Materials Today: Proceedings xxx (xxxx) xxx

Contents lists available at ScienceDirect

Materials Today: Proceedings

journal homepage: www.elsevier.com/locate/matpr

Slip and hall effects on the peristaltic flow of a jeffrey fluid through a porous medium in an inclined channel

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ARTICLE INFO

Article history:
Available online xxxx

Keywords:
Darcy number
Hall effect
Jeffrey
Peristaltic flow
Porous medium

ABSTRACT

Here within the article, the consequences of Hall as well as slip taking place on the peristaltic stream of a Jeffrey solution all the way through a permeable middling within an inclined 2D strait below the extensive wavelength estimation are explored, nearby outline explanations are attained meant for the axial swiftness as well as the axial heaviness gradient's. The possessions of a variety of up-and-coming constraints lying on the propelling distinctiveness are conversed by way of the charts.

Selection and peer-review under responsibility of the scientific committee of the International Conference on Nanoelectronics, Nanophotonics, Nanomaterials, Nanobioscience & Nanotechnology.

1. Preamble

The Jeffrey mold is moderately uncomplicated linear viscoelastic replica via instant imitative as an alternative of convicted imitative in favor of illustrations the Oldroyd-B facsimile do, it correspond to a rheology diverse on or after the Newtonian. The effect of an endoscope on the peristaltic pumping of a Jeffrey fluid was conversed by Hayat et al. [11]. Hayat et al. [12,13] analyzed the peristaltic stream a Jeffrey solution within axisymmetric tube. The effects of an endoscope as well as enticement pasture (Mag field) on the peristaltic movement of Jeffrey solution were premeditated by Hayat et al. [14]. Sudhakara Reddy et al. [25] encompassed the peristaltic propelling of Jeffrey solution by way of uneven stickiness within a pipe. Effect of variable viscosity on the peristaltic flow of a Jeffrey solution within a pipe below the consequence of a magnetic pasture by employing Adomiane decomposition system was investigated by Gangavathi et al. [9]. Gangavathi et al. [10] premeditation includes the peristaltic stream of a Newtonian solution within an leaning asymmetric strait underneath the consequence of a magnetic field among uneven stickiness.

In addition, flow through a porous medium has been of significant attention in recent years predominantly amid geo-substantial solution dynamicists. Illustrations of usual permeable middling are rye bread, the human lung, sand in coastline, stand stone, sandstone, wood, bladders by means of shingle as well as in tiny blood shipping channels. The earliest study of peristaltic transport of a Newtonian through a porous medium is presented by Elsehawey et al. [6]. Elsehawey et al. [7] have investigated peristaltic flow of a generalized Newtonian solution throughout permeable middling. Peristaltic stream all the way through a permeable middling within an leaning planar strait be premeditated by Mekheimer [18] intriguing the gravity consequence happening on propelling distinctiveness. Hayat et al. [14] have studied the peristaltic stream of a Jeffrey solution through a permeable middling within a conduit underneath the consequences of captivating pasture with compliant walls. Subbareddy and Prasnathreddy [24] insultingly examined the effect of variable viscosity on peristaltic motion of a Jeffrey solution from beginning to end a permeable middling within a planar strait. Jyothi et al. [16] premeditated the peristaltic ship of a hyperbolic tangent solution flow all the way through a permeable middling in an inclined channel. Ranjitha and Subba Reddy [20] conversed the radiation effect happening on the peristaltic stream of a Jeffrey solution during a permeable middling within a conduit.

Hayat et al. [12,13] deliberated the consequences of Hall on peristaltic stream of a Maxwell solution within a permeable middling. Abo-Eldahab et al. [1] have examined the possessions of Hall as well as ionslip current lying on magneto hydro energetic peristaltic shipment as well as combine anxiety solution. Eldabe et al. [5] premeditated the Hall consequences lying on the peri-

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https://doi.org/10.1016/j.matpr.2021.05.696
2214-7853/
Selection and peer-review under responsibility of the scientific committee of the International Conference on Nanoelectronics, Nanophotonics, Nanomaterials, Nanobioscience & Nanotechnology.

staltic propelling of 3rd categorized solution within a permeable middling by way of warmth as well as gathering relocate. consequence of hall as well as ionslip lying on peristaltic blood stream of Eyrring Poweall solution within a not identical permeable strait was conversed via Bhatti et al. [3]. Subba Narasimhudu and Subba Reddy [22] have explored the Hall possessions lying on the peristaltic propelling of a Newtonian solution within a planar strait.

