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SCIENTIFIC PAPER

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IMPACT OF CHEMICAL REACTION, VISCOUS DISSIPATION, AND THERMAL RADIATION ON MHD FLOW PAST AN OSCILLATING PLATE

Article Highlights

- Velocity rises at the time of generative reaction and drops during destructive reaction
- The crank-Nicolson method was used to solve the dimensionless governing equations
- The flow pattern is affected significantly due to plate oscillation and radiation parameters
- The time it takes to reach a steady state relies heavily on the radiation parameter and phase angle

Abstract

This study analyzes the consequences of first-order chemical reactions, radiation, and viscous dissipation on the unsteady magnetohydrodynamic natural convective flow of a viscous incompressible fluid over a vertically positioned semi-boundless oscillating plate with uniform mass diffusion and temperature. An implicit finite-difference technique is employed to solve a set of dimensionless, coupled, nonlinear partial differential equations. The numerical results for fluid velocity, concentration, and temperature at the plate under different dimensionless parameters are graphically displayed. Due to first-order homogeneous chemical reactions, it has been discovered that the velocity rises at the time of a generative reaction and drops during a destructive reaction. A decline in velocity is observed with an increase in the phase angle, radiation parameter, and chemical reaction parameter. Further, it has been revealed that plate oscillation, radiation, chemical reactions, and the magnetic field significantly influence the flow behavior.

Keywords: MHD; oscillating; finite-difference; viscous dissipation; chemical reaction.

Heat and mass transfer through MHD flow are essential in many industrial applications, including nuclear reactor cooling, power generation systems, and aerodynamics. MHD finds applications in chemical synthesis, plasma jets, crystal growth, and electromagnetic pumps. The magnetic field impacts of ionized gases, electrolytes, and liquid metals must be analyzed to understand natural convection flow.

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The development of fins, gas turbines, nuclear power plants, and various propulsion systems for spacecraft, satellites, missiles, and aircraft all depend massively on understanding radiative heat and mass transfer. Several studies have been conducted on how magnetic fields affect heat and mass transfer in different scenarios. Sparrow and Cess [1] looked at how a magnetic field affects the movement of heat through free convection. Chamkha [2] develops a numerical solution that considers a magnetic field, absorption, and mass suction or blowing by investigating an unstable flow with heat and mass transfer on a vertical permeable plate in a fluid-saturated porous medium. Raptis [3] examined the effect of radiation on mass transfer and natural convective oscillatory flow in an optically thin viscous fluid. Hussanan *et al.* [4] analyzed the unstable natural convective flow over an oscillating plate subjected to Newtonian heating. Chemical reactions can be categorized as homogeneous or heterogeneous depending on the catalyst used. Homogeneous reactions involve two gases or two liquids, while heterogeneous reactions involve a liquid and a gas. A chemical reaction with a reaction rate proportional to the concentration of a single reactant is called a first-order reaction. Additionally, chemical reactions can significantly impact mass diffusion rates. Numerous research studies have investigated how chemical reactions affect fluid flow in diverse environments. Soundalgekar *et al.* [5] investigated the influence of a chemical reaction on the impetuous motion of an unending vertical plate on species concentrations. Muthucumaraswamy and Kulaivel [6] developed an analytical solution for fluid flow across a semi-endless vertical plate that starts suddenly, accounting for first-order homogeneous chemical reactions, mass diffusion, and heat flux.

