DOI: 10.24996/ijs.2024.65.7.26

ISSN: 0067-2904

Effect of the Magnetic Field and Rotation on Peristaltic Flow of A Carreau Fluid in Asymmetric Channel with Porous Medium

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Received: 28/2/2023 Accepted: 10/6/2023 Published: 30/7/2024

Abstract:

In this paper, the instability of the Carreau fluid was discussed in the asymmetric channel with a porous medium in the presence of a changing magnetic field and rotation. The Carreau fluid behaves like a non-Newtonian fluid, where it was found that the rotation has an effect on the stability of the fluid. Numerical methods are used to solve the equations, such as the perturbation method. Assumptions are used to analyze the flow. The effect of Hartmann number (Ha), Darcy number (Da), material fluid (We), magnetic field (β), capacitance ratio (∅) and rotation are calculated(Ω)Numerical results were calculated using MATHEMATICA program

Keywords: peristaltic flow, rotation, magnetic field, Carreau.

تأثير المجال المغناطيسي والدوران على التدفق التمعجي لسائل Carreau في قناة غير متماثلة بوسط مسامي

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الخلاصة

في هذا البحث تم مناقشة عدم استقرار مائع Carreau في القناة غير متماثلة ذات وسط مسامي في وجود مجال مغناطيسي متغير ودوران يتصرف مائع Carreau مثل مائع غير نيوتني حيث وجد ان للدوران تاثير على استقرار المائع يتم استخدام طرق عددية لحل المعادلات مثل طريقة الاضطراب وتم استحدام افتراضات لتحليل التدفق وتم حساب تاثير كل من رقم هارتمان (Ha)ورقم دارسي (Da)و سائل المادة (We)و المجال المغناطيسي (β)ونسبة السعة (∅) والدوران (Ω) تم حساب النتائج العددية باستخدام برنامج MATHEMATICA

Introduction

Peristalsis is well recognized technique in which a gradual wave of contraction or expansion flows along the channel walls, causing the contents of the channel to shift. This phenomenon generally accurses in a number of biological, medicinal, and technical applications; similar to urinate transfer from kidney to bladder through ureter, lymphatic vessel transport, heart-lung machine, among other things. Many works on peristaltic flow in various geometries shown that the non-Newtonian behavior and the non-Newtonian fluid flows have many applications in engineering and medicine, have examined the peristaltic flows of Newtonian and non-Newtonian fluids in symmetric and asymmetric channels. In few other papers, Nadeem and Akbar [1] So Carreau is one of the non-Newtonian fluid models used for our research. applications of peristalsis have been attracting the interests of researchers after the seminal work of Latham [2]. The studies of non-Newtonian fluids are not only important but sometimes essential due to their excessive presence in universe. Therefore, the analysis of different non-Newtonian fluid flows has received a lot of attention from researchers. Particularly peristaltic transport of these fluids was discussed in Ref. [3-4-5] Although most prior studies of peristaltic motion have concentrate on Newtonian fluids, there are furthermore studies comprising non-Newtonian fluids, such that the shear stress might rely on the shear rate(the rapport between shear rate and shear stress isn't linear), each shear stress and shear rate is also time subordinate and also the fluid might have viscous additionally as resilient characteristics [6] Several scholars in particular biological problems dealing with conductive fluids are involved in the effect of magnetic field on fluid flow, which is denoted by Magneto hydrodynamics (MHD) as cancer therapy, blood pumping machines, polymer production, and metallurgy. Sensors, magnetic drug, and engineering can all benefit from the MHD. Several studies have been steered on MHD peristaltic transport for various fluid models and states due to its many uses [7-8-9-10] Rotation has a fixed center point around which everything else revolves in a circle. studied the effects of rotation and magnetic field on nonlinear peristaltic flow of second-order fluid in an asymmetric channel through a porous medium. Hayat et al. [11-12] discussed the Effects of an endoscope and rotation on peristaltic flow in a tube with long wavelength [13]

Mathematical Formulation for Asymmetric Flow.

Consider the flow of a Carreau Asymmetric fluid in two dimensions., canal has thickness $(E + E')$. The flow is created by an unlimited sinusoidal wave line traveling forth with constant velocity c along on the canal's walls. Asymmetric canals are created by altering wave amplitudes, phase angles, and canal thickness. The geometries of the walls are modeled as:

$$h_1(x,t)=E-r_1 \sin[\frac{2\pi}{\lambda}(x-ct)] \text{ upper wall} \tag{1}$$

$$h_2(x,t)=-E'-r_2 \sin[\frac{2\pi}{\lambda}(x-ct)+\emptyset] \text{ lower wall} \tag{2}$$

where (r_1) and (r_2) denote the amplitudes of the wave, (E) and (E') represents the width of the channel, (λ) designates the wavelength, $(\overline{X})$ represents the direction of the propagation of wave and $(\bar{t})$ stands for the time. The phase difference $(\emptyset)$ fluctuates within the range $(0 \leq \emptyset \leq \pi)$ in which $(\emptyset = 0)$ corresponds to asymmetric channel with waves out of phase and $(\emptyset = \pi)$ stands for the waves in phase. Further (r_1), (r_2), (E), (E'), and $(\emptyset)$ satisfy the condition:
$r_1^2+r_2^2+2r_1r_2\cos(\emptyset) \leq (E+E')^2$

As assumed, there is no longitudinal walls' motion. This assumption constrains wall deformation., However, this doesn't imply that the canal is rigid while moving longitudinally.

