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Outlining the Impact of Melting on Mhd Casson Fluid Flow Past a Stretching Sheet in a Porous Medium with Radiation

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Abstract: This article focused on framing the characteristics of melting heat transfer in a porous medium induced by thermal radiation on (MHD) Casson fluid flow. The current model is used to predict the porous regime's viscoelastic action of water. First, the governing PDE is converted to ODE through an effective similarity transformation, and then the formed nonlinear equations are solved using the Runge-Kutta Fehlberg-45 order method. It illustrates and examines a detailed analysis of certain parameters on the velocity, temperature, coefficient of skin friction, and reduced number of Nusselt. The results indicate that velocity profile decreases in M and around but an opposite temperature pattern. In addition, an improvement in R and Me results in the amount of Nusselt number. The present analysis results are compared with the available works in particular situations, and more agreement has been observed.

Keywords: MHD; Prandtl number; Magnetic parameter; Stretching parameter.

1. Introduction

The flow and heat transfer mechanism across stretching surfaces finds many peer-to-peer applications, such as the development of fiber-glass, improved paint and lubrication performance, plastic molding, glass blowing, paper production, crystal growing, polymer and rubber aerodynamic extrusion, and many others. In view of the distinct characteristics of very last commodities relying especially upon the charge of warmth switch, the go with the drift and warmth switch mechanism via stretching surface discover many peer-to-peer programs inclusive of production on fiber-glass, enhancement withinside the performance of paints and lubrication, plastic-molding, glass blowing, paper production, crystal growing, aerodynamic extrusion of polymer and rubber sheets, etc. A literature survey shows that various researchers have done considerable work to examine heat transfer characteristics due to melting in the fluid flows. However, many more interesting results can be obtained by employing suitable models and applying the latest techniques. The phenomenon of melting heat transfer has not been investigated as of the date on the stretching surface with radiation in the porous surface.

Crane [1] was the pioneer who analyzed the flow over a linear stretching plate and successfully obtained the Navier-Stokes equations' analytical solution. Fetecau *et al*. [2]

studied porous and magnetic effects on some fundamental motions of Newtonian fluids over an infinite plate. Zeeshan *et al*. [3] discussed the Biobi-phase flow of peristaltic transport of MHD Jeffery fluid in the human body. Shehzad *et al*. [4] discussed the MHD Power-law Al2O3-PVC nanofluid in a horizontal channel. Majeed *et al*. [5] studied Heat transfer analysis in a ferromagnetic viscoelastic fluid flow over a stretching sheet with suction. Bhatti *et al*. [6] examined the Mass transport on chemicalized fourth-grade fluid propagating peristaltically through a curved channel with magnetic effects. There exist several non- Newtonian fluid models in the open literature [7, 8, 9, 10]. Out of such models is a Casson fluid which has distinctive features. The effects of variable wall temperature for mixed Casson nanofluid flow for rotating sphere at stagnation point was analyzed by Mahdy [11], while Mabood *et al*. [12] examined the impact of radiation on a moving surface for Casson fluid in a porous medium. Subsequently, Ibrahim *et al*. [13] addressed heat transmission characteristics on dissipative convective Casson nanofluid with chemical reaction, heat source, and slip condition. Sandeep *et al*. [14] examined the MHD nonlinear radiative slip motion of a non-Newtonian fluid across a stretching sheet in the presence of the porous medium. Kumar *et al*. [15] discussed Numerical exploration of MHD radiative Micropolar liquid flow driven by the stretching sheet. Sugunamma *et al*. [16] studied the MHD flow of chemically reacting Williamson fluid over a curved surface with variable heat sources. Ramadevi *et al*. [17] discussed the Lorentz force on unsteady bio convective flow of Carreau fluid across a variable thickness sheet with a non-Fourier heat flux model.