Muthucumaraswamy [7] studied the effects of chemical reactions on fluid flow over a vertical plate oscillating with uniform mass diffusion at varying temperatures. On the other hand, Vijayalakshmi and Selvajayanthi [8] employed numerical methods to analyze the transient flow of fluid over a vertical plate that oscillates continuously. Ibrahim *et al.* [9] conducted a study to investigate the heat and mass transfer characteristics in a laminar flow of an electrically conducting, heat-generating/absorbing Newtonian fluid. This study also considered the impacts of radiation, mass flux, and a first-order homogeneous chemical reaction. The study conducted by Manivannan *et al.* [10] investigated the effects of radiation and first-order homogeneous chemical reactions on the unsteady flow of a viscous incompressible fluid through an isothermal vertical oscillating plate. Ahmed *et al.* [11] investigated the influence of magnetohydrodynamics, radiation, and first-order chemical reactions on the heat and mass transfer flow through an impulsively generated semi-endless vertical plate. Santhana Lakshmi and Muthucumaraswamy [12] examined the effects of chemical reactions on the unsteady flow of an isothermal vertical plate that accelerates exponentially, with variations in mass diffusion also considered. Hari Krishna *et al.* [13] studied the MHD fluid flow over an oscillating inclined porous plate, exploring the effects of radiation and chemical reactions and variations in temperature and mass diffusion. Srihari Babu and Jaya Rami Reddy [14] studied the unsteady magnetohydrodynamics of a fluid flowing past a porous plate subjected to radiation and chemical reactions. The plate accelerates vertically under the influence of a transverse magnetic field, while the temperature and mass diffusion vary due to the existence of a heat source or sink. Sweta Matta *et al.* [15] investigated how radiation and chemical reactions affected unsteady MHD natural convective fluid flow through a porous plate with mass transfer. Ibrahim Danjuma Yale *et al.* [16] investigated the effects of chemical reactions and thermal radiation on the unsteady MHD flow across a vertically accelerating plate.

The term' dissipation' refers to energy loss in fluid dynamics. In viscous fluid flows, the fluid's velocity extracts energy from its motion (kinetic energy) and converts it to its internal energy. It necessitates heating the fluid. It is known as ‘viscous dissipation,’ an irreversible process. Viscous dissipation in buoyancy-induced flows was explored by Mahajan and Gebhart [17]. Kishan and Amrutha [18] analyzed the nonlinear MHD steady flow of a viscous, incompressible, electrically conducting Boussinesq fluid across a vertically stretching surface subjected to viscous dissipation, chemical reactions with mass transfer, a uniform magnetic field, and thermal stratification. Rao and Shivaiah [19] investigated the effects of a chemical reaction and viscous dissipation on the unsteady magnetohydrodynamic flow over a semi-infinite, vertical porous plate. Rajakumar *et al.* [20] investigated the combined effects of radiation absorption, chemical reactions, and viscous dissipation on the unsteady MHD natural convective flow across a vertically moving semi-boundless porous plate. Satyabrat Kar *et al.* [21] explored the impact of viscous dissipation and chemical reactions on the magnetohydrodynamic flow of an incompressible, viscous fluid across a semi-infinite, vertically oriented porous plate that is submerged in a porous medium. They used the perturbation technique to determine the velocity, temperature, and concentration solutions. Reddy *et al.* [22] examined the effects of chemical reactions on the magnetohydrodynamic natural convective flow in a porous medium over an exponentially stretched surface subjected to a heat source and viscous dissipation. Kishore *et al.* [23] investigated the effect of hydromagnetic flow over an oscillating vertical plate contained in a porous medium while considering thermal radiation, surface conditions, viscous dissipation, and chemical reactions. The authors analyzed how these factors affected the flow and found that they significantly shaped the system's overall behavior.

Balla and Naikoti [24] investigated the unsteady MHD natural convective flow of an electrically conducting viscous, incompressible Newtonian fluid. Zigta [25] investigated a magnetohydrodynamic flow between limitless vertical Couette channel walls, considering the factors of thermal radiation, chemical reactions, and viscous dissipation. Prabhakar

Reddy [26] examined the impact of chemical reactions, viscous dissipation, and radiation on the unsteady MHD natural convective flow through a vertical porous plate with a parabolic starting motion. The Ritz finite element method was used to solve the governing equations numerically. Prasad *et al.* [27] studied the impact of various factors on fluid flow through a semi-boundless inclined permeable plate. Specifically, they looked at how chemical reactions and viscous dissipation impact the flow and the role of MHD, free convection, radiation, absorption, and heat generation.

However, so far, no specialists have proposed a quantitative investigation of the influence of chemical reactions on an unsteady MHD-free convective flow over a semi-limitless swaying upward plate with heat radiation and viscous dissipation. Therefore, the current study seeks to assess the effects of first-order chemical reactions on the unsteady MHD flow over an oscillating semi-infinite vertical plate while also considering thermal radiation and viscous dissipation. The finite difference method will be employed for the analysis.

