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Effect of Couple Stress on Peristaltic Transport of Powell-Eyring Fluid Peristaltic flow in Inclined Asymmetric Channel with Porous Medium

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ABSTRACT: The goal of this study is to investigate the effect of couple stress on Powell-Eyring fluid peristaltic transport in an inclined asymmetric channel using porous medium. Peristaltic motion of a magnetohydrodynamic Powell-Eyring fluid in inclined asymmetric channel with porous medium, medium is investigated in the present study. The modeling of mathematic is created in the presence of effect of couple stress, using constitutive equations following the Powell-Eyring fluid model. In flow analysis, assumptions such as long wave length approximation and low Reynolds number are utilized. Closed form formulas for the stream function and mechanical efficiency are created. On the channel walls, pressure rise per wave length has been calculated numerically. The effects of the Hartman number (Ha), Darcy number (Da), material fluid parameter (w), inclination of magnetic field (β), amplitude ratio ($\varnothing$), The effects of the Couple Stress on axial velocity and entrapment are investigated in detail and graphically shown.

Keywords: Couple Stress, PowellEyring Fluid, Porous Medium

1. INTRODUCTION

The peristaltic motion is a series of contractions and diastoles that push fluid along the path, making it easier to move. Peristalsis is a natural property of smooth muscles and tubes that carry fluid through vessels as a result of motor activity in numerous biological systems, the passage of urine from the kidney to the bladder, the movement of food through the gastrointestinal tract, and the migration of eggs through the fallopian tube are all examples of this movement . M [1]any researchers study peristaltic transport with heat transfer (with or without porous medium) in a range of subjects and applications, including:, [2] in [3]vestigated the combined influence of velocity slip, temperature, and density jump conditions on MHD peristaltic transport of a Carreau fluid in a non-uniform channel , t [4]o investigate the impact of Heat generation on MHD peristaltic flow in a nanofluid with compliant walls. Pair fluid behavior studies are essential for understanding a range of physical issues, and they can better describe the behavior of rheologic ally complicated fluids including liquid crystals, polymeric suspensions with long chain molecules, lubrication, and human/sub-human blood. A couple-stress fluid is a non-Newtonian fluid with specified particle sizes. In classical continuum theory, the effects of particle sizes are not examined. Peristaltic transmission of couple-stress fluid has been studied recently [5–8]. Despite the fact that there is always some slide in real systems, several of the experiments on couple-stress fluids defined above employed blood as a couple stress fluid and were carried out under no slip conditions. Peristalsis is a natural property of smooth muscles and tubes that carry fluid through vessels as a result of motor activity in numerous biological systems. The governing equations for continuity and motion have been constructed, and analytic solutions have been performed using the assumptions of a long wave-length and a low Reynolds number. The effect of emerging parameters on the velocity and pressure could be studied and the phenomenon of trapping also discussable.

2. MATHEMATICAL FORMULATION FOR ASYMMETRIC FLOW

Consider the flow of an incompressible "Powell-Eyring fluid" in a two-dimensional asymmetric channel of width (d + d'). The flow is caused by an infinite sinusoidal wave line moving forward and with constant velocity c along the channel's walls . An asymmetric channel is formed by varying wave amplitudes, phase angles, and channel widths.

The walls geometries get modeled as

$$\overline{h_1}(\bar{x},\bar{t}) = d - a_1 \sin\left[\frac{2\pi}{\lambda}(\bar{x} - \bar{c})\right] \text{ upper wall} \tag{1}$$

$$\overline{h_2}(\bar{x},\bar{t}) = -d' - a_2 \sin\left[\frac{2\pi}{\lambda}(\bar{x} - c\bar{t}) + \emptyset\right] \text{ lower wall} \tag{2}$$

Where (a_1), (a_2),(d),(d'), (c) , (t) are the wave amplitudes, channel width, wavelength, and wave speed, $(0 \leq \varnothing. \leq \pi)$ is the phase difference and thus the rectangular coordinate system gets chosen with the ($\overline{X}$. -axis) parallel to the wave propagation direction and the ($\overline{Y}$.-.axis) perpendicular to the wave propagation direction. It's worth noting that (∅=0) corresponds to a symmetric channel with out of phase waves, whereas(∅=) corresponds to a symmetric channel with in phase waves. (a_1), $(a_{.2})$, (d.), (d') and (∅) also meet the following criteria ."It is noticed that (∅=0) corresponds to symmetric channel with waves out of phase and for (∅=) the waves are in phase". Further (a_1), (a_2) , (d), (d') and (∅) satisfy the condition":

$a_1^2 + .a_2^2 + 2a_{.1.}a_{.2}coso(\varnothing) \leq\ (d4 + d')^2.$

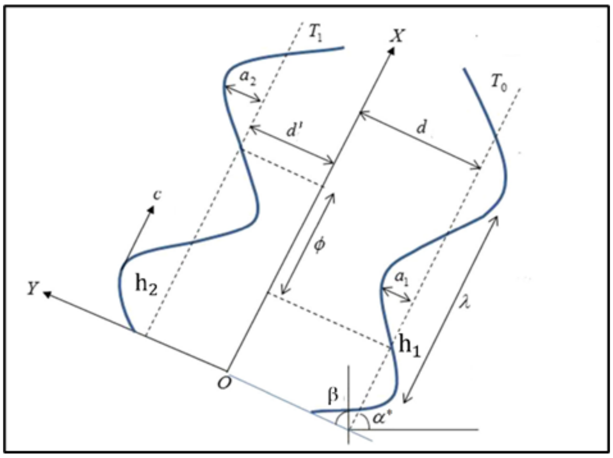

FIGURE 1. Cartesian Dimensional Inclined Asymmetric Channels Coordinates.

It's also assumed that there's no longitudinal movement of the walls. This assumption limits wall deformation but does not imply that the channel is stiff for longitudinal motions.

3. BASIC EQUATION

The fluid follows the Powell Erring model, and the Cauchy stress tensor,. of it is as follows: [9] .

$$\bar{\tau} = -PI + \bar{S}, \tag{3}$$

$$\bar{S} = \left[\mu + \frac{1}{\beta\dot{\gamma}}\sinh^{-1}\left(\frac{\dot{\gamma}}{c_1}\right)\right]A_{11}, \tag{4}$$

$$\dot{\gamma} = \sqrt{\frac{1}{2}tras(A_{11})^2} \tag{5}$$

$$A_{11} = \nabla\bar{V} + (\nabla\bar{V})^T \tag{6}$$

Where $\left(\bar{S}\right)$ expresses the extra tensor's stress, I the identity tensor, $\bar{\nabla} = (\partial \bar{X}\ ,\ \partial \bar{Y}\ , 0)$ the gradient vector, (β, c_1) the Powell-Eyring fluid's martial characteristics, $(\bar{P})$ the fluid's pressure, and (μ) the dynamic viscosity.