The problem of melting heat transfer has been accomplished significantly by researchers due to its wide range of technological and industrial applications in the preparation of semiconductor substance thawing of frozen grounds, solidification of molten rock flows, etc. Bachok *et al*. [18] examined the steady flow over the moving surface of melting heat transfer, and Yacob *et al*. [19] discussed the behavior of micropolar fluid for melting heat transfer on stagnation points over stretching/shrinking surfaces. Mabood *et al*. [20] discussed Melting heat transfer on the hydromagnetic flow of a nanofluid over a stretching sheet with second-order slip. Hayat *et al*. [21] studied the melting heat transfer in the stagnation-point flow of a Jeffrey fluid in the presence of viscous dissipation. Zheng *et al*. [22] discussed effects on the stagnation point flow of a Jeffrey fluid in the presence of the magnetic field. Makinde [23] studied vertical porous surfaces for free convection with radiation, and Hayat *et al*. [24] discussed the MHD mixed convection of stagnation point flow past a vertical stretching sheet with radiation. The slip and radiation effects on MHD flow over a flat plate were discussed in detail by Das [25]. Later, Hayat *et al*. [26] investigated the thermal radiation characteristics of Jeffrey fluid, and Sandeep *et al*. [27] examined the effects of magnetic nanoparticles in MHD nanofluid flow, while Ramdev *et al*. [28] had presented variable thickness melting on MHD Carreau fluid.

Casson nanofluid is one of the fluids that do not obey Newton's Laws, and it is potentially valuable for some applications, mainly in the flow of blood through the human body. Because of its important applications, the chemical reaction effect on the MHD flow of Casson fluid with a porous stretching sheet was studied by Hari Krishna [29] and concluded that velocity profile drops as increase the Casson parameter. As a continuation, our team proposes here to study chemical reaction and radiation effects on MHD Casson nanofluid flow over a stretching sheet with a constant temperature. The resulting governing equations are converted to ordinary differential equations through similarity transformation and then solved numerically using a shooting method with the fourth-order Runge-Kutta integration technique.

Ramana Reddy *et al.* [30] had reported a few interesting results in the case of MHD mixed convection oscillatory flow over a vertical surface in a porous medium with chemical reaction and thermal radiation. Subsequently, the radiation and chemical reaction effects on MHD flow along a moving vertical porous plate were examined by Ramana Reddy *et al.* [31]. Further, Vinodkumar Reddy [32] examines the flow performance of a chemically reacting magnetohydrodynamics flow of Casson and Williamson fluids on an enlarging surface.

Reddy [33] examined the Soret and Dufour effects on MHD free convective flow past a vertical porous plate in the presence of heat generation. After that, the MHD free convective flow past a vertical porous plate in the presence of radiation and heat generation was explored by Reddy *et al.* [34]. In a similar situation, the influence of various parameters in the case of double-diffusive magneto-hydrodynamic free convection at a vertical plate was explored by Ramalingeswara Rao *et al.* [35].

However, the interesting features of fluid flow involving chemical reaction and soret effects on Casson MHD fluid flow over a vertical plate were studied by Charan Kumar *et al.* [36]. Later, Vedavathi *et al.* [37] analyzed the chemical reaction, radiation, and Dufour effects on Casson magneto-hydrodynamic fluid flow over a vertical plate with a heat source/sink. Thereafter, Dhanalakshmi *et al.* [38] examined the chemical reaction and soret effects on radiating MHD boundary layer flow over a moving vertical porous plate with a heat source and had reported interesting results. The Soret and Dufour effects on MHD flow with heat and mass transfer past a permeable stretching sheet in the presence of thermal radiation were exhaustively studied by Sreedevi *et al.* [39]. Vedavathi *et al.* [40] reported some salient results while studying heat transfer on MHD nanofluid flow over a semi-infinite flat plate embedded in a porous medium with radiation absorption, heat source, and thermal diffusion effects. A detailed mathematical analysis of convective heat and mass transfer pour of a non -Newtonian fluid through a porous medium in a rectangular duct with heat sources was made by Raja Kumari *et al.* [41]. The analysis had thrown distinguished results. Subsequently, Chandra Sekhar Reddy *et al.* [42] had presented interesting results on Thermal diffusion and radiation effect on unsteady MHD free-convection flow past an impulsively moving plate with ramped wall temperature and ramped wall concentration while Jayarami Reddy *et al.* [43] investigated for Numerical solution of a chemical reaction and heat source on radiating MHD stagnation point flow of Carreau nanofluid with suction/injection. Later, Konda [44] examined the radiating and chemically reactive Casson nanofluid over a nonlinear permeable stretching sheet with viscous dissipation and heat source. Thereafter, Vijaya *et al.* [45] analyzed in detail the Soret and radiation effects on an unsteady flow of a Casson fluid through a porous vertical channel with expansion and contraction. Vijaya *et al.* [46] Investigated the effect of non–linear thermal radiation and velocity slip on the MHD non-Darcy flow of an incompressible, electrically conducting Casson fluid past a permeable stretching sheet taking joule heating and thermophoresis into account. Karnati *et al.* [47] examined the Cattaneo-Christov heat flux model on heat alongside mass transport of Casson nanofluid over accelerating penetrable superficies with thermal radiation and Soret-Dufour mechanism. Veera *et al*. [48] analyzed the effect of MHD Casson boundary layer nanofluid flow upon a stretching porous sheet in the existence of the radiation, chemical reaction, along viscous dissipation. Reddy *et al.* [49] considered the multiple slip contributions of MHD Casson fluid motion under the influence of linear radiation and the Soret mechanism. Hari *et al.* [50] analyzed heat and mass transfer in MHD Casson fluid flow along exponentially permeable stretching sheets in the presence of radiation and chemical reaction. Omari *et al.* [51] examined MHD Williamson flow over a