MATHEMATICAL FORMULATION

Consider the unsteady magnetohydrodynamic natural convective flow of an electrically conducting, optically thin, radiating, heat-absorbing, viscous, incompressible fluid along a semi-boundless vertical plate oscillating at a uniform ambient temperature T'_∞ and concentration C'_∞. The vertical plate is taken as the $x-axis$, and the $y-axis$ is perpendicular to it, as shown in Figure 1. When the plate begins oscillating in its plane with the velocity $u_0 \cos\omega' t'$ at the time $t' > 0$, its temperature and concentration level are elevated to T'_w and C'_w respectively.

The following assumptions are made for deriving the governing flow equations:

The flow is unsteady, laminar, and two-dimensional. Rosseland approximation is commonly applied to approximate the radiant heat flux in the energy equation. Fluid is viscous, incompressible, and electrically conducting. Viscous dissipation is taken into account in the energy equation. The fluid has constant properties except the density in the body force. The Boussinesq approximation is commonly applied to handle the effects of density variations in the body force term while assuming an incompressible fluid. A uniform magnetic field of strength *B₀* is applied normally to the plate, and the magnetic Reynolds number of the flow is assumed to be small; the induced magnetic field can be neglected compared to the applied magnetic field. There is a first-order chemical reaction between the diffusing species and the fluid.

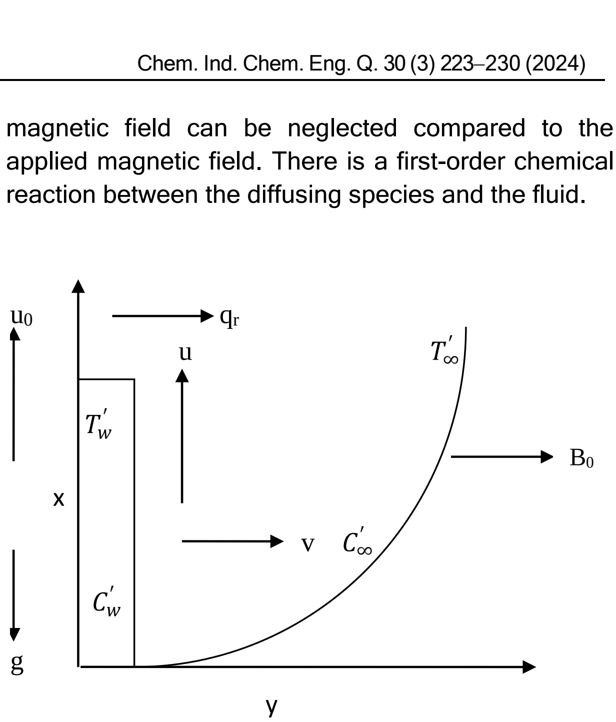

Figure 1. Physical model of the problem.

Equation of continuity:

$$u_x + u_y = 0 \tag{1}$$

Equation of momentum:

$$u_{t'} + uu_x + vu_y = g\beta\left(T' - T'_\infty\right) + g\beta^*\left(C' - C'_\infty\right) + \upsilon u_{yy} - \frac{\sigma B_0^2 u}{\rho} \tag{2}$$

Energy equation:

$$T'_{t'} + uT'_x + vT'_y = \frac{k}{\rho C_p}T'_{yy} - \frac{1}{\rho C_p}\left(q_r\right)_y + \frac{\upsilon}{\rho C_p}\left(u_y\right)^2 \tag{3}$$

Mass diffusion equation:

$$C'_{t'} + uC'_x + vC'_y = DC'_{yy} - K_1\left(C' - C'_\infty\right) \tag{4}$$

subject to

$$\left.\begin{array}{l} I.C: t' \le 0: u = 0, v = 0, T' = T'_\infty, C' = C'_\infty \\ B.C: t' > 0: u = u_0\cos\omega' t', v = 0, T' = T'_w, C' = C'_w \;\; at \;\; y = 0 \\ \qquad u = 0, T' = T'_\infty, C' = C'_\infty \quad at \;\; x = 0 \\ \qquad u \to 0, T' \to T'_\infty, C' \to C'_\infty \;\; as \;\; y \to \infty \end{array}\right\} \tag{5}$$

where u *and* v are velocity factors of a fluid in x *and* y direction respectively, t'-time, g-acceleration due to gravity, β^*-coefficient of volumetric concentration, β-volumetric coefficient of thermal expansion, B_0-magnetic field, k-thermal conductivity, K_1-chemical reaction parameter, υ-kinematic viscosity, ρ-density of the fluid, μ - viscosity coefficient, $\mathcal{C}_p$ -specific heat at constant pressure, $\mathcal{C}'$ - species concentration in the fluid, $\mathcal{T}'$ - temperature of the fluid near the plate, $\mathcal{C}'_\infty$ - concentration at the free stream, $\mathcal{T}'_\infty$ - temperature of the fluid at free stream, u_0 - velocity of the plate, $\omega' t'$ - phase angle, $\mathcal{C}'_w$ -plate concentration and $\mathcal{T}'_w$ - plate temperature.

