Effect of Chemical Reaction and Radiation Absorption on Unsteady Convective Heat and Mass Transfer Flow in a Vertical Channel with Oscillatory Wall Temperature and Concentration

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Abstract: *We investigate the combined influence of chemical reaction and radiation absorption on mixed convective flow in a vertical channel with oscillatory wall temperature and concentration .The non-linear coupled partial differential equations governing the flow heat and mass transfer are solved by a perturbation technique. The effect of various forces acting on the fluid system is analyzed by graphical representation of the velocity, temperature and concentration.*

Keywords: *chemical reaction, heat and mass transfer, radiation absorption, variable temperature and concentration, vertical channel.*

I. INTRODUCTION

Combined heat and mass transfer problems with chemical reaction are of importance in many processes and have, therefore, received a considerable amount attention in recent years. In processes such as drying, evaporation at the surface of a water body, energy transfer in a wet cooling tower and the flow in a desert cooler, heat and mass transfer occur simultaneously.

We are particularly interested in cases in which diffusion and chemical reaction occur at roughly the same speed. When diffusion is much faster than chemical reaction, then only chemical factors influence the chemical reaction rate; when diffusion is not much faster than reaction, the diffusion and kinetics interact to produce very different effects. The study of heat generation or absorption effects in moving fluids is important in view of several physical problems, such as fluids undergoing exothermic or endothermic chemical reaction. Due to the fast growth of electronic technology, effective cooling of electronic equipment has become warranted and cooling of electronic equipment ranges from individual transistors to main frame computers and from energy suppliers to telephone switch boards and thermal diffusion effect has been utilized for isotopes separation in the mixture between gases with very light molecular weight (hydrogen and helium) and medium molecular weight.

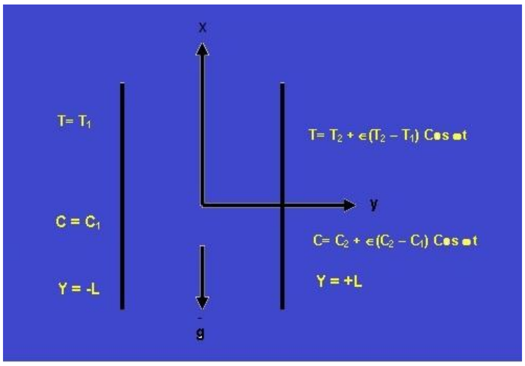
Muthucumaraswamy and Ganesan (12) studied effect of the chemical reaction and injection on flow characteristics in an unsteady upward motion of an unsteady upward motion of an isothermal plate. Deka et at. (4) studied the effect of the first order homogeneous chemical reaction on the process of an unsteady flow past an infinite vertical plate with a constant beat and mass transfer. Chamkha (3) studies the MHD flow of a numerical of uniformly stretched vertical permeable surface in the presence of heat generation/absorption and a chemical reaction. The effect of foreign mass on the free-convection flow past a semi-infinite vertical plate were studied (5) Chamkha (3) assumed that the plate is embedded in a uniform porous medium and moves with a constant velocity in the flow direction in the presence of a transverse magnetic field. Raptis and Perdikis (19) studied the unsteady free convection flow of water near 4 C in the laminar boundary layer over a vertical moving porous plate.

In spite of all these studies, the unsteady MHD free convection heat and mass transfer for a heat generating fluid with radiation absorption has received little attention. Hence, the main objective of the present investigation is to study the effects of radiation absorption, mass diffusion, chemical reaction and hear source parameter of hear generating fluid.The process of free convection as a mode of heat transfer has wide applications in the fields of Chemical Engineering, Aeronautical and Nuclear power generation. It was shown by Gill and Casal (6) that the buoyancy significantly affects the flow of low Prandtl number fluids which is highly sensitive to gravitational force and the extent to which the buoyancy force influences a forced flow is a topic of interest. Free convection flows between two long vertical plates have been studied for many years because of their engineering applications in the fields of nuclear reactors, heat exchangers, cooling appliances in electronic instruments. These flows were studied by assuming the plates at two different constant temperatures or temperature of the plates varying linearly along the plates etc. The study of fully developed free convection flow between two parallel plates at constant temperature was initiated by Ostrach (16). Combined natural and forced convection laminar flow with linear wall temperature profile was also studied by Ostrach (17). The first exact solution for free convection in a vertical parallel plate channel with asymmetric heating for a fluid of constant properties was presented by Anug (1). Many of the early works on free convection flows in open channels have been reviewed by Manca et al. (11). Recently, Campo et al.

