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A Parabolic Flow with MHD, the Dufour and Rotational Effects of Uniform Temperature and Mass Diffusion through an Accelerating Vertical Plate in the Presence of Chemical Reaction

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ABSTRACT

A study that was carried out to analyses the movement and behavior of a vertically infinite plate with a parabolic beginning velocity profile in an unsteady flow scenario, taking into account numerous elements such as rotation, chemical reaction, and the Dufour effect. The investigation included evaluating heat readings from the plate as well as accumulation levels in its surroundings. The inverse Laplace technique was used to solve the governing equations. The research looked at two fundamental governing flow constraints: rotation and diffusion, velocity, temperature (Dufour), and how they affect the speed, temperature, and accumulation of a vertically oriented plate. These flow parameters' effects on mass and heat transfer proportions were also graphically represented using Matlab R 2020a. The study's findings were supported by referencing and aligning with earlier research.

1. Introduction

Many scientists have been researching heat and mass transfer for a very long time since they are so crucial to everyday life. Numerous processes and geophysical research, as well as magnetohydrodynamics and the production of electricity. In many real-world situations, the significance of a magnetic field in a conductive fluid is especially noteworthy. It is impossible to ignore the influence of magnetic fields in these applications, and their effects are crucial for understanding and optimizing a variety of industrial processes and natural phenomena specific polymer materials on the production line is essential. In their investigation, Aruna *et al.,* [1] studied the impact of the Hall Effect. They analysed the behaviour of the flow considering variations in temperature and accumulation diffusion, along with the thermal radiation. Sheikholeslami *et al.,* [2], Soundalgekar *et al.,* [3,4], and Chamkha *et al.,* [5] studied MHD on a suddenly initiated endless plate with differing temperature and existence of a cross-field magnetic field. The effects of radiation were investigated by Hossain and Takhar [6]. The study on the effects of Dufour on suddenly initiated vertical porous

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plate was undertaken by Muthucumaraswamy *et al.,* [7]. Jha and Prasad [8], and Jha and Singh [9] investigated the impact of the thermo diffusion on naturally occurring convection and accumulation shift movement in the context of the Stoke's problem on a vertically ended plate. Jose and Selvaraj [10] researched on rotational effects on flow parabolically on a vertical plate. The combined impacts of heat source and hall examined by Lakshmikaanth *et al.,* [11]. Combined effect of the Dufour effect and the Hall effect on the magnetohydrodynamic (MHD) flow around an exponentially accelerated vertical plate, taking temperature and mass diffusion into account was collected by Angela and Selvaraj [12]. A quickening equilibrium perpendicular plate in differing the warm and accumulation was the subject of Muthucumaraswamy *et al.,* [13]. Study on rotation's effects on the MHD stream Selvaraj *et al.,* [14] investigation of MHD parabolic flow with mass and heat diffusion and rotation across an accelerating isothermal vertical plate. In their investigation, indeed, in the given scenario, the velocity of the fluid experiences a reduction if the values of the Thermal diffusion (Df) raise. According to the observations made by Gowri and Selvaraj [15], the concentration raises if Schmidt number (Sc) goes down. The Dufour effect and magnetohydrodynamics should be taken into consideration as the study takes into account heat and mass transfer phenomena. The non-dimensional administrative situation is highlighted using Laplace transform techniques. Khan [16-18] and Khan *et al.,* [19] investigated the use of fractional derivatives to characterize and study blood flow behavior as well as the processes of blood flow over an inclined surface or structure when nanofluids are present. Sheikholeslami *et al.,* [2] likely looked into the ferrofluid system's thermodynamic and energy-related properties since these characteristics might be used in a variety of contexts, including fluid dynamics, heat transport, and energy conversion. Alam and Sattar [20], and Alam *et al.,* [21] probably discussed research on non-small cell lung cancer and the investigation of signaling pathways that might be targeted for therapeutic purposes. Reddy and Makinde [22] covered how Newtonian heating affects MHD unsteady free convection boundary layer flow past an oscillating vertical porous plate immersed in a porous medium with thermal radiation, chemical reaction, and heat absorption. Sreedevi *et al.,* [23] investigated the combined effects of the magnetic field, Joule heating, on the convective heat and mass transfer flow of an electrically conducting fluid over a permeable vertically stretching sheet. The unstable mixed convection flow through a vertical porous plate traveling through a binary mixture in the presence of radiative heat transfer is examined by Makinde and Olanrewaju [24]. Non-dimensional variables effects on concentration, temperature, and velocity were discussed by Krishna and Chamkha [25], and Krishna *et al.,* [26,27]. Soret and Joule effects of MHD mixed convective flow of an electrically conducting, compressible fluid across an infinite vertical porous plate while accounting for Hall effects.

2. Mathematical Formulation

An unstable, viscous and incompressible fluid's flow is being examined in the current study. The vertical and ordinate axis is right angle to it as shown in Figure 1. Initially Plate is in temperature T_∞ and Fluid is in accumulation C_∞. The plate starts moving with a velocity $u = u_0 {t'}^2$. The Concentration (Fluid) and Temperature (Fluid) are both increased simultaneously to T'_w and C'_w respectively.

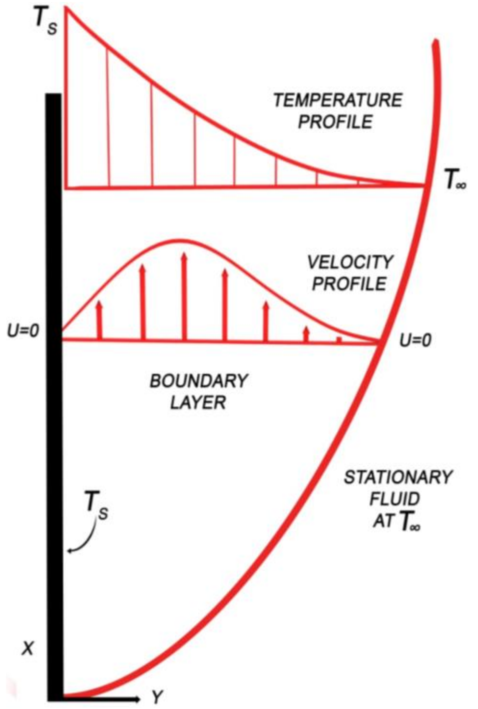

Fig. 1. Geometry of the problem

Using the standard Boussinesq's approximations:

$$\frac{\partial \mathrm{u}}{\partial \mathrm{t}'} - 2\Omega'\mathrm{v} = -g\left(\beta^*(\mathrm{C}' - \mathrm{C}'_\infty) + \beta(\mathrm{T}' - \mathrm{T}'_\infty)\right) + \mathrm{v}\frac{\partial^2 \mathrm{u}}{\partial \mathrm{z}^2} - \frac{\sigma \mathrm{u} \mathrm{B}_0^2}{\rho} \tag{1}$$

$$\frac{\partial \mathrm{v}}{\partial \mathrm{t}'} + 2\Omega'\mathrm{u} = \frac{\partial^2 v}{\partial \mathrm{z}^2} - \frac{\sigma \mathrm{B}_0^2}{\rho}\mathrm{v} \tag{2}$$

$$\frac{\partial T}{\partial \mathrm{t}'} = \frac{k}{\rho Cp}\frac{\partial^2 T\prime}{\partial z^2} + \frac{DmK_T}{CsCp}\frac{\partial^2 C}{\partial z^2} \tag{3}$$

$$\rho \mathrm{C_p}\frac{\partial \mathrm{C}'}{\partial \mathrm{t}'} = \mathrm{D}\frac{\partial^2 \mathrm{C}'}{\partial \mathrm{z}^2} - K_0(-\mathrm{C}'_\infty + \mathrm{C}') \tag{4}$$

Initially,

$$\begin{aligned} &u = 0, T' = T'_\infty, C'_\infty = C' \ \forall z, t^1 \leq 0 \\ &t' > 0: u = u_0 t'^2, T^1 = T^1_\infty + (T^1_w - T^1_\infty)t^1, C^1 = C^1_\infty + (C^1_w - C^1_\infty)t^1 \ at \ z = 0 \\ &u = 0, T' \to T'_\infty, C' \to\to C'_\infty, as \ z \to \infty \end{aligned} \tag{5}$$

After proposing the following dimensionless parameters

$$U = \frac{u}{u_0}\ ,\ V = \frac{v}{u_0},\ t = \frac{\mathrm{t}'}{v}\ , Z = \frac{z}{vu_0}$$
$$\theta = \frac{\mathrm{T}' - \mathrm{T}'_\infty}{\mathrm{T}'_w - \mathrm{T}'_\infty},\ \ Gr = \frac{g\beta(\mathrm{T}'_w - \mathrm{T}'_\infty)}{u_0}\ ,\ C = \frac{C' - C'_\infty}{C'_W - C'_\infty}$$
$$Gc = \frac{g\beta^*(C'_W - C'_\infty)}{u_0}\ \ , M = \frac{\sigma B_0^2 v}{\boldsymbol{u_0^2}\rho}\ \ ,\ pr = \frac{\mu C_p}{k}\ , Sc = \frac{v}{D} \tag{6}$$
$$Df = \frac{DmK_T(C'_W - C'_\infty)}{\vartheta CsCp(\mathrm{T}' - \mathrm{T}'_\infty)}, K = \frac{vK_0}{\boldsymbol{u_0^2}}, \Omega = \frac{v\Omega'}{\boldsymbol{u_0^2}}$$

Using Eq. (6) in the Eq. (1) to Eq. (4), we have derived

$$\frac{\partial U}{\partial t} - 2\Omega V = Gr\theta + GcC + \frac{\partial^2 U}{\partial Z^2} - MU \tag{7}$$

$$\frac{\partial V}{\partial t} + 2\Omega U = \frac{\partial^2 V}{\partial Z^2} - MV \tag{8}$$

$$\frac{\partial \theta}{\partial t} = \frac{1}{Pr}\frac{\partial^2 \theta}{\partial Z^2} + Df\,\frac{\partial^2 \bar{C}}{\partial Z^2} \tag{9}$$

$$\frac{\partial C}{\partial t} = \frac{1}{sc}\frac{\partial^2 C}{\partial Z^2} - \mathrm{KC} \tag{10}$$

with

$$u = 0, T' = T'_\infty\ , C' = C'_\infty\ ,\ \forall\, z, t^1 \le 0$$
$$\mathrm{t}' > 0 \quad u = \boldsymbol{u_0 t'^2}, \mathrm{T}' = \mathrm{T}'_\mathrm{W}, C' = C'_w\ \ at\ z =\ 0 \tag{11}$$
$$u \to 0, T' \to T'_\infty\ , C' \to C'_\infty\ , as\ \ z \to \infty$$

Adding (7) + $i \times$ (8) we get

$$\frac{\partial q}{\partial t} = \mathrm{Gr}\theta + \mathrm{Gc}C + \frac{\partial^2 q}{\partial \mathrm{Z}^2} - qm \tag{12}$$

$$\frac{\partial \theta}{\partial t} = \frac{1}{Pr}\frac{\partial^2 \theta}{\partial Z^2} + Df\,\frac{\partial^2 \bar{C}}{\partial Z^2} \tag{13}$$

$$\frac{\partial C}{\partial t} = \frac{1}{sc}\frac{\partial^2 C}{\partial Z^2} - \mathrm{KC} \tag{14}$$

The first and final conditions are

$$q = 0, C = 0, \theta = 0, \forall\, z, t \le 0$$
$$q = t^2\ , \theta = 1, C = 1\ at\ \ z = 0, t > 0 \tag{15}$$
$$q \to 0, \theta \to 0\ and\ \ C\ \to 0\ as\ \ z \to \infty$$

3. Mathematical Result of the Problem

Using the Inv Laplacian Technique, to the above equations which have corresponding initial conditions and dimensionless controlling conditions. The system is solved in the Laplace domain following the application of the Laplace transforms. To return the answers to the time domain, an inverse Laplace transform is then used.