The terms $sinh^{-1}$ is approximated as

$$\sinh^{-1}\left(\frac{\dot{\gamma}}{c_1}\right) = \frac{\dot{\gamma}}{c_1} - \frac{\dot{\gamma}^3}{6{c_1}^3}, \left|\frac{\dot{\gamma}^5}{{c_1}^5}\right| \ll 1 \tag{7}$$

$$\bar{s}_{\bar{x}\bar{x}} = 2(\mu + \frac{1}{\beta\, c_1})\bar{u}_{\bar{x}} - \frac{1}{3\,\beta\, {c_1}^3}[2\bar{u}_{\bar{x}}^{\ 2} + \left(\bar{v}_{\bar{x}} + \bar{u}_{\bar{y}}\right)^2 + 2\bar{v}^{\ 2}_{\ \bar{y}}]\bar{u}_{\bar{x}} \tag{8}$$

$$\bar{s}_{\bar{x}\bar{y}} = \left(\mu + \frac{1}{\beta c_1}\right)\left(\bar{v}_{\bar{x}} + \bar{u}_{\bar{y}}\right) - \frac{1}{6\beta {c_1}^3}\left[2\bar{u}_{\bar{x}}^{2} + \left(\bar{v}_{\bar{x}} + \bar{u}_{\bar{y}}\right)^2 + 2\bar{v}_{\bar{y}}^2\right]\left(\bar{v}_{\bar{x}} + \bar{u}_{\bar{y}}\right), \tag{9}$$

$$\text{And } \bar{s}_{\bar{y}\bar{y}} = 2\left(\mu + \frac{1}{\beta c_1}\right)\bar{v}_{\bar{y}} - \frac{1}{3\beta {c_1}^3}\left[2\bar{u}_{\bar{x}}^2 + \left(\bar{v}_{\bar{x}} + \bar{u}_{\bar{y}}\right)^2 + 2\bar{v}^2\right]\bar{v}_{\bar{y}}. \tag{10}$$

4. THE GOVERNING EQUATION

With in laboratory frame $(\bar{x}\ , , \bar{y}\ )$, the governing equations inside an inclined channel with inclined magnetic field on Powel-Eyring fluid can be written as the continuous equation:

$$\frac{\partial\, \bar{u}}{\partial \bar{x}} + \frac{\partial\, \bar{v}}{\partial \bar{y}} = 0 \tag{11}$$

The $\bar{x}$ – component of moment equation :

$$\rho\left(\frac{\partial\, \bar{u}}{\partial \bar{t}} + \bar{u}\frac{\partial\, \bar{u}}{\partial \bar{x}} + \bar{v}\frac{\partial\, \bar{u}}{\partial \bar{y}}\right) = -\frac{\partial \bar{p}}{\partial \bar{x}} + \frac{\partial}{\partial \bar{x}}\bar{s}_{\bar{x}\bar{x}} + \frac{\partial}{\partial \bar{y}}\bar{s}_{\bar{x}\bar{y}} - \sigma {\beta_0}^2 cos\beta\left(\bar{u}\ cos\beta - \bar{v}\ sin\beta\right) - \frac{\mu}{\bar{k}}\ \bar{u} - \mu_1\ \nabla^4\ \bar{u} + \rho\ g\ sin\ \alpha^* \tag{12}$$

The $\bar{y}$ – component of moment equation :

$$\rho\left(\frac{\partial \bar{v}}{\partial \bar{t}} + \bar{u}\frac{\partial \bar{v}}{\partial \bar{x}} + \bar{v}\frac{\partial \bar{v}}{\partial \bar{y}}\right) = -\frac{\partial \bar{p}}{\partial \bar{y}} + \frac{\partial}{\partial \bar{x}}\bar{s}_{\bar{x}\bar{y}} + \frac{\partial}{\partial \bar{y}}\bar{s}_{\bar{y}\bar{y}} - \sigma\beta_0^2 \sin\beta(\bar{u}\cos\beta - \bar{v}\sin\beta) - \frac{\mu}{\bar{k}}\bar{v} - \mu_1\nabla^4\bar{v} - \rho g \cos\alpha^*. \tag{13}$$

Let $\nabla^2 = \left(\frac{\partial^2}{\partial \bar{x}^2} + \frac{\partial^2}{\partial \bar{y}^2}\right)$ then $\nabla^4 = \left(\nabla^2\right)^2$

where the (ρ) , $(\bar{u})$, $(\bar{v})$, $(\bar{y}\ )$, $(\bar{p})$, $(\mu\ )$, $(\bar{k}\ )$, (B_0) are" the fluid density ,axial velocity , transverse velocity, transverse coordinate , pressure, viscosity , material constant, permeability parameter, constant magnetic field, is the electrical conductivity.

This flow is unsteady with in laboratory frame $(\bar{x}\ , \bar{y}\ )$, whereas the motion is steady inside a coordinate system flowing there at wave speed (c) in the wave framer $(\bar{x}\ , \bar{y}\ )$.

5. DIMENSIONLESS PARAMETER

We setup the following non-dimensional quantities to perform the non-dimensional analysis:

$$\begin{gathered} x = \frac{1}{\lambda}\bar{x}, y = \frac{1}{d}\bar{y}, u = \frac{1}{c}\bar{u}, v = \frac{1}{\delta c}\bar{v}, p = \frac{d^2}{\lambda\mu c}\bar{p}, t = \frac{c}{\lambda}\bar{t}, h_1 = \frac{1}{d}\overline{h_1},\ h_2 = \frac{1}{d}\overline{h_2}, \\ \delta = \frac{d}{\lambda}, \emptyset = \frac{b}{d}, Re = \frac{\rho c d}{\mu}, Ha = d\sqrt{\frac{\sigma}{\mu}}\beta_0, Da = \frac{\bar{k}}{d^2}, w = \frac{1}{\mu\beta c_1},\ A = \frac{w}{6}\left(\frac{c}{c_1\ d}\right)^2, \alpha = \\ d\sqrt{\frac{\mu}{\mu_1}}, Fr = \frac{c^2}{dg}, s_{xx} = \frac{\lambda}{\mu c}\bar{s}_{\bar{x}\bar{x}}, s_{xy} = \frac{d}{\mu c}\bar{s}_{\bar{x}\bar{y}}, s_{yy} = \frac{d}{\mu c}\bar{s}_{\bar{y}\bar{y}}, \beta_1 = \frac{\beta^*}{d} \end{gathered} \tag{14}$$

where (δ) is the wave number, (Ha) is the Hartman number, (Da) Darcy number, (Re) is the Renold number, (Fr) Froude. Number, ($\varnothing$) is the amplitude ratio, (w) is the dimensionless permeability of the porous medium parameter, (w, A) material fluid parameters, (α) couple stress, (α^*) Inclination. angle of the channel. to the horizontal axis, (β_1) represent the dimensionless slip parameters.