Stretching Sheet through a Porous Medium with Joule Heating, Nonlinear Thermal Radiation. Rami Reddy *et al.* [52] studied the presence of radiation and viscous dissipation of Casson nanofluid flow. Govind *et al.* [53] studied thermal radiation over magnetized stagnation point flow of Williamson fluid in porous media driven by stretching sheet. Abbas *et al.* [54] studied the thermal-dependent conductivity and viscosity on the steady motion of a Powell-Eyring fluid over a stratified stretching sheet embedded in a porous medium. The method for analyzing the MHD boundary layer flow over a stretching sheet has been discussed by Hakeem *et al.* [55]. Mohan *et al.* [56] analyzed the heat transfer effect of melting on magneto-hydrodynamic Casson fluid flow surrounded by the porous medium in the presence of first-order chemical reaction with radiation. Manoj *et al.* [57] studied melting heat transfer and non-uniform heat sources on magnetic Cu–H_2O nanofluid flow through a porous cylinder. Kapil *et al.* [58] studied had involved the 'Keller-Box method' to investigate the numerical solution of the stagnation point flow of a micropolar fluid over a porous stretching sheet. MHD couple stress nanofluid flow with melting, nonlinear radiation, and first-order slip has not been studied by Mabood *et al.* [59].

2. Mathematical Model

We consider the 2-D steady flow of a Casson fluid over a horizontal linear stretching sheet in a porous medium of permeability K, melting at a steady rate into a constant property as shown in Figure 1 has been considered. The fluid is grey and is electrically conducting. The induced magnetic field is considered to be negligible. Consider external flow is $u_e(x) = ax$ and the velocity of the stretching sheet is $u_w(x) = cx$, where a and c are positive constants, and the x-axis is the coordinate considered along with the stretching sheet. We assumed that both T_m and T_n are the fluid's melting and free stream temperature respectively, where $T_\infty > T_m$. The rheological equation of the Casson fluid is given by:

$$\tau_{ij} = \begin{cases} 2\left(\mu_B + Py/\sqrt{2\pi}\right), \pi \succ \pi_c \\ 2\left(\mu_B + Py/\sqrt{2\pi_c}\right), \pi \succ \pi_c \end{cases} \quad (1)$$

where μ_B plastic dynamic viscosity, $\pi = e_{ij}e_{ij}$ and e_{ij} is the $(i, j)^{th}$ component of deformation rate, π denotes rate, π_c is critical value fo non-newtonian model, π_y is the yield stress of fluid. Under these assumptions, the governing equations are [12,13]:

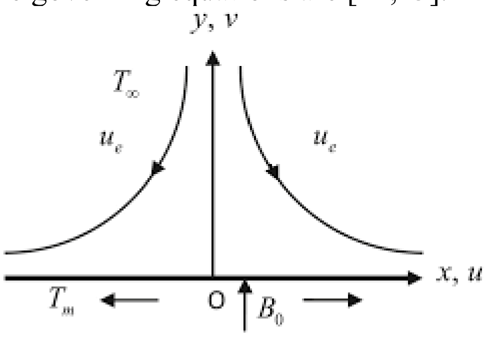

Figure 1. Physical model and coordinate system.

$$\frac{\partial u}{\partial x} + \frac{\partial u}{\partial y} = 0 \quad (2)$$

$$u\frac{\partial u}{\partial x}+v\frac{\partial u}{\partial y}=\nu\left(1+\frac{1}{\beta}\right)\frac{\partial^2 u}{\partial y^2}+u_e\frac{du_e}{dx}-\left(\frac{\sigma B_0^2}{\rho}+\frac{\nu}{K^*}\right)(u-u_e) \quad (3)$$

$$u\frac{\partial T}{\partial x}+v\frac{\partial T}{\partial y}=\alpha\frac{\partial^2 T}{\partial y^2}+Q(T-T_\infty)-\frac{1}{\rho Cp}\frac{\partial q_r}{\partial y} \quad (4)$$

$$u\frac{\partial C}{\partial x}+v\frac{\partial C}{\partial y}=D\frac{\partial^2 C}{\partial y^2}-K_r^*(C-C_\infty) \quad (5)$$

