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Effect of Heat Source on MHD Flow Through Permeable Structure under Chemical Reaction and Oscillatory Suction

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ABSTRACT

Magnetohydrodynamics (MHD) deals with the study of the magnetic properties and behaviour of electrically conducting fluids. In literature, researchers have studied. The study of MHD is widely applied in drawing of plastics and elastic sheets, metal and polymer expulsion forms, paper creation, cooling of metallic sheets, etc. Most of the previous researchers have studied only the concentration and velocity boundary layer profiles. However, the effect of heat sources using temperature boundary layer profiles is not studied. Therefore, in this work, an analysis of a convective flow of an electrically conductive, viscid compact fluid through a perpendicular plate which is porous with oscillatory suction with first-order temperature and chemical reaction and the transverse magnetic field is carried out. The developed model consists of continuity, momentum, and heat and mass transfer equations, and the perturbation technique was applied in order to find the result for the velocity field, temperature profiles, and concentration distributions. Further, the influence of the flow variables on the temperature field, velocity field, and concentration dispersal was analyzed and the results were depicted graphically. Moreover, the skin friction and the rate of mass transfer (local Sherwood number) were analyzed using tables. In this work, an unstable 2D flow of a laminar, viscid (Newtonian), electrically conducting fluid across a semi-limitless perpendicular permeable plate under motion in its plane (x-axis) embedded in a constant permeable structure was investigated.

1. INTRODUCTION

The MHD flow analysis over vertical porous surfaces has obtained wide attention from researchers because of its applications in the areas of astrophysics, geophysics, chemical engineering, etc. MHD effects are used in many applications to resolve complex problems that occur day-to-day in industries. Many researchers have conducted various researches to analyze the MHD effects. Qatanani et al. [1] developed a mathematical structure and analyzed the MHD flow in porous media. Kumar et al. [2] investigated the dynamic behaviour of a pulsatile flow. The flow was electrically conductive through a medium that was porous in a conduit under a magnetic field. From the results, it was found that the flow behaviour was strongly affected by the permeability parameter of medium porosity and the Hartmann number. Hussaini et al. [3] analyzed a visco-elastic flow in a structure that was porous. The medium was surrounded by a limitless perpendicular plate in permeable conditions, and the heat flux under the influence of a transverse uniform magnetic field was investigated. Abdul et al. [4] examined the unstable MHD convection heat and mass transfer across the boundary layer of a fluid that was incompressible flowing across a vertical plate in porous condition under the viscid dissolution, production of heat, chemical reaction, and Arrhenius activation energy. Then the equations were solved analytically using the shooting method using the Nachtsheim-Swigert iteration technique. Singh et al. [5] discussed the influence of the Visco-elastic MHD oscillatory flow through a medium in permeable conditions. Ashraf et al. [6] analyzed the difference in permeability and the fluctuating suction velocity in a convective and mass transfer flow. In this work, a fluid that was viscid and compact across a limitless perpendicular permeable plate through a structure in porous conditions was studied. The influences of the flow variables were obtained using the perturbation technique. Reddy et al. [7] analyzed the influence of varying viscosity and thermal conductivity on an unstable 2D laminar flow of a viscid fluid across a semi-limitless perpendicular moving plate which was in permeable condition. By using the Shooting method, the numerical solutions were discussed. Lawanya et al. [8] reported the influence of mass transfer and radiation on unsteady convective flow across a perpendicular plate in porous conditions with varying temperatures with transverse magnetic fields. Vidhya et al. [9] analyzed the influence of the mass transfer with chemical reaction in a hot perpendicular medium with heat radiation [9]. Ahmed et al. [10] discussed the effect of heat radiation and chemical reaction for an unstable viscid electrically conductive fluid across a semi-limitless perpendicular plate inside a porous medium. Singh et al. [11] examined the influence of radiation and chemical reaction on an unstable MHD heat and mass transfer across a vertical flat plate in the permeable conditions in a slip-flow regime. Sudheer et al. [12] examined the influence of the chemical reaction and thermal radiation on MHD convective fluid across a semi-limitless plate with viscid dispersal. Sivaiah et al. [13] examined the influence of thermal diffusion and radiation across an infinite heated plate using Galerkin finite element method. Sharma et al. [14] studied the influence of an analogous chemical reaction, heat radiation, heat source, Dufour, and Soret effects in the presence of suction. Sandeep et al. [15] investigated the MHD radiation, and chemical reaction influences on an unstable flow using the perturbation technique. Dass et al. [16] examined the influence of mass transfer on the hydromagnetic convective flow of a viscid fluid across with uniform suction and thermal source. It was found that an increasing Hartmann number or Schmidt number reduces the mean velocity and the transient velocity. Further, it was also found that the influence of a high Grashof number for heat and mass transfer accelerated both the mean and the transient velocity. Moreover, the influence of rising Schmidt number was found to decrease the concentration boundary layer thickness at all points. Harish et al. [17] analyzed unstable convection for a micropolar fluid surrounded with a semi-limitless perpendicular plate with heat generation and the radiation absorption was noted. Ahmed et al. [18] examined the influence of the chemical reaction and magnetic field on the heat and mass transfer in Newtonian fluids. The Laplace Transform technique and the stable finite difference scheme of the Crank-Nicolson type were used. Essawy et al. [19] studied the influence of the porosity, inertial outcomes, and the constant suction and injection velocity on the velocity and temperature distributions. Lawanya et al. [20] analyzed the Soret Effects of mass transfer and radiation on MHD fluid in a permeable channel by using the perturbation technique. Chitra et al. [21] studied the influence of chemical reaction on the unsteady oscillatory MHD flow through a porous medium in a porous vertical channel in the presence of suction velocity. The flow was considered to be incompressible electrically conducting and radiating viscoelastic fluid in the presence of a uniform magnetic field applied perpendicular to the plane of the plates of the channel. From the analysis, they formulated the momentum, energy, and concentration equation. Suresh et al. [22] investigated the influence of force buoyancy and magnetohydrodynamic on convective mass and heat transfer flow in a vertical porous plate during thermal radiation and chemical reaction. Bejawada et al. [23] conducted a numerical study of chemically reactive effects on Magnetohydrodynamics (MHD) free convective unsteady flow under viscous dissipation. The computational relationships of speed, energy, and concentricity were obtained.