$$q = q_1 + q_2 + \cdots + q_7 \tag{16}$$

$$q_{1=}\frac{(\eta^2+mt)t}{4m}\Bigg[\Bigg(e^{2\eta\sqrt{mt}}erfc\left(\sqrt{t}\left(\frac{\eta}{\sqrt{t}}+\sqrt{m}\right)\right)+e^{-2\eta\sqrt{mt}}erfc\left(\sqrt{t}\left(\frac{\eta}{\sqrt{t}}-\sqrt{m}\right)\right)\Bigg)+ \frac{\eta\sqrt{t}(1-4mt)}{8m^{\frac{3}{2}}}\left(e^{-2\eta\sqrt{mt}}erfc\left(\sqrt{t}\left(\frac{\eta}{\sqrt{t}}-\sqrt{m}\right)\right)-e^{2\eta\sqrt{mt}}erfc\left(\sqrt{t}\left(\frac{\eta}{\sqrt{t}}+\sqrt{m}\right)\right)\right)-\frac{\eta t}{2m\sqrt{\pi}}e^{-(\eta^2+mt)}\Bigg]$$

$$q_{1=}\frac{(\eta^2+mt)t}{4m}\Bigg[\Bigg(e^{2\eta\sqrt{mt}}erfc\left(\sqrt{t}\left(\frac{\eta}{\sqrt{t}}+\sqrt{m}\right)\right)+e^{-2\eta\sqrt{mt}}erfc\left(\sqrt{t}\left(\frac{\eta}{\sqrt{t}}-\sqrt{m}\right)\right)\Bigg)+ \frac{\eta\sqrt{t}(1-4mt)}{8m^{\frac{3}{2}}}\left(e^{-2\eta\sqrt{mt}}erfc\left(\sqrt{t}\left(\frac{\eta}{\sqrt{t}}-\sqrt{m}\right)\right)-e^{2\eta\sqrt{mt}}erfc\left(\sqrt{t}\left(\frac{\eta}{\sqrt{t}}+\sqrt{m}\right)\right)\right)-\frac{\eta t}{2m\sqrt{\pi}}e^{-(\eta^2+mt)}\Bigg]$$

$$q_2 = \frac{Gr}{a(1-pr)}\Bigg[erfc(\eta\sqrt{Sc})-\frac{1}{2}\left(e^{2\eta\sqrt{mt}}erfc\left(\sqrt{t}\left(\frac{\eta}{\sqrt{t}}+\sqrt{m}\right)\right)+e^{-2\eta\sqrt{mt}}erfc\left(\sqrt{t}\left(\frac{\eta}{\sqrt{t}}-\sqrt{m}\right)\right)\right)+ \frac{e^{at}}{2}\left(e^{2\eta\sqrt{t}\sqrt{(m+a)}}erfc\left(\sqrt{t}\left(\frac{\eta}{\sqrt{t}}+\sqrt{(m+a)}\right)\right)+e^{-2\eta\sqrt{(m+a)t}}erfc\left(\sqrt{t}\left(\frac{\eta}{\sqrt{t}}-\sqrt{(m+a)}\right)\right)\right)- \frac{e^{at}}{2}\left(e^{2\eta\sqrt{Scat}}erfc\left(\sqrt{t}\left(\eta\frac{\sqrt{Sc}}{\sqrt{t}}+\sqrt{a}\right)\right)+e^{-2\eta\sqrt{Scat}}erfc\left(\sqrt{t}\left(\eta\frac{\sqrt{Sc}}{\sqrt{t}}-\sqrt{a}\right)\right)\right)\Bigg]$$

$$q_3 = \frac{GrPr\ Df}{b(Sc-1)}\Bigg[erfc(\eta\sqrt{Sc})-\frac{1}{2}\left(e^{2\eta\sqrt{mt}}erfc\left(\sqrt{t}\left(\frac{\eta}{\sqrt{t}}+\sqrt{m}\right)\right)+e^{-2\eta\sqrt{mt}}erfc\left(\sqrt{t}\left(\frac{\eta}{\sqrt{t}}+\sqrt{m}\right)\right)\right)+ \frac{e^{bt}}{2}\left(e^{2\eta\sqrt{(m+b)t}}erfc\left(\sqrt{t}\left(\frac{\eta}{\sqrt{t}}+\sqrt{(m+b)}\right)\right)+e^{-2\eta\sqrt{(m+b)t}}erfc\left(\sqrt{t}\left(\frac{\eta}{\sqrt{t}}-\sqrt{(m+b)}\right)\right)\right)- \frac{e^{bt}}{2}\left(e^{2\eta\sqrt{Scbt}}erfc\left(\sqrt{t}\left(\eta\frac{\sqrt{Sc}}{\sqrt{t}}+\sqrt{b}\right)\right)+e^{-2\eta\sqrt{Scbt}}erfc\left(\sqrt{t}\left(\eta\frac{\sqrt{Sc}}{\sqrt{t}}-\sqrt{b}\right)\right)\right)\Bigg]$$

$$q_4 = \frac{GrPr\ Df}{(a-b)(Sc-1)}\Bigg[\frac{e^{at}}{2}\left(e^{2\eta\sqrt{Scat}}erfc\left(\sqrt{t}\left(\eta\frac{\sqrt{Sc}}{\sqrt{t}}+\sqrt{a}\right)\right)+e^{-2\eta\sqrt{Scat}}erfc\left(\sqrt{t}\left(\eta\frac{\sqrt{Sc}}{\sqrt{t}}-\sqrt{a}\right)\right)\right)- \frac{e^{at}}{2}\left(e^{2\eta\sqrt{(m+a)t}}erfc\left(\sqrt{t}\left(\frac{\eta}{\sqrt{t}}+\sqrt{m+a}\right)\right)+e^{-2\eta\sqrt{(m+a)t}}erfc\left(\sqrt{t}\left(\frac{\eta}{\sqrt{t}}-\sqrt{m+a}\right)\right)\right)+ \frac{e^{bt}}{2}\left(e^{2\eta\sqrt{(m+b)t}}erfc\left(\sqrt{t}\left(\frac{\eta}{\sqrt{t}}+\sqrt{m+b}\right)\right)+e^{-2\eta\sqrt{(m+b)t}}erfc\left(\sqrt{t}\left(\frac{\eta}{\sqrt{t}}-\sqrt{m+b}\right)\right)\right)- \frac{e^{bt}}{2}\left(e^{2\eta\sqrt{Scbt}}erfc\left(\sqrt{t}\left(\eta\frac{\sqrt{Sc}}{\sqrt{t}}+\sqrt{b}\right)\right)+e^{-2\eta\sqrt{Scbt}}erfc\left(\sqrt{t}\left(\eta\frac{\sqrt{Sc}}{\sqrt{t}}-\sqrt{b}\right)\right)\right)\Bigg]$$