Subject to the boundary conditions are:

$$\begin{aligned} &u=u_w(x)=cx,\ T=T_m,\ C=C_m \quad at\ y=0\\ &u\to u_e(x)=cx,\ T\to T_m,\ C\to C_\infty \ \ at\ y\to\infty \end{aligned} \quad (6)$$

and

$$k\left(\frac{\partial T}{\partial y}\right)_{y=0}=\rho[\lambda+c_s(T_m-T_\infty)]v(x,0) \quad (7)$$

Here (u,v) = velocity components along axes, ν is the kinematic viscosity of the fluid, K_r thermal conductivity, β casson fluid parameter, B is the magnetic parameter, α is thermal diffusivity of the fluid, K^* permeability of the medium, σ the electrical conductivity of fluid, λ latent heat of the fluid , c_s cs heat capacity of the solid surface, ρ the density of fluid, q_r radiative heat flux and c_p the specific heat at constant pressure.

The Rosseland diffusion approximation and by following among other researchers

$$q_r=-\frac{4\sigma^*}{3K_s}\frac{\partial T'^4}{\partial y'} \quad (8)$$

where $\sigma*$ Stefan-boltzmann constant and $k*$ the absorption coefficient and $T^4\approx 4T_\infty^3T-3T_\infty^4$

Therefore eq(4) turns to :

$$u\frac{\partial T}{\partial x}+v\frac{\partial T}{\partial y}=\alpha\frac{\partial^2 T}{\partial y^2}+\frac{16\sigma * T_\infty^3}{3\rho c_p k*}\frac{\partial^2 T}{\partial y^2} \quad (9)$$

The similarity variables are [14]:

$$\psi=x\sqrt{a\nu}f(\eta),\theta(\eta)=\frac{T-T_m}{T_m-T_\infty},\ \phi(\eta)=\frac{C-C_m}{C_m-C_\infty},\ \eta=y\sqrt{\frac{a}{\nu}} \quad (10)$$

where is the stream function defined in such a way that $u=\frac{\partial\psi}{\partial y}\ and\ v=-\frac{\partial\psi}{\partial x}$, which automatically satisfied the continuity eq(1). By using this definition, we obtain:

$$u=axf'(\eta),v=-\sqrt{a\nu}f(\eta) \quad (11)$$

Substitute eqs.(10) and (11) into eqs. (3) and (9), the transformed equations are:

$$\left(1+\frac{1}{\beta}\right)f'''+ff''-f'^2-\left(M+\frac{1}{K}\right)(1-f')+1=0 \quad (12)$$

$$(1+R)\theta''+\Pr f\theta'=0 \quad (13)$$

$$\phi''+Scf\phi'-Sck_r\phi=0 \quad (14)$$

subject to boundary conditions

$$\left.\begin{array}{l} f'(0)=\varepsilon, \Pr f(0)+Me\theta'(0)=0, \phi(0)=0, \\ f'(\infty)=1, \theta(\infty)=1, \phi(\infty)=1 \end{array}\right\} \quad (15)$$

where the primes denote differentiation with respect to η, $\beta=\mu_B \frac{\sqrt{2\pi_c}}{Py}$ non-newtonian Casson fluid parameter, $M=\frac{\sigma B_0^2}{\rho a}$ magnetic parameter, $K=\frac{\nu}{ka}$ permeability parameter, $R=\frac{16\sigma^* T_\infty^3}{3k^* k}$ radiation parameter, $\varepsilon=\frac{c}{a}$ stretching parameter, $\Pr=\frac{\nu}{\alpha}$ Prandtl number, $Sc=\frac{\nu}{D}$ Schmidt number, $Kr=\frac{K_r^* u(C_m-C_\infty)}{\nu}$ chemical reaction, $Me=\frac{c_p(T_\infty-T_m)}{\lambda+c_s(T_m-T_0)}$ melting parameter, and Me combination of the Stefan numbers $c_p(T_\infty-T_m)/\lambda$ and $c_s(T_m-T_0)/\lambda$ for the liquid and solid phases, respectively.