Then, in view of Eq. (14), Eq. (1),(2),and (8) to (13) take the form :

$$h_{i1}\,(x,t) = 1 - asin.X \tag{15}$$

$$h_2(x,t) = -d^* - b\sin[X + \emptyset]. \tag{16}$$

$$s_{xx} = 2\,(1+w)\,\frac{\partial u}{\partial x} - 2A\left(2\delta^2\left(\frac{\partial u}{\partial x}\right)^2 + \left(\delta^2\,\frac{\partial v}{\partial x} + \frac{\partial u}{\partial y}\right)^2 + 2\delta^2\left(\frac{\partial v}{\partial y}\right)^2\right]\frac{\partial u}{\partial x} \tag{17}$$

$$s_{xy} = (1+w)\left(\delta^2\,\frac{\partial v}{\partial x} + \frac{\partial u}{\partial y}\right) - A\left(2\delta^2\left(\frac{\partial u}{\partial x}\right)^2 + \left(\delta^2\,\frac{\partial v}{\partial x} + \frac{\partial u.}{\partial y}\right)^2 + 2\delta^2\left(\frac{\partial v}{\partial y}.\right)^2\right]\left(\delta^2\,\frac{\partial v}{\partial x} + \frac{\partial u.}{\partial y}\right) \tag{18}$$

$$s_{yy} = 2\,(1+w)\;\delta\frac{\partial v}{\partial y} - 2A\delta\left(2\delta^2\left(\frac{\partial u}{\partial x}\right)^2 + \left(\delta^2\,\frac{\partial v}{\partial x} + \frac{\partial u}{\partial y}\right)^2 + 2\delta^2\left(\frac{\partial v}{\partial y}\right)^2\right]\frac{\partial v}{\partial y} \tag{19}$$

$$\frac{\partial u.}{\partial x} + \frac{\partial v.}{\partial y} = 0 \tag{20}$$

$$Re\delta(\frac{\partial u}{\partial t} + u\frac{\partial u}{\partial x} + v\frac{\partial u}{\partial y}) = -\frac{\partial p}{\partial x} + \delta^2\frac{\partial}{\partial x}s_{xx} + \frac{\partial}{\partial y}s_{xy} - Ha^2 cosi\beta\,(ucos\beta - \delta vsini\beta) - \frac{1}{Da}u - \frac{1}{\alpha^2}$$
$$\left(\delta^4\,\frac{\partial^4}{\partial x^4} + 2\delta^2\frac{\partial^4}{\partial x^2\partial y^2} + \frac{\partial^4}{\partial y^4}\right)u + \frac{Re}{Fr}\;sin\;\alpha^* \tag{21}$$

$$\mathrm{Re}\,\delta^3\left(\frac{\partial \mathrm{v}}{\partial \mathrm{t}} + \mathrm{u}\frac{\partial \mathrm{v}}{\partial \mathrm{x}} + \mathrm{v}\frac{\partial \mathrm{v}}{\partial \mathrm{y}}\right) = -\frac{\partial \mathrm{p}}{\partial \mathrm{y}} + \delta^2\frac{\partial}{\partial \mathrm{x}}\mathrm{s_{xy}} + \delta\frac{\partial}{\partial \mathrm{y}}\mathrm{s_{yy}} + \mathrm{Ha}^2\sin\beta(\delta \mathrm{u}\cos\beta -$$
$$\delta^2 \mathrm{v}\sin\beta\Big) - \delta^2\frac{1}{\mathrm{Da}}\mathrm{v} - \frac{1}{\alpha^2}\delta^2\left(\delta^4\frac{\partial^4}{\partial \mathrm{x}^4} + 2\delta^2\frac{\partial^4}{\partial \mathrm{x}^2\partial \mathrm{y}^2} + \frac{\partial^4}{\partial \mathrm{y}^4}\right) - \delta\frac{\mathrm{Re}}{\mathrm{Fr}}\cos\alpha^* \tag{22}$$

The relations connect the stream function ($.\psi.$) to the velocity components.

$$\mathrm{u} = \frac{\partial\psi}{\partial \mathrm{y}}, \mathrm{v} = -\frac{\partial\psi}{\partial \mathrm{x}} \tag{23}$$

Substituted Eqs.(23) in Eqs. (17) to Eqs. (22) respectively,

$$s_{xx} = 2\,(1+w)\,\frac{\partial^2\psi}{\partial x\partial y} - 2A\left(2\delta^2\left(\frac{\partial^2\psi}{\partial x\partial y}\right)^2 + \left(-\delta^2\,\frac{\partial^2\psi}{\partial x^2} + \frac{\partial^2\psi}{\partial y^2}\right)^2 + 2\delta^2\left(-\frac{\partial^2\psi}{\partial x\partial y}\right)^2\right]\frac{\partial^2\psi}{\partial x\partial y} \tag{24}$$

$$s_{xy} = (1+w)\left(-\delta^2\,\frac{\partial^2\psi}{\partial x^2} + \frac{\partial^2\psi}{\partial y^2}\right) - A\left(2\delta^2\left(\frac{\partial^2\psi}{\partial x\partial y}\right)^2 + \left(-\delta^2\,\frac{\partial^2\psi}{\partial x^2} + \frac{\partial^2\psi}{\partial y^2}\right)^2 + 2\delta^2\left(-\frac{\partial^2\psi}{\partial x\partial y}\right)^2\right]\left(-\delta^2\,\frac{\partial^2\psi}{\partial x^2} + \frac{\partial^2\psi}{\partial y^2}\right) \tag{25}$$

$$s_{yy} = -2\,(1+w)\,\delta\frac{\partial^2\psi}{\partial x\partial y} - 2A\delta\left(2\delta^2\left(\frac{\partial^2\psi}{\partial x\partial y}\right)^2 + \left(-\delta^2\,\frac{\partial^2\psi}{\partial x^2} + \frac{\partial^2\psi}{\partial y^2}\right)^2 + 2\delta^2\left(-\frac{\partial^2\psi}{\partial x\partial y}\right)^2\right]\frac{\partial^2\psi}{\partial x\partial y} \tag{26}$$

$$\frac{\partial^2\psi}{\partial x\partial y} - \frac{\partial^2\psi}{\partial x\partial y} = 0 \tag{27}$$