Basic Equation

The equations for a fluid with a Carreau structure (Continued [14]):

$$\underline{\tau} = -P\,I + \underline{S} \tag{3}$$

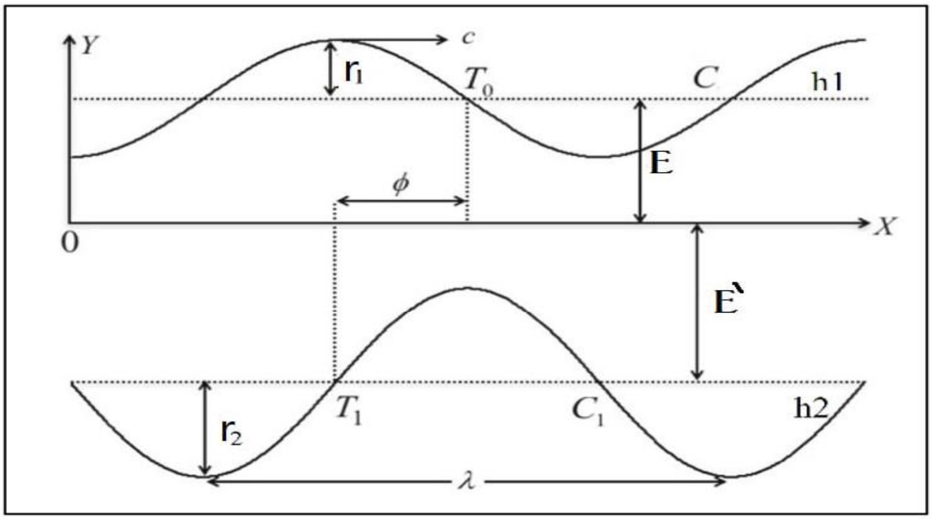


Figure 1: Cartesian Dimensional Asymmetric Channels Coordinates.

$$\bar{S} = -[\mu_\infty + (\mu_0 - \mu_\infty)(1+(\Gamma\bar{\dot{y}})^2)^{\frac{n-1}{2}}]\,\bar{\dot{y}} \quad (4)$$

Where $(\bar{S})$ express the extra stress tensor, $\bar{\nabla}=(\partial\bar{X}, \partial\bar{Y}, 0)$ the gradient vector (μ) the dynamic viscosity and the shear rate which is defined by:

$$\dot{\gamma} = \sqrt{\frac{1}{2}\mathrm{tras}(A_{11})^2}, = \sqrt{\frac{1}{2}\Pi} \quad (5)$$

Where Π is the second invariant of strain-rate tensor We consider in the constitutive equations 3) the case for which $\mu_{\infty=}0$ and So we can write

$$\bar{S} = -\mu_0\,[1+(\Gamma\bar{\dot{y}})^2)^{\frac{n-1}{2}}]\bar{\dot{y}} \quad (6)$$

$$\bar{s}_{\bar{x}\bar{x}} = -2\mu_0[(1+(\Gamma\bar{\dot{y}})2)^{\frac{n-1}{2}}]\,\bar{u}_{\bar{x}} \quad (7)$$

$$\bar{s}_{\bar{x}\bar{y}} = \bar{s}_{\bar{y}\bar{x}} = -\mu_0\,(1+(\Gamma\bar{\dot{y}})2)^{\frac{n-1}{2}}]\,.\,(\bar{u}_{\bar{y}} + \bar{v}_{\bar{x}}) \quad (8)$$

$$\bar{s}_{\bar{y}\bar{y}} = -\mu_0\,(1+(\Gamma\bar{\dot{y}})2)^{\frac{n-1}{2}}]\,\bar{v}_{\bar{y}} \quad (9)$$

And

$$\bar{\dot{y}} = \sqrt{2[(\bar{u}_{\bar{x}})^2 + (\bar{v}_{\bar{y}})^2] + [\bar{u}_{\bar{y}} + \bar{v}_{\bar{x}}]^2} \quad (10)$$