3. Methodology

The equations boundary layer of governing (11)–(13) BVP4C are solved numerically together with using the Newton Raphson shooting method alongside the fourth-order Runge-Kutta algorithm, subject to boundary conditions (14). First of all, higher-order nonlinear differential equations Eqs. (11)–(25) are converted into simultaneous linear differential equations of the first order. They are further transformed into initial value problems by applying the Newton Raphson shooting method alongside the fourth-order Runge-Kutta algorithm.

4. Results and Discussion

Figure 2 represents the Velocity field for different values of M. It is observed that the flow rate decreases and reduction in Velocity as M increases. This happens mainly because of the impact of Lorenz's force property. It is worth mensuration in that all of these numerical results occur for S=1.5, but a reverse trend is observed for S=0.5. This force diminishes the fluid motion; hence, it results to reduces the velocity. The same effect is noted for K for velocity field, as shown in Figure 3. Velocity plus the layer thickness increment clarifies the physical circumstance that as K increments, the resistance of the penetrable channel is lowered, which accelerates the momentum model of the motion regime and ultimately facilitates the velocity plot. In Figure 4, the effect of variation of non-Newtonian Casson fluid parameter (β) on the velocity profiles is illustrated. This parameter appeared in the shear term of momentum of the boundary layer equation and the velocity boundary condition. It is noted that with an increased beta, the velocity decreases so that hydrodynamic boundary layer thickness reduces for higher values of Casson fluid parameter for S=1.5, but the opposite effect is observed for S=0.5. Figures 5 and 6 elucidate the effect of *Me* on the velocity and temperature profiles. It is observed that the velocity increases with an increase *Me*, but a reverse trend is observed in temperature profiles. That phenomenon is due to plunges of the cold sheet into warm water its starts to melt. As the melting progresses, the surface slowly transfers to the required state, causing the velocity to grow poster when it causes a decrease in temperature. Figures 7 and 8 depict the effect of various Pr values on dimensionless velocity and temperature distributions. It is observed that the velocity decreases for the cause of S=1.5, but a reverse trend is observed for S=0.5. Temperature increases, then Pr is increased. Figure 9 elaborates the effect of R on the temperature profile. For ε = 0.5 or 1.5. It is observed that the temperature retards consistently with increasing thermal radiation parameters. In this study, temperature decreases as R increase due to the thermal effect, as a result of which strange melting leans to increase the thickness of the boundary layer. Figure 10 illustrates the effect of Sc on concentration profiles.

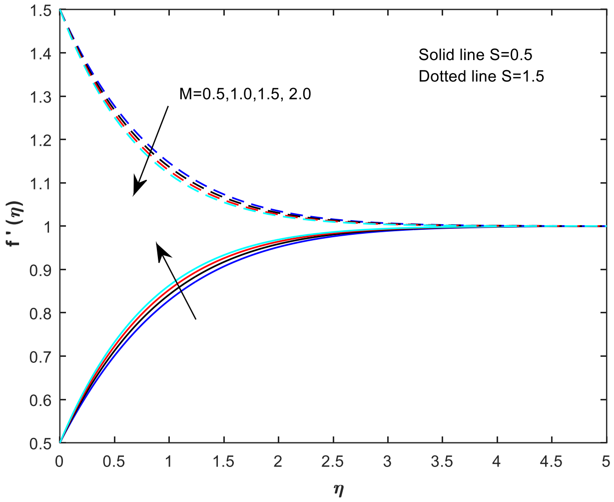

Figure 2. Effect of M on velocity.

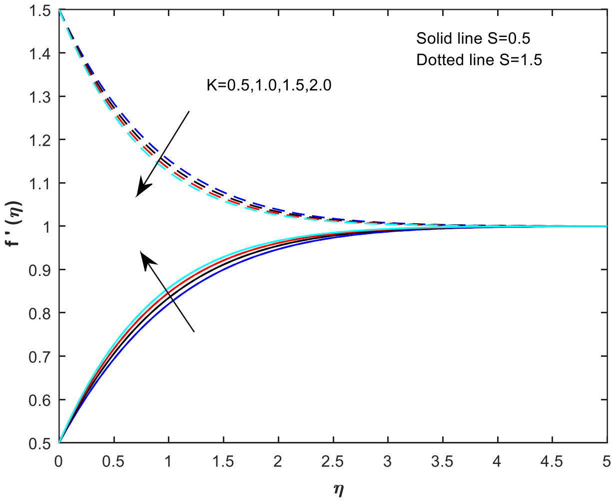

Figure 3. Effect of K on velocity.