The peristaltic transport of a Newtonian solution from beginning to end of 2D micro (10^{-6}) strait where the slither consequence is present be explored by Kwang [15]. El Sehaway et al. [8] has premeditated the consequences of slither lying on the peristaltic stream of a Maxwell solution within a strait. The consequence of slip as well as non– Newtonian constraints lying on the peristaltic stream of a third ranking solution within a rounded cylindrical pipe was explored via Ali et al. [2]. Chaube et al. [4] cover studied the slither consequences on the peristaltic stream of a micro (10^{-6}) polar solution within a conduit. Consequences of slither and provoked magnetic field on the peristaltic stream of pretend plastic solution are examined by Noreen et al. [19]. Subba reddy et al. [23] examined the slither consequences on the peristaltic shift of a Jeffrey solution from beginning to end a permeable middling in an asymmetric conduit below the consequence of mesmeric pasture. Slither personal property on peristaltic ship of a Prandtl solution in a strait in the effect of magnetic pasture was deliberated by Jyothi et al. [15].

In sight of these, we deliberated the consequences of Hall as well as slither on the peristaltic stream of a Jeffrey solution from beginning to end a permeable middling in an leaning 2D conduit below the elongated wavelength estimation. Congested appearance explanations be acquired for axial swiftness as well as axial heaviness slope. The consequences of an assortment of budding constraints on the propelling distinctiveness are conversed among the abet of graphs [17].

2. Geometrical formulation

We think about the peristaltic stream of a Jeffrey solution from beginning to end a permeable middling within a 2D symmetric conduit of thickness $2a$ below the consequences of magnetic field. The conduit fortifications are leaning next to an viewpoint α to the horizontal. The stream is generated via sinusoidal gesture trains proliferating through invariable pace c all besides the conduit fortifications. A unvarying mesmeric pasture B_0 is functional in the sloping bearing to the stream. The mesmeric Reynolds integer is pain staked tiny and so provoking mesmeric pasture mistreated. Diagram1 corresponds to the corporeal replica of the strait.

The geometry of the partition surface is defined as

$$Y = \pm H(X,t) = \pm a \pm b\cos\frac{2\pi}{\lambda}(X - ct) \tag{2.1}$$

where b is the wave amplitude and λ is the wave length.

We shall carryout this investigation in a co-ordinate system moving with wave speed, in which the boundary shape is stationary. The co-ordinates and velocities in the laboratory frame (X, Y) and the wave frame (x, y) are related by

$$x = X - ct,\ y = Y,\ u = U - c,\ v = V,\ p(x) = P(X,t) \tag{2.2}$$

The equations governing the flow in the wave frame are

$$\frac{\partial u}{\partial x} + \frac{\partial v}{\partial y} = 0 \tag{2.3}$$

$$\rho\left(u\frac{\partial u}{\partial x} + v\frac{\partial u}{\partial y}\right) = -\frac{dp}{dx} + \frac{\partial \tau_{xx}}{\partial x} + \frac{\partial \tau_{yx}}{\partial y} + \frac{\sigma B_0^2}{1+m^2}(mv - (u+c)) - \frac{\mu}{k}(u+c) + \rho g\sin\alpha \tag{2.4}$$

$$\rho\left(u\frac{\partial v}{\partial x} + v\frac{\partial v}{\partial y}\right) = -\frac{dp}{dy} + \frac{\partial \tau_{xy}}{\partial x} + \frac{\partial \tau_{yy}}{\partial y} - \frac{\sigma B_0^2}{1+m^2}(m(u+c) + v) - \frac{\mu}{k}v - \rho g\cos\alpha \tag{2.5}$$

where ρrepresents density, $g$be the quickening(accrtn) because of gravity, σ be electrical conductivity, B_0 be mesmeric pasture potency as well as m be Hall constraint.

The prevailing eqtn for the Jeffery solution be

$$\tau = \frac{\mu}{1+\lambda_1}(\dot{\gamma} + \lambda_2\ddot{\gamma}) \tag{2.6}$$

Everyplace λ_1 be fraction of recreation instance to retard moment, λ_2 be retardation time, μ be energetic stickiness, $\dot{\gamma}$ be shear pace as well as blotch above the Parameter point out discrimination (differentiation) with via point in time t.

The consequent measuremental border line circumstances be

$u + \beta\tau_{xy} = -c$ at$y = H(x)$ (slither situation) (2.7) $\frac{\partial u}{\partial y} = 0$ at $y = 0$ (equilibrium situation) (2.8)