4- The governing equation

The continuity equation may be used to illustrate the fundamental equations of motion in a peristaltic transport and magnetic of carreau fluid in experimental frame $(\bar{x}, \bar{y})$

$$\frac{\partial\bar{u}}{\partial\bar{x}} + \frac{\partial\bar{v}}{\partial\bar{y}} = 0 \quad (11)$$

The $\bar{x}$– part of instant equation:

$$\rho\left(\frac{\partial\bar{u}}{\partial\bar{t}} + \bar{u}\frac{\partial\bar{u}}{\partial\bar{x}} + \bar{v}\frac{\partial\bar{u}}{\partial\bar{y}}\right) - \rho\Omega(\Omega\bar{u} - 2\frac{\partial\bar{v}}{\partial\bar{t}}) = -\frac{\partial\bar{p}}{\partial\bar{x}} + \frac{\partial}{\partial\bar{x}}\bar{s}_{\bar{x}\bar{x}} + \frac{\partial}{\partial\bar{y}}\bar{s}_{\bar{x}\bar{y}} - \sigma B_0^2\bar{u} - \frac{\mu}{\bar{k}}\bar{u} \quad (12)$$

The $\bar{y}$– part of instant equation:

$$\rho\left(\frac{\partial\bar{v}}{\partial\bar{t}} + \bar{u}\frac{\partial\bar{v}}{\partial\bar{x}} + \bar{v}\frac{\partial\bar{v}}{\partial\bar{y}}\right) - \rho\Omega(\Omega\bar{v} - 2\frac{\partial\bar{u}}{\partial\bar{t}}) = -\frac{\partial\bar{p}}{\partial\bar{y}} + \frac{\partial}{\partial\bar{x}}\bar{s}_{\bar{x}\bar{y}} + \frac{\partial}{\partial\bar{y}}\bar{s}_{\bar{y}\bar{y}} - \sigma B_0^2\bar{v} - \frac{\mu}{\bar{k}}\bar{v} \quad (13)$$

wherever (ρ)(p) (μ) (k) (B_0)(Ω)the constant density, pressure ,dynamic viscosity, permeability parameter, constant magnetic field, rotation, and (u) (v) are the velocities in X

and Y paths in given frame The flow in the framework for a laboratory is erratic ($\bar{x}$, $\bar{y}$). Therefore, with a coordinate system traveling at the rapidity of a wave (c) in wave frame (X, Y), the motion is steady. The following expressions
The no dimensional bounds as:

$$x=\frac{1}{\lambda}\bar{x},\ y=\frac{1}{d}\bar{y},\ u=\frac{1}{c}\bar{u},\ v=\frac{1}{\delta c}\bar{v},\ t=\frac{c}{\lambda}\bar{t},\ \delta=\frac{d}{\lambda},\ h_1=\frac{1}{E}\bar{h}_1,\ h_2=\frac{1}{E}\bar{h}_2,\ Re=\frac{\rho c d}{\mu},\ Ha=d\sqrt{\frac{\sigma}{\mu}}\beta_0,$$
$$Da=\frac{K}{d^2}\ p=\frac{d^2}{\lambda\mu c}\bar{p},\ We=\frac{\Gamma c}{d},\ \dot{y}=\frac{d}{c}\bar{\dot{y}},\ S_{xx}=\frac{\lambda}{\mu c}\bar{s}_{\bar{x}\bar{x}},\ S_{xy}=\frac{d}{\mu c}\bar{s}_{\bar{x}\bar{y}},\ S_{yy}=\frac{d}{\mu c}\bar{s}_{\bar{y}\bar{y}} \quad (14)$$

(δ) wave number, (Re) Reynold number, (Ha) Magnetic field, (∅) phase difference, (Da) Darcy number, Then, as a result of equation (14) equations (1), (2) and (7) to (10) take the form:

$$h_1(x,t) = 1 - r_1 \sin[2\pi x]. \quad (15)$$

The equation (2) becomes:

$$h_2(x,t)=-E' - r_2 \sin[(2\pi x) + \emptyset] \quad (16)$$

The equation (7) becomes:

$$s_{xx} = -2\delta[1 + (\frac{n-1}{2})(We)^2(\dot{y})^2]\frac{\partial u}{\partial x} \quad (17)$$

The equation (8) becomes:

$$s_{xy} = -(1 + (\frac{n-1}{2})(We)^2(\dot{y})^2)\left(\frac{\partial u}{\partial y} + \delta^2\ \frac{\partial vl}{\partial x}\right) \quad (18)$$

The equation (9) becomes:

$$s_{yy} = -2\delta(1 + (\frac{n-1}{2})(We)^2\ (\dot{y})^2)\ \frac{\partial v}{\partial y} \quad (19)$$

The equation (10) becomes:

$$\dot{y} = \sqrt{2\delta^2((\frac{\partial u}{\partial x})^2 + (\frac{\partial v}{\partial y})^2) + (\frac{\partial u}{\partial y} + \delta^2\frac{\partial v}{\partial x})^2} \quad (20)$$