$$Re\delta(\frac{\partial^2\psi}{\partial t\partial y} + \frac{\partial^3\psi}{\partial x\partial y^2} - \frac{\partial^3\psi}{\partial x\partial y^2}) = -\frac{\partial p}{\partial x} + \delta^2\frac{\partial}{\partial x}s_{xx} + \frac{\partial}{\partial y}s_{xy} - Ha^2cos\beta\left(\frac{\partial\psi}{\partial y}cos\beta\; + \;\delta\frac{\partial\psi}{\partial x}\;sin\beta\right) - \frac{1}{Da}\,\frac{\partial\psi}{\partial y} - \frac{1}{\alpha^2}$$
$$\left(\delta^4\,\frac{\partial^4}{\partial x^4} + 2\delta^2\frac{\partial^4}{\partial x^2\partial y^2} + \frac{\partial^4}{\partial y^4}\right)\frac{\partial\psi}{\partial y} + \frac{Re}{Fr}\;sin\;\alpha^* \tag{28}$$

$$\mathrm{Re}\,\delta^3\left(-\frac{\partial^2\psi}{\partial \mathrm{t}\partial \mathrm{y}} + \frac{\partial^3\psi}{\partial \mathrm{x}^2\partial y} - \frac{\partial^3\psi}{\partial \mathrm{x}^2\partial y}\right) = -\frac{\partial \mathrm{p}}{\partial \mathrm{y}} + \delta^2\frac{\partial}{\partial \mathrm{x}}\mathrm{s_{xy}} + \delta\frac{\partial}{\partial \mathrm{y}}\mathrm{s_{yy}} +$$
$$\mathrm{Ha}^2\sin\beta\left(\delta\frac{\partial\psi}{\partial \mathrm{y}}\cos\beta + \delta^2\frac{\partial\psi}{\partial \mathrm{x}}\sin\beta\right) + \delta^2\frac{1}{\mathrm{Da}}\frac{\partial\psi}{\partial \mathrm{x}} + \frac{1}{\alpha^2}\delta^2\left(\delta^4\frac{\partial^4}{\partial \mathrm{x}^4} + 2\delta^2\frac{\partial^4}{\partial \mathrm{x}^2\partial \mathrm{y}^2} + \right. \tag{29}$$
$$\left.\frac{\partial^4}{\partial \mathrm{y}^4}\right)\frac{\partial\psi}{\partial \mathrm{x}} - \delta\frac{\mathrm{Re}}{\mathrm{Fr}}\cos\alpha^*$$

The wave frame's dimensionless boundary conditions are [10]:
$\psi = \frac{F}{2}$, at y= h.$_1$, $\psi = -\frac{F}{2}$, at y= h.$_2$,
$\frac{\partial\psi}{\partial y} + \beta_1 \frac{\partial^2\psi}{\partial y^2} = -1$ at y= h.$_1$, $\frac{\partial\psi}{\partial y} - \beta_1 \frac{\partial^2\psi}{\partial y^2} = -1$ at y= h.$_2$,

$$\frac{\partial^3\psi}{\partial y^3} = 0 \text{ at } y = h_1, \frac{\partial^3\psi}{\partial y^3} = 0 \text{ at } y = h_2 \tag{30}$$

In the wave frame, (F) is the dimensionless temporal mean flow rate. Through the expression, it is related to the dimensionless temporal mean flow rate (Q) in the laboratory frame. [58]

$$Q = F. + 1 + d^* \tag{31}$$

$h_1(x)$ and $h_2(x)$ have dimensionless forms:

$$h_1(x) = 1 + a\sin(X), \quad h_2(x) = -d^* - b\sin(X + \emptyset) \tag{32}$$

where (a) , (b).,($\varnothing$). and (d^*). satisfy. [10]:

$$a^2 + b^2 + 2.abcos(\varnothing.) \leq (1 + d^*)^2.$$

6. EFFECT OF COUPLE - STRESS

A relationship here between couple stress parameter (α) and the material fluid parameters (A) would be discovered in this section.

This relationship will aid us in simplifying the problem's solution strategy. Because, as mentioned in the previous chapter, finding the zero and first-order solutions is required seeing the effect of any and all parameters that present in the problem. However , using the relationship between the couple stress parameter and the material fluid parameters we need to find the zero order only .

From dimensionless the material fluid parameters :
Let $A = \frac{w}{6}(\frac{c}{c_1 \ d})^2$
then

$$d = \sqrt{\frac{w}{6A}}(\frac{c}{c_1}) \tag{33}$$

$$\text{since} \quad \alpha = d\sqrt{\frac{\mu}{\mu_1}} \tag{34}$$

substitute Eq.(34) into Eq.(34), we get $\alpha = \sqrt{\frac{w\mu}{6A\mu_1}}(\frac{c}{c_1})$

$$\alpha^2 = \frac{w\mu}{6A\mu_1}\left(\frac{c}{c_1}\right)^2 \text{ and } \frac{1}{\alpha^2} = \frac{6A\mu_1}{w\mu}\left(\frac{c_1}{c}\right)^2 \tag{35}$$

7. SOLUTION OF THE PROBLEM

Substitute the terms (31) in to Eqs. (24) to Eqs. (29), together with the boundary conditions Eqs. (30) Since $\delta \leq 1$, and using the approximation of a long wavelength and a low Reynolds number. For the appearance of the couple stress parameter in the equation, the solution is limited to the zero order by giving all the parameters required to solve the problem and find the results, we get the motion equation in the terms of stream function which is

$$\psi_{yyyy} - \xi \ \psi_{yy} - \frac{1}{\alpha^2}\psi_{yyyyyy} = 0 \tag{36}$$

$$\xi = \frac{Ha^2 cos^2\beta + \dfrac{1}{Da}}{w + 1} \tag{37}$$

$$\eta = \frac{1}{1 + w} \tag{38}$$

The solution of the momentum equation.is straight forward. and can be written as

$$\psi = \sqrt{2}\left(\frac{\sqrt{2}e^{\frac{y\sqrt{\frac{\alpha\left(\alpha-\sqrt{\alpha^2-4\zeta\eta}\right)}{\eta}}}{\sqrt{2}}}\eta c1}{\alpha\left(\alpha-\sqrt{\alpha^2-4\zeta\eta}\right)} + \frac{\sqrt{2}e^{-\frac{y\sqrt{\frac{\alpha\left(\alpha-\sqrt{\alpha^2-4\zeta\eta}\right)}{\eta}}}{\sqrt{2}}}\eta c2}{\alpha\left(\alpha-\sqrt{\alpha^2-4\zeta\eta}\right)} + \frac{\sqrt{2}e^{\frac{y\sqrt{\frac{\alpha\left(\alpha+\sqrt{\alpha^2-4\zeta\eta}\right)}{\eta}}}{\sqrt{2}}}\eta c3}{\alpha\left(\alpha+\sqrt{\alpha^2-4\zeta\eta}\right)} + \frac{\sqrt{2}e^{-\frac{y\sqrt{\frac{\alpha\left(\alpha+\sqrt{\alpha^2-4\zeta\eta}\right)}{\eta}}}{\sqrt{2}}}\eta c44}{\alpha\left(\alpha+\sqrt{\alpha^2-4\zeta\eta}\right)}\right) + c5 + yc6 \quad (39)$$