The local radiant for a gray gas that is optically thin is expressed by

$$\left(q_r\right)_y = -4a^*\sigma\left(\mathcal{T}'^4_\infty - \mathcal{T}'^4\right) \tag{6}$$

where q_r - radiative heat flux, a^* - absorption constant, and σ - electrical conductivity.

Assuming no significant variations in temperature across the flow, Eq. (6) can be linearized by extending $\mathcal{T}'^4$ in a Taylor series about $\mathcal{T}'_\infty$ and discarding the higher-order terms, resulting in

$$\mathcal{T}'^4 \cong 4\mathcal{T}'^3_\infty \mathcal{T}' - 3\mathcal{T}'^4_\infty \tag{7}$$

Because of Eqs. (6) and (7), Eq. (3) modifies to

$$\begin{aligned}&\mathcal{T}'_{t'} + u\mathcal{T}'_x + v\mathcal{T}'_y = \frac{k}{\rho C_p}\left(\mathcal{T}'_{yy}\right) + \\ &\frac{16a^*\sigma\mathcal{T}'^3_\infty\left(\mathcal{T}'_\infty - \mathcal{T}'\right)}{\rho C_p} + \frac{\upsilon}{\rho C_p}\left(u_y\right)^2\end{aligned} \tag{8}$$

Consider the following dimensionless quantities:

$$\left.\begin{aligned}&X = \frac{xu_0}{\upsilon}, Y = \frac{yu_0}{\upsilon}, U = \frac{u}{u_0}, V = \frac{v}{u_0}, t = \frac{t'u_0^2}{\upsilon}, \omega = \frac{\omega'\upsilon}{u_0^2}, K = \frac{\upsilon K_1}{u_0^2},\\ &\mathcal{T} = \frac{\mathcal{T}' - \mathcal{T}'_\infty}{\mathcal{T}'_w - \mathcal{T}'_\infty}, \mathcal{C} = \frac{\mathcal{C}' - \mathcal{C}'_\infty}{\mathcal{C}'_w - \mathcal{C}'_\infty}, Gr = \frac{\upsilon g\beta\left(\mathcal{T}'_w - \mathcal{T}'_\infty\right)}{u_0^3}, Gc = \frac{\upsilon g\beta^*\left(\mathcal{C}'_w - \mathcal{C}'_\infty\right)}{u_0^3},\\ &\Pr = \frac{\upsilon}{\alpha}, Sc = \frac{\upsilon}{D}, Ec = \frac{u_0^2}{C_p\left(\mathcal{T}'_w - \mathcal{T}'_\infty\right)}, R = \frac{16a^*\upsilon^2\sigma\mathcal{T}'^3_\infty}{ku_0^2}, M = \frac{\sigma B_0^2\upsilon}{\rho u_0^2}\end{aligned}\right\} \tag{9}$$

where X is the dimensionless coordinate along the plate, Y is the dimensionless coordinate normal to the plate, U and V are dimensionless velocity components in the X and Y directions respectively, $\mathcal{T}$ is the dimensionless temperature, C is the dimensionless concentration, Gr and Gc are the respective thermal Grashof and mass Grashof numbers, Pr is the Prandtl number, Sc is the Schmidt number, Ec is the Eckert number, R is the radiation parameter, M is the magnetic parameter, α is the thermal diffusivity, t is the dimensionless time, ω is the frequency of oscillation, K is the dimensionless chemical reaction parameter, and D is the mass diffusion coefficient.