The equation (11) becomes:

$$\frac{\partial u}{\partial x} + \frac{\partial v}{\partial y} = 0 \quad (21)$$

The equation (12) becomes

$$Re\,\delta(\frac{\partial u}{\partial t} + u\frac{\partial u}{\partial x} + v\frac{\partial u}{\partial y}) - \frac{\rho d^2}{\mu}\Omega^2 u + 2\Omega\delta^2 Re\frac{\partial v}{\partial t} = -\frac{\partial p}{\partial x} + \delta^2\frac{\partial}{\partial x}s_{xx} + \frac{\partial}{\partial y}s_{xy} - [(Ha)^2 + \frac{1}{Da}]u \quad (22)$$

and then Eq. (13) becomes

$$Re\,\delta^3(\frac{\partial v}{\partial t} + u\frac{\partial v}{\partial x} + v\frac{\partial v}{\partial y}) - \delta^2\frac{\rho d^2\Omega^2}{\mu}v - 2\delta\Omega Re\frac{\partial u}{\partial t} = -\frac{\partial p}{\partial y} + \delta^2\frac{\partial}{\partial x}s_{xy} + \delta\frac{\partial}{\partial y}s_{yy} - \delta^2(Ha^2 + \frac{1}{Da})v \quad (23)$$

The stream function (ψ) is connected with the velocity components by the relations:

$$u = \frac{\partial\psi}{\partial y},\ v = -\frac{\partial\psi}{\partial x} \quad (24)$$

Substituted Equations. (24) in equations (17), (18), (19), (20), (21), (22) and (23) respectively:

$$s_{xx} = -2\delta[1 + (\frac{n-1}{2})(We)^2(\dot{y})^2](\frac{\partial^2\psi}{\partial x\,\partial y}) \quad (25)$$

$$s_{xy} = -(1 + (\frac{n-1}{2})(We)^2(\dot{y})^2)(\frac{\partial^2\psi}{\partial y^2} - \delta^2\frac{\partial^2\psi}{\partial x^2}) \quad (26)$$

$$s_{yy=}2\delta(1 + (\frac{n-1}{2})(We)^2\ (\dot{y})^2)\left(\frac{\partial^2\psi}{\partial x\,\partial y}\right) \quad (27)$$

$$\dot{y} = \sqrt{2\delta^2[(\frac{\partial^2\psi}{\partial x\,\partial y})^2 + (\frac{-\partial^2\psi}{\partial x\,\partial y})^2] + [\frac{\partial^2\psi}{\partial y^2} - \delta^2\frac{\partial^2\psi}{\partial x^2}]} \quad (28)$$

$$\frac{\partial^2 \psi}{\partial x\,\partial y} - \frac{\partial^2 \psi}{\partial x\,\partial y} = 0 \qquad (29)$$

$$\mathrm{Re}\,\delta\left(\frac{\partial^2 \psi}{\partial t\,\partial y} + \frac{\partial^3 \psi}{\partial x\,\partial y^2} - \frac{\partial^3 \psi}{\partial x\,\partial y^2}\right) - \frac{\rho d^2 \Omega^2}{\mu}\frac{\partial \psi}{\partial y} - 2\delta^2 \Omega \mathrm{Re}\frac{\partial^2 \psi}{\partial t \partial x} = -\frac{\partial p}{\partial x} + \delta^2 \frac{\partial}{\partial x} s_{xx} + \frac{\partial}{\partial y} s_{xy} - (\mathrm{Ha}^2 + \frac{1}{\mathrm{Da}})\frac{\partial \psi}{\partial y} \qquad (30)$$

$$\mathrm{Re}\,\delta^3\left(-\frac{\partial^2 \psi}{\partial t\,\partial y} + \frac{\partial^3 \psi}{\partial x^2\,\partial y} - \frac{\partial^3 \psi}{\partial x^2\,\partial y}\right) + \delta^2\frac{\rho d^2 \Omega^2}{\mu}\frac{\partial \psi}{\partial x} - 2\delta^2 \mathrm{Re}\Omega\frac{\partial^2 \psi}{\partial t \partial y} = -\frac{\partial p}{\partial y} + \delta^2 \frac{\partial}{\partial x} s_{xy} + \delta\frac{\partial}{\partial y} s_{yy} - \delta^2(\mathrm{Ha}^2 + \frac{1}{\mathrm{Da}})\frac{\partial \psi}{\partial x} \qquad (31)$$

The dimensionless boundary conditions in the wave frame are:

$\psi = f/2$, $\partial\psi = -\partial y$ at $y = h_1$ (32)

$\psi = -f/2$, $\partial\psi = -\partial y$ at $y = h_2$ (33)

