



## Heat Source effects of flow past a parabolic accelerated isothermal vertical plate in the presence of Hall Current , Chemical reaction , Rotation and Radiation

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**Abstract:** This is a study of Hall current, Heat Source with Radiation & Chemical reaction effects on First-order viscous fluid flow which is an incompressible fluid and we focus on heat and mass transfer past an accelerated isothermal vertical plate with Rotation. We employ Inverse Laplace Transform Technique to solve the ascendant mathematical equations. The numerical values are given after our study of the accelerated flow with respect to certain parameters like Thermal Grashof number, Prandtl number, Schmidt number, and Mass Grashof number. Based on the study we have deduced that, Velocity increases when Heat Source, Hall Current and Grashof Values rises, Velocity reduces when Radiation rises. Also, Temperature falls when radiation rises and temperature rises when Heat Source rises. Concentration reduces when chemical reaction increased.

**Key words:** Hall Current, Radiation, Rotation, Heat source, Chemical reaction.

### 1. Introduction

Movement of fluid subject to some unbalance forces plays an important role in the study of heat and Mass transfer in fluid dynamics. As this is needed to understand working of a wide range of systems like biological systems, home appliances, industrial operations, food preparation etc., this kind of study is an imperative one. [1] Is one such study which found out that velocity of the fluid decreases when increasing the Schmidt number and chemical reaction parameter? [2] Is another study which concludes that the velocity of fluid rises as 'time' and the velocity falls as the Prandtl number increases? [3] Is a study which found out that the velocity rises as Thermal Grashof, Chemical Reaction, time, and Mass Grashof values are increased? In addition, it also claims that as Pr and Sc increase as velocity reduces. [4] Found out that the axial velocity hiked as value of hall parameter, Mass and thermal Grashof number [5] concludes that the velocity rises as Grashof numbers are increased. Similar findings in literature show that as the rotational limit is lowered, speed increases. [6] Deduced the result that Concentration profile decreases with increasing Schmidt number. [7] is an analysis deducing how the parameters of the thermal Grashof values, Mass Grashof values, time and variable thermal conductivity cause rise in velocity while parameters like Prandtl, Schmidt, Radiation, chemical reaction and magnetic field

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cause velocity to decrease. [8] Gives a graphical estimation of temperature, float speed, and mindfulness. It is an interesting study which observes an executed attractive region's tendency edge increases as the speed decreases. [9] Theorizes that velocity rises as Gr and Gc rise. Also, as the Prandtl number rises, the temperature drops, and as the Schmidt number rises, the mass concentration rises. [10] Depicts the impacts of the non-uniform heat parameter on dynamics of speed. The numerical technique on several parameters of heat radiation was obtained by [11]. [12] Is regarding The Hall current effect on unsteady hydro magnetic flow. [17] Observed that destructive reaction has a fall in velocity and concentration while the generative reaction has an increase. Inspired by the above we are pursuing the study of heat source effects where we observe fluid flow past a parabolic, accelerated, isothermal and vertical plate with respect to Hall current, chemical reaction, Rotation and radiation.

## 2. Numerical Formulation

Here, we assume viscous, incompressible fluid that conducts current flowing past an infinite plate that is located in the plane  $z = 0$ . The y-axis is normal to other axes, while x-axis is measured in the object's drift order. This plate is parabolic accelerated along the x-axis with a velocity of  $q = t^2$ . The plate in this instance is not electrically conductive. In the flow field, the pressure is uniform as well. The continuity equation if  $(u^*, v^*, w^*)$  denotes the elements of 'F' velocity vector.  $w^* = 0$  is satisfied when  $F = 0$  results in  $w^* = 0$  everywhere in the flow. Here, just  $z$  and  $t$  determine the flow volumes, The following equations regulate the unsteady flow under these presumptions.

$$\frac{\partial u^*}{\partial t^*} - 2\Omega v^* = \mathfrak{g} \frac{\partial^2 u^*}{\partial z^{*2}} + g\beta(T^* - T_\infty^*) + g\beta(C^* - C_\infty^*) - \frac{\sigma B_0^2 \mu^2 (u^* + m_1 v^*)}{\rho(1+m_1^2)} \quad (1)$$

$$\frac{\partial v^*}{\partial t^*} + 2\Omega u^* = \mathfrak{g} \frac{\partial^2 v^*}{\partial z^{*2}} + \frac{\sigma B_0^2 \mu^2 (m_1 u^* - v^*)}{\rho(1+m_1^2)} \quad (2)$$

$$\frac{\partial \theta^*}{\partial t^*} = \frac{1}{Pr} \frac{\partial^2 \theta^*}{\partial z^{*2}} - R\theta^* + Q\theta^* \quad (3)$$

$$\frac{\partial C^*}{\partial t^*} = \frac{1}{Sc} \frac{\partial^2 C^*}{\partial z^{*2}} - kC^* \quad (4)$$

The boundary conditions are

$$u^* = 0, v^* = 0, T^* = T_\infty^*, C^* = C_\infty^* \text{ at } t_\infty^* \leq 0 \forall z_\infty^*$$

$$u^* = t^{*2}, T^* = T_\infty^*, C^* = C_\infty^* \text{ at } t^* > 0 \text{ for } z^* = 0 \quad (5)$$

$$u^* \rightarrow 0, T^* \rightarrow T_\infty^*, C^* \rightarrow C_\infty^* \text{ at } z_\infty^* \rightarrow \infty$$

The consequent dimensionless aggregate is

$$U = \frac{u^*}{(Vu_0)^{\frac{1}{3}}}, V = \frac{v^*}{(Vu_0)^{\frac{1}{3}}}, t = t^* \left( \frac{(u_0^2)}{v} \right)^{\frac{1}{3}}, Z = z^* \left( \frac{(u_0^2)}{v^2} \right)^{\frac{1}{3}}$$

$$\theta = \frac{T^* - T_\infty^*}{T_w^* - T_\infty^*}, G_r = \frac{g\beta(T_w^* - T_\infty^*)}{u_0}, C = \frac{C^* - C_\infty^*}{C_w^* - C_\infty^*}, G_c = \frac{g\beta(C^* - C_\infty^*)}{C_w^* - C_\infty^*} \quad (6)$$

$$Pr = \frac{\mu C_p}{k}, K = K_1 \left( \frac{v}{u_0^2} \right)^{\frac{1}{3}}, Sc = \frac{v}{D}, M^2 = \frac{\sigma B_0^2}{\rho} \left( \frac{v}{u_0^2} \right)^{\frac{1}{3}}$$

On suggesting non dimensional parameters, Pr, Sc, Gc, Gr ratios areas presented in equation. It is important to determine the values of thermal layer transfer and proportionate heat transfer when measuring velocity since Pr is the ratio between momentum and thermal diffusivity. The heat transfer known as the Grashof number calculates the buoyancy to viscosity ratio. Since the buoyant force, as opposed to the viscous force, is mostly responsible for the convection, it is appropriate to measure the fluid to demonstrate this.

To examine the diffusion coefficient, use Schmidt as the ratio between mass diffusivity and momentum. 1st order chemical reaction on flow past a parabolic with rotation is shown using coupled partial differential equations. Complex velocity  $q = u + iv$  was used to solve eq. (1) and (2), which were then combined into one equation.

$$\frac{\partial q}{\partial t} = G_r \theta + G_c C + \frac{\partial^2 q}{\partial z^2} - mq \quad \text{where } m = \frac{M^2}{(1+hi)} - 2\Omega i \quad (7)$$

$$\frac{\partial \theta}{\partial t} = \frac{1}{Pr} \frac{\partial^2 \theta}{\partial z^2} - R\theta + Q\theta \quad (8)$$

$$\frac{\partial C}{\partial t} = \frac{1}{Sc} \frac{\partial^2 C}{\partial z^2} - kC \quad (9)$$

With conditions,

$$q = 0, \theta = 0, C = 0 \text{ for all } z, t \leq 0$$

$$q = t^2, \theta = 1, C = 1 \text{ for all } z, t = 0 \quad (10)$$

$$q \rightarrow 0, \theta \rightarrow 0, C \rightarrow 0 \text{ as } z \rightarrow \infty.$$

