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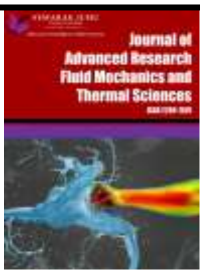

Synchronous Heat and Mass Transmission in MHD Ohmic Dissipative Viscous Fluid Flow Cavorted by an Upright Surface with Chemical Reaction

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ABSTRACT

The present inquiry looks at the movement of a free-convective, viscous MHD transpire as well as the conveyance of an upright plate with mass and heat. The consequences of radiation, chemical reactions, viscous dissipation, and ohmic heating are additionally considered. Transversely, in the potential flow direction, a constant magnetic field is introduced. To overlook the instigated magnetic field with respect to the generated one, a very tiny magnetic Reynolds number is taken into consideration. The coupled differential equations have been solved using MATLAB's built-in solver, bvp4c, which is a numerical method. The numerical repercussions for several values of relevant parameters on flow, heat, and the transfer of mass are laid out graphically. Furthermore, table-based information is maintained for the numerical projections of skin friction, couple stress at the wall's surface, Nusselt amount, and Sherwood value. Numerous industrial and chemical processes have demonstrated the applicability of this paradigm.

1. Introduction

Analysis of the combination of heat and mass transmission is extremely important in many fields of research and technology. The underlying perspective is increasingly intricate when there is a concomitant exchange of heat and mass within the flow rates. The aforementioned study has numerous potential applications in engineering, including groundwater hydrology, chemical waste recycling, and petrochemical reservoirs. An analytical investigation of the issue of heat and mass exchange challenges facing an opaque flow is conducted by Ene *et al.,* [1] and uncovered that the phenomenon of mass exchange issue has two comparable predictive approaches.

Studying the mass and heat transmission of MHD on a semi-infinite flow flat surface containing radiation has been conducted by Dharmaiah *et al.,* [2]. Salahuddin *et al.,* [3] conducted an analysis of the transfer of energy and mass in micropolar fluid movement close to an object's inertia zones and discovered that, depending on the location, flow division might happen quickly or gradually. After examining the distinctive features of mass and heat exchange in MHD Casson flows across a cylinder,

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Majeed *et al.,* [4] came to the conclusion that the drag and lift parameters exhibit an apparent decrease with the magnetic variable. Sharada's [5] analysis of the consequences of the conveyance of heat and mass on MHD combined convection circulation of resilient flow with uniform viscosity and heat conductivity demonstrated that thermal energy is the source of the energy transfer mechanism. Previous manuscripts also highlight some other significant studies on the transfer of mass and heat with a variety of discernible characteristics [6-9]. Viscous dissipation is the term used to describe the heat produced by the viscous effects of physical fluid-particle collisions. By enabling the fact that the collision of particles in a fluid affects both temperature and flow rate, viscous dissipation is a crucial characteristic throughout lubrication adversity. The impact of the dissipation of viscosity in the process of natural convection was initially studied by Gebhart [10]. He came to the conclusion that the dissipation of viscosity can't be ignored in the inherent dispersion motion of a fluid with a large Prandtl number or as a motion subject to strong gravitational pull. Exploration of the impact of fluid dissipation was later conducted because of its uses in factories and in scientific and technical fields. Added applications include mineral energy, plasma physics, gas evaporation, nuclear power plant cooling, steam turbine thawing, crude oil fields, biomass burning, electronic device ventilation, and numerous other fields where heat transfer and viscosity are temperature-dependent. Some related works in this regard can be found in previous studies [11-14].

One important component of the heat transfer process is thermal radiation. Plenty of industrial and technological endeavors, including the extraction of gas, spacecraft, solar panel systems, power generation in renewable energy, and planetary processes, have the ability to use the influence of thermal radiation. Sahoo and Nandkeolyar [15] developed a remarkable mathematical paradigm for investigating dissipative energy transfer and entropy formation in the coupled asymmetrical hydromagnetic motion of a Casson nanofluid containing radiant heat. A power-law stretched impervious surface was the subject of an investigation by Haldar *et al.,* [16] to determine how thermal radiation affected Eyring-Powell fluid motion and heat transition. They discovered that as the coefficient of radiation increased, the temperature differential diminished. In their study, Hassan and Fenuga [17] examined how heating radiation affected the circulation of a recurrent hydromagnetic heat-generating pair tension fluid via a perforated conduit. In their investigation of the effects of radiation on MHD heat displacement through stochastic adiabatic nanofluid motion over an erratically begun upright plate, Kumar *et al.,* [18] discovered that increasing the quantity of the radiation coefficient improved the flow rate and temperature distributions. According to M. Prameela's *et al.,* [19] study on the effect of radiant heat on MHD flow patterns on a sphere, trajectory profiles deteriorate as the field's magnetic and infrared exposure characteristics converge. According to Idowu and Sani [20], as the thermal exposure component grows, the fluid's temperature rises and its viscosity decreases, whereas the fluid's concentration decreases as the chemical reactive attribute elevates. More recent research that takes into account the influence of heat radiation may be accessible through the writings of different writers [21-25]. Another name for joule heating is ohmic heating. It's a process where heat is produced when a power source flows across a wire. It pertains to a process wherein radiation is produced when a flow of electricity passes through a conducting material. Many manufacturing and technical operations, including those using electric cooking appliances, electric radiators, luminous fluorescent bulbs, thermistor devices, food-processing equipment, and numerous others, employ ohmic heating. Goud and Nandeppanavar [26] examined how chemical reactions and ohmic radiation combine to affect MHD micropolar fluid motion over a stretched interface. Apart from them, Iranian *et al.,* [27] and Karthik *et al.,* [28] contribute their thoughts towards these kinds of research. Also, similar kinds of research have been done by Khan *et al.,* [29] and Parvin *et al.,* [30].