Given Eq. (9), the dimensionless form of Eqs. (1–4) are:

$$U_X + V_Y = 0 \tag{10}$$

$$U_t + UU_X + VU_Y = Gr\mathcal{T} + Gc\mathcal{C} + U_{YY} - MU \tag{11}$$

$$\mathcal{T}_t + U\mathcal{T}_X + V\mathcal{T}_Y = \frac{1}{\Pr}\left(\mathcal{T}_{YY}\right) - \frac{R\mathcal{T}}{\Pr} + Ec\left(U_Y\right)^2 \tag{12}$$

$$\mathcal{C}_t + U\mathcal{C}_X + V\mathcal{C}_Y = \frac{1}{Sc}\mathcal{C}_{YY} - K\mathcal{C} \tag{13}$$

subject to

$$\left.\begin{aligned}&t \le 0 : U = 0, V = 0, \mathcal{T} = 0, \mathcal{C} = 0\\ &t > 0 : U = \cos\omega t, V = 0, \mathcal{T} = 1, \mathcal{C} = 1 \; at \; Y = 0\\ &\qquad U = 0, \mathcal{T} = 0, \mathcal{C} = 0 \qquad at \; X = 0\\ &\qquad U \to 0, \mathcal{T} \to 0, \mathcal{C} \to 0, \; as \; Y \to \infty\end{aligned}\right\} \tag{14}$$

METHOD OF SOLUTION

The Crank-Nicolson methodology, an unequivocally stable implicit finite-difference strategy, solves the dimensionless governing Eqs. (10–13), subject to the dimensionless boundary condition Eq. (14) of the problem, and the corresponding finite-difference equations are:

$$\begin{aligned}&\frac{\left[U_{i,j}^{n+1} - U_{i-1,j}^{n+1} + U_{i,j}^{n} - U_{i-1,j}^{n} + U_{i,j-1}^{n+1} - U_{i-1,j-1}^{n+1} + U_{i,j-1}^{n} - U_{i-1,j-1}^{n}\right]}{4\Delta X}\\ &+\frac{\left[V_{i,j}^{n+1} - V_{i,j-1}^{n+1} + V_{i,j}^{n} - V_{i,j-1}^{n}\right]}{2\Delta Y} = 0\end{aligned} \tag{15}$$

$$\begin{aligned}&\frac{\left[U_{i,j}^{n+1} - U_{i,j}^{n}\right]}{\Delta t} + U_{i,j}^{n}\frac{\left[U_{i,j}^{n+1} - U_{i-1,j}^{n+1} + U_{i,j}^{n} - U_{i-1,j}^{n}\right]}{2\Delta X}\\ &+V_{i,j}^{n}\frac{\left[U_{i,j+1}^{n+1} - U_{i,j-1}^{n+1} + U_{i,j+1}^{n} - U_{i,j-1}^{n}\right]}{4\Delta Y}\\ &= \frac{Gr}{2}\left[\mathcal{T}_{i,j}^{n+1} + \mathcal{T}_{i,j}^{n}\right] + \frac{Gc}{2}\left[\mathcal{C}_{i,j}^{n+1} + \mathcal{C}_{i,j}^{n}\right] -\\ &\frac{M}{2}\left[U_{i,j}^{n+1} + U_{i,j}^{n}\right] +\\ &\frac{\left[U_{i,j-1}^{n+1} - 2U_{i,j}^{n+1} + U_{i,j+1}^{n+1} + U_{i,j-1}^{n} - 2U_{i,j}^{n} + U_{i,j+1}^{n}\right]}{2\left(\Delta Y\right)^2}\end{aligned} \tag{16}$$

$$\begin{aligned}&\frac{\left[\mathcal{T}_{i,j}^{n+1} - \mathcal{T}_{i,j}^{n}\right]}{\Delta t} + U_{i,j}^{n}\frac{\left[\mathcal{T}_{i,j}^{n+1} - \mathcal{T}_{i-1,j}^{n+1} + \mathcal{T}_{i,j}^{n} - \mathcal{T}_{i-1,j}^{n}\right]}{2\Delta X} +\\ &V_{i,j}^{n}\frac{\left[\mathcal{T}_{i,j+1}^{n+1} - \mathcal{T}_{i,j-1}^{n+1} + \mathcal{T}_{i,j+1}^{n} - \mathcal{T}_{i,j-1}^{n}\right]}{4\Delta Y}\\ &= \frac{1}{\Pr}\frac{\left[\mathcal{T}_{i,j-1}^{n+1} - 2\mathcal{T}_{i,j}^{n+1} + \mathcal{T}_{i,j+1}^{n+1} + \mathcal{T}_{i,j-1}^{n} - 2\mathcal{T}_{i,j}^{n} + \mathcal{T}_{i,j+1}^{n}\right]}{2\left(\Delta Y\right)^2} -\\ &\frac{R}{2\Pr}\left[\mathcal{T}_{i,j}^{n+1} + \mathcal{T}_{i,j}^{n}\right] + Ec\left[\frac{U_{i,j+1}^{n} - U_{i,j}^{n}}{\Delta Y}\right]^2\end{aligned} \tag{17}$$