(2) considered natural convection for heated iso-flux boundaries of the channel containing a low-Prandtl number fluid. Pantokratoras (18) studied the fully developed free convection flow between two asymmetrically heated vertical parallel plates for a fluid of varying thermophysical properties. However, all the above studies are restricted to fully developed steady state flows. Very few papers deal with unsteady flow situations in vertical parallel plate channels.

Transient free convection flow between two long vertical parallel plates maintained at constant but unequal temperatures was studied by Singh et al.(20). Jha et al. (9) extended the problem to consider symmetric heating of the channel walls. Narahari et al. (15) analyzed the transient free convection flow between two long vertical parallel plates with constant heat flux at one boundary, the other being maintained at a constant temperature. Singh and Paul (20) presented an analysis of the transient free convective flow of a viscous incompressible fluid between two parallel vertical walls occurring as a result of asymmetric heating / cooling of the walls. Narahari (14) presented an exact solution to the problem of unsteady free convective flow of a viscous incompressible fluid between two long vertical parallel plates with the plate temperature linearly varying with time at one boundary, the other boundary being held at constant. There are many reasons for the flow to become unsteady. When the current is periodic due to on-off control mechanisms or due to partially rectified a-c voltage, there exist periodic heat inputs. Hence, it is important to study the effects of periodic heat flux on the unsteady natural convection, imposed on one of the plates of a channel formed by two long vertical parallel plates, the other being held at a constant initial fluid temperature. Recently Narahari(15) has discussed the unsteady free convection flow of dissipative viscous incompressible fluid between two long vertical parallel plates in which the temperature of one of the plates is oscillatory whereas that of the other plate is uniform. Haritha (7) has analysed unsteady convective heat transfer of dissipative viscous fluid through a porous medium confined in a vertical channel on whose walls an oscillatory temperature is prescribed. Ibrahim et al. (8) have studied the effect of 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 Kesavaiah et al (10) have studied the effect of the chemical reaction and radiation absorption on an unsteady MHD convective Heat and Mass Transfer flow past a semi-infinite vertical permeable moving plate embedded in a porous medium with heat source and suction

In this paper we analyse the effect of chemical reaction and radiation absorption on unsteady convective Heat and Mass Transfer flow of a viscous fluid in a Vertical channel on whose walls an oscillatory temperature is prescribed. Approximate solutions to coupled non-linear partial differential equations governing the flow, heat and mass transfer are solved by a perturbation technique. The velocity, temperature, skin friction, concentration and rate of heat and mass transfer are discussed for different variations of Sc, N, K, Q_1, γ.



II. FORMULATION OF THE PROBLEM

We consider the flow of a viscous incompressible chemically reacting fluid in a vertical channel bounded by flat walls in the presence of constant heat sources. We choose a Cartesian coordinate system 0(x y) with walls at y = ± 1 by using Boussinesq approximation we consider the density variation only on the buoyancy term. The equation governing the flow to heat and mass transfer are

Equation of Linear Momentum

$$\frac{\partial u}{\partial t} = \frac{\mu}{\rho_0}\frac{\partial^2 u}{\partial y^2} - \rho\bar{g} - (\frac{\mu}{k})u \tag{1}$$

Equation of Energy

$$\rho_0 C_p(\left[\frac{\partial T}{\partial t}\right] = k_f\frac{\partial^2 T}{\partial y^2} + Q + Q_1'(C - C_0) \tag{2}$$

Equation of Diffusion

$$\frac{\partial C}{\partial t} = D_1\frac{\partial^2 C}{\partial^2 y} - K'C \tag{3}$$

Equation of State

$$\rho - \rho_0 = -\beta_0(T - T_0) - \beta^*(C - C_0) \tag{4}$$

where u is the velocity component in x-direction, T is the temperature, p is the pressure, ρ is the density, σ is the electrically conductivity, μ_e is the magnetic permeability, k is the coefficient of porous permeability, μ is dynamic viscocity, k_f is coefficient of thermal conductivity β is the coefficient of volume expansion, Q is the strength of heat source, β* is the volumetric coefficient of expansion with mass fraction, D_1 is the chemical molecular diffusivity and K′ is the coefficient of chemical reaction. Q_1 is radiation absorption parameter.