$$q_5 = \frac{GrPr\,Df}{c(Sc-1)}\left[\begin{array}{c} \frac{1}{2}\left(e^{2\eta\sqrt{mt}}erfc\left(\sqrt{t}\left(\frac{\eta}{\sqrt{t}}+\sqrt{m}\right)\right)+e^{-2\eta\sqrt{mt}}erfc\left(\sqrt{t}\left(\frac{\eta}{\sqrt{t}}-\sqrt{m}\right)\right)\right) \\ -\frac{1}{2}\left(e^{2\eta\sqrt{ScKt}}erfc\left(\sqrt{t}\left(\eta\frac{\sqrt{Sc}}{\sqrt{t}}+\sqrt{k}\right)\right)+e^{-2\eta\sqrt{ScKt}}erfc\left(\sqrt{t}\left(\eta\frac{\sqrt{Sc}}{\sqrt{t}}-\sqrt{k}\right)\right)\right) \\ +\frac{e^{ct}}{2}\left(e^{2\eta\sqrt{Sc(K+c)t}}erfc\left(\sqrt{t}\left(\eta\frac{\sqrt{Sc}}{\sqrt{t}}+\sqrt{k+c}\right)\right)+e^{-2\eta\sqrt{Sc(K+c)t}}erfc\left(\sqrt{t}\left(\eta\frac{\sqrt{Sc}}{\sqrt{t}}-\sqrt{k+c}\right)\right)\right) \\ -\frac{e^{ct}}{2}\left(e^{2\eta\sqrt{(c+m)t}}erfc\left(\sqrt{t}\left(\eta\frac{\sqrt{Sc}}{\sqrt{t}}+\sqrt{m+c}\right)\right)+e^{-2\eta\sqrt{(c+m)t}}erfc\left(\sqrt{t}\left(\eta\frac{\sqrt{Sc}}{\sqrt{t}}-\sqrt{m+c}\right)\right)\right) \end{array}\right]$$

$$q_6 = \frac{\mathrm{Df\,pr\,Gr}}{\mathrm{c(Sc-1)}}\left[\frac{1}{2}\left(e^{2\eta\sqrt{ScKt}}erfc\left(\sqrt{t}\left(\frac{\eta\sqrt{Sc}}{\sqrt{t}}+\sqrt{k}\right)\right)+e^{-2\eta\sqrt{ScKt}}erfc\left(\sqrt{t}\left(\frac{\eta\sqrt{Sc}}{\sqrt{t}}-\sqrt{k}\right)\right)\right)-\frac{1}{2}\left(e^{-2\eta\sqrt{mt}}erfc\left(\sqrt{t}\left(\frac{\eta}{\sqrt{t}}-\sqrt{m}\right)\right)+e^{2\eta\sqrt{mt}}erfc\left(\sqrt{t}\left(\frac{\eta}{\sqrt{t}}+\sqrt{m}\right)\right)\right)-erfc(\eta\sqrt{pr})-\frac{e^{ct}}{2}\left(e^{2\eta\sqrt{Sc(k+c)t}}erfc\left(\sqrt{t}\left(\frac{\eta\sqrt{Sc}}{\sqrt{t}}+\sqrt{k+c}\right)\right)+e^{-2\eta\sqrt{Sc(k+c)t}}erfc\left(\sqrt{t}\left(\frac{\eta\sqrt{Sc}}{\sqrt{t}}-\sqrt{k+c}\right)\right)\right)+\frac{e^{ct}}{2}\left(e^{2\eta\sqrt{(m+c)t}}erfc\left(\sqrt{t}\left(\frac{\eta}{\sqrt{t}}+\sqrt{m+c}\right)\right)+e^{-2\eta\sqrt{(m+c)}}erfc\left(\sqrt{t}\left(\frac{\eta}{\sqrt{t}}+\sqrt{m+c}\right)\right)\right)\right]$$

$$q_7 = \frac{\mathrm{Df\,pr\,Gr}}{\mathrm{(Sc-1)(a-b)}}\frac{e^{at}}{2}\left(e^{2\eta\sqrt{(m+a)t}}\,erfc\left(\sqrt{t}\left(\frac{\eta}{\sqrt{t}}+\sqrt{m+a}\right)\right)+e^{-2\eta\sqrt{(m+a)t}}erfc\left(\sqrt{t}\left(\frac{\eta}{\sqrt{t}}-\sqrt{m+a}\right)\right)\right)-\frac{e^{at}}{2}\left(e^{2\eta\sqrt{sc(k+a)bt}}erfc\left(\sqrt{t}\left(\frac{\eta}{\sqrt{t}}+\sqrt{k+a}\right)\right)+e^{-2\eta\sqrt{sc(a+k)bt}}erfc\left(\sqrt{t}\left(\frac{\eta}{\sqrt{t}}-\sqrt{k+a}\right)\right)\right)+\frac{e^{ct}}{2}\left(e^{2\eta\sqrt{(k+Sc)t}}erfc\left(\sqrt{t}\left(\frac{\eta}{\sqrt{t}}+\sqrt{k+Sc}\right)\right)+e^{-2\eta\sqrt{(k+Sc)t}}erfc\left(\sqrt{t}\left(\frac{\eta}{\sqrt{t}}-\sqrt{k+Sc}\right)\right)\right)-\frac{e^{ct}}{2}\left(e^{2\eta\sqrt{(m+c)t}}erfc\left(\sqrt{t}\left(\frac{\eta}{\sqrt{t}}+\sqrt{m+c}\right)\right)+e^{-2\eta\sqrt{(m+c)t}}erfc\left(\sqrt{t}\left(\frac{\eta}{\sqrt{t}}-\sqrt{m+c}\right)\right)\right)$$

$$\mathrm{C} = \frac{1}{2}\left[e^{2\sqrt{Ktsc}\eta}erfc\left(\eta\sqrt{sc}+\sqrt{Kt}\right) + e^{-2\sqrt{Ktsc}\eta}erfc\left(\eta\sqrt{sc}-\sqrt{Kt}\right)\right] \tag{17}$$

$$\theta = erfc\left(\eta\sqrt{Pr}\right) - DfPr\left[\frac{1}{2}\left(e^{2\sqrt{ScKt}\eta}erfc\left(\eta\sqrt{Sc}+\sqrt{Kt}\right)+e^{-2\sqrt{ScKt}\eta}erfc\left(\eta\sqrt{Sc}-\sqrt{Kt}\right)\right)-erfc\eta\sqrt{Sc}+\frac{e^{td}}{2}\left(e^{2\sqrt{Sc(Kt+dt)}\eta}erfc\left(\eta\sqrt{Sc}+\sqrt{(Kt+dt)}\right)+e^{-2\sqrt{Sc(Kt+dt)}\eta}erfc\left(\eta\sqrt{Sc}-\sqrt{(Kt+dt)}\right)\right)+\frac{e^{td}}{2}\left(e^{2\sqrt{Scdt}\eta}erfc\left(\eta\sqrt{Sc}+\sqrt{dt}\right)+e^{-2\sqrt{Scdt}\eta}erfc\left(\eta\sqrt{Sc}-\sqrt{dt}\right)\right)\right] \tag{18}$$

4. Results and Discussions

The effect of heat and mass transfer on temperature, velocity, and concentration profile was considered, together with the dufour effect for (i) the prandtl number (ii) dufour number (iii) magnetic number (iv) chemical reaction (v) schmidt number (vi) Grashof Number.