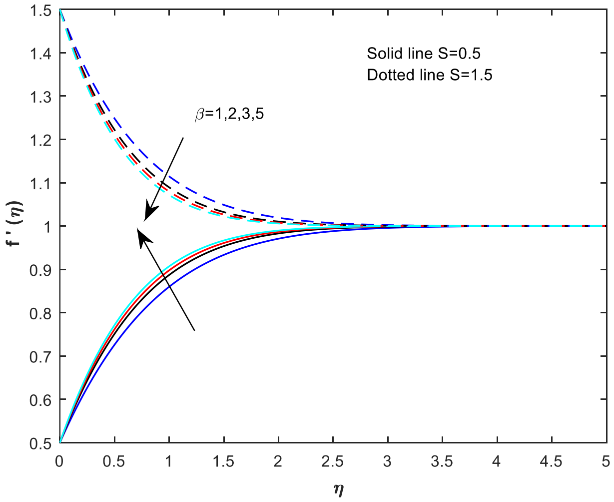

Figure 4. Effect of B on velocity.

It is observed that when Sc increases, concentration also increases for both cases of S=0.5 and S=1.5. Figure 11 is presented to analyze the behavior of the concentration distribution for different values of Kr. This is because the concentration level of the fluid falls due to an increase in the chemical reaction, i.e., the consumption of chemical species leads to a fall in the species concentration field. It is evident from Figure 11 that increases Kr values to decrease concentration profiles in boundary layer thickness.

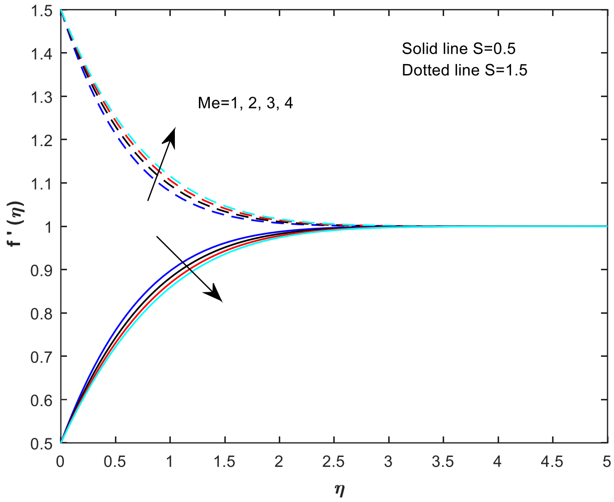

Figure 5. Effect of Me on velocity.

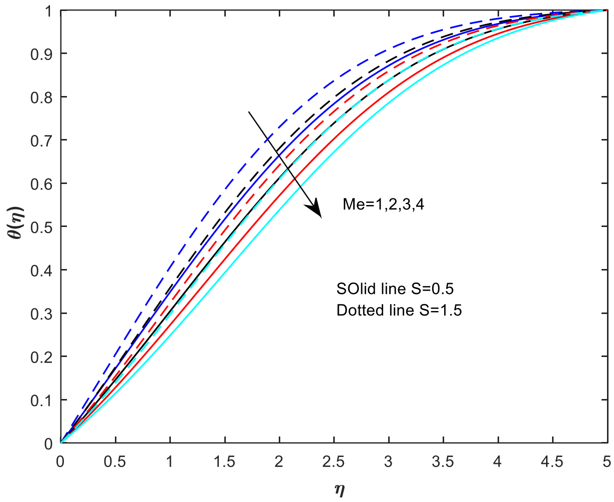

Figure 6. Effect of Me on temperature.

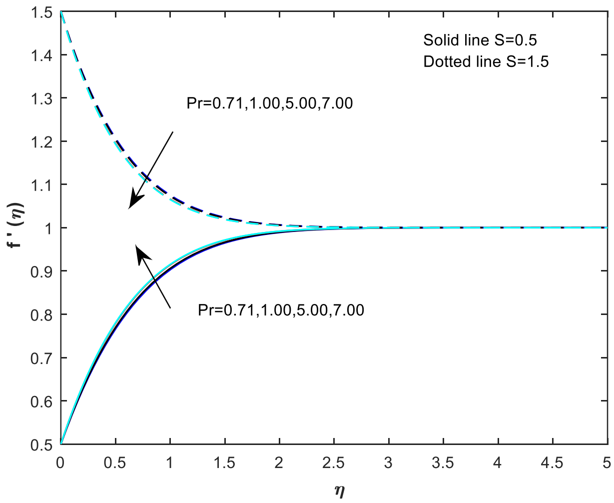

Figure 7. Effect of Pr on velocity.