The boundary conditions are

$u = 0, T = T_1, C=C1$ at y = -L

$u = 0$, $T = T_1 + \in(T_2 - T_1)\cos(\omega t)$, $C = C_1 + \in(C_2 - C_1)\cos(\omega t)$ at $y = +L$ (5)

On introducing the non-dimensional variables.

$$u' = \frac{u}{\nu / L}, \quad y' = y/L, \quad \theta = \frac{T - T_1}{T_2 - T_1}, \quad t' = \omega t, \quad \phi = \frac{(c - c_1)}{(c_2 - c_1)}$$

Equations (2.1) – (2.3) reduce to (dropping the dashes)

$$\gamma^2 \frac{\partial u}{\partial t} = G[\theta + N\phi] + \frac{\partial^2 u}{\partial y^2} - D^{-1}u \quad (6)$$

$$P\gamma^2 \frac{\partial \theta}{\partial t} = \frac{\partial^2 \theta}{\partial y^2} + \alpha + Q_1\phi \quad (7)$$

$$S_c\gamma^2 \frac{\partial C}{\partial t} = C_{yy} - KC \quad (8)$$

where

$G = \beta g L^3 \frac{(T_2 - T_1)}{\gamma^2}$ (Grashoff number)

$P = \frac{\mu C_P}{K_f}$ (Prandtl number)

$\alpha = \frac{\theta L^2}{(T_2 - T_1)K_f}$ (Heat source parameter)

$S_c = \frac{\gamma^2}{D_1}$ (Schmidt number)

$\gamma = \frac{\omega L^2}{\gamma}$ (Wormsly number)

$N = \frac{\beta^*(C_L - C_0)}{\beta(T_L - T_0)}$ (Buoyancy ratio)

$K = \frac{K' L^2}{D}$ (Chemical reaction parameter)

$Q_1 = \frac{Q_1 \Delta C L^2}{\Delta + K_f}$ (radiation absorption parameter)

The transformed boundary conditions are

$$\left.\begin{array}{l} u = 0, \quad \theta = 0, \quad \phi = 0 \text{ at } y = -1 \\ u = 0, \quad \theta = 1 + \varepsilon\cos(\omega t), \; c = 1 + \varepsilon\cos(\omega t) \text{ at } y = +1 \end{array}\right\} \quad (9)$$

III. METHOD OF SOLUTION

In view of the boundary conditions (5) we assume

$$\left.\begin{array}{l} u = u_0 + \in e^{it} u_1 \\ \theta = \theta_0 + \in e^{it} \theta_1 \\ \phi = \phi_0 + \in e^{it} \phi_1 \end{array}\right\} \quad (10)$$

substituting (10) in the equations6-8 and comparing harmonic & Non harmonic terms we get

$$\frac{\partial^2 u_0}{\partial y^2} - D^{-1}u_0 = G(\theta + N\phi_0) \quad (11)$$

$$\frac{\partial^2 u_1}{\partial y^2} - (D^{-1} + i\gamma^2)u_1 = -G(\theta_1 + N\phi_1) \quad (12)$$

$$\frac{\partial^2 \theta_0}{\partial y^2} + \alpha + Q_1\phi_0 = 0 \quad (13)$$

$$\frac{\partial^2 \theta_1}{\partial y^2} - iP\gamma^2\theta_1 + Q_1\phi_1 = 0 \qquad (14)$$

$$\frac{d^2\phi_0}{dy^2} - K_1\phi_0 = 0 \qquad (15)$$

$$\frac{d^2\phi_1}{dy^2} - (K + i\,Sc\,\gamma^2)\phi_1 = 0 \qquad (16)$$

III. SOLUTIONS OF THE PROBLEM

The solutions of (11)- (16) subject to the boundary conditions are

$$\phi_0 = \frac{Ch\beta_1 y}{2Ch\beta_1} + \frac{Sh\beta_1 y}{2Sh\beta_1}$$

$\theta_0 = b_1 y^2 + b_2 \,Ch\, \beta_1 y + b_3 \,Sh\, \beta_1 y + a_3 y + a_4$
$u_0 = b_4 y^4 + b_7 y^3 + b_8 y^2 + a_5 y + a_6 + (b_5 + b_9)\, Ch\, \beta_1 y) + (b_6 + b_{10})\, Sh\, \beta_1 y.$

