

Peristaltic Flow of Rabinowitsch Fluid through an Inclined Nonuniform Channel

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Abstract: This study is carried out to analyze the Rabinowitsch fluid flow through a non-uniform channel between two flexible and symmetric inclined channel under peristaltic motion. Considering long wavelength and low Reynolds number assumptions the governing equations are simplified and thus obtained coupled non-linear governing equations are tackled via analytical method. The Graphs are drawn for the relevant parameters to explore the characteristics of the velocity field, temperature, and streamlines. The temperature profile are the increasing function of coffeicient of viscosity and Thermal conductivity.

Keywords: Variable viscosity, wall properties, variable thermal conductivity, Rabinowitsch fluid, nonuniform channel.

1. Introduction

Peristalsis is when the muscular ducts move back and forth at regular intervals. This is caused by transverse progressive waves moving through the flexible wall. The wave that moves from low pressure to high pressure along the edges of the tract is the mechanism that makes this happen. Peristaltic flow is a well-known natural process that helps mix and move fluids in biological systems. It happens in different body parts, such as when food grains and liquids move through the esophagus, when urine moves through the ureter, and when blood moves through tiny blood arteries, among other things. This system is used to pump clean and corrosive fluids in various industrial and medical settings. Researchers are now focusing on peristaltic

transport because it has many uses in biological systems, chemical industries, physiology, and therapeutic procedures. Shapiro *et al.*¹ have looked into peristaltic motion in lubricated systems. Medhavi² looked at the peristaltic flow of a fluid that wasn't Newtonian. Ramanamurthy *et al.*³ use a curved two-dimensional peristaltic conduit to explain how a viscous liquid moves in a way that is not steady. Nadeem *et al.*⁴ looked at how the Prandtl fluid model moved in an endoscope while peristalsis was going on. There is already much information on the subject.

In the past few decades, scientists have made much progress in their studies of how non-Newtonian fluids move. This strict change could be caused by changes in industry and technology, as well as by the fact that the governing equations of flow are complex to solve numerically. Non-Newtonian fluids are a large group of liquids that don't have a straight line between the deformation rate and the shear stress. Also, no model can be called a universal constitutive model that can predict how all non-Newtonian fluids behave. Because of this, several constitutive models of fluids that are not Newtonian have been made. The Rabinowitsch fluid model shows the complex rheological properties of biological fluids. The Rabinowitsch fluid model shows that the relationship between strain rate and shear stress is not linear. The Rabinowitsch fluid acts differently depending on the nonlinear factor, representing a Newtonian fluid, a shear thickening fluid, and a shear thinning fluid. Akbar and Nadeem⁵ looked into the transfer of the Rabinowitsch fluid under the peristaltic mechanism. Sadaf *et al.*⁶ used a Rabinowitsch fluid model to study the effects of viscous dissipation and convective boundary conditions in a non-uniform peristaltic tube with different wall properties. Sing *et al.*⁷ investigated the Rabinowitsch fluid model in an elastic peristaltic tube for homogeneous-heterogeneous reactions. Saravana *et al.*⁸ looked at how heat flow affects the flow of a Rabinowitsch fluid in a peristaltic conduit with flexible, angled walls. Hanumesh *et al.*⁹ looked into the peristaltic process using a slanted porous convective channel and the way a Rabinowitsch liquid changes as it moves. Hanumesh *et al.* looked at the same fluid with different characteristics on the walls and in the fluid¹⁰. Vaidya *et al.*¹¹ used a porous peristaltic inclined channel to study the effects of a flexible wall and the rheological properties of a fluid called Rabinowitsch. Naveed *et al.*¹² have examined the impact of heterogeneous and homogeneous processes and thermal radiation on the Rabinowitsch fluid model of peristaltic flow.

Peristalsis has been studied using thermophysical properties like variable viscosity and variable heat conduction. On the other hand, isotropic fluids can't take advantage of these traits. When the fluid's temperature and viscosity change, as they do in the blood¹³⁻¹⁷, they become more critical. Because of

this, it is essential to study heat conductivity and change viscosity. Inner contacts for lubricating fluids cause heat and temperature instability, which changes how the liquid behaves and makes it hard to get back to a steady state. There is a link between a rise in temperature and more people using transportation. Nadeem *et al.*¹³ looked into how peristaltic transport works when heat is transferred and viscosity changes. Khan *et al.*¹⁴ looked at the flow properties of fluid properties that change with temperature, precisely the viscosity of a Jeffrey fluid in a permeable asymmetric channel. Khan *et al.*¹⁵ looked at how a non-Newtonian liquid moved in an inclined peristaltic porous medium to see what happened when the viscosity changed in a conduit with slip boundary conditions. Mehdi¹⁶ looked into the peristaltic flow of a Newtonian liquid to find out what happens when the viscosity of the liquid changes in an asymmetric channel. Ahmad *et al.*¹⁷ look at how magneto-bio-fluid flows in a vertical ciliated channel with changing thermal viscosity and heat transfer. Manjunath *et al.*¹⁸ wrote about the effects of thermal conductivity and variable density, heat, and mass transfer on the flow of a Jeffrey fluid with a peristaltic mechanism through a non-uniform conduit with pores. Hanumesh *et al.*¹⁹ used MHD peristaltic transport to study the different thermal conductivities and convective conditions in a compliant porous channel.