The constitute equation for the Jeffery fluid is

$$\tau = \frac{\mu}{1+\lambda_1}(\dot{\gamma} + \lambda_2\ddot{\gamma}) \tag{2.9}$$

by means of the subsequent non measuremental parameters

$$\bar{x} = \frac{x}{\lambda},\ \bar{y} = \frac{y}{a},\ \delta = \frac{a}{\lambda},\ \bar{\mu} = \frac{u}{c},\ \bar{t} = \frac{ct}{\lambda},\ \bar{v} = \frac{v}{c\delta},\ \bar{\tau} = \frac{a\tau}{\mu c},\ \bar{p} = \frac{pa^2}{\mu c\lambda} \tag{2.10}$$

in the equations (2.4) and (2.5), we get

$$Re\delta\left(u\frac{\partial u}{\partial x} + v\frac{\partial u}{\partial y}\right) = -\frac{dp}{dx} + \delta\frac{\partial \tau_{xx}}{\partial x} + \frac{\partial \tau_{yx}}{\partial y} + \frac{M^2}{1+m^2}(m\delta v - (u+1)) - \frac{1}{Da}(u+1) + \frac{Re}{Fr}\sin\alpha \tag{2.11}$$

$$Re\delta^3\left(u\frac{\partial v}{\partial x} + v\frac{\partial v}{\partial y}\right) = -\frac{dp}{dx} + \delta^2\frac{\partial \tau_{xy}}{\partial x} + \delta\frac{\partial \tau_{yy}}{\partial y} - \frac{\delta M^2}{1+m^2}(m(u+1) + \delta v) - \frac{\delta^2}{Da}v - \frac{Re}{Fr}\delta\cos\alpha \tag{2.12}$$

everywhere $Re = \frac{\rho ac}{\mu}$ be the Reynolds quantity,$Fr = \frac{c^2}{ag}$ be Froude integer,$M = aB_0\sqrt{\frac{\sigma}{\mu}}$ is the Hartmann integer,

$$\tau_{xx} = \frac{2\delta}{(1+\lambda_1)}\left[1 + \frac{\lambda_2 c\delta}{a}\left(u\frac{\partial}{\partial x} + v\frac{\partial}{\partial y}\right)\right]\frac{\partial u}{\partial x}$$

$$\tau_{xy} = \frac{1}{(1+\lambda_1)}\left[1 + \frac{\lambda_2 c\delta}{a}\left(u\frac{\partial}{\partial x} + v\frac{\partial}{\partial y}\right)\right]\left(\frac{\partial u}{\partial y} + \delta^2\frac{\partial v}{\partial x}\right)$$

and $\tau_{yy} = \frac{2\delta}{(1+\lambda_1)}\left[1 + \frac{\lambda_2 c\delta}{a}\left(u\frac{\partial}{\partial x} + v\frac{\partial}{\partial y}\right)\right]\frac{\partial v}{\partial y}$.

in view of the fact that we are concerned within the case of inactivity gratis, elongated signal extent as in Shapiro et al. [21] as well as thus eqtns (2.11) and (2.12) reduces to

$$\frac{1}{(1+\lambda_1)}\frac{\partial^2 u}{\partial y^2} - \left(\frac{M^2}{1+m^2} + \frac{1}{Da}\right)u = \frac{\partial p}{\partial x} - \frac{Re}{Fr}\sin\alpha + \left(\frac{M^2}{1+m^2} + \frac{1}{Da}\right) \tag{2.13}$$

$$\frac{\partial p}{\partial y} = 0 \tag{2.14}$$

Equation (2.14) involves so as to, hence be single role of x. as a result, the Eqtn (2.13) be able to be redrafted like

$$\frac{1}{(1+\lambda_1)}\frac{\partial^2 u}{\partial y^2}-\left(\frac{M^2}{1+m^2}+\frac{1}{Da}\right)u=\left(\frac{dp}{dx}-\frac{Re}{Fr}\sin\alpha\right)+\left(\frac{M^2}{1+m^2}+\frac{1}{Da}\right) \tag{2.15}$$

The consequent no measuremental slither border line circumstances within the signal casing be specified via

$$u+\frac{\beta}{1+\lambda_1}\frac{\partial u}{\partial y}=-1\ at\ y=h=1+\phi\cos 2\pi x \tag{2.16}$$

$$\frac{\partial u}{\partial y}=0 \quad at \quad y=0 \tag{2.17}$$

The volumetric stream ratio q in the signal casing be specified via

$$q=\int_0^h u dy \tag{2.18}$$

The immediate quantity (volume) stream pace within the unchanging casing is specified via

$$Q(x,t)=\int_0^h u dy=\int_0^h (u+1)dy=q+h \tag{2.19}$$

The instance typical fluctuation above individual phase $T\left(=\frac{\lambda}{c}\right)$ of the peristaltic signal be

$$\bar{Q}=\frac{1}{T}\int_0^T Qdt=q+1 \tag{2.20}$$

3. Explanation

Explaining Eqn (2.15) by means of border line circumstances (2.16) as well as (2.17) we acquire

$$u=\left(\frac{1+\lambda_1}{\alpha^2}\right)\left(\frac{dp}{dx}-\frac{Re}{Fr}\sin\alpha\right)[c_1\cosh\alpha y-1]-1 \tag{3.1}$$

Where $\alpha=\sqrt{(1+\lambda_1)\left(\frac{M^2}{1+m^2}+\frac{1}{Da}\right)}$, $c_1=\frac{1}{\cosh\alpha h+\beta_1\sinh\alpha h}$ and $\beta_1=\frac{\alpha\beta}{1+\lambda_1}$.