The main goal of this study is to make models that show how radiated mass and heat, along with ohmic heating and chemical interactions in different situations, affect the motion of an MHD viscous fluid. Boundary-level estimations and imperceptible alterations are used to increase the efficiency of the proposed framework. MATLAB's bvp4c quantitative algorithm is then utilised to solve the fundamentally governed nonlinear set of equations. Its distinctiveness lies in the fact that it finds widespread use in thermal processes, aerospace technology, and associated equipment design. The chemical reaction has attracted a lot of attention as a mass transmission flow and collective heat issue in recent decades due to its central position in many chemical production procedures. A few examples of these models include haze generation and propagation, crop damage from thawing, food processing, refrigerated facilities, temperature mimicking, and moisture circulation. The issue of prejudice has applications in manufacturing, as well as food processing, cooling and refrigeration medical equipment, and electrical appliances. From the information we understand, the problem is new and has not yet been the subject of any investigations in the available literature.

2. Mathematical Formulation

The free-convective persistent flow of an unyielding, viscous, electrically preside-over fluid is taken into consideration. As shown in Figure 1, the permeable plate is being tracked along by the $\overline{\mathrm{X}}$-axis in an upward direction, while the $\overline{\mathrm{Y}}$-axis is perpendicular to it. In the $\overline{\mathrm{Y}}$-axis course, an oblique magnetic field is put in place. In the $\overline{\mathrm{Y}}$-axis direction, an oblique magnetic field is put in place. Let $\overline{\mathrm{U}}$ and $\overline{\mathrm{V}}$ be the facets of velocity along $\overline{\mathrm{X}}$ and $\overline{\mathrm{Y}}$ axes apart.

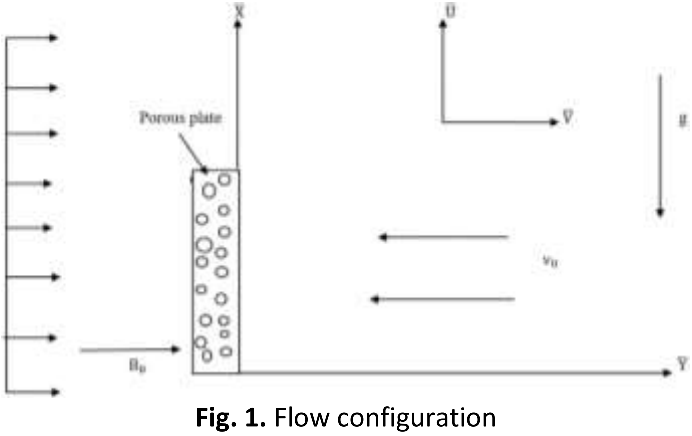

Fig. 1. Flow configuration

Governing equations are as follows

$$\frac{\partial \overline{\mathrm{V}}}{\partial \overline{\mathrm{Y}}} = 0 \Rightarrow \overline{\mathrm{V}} = -\mathrm{V}_0 (\mathrm{V}_0 > 0) \tag{1}$$

$$\overline{\mathrm{V}} \frac{\partial \overline{\mathrm{U}}}{\partial \overline{\mathrm{Y}}} = \nu \frac{\partial^2 \overline{\mathrm{U}}}{\partial \overline{\mathrm{Y}}^2} + \mathrm{g}\beta(\overline{\mathrm{T}} - \mathrm{T}_\infty) + \mathrm{g}\beta^*(\overline{\mathrm{C}} - \mathrm{C}_\infty) - \frac{\sigma \mathrm{B}_0^2}{\rho} \overline{\mathrm{U}} \tag{2}$$

$$\overline{\mathrm{V}} \frac{\partial \overline{\mathrm{T}}}{\partial \overline{\mathrm{Y}}} = \frac{\kappa}{\rho \mathrm{C_p}} \frac{\partial^2 \overline{\mathrm{T}}}{\partial \overline{\mathrm{Y}}^2} + \frac{\nu}{\mathrm{C_p}} \left(\frac{\partial \overline{\mathrm{U}}}{\partial \overline{\mathrm{Y}}}\right)^2 + \left(\frac{\sigma \mathrm{B}_0^2}{\rho \mathrm{C_p}}\right) \overline{\mathrm{U}}^2 - \frac{1}{\rho \mathrm{C_P}} \frac{\partial \overline{\mathrm{q}}_\mathrm{r}}{\partial \overline{\mathrm{Y}}} \tag{3}$$