### 3. Elucidation of the Problem

Applying Inverse Laplace Technique to Solve eqn (7) to (9) using eqn (10)

$$\begin{aligned}
q(z) = & \left( \begin{aligned} & \left[ \frac{\eta^2 t}{m} + t^2 \right] \frac{1}{2} \left[ \begin{aligned} & e^{-2\eta\sqrt{t}\sqrt{m}} \operatorname{erfc}(\eta - \sqrt{mt}) \\ & + e^{2\eta\sqrt{t}\sqrt{m}} \operatorname{erfc}(\eta + \sqrt{mt}) \end{aligned} \right] \\ & + \left[ \frac{1}{4m} - t \right] \frac{2\eta\sqrt{t}}{2\sqrt{m}} \left[ \begin{aligned} & e^{-2\eta\sqrt{t}\sqrt{m}} \operatorname{erfc}(\eta - \sqrt{mt}) \\ & - e^{2\eta\sqrt{t}\sqrt{m}} \operatorname{erfc}(\eta + \sqrt{mt}) \end{aligned} \right] \\ & - \frac{2}{m} \sqrt{\frac{t}{\pi}} e^{\left(\frac{-z^2}{4t} - mt\right)} \end{aligned} \right) \\
& - \frac{G_r}{a(1 - P_r)} \left( \begin{aligned} & \frac{e^{at}}{2} \left[ \begin{aligned} & e^{-2\eta\sqrt{t}\sqrt{a+m}} \operatorname{erfc}(\eta - \sqrt{(a+m)t}) \\ & + e^{2\eta\sqrt{t}\sqrt{a+m}} \operatorname{erfc}(\eta + \sqrt{(a+m)t}) \end{aligned} \right] \\ & - \frac{1}{2} \left[ \begin{aligned} & e^{-2\eta\sqrt{t}\sqrt{m}} \operatorname{erfc}(\eta - \sqrt{mt}) \\ & + e^{2\eta\sqrt{t}\sqrt{m}} \operatorname{erfc}(\eta + \sqrt{mt}) \end{aligned} \right] \end{aligned} \right) \\
& - \frac{G_s}{b(1 - S_c)} \left( \begin{aligned} & \frac{e^{at}}{2} \left[ \begin{aligned} & e^{-2\eta\sqrt{t}\sqrt{b+m}} \operatorname{erfc}(\eta - \sqrt{(b+m)t}) \\ & + e^{2\eta\sqrt{t}\sqrt{b+m}} \operatorname{erfc}(\eta + \sqrt{(b+m)t}) \end{aligned} \right] \\ & - \frac{1}{2} \left[ \begin{aligned} & e^{-2\eta\sqrt{t}\sqrt{m}} \operatorname{erfc}(\eta - \sqrt{mt}) \\ & + e^{2\eta\sqrt{t}\sqrt{m}} \operatorname{erfc}(\eta + \sqrt{mt}) \end{aligned} \right] \end{aligned} \right) \\
& + \frac{G_r}{a(1 - P_r)} \left( \begin{aligned} & \frac{e^{at}}{2} \left[ \begin{aligned} & e^{-2\eta\sqrt{t}\sqrt{P_r(a+R-Q)}} \operatorname{erfc}(\eta\sqrt{P_r} - \sqrt{(a+R-Q)t}) \\ & + e^{2\eta\sqrt{t}\sqrt{P_r(a+R-Q)}} \operatorname{erfc}(\eta\sqrt{P_r} + \sqrt{(a+R-Q)t}) \end{aligned} \right] \\ & - \frac{1}{2} \left[ \begin{aligned} & e^{-2\eta\sqrt{t}\sqrt{P_r(R-Q)}} \operatorname{erfc}(\eta\sqrt{P_r} - \sqrt{(R-Q)t}) \\ & + e^{2\eta\sqrt{t}\sqrt{P_r(R-Q)}} \operatorname{erfc}(\eta\sqrt{P_r} + \sqrt{(R-Q)t}) \end{aligned} \right] \end{aligned} \right) \\
& + \frac{G_c}{b(1 - S_c)} \left( \begin{aligned} & \frac{e^{bt}}{2} \left[ \begin{aligned} & e^{-2\eta\sqrt{t}\sqrt{S_c(b+k)}} \operatorname{erfc}(\eta\sqrt{S_c} - \sqrt{(b+k)t}) \\ & + e^{2\eta\sqrt{t}\sqrt{S_c(b+k)}} \operatorname{erfc}(\eta\sqrt{S_c} + \sqrt{(b+k)t}) \end{aligned} \right] \\ & - \frac{1}{2} \left[ \begin{aligned} & e^{-2\eta\sqrt{t}\sqrt{S_c k}} \operatorname{erfc}(\eta\sqrt{S_c} - \sqrt{kt}) \\ & + e^{2\eta\sqrt{t}\sqrt{S_c k}} \operatorname{erfc}(\eta\sqrt{S_c} + \sqrt{kt}) \end{aligned} \right] \end{aligned} \right) \tag{11}
\end{aligned}$$

$$\text{where } \eta = \frac{z}{2\sqrt{t}}, a = \frac{\operatorname{Pr}(R-Q) - m}{1 - \operatorname{Pr}} \quad \text{and} \quad b = \frac{kS_c - m}{1 - S_c}$$

$$\theta = \frac{1}{2} \left[ \begin{aligned} & e^{-2\eta\sqrt{\operatorname{Pr}}\sqrt{(R-Q)t}} \operatorname{erfc}(\eta\sqrt{\operatorname{Pr}} - \sqrt{(R-Q)t}) \\ & + e^{2\eta\sqrt{\operatorname{Pr}}\sqrt{(R-Q)t}} \operatorname{erfc}(\eta\sqrt{\operatorname{Pr}} + \sqrt{(R-Q)t}) \end{aligned} \right] \tag{12}$$

$$C = \frac{1}{2} \left[ e^{-2\eta\sqrt{t}\sqrt{S_c k}} \operatorname{erfc}(\eta\sqrt{S_c} - \sqrt{kt}) + e^{2\eta\sqrt{t}\sqrt{S_c k}} \operatorname{erfc}(\eta\sqrt{S_c} + \sqrt{kt}) \right] \tag{13}$$

#### 4. Results and Discussion

The outcome for varying values of Chemical Reaction  $k$ , Schmidt Number  $Sc$ , Prandtl Number  $Pr$ , Thermal Grashof  $Gr$ , Mass Grashof  $Gc$ , Hall current  $h$ , radiation  $R$ , Heat Source  $Q$ , Rotation  $w$ . The values are fixed and generated where ever necessary  $k=1.0$ ,  $Pr=7.0$ ,  $Sc=2.01$ ,  $Gr=7.0$ ,  $Gc=7.0$ ,  $h=2$ ,  $R=5$  and  $Q=1$ .

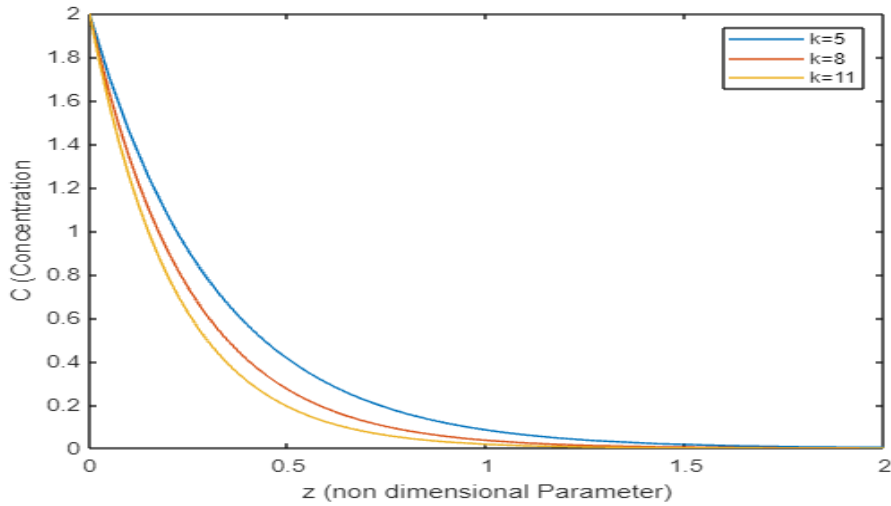


Fig 1: Concentration Profile for various values of Chemical Reaction  $k$

It is clearly observable from the diagram that increase in the value  $k$  of the chemical reaction induces a decline in the concentration  $C$  and the same is true for all the three values experimented with  $k = 5.0, 8.0, 11.0$