Acknowledging the research done by numerous researchers, the Rabinowitsch fluid moving under peristalsis in a nonuniform channel is considered for analyzing the compliant wall effects. Governing equations for the problem under consideration have been simplified under the lubrication approach. Solutions are evaluated for mean velocity and streamlines using the perturbation method. Physical behaviors of the different parameters of Rabinowitsch fluid flow are explored graphically.

2. Mathematical formation

A flow of an incompressible Rabinowitsch fluid in the anon-uniform channel between two flexible walls is modeled under peristaltic motion. The channel is symmetric and inclined to the axis (See Fig. 1). The motion of the liquid is induced by the peristaltic wave trains accelerating at a constant speed c . The deformation in the channel walls due to the peristaltic waves is represented by:

$$(1) \quad \bar{h}(\bar{X}, \bar{t}) = l(\bar{X}) + b \sin \left[\frac{2\pi}{\lambda} (\bar{X} - c\bar{t}) \right]$$

where nonuniform channel width is represented by $l(\bar{X})$, wave amplitude by b and the time by t .

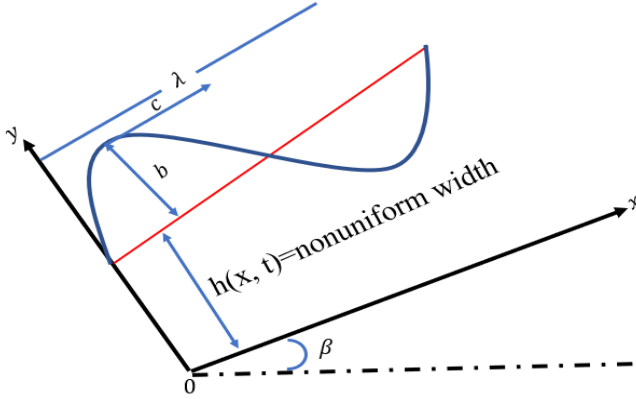


Fig. 1. Geometry of the physical model

The two-dimensional governing equations of the fluid motion in the laboratory frame is given by

$$(2) \quad \frac{\partial \bar{U}}{\partial \bar{X}} + \frac{\partial \bar{V}}{\partial \bar{Y}} = 0$$

$$(3) \quad \rho \left(\frac{\partial \bar{U}}{\partial t} + \bar{U} \frac{\partial \bar{U}}{\partial \bar{X}} + \bar{V} \frac{\partial \bar{U}}{\partial \bar{Y}} \right) = - \frac{\partial \bar{P}}{\partial \bar{X}} + \frac{\partial \bar{\tau}_{xx}}{\partial \bar{X}} + \frac{\partial \bar{\tau}_{xy}}{\partial \bar{Y}} + \rho g \sin \beta$$

$$(4) \quad \rho \left(\frac{\partial \bar{V}}{\partial t} + \bar{U} \frac{\partial \bar{V}}{\partial \bar{X}} + \bar{V} \frac{\partial \bar{V}}{\partial \bar{Y}} \right) = - \frac{\partial \bar{P}}{\partial \bar{Y}} + \frac{\partial \bar{\tau}_{xx}}{\partial \bar{X}} + \frac{\partial \bar{\tau}_{xy}}{\partial \bar{Y}} - \rho g \cos \beta,$$

$$(5) \quad \rho c_p \left(\frac{\partial \bar{T}}{\partial t} + \bar{U} \frac{\partial \bar{T}}{\partial \bar{X}} + \bar{V} \frac{\partial \bar{T}}{\partial \bar{Y}} \right) = \frac{\partial}{\partial \bar{X}} \left(k(\bar{T}) \frac{\partial \bar{T}}{\partial \bar{X}} \right) + \frac{\partial}{\partial \bar{Y}} \left(k(\bar{T}) \frac{\partial \bar{T}}{\partial \bar{Y}} \right) + \bar{\tau}_{xx} \frac{\partial \bar{U}}{\partial \bar{X}} + \bar{\tau}_{yy} \frac{\partial \bar{V}}{\partial \bar{Y}} + \bar{\tau}_{xy} \left(\frac{\partial \bar{V}}{\partial \bar{X}} + \frac{\partial \bar{U}}{\partial \bar{Y}} \right)$$

The flexible wall motions equation is governed by

$$(6) \quad L(P) = P - P_0$$

where $P_0 (= 0)$ indicates the pressure on the outer wall due to the tension of muscles. Here the linear operator L infers the membrane stretching accompanied by the focus of viscous damping and is represented as

$$(7) \quad L = -\tau \frac{\partial^2}{\partial x^2} + m_1 \frac{\partial^2}{\partial t^2} + m_2 \frac{\partial}{\partial t} + m_3 \frac{\partial^4}{\partial x^4} + H,$$

where τ denotes the elastic tension, H denotes the spring stiffness, m_1 denotes the mass/unit area, m_2 denotes the coefficient of the wall damping force, m_3 denotes the flexible rigidity of the plate.