$$\overline{\mathrm{V}} \frac{\partial \overline{\mathrm{C}}}{\partial \overline{\mathrm{Y}}} = \mathrm{D} \left(\frac{\partial^2 \overline{\mathrm{C}}}{\partial \overline{\mathrm{Y}}^2}\right) + \mathrm{D}_1 \left(\frac{\partial^2 \overline{\mathrm{T}}}{\partial \overline{\mathrm{Y}}^2}\right) - \mathrm{k_r}(\overline{\mathrm{C}} - \overline{\mathrm{C}}_\infty) \tag{4}$$

where, $\overline{\mathrm{U}}$ and $\overline{\mathrm{V}}$ are the components of velocity along and normal to the plate, ν is kinematic viscosity, g is the gravitational acceleration, β is degree of thermal growth, $\overline{\mathrm{T}}$ is fluid temperature, T_∞ temperature far away from the plate, T_W temperature near the plate, β^* degree of mass augmentation, $\overline{\mathrm{C}}$ Species concentration of the fluid, C_∞ species concentration distant against the plate, C_W species concentration near the plate, σ magnetic permeability of the fluid, ρ density of fluid, κ is thermal conductivity, C_p is precise heat under perpetual pressure, $\overline{\mathrm{q}}_\mathrm{r}$ is heat flux per unit area, B_0 is magnetic field degree, D is molecular diffusivity, D_1 is degree of thermal diffusivity, k_r is chemical reaction factor.

The specifications near the boundary consist of

$$\left.\begin{array}{l}\overline{\mathrm{Y}} = 0 : \ \overline{\mathrm{U}} = 0, \overline{\mathrm{T}} = \mathrm{T}_\mathrm{W}, \overline{\mathrm{C}} = \mathrm{C}_\mathrm{W} \\ \overline{\mathrm{Y}} \to 0 : \ \overline{\mathrm{U}} \to 0, \overline{\mathrm{T}} \to \mathrm{T}_\infty, \overline{\mathrm{C}} \to \mathrm{C}_\infty\end{array}\right\} \tag{5}$$

While confronted with a thin-looking gray gas, the local radiant is represented by

$$\frac{\partial \overline{\mathrm{q}}_\mathrm{r}}{\partial \overline{\mathrm{Y}}} = -4\mathrm{a}^*\sigma(\mathrm{T}_\infty^4 - \overline{\mathrm{T}}^4) \tag{6}$$

Taking into account the very minor thermal differential inside the stream, $\overline{\mathrm{T}}^4$ may be outlined as the temperature's linear relationship. This is adept by dilate $\overline{\mathrm{T}}^4$ in a Taylors concatenation about T_∞ and overlooking higher- order specifications. Thus

$$\overline{\mathrm{T}}^4 \cong 4\mathrm{T}_\infty^3\overline{\mathrm{T}} - 3\mathrm{T}_\infty^4 \tag{7}$$

Employing Eq. (6) and Eq. (7), it is seen that Eq. (3) reduces to

$$\overline{\mathrm{V}}\frac{\partial \overline{\mathrm{T}}}{\partial \overline{\mathrm{Y}}} = \frac{\kappa}{\rho \mathrm{C}_\mathrm{p}}\frac{\partial^2 \overline{\mathrm{T}}}{\partial \overline{\mathrm{Y}}^2} + \frac{\nu}{\mathrm{C}_\mathrm{p}}\left(\frac{\partial \overline{\mathrm{U}}}{\partial \overline{\mathrm{Y}}}\right)^2 + \left(\frac{\sigma \mathrm{B}_0^2}{\rho \mathrm{C}_\mathrm{p}}\right)\overline{\mathrm{U}}^2 + \frac{1}{\rho \mathrm{C}_\mathrm{P}}\{16\mathrm{a}^*\sigma \mathrm{T}_\infty^3(\mathrm{T}_\infty - \overline{\mathrm{T}})\} \tag{8}$$

Non dimensional parameters are introduced as follows [9]:

$$\begin{gathered}\mathrm{y} = \frac{\overline{\mathrm{Y}}\mathrm{V}_0}{\nu}, \mathrm{u} = \frac{\overline{\mathrm{U}}}{\mathrm{v}_0}, \mathrm{Pr} = \frac{\nu\rho \mathrm{C}_\mathrm{p}}{\kappa}, \theta = \frac{\overline{\mathrm{T}} - \mathrm{T}_\infty}{\mathrm{T}_\mathrm{W} - \mathrm{T}_\infty}, \phi = \frac{\overline{\mathrm{C}} - \mathrm{C}_\infty}{\mathrm{C}_\mathrm{W} - \mathrm{C}_\infty}, \mathrm{Gr} = \frac{\nu\beta \mathrm{g}(\mathrm{T}_\mathrm{W} - \mathrm{T}_\infty)}{\mathrm{V}_0^3}, \\ \mathrm{Gm} = \frac{\nu\beta^* \mathrm{g}(\mathrm{C}_\mathrm{W} - \mathrm{C}_\infty)}{\mathrm{V}_0^3}, \mathrm{E} = \frac{\mathrm{V}_0^2}{\mathrm{C}_\mathrm{p}(\mathrm{T}_\mathrm{W} - \mathrm{T}_\infty)}, \mathrm{M} = \frac{\sigma\nu \mathrm{B}_0^2}{\mathrm{V}_0^2\rho}, \nu = \frac{\mu}{\rho}, \mathrm{Sc} = \frac{\nu}{\mathrm{D}}, \mathrm{So} = \frac{\mathrm{D}_1(\mathrm{T}_\mathrm{W} - \mathrm{T}_\infty)}{\nu(\mathrm{C}_\mathrm{W} - \mathrm{C}_\infty)}, \\ \mathrm{K} = \frac{\nu \mathrm{k}_\mathrm{r}}{\mathrm{v}_0^2}, \mathrm{R} = \frac{16\mathrm{a}^*\nu^2\sigma \mathrm{T}_\infty^3}{\kappa \mathrm{V}_0^2}\end{gathered} \tag{9}$$

Pr is Prandtl number, θ dimensionless temperature, ϕ is dimensionless concentration, Gr is Grashof number for heat transport, Gm is Grashof number for mass transmission, E is Eckert number, M is magnetic characteristic, Sc is Schmidt number, So is Soret amount, K is chemical reaction specifications, R is radiation limitation.

Using Eq. (9), Eq. (2), Eq. (8) and Eq. (4) in dimensionless form are as follows

$$\frac{\mathrm{d}^2\mathrm{u}}{\mathrm{dy}^2} + \frac{\mathrm{du}}{\mathrm{dy}} - \mathrm{Mu} = -\mathrm{Gr}\theta - \mathrm{Gm}\phi \tag{10}$$

$$\frac{d^2\theta}{dy^2}+\Pr\frac{d\theta}{dy}+\Pr E\left(\frac{du}{dy}\right)^2+\Pr EMu^2-R\theta=0 \tag{11}$$

$$\frac{d^2\phi}{dy^2}+Sc\left(\frac{d\phi}{dy}\right)+ScSo\left(\frac{d^2\theta}{dy^2}\right)-KSc\phi=0 \tag{12}$$

Modified boundary condition

$\text{At}\, y=0:u=0,\theta=1,\phi=1$

$$y=0:u=0,\theta\rightarrow 0,\phi=0 \tag{13}$$

3. Method of Solutions

Various software, including Mathematica, MATLAB, Maple, and others, is available for solving numerical problems involving differential equations. The bvp4c integrated problem solver in MATLAB was utilised in this investigation. MATLAB is software for highly efficient visualization. The word matrix laboratory is the acronym for MATLAB. The functions that are built-in in MATLAB provide great tools for working with statistical analysis, exponential equations, linear programming, data processing, transmission of signals, and the numerical formulation of ordinary equations involving differentials. The bvp4c solver method in MATLAB employs the finite difference approach. The MATLAB built-in solver bvp4c approach was utilised to tackle the current problem. Three essential components of information are imperative for this solver to function: the mathematical formula that needs to be solved, the input for the problem's boundary constraints, and an initial estimation of the answer.

The bvp4c methodology was originally presented by Shampine *et al.,* [31]. Eq. (10) to Eq. (12) along with the boundary condition (13) are converted into the differential equation of first order in the current investigation by employing the MATLAB built in solver bvp4c, as indicated below:

Let, $u=y(1),\frac{du}{dy}=y(2),\theta=y(3),\frac{d\theta}{dy}=y(4),\phi=y(5),\frac{d\phi}{dy}=y(6)$ gives

dy/dx =[y(2)-y(2)+M*y(1)-Gr*y(3)-Gm*y(5)

y(4)
-Pr*y(4)-Pr*E*y(2)*y(2)-Pr*E*M* y(1)* y(1)+R*y(3)

y(6)
-Sc*y(6)-Sc*Sc*[-Pr*y(4)-Pr*E*y(2))*y(2)-Pr*E*M* y(1)* y(1)+R*y(3)]+Kr*Sc*y(5)

4. Results and Discussions

Using various estimations of appropriate non-dimensional flow parameters, precise estimates of temperature, concentration, and velocity were all calculated to facilitate the physical relevance of the situation. Initially, compile a list of arbitrary qualities and their values. These include Grashof number for heat transport (Gr=5), Prandtl number (Pr=6.9), Schmidt number (Sc=4), Magnetic parameter(M=1), Soret number (So=2), Grashof amount for mass transmission (Gm=5), Radiation parameter(R=1), Chemical reaction factor(K=1), Eckert number(E=0.01) unless otherwise stated. Figure 2 to Figure 6 display the velocity contours that are integrated with different fluid parameters.