From the literature, it is observed that most of the researchers studied only the effect of velocity and concentration of the MHD fluid. There are not many researches to analyze and study the effect of the temperature. Therefore, in this study, the heat source effect is also studied along with the effect of the velocity and concentration through permeable structure under chemical reaction and Oscillatory suction.

2. FORMULATION OF THE PROBLEM

In this work, an unstable 2D flow of a laminar, viscid (Newtonian), electrically conducting fluid across a semi-limitless perpendicular permeable plate under motion in its plane (x-axis) embedded in a constant permeable structure was investigated. The medium is considered to be under a transverse magnetic field with concentrated buoyancy effects. Further, it is considered that no voltage is supplied which indicates that there is no electrical field. The fluid properties are considered to be uniform. The concentration of the imparting species is considered as C'w at the plate; the concentration of the specimens away from the wall, C'∞, is considered to be limitlessly less. Therefore, the Soret and the Dufour effects are ignored. The first-order chemical reaction is considered to be seen in the flow. Due to the semi-limitless plane surface considerations, the flow parameters are the functions of *y'* and the time *t'* only. The oscillatory suction velocity of the fluid at the plate normal to it is v'; initially, the plate relocates with the oscillatory velocity u', in the direction of x that is in its plane. The pressure gradient is towards the x-axis. Further, there is a chemical reaction of the first order in the fluid. It is shown in Figure 1.