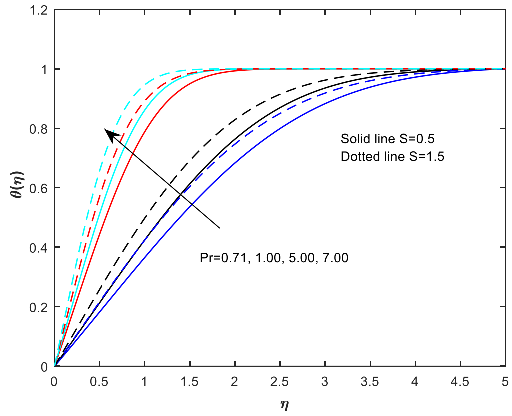

Figure 8. Effect of Pr on temperature.

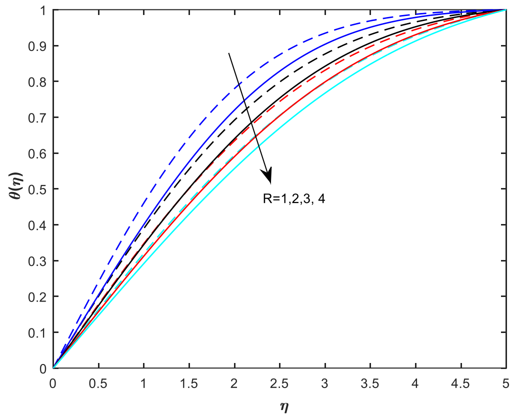

Figure 9. Effect of R on temperature.

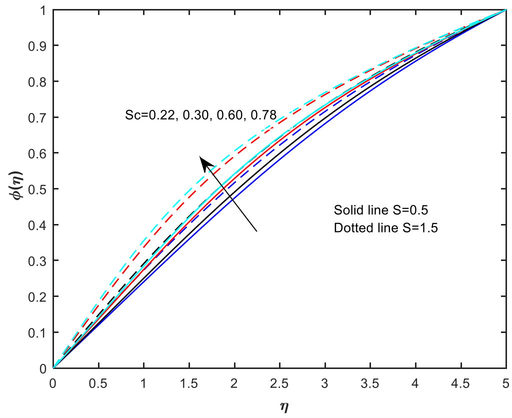

Figure 10. Effect of Sc on concentration.

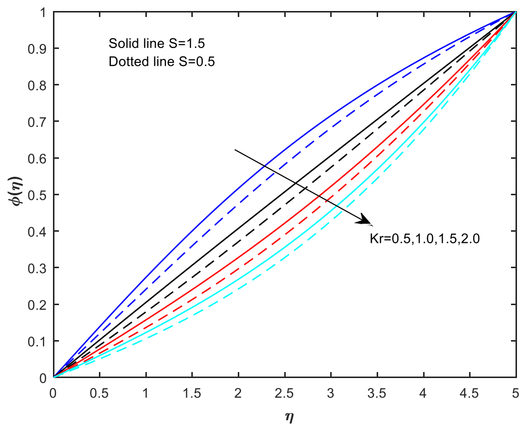

Figure 11. Effect of Kr on concentration.

Table 1. Numerical computations for local skin friction (SF), local Nusselt number (Nu), and local Sherwood number (Sh) for different values of flow parameters $M, K, B, Pr, Me, R, Sc, Kr$ and S.