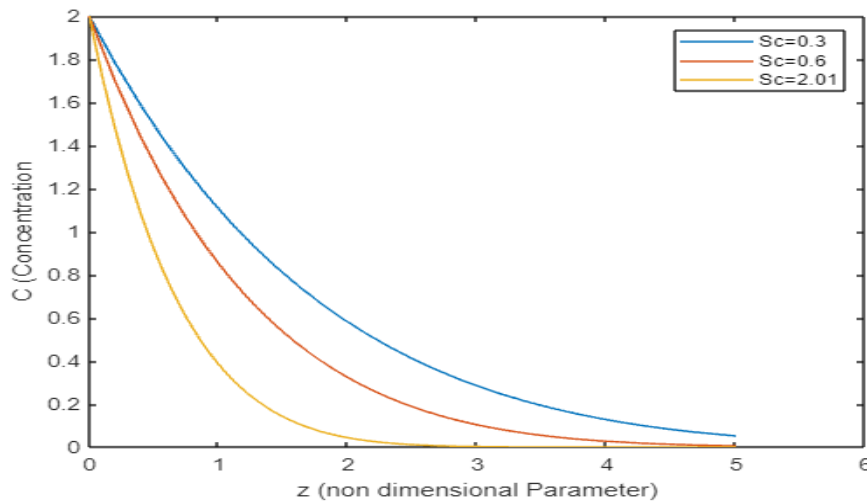


Fig 2: Concentration Profile for various values of Schmidt Number  $Sc$ .

It is clearly observable from the diagram that increase in the value of the Schmidt number induces a decline in the concentration  $C$  and the same is true for all the three values experimented with,  $0.3, 0.6$  as well as  $2.01$ .

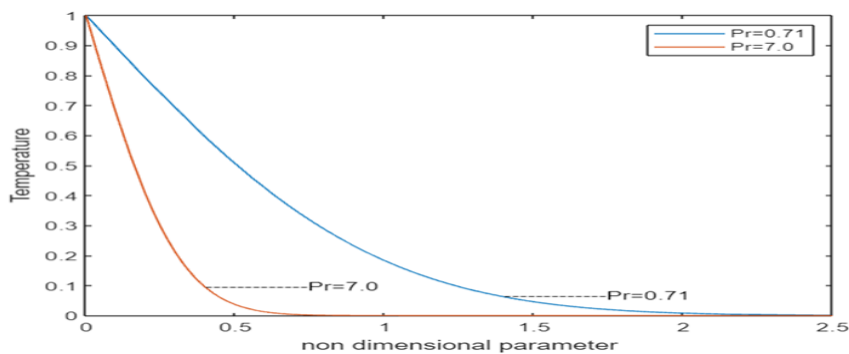


Fig 3 :Temperature Profile for various values of Prandtl Number Pr.

It is clearly observable from the diagram that the temperature for the liquid with the prandtl number 0.71 is more than that for the gas, Prandtl number 7 though they both are equal to start with in the initial value.

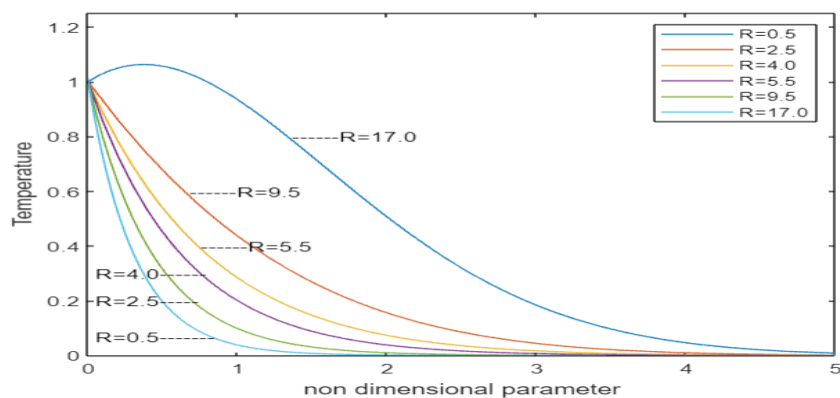


Fig 4 :Temperature Profile for various values of Radiation R.

It is clearly observable from the diagram that increase in the value of the Radiation induces increase in the Temperature T and the same is true for all the six values experimented with  $R = 0.5, 2.5, 4.0, 5.5, 9.5$  and  $17.0$ .

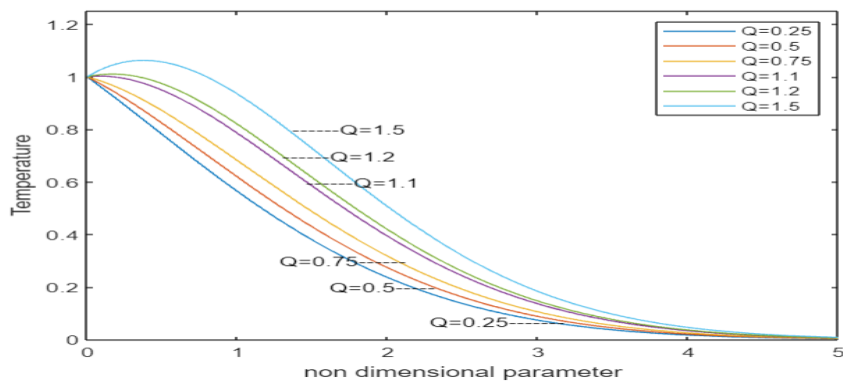


Fig 5 :Temperature Profile for distinct values of Heat Source Q

It is clearly observable from the diagram that increase in the value of the Heat Sources induces increase in the Temperature T and the same is true for all the six values experimented with  $Q = 0.25, 0.5, 0.75, 1.1, 1.2$  as well as  $1.5$ .

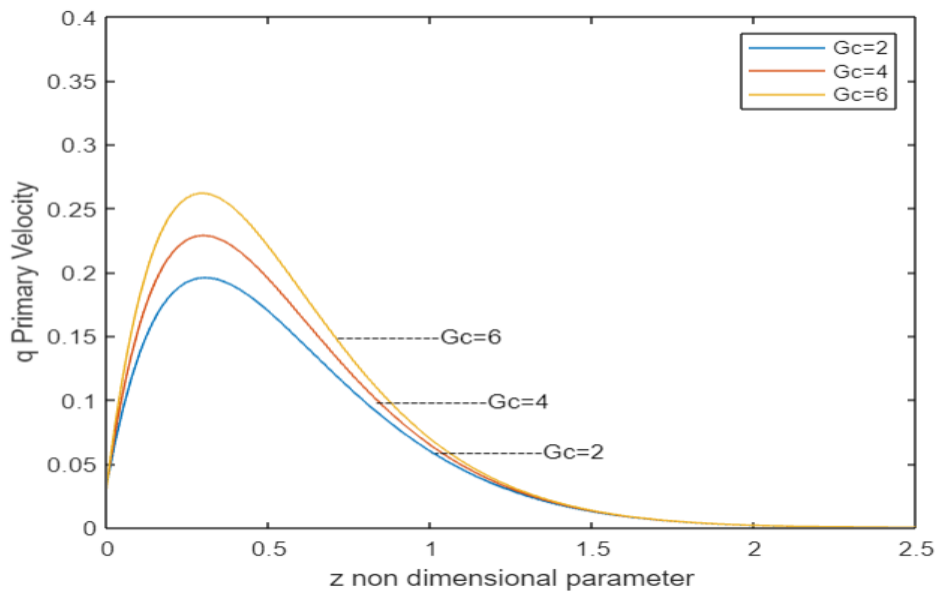


Fig 6 :Primary Velocity Profile for distinct values of Mass Grashof Number Gc

It is clearly observable from the diagram that increase in the value of Mass Grashof values induces increase in the Primary Velocity and the same is true for all the three values experimented With Gc = 2, 4, 6.