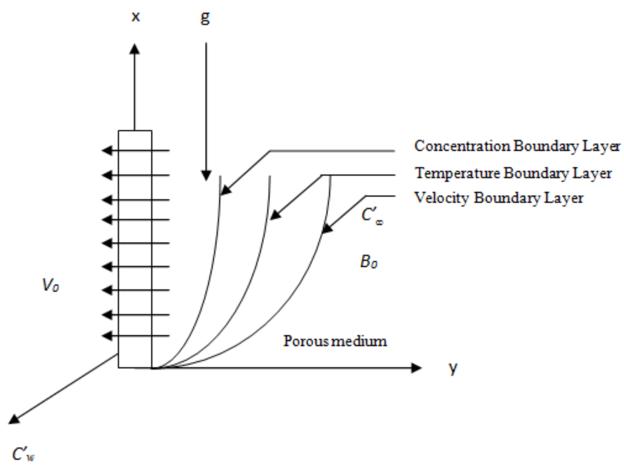


Figure 1. Model and coordinate system of the problem

The following governing equations considered in this work include the continuity equation (Eq. (1)), momentum equation (Eqns. (2)-(3)), temperature equation (Eq. (4)), and the equation of mass Eqns. (5)-(6).

$$\frac{\partial v'}{\partial y'} = 0 \tag{1}$$

$$\frac{\partial u'}{\partial t'} + v'\frac{\partial u'}{\partial y'} = -\frac{1}{\rho}\frac{\partial p'}{\partial x'} + \mathrm{v}\frac{\partial^2 u'}{\partial y'^2} + g\beta_r{}'(T' - T_\infty{}') + g\beta_c{}'(C' - C_\infty{}') - \frac{\sigma\beta_0{}^2}{\rho}u' - \frac{\mu}{k}u' \tag{2}$$

where,

$$-\frac{1}{\rho}\frac{\partial p'}{\partial x'} = -\frac{\partial U_\infty{}'}{\partial t'} + \left(\frac{\sigma\beta_0{}^2}{\rho}u' - \frac{\mu}{k}\right)U_\infty{}' \tag{3}$$

$$\frac{\partial T'}{\partial t'} = \frac{k}{\rho C_p}\frac{\partial^2 T'}{\partial y'^2} + \frac{1}{\rho C_p}4\alpha_1{}^2(T^1 - T_0{}') + \frac{Q'(T' - T_0{}')}{\rho C_p} - v'\frac{\partial T'}{\partial y'} \tag{4}$$

$$\frac{\partial C'}{\partial t'} + v'\frac{\partial C'}{\partial y'} = D_M\frac{\partial^2 C^*}{\partial y^{*2}} - K_T(C' - C_\infty{}') \tag{5}$$

$$U'(t') = U_\infty' = U_0\left(1 + \varepsilon e^{n't'}\right), v' = -V_0(1 + \varepsilon A e^{n't'}) \quad (6)$$

In Eqns. (1)-(6), k refers to the permeability of the porous medium. ρ, μ, v, β_c, and σ refer to the density, dynamic viscosity, kinematic viscosity, coefficient of volume expansion due to concentration, and the coefficient of electrical conductivity of the fluid respectively. D_M refers to the mass diffusion coefficient. K_r refers to the first-order chemical reaction coefficient. V_0 refers to the mean suction velocity and ε refers to a minimal quantity less than unity, and A refers to a positive constant such that $\varepsilon A < 1$. The negative sign shows that the suction velocity is directed towards the plate. The boundary conditions are considered as shown in Eq. (7).

$$t' \geq 0: u' = U_0 \text{ at, } y' = 0;\ C' = C_w' + \varepsilon(C_w' - C_\infty')e^{n't'} \text{ at } y' = 0,\ u' \to U'(t'), C' \to C_\infty' \text{ as } y' \to \infty \quad (7)$$

In Eq. (7), $U'(t') = U_\infty' = U_0\left(1 + \varepsilon e^{n't'}\right)$.

The dimensionless quantities are considered as shown in Eq. (8) and the dimensionless parameters are given in Eqns. (9)-(12).