Figure 2 displays the velocity waveform for different variations of M. The figure reveals how increasing the magnetic strength M reduces the flow pace. The intense magnetism that forms amid the fluid's regular motion causes impedance amongst the particles, which lowers the rate at which the fluid moves. Thus, extreme attrition or resistance stops fluid movement by acting as a drag or a form of "enticing firmness" for a transferable flow. Due to the diminution of velocity, the fluid's total stream of flow turns into hostile. In order to characterize the amount of thermal dissipation to mass dispersion, a dimensionless quantity So is used in heat and mass transport called Soret number.

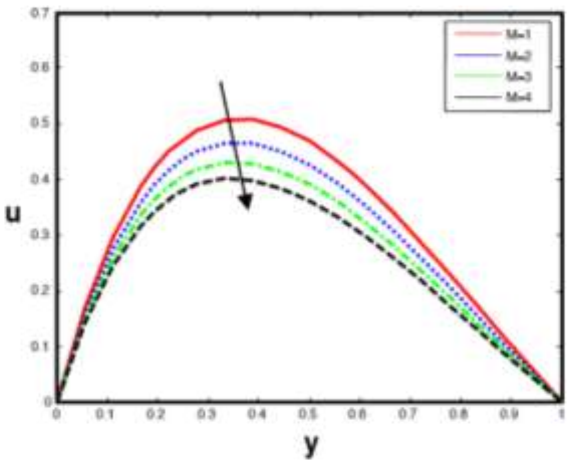

Fig. 2. Velocity pattern for diverse values of M

As can be seen in Figure 3, an increase in So causes fluctuations in denseness, which subsequently in turn affects the velocity of the fluid configuration through the influence of buoyancy in the process of convection. It is essential to consider the chemical reaction property and associated heating factors when seeking to understand how changes in adaptation attributes affect the flow rate. Chemical reactions parameter K may cause the viscosity of a fluid to increase.

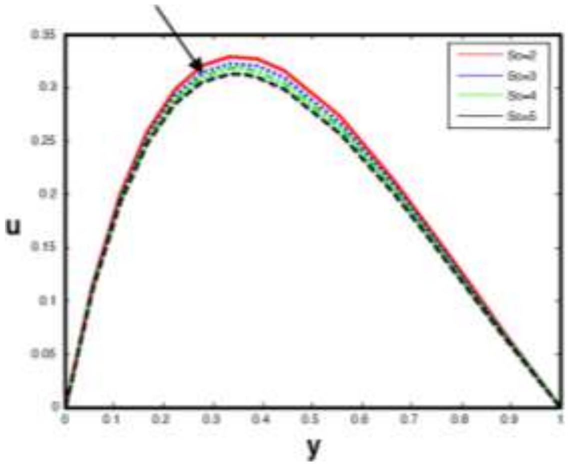

Fig. 3. Velocity pattern for diverse values of So

Figure 4 shows how its viscosity increases and causes a reduction in the velocity of the fluid, making the fluid harder to flow across.

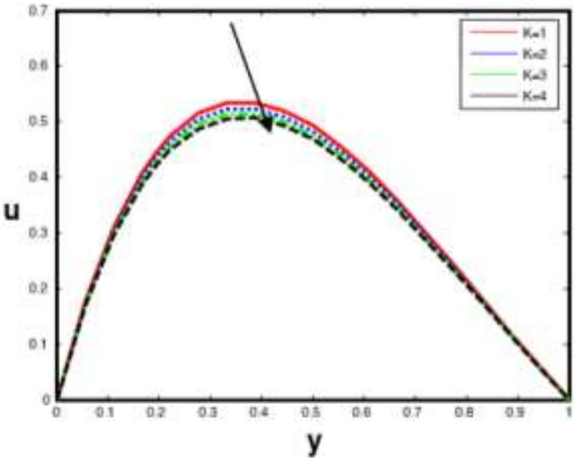

Fig. 4. Velocity pattern for diverse values of K

However, Figure 5 illustrates the most salient feature of the velocity representation when Gr is elevated. Initially, the fluid's motion was regulated by viscous coercion, but when the Grashof value increases, buoyancy effects take over. Increases in the Schmidt number Sc indicates the fact that momentum diffusivity, or viscosity, is comparatively larger than the diffusivity of mass. Because of this, the fluid's momentum tends to disperse more readily than the material it is carrying, thus resulting in a drop in the flow rate as seen in Figure 6.