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

5- Solution of the Problem

The system Equations (31) is highly nonlinear and difficult, obtaining a exactly solution for all of the arbitrary parameters involved is impossible. To locate the solution, we use the perturbation approach. We extend for the perturbation solution.

$$\Psi = \Psi_0 + (We)^2\Psi_1 + O((We)^4)$$
$$F = F_0 + (We)^2 F_1 + O((We)^4) \qquad (34)$$
$$P = P_0 + (We)^2 P_1 + O((We)^4)$$

Substitute the terms (34) into Equation (25) together with the boundary conditions Equation (32) also (33) Since ((δ ≤ 1)), the higher order terms involving the power of δ are smaller and hence unimportant, we get the following system of equations by equating the coefficients of comparable powers of (We) :

From Equation (26) and Equations (30) we get:

$$\frac{dp}{dx} = -\psi_{yyy} - \left(\frac{n-1}{2}\right)(We)^2\left(\frac{\partial^2\psi}{\partial y^2}\right)^2\psi_{yyy} + \eta\psi_y - \beta\psi_y \qquad (35)$$

$$\eta = \frac{\rho d^2 \Omega^2}{\mu} \qquad (36)$$

$$\beta = \mathrm{H}a^2 + \frac{1}{Da} \qquad (37)$$

from differential of y for Equation (35)

$$0 = -\psi_{yyyy} - \left(\frac{n-1}{2}\right)(We)^2\left(\frac{\partial^2\psi}{\partial y^2}\right)^2\psi_{yyyy} + \eta\psi_{yy} - \beta\,\psi_{yy} \qquad (38)$$

From Equation (31) we get:

$$\frac{\partial p}{\partial y} = 0 \qquad (39)$$

5.1- For the system of order Zero ($\mathbf{W}\boldsymbol{e}^{(\mathbf{0})}$)

When the terms of order (We) are negligible in the zeroth order system, we get:

$$\eta\psi_{0yy} - \psi_{0yyyy} - \beta\psi_{0yy} = 0 \qquad (40)$$

Such that

$\psi_0 = f_0/2$, $\partial\psi_0 = -\partial y$ at $y = h_{.1}$

$\psi_0 = -f_0/2$, $\partial\psi_0 = -\partial y$ at $y = h_{.2}$. (41)

5.2- For the System of order two ($\mathbf{W}\boldsymbol{e}^{(\mathbf{2})}$)

$$\eta\psi_{1_{yy}} - \psi_{1yyyy} - \left[\left(\frac{n-1}{2}\right)\psi_{0yy}^2\psi_{0yyyy}\right] - \beta\psi_{1yy} = 0 \qquad (42)$$

$$\eta\psi_{1_{yy}} - \psi_{1yyyy} - \beta\psi_{1yy} = \left(\frac{n-1}{2}\right)\psi_{0yy}^2\psi_{0yyyy} \qquad (43)$$

$\psi_1 = f_1/2\ , \partial\psi_1 = -\partial y$ at y= h.1 and
$\psi_1 = -f_1/2\ , \partial\psi_1 = -\partial y$ at y= h.2 (44)

And get the final equation for stream function by solving the associated zeroth and first order systems:

$$\psi = \psi_0 + (We^2)\ \psi_1 \quad (45)$$

Where the functions (Ψ_0 , ψ_1) hefty expressions Consequently, they will be mentioned in Appendix. The Equation (30) can be written as:

$$\frac{dp}{dx} = -\psi_{0yyy} - \left(\frac{n-1}{2}\right)(We^2)\left(\frac{\partial^2\psi_0}{\partial y^2}\right)^2\psi_{0yyy} + \eta\psi_{0y} - \beta\psi_{0y} \quad (46)$$

The pressure rise per wave length (Δp) is well-definite:

$$\Delta p = \int_0^1 \frac{dp}{dx}dx \quad (47)$$

6- Results and Discussion

To examine the influence of , Darcy Figure (Da), Reynolds Figure (Re), Rotation (Ω), Porous medium parameter (k), Material fluid parameters (We), Density (ρ), Viscosity (μ) Magnetic field (Ha) and phase difference (∅), the plotted axial velocity (u), pressure rise (Δp) and stream function (ψ) in Figure 2-18 utilizing the program, shown "MATHEMATICA".

7- Velocity Distribution (u)

(Figure 3,6) show the effect of different values for (Da)and (Ω) on the velocity axial (u), when axial speed increases, it starts decreasing and then it is combined with the other, **(Figure 4)** It shows no effect of different values for (µ) on the velocity axial (u), **(Figure 2,5)** show the effect of different values for (Ha)and (We)on the velocity axial (u) It increases with increasing values, but starts decreasing from the lower right, **(Figure 7)** show the effect of different values for (∅) on the velocity axial (u), It can be seen that it increases with increasing values from the lower left side and starts decreasing from the middle towards the lower right.