$$y = \frac{V_0}{v} y',\ u = \frac{u'}{V_0},\ t = \frac{V_0^2}{v} t',\ n = \frac{vn'}{V_0^2},\ v' = V_0(1 + \varepsilon A e^{nt}) \quad (8)$$

$$K = \frac{K' V_0^2}{v^2}, M = \frac{\sigma \beta_0^2 v}{\rho V_0^2}, C = \frac{C' - C_\infty'}{C_w' - C_\infty'}, Sc = \frac{v}{D_M}, Gm = \frac{g\,\beta_C v(C_w' - C_\infty')}{U_0 V_0^2}, Kr = \frac{K_r'}{V_0^2} \quad (9)$$

$$\frac{\partial u}{\partial t} - (1 + \varepsilon A e^{nt})\frac{\partial u}{\partial y} = \frac{\partial^2 u}{\partial y^2} + GmC + GrT - (M + \frac{1}{k})(u - v) \quad (10)$$

$$\frac{\partial T}{\partial t} - (1 + \varepsilon A e^{nt})\frac{\partial T}{\partial y} = \frac{1}{P_r}\frac{\partial^2 T}{\partial y^2} + N^2 T - S\,T \quad (11)$$

$$\frac{\partial C}{\partial t} - (1 + \varepsilon A e^{nt})\frac{\partial C}{\partial y} = \frac{1}{S_c}\frac{\partial^2 C}{\partial y^2} - K_r C \quad (12)$$

Further, the other boundary conditions that are used are shown in Eqns. (13)-(14).

$$t \geq 0: u = 1, T = (1 + \varepsilon e^{nt}), C = (1 + \varepsilon e^{nt}) \text{ at } y = 0; \quad (13)$$

$$u \to (1 + \varepsilon e^{nt}), T \to 0, C \to 0 \text{ as } y \to \infty \quad (14)$$

The model is developed using the perturbation method as follows.

Initially, the Eqns. (15)-(17) are considered.

$$u(y,t) = u_0(y) + \varepsilon e^{nt} u_1(y) + O(\varepsilon^2); \quad (15)$$

$$T(y,t) = T_0(y) + \varepsilon e^{nt} T_1(y) + O(\varepsilon^2); \quad (16)$$

$$c(y,t) = C_0(y) + \varepsilon e^{nt} C_1(y) + O(\varepsilon^2); \quad (17)$$

Thereafter, the Eq. (15) and Eq. (16) are substituted in Eq. (10) and Eq. (12). Then, by comparing the coefficients of ε^0 and ε^1, Eqns. (18)-(23) are obtained.

$$u_0'' + u_0' - \left(M + \frac{1}{K}\right)u_0 = -\left(M + \frac{1}{K}\right) - GmC_0 - GrT_0 \quad (18)$$

$$u_1'' + u_1' - \left(M + \frac{1}{K} + n\right)u_1 = -\left(M + \frac{1}{K} + n\right) - Au_0' - GmC_1 - GrT_1 \quad (19)$$

$$T_0'' + PrT_0' + (N^2 - S)PrT_0 = 0 \quad (20)$$

$$T_1'' - (n - N^2 + S)PrT_1 = -PrAT_0' \quad (21)$$

$$C_0'' + ScC_0' - KrScC_0 = 0 \quad (22)$$

$$C_1'' + ScC_1' - (Kr + n)ScC_1 = -AScC_0' \quad (23)$$

Then, the boundary conditions as shown in Eq. (13) and Eq. (14) become as shown in Eq. (24).

$$t \geq 0: u_0 = 1, u_1 = 0; T_0 = 1, T_1 = 1; C_0 = 1, C_1 = 1 \text{ at } y = 0; \quad u_0 \to 1, u_1 \to 1; T_0 \to 0, T_1 \to 0; C_0 \to 0, C_1 \to 0, \text{ as } y \to \infty \quad (24)$$

Further, by solving Eqns. (18)-(23) using the boundary conditions as shown in Eq. (24), Eqns. (25)-(30) are obtained.

$$C_0 = e^{m_2 y} \quad (25)$$

$$C_1 = B_4 e^{m_4 y} + (1 - B_4)\, e^{m_2 y} \quad (26)$$

$$T_0 = e^{m_6 y} \quad (27)$$

$$T_1 = B_8 e^{m_8 y} + (1 - B_8)\, e^{m_6 y} \quad (28)$$

$$u_0 = L_1(e^{m_6 y} - e^{m_{10} y}) + L_2(e^{m_2 y} - e^{m_{10} y}) + 1 \quad (29)$$

$$u_1 = L_3(e^{m_{10} y} - e^{m_{12} y}) + L_4(e^{m_4 y} - e^{m_{12} y}) + L_5(e^{m_8 y} - e^{m_{12} y}) + L_6(e^{m_6 y} - e^{m_{12} y}) + L_7(e^{m_2 y} - e^{m_{12} y}) \quad (30)$$