From Eq. (25) in Eq. (28) we get :

$$\frac{\partial p}{\partial x} = (w+1)\psi_{yyy} - (w+1)\xi\,\psi_y - \frac{1}{\alpha^2}\psi_{yyyyy} + \frac{Re}{Fr}\sin\propto^* \quad (40)$$

$$-\frac{\partial p}{\partial y} = 0 \quad (41)$$

The pressure rise per wave length ($\triangle p$.) is defined. as

$$\Delta p = \int_0^1 .\frac{\partial p}{\partial x}dx \ . \quad (42)$$

In the fixed frame, this axial velocity component is given as

$$\mathrm{u(x., y., t.)} = 1 + \psi_{\mathrm{y}} \quad (43)$$

8. RESULTS AND DISCUSSION

To study the effect of physical parameters such as Effect of Hartman number (Ha), Darcy number (Da), Renold number (Re), Froude number (Fr) ,couple stress (α), Inclination angle of the channel to the horizontal axis (α^*), inclination of magnetic field (β), represent the dimensionless slip parameters (β_1), material fluid parameter (w) and amplitude ratio ($\varnothing$). we have plotted the axial velocity (u), and stream function (ψ) in figs. 2.-15. are illustrated using the software MATHEMATICA .

8.1 VELOCITY DISTRIBUTION

For varying values of (u), difference in axial velocity throughout the channel . "The effect different values of (Ha), (Da), (β), (β_1),(w),(α) and ($\varnothing$) on axial velocity (u) are explained in Figs. 2.- 8."The behavior of velocity distribution is parabolic as seen in figures. Figs. 2.,5. shows that the axial velocity with increasing (Ha) and (β_1) increases in the central region and the boundary of the channel wall. Fig.3. displayed the influence of (Da) on the axial velocity, it is noticed that at the walls of the channel, the axial velocity decreases with an increase of (Da), and decreases at the center of the channel. Fig. 4. noted that the axial velocity do not change at increasing in (β). Figs 6.,7. the axial velocity increasing with increasing (α) and (w) increasing in the central region and not change in the boundary of the channel wall. From fig.8. At increasing in ($\varnothing$), the axial velocity falls in the middle region and the channel's boundary right, while increasing in the channel's boundary left.

8.2 TRAPPING PHENOMENON

Closed stream lines trap the amount of fluid known as bolus inside the channel tube near the walls in peristaltic flows, and this trapped bolus pushes forward in the direction of wave propagation. In figs 9. – 15. the stream lines are plotted at various values of Ha, Da, β, β_1, α ,w and $\varnothing$. Figs 9. , 14. the exhibits that the trapping exist for both upper and lower walls , we observe that size of trapping bolus decreases with increases (Ha) and (w) . Figs 10. and 11. the exhibits that the trapping exist for both upper and lower walls , we observe that size of trapping bolus no change with increases (Da) and (β) . Figs 12. , 13. show that trapping exists for both the upper and lower walls, and that the size of the trapping bolus lowers and expands as (β_1) and (α) increase. Fig 15. the exhibits that the trapping exist for both upper and lower walls, we observe that size of trapping bolus increases with increases ($\varnothing$) and open channel with ($\varnothing = \pi$) ".

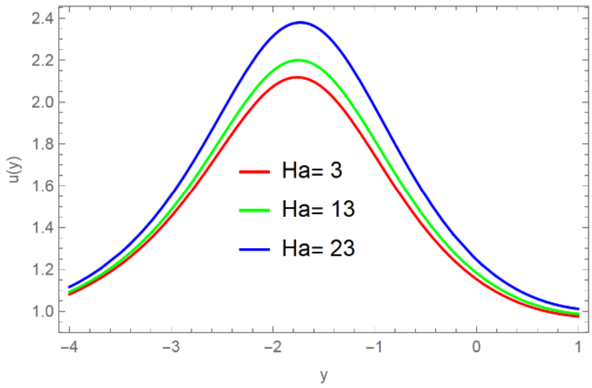

FIGURE 2. Variation of velocity for different values of Ha when Da=3,β=0.5, β 1 =4, α= 0.4,w= 3,∅= 0.5 ,a= 0.2 , b= 0.2 , d * = 0.5 ".

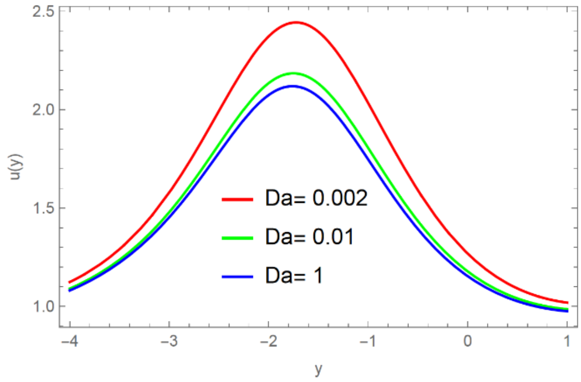

FIGURE 3. Variation of velocity for different values of Da when Ha=3, β=0.5,β 1 =4 ,α=0.4,w= 3,∅= 0.5, a= 0.2 , b= 0.2, d * = 0.5 ".

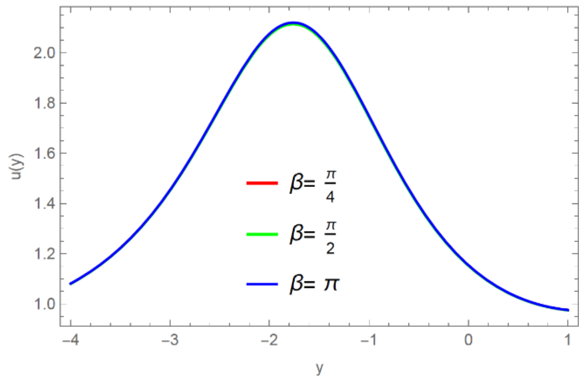

FIGURE 4. Variation of velocity for different values of β when Ha=3 , Da=3, β 1 =4, α= 0.4, w= 3 , ∅= 0.5 ,a= 0.2 , b= 0.2 , d * = 0.5"

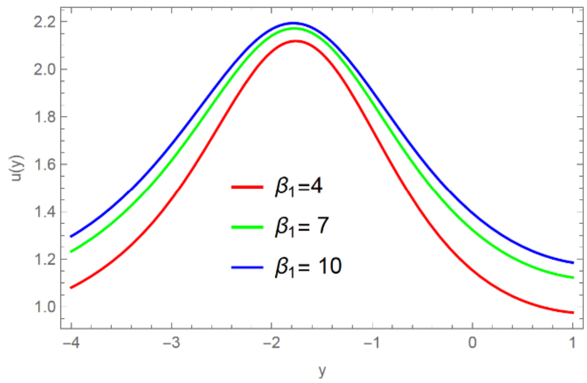

FIGURE 5. Variation of velocity for different values of β 1 when Ha=3,Da=3, β=0.5,α= 0.4, w= 3 , ∅= 0.5 ,a= 0.2 , b= 0.2, d * = 0.5''.