$$\frac{\left[C_{i,j}^{n+1}-C_{i,j}^{n}\right]}{\Delta t}+U_{i,j}^{n}\frac{\left[C_{i,j}^{n+1}-C_{i-1,j}^{n+1}+C_{i,j}^{n}-C_{i-1,j}^{n}\right]}{2\Delta X}+V_{i,j}^{n}\frac{\left[C_{i,j+1}^{n+1}-C_{i,j-1}^{n+1}+C_{i,j+1}^{n}-C_{i,j-1}^{n}\right]}{4\Delta Y}=\frac{1}{Sc}\frac{\left[C_{i,j-1}^{n+1}-2C_{i,j}^{n+1}+C_{i,j+1}^{n+1}+C_{i,j-1}^{n}-2C_{i,j}^{n}+C_{i,j+1}^{n}\right]}{2\left(\Delta Y\right)^{2}}-\frac{K}{2}\left[C_{i,j}^{n+1}+C_{i,j}^{n}\right] \tag{18}$$

Here, i and j denotes the x and y coordinates of the grid point and n is the time variable. A rectangular mesh with sides $X_{\max}=1$ *and* $Y_{\max}=10$ is assumed. The mesh sizes are fixed as $\Delta X=0.05$, $\Delta Y=0.125$, and $\Delta t=0.01$ as time step.

RESULTS AND DISCUSSION

The graphical representation of the impact of velocity, concentration, temperature, skin friction, Nusselt number, and Sherwood number on various physical parameters is illustrated in this section through numerical results. The default physical parameters used in this analysis are phase angle *ωt=π/6*, thermal Grashof number *Gr=5*, mass Grashof number *Gc=5*, radiation parameter *R=2* (strong thermal radiation), magnetic parameter *M=2*, Eckert number *Ec=0.5*, chemical reaction parameter *Ec=0.2*, Prandtl number *Pr=0.71* (air), and Schmidt number *Sc=0.6* (water vapor).

Figure 2 depicts the velocity patterns obtained for various phase angle values. From the graph, it is evident that as the phase angle rises, the velocity drops. This observation illustrates that increased oscillation levels lead to reduced velocity.

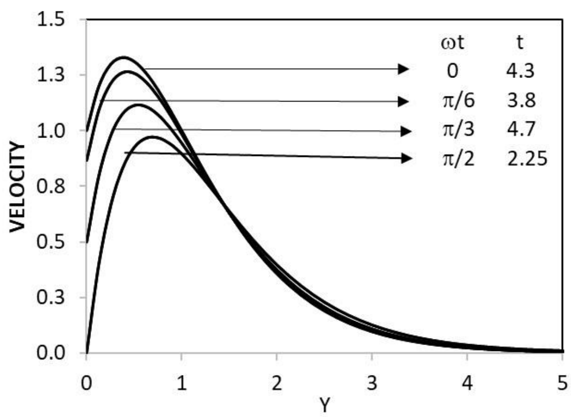

Figure 2. Velocity profiles for different values of ωt.

The impact of the radiation parameter R on velocity is represented in Figure 3. The research findings indicate that the flow velocity tends to decrease with an increase in the radiation parameter. It suggests that a higher presence of heat radiation leads to a reduction in velocity.

