Influence of MHD for energy generation of Peristaltic Flow of Nano Fluid

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Abstract - **The current examination depicts the entropy age on peristaltic wave of Nanofluid with the impact of MHD. The overseeing condition of coherence, nano molecule, condition of movement and entropy age condition are addressed by ignoring the inertial powers and taking long frequency guess. With the assistance of bother strategy, the subsequent profoundly nonlinear coupled incomplete differential condition has been settled scientifically. Some unmistakable graphical consequences of the relevant actual boundaries for temperature profile, pressure conveyance, and entropy age are introduced. Connection between the entropy age and some different boundaries has been examined mathematically. Since it is vital to discover the affectability of every boundary on entropy age. Also, Magneto hydrodynamics assumes an essential part in the use of siphoning the liquids for throbbing and non-throbbing proceeds with stream in various**

keywords - **Magneto hydrodynamics .MHD, NANO Molecule, Nano fluid, Entropy Generation, Correlation.**

I. Introduction

Warmth move liquids have extraordinary requests set upon them in terms of expanding or diminishing energy delivery to frameworks, and their persuasions rely upon warm conductivity, heat limit what's more, other actual properties in current warm and fabricating measures. The warm conductivity of metals is amazingly higher in contrast with the customary warmth move liquids. Suspending ultrafine strong metallic particles in mechanical liquids causes an increment in the warm conductivity. This is perhaps the most present day and fitting strategies for expanding the coefficient of warmth move. Choi and Eastman [1] were likely quick to utilize a combination of nanoparticles and base liquid that such liquids were assigned as "Nanofluid". Test considers have shown that with 1 to 5% volume of strong metallic, metallic oxide particles [2] or carbon nanotubes, the successful warm conductivity of the coming about combination can be expanded by 20% contrasted with that of the base liquid. One of the innovative utilizations of nanoparticles that hold gigantic guarantee is the utilization of warmth move liquids containing suspensions of nanoparticles to go up against cooling issues in the warm frameworks. Investigation of Magnetohydrodynamics (MHD) impacts has drawn in impressive consideration in designing sciences due to its wide applications, for example, in the polymer business and metallurgy where hydro-magnetic methods are being utilized.To be more explicit, it very well might be called attention to that many metal careful cycles include the cooling of consistent strips or fibers by drawing them through a quiet liquid and that in the way toward drawing, these strips are some of the time extended. In this load of cases, the properties of the eventual outcome depend to a incredible degree on the pace of cooling by attracting such strips an electrically directing liquid subject to a magnetic field and the trademark wanted in the end result. Contingent upon the intricacy of the issue, the investigations of peristaltic stream, under the impact of magnetic field, have been done both hypothetically and mathematically. For example, Ellahi et al. [3] determined the arrangement answer for magneto hydrodynamic stream of non- Newtonian nanofluid. Impact of warmth and mass exchange on peristaltic stream of Eyring Powell and Jeffery's liquid are considered by Akbar and Nadeem [4]. The second law of thermodynamics is utilized by engineers to acquire the ideal plan of warm frameworks by means of limiting the irreversibility, which can improve the productivity of modern frameworks [5]. Entropy age work is an action of the level of the accessible irreversibility in an interaction. Entropy age includes thermodynamic irreversibility, for example, qualities of convective warmth move, heat move across limited temperature inclinations, gooey dissemination impacts and magnetic field impacts which emerge in present day heat move measures. The liquid stream and warmth move measures are inherently irreversible, which prompts an expansion entropy age and valuable energy obliteration. It is critical to underscore that the second law of thermodynamics is more dependable than the primary law of thermodynamics investigation, in light of the fact that of the restriction of the principal law effectiveness in the warmth move designing frameworks. Entropy age has invigorated critical interest lately in warm sciences. The principle objective of the proposed work is to research the connection of entropy age of the peristaltic stream of nanofluid within the sight of magnetic field. For this reason, the improved on fractional differential conditions are tackled with the help of Homotopy Perturbation Method (HPM). A few importance results are plotted graphically for different boundaries. The second law of thermodynamics utilized to get the ideal upsides of dynamic boundaries to limit the entropy age. One of the unique examination of the current investigation is to discover the connection of entropy age for various appropriate boundaries, for example, a magnetic boundary, Brinkman boundary and so on This can be accommodating to discover the affectability of every boundary on objective capacities which are considered as entropy age in this model.