Figure 2 illustrates the conc curves at time t = 0.2 for distinct K. As the K value drops, the concentration raises.

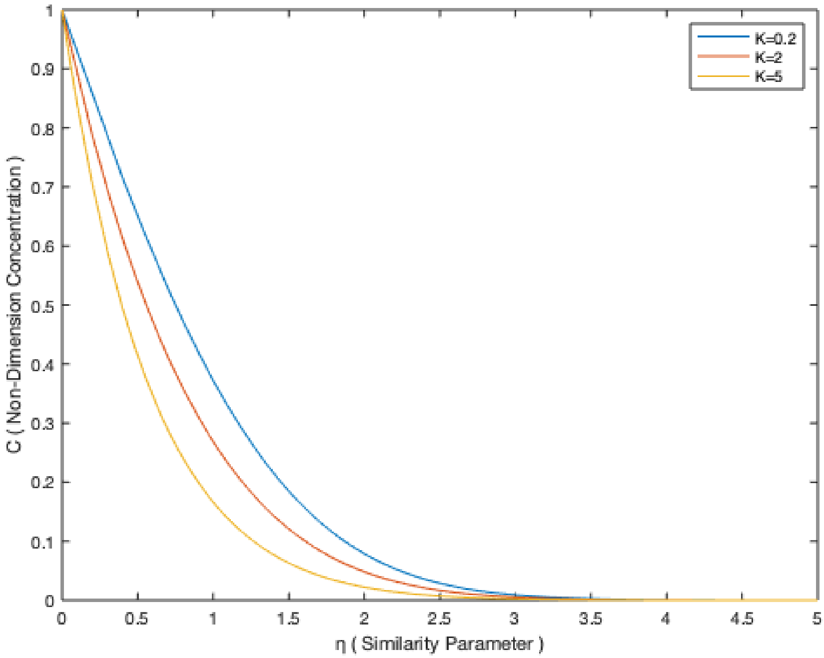

Fig. 2. Conc (Concentration) curves observed for distinct values of k

Using various Schmidt numbers, the result is seen in Figure 3. When the Schmidt value is assumed to be less precise, it may be noticed that the divided concentration rises.

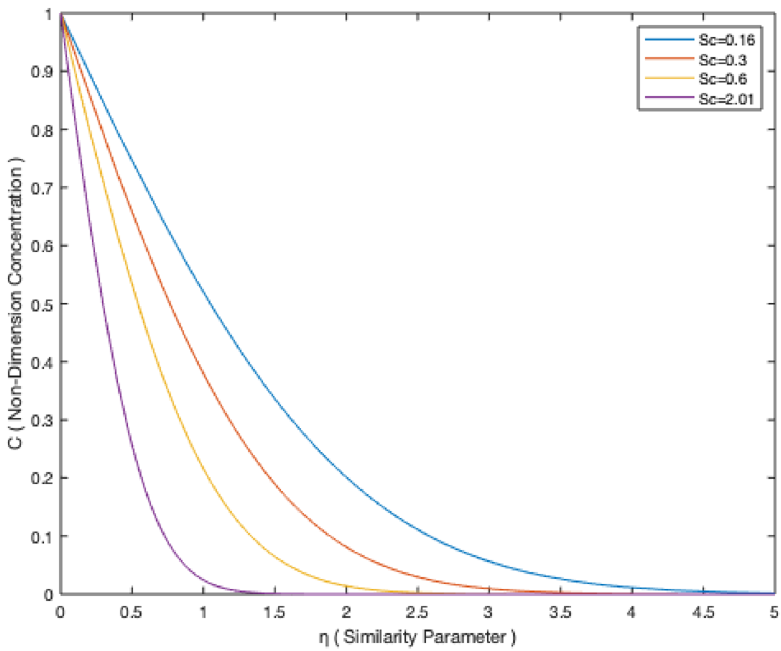

Fig. 3. Conc Curves for distinguished Sc

Figure 4 The fluid has a reduced ability to transfer heat compared to its ability to transfer momentum. As a result, in situations like heat conduction through a fluid boundary layer, a higher Pr may exhibit slower boundary layer growth, leading to slightly different temperature profiles.

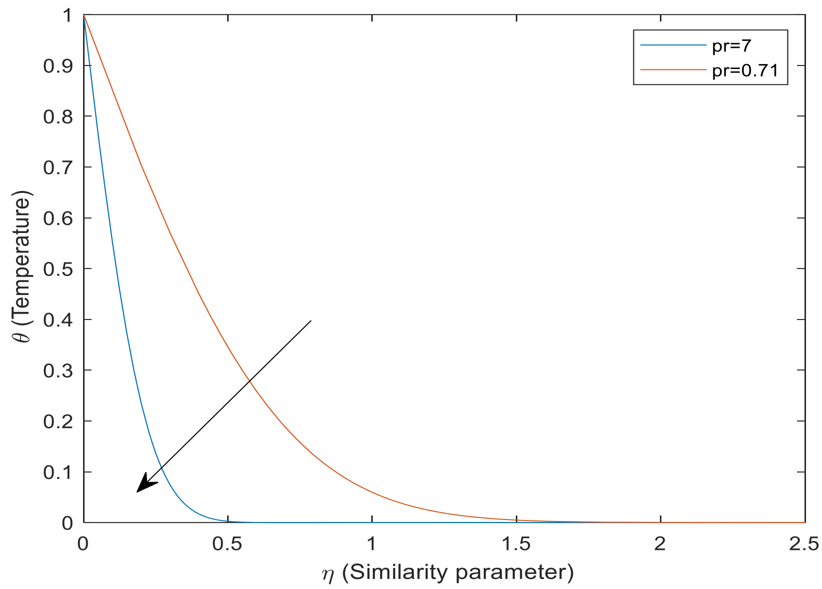

Fig. 4. Temperature Profiles for several values of Pr

Figure 5 represents the behaviour of temp for time t = 0.1,0.2,0.3. As time progresses, the fluid's response to move u in temperature becomes more evident. The temperature raises when time moves up.