In Eqns. (25)-(30),

$$m_2 = \frac{-Sc - \sqrt{Sc^2 + 4KrSc}}{2},\ m_4 = \frac{-Sc - \sqrt{Sc^2 + 4Sc(Kr + n)}}{2},$$
$$m_6 = \frac{-Pr - \sqrt{Pr^2 - 4\mathrm{Pr}\,(N^2 - S)}}{2},\ m_8 = -\sqrt{Pr(n - N^2 + S)},$$
$$m_{10} = \frac{-1 - \sqrt{1 - 4\left(M + \frac{1}{K}\right)}}{2},\ m_{12} = \frac{-1 - \sqrt{1 + 4\left(M + \frac{1}{K} + n\right)}}{2}$$

$$B_4 = 1 - \frac{-AScm_2}{m_2^2 + Scm_2 - E_2},\ B_8 = 1 - \frac{-PrAm_6}{m_6^2 - Pr(n - N^2 + S)},$$

$$L_1 = \frac{-Gr}{m_6^2 + m_6 - \left(M + \frac{1}{K}\right)},\ L_2 = \frac{-Gm}{m_2^2 + m_2 - \left(M + \frac{1}{K}\right)},$$
$$L_3 = \frac{Am_{10}(L_1 + L_2)}{m_{10}^2 + m_{10} - \left(M + \frac{1}{K} + n\right)},\ L_4 = \frac{-GmB_4}{m_4^2 + m_4 - \left(M + \frac{1}{K} + n\right)}$$

$$L_5 = \frac{-GrB_8}{m_8^2 + m_8 - \left(M + \frac{1}{K} + n\right)},\ L_6 = \frac{-Gr(1 - B_8) - AL_1 m_6}{m_6^2 + m_6 - \left(M + \frac{1}{K} + n\right)},$$
$$L_7 = \frac{-Gm(1 - B_4) - AL_2 m_2}{m_2^2 + m_2 - \left(M + \frac{1}{K} + n\right)}$$

Thereafter, the skin friction, rate of heat transfer, and rate of mass transfer are obtained as shown in Eq. (31), Eq. (32), and Eq. (33) respectively.

$$\left(\frac{\partial u}{\partial y}\right)_{y=0} \tag{31}$$

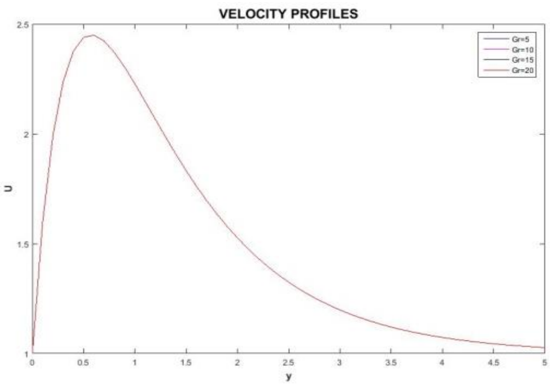
$$\left(\frac{\partial T}{\partial y}\right)_{y=0} \tag{32}$$

$$\left(\frac{\partial C}{\partial y}\right)_{y=0} \tag{33}$$

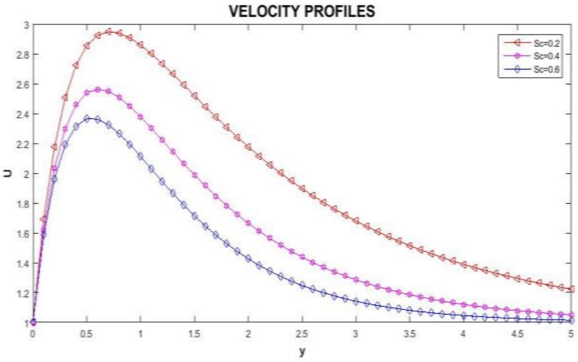
3. RESULTS AND DISCUSSIONS

The analytical solutions were obtained using the above analytical method for a few values of the governing parameters, such as the magnetic parameter (M), the permeability parameter (K), Schmidt number (Sc), chemical reaction parameter (Kr), Oscillatory Suction parameter (n), and Grashoff number for the concentration (Gm). The influence of M, K, Sc Kr, n, and Gm on the fluid velocity and the concentration over the semi-infinite porous plate were obtained. Further, the numerical computation was carried out using MATLAB.