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II. Math Formulae

Consider the Peristaltic movement gooey, incompressible and electrically leading nanofluid properties through a two-dimensional non-uniform channel with sinusoidal wave proliferating towards down its dividers. The Cartesian arrange framework is taken so that x − pivot is considered alongside the middle line in the heading of wave engendering and y − hub is cross over to it (see Fig. (1)). A uniform outer magnetic field 0 B is acting along the y − pivot and the instigated magnetic field is accepted to be insignificant. The math of the divider surface is characterized as,

$$H(\tilde{x},\tilde{t}) = b(\tilde{x}) + \tilde{a}\sin\frac{2\pi}{\lambda}(\tilde{x} - c\tilde{t}), \qquad (1)$$

where

$$b(\tilde{x}) = b_0 + K\tilde{x},$$

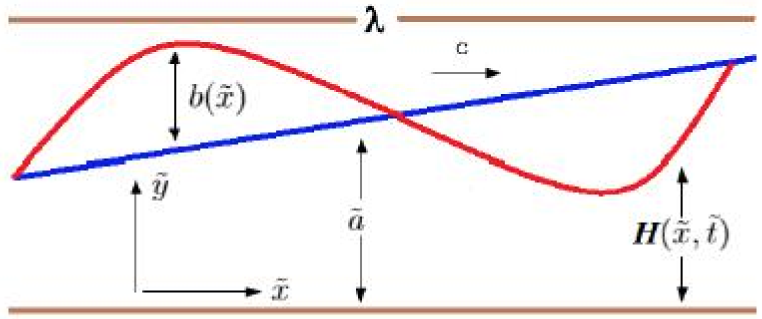

Fig. 1: Geometry of the problem

$$\frac{\partial\tilde{u}}{\partial\tilde{x}} + \frac{\partial\tilde{v}}{\partial\tilde{y}} = 0, \qquad (2)$$

$$\rho_f\left(\frac{\partial\tilde{u}}{\partial\tilde{t}} + \tilde{u}\frac{\partial\tilde{u}}{\partial\tilde{x}} + \tilde{v}\frac{\partial\tilde{u}}{\partial\tilde{y}}\right) = -\frac{\partial\tilde{p}}{\partial\tilde{x}} + \frac{\partial}{\partial\tilde{x}}S_{\tilde{x}\tilde{x}} + \frac{\partial}{\partial\tilde{y}}S_{\tilde{x}\tilde{y}} - \sigma B_0\tilde{u}$$

$$-\frac{\mu}{k}\tilde{u} + g\left[(1-F)\rho_{f_0}\zeta(T-T_0) - (\rho_p - \rho_{f_0})(F-F_0)\right], \qquad (3)$$

$$\rho_f\left(\frac{\partial\tilde{v}}{\partial\tilde{t}} + \tilde{v}\frac{\partial\tilde{u}}{\partial\tilde{x}} + \tilde{v}\frac{\partial\tilde{v}}{\partial\tilde{y}}\right) = -\frac{\partial\tilde{p}}{\partial\tilde{y}} + \frac{\partial}{\partial\tilde{x}}S_{\tilde{y}\tilde{x}} + \frac{\partial}{\partial\tilde{x}}S_{\tilde{y}\tilde{y}} - \sigma B_0\tilde{v} -$$

$$\frac{\mu}{k}\tilde{v} + g\left[(1-F)\rho_{f_0}\zeta(T-T_0) - (\rho_p - \rho_{f_0})(F-F_0)\right], \qquad (4)$$