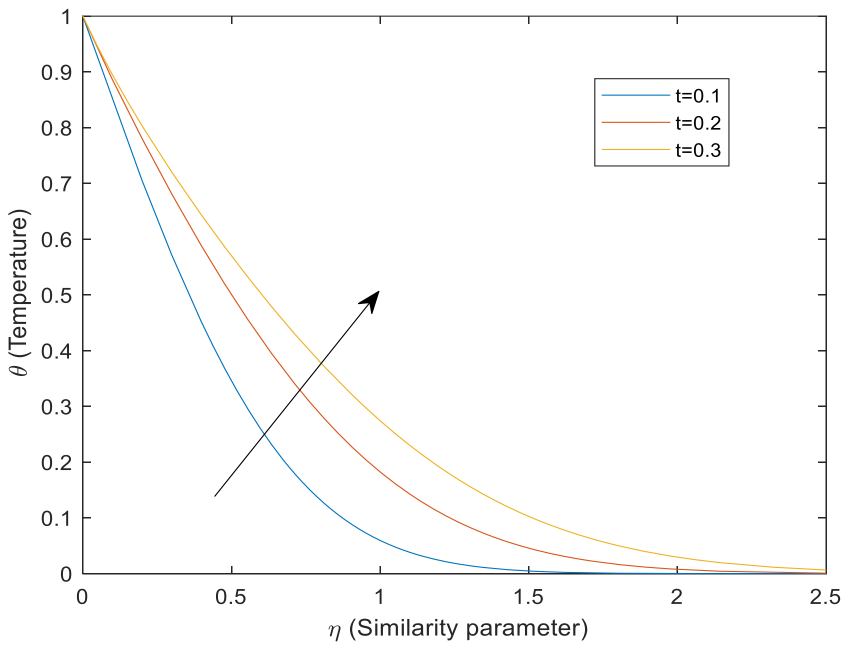

Fig. 5. Temp (Temperature) Curves

In Figure 6, we can explore the heat behaviour in more detailed by considering the thermal diffusion (Dufour) numbers (Df = 1,5,10). In general, as Dufour parameter increases, it means that the Dufour effect becomes more pronounced, and the temperature distribution within the mixture becomes more affected by the concentration gradients. This can lead to higher or lower temperatures depending on the specific circumstances and the sign of the Dufour effect.

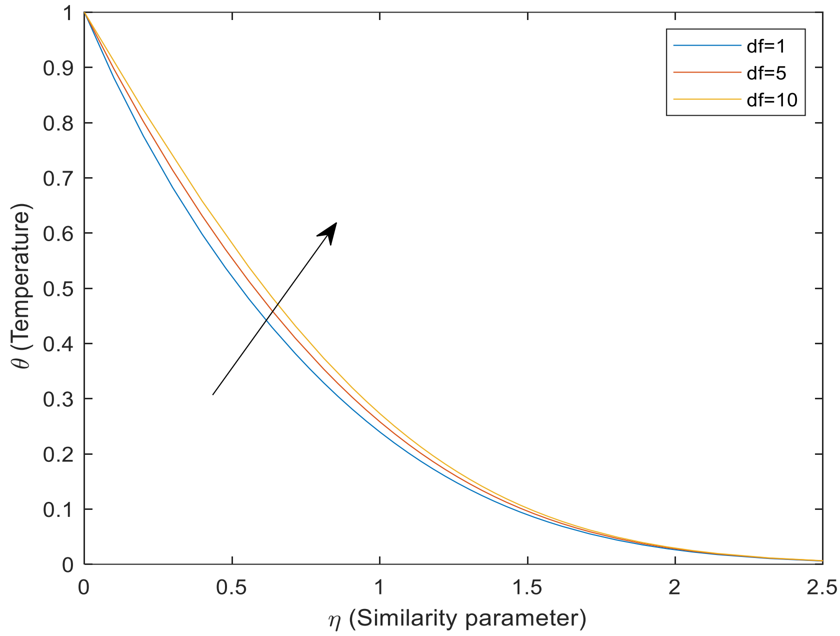

Fig. 6. Temperature Profiles for various values of Df

Figure 7 shows that the Schmidt number increases, indicating a tendency for the temperature to rise initially. However, the temperature subsequently fluctuates, revealing a change in trend, decrease in warm at this stage.

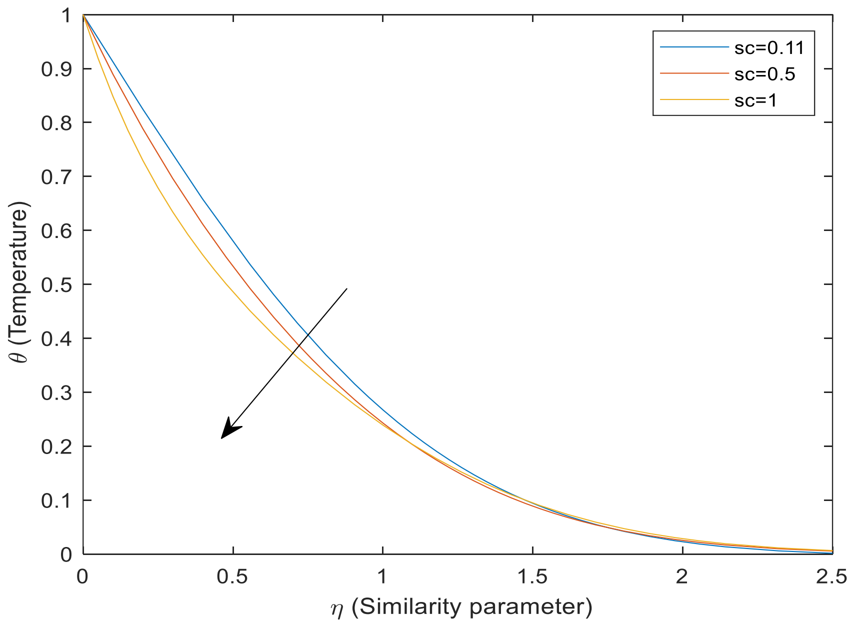

Fig. 7. Temperature for distinguished Sc

Figure 8 illustrates the temperature profile, K goes up, the temperature goes down.