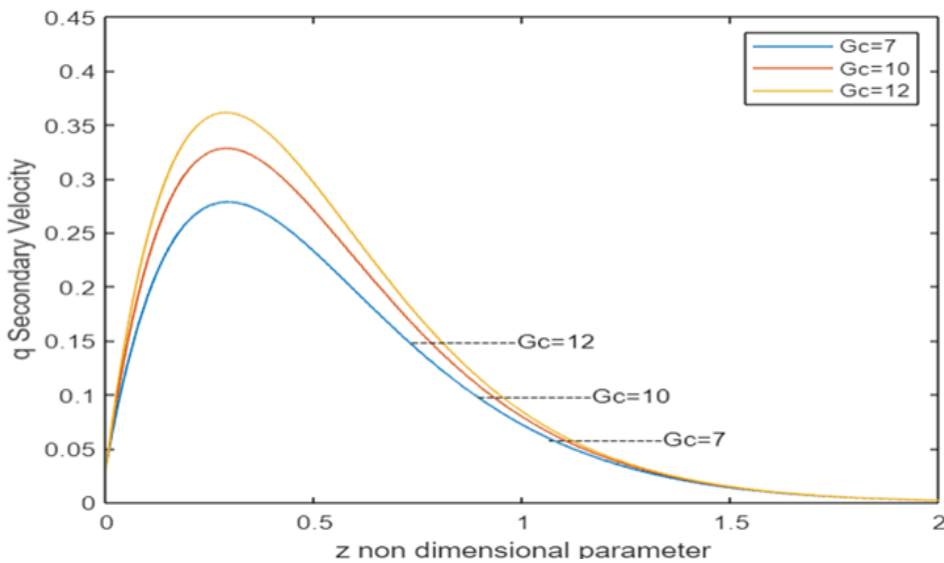


Fig 7 :Secondary Velocity Profile for distinct values of Mass Grashof Number Gc

It is clearly observable from the diagram that increase in the value of Mass Grashof values induces increase in the Secondary velocity and the same is true for all the three values experimented with Gc = 7, 10, 12 .

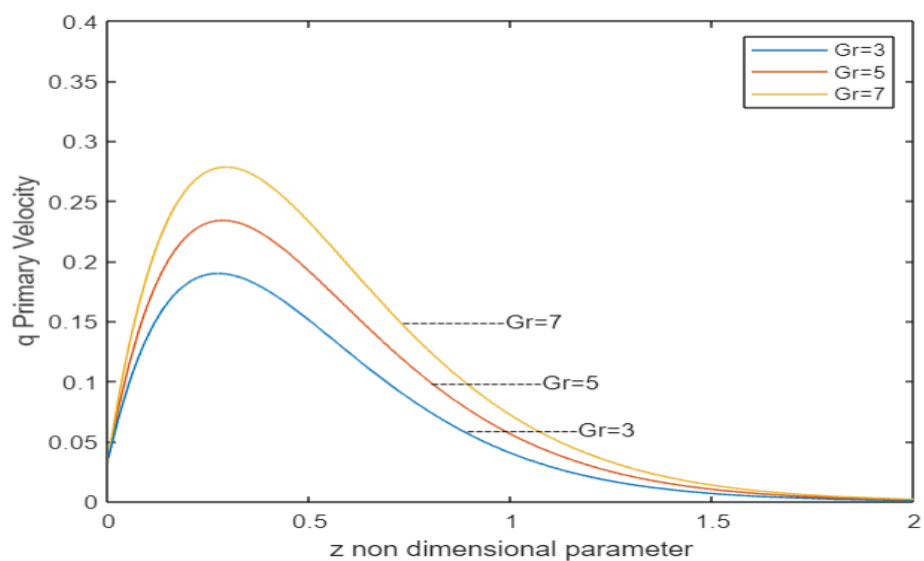


Fig 8 :Primary Velocity Profiles for the distinctive values of Grashof Thermal Gr

It is clearly observable from the diagram that increase in the value of Thermal Grashof values induces increase in the Primary Velocity and the same is true for all the six values experimented with Gr = 3 , 5 , 7.

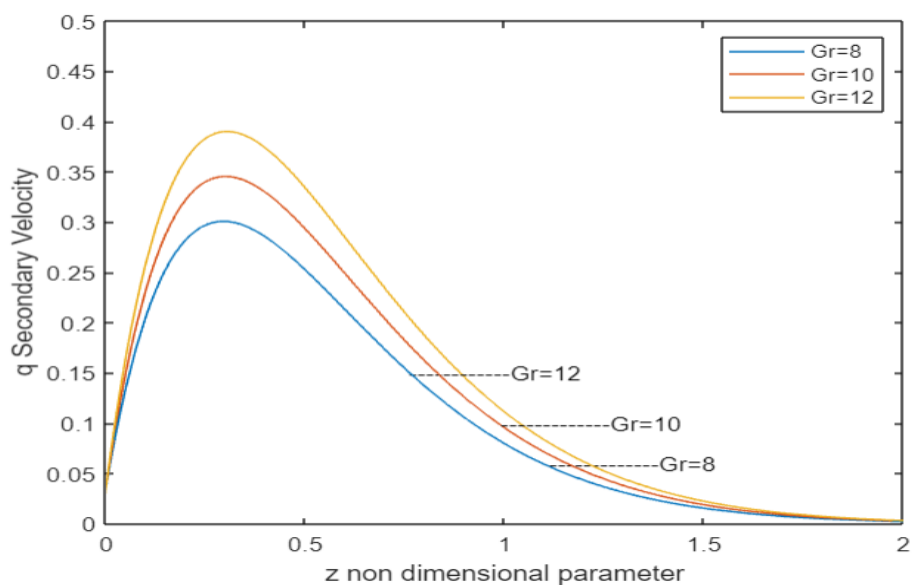


Fig 9 : Secondary Velocity Profiles for the distinctive values of Grashof Thermal Gr

It is clearly observable from the diagram that increase in the value of Thermal Grashof values induces increase in the Secondary velocity and the same is true for all the six values experimented with Gr = 8 , 10 , 12 .



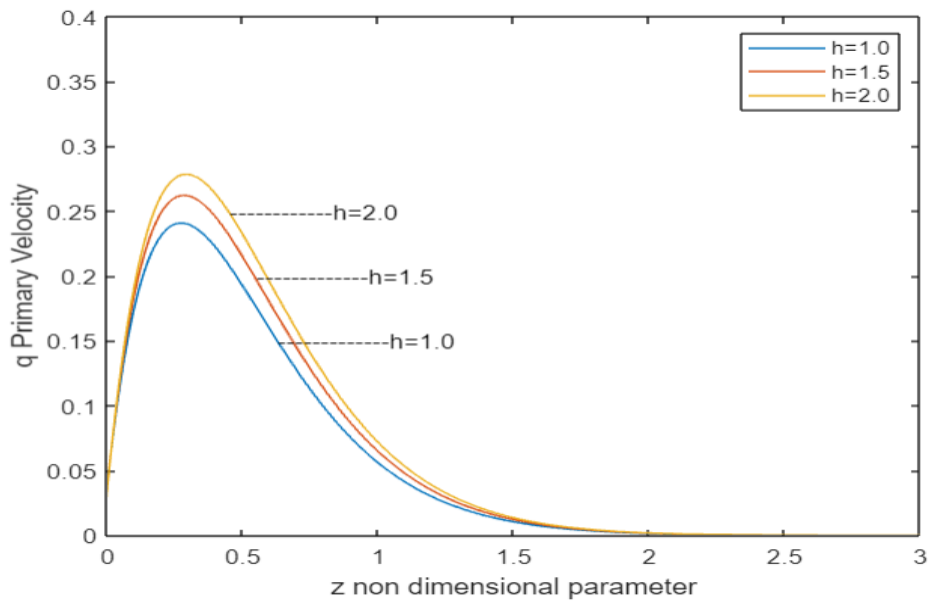


Fig 10 :Primary Velocity Profiles for the distinctive values of Hall Current h

It is clearly observable from the diagram that increase in the value of Hall current induces decline in the Primary Velocity as well as Secondary velocity and the same is true for all the six values experimented with, 1.0 ,1.5 ,2.0.