$$\phi_1 = \frac{Ch\beta_3 y}{2Ch\beta_3} + \frac{Sh\beta_3 y}{2Sh\beta_3}$$

$\theta_1 = k_{49}\, Ch\beta_3 y + k_{50}\, Sh\, \beta_3 y + k_{51}\, Ch\, \beta_2 y + k_{52}\, Sh\, \beta_2 y$
$u_1 = k_{55}\, Ch\, \beta_3 y + k_{56}\, Sh\, \beta_3 y + k_{57}\, Ch\beta_2 y + k_{58}\, Sh\beta_2 y + k_{59}\, Ch\, \beta_4 y + k_{60}\, Sh\, \beta_4 y.$

Where $\beta_1^2 = \alpha$ $\qquad \beta_2^2 = K$ $\qquad \beta_3^2 = i\gamma^2 P$ $\qquad \beta_4^2 = i\gamma^2 Sc$

IV. NUSSELT NUMBER and SHERWOOD NUMBER

The rate of heat transfer (Nusselt number) at the walls y = ±1 is given by

$$(Nu)_{y=\pm 1} = \left(\frac{d\theta}{dy}\right)_{y=\pm 1}$$

and the corresponding expressions are

$$(Nu)_{y=-1} = a_{27} + Ec[a_{28} + a_{29} + a_{30}Sh\beta_1 + a_{31}Ch\beta_1] + (0.01).E_{33}.a_{32}$$

$$(Nu)_{y=+1} = a_{21} + Ec[a_{22} + a_{23} + a_{24}Sh\beta_1 + a_{25}Ch\beta_1] + (0.01).E_{33}.a_{26}$$

The rate of mass transfer (Sherwood number) at the walls y = ±1 is given by

$$(Sh)_{y=\pm 1} = \left(\frac{dc}{dy}\right)_{y=\pm 1}$$

And the corresponding expressions are

$$(Sh)_{y=-1} = a_{35} + (0.01)E_{33}.a_{36}$$

$$(Sh)_{y=+1} = a_{33} + (0.01)E_{33}.a_{34}$$

where $a_1, a_2, \ldots\ldots a_{36}$ are constants shown in appendix.

V. RESULTS AND DISCUSSION

In this analysis we investigate the effect of chemical reaction on mixed convection heat and mass transfer flow of a viscous fluid through a porous medium in a vertical channel on whose walls oscillatory temperature and concentration are prescribed.

The velocity (u) is shown in figures 1-4 for different values of N,Sc , K, Q_1. The variation of u with buoyancy ratio N shows that when the molecular buoyancy force dominates over the thermal buoyancy force, the velocity enhances in the left half and reduces in the right half when the buoyancy forces act in the same direction and for the forces acting in opposite directions u reduces in the left half and enhances in the right half(fig.1). Fig 2 represents the variation of 'u' with Sc.Lesser the molecular diffusivity smaller 'u' in the flow region, and for further lowering of the diffusivity the velocity enhances in the left half and reduces in the right half and for still lowering of the molecular diffusivity the velocity enhances in the entire flow region. The effect of chemical reaction on u is shown in fig 3. It is found that an increase in $k < 1.5$ enhances |u| in entire region and for higher $k \geq 2.5$, |u| enhances in the left half and reduces in the right half. The variation of 'u' with radiation absorption parameter 'Q_1' is shown in fig 4. Fixing the other parameters. It is found that an increase in Q_1

≤ 2 leads to an enhancement in |u| and for further higher $Q_1 = 4$, |u| reduces in the flow region and for still higher $Q_1 \geq 6$, |u| reduces in the left half and enhances in the right half.