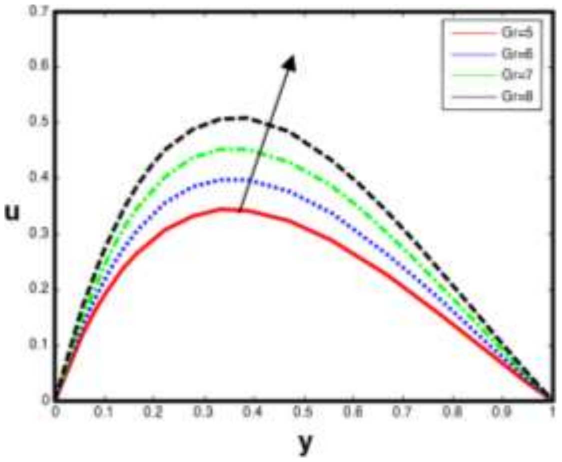

Fig. 5. Velocity pattern for diverse values of Gr

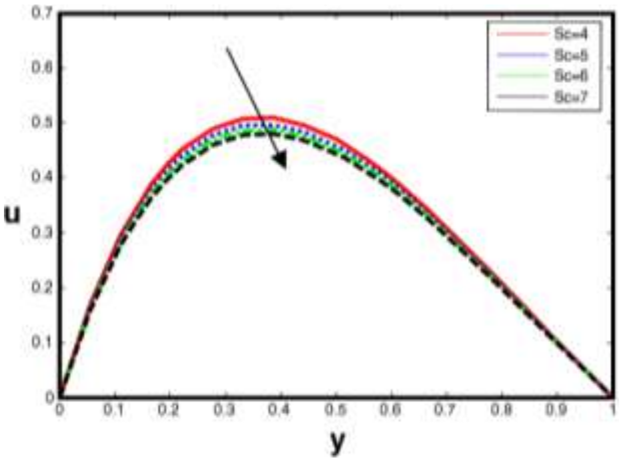

Fig. 6. Velocity pattern for diverse values of Sc

Figure 7 to Figure 9 depict a number of temperature eventualities appropriate for different fluid characteristics. The unrestricted Prandtl number characterizes the relationship between a fluid's viscosity during the movement and its thermal transmission efficacy. It shows how much the contraction of momentum and the diversification of heat differ while a fluid is moving. A greater Prandtl number indicates that heat diffusion is more important than momentum inflation, this is seen in Figure 7 because heat diffuses more quickly than momentum. R makes radiation-induced heat transport more significant. Efficiency in convective heat transmission increases with increasing Eckert number E. The increased mobility of the fluid allows it to transport greater amounts of thermal energy, which raises the temperature of the fluid, shown in Figure 8.

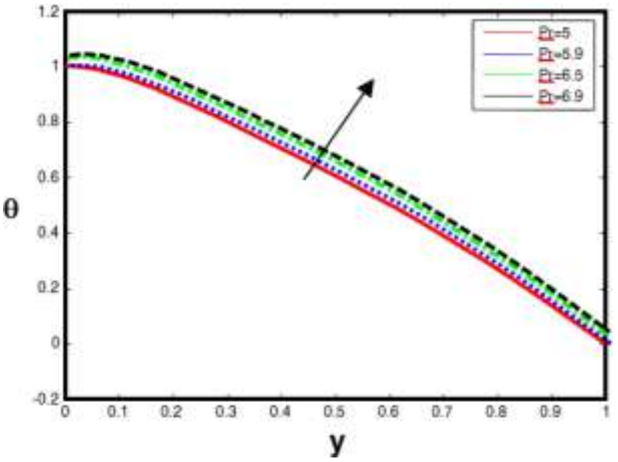

Fig. 7. Temperature illustration for diverse values of Pr

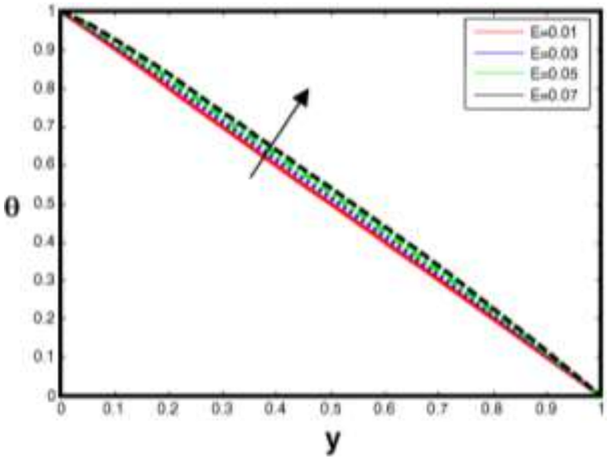

Fig. 8. Temperature illustration for diverse values of E

One aspect of radiation transfer's effect is the movement of heat caused by ionizing heat waves. As radiation index R gets increasingly prevalent in all aspects of the heat transmission procedure, the thermal disparity may decrease, as Figure 9 illustrates.