8- Pressure Rise (Δp)

Figures 8–14 display the various pressure increases in the wave outline's capability of volumetric stream rate for various Darcy number (Da), Rotation (Ω), fluid parameter (We), magnetic field (Ha) and phase difference (∅). The link between the average pressure that is not dimensional rises per wavelength and the dimensionless mean flow rate (Q1) with difference in the characteristics of interest included in (Δp) will be demonstrated in this subsection, **Figure.8** shows the effect of parameter (Ha) on (ΔP) reveals that pressure increases with an increase in the value of (Ha) and decreases with a decrease in the value of (Ha), **Figure.9** Shows the effect of parameter (Da) on (ΔP) reveals that pressure decreases with an increase (Da) and increases with a decrease (Da), **Figure.10** shows the effect of increasing the parameter (µ) on (ΔP) reveals that pressure rice per wave length (ΔP) increase in all regions, **Figure.11** shows the effect of increasing the parameter (We) on (ΔP) reveals that pressure rice per wave length (ΔP) increase in all regions, **Figure.12** shows the pressure rice for each wavelength that decreases in magnitude with increasing parameter (**Ω**). Figure 13 It shows us that the pressure(ΔP) is not affected by the increase or decrease of the parameter (∅)

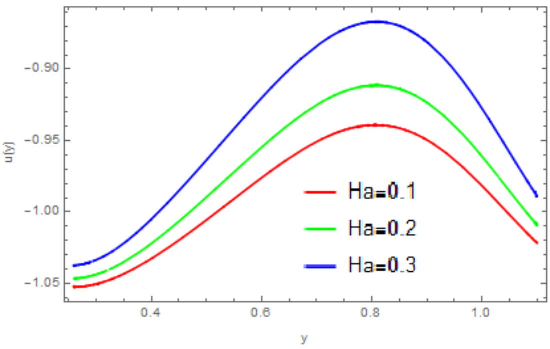


Figure 2: Effectiveness of various parameters of **(Ha)** on the velocity while

Da=7, μ=0.3, We=0.3, Ω=0.03, d=1.5, v=0.5, Q=1.5, ∅=1.5, a=0.5, b=0.5, E=0.03, n=1.

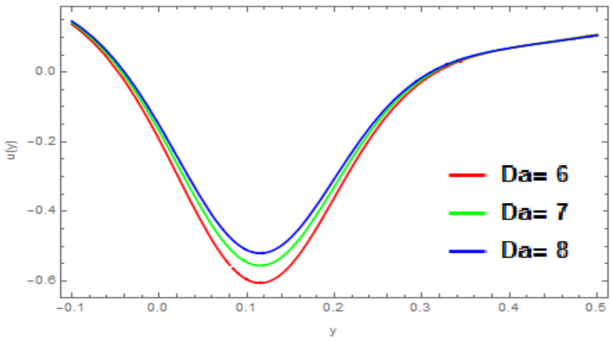


Figure 3: Effectiveness of various parameters of **(Da)** on the velocity while

Ha=2, μ=0.3, We=0.3, Ω=0.03, d=1.5, v=0.5, Q=1.5, ∅=1.5, a=0.2, b=0.2, E=0.5, n=2