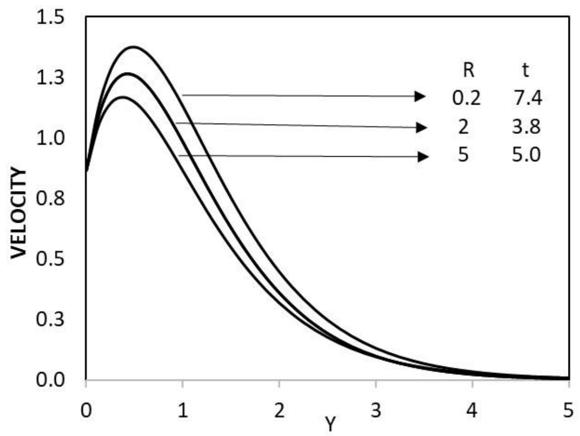

Figure 3. Velocity profiles for different values of R.

The graphical representation in Figure 4 displays the correlation between the chemical reaction parameter K and the velocity field. The investigations have revealed that an increase in the chemical reaction parameter results in a decrease in velocity. This observation highlights that velocity rises during generative reactions while falling during destructive reactions.

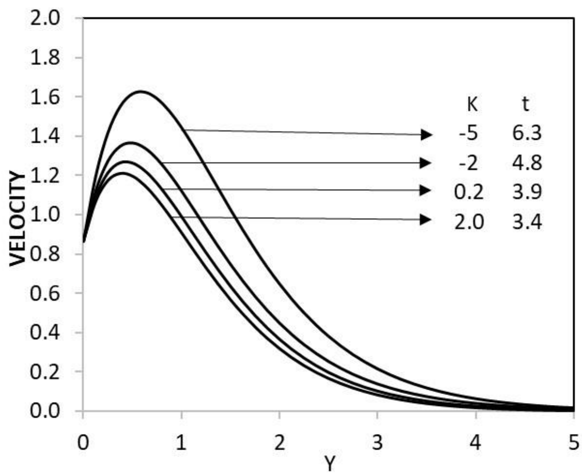

Figure 4. Velocity profiles for different values of K.

Figure 5 illustrates how various chemical reaction parameter K values influence the dimensionless concentration profile. The research findings indicate that an increase in the chemical reaction parameter results in a reduction in concentration. Specifically, the wall concentration rises during generative reactions and falls during destructive reactions.

The concentration profile for various values of the Schmidt number Sc is shown in Figure 6. The graph clearly illustrates that when the Schmidt number increases, the plate concentration decreases significantly. This observation holds in the physical context, as a higher value of *Sc* greatly hampers molecular diffusivity.

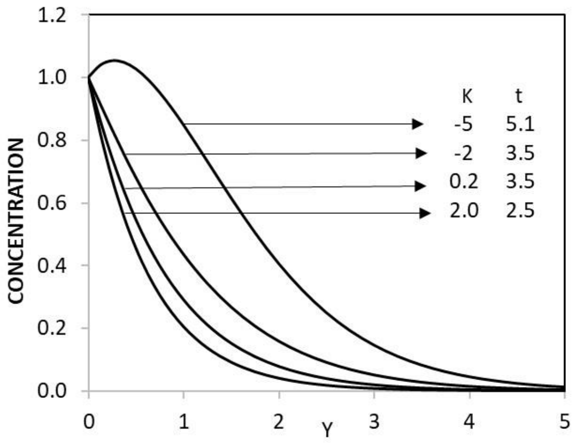

Figure 5. Concentration profiles for different values of K.

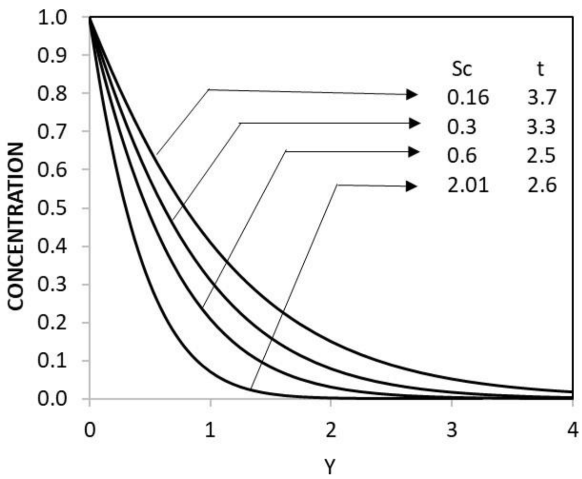

Figure 6. Concentration profiles for different values of Sc.

The influence of the thermal radiation parameter *R* on the dimensionless fluid temperature is illustrated in Figure 7. The results demonstrate that as the radiation parameter increases, the velocity and temperature of the boundary layer decrease.