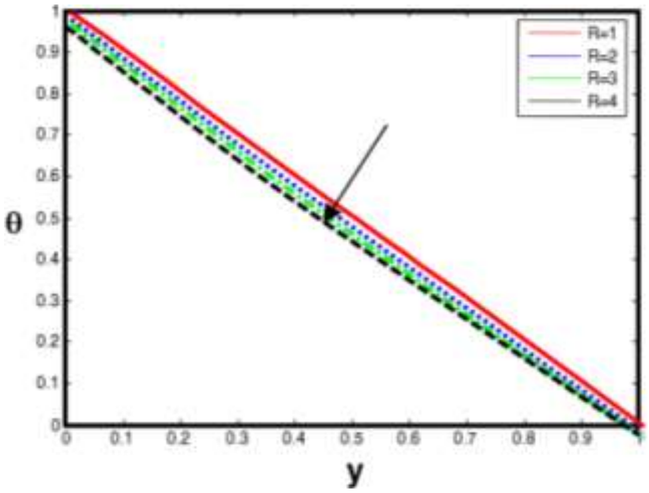

Fig. 9. Temperature illustration for diverse values of R

Figure 10 to Figure 13 display different spatial patterns of concentrations. Figure 10 illustrates how the concentration variation changes somewhat when the chemical reaction parameter is increased. The effect of temperature's impact on the motion of fluid essentially gets more apparent as the Soret number grows. This can reduce the variance in concentration within the flow rate and, as a result, lower the concentration persona, illustrated in Figure 11.

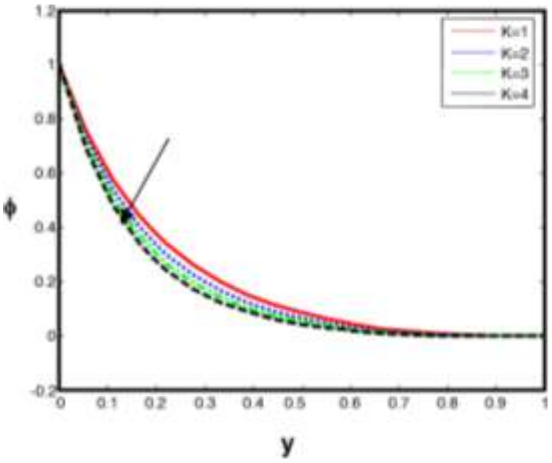

Fig. 10. Concentration illustration for diverse values of K

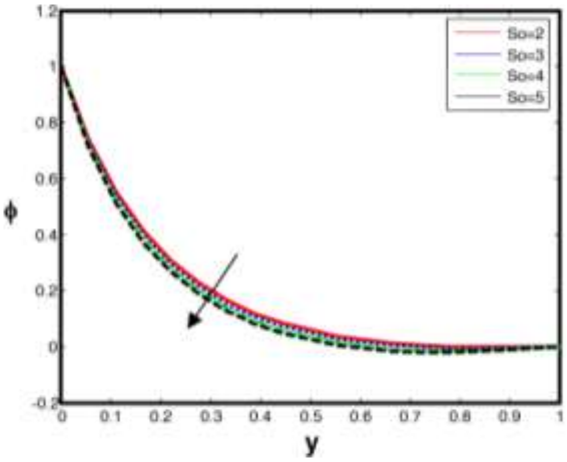

Fig. 11. Concentration illustration for diverse values of So

The concentration gradient decreases when the mass diffuses within the medium progressively, as seen in Figure 12 when the Schmidt number rises. This is because a higher Schmidt number indicates a significantly slower transmission of mass per unit momentum. In general, a jump in the radiation parameter can affect the concentration distributions seen in Figure 13 by influencing particle mobility, thermal payouts, and the flow or dispersion of chemicals within an environment.