Figure 2a reveals the effects of the Grashoff number for the heat transfer *Gr* on the velocity profiles. From Figure 2a, it is found that the velocity remains constant as the value of the Grashoff number rises. Figure 2b reveals the influence of the Schmidt number Sc on the velocity profiles. From Figure 2b, it is found that the velocity profiles decrease as the value of the Schmidt number rises. Figure 2c shows the effect of the Grashoff number for the heat transfer *Gr* on the velocity profiles. From Figure 2c, it is found that the velocity profiles decrease as the value of the Grashoff number rises. Further, Figure 2d shows the effect of S on the temperature profiles. It is seen that as the values of S rise, temperature profiles also rise. Figure 2e reveals the influence of Kr on the temperature profiles. It is found that the temperature profiles remain constant as the values of Kr increase. Furthermore, Figure 2f reveals the influence of Kr on the concentration profiles. From the figure, it is found that the concentration profiles remain constant as the values of Kr increase. Figure 2g demonstrates the influence of Sc on the concentration profiles. It is found that the concentration profiles decrease as the values of Sc rise. Finally, Figure 2h shows the influence of Kr on the concentration profiles. It is found that the concentration profiles decrease as the values of Kr increase.



(a)



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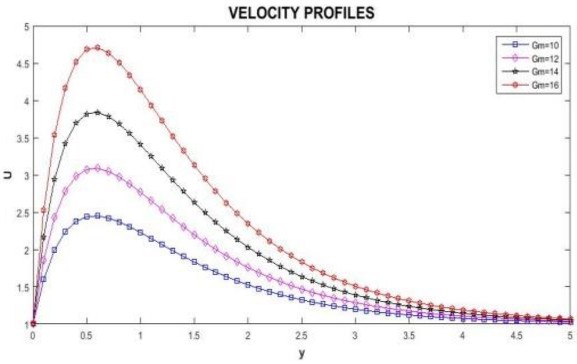
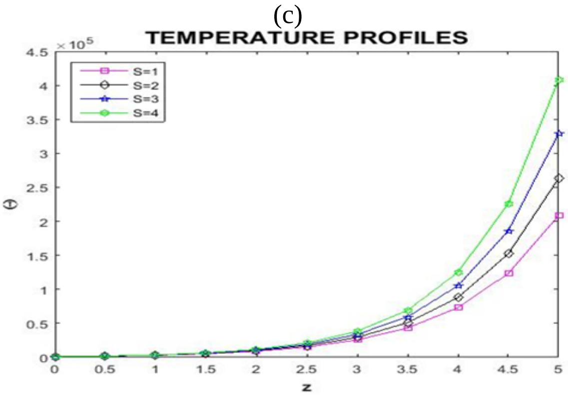


(c)