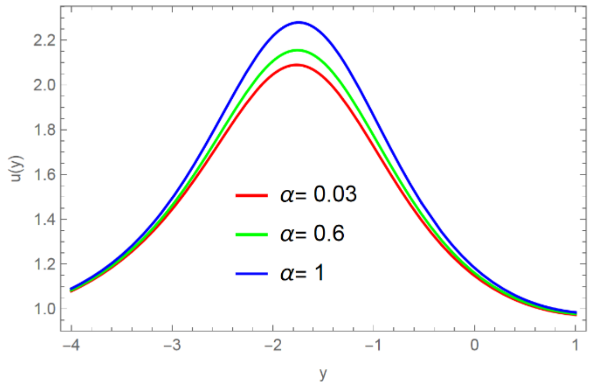

FIGURE 6. Variation of velocity for different values of α when Ha=3 ,Da=3, β=0.5, β 1 =4 ,w= 3 ,∅= 0.5 ,a= 0.2, b= 0.2 , d * = 0.5''.

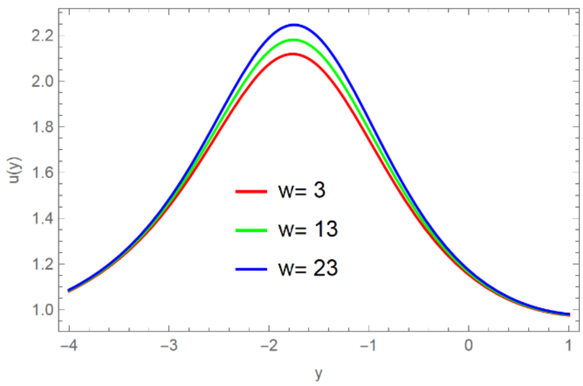

FIGURE 7. Variation of velocity for different values of w when Ha=3 , Da=3, β=0.5, β 1 =4 ,α= 0.4,∅= 0.5 ,a= 0.2, b= 0.2 ,d * = 0.5''.

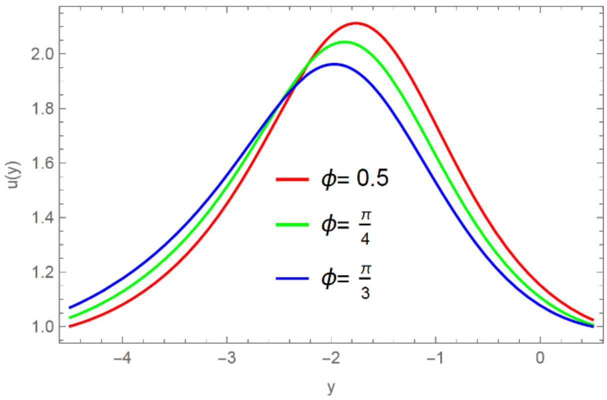

FIGURE 8. **Variation of velocity for different values of ∅ when Ha=3, Da=3, β=0.5, β 1 =4, α= 0.4, w= 2,a= 0.2 , b= 0.2 , d * = 0.5''.**

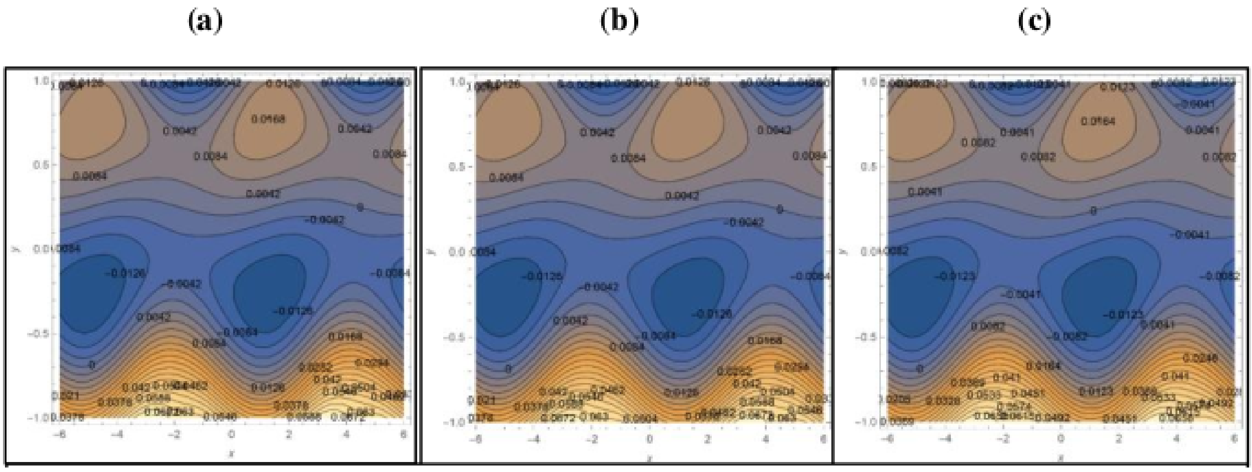

FIGURE 9. **Stream function in the wave frame of Ha such that in (a) Ha=3,(b) Ha=6,(c)Ha=9, in Da =2, β=0.5, β 1 =4, α = 0.4, w=2, ∅ = 0.5, a = 0.2, b = 0.2, d * = 0.5'' .**