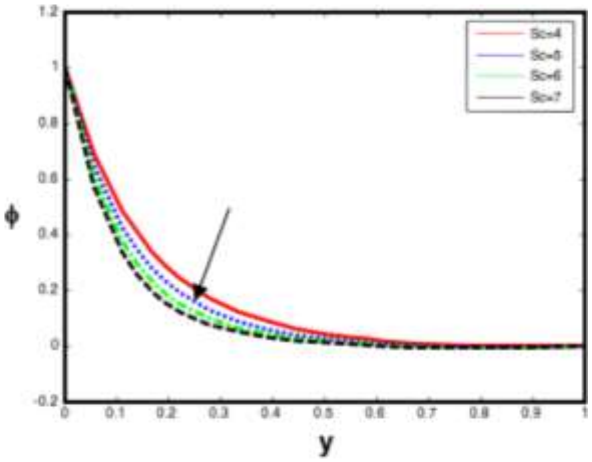

Fig. 12. Concentration illustration for diverse values of Sc

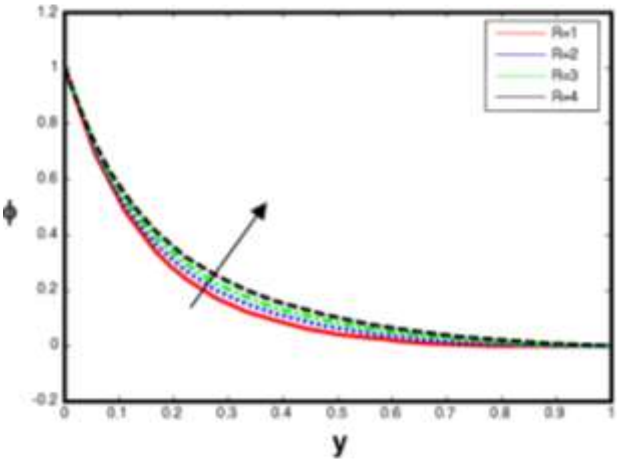

Fig. 13. Concentration illustration for diverse values of R

Table 1, Table 2, and Table 3 show various estimations of shearing stress, Nusselt and Sherwood number based on diverse flow parameters. Table 1 shows that shearing stress decreases with increasing Schmidt parameter, Soret number, chemical reaction factor, and magnetic field number but increases with rising Grashof numbers. Table 2 shows how the Soret variable and heat radiation lower the Nusselt value while the Prandtl and Eckert features raise it. As can be shown in Table 3, the Sherwood number increases with the radiation consequence but decreases with the chemical responses factor, Soret number, and Schmidt number.

Table 1
Shearing stress(σ)

M	Gr	Gm	Sc	Pr	So	K	E	R	Shearing stress(σ)	
1									3.4605	↓
2	5	5	4	6.9	2	1	0.01	1	3.2653	
3									3.1017	
4									2.9621	
	5								2.4319	↑
1	6	5	4	6.9	2	1	0.01	1	2.7744	
	7								3.1172	
	8								3.4605	
					2				3.4605	↓
1	5	5	4	6.9	3	1	0.01	1	3.2833	
					4				3.2277	
					5				3.1769	
						1			3.6229	↓
1	5	5	4	6.9	2	2	0.01	1	3.5544	
						3			3.5022	
						4			3.4605	
			4						3.4605	↓
1	5	5	5	6.9	2	1	0.01	1	3.3754	
			6						3.3108	
			7						3.2599	

Table 2
Nusselt number (Nu)

M	Gr	Gm	Sc	Pr	So	K	E	R	Nusselt number (Nu)	
				5					-1.0072	↑
1	5	5	4	5.9	2	1	0.01	1	-0.9870	
				6.5					-0.9751	
				6.9					-0.9677	
							0.01		-0.9677	↑
1	5	5	4	6.9	2	1	0.03	1	-0.8146	
							0.05		-0.6704	
							0.07		-0.5340	
					2				-0.9585	↓
1	5	5	4	6.9	3	1	0.01	1	-0.9589	
					4				-0.9592	
					5				-0.9595	
1	5	5	4	6.9	2	1	0.01	1	-0.9677	↓
								2	-1.0138	
								3	-1.0591	
								4	-1.1035	

Table 3
Sherwood no (Sh)

M	Gr	Gm	Sc	Pr	So	K	E	R	Sherwood no (Sh)	
1	5	5	4	6.9	2	1	0.01	1	-6.7363	↓
			5						-7.9166	
			6						-9.0664	
			7						-10.1947	
1	5	5	4	6.9	2	1	0.01	1	-5.0195	↓
					3				-5.3566	
					4				-5.6879	
					5				-6.0143	
1	5	5	4	6.9	2	1	0.01	1	-5.1889	↓
						2			-5.7738	
						3			-6.2820	
						4			-6.7363	
1	5	5	4	6.9	2	1	0.01	1	-6.7363	↑
								2	-6.4570	
								3	-6.1821	
								4	-5.9115	

5. Conclusions

The following are the most noteworthy features of the present investigation into the effects of ohmic heating, chemical interactions, and radiated mass and heat transfer on MHD viscous fluid motion under different conditions

i. Frictional forces cause fluid velocity to surge near solid boundaries, such as plates. Factors like viscosity and pressure differential cause the fluid's rate to progressively decrease as it flows away from the barrier, which causes the flow characteristics to gradually slow down.
ii. Raising the field's intensity or adding magnetism to the medium creates Lorentz forces on charged elements. The aforementioned forces reduce the flow rate by opposing its motion. In magnetohydrodynamics, magnetic forces influence fluid flow in aircraft propellers, mining, and biological uses such drug delivery devices.
iii. Increased Prandtl and Eckert numbers indicate greater momentum diffusivity to thermal diffusivity and kinetic energy to enthalpy ratios. Higher fluid temperatures arise from enhanced convective heat transfer and mixing. However, increasing the radiation parameter favors radiation heat transfer over convective heat transfer. Radiation heat transfer lowers fluid temperature by losing thermal energy to the environment.
iv. The concentration profile reveals a diminishing tendency with the rise of Chemical reaction factor, Soret quantity and Schmidt characteristic respectively but reverse nature is observed for the case of radiation factor.
v. The fluctuation of Skin resistance, Nusselt number and Sherwood number for different arbitrary non-zero values of pertinent-flow parameters induced by viscous fluid performs an important role in the fluid flow region.

6. Future Scope

More thorough knowledge may be achieved by expanding the research to include multi-physics and multi-scale modelling; this, in turn, will have practical applications in chemical reactors, heat exchangers, and microfluidic devices. Research on environmentally friendly solvents, alternate chemical routes, and energy-saving operating procedures will also be guided by sustainability and environmental concerns.

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