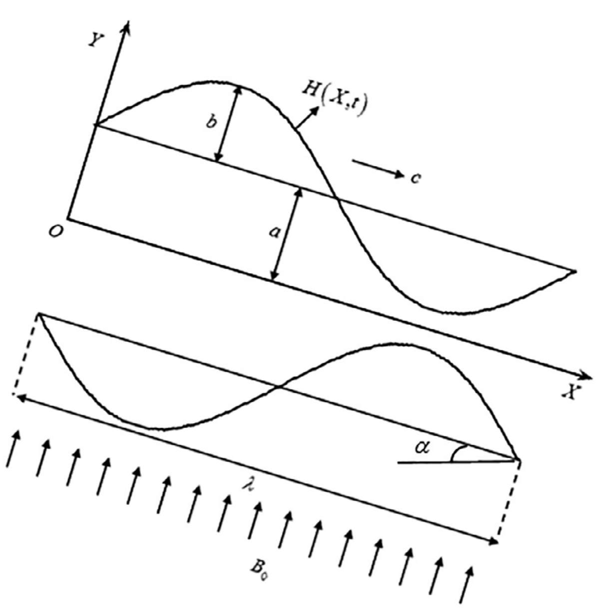

Fig. 1. Physical model.

The dimensions (volume) stream pace q within a signal outline of situation be specified via

$$q=\frac{1+\lambda_1}{\alpha^3}\left(\frac{dp}{dx}-\frac{Re}{Fr}\sin\alpha\right)[c_1\sin h\alpha h-\alpha h]-h \tag{3.2}$$

as of Eq. (3.2), we put pen to paper

$$\frac{dp}{dx}=\frac{(q+h)\alpha^3}{c_1\sinh\alpha h-\alpha h}+\frac{Re}{Fr}\sin\alpha \tag{3.3}$$

The pressure augment above the 1 signal distance end to end of the peristaltic signal is specified via

$$\Delta p=\int_0^1\frac{dp}{dx}dx \tag{3.4}$$

As $\alpha\to 0$, $\lambda_1\to 0$, $Da\to\infty$, $M\to 0$, $m\to 0$ and $\beta\to 0$ outcomes of these concur among outcome of Shapiro et al. [21]. (See Fig. 1)

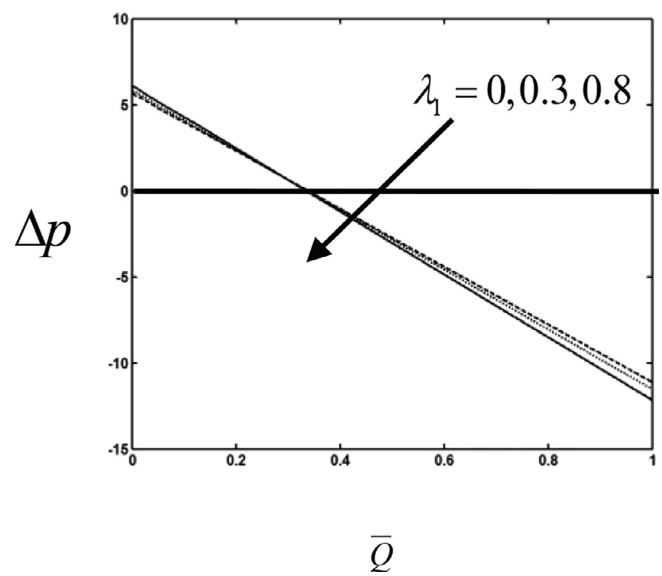

Fig. 2. The dissimilarity of heaviness climb Δp with time averaged stream pace $\bar{Q}$ for diverse ideals of Jeffrey solution parameter λ_1 by way of $\phi=0.5, M=1, Da=0.1, Re=2, Fr=0.5, \alpha=\frac{\pi}{4}, \beta=0.1$ as well as $m=0.3$

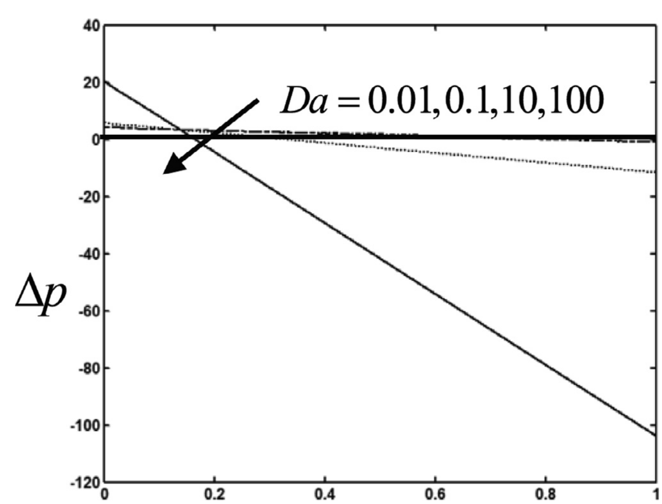

Fig. 3. The disparity of heaviness mount Δp with time averaged stream pace $\bar{Q}$ for diverse ideals of Darcy integer Da by $\phi=0.5$, $\lambda_1=0.4$, $Re=2$, $Fr=0.5$, $\alpha=\frac{\pi}{4}, m=0.3$, $\beta=0.1$ as well as $M=1$.