Figure 8 depicts the effect of the Eckert number Ec on dimensionless fluid temperature. The research has revealed that increasing the dissipation parameter leads to an elevation in temperature. Viscous dissipation affects flow fields by raising energy levels, resulting in higher fluid temperatures and increased buoyancy forces.

CONCLUSION

A numerical study explored the impact of chemical reactions, thermal radiation, and viscous dissipation on an unsteady MHD flow over an

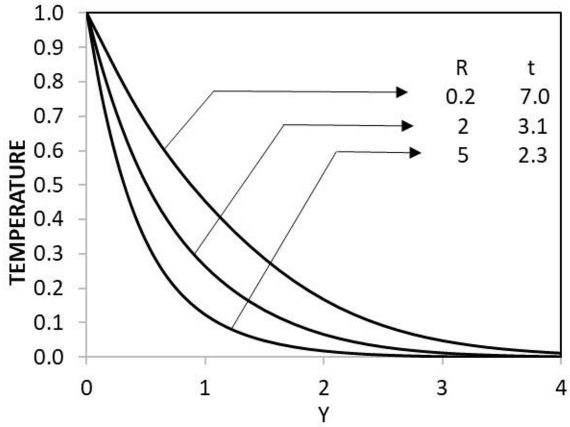

Figure 7. Temperature profiles for different values of R.

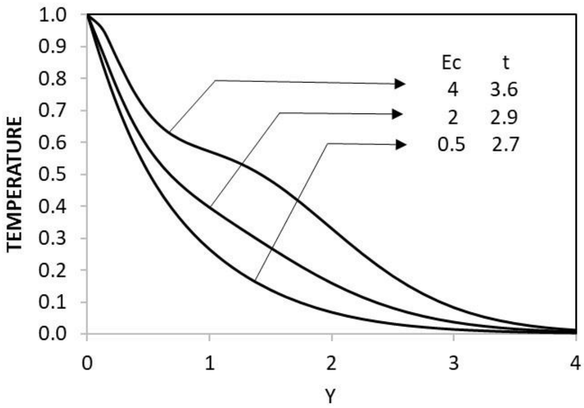

Figure 8. Temperature profiles for different values of Ec.

oscillating semi-boundless vertical plate with constant surface temperature and mass diffusion. An implicit finite-difference method was utilized to solve the governing flow equations. The impact of various parameters on the fluid velocity, concentration, and temperature are demonstrated graphically. The current investigation reveals the following major findings:

Velocity drops when the phase angle, radiation, and chemical parameters increase. When the Eckert number rises, the velocity and temperature profiles also rise. The temperature drops as the radiation parameter rises. A drop in concentration was seen with an increase in the chemical reaction parameter and the Schmidt number.

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NAUČNI RAD

UTICAJ HEMIJSKE REAKCIJE, VISKOZNE DISIPACIJE I TOPLOTNOG ZRAČENJA NA MAGNETOHIDRODINAMIČKI PROTOK PREKO OSCILIRAJUĆE PLOČE

Ova studija analizira posledice hemijskih reakcija prvog reda, zračenja i viskozne disipacije na nestacionarni magnetohidrodinamički prirodni konvektivni tok viskoznog nestišljivog fluida preko vertikalne polubeskonačne oscilirajuće ploče sa ujednačenom masenom difuzijom i temperaturom. Implicitna tehnika konačnih razlika se koristi za rešavanje skupa bezdimenzionalnih, spregnutih, nelinearnih parcijalnih diferencijalnih jednačina. Numerički rezultati za brzinu tečnosti, koncentraciju i temperaturu na ploči pod različitim bezdimenzionalnim parametrima su grafički prikazani. Zbog homogenih hemijskih reakcija prvog reda, otkriveno je da brzina raste u vreme generativne reakcije, a pada tokom destruktivne reakcije. Pad brzine se primećuje sa povećanjem faznog ugla, parametra zračenja i parametra hemijske reakcije. Dalje, otkriveno je da oscilacije ploče, zračenje, hemijske reakcije i magnetno polje značajno utiču na ponašanje protoka.

Ključne reči: MHD; oscilirajuća ploča; konačna razlika; viskozna disipacija; hemijska reakcija.