$$(\rho c)_f \left(\frac{\partial T}{\partial \bar{t}} + \tilde{u}\frac{\partial T}{\partial \bar{x}} + \tilde{v}\frac{\partial T}{\partial \bar{y}}\right) = \kappa\left(\frac{\partial^2 T}{\partial \bar{x}^2} + \frac{\partial^2 T}{\partial \bar{y}^2}\right) - \frac{\partial q_r}{\partial \bar{y}} + Q_0$$

$$+(\rho c)_p \mathrm{D}_B \left(\frac{\partial T}{\partial \bar{x}}\frac{\partial F}{\partial \bar{x}} + \frac{\partial F}{\partial \bar{y}}\frac{\partial T}{\partial \bar{y}}\right) + \frac{\mathrm{D}_T}{T_0}\left(\left(\frac{\partial T}{\partial \bar{x}}\right)^2 + \left(\frac{\partial T}{\partial \bar{y}}\right)^2\right), \quad (5)$$

$$\left(\frac{\partial F}{\partial \bar{t}} + \tilde{u}\frac{\partial F}{\partial \bar{x}} + \tilde{v}\frac{\partial F}{\partial \bar{y}}\right) = \mathrm{D}_B\left(\frac{\partial^2 F}{\partial \bar{x}^2} + \frac{\partial^2 F}{\partial \bar{y}^2}\right) + \frac{\mathrm{D}_T}{T_0}\left(\frac{\partial^2 T}{\partial \bar{x}^2} + \frac{\partial^2 T}{\partial \bar{y}^2}\right) -$$

$$k_1(F - F_0), \quad (6)$$

$$\frac{\partial^2 u}{\partial y^2} + We\frac{\partial}{\partial y}\left(\frac{\partial u}{\partial y}\right)^2 - M^2 u - \frac{1}{k}u + Gr_T\theta -$$

$$Gr_F\Phi - \frac{\partial p}{\partial x} = 0, \quad (7)$$

$$\left(\frac{1+\mathrm{R_n}}{\mathrm{Pr}}\right)\frac{\partial^2\theta}{\partial y^2} + N_b\frac{\partial\theta}{\partial y}\frac{\partial\Phi}{\partial y} + N_t\left(\frac{\partial\theta}{\partial y}\right)^2 + \beta = 0, \quad (8)$$

$$\frac{\partial^2\Phi}{\partial y^2} + \frac{N_t}{N_b}\left(\frac{\partial^2\theta}{\partial y^2}\right) - \gamma\Phi = 0. \quad (9)$$

Subject to the respective boundary conditions

$$\frac{\partial u(0)}{\partial y} = 0, \theta(0) = 0, \Phi(0) = 0, \quad (10)$$

$$u(h) = 0, \theta(h) = 1, \Phi(h) = 1, \quad (11)$$

Where, $h = 1 + \frac{\lambda\bar{K}x}{b_0} + \phi\sin 2\pi(x - t)$.

$$\mathrm{S_{gen}} = \frac{\mathcal{K}_{nf}}{T_0^2}(\nabla\mathrm{T})^2 + \frac{\mu_{nf}}{kT_0}\left[2\left(\frac{\partial\bar{u}}{\partial\bar{x}}\right)^2 + 2\left(\frac{\partial\bar{v}}{\partial\bar{y}}\right)^2 + \left(\frac{\partial\bar{u}}{\partial\bar{y}} + \frac{\partial\bar{v}}{\partial\bar{x}}\right)^2\right] +$$

$$\frac{\sigma\mathrm{B}_0^2}{\mathrm{T}_0}\left(\frac{\partial\bar{u}}{\partial\bar{y}}\right)^2 + \frac{R\mathrm{D}_B}{F_0}(\nabla F)^2 + \frac{R\mathrm{D}_B}{T_0}(\nabla F\cdot\nabla T). \quad (12)$$