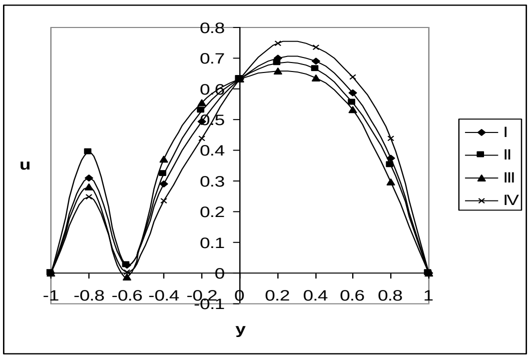


Fig. 1 : Variation of u with N

	I	II	III	IV
N	1	2	-0.5	-0.8

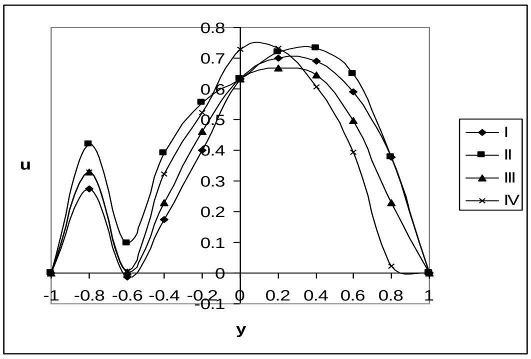


Fig. 2 : Variation of u with Sc

	I	II	III	IV
Sc	0.24	0.6	1.3	2.01

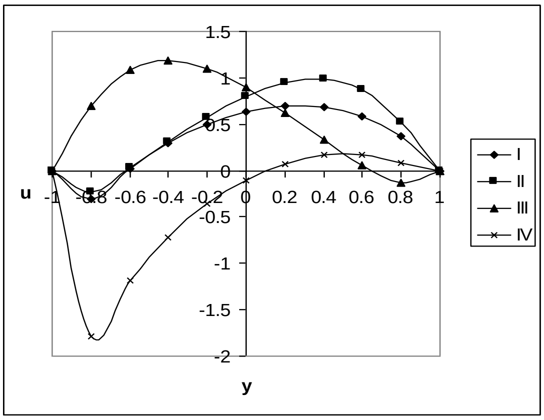


Fig. 3: Variation of u with K

	I	II	III	IV
K	0.5	1.5	2.5	3.5

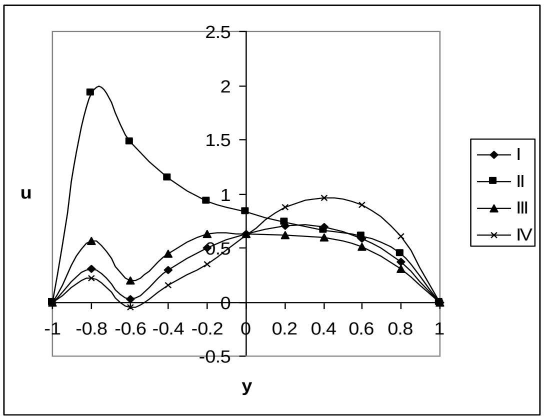


Fig. 4 : Variation of u with Q_1

	I	II	III	IV
Q_1	1	2	4	6

The Non-dimensional temperature distribution (θ) is shown in fig 5- 8 for different parametric values N,Sc , K, Q_1 . The variation of θ with the buoyancy ratio N shows that the actual temperature experiences a depreciation with increasing in |N| irrespective of the directions of the buoyancy forces(fig.5). The variation of 'θ' with Schmidt number Sc shows that lesser the molecular diffusivity larger the actual temperature in the left half and smaller in the right half, and for further lowering of the molecular diffusivity smaller the actual temperature in the entire flow region and for still lowering of the molecular diffusivity smaller the actual temperature in the left half and larger in the right half (fig 6). From fig 7 we notice that for smaller and larger values of the chemical reaction parameter K, the actual temperature depreciates in the flow region and for any intermediate value of K = 2.5, the actual temperature experiences an enhancement in the flow region. The variation of 'θ' with radiation absorption; parameter Q_1 shows that the actual temperature depreciates appreciabelly with increase in Q_1 in the entire flow region (fig.8).