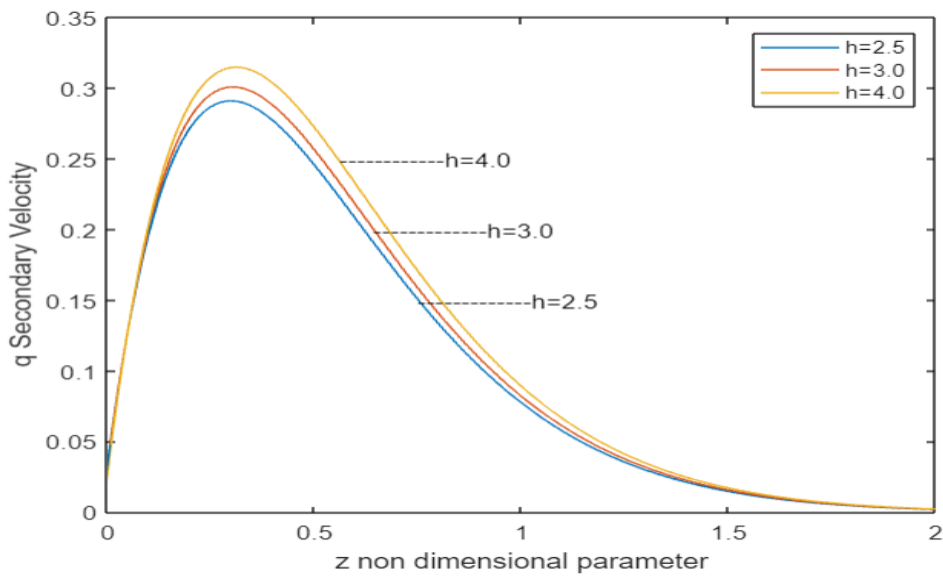


Fig 11 :Secondary Velocity Profiles for the distinctive values of Hall Current h

It is clearly observable from the diagram that increase in the value of Hall current induces decline in the Secondary velocity and the same is true for all the six values experimented with h = 7.0 , 10.0, 13.0.

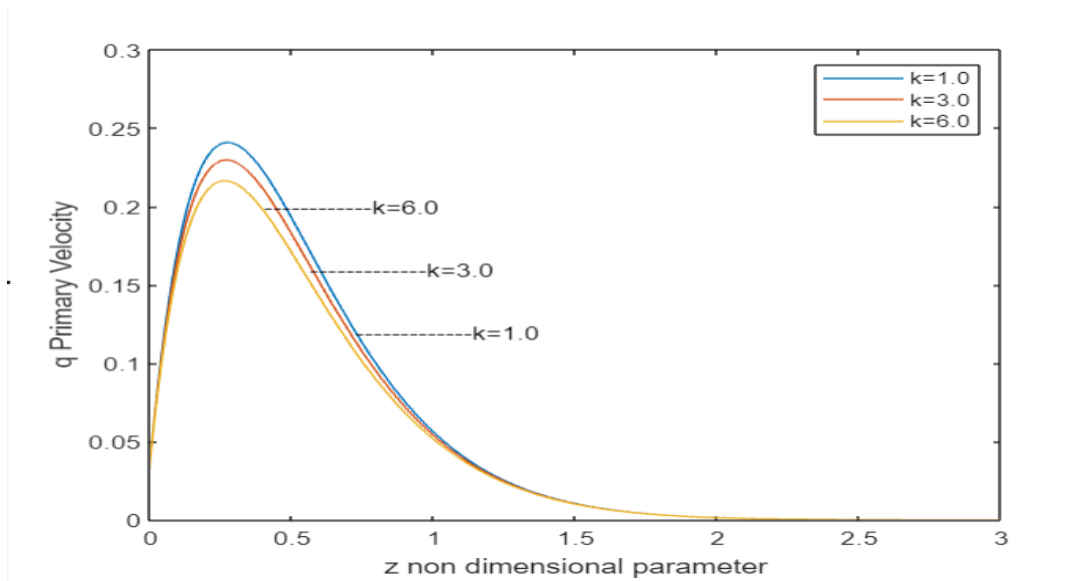


Fig 12 :Primary Velocity Profiles for the distinctive values of Chemical Reacion k.

It is clearly observable from the diagram that increase in the value of Chemical reaction k values induces declines in the Primary Velocity and the same is true for all the six values experimented with  $k = 1.0, 3.0, 5.0$ .

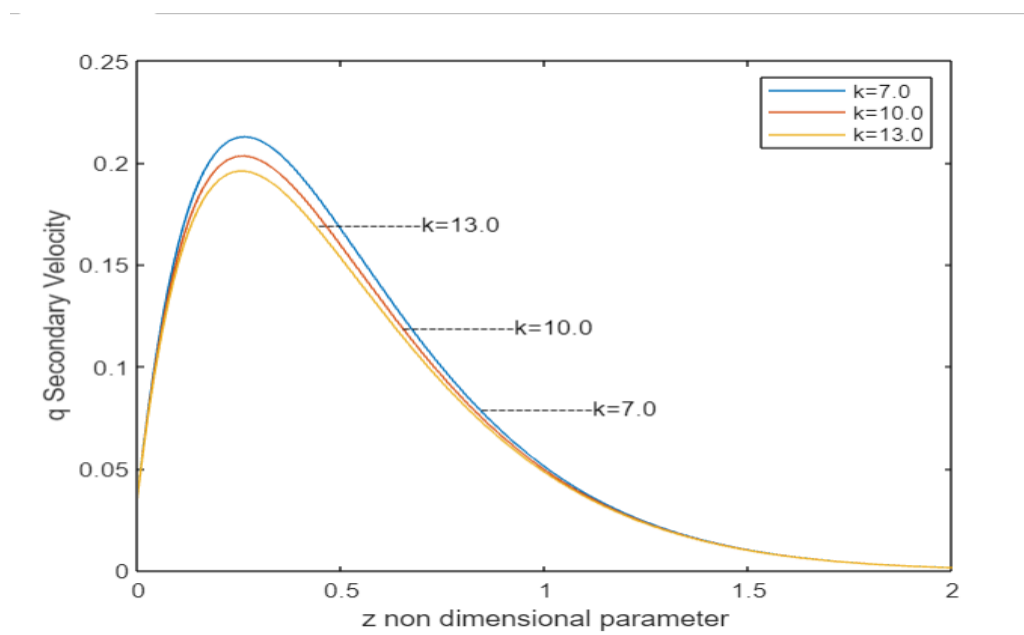


Fig 13 :Secondary Velocity Profiles for the distinctive values of Chemical reaction k

It is clearly observable from the diagram that increase in the value of Chemical reaction k values induces declines in the Secondary Velocity and the same is true for all the six values experimented with  $k = 7.0, 10.0, 13.0$ .

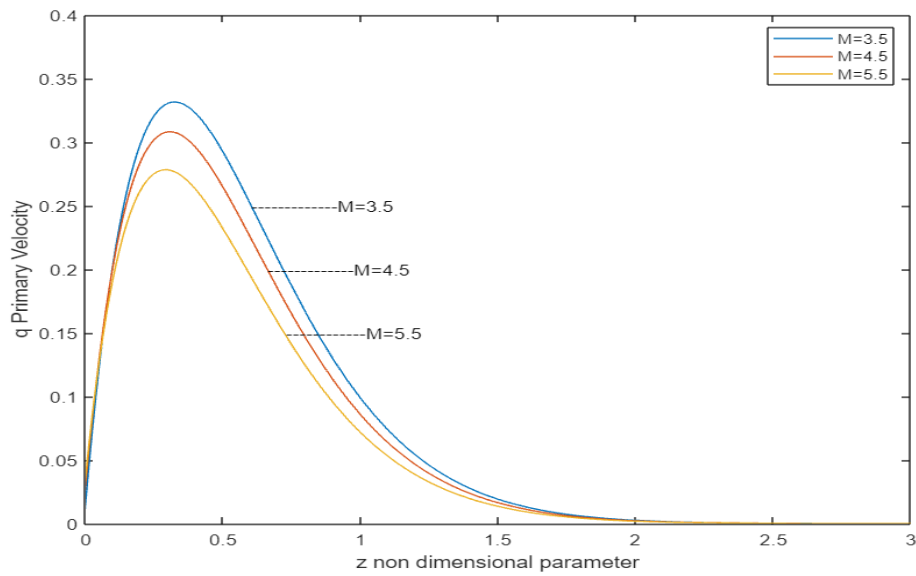


Fig 14: Primary Velocity Profiles for the distinctive values of Hartmann number M

It is clearly observable from the diagram that increase in the value of Hartmann number values induces increase in the Primary Velocity and the same is true for all the six values experimented with  $M = 3.5, 4.5, 5.5$ .