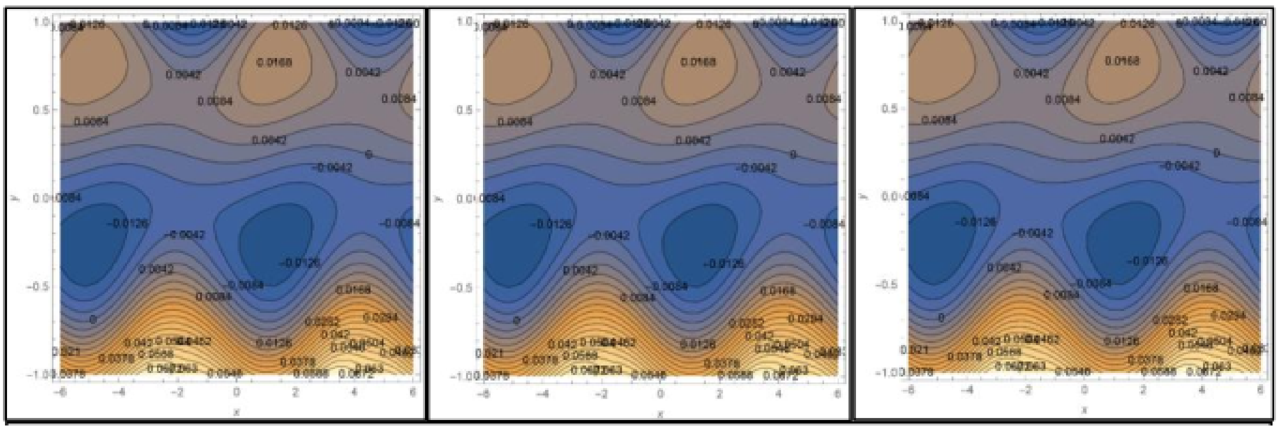

FIGURE 10. **Stream function in the wave frame of Da such that in (a) Da=2, (b) Da=4, (c) Da=6, in Ha=3, β=0.5, β 1 =4, α = 0.4, w=2, ∅ = 0.5, a = 0.2, b = 0.2, d * = 0.5'' .**

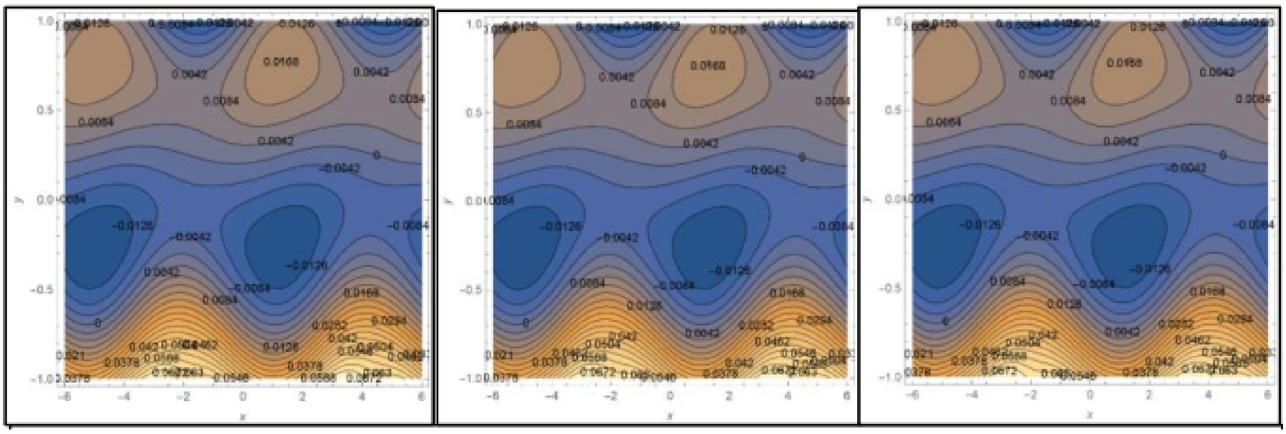

FIGURE 11. "stream function in the wave frame of β such that in (a) β =0.5, (b) $\beta = \frac{\pi}{3}$, (c) $\beta = \frac{\pi}{2}$ in Ha =3, Da = 2, β 1 = 4, α = 0.4, w = 2, ∅ = 0.5, a = 0.2, b = 0.2, d * = 0.5" .

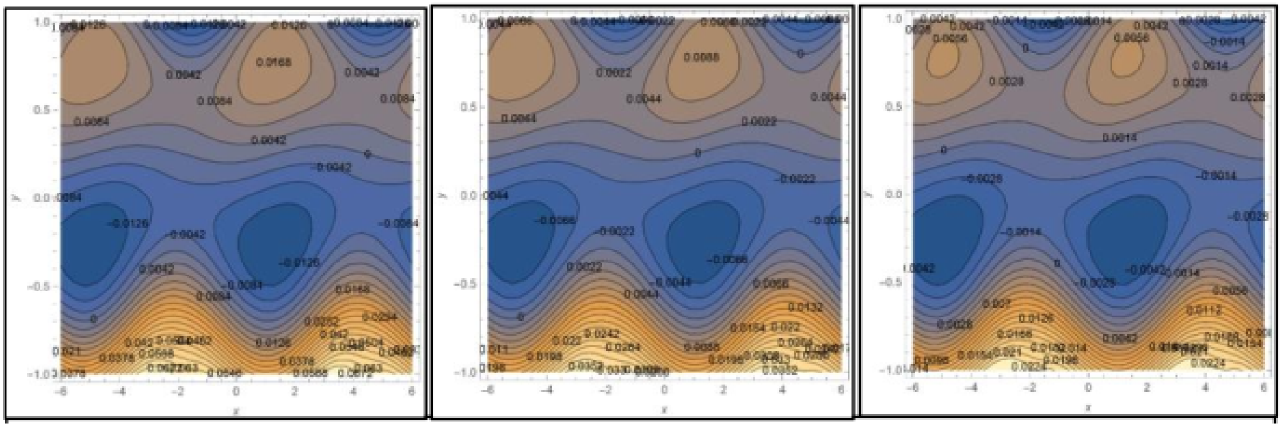

FIGURE 12. "stream function in the wave frame of βsuch that in (a) β 1 =4, (b) β 1 =8 , (c) β 1 =12 , in Ha =3, Da = 2, β = 0.5, α = 0.4, w = 2, ∅ = 0.5, a = 0.2, b = 0.2, d * = 0.5" .