A characteristic entropy generation is given by as:

$$\mathrm{S_{gen}} = \frac{\mathcal{K}_f(\mathrm{T}_1 - \mathrm{T}_0)^2}{\mathrm{T}_0{}^2\bar{b}_0{}^2}. \quad (13)$$

$$N_s = \frac{S_{gen}}{S_g} = \left(\frac{\mathcal{K}_{nf}}{\mathcal{K}_f}\right)\left(\left(\frac{\partial\theta}{\partial y}\right)^2\right) + (1 + M^2)B_r\frac{1}{\Omega}\left(\frac{\mu_{nf}}{\mu_f}\right)\left(\frac{\partial u}{\partial y}\right)^2 + \Gamma\left(\frac{\Lambda}{\Omega}\right)^2\left(\frac{\partial\Phi}{\partial y}\right)^2 + \zeta\left(\frac{\partial\theta}{\partial y}\right)\left(\frac{\partial\Phi}{\partial y}\right), \quad (14)$$

where $B_r, \Omega, \Lambda, \zeta, \Gamma$ are the Brinkman number, dimensionless temperature difference, concentration difference, constant parameter and a diffusive coefficient which are represented as

$$B_r = \frac{\bar{c}^2\mu_f}{\bar{k}\mathcal{K}_f(T_1 - T_0)}, \zeta = \frac{RD_BT_0}{\mathcal{K}_f}\left(\frac{F_1 - F_0}{T_1 - T_0}\right), \Omega = \frac{(T_1 - T_0)}{T_0}, \Gamma = \frac{RD_BF_0}{\mathcal{K}_f}, \Lambda = \frac{F_1 - F_0}{F_0}. \quad (15)$$

For nanofluid, the viscosity model can be defined as [9]

$$\mu_{nf} = \frac{\mu_f}{(1-\bar{\phi})^{2.5}}, \quad (16)$$

$$\mathcal{K}_{nf} = \frac{\kappa_p + 2\kappa_f + 2\bar{\phi}(\kappa_p - \kappa_f)}{\kappa_p + 2\kappa_f - \bar{\phi}(\kappa_p - \kappa_f)}\kappa_f. \quad (17)$$

III. Results And Discussions

To examine the above outcomes all the more enthusiastically, we expect to be that for prompt volume stream rate is occasional in and is characterized b Where depicts the normal time stream more than one time of the wave. It portrays from Fig. 2 and (3) that temperature profile too increments when and Pr increment. The actual purpose for these wonders is that the Brownian movement makes micro mixing which rises warm conductivity while an expansion in Pr more slender warm limit layer creates. It can likewise be seen from Fig. 4 that when the magnetic boundary increments then, at that point the pressing factor rise diminishes. This wonder depicts the truth that reasonable magnetic field can be applied to control the pressing factor and pressing factor is diminishing implies that stream can pass effectively without forcing higher pressing factor. It is seen from Fig. 5 that grating powers show totally inverse conduct for similar actual boundaries as contrasted with pressure rise. Fig. 6 shows that for higher qualities of Brinkman boundary entropy age increments emphatically. Since is straightforwardly relative to the square of the velocity profile of the stream, thus entropy age increments with the expansion . Also, it is analyzed from Fig. 7 and (8) that entropy age marginally increments for bigger upsides of the boundaries separately. As indicated by Eq. (14) what's more, (15) that thermophoresis boundary and Brownian boundary is straightforwardly relative to temperature profile consequently with the increment in the temperature of the stream increments and as an outcome the entropy age moreover become bigger. It very well may be seen from Fig. 9 that there is a decrease in entropy age for higher upsides of the magnetic boundary. At the point when the cross over magnetic field presented in the stream, there is a propensity to make the drag known as the Lorentz power which will in general oppose the stream and accordingly, the decrease happens in entropy age.

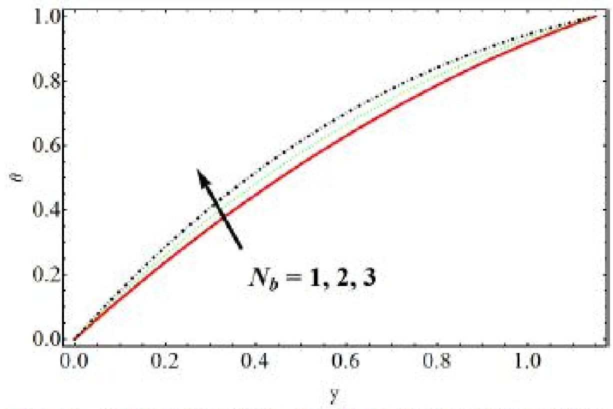

Fig. 2. Temperature distribution for various values of Brownian parameter N_b.