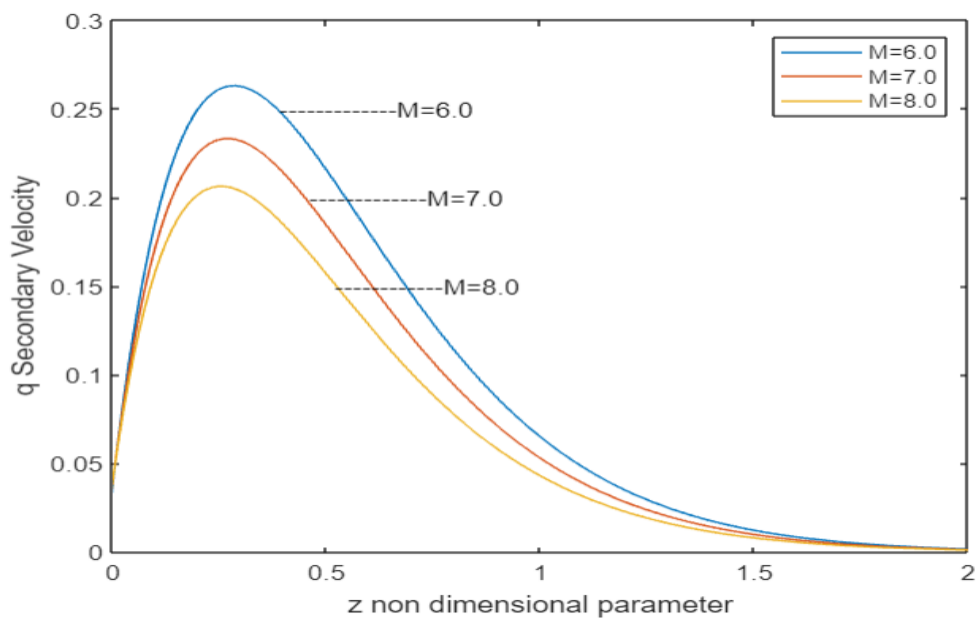


Fig 15 : Secondary Velocity Profiles for the distinctive values of Hartmann number M

It is clearly observable from the diagram that increase in the value of Hartmann number values induces increase in the Secondary velocity and the same is true for all the three values experimented with  $M = 6.0, 7.0, 8.0$ .

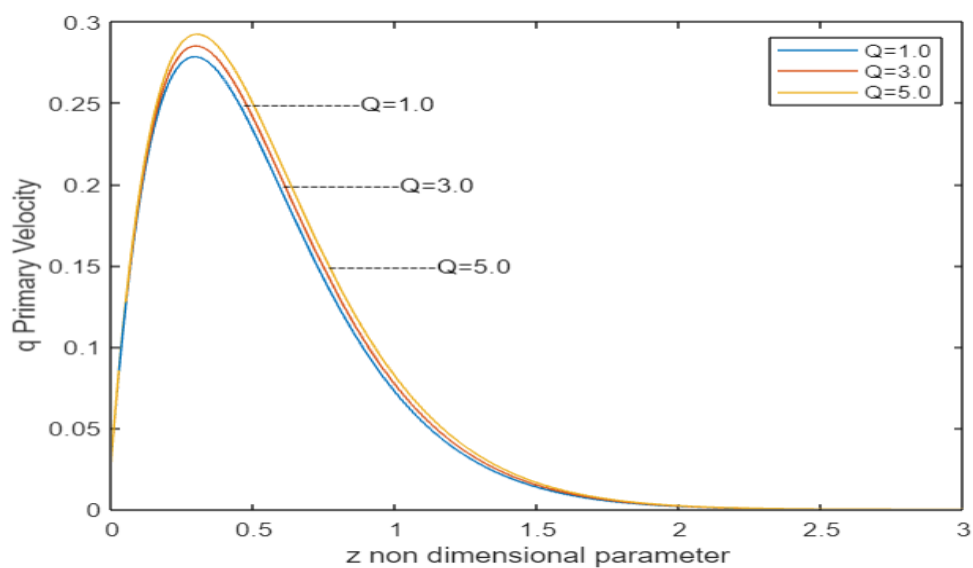


Fig 16 : Primary Velocity Profiles for the various values of Heat Source  $Q$ .

It is clearly observable from the diagram that increase in the value of Heat Source  $Q$  values induces increase in the Primary Velocity and the same is true for all the three values experimented with  $Q = 1.0, 3.0, 5.0$ .

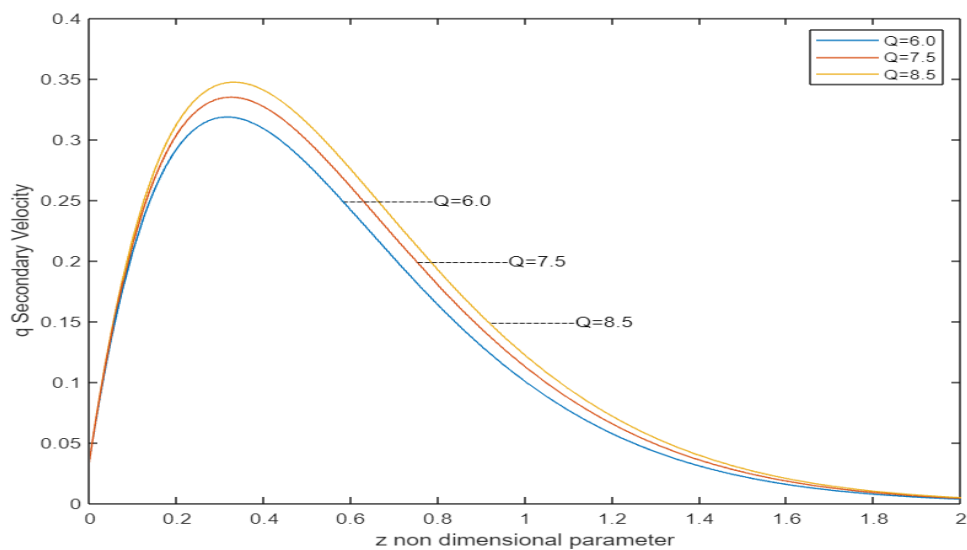


Fig 17 :Secondary Velocity Profiles for the various values of Heat Source  $Q$ .

It is clearly observable from the diagram that increase in the value of Heat Source  $Q$  values induces increase in the Secondary velocity and the same is true for all the three values experimented with  $Q = 6.0, 7.5, 8.5$ .

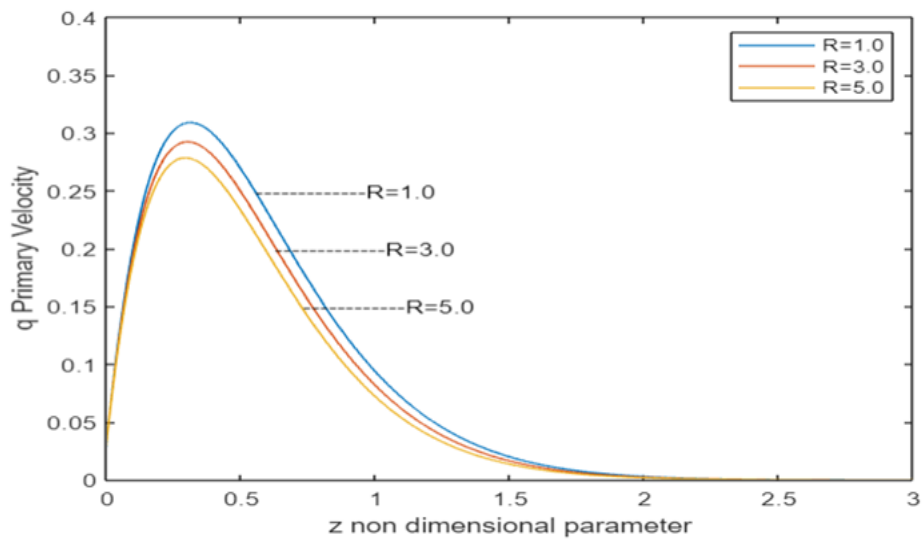


Fig 18 : Primary Velocity Profiles for the various values of Radiation R.

