmidt number Sc the effect of concentration is important in concentration field. It is seen that the wall concentration increases with decreasing values of the Schmidt number.Figure11 represents of concentration profiles at the Schmidt number Sc of different values. It is observed that the wall concentration increases with increasing values of time. Figure 12 represents of concentration profiles at the Schmidt number Sc for different chemical reaction parameter k .We conclude that the wall concentration increases with decreasing values of chemical reaction parameters.

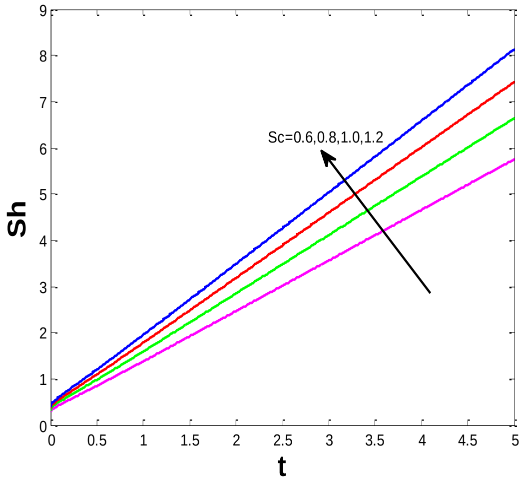

Figure 14 Sherwood number of different values S_c

6.4 Nusselt number and Shear wood number profile

The rate at mass transfers and the rate at which mass transfers are examined through the figures 13 and 14.Figure 13 it is observed that the Sherwood number increased with are increases values of Schmidt number and figure 14 represents that the rate of heat transfer Nusselt number decreased with are increasing the values of Prandtl number.

7. CONCLUSION

The present analysis discussed in the thermo diffusion and radiation effects of free convection flow past an accelerated infinite inclined plate with mass diffusion and variable temperature. The governing equations have been solved by usual Laplace transform method. The effects of the flow parameters on the dimensionless axial and transverse velocities, temperature, concentration, Sherwood number and Nusselt number are explored through most appropriate graphs. In this paper we conclude that the following.

- The concentration increases with the decreasing values of Chemical reaction parameter and Schmidt number.
- The concentration decreases with the increasing value of time.
- Temperature increases with decreasing values of Prandtl number and Radiation parameter.
- The velocities of fluid increased with are increases values of thermal Grashof number, accelerated parameter, Mass Grashof number and Magnetic field parameter.
- The velocities of fluid decreased with are increases values of Dufour effect.
- Sherwood number increase with increase in Schmidt number.
- Nusselt number decrease with the increase in Prandtl number.

NOMENCLATURE

a_0 -Accelerated parameter	T -Temperature of the fluid near the plate
a^* -absorption coefficient	T_w -Temperature of the plate
$\overline{a_0}$ -Dimensionless Accelerated parameter	T_∞ -Temperature of the fluid far away from the plate
B_0 -External magnetic field	t -Time
C - Species concentration	$\bar{t}$ - Dimensionless time
C_w -Concentration of the plate	u -Velocity of the fluid in the –direction
C_∞ - Concentration of the fluid far away from the plate	u_0 -Velocity of the plate
$\overline{C}$ - Dimensionless concentration	$\bar{u}$ -Dimensionless velocity
C_p -Specific heat at constant pressure	y -Coordinate axis normal to the plate
Du - Dufour effect	$\overline{y}$ -Dimensionless Coordinate axis normal to the plate
g -Acceleration due to gravity	k -Thermal conductivity of the fluid
G_r -Thermal Grash of number	y -Thermal diffusivity
G_m - Mass Grash of number	β -Volumetric coefficient of thermal expansion
M -Magnetic field parameter	β^* -Volumetric coefficient of expansion with Concentration
N_u - Nusselt number	μ - Coefficient of viscosity
P_r - Prandtl number	ν - Kinematic viscosity
q_r - Radiative heat fluxes in the - $\overline{y}$ direction	ρ -Density of the fluid
D_m -Coefficient of mass diffusivity	σ - Electric conductivity
R -Radiation parameter	Q_0 - Dimensionless heat source
S_c -Schmidt number	θ - Inclination angle from the vertical direction

APPENDIX

$$A_1 = \frac{-DuP_r kS_c}{S_c - P_r}, A_2 = \frac{kS_c - R - Q_0 P_r}{S_c - P_r}, A_3 = \frac{-DuP_r S_c}{S_c - P_r}, A_4 = \frac{A_1}{A_2}, A_5 = \frac{G_r \cos\alpha}{P_r - 1}, A_6 = \frac{R - M + Q_0 P_r}{P_r - 1}, A_7 = \frac{G_r \cos\alpha}{S_c - 1}$$

$$A_8 = \frac{kS_c - M}{S_c - 1}, A_9 = \frac{-G_m \cos\alpha}{S_c - 1}, A_{10} = \frac{A_5}{A_6{}^2}, A_{11} = \frac{A_5}{A_6}, A_{12} = \frac{A_1 A_5}{A_2 A_6}, A_{13} = \frac{A_1 A_5}{A_6 (A_2 - A_6)}, A_{14} = \frac{A_1 A_5}{A_2 (A_2 - A_6)}$$

$$A_{16} = \frac{A_1 A_5}{(A_2 - A_6)}, A_{17} = \frac{A_1 A_7}{A_2 A_8}, A_{18} = \frac{A_1 A_7}{A_8 (A_2 - A_6)}, A_{19} = \frac{A_1 A_7}{A_2 (A_2 - A_8)}, A_{20} = \frac{A_3 A_7}{(A_2 - A_8)}, A_{21} = \frac{A_9}{A8}$$

$$B_1 = (-A_{10} - A_{13} + A_{17} - A_{21}),\ B_2 = A_{11}, B_3 = (A_{10} + A_{14} - A_{16}), B_4 = (-A_{15} + A_{16} + A_{19} - A_{20})$$

$$B_5 = (-A_{18} + A_{20} + A_{21}), B_6 = (A_{10} + A_{13}), B_7 = (-A_{10} - A_{14} + A_{16}), B_8 = (A_{15} - A_{16}),$$

$$B_9 = (A_{21} - A_{17}), B_{10} = (-A_{19} + A_{20}), B_{11} = (A_{18} - A_{20} + A_{21}),\ \eta = \frac{y}{2\sqrt{t}}$$

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