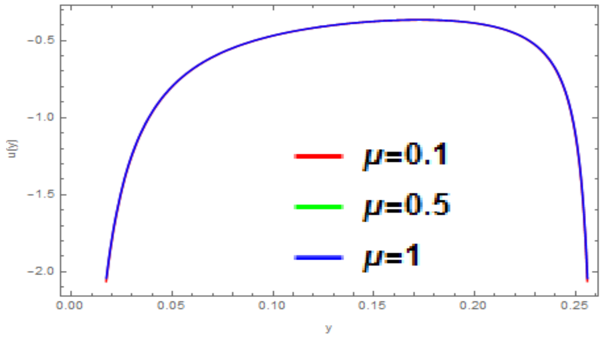


Figure 4: Effectiveness of various parameters of **(μ)** on the velocity while

Ha=8, Da=7, We=0.3, Ω=0.03, d=1.5, v=0.5, Q=1.5, ∅=1.5, a=0.2, b=0.2, E=0.5, n=1

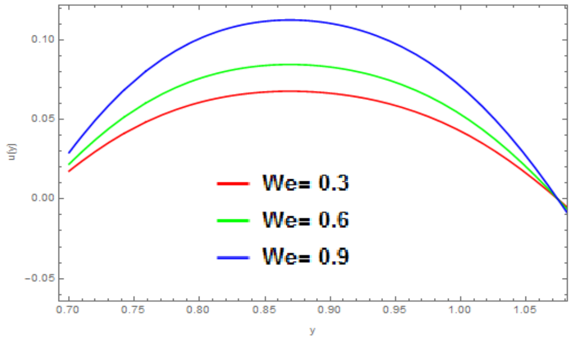


Figure 5: Effectiveness of various parameters of **(We)** on the velocity while

Ha=6, Da=7, μ=0.3, Ω=0.03, d=1.5, v=0.5, Q=1.5, ∅=1.5, a=0.2, b=0.2, E=0.5, n=1

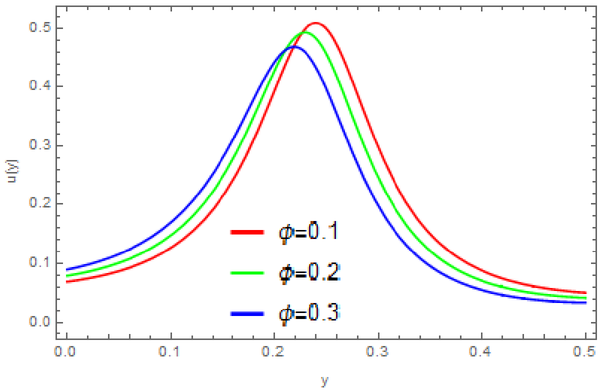


Figure 6: Effectiveness of various parameters of **(Ω)** on the velocity while

Ha=7.5, Da=7, μ=0.3, We=0.3, d=1.5, v=0.5, Q=1.5, ∅=1.5, a=0.2, b=0.2, E=0.5, n=1

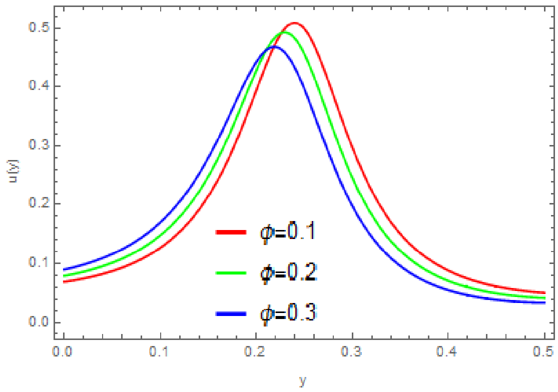


Figure 7: Effectivenessof various parameters of **(∅)** on the velocity while

Ha=7, Da=7, μ=0.3, We=0.3, Ω=0.03, d=1.5, v=0.5, Q=1.5, a=0.2, b=0.2, E=0.5, n=1

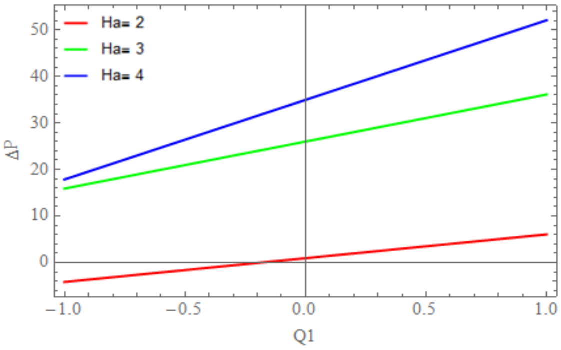


Figure 8: The effectiveness of various **(Ha)** values on pressure (Δ P) while

Da=0.9, μ=0.2, We=0.001, Ω=0.8, d=1.5, v=0.5, Q=1.5, Ø=0.01, a=0.2, b=0.2, E=0.5, n=1

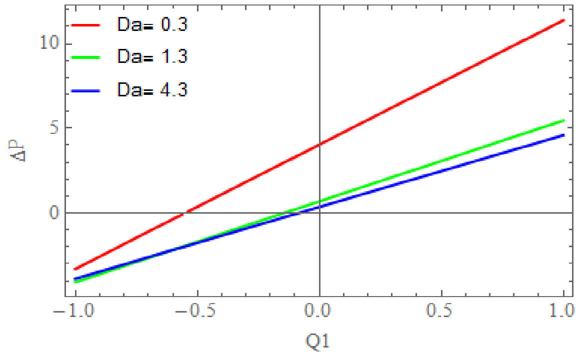


Figure 9: The effectiveness of various **(Da)** values on pressure (Δ P) while

Ha=2, μ=0.2, We=0.001, Ω=0.8, d=1.5, v=0.5, Q=1.5, Ø=0.01, a=0.2, b=0.2, E=0.5. n=1