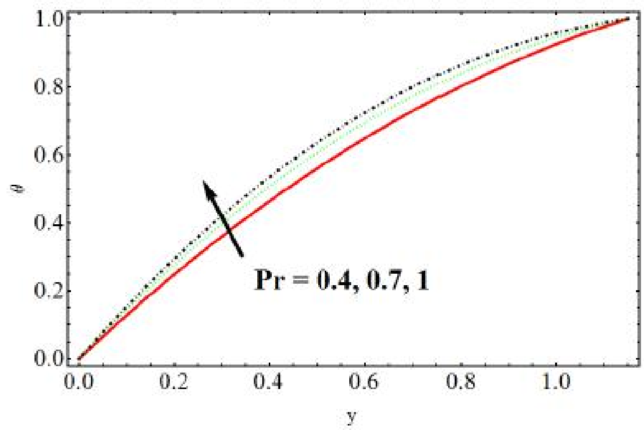

Fig. 3. Temperature distribution for various values of Prandtle *Pr*.

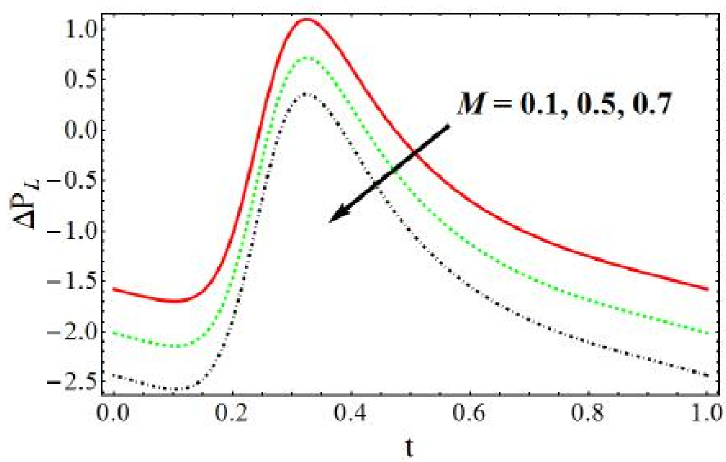

Fig. 4. Pressure distribution for various values of Magnetic, *M*.

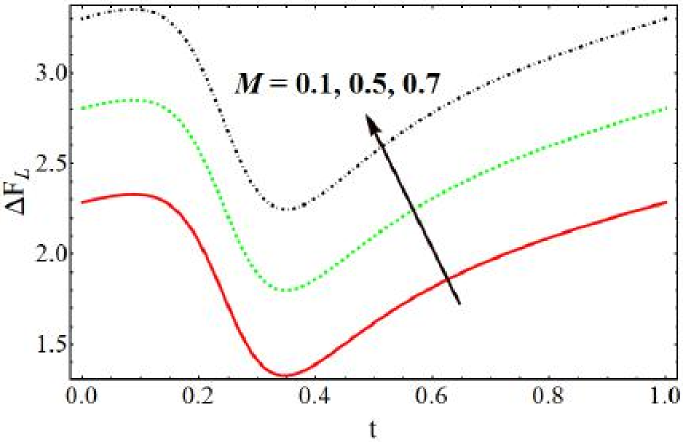

Fig. 5. Friction force for various values of Magnetic, *M*.

IV. Conclusion

The accompanying results are acquired from the current investigation. Temperature profile increments for higher upsides of Pr and Pressure dispersion and Friction power have inverse conduct for bigger upsides of M. Entropy age unequivocally increments for enormous upsides while it increments marginally with the expansion in and M. It has been finished up from the table. 1 that critical great positive relationship exists between Brinkman boundary and entropy age while solid negative relationship has been seen between Magnetic boundary and entropy age.

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