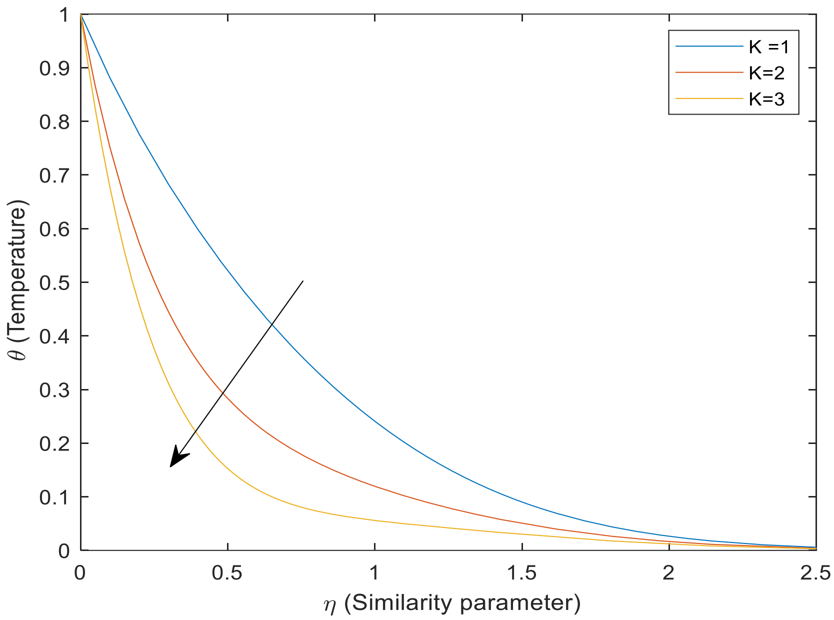

Fig. 8. Temperature profiles of distinct Chemical Reaction 'K'

Figure 9 illustrates speed for thermal diffusion values (Df = 1, 2, 3), it is evident that the highest speed is achieved if Dufour number gets high.

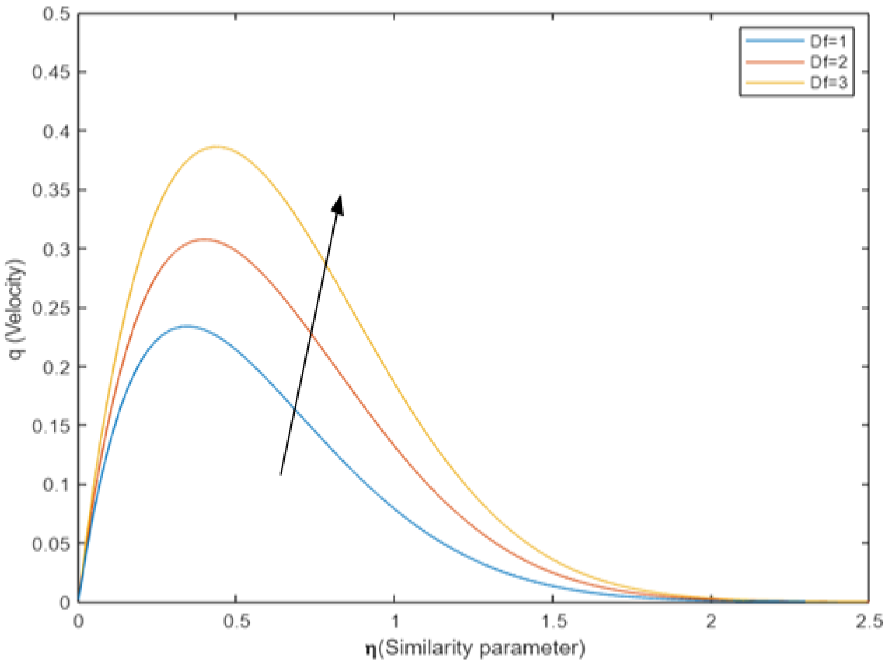

Fig. 9. Velocity Profiles for Df

Figure 10 displays plate's velocity contours at various Schmidt values. (Sc = 0.05, 0.11, 0.22). A plate's Schmidt number falls as speed rises.

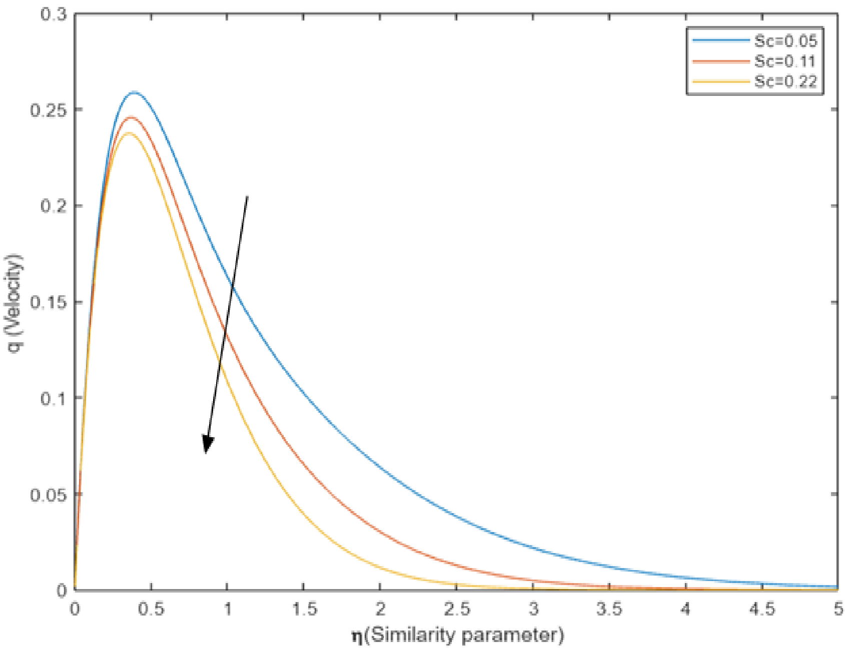

Fig. 10. Velocity for distinct S_c

Figure 11 shows the velocity of the plate for different number of observation (M=3,5,7) and declined velocity with up in M.