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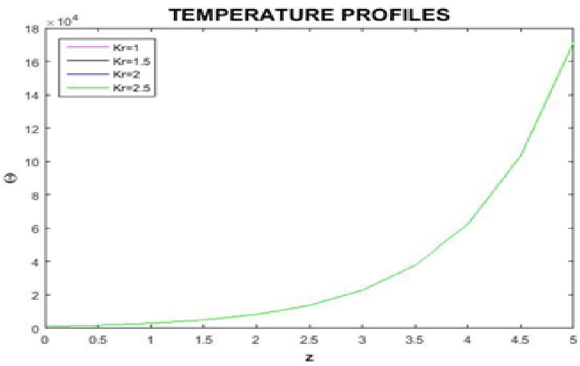
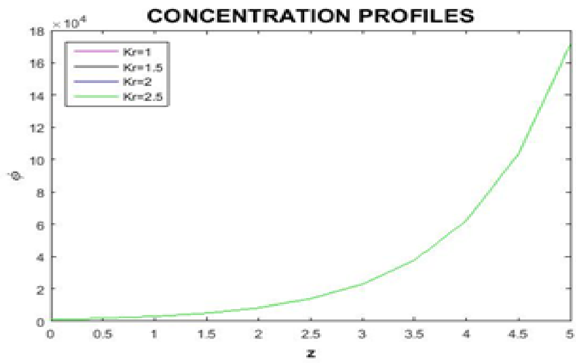
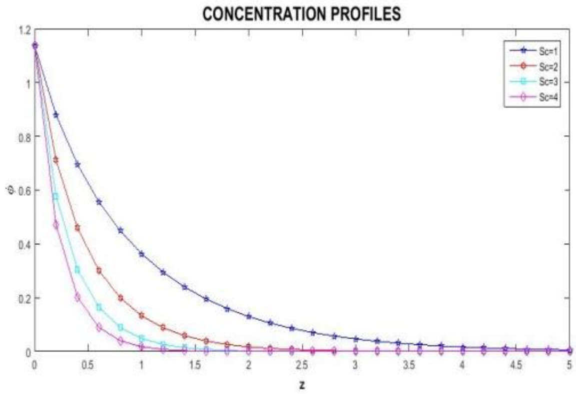


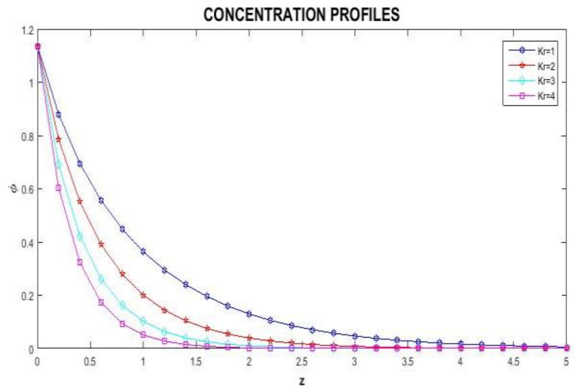
(e)



(f)



(g)



(h)

Figure 2. Graphical representation of the velocity, temperature, and concentration profiles: (a) velocity profile for some values of Gr; (b) Velocity profile for some values of Sc; (c) Velocity profile of some values of Gr; (d) Temperature profile of for some values of S; (e) Temperature profile for some values of Kr; (f) Concentration profile for some values of Kr; (g) Concentration profile for some values of Sc; (h) Concentration profile for some values of Kr

In Tables 1-8, the analytical values of Skin Friction coefficients Cf, and the rate of mass transfer in terms of local Sherwood number Sh for various values of M, K, Sc, Kr, n, and Gm are respectively tabulated. It is found that a rise in K, n, and Gm results in a rise in the Skin Friction value while a rise of M, Sc, and Kr results in the reduction of the value of Skin Friction. It is found that a rise in Sc, Kr, and n results in the reduction of the value of the local Sherwood Number while an increase of M, K, and Gm does not have any effect. From Table 1, it is found that when the value of M increases Skin friction increases and Sherwood also rises. From Table 2, it is observed that when the value of K rises, the Skin friction rises and Sherwood remains constant. Further, from Table 3, it is found that when the value of Sc rises Skin friction decreases and Sherwood decreases. From Table 4, it is found that when the value of K rises Skin friction reduces, Nusselt remains constant and Sherwood decreases. Moreover, in Table 5, it is found that when the value of n rises Skin friction increases, Nusselt decreases and Sherwood decreases. It is also observed from Table 6 that when the value of Gm increases Skin friction increases. From Table 7, it is found that when the value of Pr increases Nusselt decreases. Furthermore, from Table 8, it is found that when the value of N rises Nusselt increases.