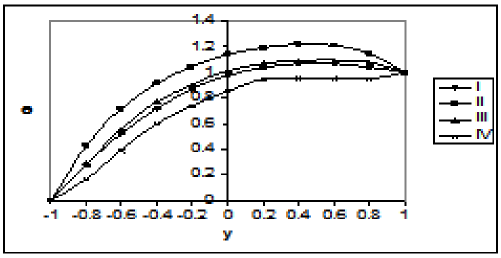


Fig. 5 : Variation of θ with N

	I	II	III	IV
N	1	2	-0.5	-0.8

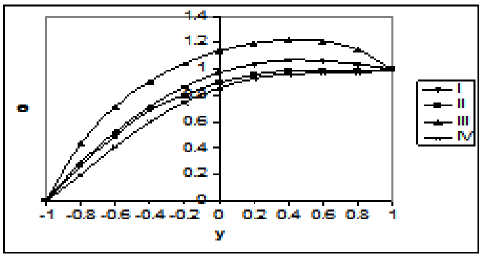


Fig. 6 : Variation of θwith Sc

	I	II	III	IV
Sc	0.24	0.6	1.3	2.01

I

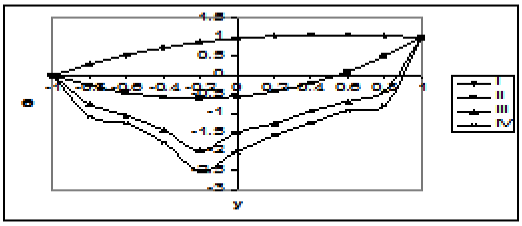


Fig. 7 : Variation of θ with K

	I	II	III	IV
K	0.5	1.5	2.5	3.5

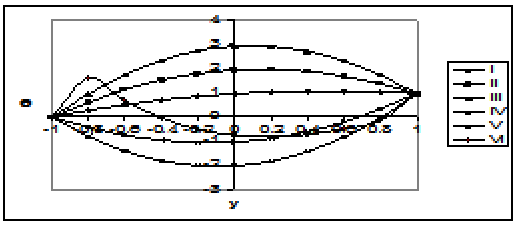


Fig. 8 : Variation of θ with Q_1

	I	II	III	IV
Q_1	1	2	4	6

The non-dimensional concentration ‘C’ is shown in fig 9-11 for different values of Sc, K and γ. From fig 9 we notice that lesser the molecular diffusivity larger the actual concentration in the flow region. An increase in the chemical reaction parameter ‘K’ results in a depreciation in the concentration in the entire flow region (fig. 10). An increase in the Wormsely number (γ) leads to an enhancement in the actual concentration in the flow field(fig.11).

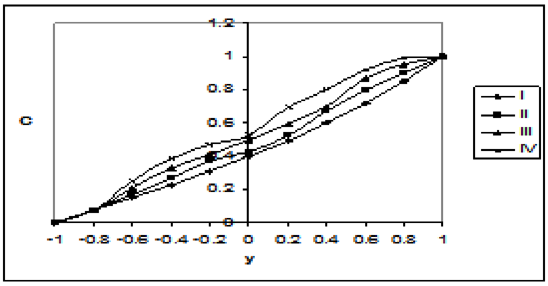


Fig 9 : Variation of C with Sc

	I	II	III	IV
Sc	0.24	0.6	1.3	2.01

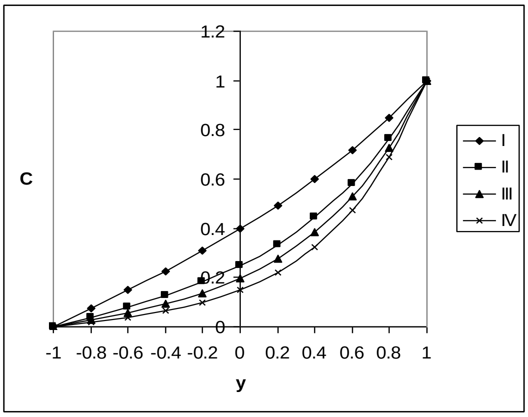


Fig.10 : Variation of C with K

	I	II	III	IV
K	0.5	1.75	2.5	3.5

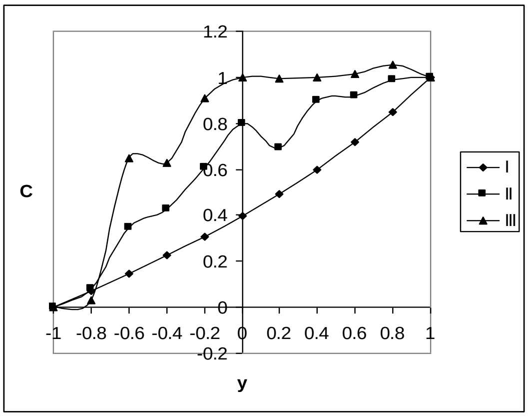


Fig 11 : Variation of C with γ

	I	II	III
γ	2	4	6

The rate of heat transfer at y = ±1 are exhibited in tables 1-4 for different parametric values. It is found that the rate of heat transfer increases with increase in |G| (or) M (or) K, thus higher the Lorentz force larger the Nusselt number at both the walls. An increase in the radiation absorption parameter Q_1 enhances |Nu| at y=+1 and reduces at y = -1 (tables 1 and 3).