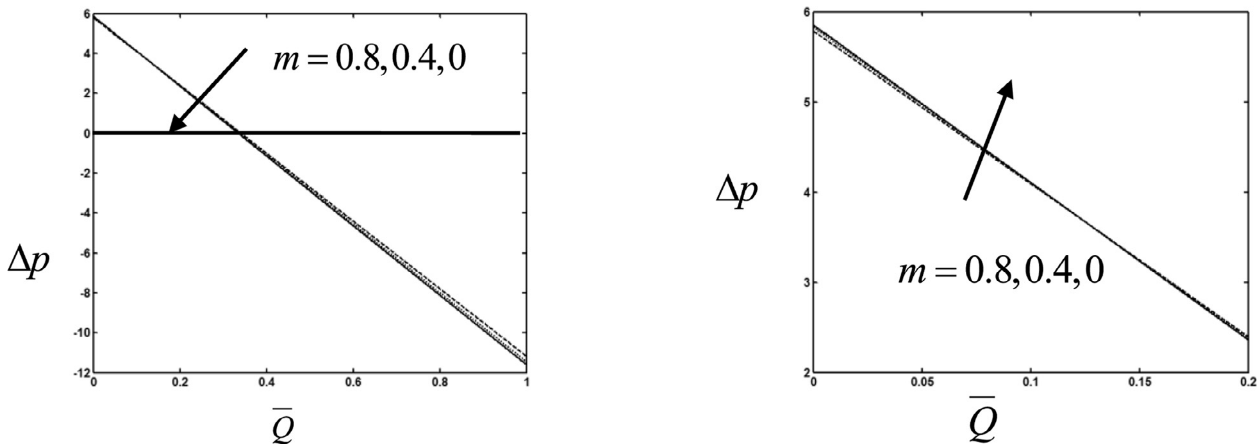

Fig. 4. The disparity of heaviness mount Δp with time averaged stream pace $\bar{Q}$ for unlike values of Hall constraint m with $\phi = 0.5$, $Da = 0.1$,$Re = 2$, $Fr = 0.5$, $\alpha = \frac{\pi}{4}$,$\lambda_1 = 0.4$, $\beta = 0.1$ as well as $M = 1$.

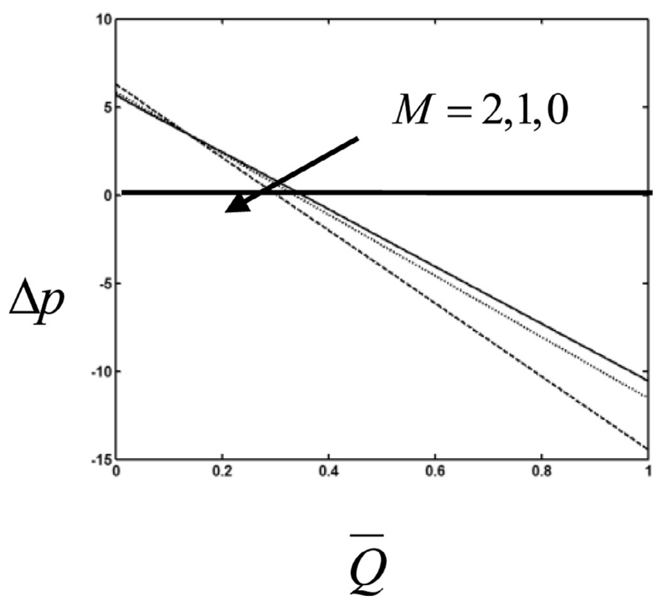

Fig. 5. The disparity of heaviness mount Δp through time averaged stream pace $\bar{Q}$ for diverse ideals of Hartmann quantity M with $\phi = 0.5$, $Da = 0.1$, $\lambda_1 = 0.4$, $Re = 2$, $Fr = 0.5$, $\alpha = \frac{\pi}{4}$,$\beta = 0.1$ as well as $m = 0.3$.