Table 1. Epsilon=0.05; A=0.1;n=5; Gm=10; K=10; Sc=0.5; Kr=0.2; t=0.1; Kr=0.1; Pr=0.1; N=0.1; S=0.2

M	Tow	Sh
0	9.8988	-0.6626
0.5	10.0731	-0.6626
1	10.1577	-0.6626
2	10.172	-0.6626

Table 2. Epsilon=0.05; A=0.1; n=5; Gm=10; M=1; Sc=0.5; Kr=0.2; t=0.1; Kr=0.1; Pr=0.1; N=0.1; S=0.2

K	Tow	Sh
0.5	2.9639	-0.6626
1	4.3665	-0.6626
5	8.6043	-0.6626
10	10.172	-0.6626

Table 3. Epsilon=0.05; A=0.1; n=5; Gm=10; K=10; M=1; Kr=0.2; t=0.1; Kr=0.1; Pr=0.1; N=0.1; S=0.2

Sc	Tow	Sh
0.1	27.3903	-0.1479
0.3	15.7654	-0.377
0.5	10.172	-0.599
0.8	3.1571	-1.1452

Table 4. y=0:0.5:5; n=5; t=0.1; Kr=0.1; epsilon=0.05; A=0.1; Pr=0.1; N=0.1; S=0.2

Kr	Tow	Nu	Sh
0.1	11.3181	-0.2562	-0.6664
0.2	10.172	-0.2562	-0.7356
0.5	8.0634	-0.2562	-0.8957
1	6.0947	-0.2562	-1.0931

Table 5. t=0.1; Kr=1; epsilon=0.05; A=0.1; Pr=0.1; N=0.1; S=0.2

n	Tow	Nu	Sh
5	10.172	-0.2562	-0.8096
8	11.8026	-0.2975	-0.9094
10	15.4532	-0.334	-0.9976
12	25.1854	-0.3802	-1.1086

Table 6. Gr=5; M=2; K=10; n=5; Gm=4; Sc=0.5; A=0.10; Pr=1; N=1; S=0.1; Kr=0.2; epsilon=0.005; t=0.5

Gm	Tow
4	4.7997
6	6.5904
8	8.3812
10	10.172

Table 7. n=5; t=0.1; Kr=0.1; epsilon=0.05; A=0.1; Pr=0.4; N=0.1; S=0.2

pr	NU
0.1	-0.2562
0.2	-0.4035
0.3	-0.5355
0.4	-0.6603

Table 8. y=0:0.5:5; n=5; t=0.1; Kr=0.1; epsilon=0.05; A=0.1; Pr=0.1; N=0.1; S=0.2

N	Nu
0.1	-0.6603
0.2	-0.2454
0.3	-0.2253
0.4	-0.1893

4. CONCLUSIONS

In this work, a free convective flow of a viscid compact, electrically conductive fluid was analyzed during its flow through a plate in permeable condition with oscillatory suction with first-order temperature and chemical reaction, and the transverse magnetic field. The influence of the flow variables on the velocity field, temperature field, and concentration dispersion was analyzed and the results were depicted graphically. From the results, it was observed that with the increase in the value of the magnetic parameter, Schmidt number, and the chemical reaction parameter Kr, the velocity of the flow field showed a decrease at all points. Therefore, the thickness of the velocity boundary layer decreased. Further, it was found that with the increase in the value of the porosity parameter K and the Grashoff number for mass transfer Gm, the velocity of the flow field showed an increase at all points. Thus, the thickness of the velocity boundary layer was found to increase. Moreover, it is identified that as the value of Schmidt number increased, the chemical reaction parameter Kr and the concentration of the flow field decreased at all points and hence the thickness of the concentration boundary layer decreased. Furthermore, it is found that as the porosity parameter K and the Grashoff number for the mass transfer Gm, Schmidt number Sc, and the Oscillatory Suction parameter 'n' increased, the concentration of the flow field was found to be unaltered at all points and therefore the thickness of the concentration boundary layer also remained unaltered.

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NOMENCLATURE

A	positive constant
D_M	mass diffusion coefficient
Gm	Grashoff number for the concentration
K	permeability parameter
k	permeability of the porous medium
M	magnetic parameter force coefficient in the y-direction
n	oscillatory suction parameter
Sc	Schmidt number
V_o	mean suction velocity
β_c	coefficient of volume expansion due to concentration
ρ	minimal quantity less than unity
μ	dynamic viscosity
υ	kinematic viscosity