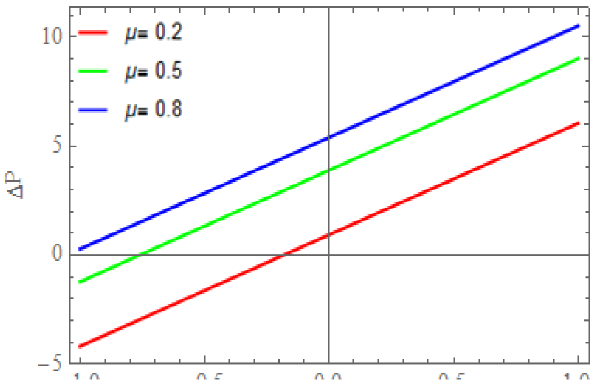


Figure 10: The effectiveness of various **(μ)** values on pressure (Δ P) while
Ha=2, Da=0.9, We=0.001, Ω=0.8, d=1.5, v=0.5, Q=1.5, Ø=0.01, a=0.2, b=0.2, E=0.5, n=1

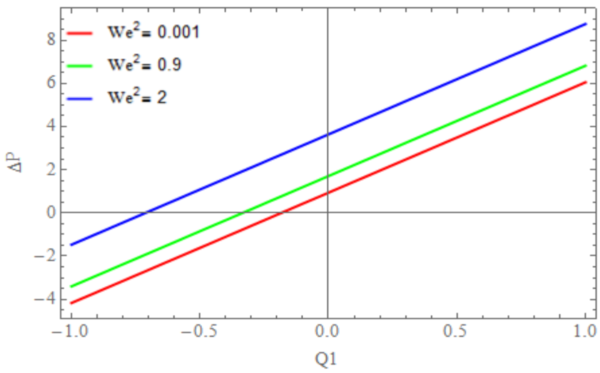


Figure 11: The effectiveness of various **(We)** values on pressure (Δ P) while
Ha=2, Da=0.9, μ=0.2, Ω=0.8, d=1.5, v=0.5, Q=1.5, Ø=0.2, a=0.2, b=0.2, E=0.5, n=1

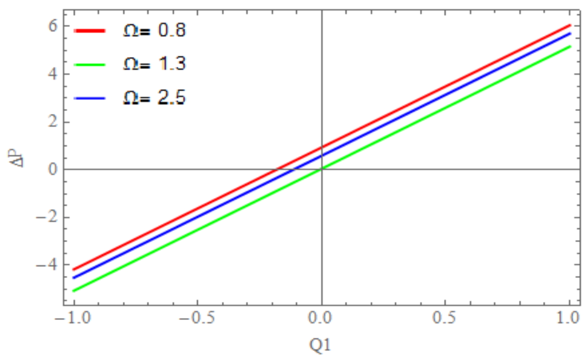
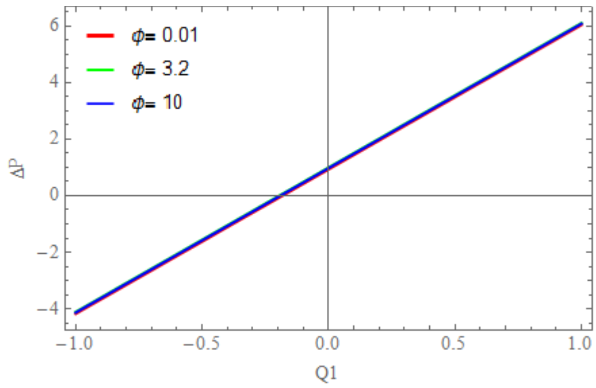


Figure 12: The effectiveness of various **(Ω)** values on pressure (Δ P) while

Ha=2, Da=0.9, μ=0.2, We=0.001, d=1.5, v=0.5, Q=1.5, Ø=0.2, a=0.2, b=0.2, E=0.5, n=1



Figure'13' The effectiveness of various **(Ø)** values on pressure (Δ P) while

Ha=2, Da=0.9, μ=0.2, We=0.001, Ω=0.8, d=1.5, v=0.5, Q=1.5, a=0.2, b=0.2, E=0.5, n=1

9- Conclusions

A mathematical model was used to inspect the peristaltic motion of Carreau's fluid in an asymmetric porous material. Where this study was conducted to know the effect of both magnetism and rotation. Under turbulence technique is used Approximate long and low wavelengths Reynolds number. to express the axial velocity Graphs are used to illustrate the results as follows:

- The velocity profile increases in view of an increase in (Ha)(We) but decreases with increasing(Ω)(∅)
- When increasing the speed relative to (Da) it starts decreasing and then remains constant.
- The velocity profile is not changes despite the variance in parameter values(μ)
- the pressure rice per wave length ΔP decreases in magnitude for fixed values of the viscosity Ω, show the effect of increasing the parameter We and μ on ΔP reveals that pressure rice per wave length ΔP increase in magnitude in all regions.
- the pressure rice per wave length ΔP is not changes despite the variance in parameter values(∅)
- There are several applications for peristaltic movement in both engineering and physical sciences. These waves, which spread throughout the length of an extensible tube and mix and transport fluid in the wave's direction, are really produced by the expansion and contraction of the extensible tube. The ureter and extracorporeal blood circulation are two tubular organs in the human body where this process takes place

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