It is clearly observable from the diagram that increase in the value of Radiation values induces declines in the Primary Velocity and the same is true for all the three values experimented with  $R = 1.0, 3.0, 5.0$ .

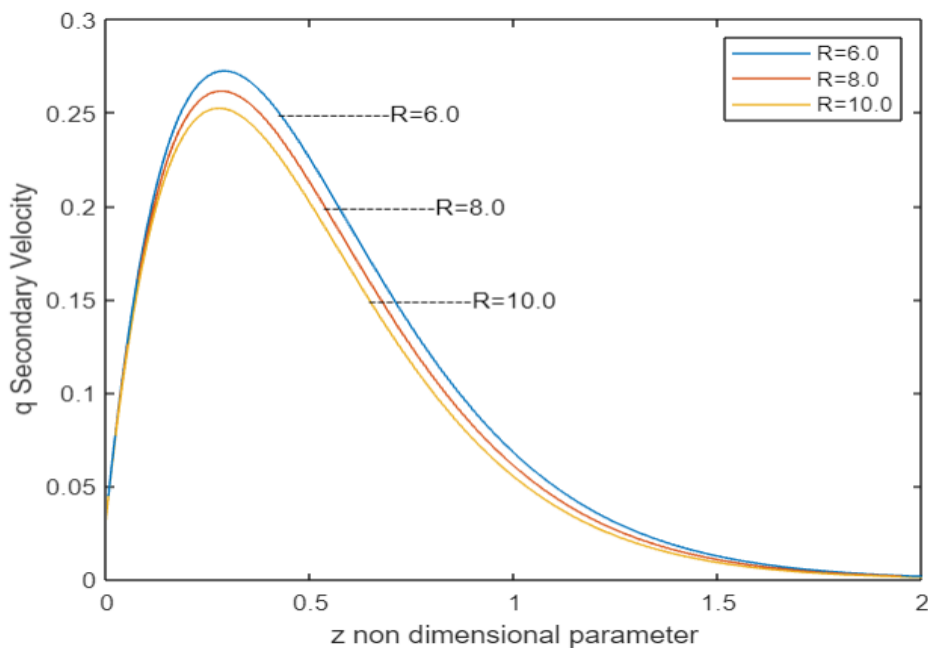


Fig 19 : Secondary Velocity Profiles for the various values of Radiation R.

It is clearly observable from the diagram that increase in the value of Radiation values induces declines in the Secondary velocity and the same is true for all the three values experimented with  $R = 6.0, 8.0, 10.0$ .

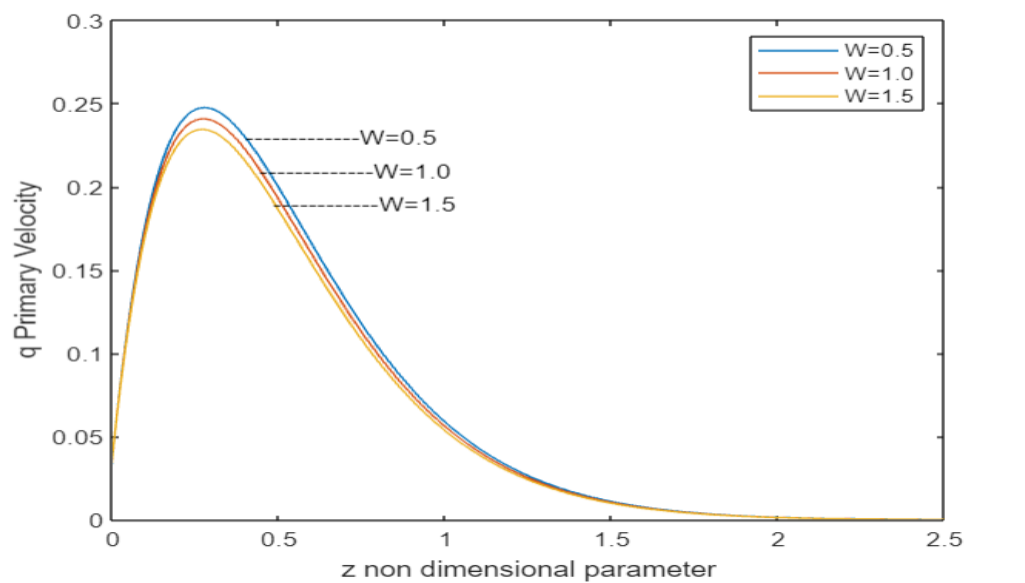


Fig 20 : Primary Velocity Profiles for the distinct values of Rotation  $W$ .

It is clearly observable from the diagram that increase in the value of Rotation values induces declines in the Primary Velocity and the same is true for all the six values experimented with  $W = 0.5, 1.0, 1.5$ .

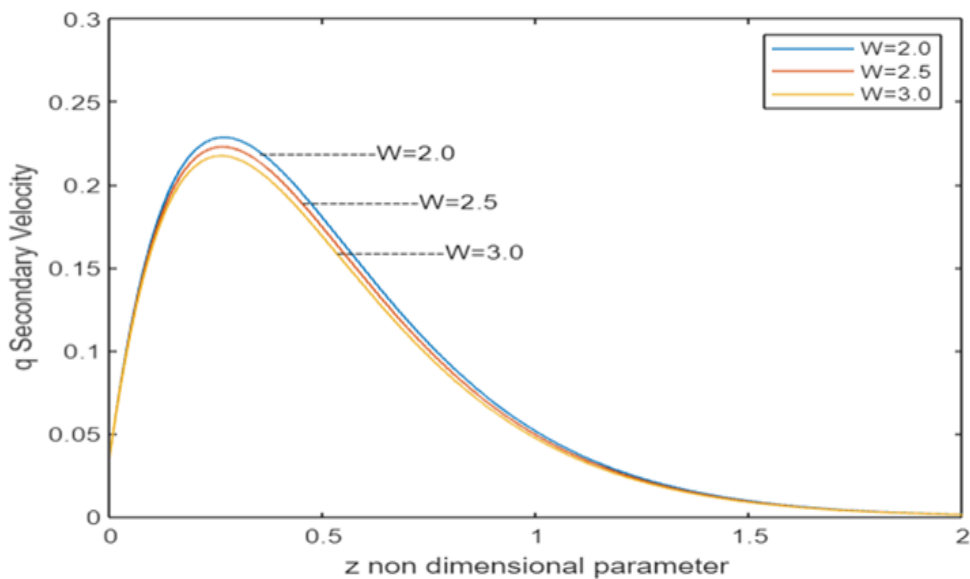


Fig 21 : Secondary Velocity Profiles for the distinct values of Rotation  $W$ .

It is clearly observable from the diagram that increase in the value of Rotation values induces declines in the Secondary velocity and the same is true for all the six values experimented with  $W = 2.5, 3.0, 3.5$ .

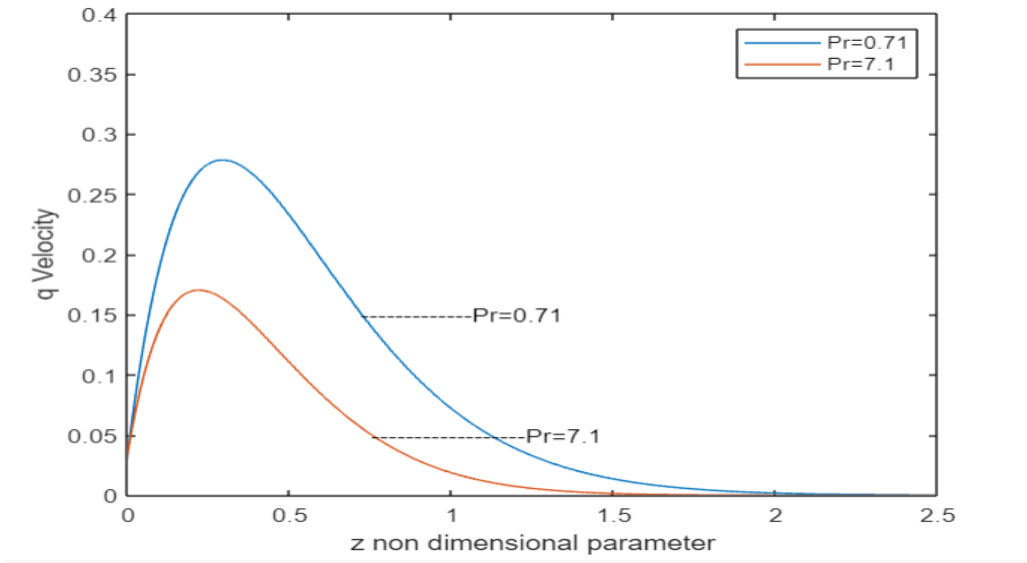


Fig 22 :Velocity Profiles for the PrandtlNumberPr .