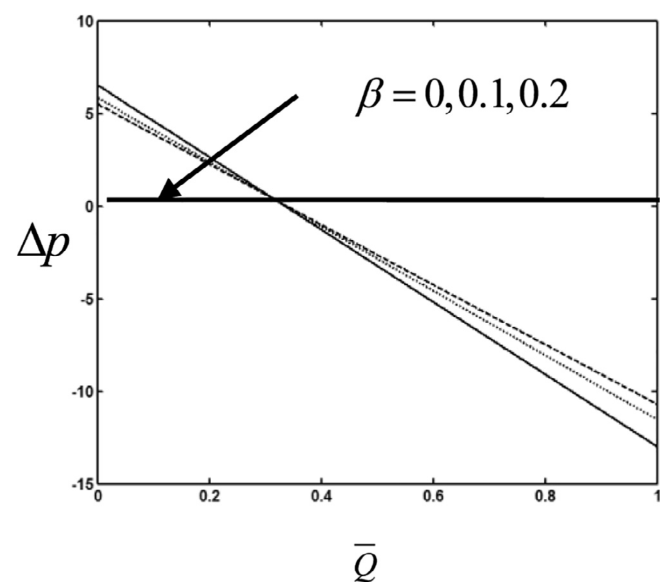

Fig. 6. The dissimilarity of heaviness mount Δp by time averaged stream pace $\bar{Q}$ for unlike ideals of slip parameter β through $\phi = 0.5$, $Da = 0.1$,$\lambda_1 = 0.4$, $Re = 2$, $Fr = 0.5$, $\alpha = \frac{\pi}{4}$,$M = 1$ as well as $m = 0.3$.

4. Conversation and outcomes

During distinguish the possessions of a variety of constraints like Jeffrey fluid parameter λ_1, Darcy number Da, Hall parameter m, Hartmann digit M, slip parameter β, amplitude fraction ϕ, proclivity viewpoint α, Reynolds integer Re as well as Froude number Fr lying on the propelling distinctiveness, we could contrive Figs. 2-10.

The discrepancy of heaviness augment Δp by way of moment middling stream pace $\bar{Q}$ in favor of diverse ideals of Jeffrey fluid constraint λ_1 by means of $\phi = 0.6$, $Da = 0.1$, $Re = 2$, $Fr = 0.5\alpha = \frac{\pi}{4}$,$M = 1\beta = 0.1$ and $m = 0.2$ is revealed within Fig. 2. It's viewed to, the time middling stream pace $\bar{Q}$ diminish together within the propelling($\Delta p > 0$) as well as free - propelling($\Delta p = 0$) province by way of escalating λ_1, although it amplifies during the co– propelling section($\Delta p < 0$) by way of mounting λ_1.

Fig. 3 shows the dissimilarity of heaviness climb Δp by way of timeaveraged stream pace $\bar{Q}$ in favor of dissimilar ideals of Darcy integers Da among $\phi = 0.5$, $m = 0.3$, $Re = 2$, $Fr = 0.5$, $\alpha = \frac{\pi}{4}$,$\lambda_1 = 0.4$, $\beta = 0.1$ and $M = 1$. It's established to, the timeaveraged stream pace $\bar{Q}$ diminishes within the propelling section by way of mounting Da, whereas it amplify within together the free propelling as well as co– propelling sections by way of escalating Da.

The dissimilarity of heaviness mount Δp by means of timeaveraged stream pace $\bar{Q}$ for unlike ideals of Hall constraints m by way of $\phi = 0.5$, $Da = 0.1$, $Re = 2$, $Fr = 0.5$, $\alpha = \frac{\pi}{4}$,$\lambda_1 = 0.4$, $\beta = 0.1$ and $M = 1$ is offered within Fig. 4. It's monitored that, the timeaveraged stream pace $\bar{Q}$ diminished within the propelling province by way of escalating m, whereas it amplifies inside together free propelling as well as co propelling sections by way of escalating m.

Fig. 5 depicts the dissimilarity of heaviness mount Δp by way of timeaveraged stream pace $\bar{Q}$ for diverse ideals of Hartmann integers M by way of $\phi = 0.5$,$Da = 0.1$, $Re = 2$, $Fr = 0.5$, $\alpha = \frac{\pi}{4}$, $\lambda_1 = 0.4$, $\beta = 0.1$ and $m = 0.3$. It's seen so as to, the timeaveraged flow rate $\bar{Q}$ amplifies within the propelling section by way of esca-