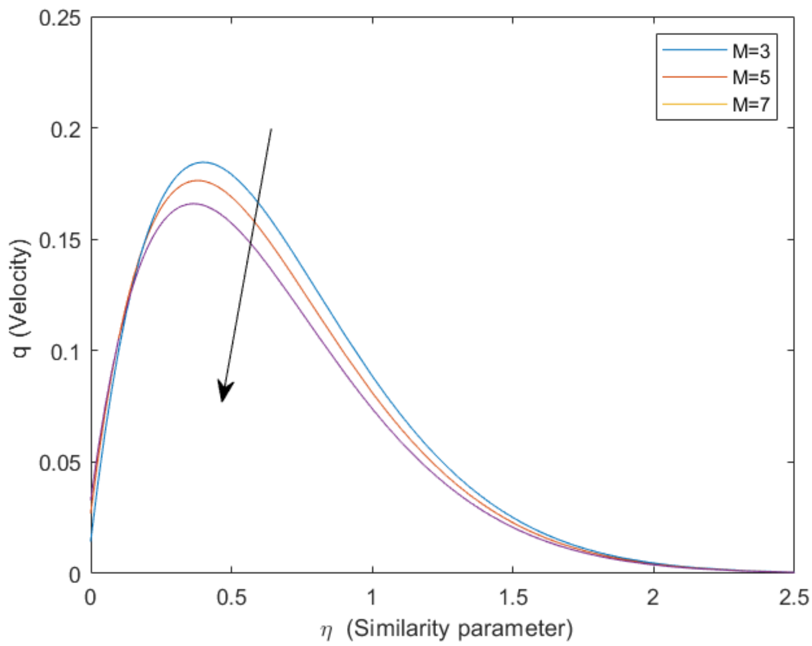

Fig. 11. Velocity for distinct M

Various Gr = 2, 3, and 4, the velocity contours of the plate are shown in Figure 12. Increasing velocity causes the Gr values to increase.

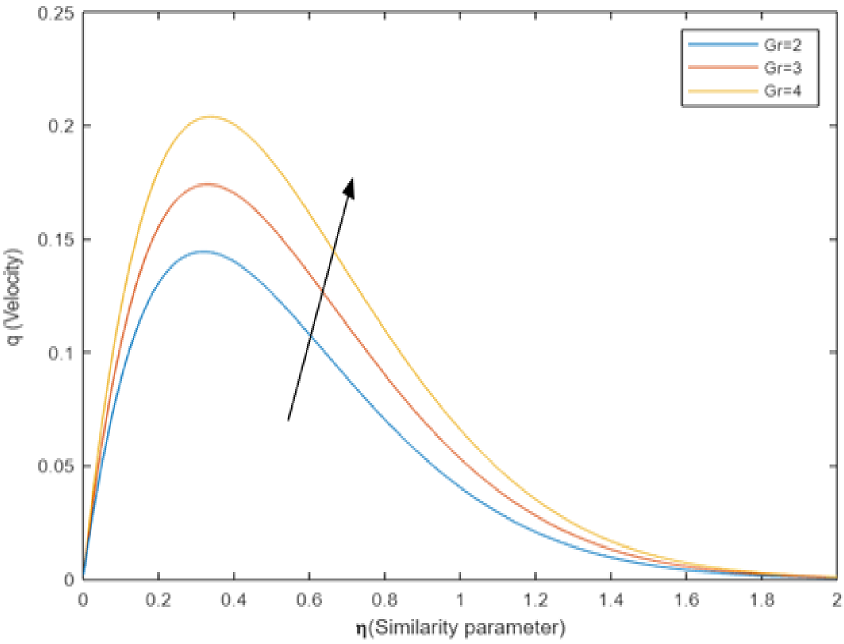

Fig. 12. Velocity graph for distinct G_r

Figure 13 displays velocity distribution over plate, presenting different values of K, namely 3, 4, and 5. As the chemical reaction rate intensifies, the associated K values exhibit a reduction.

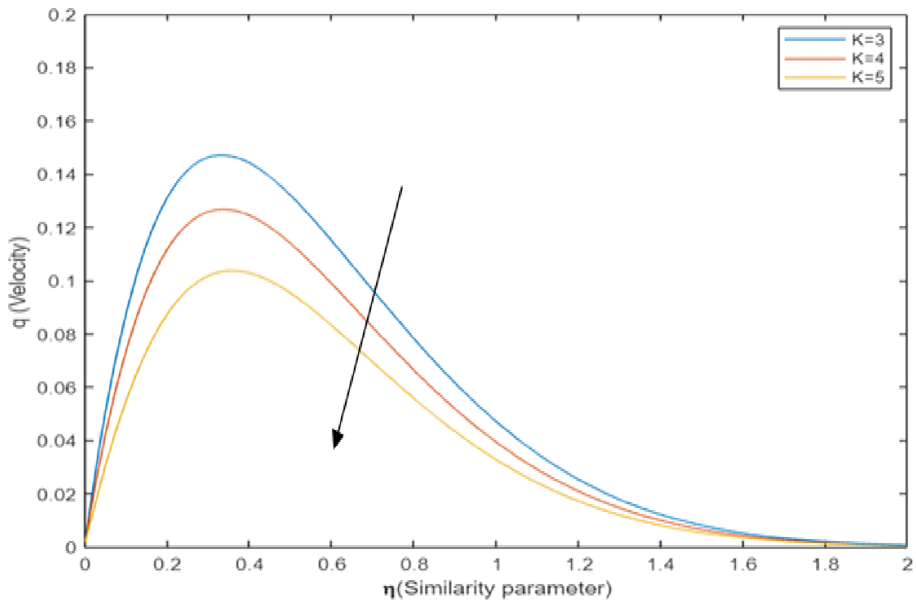

Fig. 13. Velocity trend for distinct K

5. Conclusion

In this paper, it is possible to observe and study the precise interaction of impacts of rotational and Dufour on MHD with uniform temperature and accumulation diffusing with chemical reaction is seen and studied. Laplace transforms are used to decipher the basic flow of mathematical statements and get an improved idea of the equations. Graphs, which are a good way to show data and show how it differs, are used to help show all of the effects, which can be shown to be the result based on what the study found, the sketches of the schemes for temperature, concentration, and speed are as follows:

(i) When the Dufour number Df and time t increase the tendency of the temperature profile while having Prandtl number Pr, Schmidt number Sc, and chemical reaction parameter K reverse on it.
(ii) As the Schmidt number Sc and chemical reaction parameter K were increased, the concentration boundary layer dropped
(iii) Velocity drops as magnetic parameter M and chemical reaction parameter K and Schmidt number Sc are increases but Velocity rises as K, the Dofour number Df, and Gr, the thermal grashof number, are increased.

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