From tables 2 and 4 we find that the rate of heat transfer depreciates at y = +1 and enhances at y = -1. The variation of Nu with heat source parameter α shows that the rate of heat transfer reduces at y = +1 and enhances at y = -1 with increase in α > 0, while an increase in α < 0 reduces |Nu| at y = ±1.

The rate of mass transfer at y = ±1 is shown tables 5-6 for different Sc, K and γ. The rate of mass transfer enhances with Schmidt number Sc.Thus higher the molecular diffusivity larger |Sh| at y = ±1. The variation of Sh with chemical reaction parameter K shows that the rate of mass transfer enhances with K at y = +1 while at y = -1 it enhances with K ≤ 1.5 and reduces with higher K ≥ 2.5. With reference to variation of Sh with Wormsely number (γ) exhibits that |Sh| reduces with increase in γ ≤ 4 and enhances with γ ≥ 6, while at y = -1 it experiences an enhancement with γ(tables.5-7).

Table 1

Nusselt Number (Nu) at y = + 1

G	I	II	III	IV	V	VI	VII	VIII	IX	X	XI
10	2.09075	10.62459	53.76271	4.41728	8.59022	125.20120	2.29075	2.19075	1.99075	3.23336	-7.03273
30	21.04668	97.73100	485.93610	40.50675	76.52689	1124.36	22.04668	21.94668	20.64668	6.64833	-151.193701
-10	2.15887	10.65264	53.77809	4.45838	8.63823	125.4219	2.25887	2.20887	20.00887	4.18804	7.70093
-30	21.25105	97.81516	485.9823	40.63005	76.67091	1125.023	22.25105	21.95105	20.65105	9.51236	-106.9927
M	2	3	4	2	2	2	2	2	2	2	2
K	0.5	0.5	0.5	1.5	2.5	3.75	0.5	0.5	0.5	0.5	0.5
Sc	1.3	1.3	1.3	1.3	1.3	1.3	0.24	0.6	2.01	1.3	1.3
Q_1	1	1	1	1	1	1	1	1	1	2	4

Table 2

Nusselt Number (Nu) at y = + 1

G	I	II	III	IV	V	VI
10	-79.46017	2.09075	0.30845	-1.60624	5.25822	6.64338
30	-801.2485	21.04668	21.00595	19.77381	17.55389	14.02036
-10	-5.37833	2.15887	0.37657	-1.53811	5.32634	6.7115
-30	-579.0029	21.25105	21.21033	19.97817	17.75823	14.22473
γ	2	4	2	2	2	2
N	1	1	1	1	1	1
α	2	2	4	6	-2	-4

Table 3

Nusselt Number (Nu) at y = – 1

G	I	II	III	IV	V	VI	VII	VIII
10	23.43691	307.9708	531.3494	44.84242	54.50365	64.98	2.84563	7.1667
30	22.9964	42.5871	68.611	64.8271	76.9875	84.125	3.53735	2.4623
-10	24.12496	38.2541	53.5047	45.25756	54.98854	65.209	2.48786	1.35672
-30	35.0605	43.4371	19.077	66.0725	77.4422	86.156	6.46406	2.63609
M	2	3	4	2	2	2	2	2
K	0.5	0.5	0.5	1.5	2.5	3.75	0.5	0.5
Sc	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3
Q_1	1	1	1	1	1	1	2	4