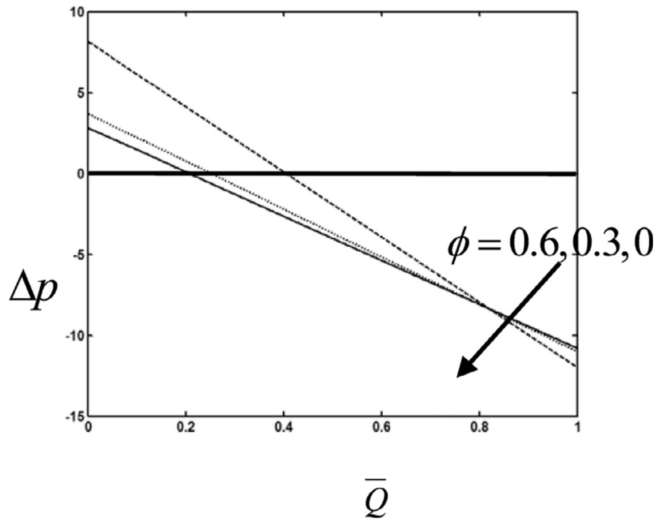

Fig. 7. The disparity of heaviness mount Δp through time averaged stream pace $\bar{Q}$ for diverse ideals of amplitude proportion ϕ through $M = 1$, $Da = 0.1$, $Re = 2$, $Fr = 0.5$, $\alpha = \frac{\pi}{4}$, $\lambda_1 = 0.4$, $\beta = 0.1$ as well as $m = 0.3$.

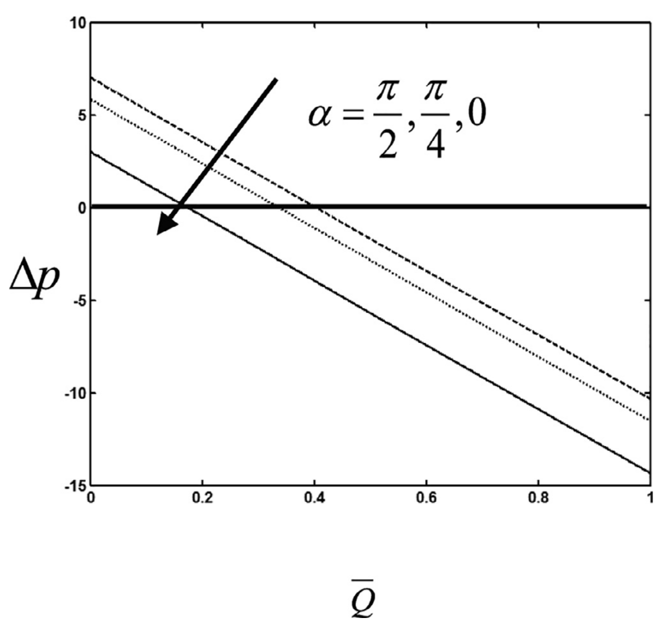

Fig. 8. The dissimilarity of heaviness mount Δp through time averaged stream pace $\bar{Q}$ for unlike ideals of leaning viewpoint α with $M = 1$, $Da = 0.1$, $Re = 2$, $Fr = 0.5$, $\phi = 0.5$, $\lambda_1 = 0.4$, $\beta = 0.1$ as well as $m = 0.3$.

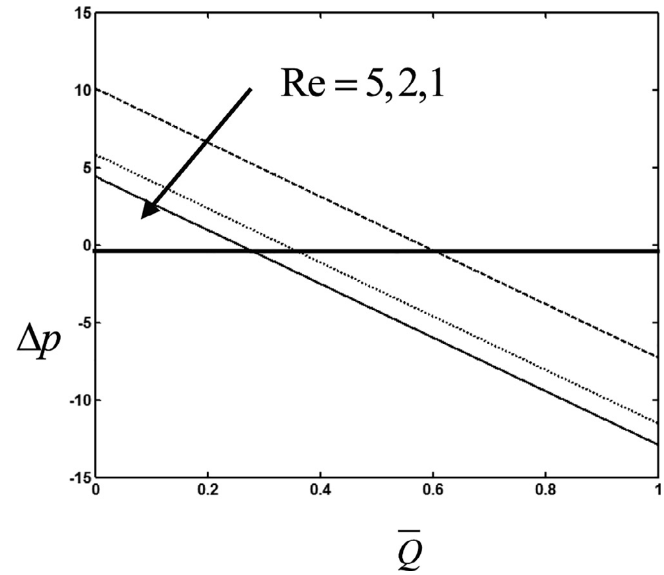

Fig. 9. The dissimilarity of heaviness mount Δp through time averaged stream pace $\bar{Q}$ for diverse ideals of Reynold's integer Re through $M = 1$, $Da = 0.1$, $\phi = 0.5$, $Fr = 0.5$, $\alpha = \frac{\pi}{4}$, $\lambda_1 = 0.4$, $\beta = 0.1$ as well as $m = 0.3$.