It is clearly observable from the diagram that increase in the value of Prandtl values induces declines in the velocity and the same is true for all the values experimented with Pr = 0.71 ,7.0 .

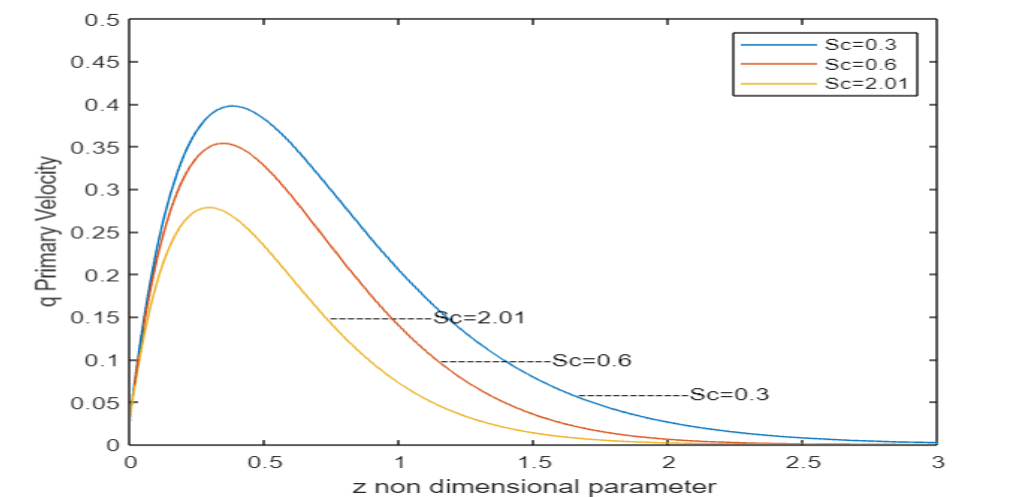


Fig 23: Velocity Profiles for the Schmith number Sc .

It is clearly observable from the diagram that increase in the value of Schmith number values induces declines in the Velocity and the same is true for all the six values experimented with Sc = 0.3 ,0.6 , 2.01

## 5. Tabulation

**Table 1.** Numerical values for estimated Conc. profiles various  $k$  and  $Sc$ .

Non-dimensional Parameter	Figure 1	Figure 2
	Concentration $k$	Concentration $Sc$
$Sc$	2.01	<b>0.3,0.6,2.01</b>
$k$	<b>5,8,11</b>	1
$t$	0.2	0.2

**Table 2.** Numerical estimated Temp. profiles values for several values of  $Pr$ ,  $R$ , and  $Q$ .

Non-dimensional Parameters	Fig. 3	Fig. 4	Fig. 5
	Temperature $Pr$	Temperature $R$	Temperature $Q$
$Pr$	<b>0.71,7.0</b>	0.71	0.71
$R$	5	<b>5,10,15</b>	5
$Q$	1	1	<b>2,3,4</b>
$t$	0.2	0.2	0.2

**Table 3.** Numerical estimated Velocity. Profiles values for several values of  $Gc$  and  $Gr$ .

Non-dimensional Criteria	Fig. 6	Fig. 7	Fig. 8	Fig. 9
	Primary Velocity $Gc$	Secondary Velocity $Gc$	Primary Velocity $Gr$	Secondary Velocity $Gr$
$Gr$	7	7	<b>5,7,10</b>	<b>11,14,17</b>
$Gc$	<b>5,7,10</b>	<b>11,14,17</b>	7	7
$Pr$	0.71	0.71	0.71	0.71
$R$	5	5	5	5
$Q$	1	1	1	1
$M$	5.5	5.5	5.5	5.5
$h$	2	2	2	2
$w$	1	1	1	1
$Sc$	2.01	2.01	2.01	2.01
$k$	1	1	1	1
$t$	0.2	0.2	0.2	0.2



**Table 4.** Numerical estimated Velocity profiles values for several values of h and k

Non-dimensional Criteria	Fig10	Fig 11	Fig 12	Fig 13
	Primary Velocity h	Secondary Velocity h	Primary Velocity k	Secondary Velocity k
Gr	7	7	7	7
Gc	7	7	7	7
Pr	0.71	0.71	0.71	0.71
R	5	5	5	5
Q	1	1	1	1
M	5.5	5.5	5.5	5.5
h	<b>1,1.5,2</b>	<b>1.75,2,4</b>	2	2
w	1	1	1	1
Sc	2.01	2.01	2.01	2.01
k	1	1	<b>1,3,5</b>	<b>8,10,12</b>
t	0.2	0.2	0.2	0.2

**Table 5.** Numerical estimated Velocity. profiles values for several values of Q and R

Non-dimensional Parameters	Fig. 14	Fig. 15	Fig. 16	Fig. 17
	Primary Velocity Q	Secondary Velocity Q	Primary Velocity M	Secondary Velocity M
Gr	7	7	7	7
Gc	7	7	7	7
Pr	0.71	0.71	0.71	0.71
R	5	5	5.0	5.0
Q	<b>1,4,7</b>	<b>5,8,11</b>	1	1
M	5.5	5.5	<b>5,6,7</b>	<b>8,10,12</b>
h	2	2	2	2
w	1	1	1	1
Sc	2.01	2.01	2.01	2.01
k	1	1	1	1
t	0.2	0.2	0.2	0.2

**Table 6.** Numerical values for estimated Velocity profiles for varying R and W values.

Non-dimensional Parameters	Fig. 18	Fig. 19	Fig. 20	Fig. 21
	Primary Velocity R	Secondary Velocity R	Primary Velocity w	Secondary Velocity w
Gr	7	7	7	7
Gc	7	7	7	7
Pr	0.71	0.71	0.71	0.71
R	<b>0.5,2.5,6</b>	<b>5.5,9.5,17</b>	5	5
Q	1	1	1	1
M	5.5	5.5	5.5	5.5
h	2	2	2	2
w	1	1	<b>0.5,1.0,1.5</b>	<b>2.0,2.5,3.0</b>
Sc	2.01	2.01	2.01	2.01
k	1	1	1	1
t	0.2	0.2	0.2	0.2

**Table 7.** Numerical values for estimated Velocity profiles for varying Pr and Sc values.

Non-dimensional Parameters	Fig. 22	Fig. 23
	Velocity Pr	Velocity Sc
Gr	7	7
Gc	7	7
Pr	<b>0.71 , 7.0</b>	0.71
R	5	5
Q	1	1
M	5.5	5.5
h	2	2
w	1	1
Sc	2.01	<b>0.3,0.6,2.01</b>
k	1	1
t	0.2	0.2

## 6. Conclusion

As this is a variational study from the literature involving accelerated isothermal vertical plate with the basic HMT aspects, this provides a simple and nice platform for computational work and based on the calculations, we could conclude that

- (i) Velocity reduces when Radiation 'R' rises  
Velocity reduces when Hartmann number M rises  
Velocity reduces when Rotation Values  $\omega$  rises and  
Velocity rises when Grashof ' $G_c$ ' and ' $Gr$ ' Values rises  
Velocity rises when Heat Source 'Q' rises,  
Velocity rises when Hall Current 'h' rises
- (ii) Temperature falls when Radiation 'R' rises and  
Temperature rises when Heat Source 'Q' rises.
- (iii) Concentration reduces when Chemical reaction 'k' increased.

So, we are able to achieve an extended list of conclusions by the variation and we intend to enhance the study by including more parameters in our future study.

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