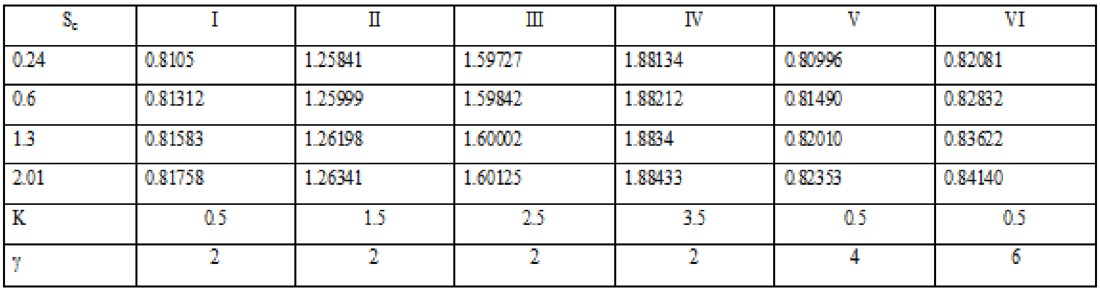
Table 4

Nusselt Number (Nu) at y = – 1

G	I	II	III	IV	V	VI
10	23.4361	23.49691	25.82237	26.95587	14.91011	8.76877
30	32.9964	35.1064	34.4655	44.667	36.2552	10.98309
-10	24.1248	24.42496	26.51042	27.64391	15.59815	9.45681
-30	35.0605	36.0805	36.5296	46.7311	38.3193	13.04721
γ	2	4	2	2	2	2
α	2	2	4	6	-2	-4

Table 5

Sherwood Number (Sh) at y = + 1



S_c	I	II	III	IV	V	VI
0.24	0.8105	1.25841	1.59727	1.88134	0.80996	0.82081
0.6	0.81312	1.25999	1.59842	1.88212	0.81490	0.82832
1.3	0.81583	1.26198	1.60002	1.8834	0.82010	0.83622
2.01	0.81758	1.26341	1.60125	1.88433	0.82353	0.84140
K	0.5	1.5	2.5	3.5	0.5	0.5
γ	2	2	2	2	4	6

Table 6

S_c	I	II	III	IV	V	VI
0.24	1.44945	1.52393	1.05223	0.85282	1.50818	2.49153
0.6	1.71269	1.68234	1.16664	0.93067	1.90167	3.24322
-101.3	1.98342	1.88206	1.32729	1.05200	2.42227	4.03263
2.01	2.15846	2.02504	1.44943	1.15108	2.76520	4.55103
K	0.5	1.5	2.5	3.5	0.5	0.5
γ	2	2	2	2	4	6

VI. CONCLUSION

An attempt has been made to investigate the combined influence of chemical reaction and radiation absorption on the unsteady convective heat and mass transfer flow in a vertical channel technique using a regular perturbation technique the non-linear coupled equations has been solved. The important conclusions of this analysis are

1. Lesser the molecular diffusivity smaller ‘u’ in the flow region, and for further lowering of the diffusivity the velocity enhances in the left half and reduces in the right half and for still lowering of the molecular diffusivity the velocity enhances in the entire flow region. An increase in $k < 1.5$ enhances $|u|$ in entire region and for higher $k \geq 2.5$, $|u|$ enhances in the left half and reduces in the right half.An increase in $Q_1 \leq 2$ leads to an enhancement in $|u|$ and for further higher $Q_1 = 4$, $|u|$ reduces in the flow region and for still higher $Q_1 \geq 6$, $|u|$ reduces in the left half and enhances in the right half.
2. The actual temperature experiences a depreciation with increasing in $|N|$ irrespective of the directions of the buoyancy forces.Lesser the molecular diffusivity larger the actual temperature in the left half and smaller in the right half, and for further lowering of the molecular diffusivity smaller the actual temperature in the entire flow region and for still lowering of the molecular diffusivity smaller the actual temperature in the left half and larger in the right half.
3. For smaller and larger values of the chemical reaction parameter K, the actual temperature depreciates in the flow region and for any intermediate value of K = 2.5, the actual temperature experiences an enhancement in the flow region.The actual temperature depreciates appreciabelly with increase in Q_1 in the entire flow region.
4. Lesser the molecular diffusivity larger the actual concentration in the flow region. An increase in the chemical reaction parameter ‘K’ results in a depreciation in the concentration in the entire flow region.
5. Higher the Lorentz force larger the Nusselt number at both the walls. An increase in the radiation absorption parameter Q_1 enhances $|Nu|$ at $y=+1$ and reduces at $y = -1$.
6. The rate of mass transfer enhances with Schmidt number Sc.The rate of mass transfer enhances with K at $y = +1$ while at $y = -1$ it enhances with $K \leq 1.5$ and reduces with higher $K \geq 2.5$.

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