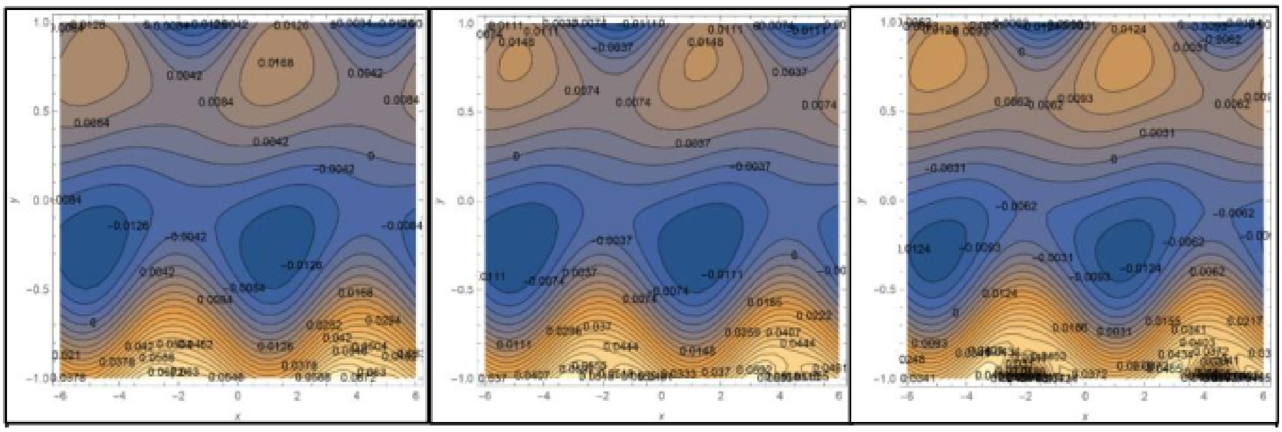

FIGURE 13. stream function in the wave frame of α such that in (a) α =0.4 , (b) α =1.6 , (c) α =2.8 , in Ha =3, Da =2, β=0.5, β 1 =4, w=2, ∅ = 0.5, a = 0.2, b = 0.2, d * = 0.5".

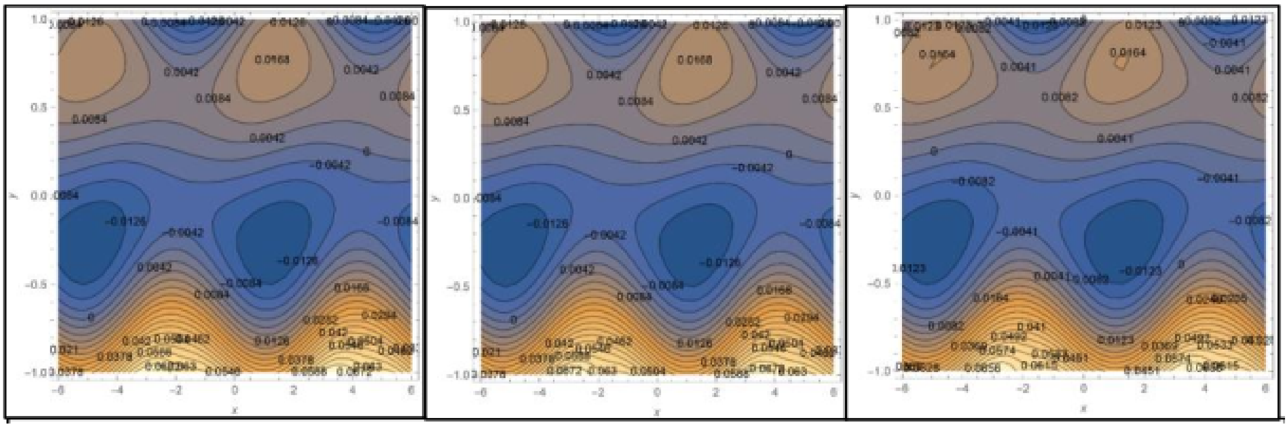

FIGURE 14. **stream function in the wave frame of w such that in (a)w= 2, (b)w =6, (c)w=10 in Ha =3 , Da =2, β=0.5, β 1 =4, α = 0.4, $\varnothing$ = 0.5, a = 0.2, b = 0.2, d * = 0.5 ".**

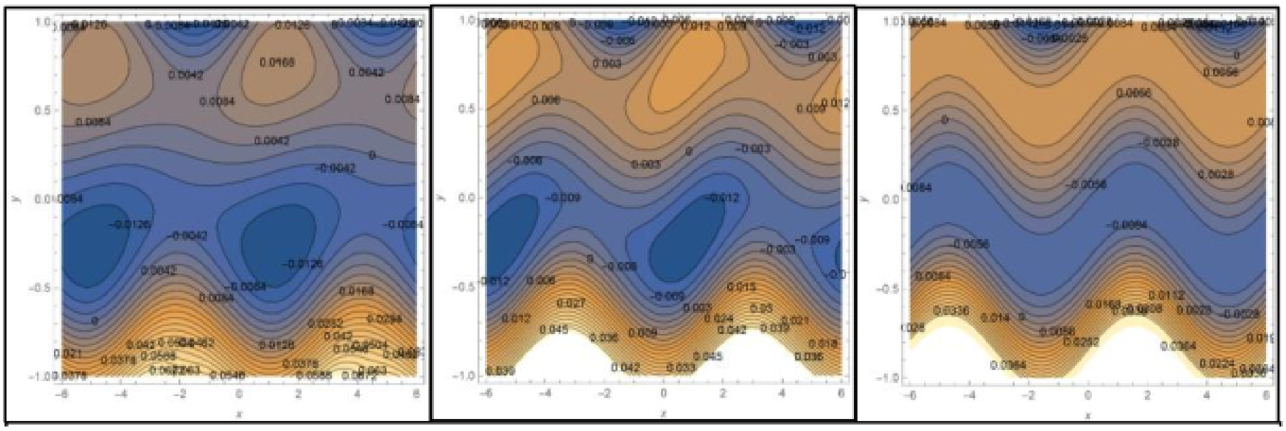

FIGURE 15. **stream function in the wave frame of $\varnothing$ such that in (a)$\varnothing$=0.5,(b) $\emptyset = \frac{\pi}{2}$, (c)$\emptyset = \pi$ in Ha 2 =3 , Da =2, β=0.5, β 1 =4, α = 0.4, w=2, a = 0.2, b = 0.2, d * = 0.5" .**

9. CONCLUSIONS

In light of this studies, some of the more intriguing findings have been described, with a focus on the study Effect of Couple Stress on Peristaltic Transport of Powell-Eyring Fluid Peristaltic flow in Inclined Asymmetric Channel with Porous Medium The results are discussed through graphs , as follows :

- By increasing (Ha) and (β_1) increases in the central region and the boundary of the channel wall but the opposite occur for increasing (Da).
- The axial velocity no change near the wall while it increases at the center of the channel by increasing (α) and (w) . Furthermore increasing (β) has not effected on the axial velocity.
- At increasing in ($\varnothing$.) , the axial velocity falls in the middle region and the channel's boundary right, while increasing in the channel's boundary left.
- The size of trapped bolus decreases with increasing (Ha) and (w) , we observe that size of trapping bolus no change with increases (Da) and (β) ".
- Demonstrate "that trapping exists for both the upper and lower walls, and that the size of the trapping bolus decreases and increases as (β 1) and (α) rise".
- The exhibits show that the trapping is present on both the upper and lower sides, we observe that size of trapping bolus increases with increases ($\varnothing$.) and open channel with ($\varnothing = \pi$) .

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None

CONFLICTS OF INTEREST

The author declares no conflict of interest.

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