M	K	B	Pr	Me	R	Sc	Kr	S	SF	Nu	Sh
0.5	0.5	0.5	0.71	0.2	1	0.22	0.6	0.5	0.492174	0.394685	0.217306
1									0.531874	0.396721	0.218387
1.5									0.568901	0.398495	0.219322
2									0.603726	0.400061	0.220144
0.5	0.5	0.5	0.71	0.2	1	0.22	0.6	1.5	-0.568071	0.494834	0.265687
1									-0.602715	0.496026	0.266364
1.5									-0.635559	0.497335	0.267116
2									-0.666852	0.498786	0.267956
0.5	0.5	0.5	0.71	0.2	1	0.22	0.6	0.5	0.466807	0.393304	0.216571
	1								0.508412	0.395535	0.217758
	1.5								0.546976	0.397458	0.218776
	2								0.583073	0.399144	0.219663
0.5	0.5	0.5	0.71	0.2	1	0.22	0.6	1.5	0.466807	0.393304	0.216571
	1								0.508412	0.395535	0.217758
	1.5								0.546976	0.397458	0.218776
	2								0.583073	0.399144	0.219663
0.5	0.5	1	0.71	0.2	1	0.22	0.6	0.5	0.568758	0.399404	0.219863
		2							0.653867	0.403589	0.222066
		3							0.692146	0.405256	0.222931
		5							0.728204	0.406722	0.223685
0.5	0.5	1	0.71	0.2	1	0.22	0.6	1.5	-0.665897	0.487353	0.261484
		2							-0.765873	0.488722	0.262221
		3							-0.810882	0.490275	0.263068
		5							-0.853305	0.494154	0.265238
0.5	0.5	10	0.71	0.2	1	0.22	0.6	0.5	0.703300	0.356352	0.202182
			1						0.717093	0.416038	0.207639
			5						0.757167	0.872875	0.223441
			7						0.762117	1.018594	0.225388
0.5	0.5	10	0.71	0.2	1	0.22	0.6	1.5	-0.824558	0.425499	0.234657
			1						-0.838835	0.508079	0.240398
			5						-0.882629	1.185146	0.257961
			7						-0.888445	1.413698	0.260289
0.5	0.5	10	0.71	1	1	0.22	0.6	0.5	0.541754	0.208403	0.147005
				2					0.572717	0.236398	0.160387
				3					0.615130	0.275166	0.178576
				4					0.678343	0.333348	0.205404
0.5	0.5	10	0.71	1	1	0.22	0.6	1.5	-0.636125	0.250096	0.168818
				2					-0.672209	0.283423	0.184587
				3					-0.721669	0.329462	0.206054
				4					-0.795430	0.398340	0.237761
0.5	0.5	10	0.71	0.2	1	0.22	0.6	0.5	-0.889950	0.328368	0.277935
					2				-0.895342	0.358243	0.280214
					3				-0.898444	0.404865	0.281524
					4				-0.900436	0.486240	0.282366
0.5	0.5	10	0.71	0.2	1	0.22	0.6	1.5	0.759333	0.294728	0.239355
					2				0.763266	0.316305	0.240994
					3				0.765543	0.349827	0.241942
					4				0.767012	0.407912	0.242554
0.5	0.5	10	0.71	0.2	1	0.22	0.6	0.5	0.759333	0.407912	0.239355
						0.3			0.759333	0.407912	0.248457
						0.6			0.759333	0.407912	0.270124
						0.78			0.759333	0.407912	0.277869
0.5	0.5	10	0.71	0.2	1	0.22	0.6	1.5	-0.889950	0.486240	0.277935
						0.3			-0.889950	0.486240	0.297811
						0.6			-0.889950	0.486240	0.351276
						0.78			-0.889950	0.486240	0.374246
0.5	0.5	10	0.71	0.2	1	0.22	0.5	0.5	0.759333	0.407912	0.099936
							1		0.759333	0.407912	0.130941
							1.5		0.759333	0.407912	0.174902
							2		0.759333	0.407912	0.239355
0.5	0.5	10	0.71	0.2	1	0.22	0.5	1.5	-0.889950	0.486240	0.118244
							1		-0.889950	0.486240	0.154162
							1.5		-0.889950	0.486240	0.204668
							2		-0.889950	0.486240	0.277935

5. Conclusions

Detailed study of the impact of melting MHD Casson fluid flow past a porous stretching sheet in thermal radiation and chemical reaction is carried out. The numerical values approach is adapted to extract the fluid flow characteristics. Various pertinent parameters on the flow are analyzed, and the outcome is summarized below: The velocity decrease as M increases because of the impact of the Lorenz force property; An increases (β) the velocity decreases so that hydrodynamic boundary layer thickness reduces for higher values of Casson fluid parameter; The velocity increases with an increase *Me*, but a reverse trend is observed in temperature profiles. The reason behind that phenomenon is due to plunges of the cold sheet into warm water its starts to melt; The concentration profiles are to be reduced when increasing the slip number and chemical reaction number; The velocity decreases for the cause of S=1.5, but a reverse trend is observed for S=0.5. Temperature increases, then Pr is increased; Temperature decreases as R increases due to thermal effect, as a result of which strange melting leans to increases thickness of boundary layer; Sc increases, then concentration also increases for both cases of S=0.5 and S=1.5; Increases Kr values to decreases concentration profiles in boundary layer thickness.

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Conflicts of Interest

The authors declare no conflict of interest.

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