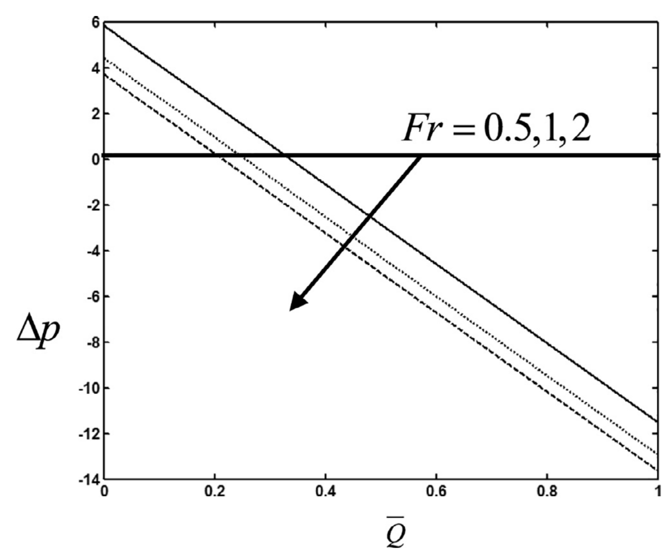

Fig. 10. The variation of pressure rise Δp with time averaged stream pace $\bar{Q}$ for diverse ideals of Froude numeral Fr through $M = 1$, $Da = 0.1$, $Re = 2$, $\phi = 0.5$, $\alpha = \frac{\pi}{4}$, $\lambda_1 = 0.4$, $\beta = 0.1$ as well as $m = 0.3$.

lating M, whereas it declines within equally in free propelling as well as co propelling sections by way of escalating M.

The dissimilarity of heaviness mount Δp with timeaveraged flow rate $\bar{Q}$ in favor of diverse ideals of slip parameter β with $\phi = 0.5$, $Da = 0.1$, $Re = 2$, $Fr = 0.5$, $\alpha = \frac{\pi}{4}$, $\lambda_1 = 0.4$, $M = 1$ and $m = 0.3$ is represented within Fig. 6. It's established that, the timeaveraged stream pace $\bar{Q}$ diminishes within equally in the propelling as well as free propelling sections by way of escalating β, whereas it amplifies in the co propelling sections by way of escalating β for preferred $\Delta p(< 0)$

Fig. 7 demonstrated the disparity of heaviness augment Δp by way of timeaveraged stream pace $\bar{Q}$ for diverse ideals of amplitude ratio ϕ with $M = 1$, $Da = 0.1$, $Re = 2$, $Fr = 0.5$, $\alpha = \frac{\pi}{4}$, $\lambda_1 = 0.4$, $\beta = 0.1$ & $m = 0.3$. It's observed so as to, the timeaveraged stream rate $\bar{Q}$ amplifies in together inthe propelling as well as free propelling sections with increasing ϕ, whereas it declines in the co propelling sections by means of increasing ϕ in favor of preferred $\Delta p(< 0)$.

The disparity of heaviness augment Δp by way of timeaveraged flow rate $\bar{Q}$ for diverse values of leaning viewpoint α by way of $M = 1$, $Da = 0.1$, $Re = 2$, $Fr = 0.5$, $\phi = 0.5$, $\lambda_1 = 0.4$, $\beta = 0.1$ and $m = 0.3$ is illustrated in Fig. 8. It's seen that, the timeaveraged stream pace $\bar{Q}$ amplifies through escalating αin the propelling, free propelling as well as co propelling sections.

Fig. 9 shows the dissimilarity of heaviness mount Δp with timeaveraged flow rate $\bar{Q}$ for diverse ideals of Reynolds digit Re with $M = 1$, $Da = 0.1$, $\phi = 0.5$, $Fr = 0.5$, $\alpha = \frac{\pi}{4}$, $\lambda_1 = 0.4$, $\beta = 0.1$ and $m = 0.3$. It's seen that, the timeaveraged stream pace $\bar{Q}$ amplifies by way of escalating *Re*within the propelling, free propelling and co propelling sections.

The disparity of heaviness mount Δp through timeaveraged stream pace $\bar{Q}$ for unlike ideals of Froude number *Fr* with $M = 1$, $Da = 0.1$,$Re = 2$, $\phi = 0.5$, $\alpha = \frac{\pi}{4}$,$\lambda_1 = 0.4$, $\beta = 0.1$ and $m = 0.3$ is revealed in Fig. 10. It's seen that, the timeaveraged stream pace $\bar{Q}$ decline by escalating *Fr*in the propelling, free propelling and co propelling sections.

5. Conclusion

Herein present manuscript, we studied the possessions of Hall as well as slip effects taking place on the peristaltic propelling of a Jeffrey solution during a permeable middling in an leaning 2D strait beneath the postulation of elongated signal extent. The expressions for the swiftness pasture as well as axial heaviness slope are attained systematically. It's established that, the timeaveraged stream pace $\bar{Q}$ within the propelling section is amplifies through growing M, ϕ, α or Re, although it diminishes through escalating λ_1, m,β or Fr. Further, it's established that the propelling is additional for Newtonian solution $(\lambda_1 \to 0)$ than that of Jeffrey solution.

CRediT authorship contribution statement

P. Gangavathi: Methodology. **S. Jyothi:** Writing - original draft. **M.V. Subba Reddy:** Conceptualization. **P. Yogeswara Reddy:** Writing - review & editing.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Further Reading

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