$$(8) \quad \frac{\partial p}{\partial x} = E_1 \frac{\partial^3 h}{\partial x^3} + E_2 \frac{\partial^3 h}{\partial x \partial t^2} + E_3 \frac{\partial^2 h}{\partial x \partial t} + E_4 \frac{\partial^5 h}{\partial x^5} + E_5 \frac{\partial h}{\partial x}$$

The constitutive equation of Rabinowitsch fluid in the dimensional form is:

$$(9) \quad \tau_{xy} + \mu_1 \tau_{xy}^3 = \mu \frac{\partial u}{\partial y}$$

where μ symbolizes the fluid viscosity and μ_1 the coefficient of pseudoplasticity. The unsteady flow in stationary frame is considered to become steady in the moving frame of reference. The interrelated transformations among stationary co-ordinates $(\bar{X}, \bar{Y})$ and varying co-ordinates $(\bar{x}, \bar{y})$ is given by

$$(10) \quad \begin{aligned} \bar{x} &= \bar{X} - c\bar{t}, \bar{y} = \bar{Y}, \quad \bar{u}(\bar{x}, \bar{y}) = \bar{U}(\bar{X}, \bar{Y}, \bar{t}) - c, \\ \bar{v}(\bar{x}, \bar{y}) &= \bar{V}(\bar{X}, \bar{Y}, \bar{t}), \quad \bar{T}(\bar{x}, \bar{y}) = \bar{T}(\bar{X}, \bar{Y}, \bar{t}), \quad \bar{p}(\bar{x}, \bar{y}) = \bar{P}(\bar{X}, \bar{Y}, \bar{t}). \end{aligned}$$

The following dimensionless parameters are used for non dimensionalisation:

$$(11) \quad \begin{aligned} x &= \frac{\bar{x}}{\lambda}, y = \frac{\bar{y}}{l_2}, u = \frac{\bar{u}}{l_2}, t = \frac{c\bar{t}}{\lambda}, p = \frac{\bar{p}l_2^2}{\lambda\mu_0 c}, \varepsilon = \frac{b}{l_2}, Re = \frac{\rho c l_2}{\mu_0}, \\ Pr &= \frac{\mu_0 c_p}{k}, Ec = \frac{c^2}{c_p(\bar{T}_1 - \bar{T}_0)}, \theta = \frac{\bar{T} - \bar{T}_0}{\bar{T}_1 - \bar{T}_0}, l(\bar{x}) = l_2 + m_1(\bar{x}), \\ N &= Ec Pr, E_1 = \frac{-\tau l_2^3}{\lambda\mu_0^3 c}, E_2 = \frac{m_1 c l_2^3}{\lambda^3 \mu_0}, E_3 = \frac{m_2 l_2^3}{\lambda^3 \mu_0}, E_4 = \frac{m_3 l_2^3}{\lambda^3 \mu_0 c}, \\ E_5 &= \frac{H l_2^3}{\lambda\mu_0 c}, F = \frac{\rho c}{\mu_0 g l_2^2}, \bar{\mu}_0 = \frac{\mu_0}{\mu}, \\ \bar{\tau}_{xy} &= \frac{l_2 \tau_{xy}}{\mu_0 c}, \bar{\tau}_{xx} = \frac{l_2 \tau_{xx}}{\mu_0 c}, \bar{\tau}_{yy} = \frac{l_2 \tau_{yy}}{\mu_0 c}, \\ h &= \frac{\bar{h}}{l_2} = 1 + \frac{\lambda m x}{l_2} + \varepsilon \sin(2\pi(x - t)), \alpha = \frac{\mu_0^2 c^2 \mu_1}{l_2^2}. \end{aligned}$$

Therefore, incorporating the lubrication approach to the equations (2) – (5) and using the non-dimensional quantities in Eq. (11), the current fluid flow problem is governed by the differential equations:

$$(12) \quad \frac{dp}{dx} = \frac{\partial \tau_{xy}}{\partial y} + \frac{\sin \beta}{F},$$

$$(13) \quad \frac{\partial p}{\partial y} = 0,$$

$$(14) \quad \frac{\partial}{\partial y} \left(k(\theta) \frac{\partial \theta}{\partial y} \right) + N \tau_{xy} \left(\frac{\partial u}{\partial y} \right) = 0$$

The equivalent boundary conditions after non-dimensionalisation are

$$(15) \quad \frac{du}{dy} = 0, \quad \frac{d\theta}{dy} = 0, \quad \text{at } y = 0,$$

$$(16) \quad u = -1, \quad \theta = 1, \quad \text{at } y = h.$$

The constitutive equation of Rabinowitsch fluid in the nondimensional form is given by

$$(17) \quad \tau_{xy} + \alpha \tau_{xy}^3 = \mu(y) \frac{\partial u}{\partial y}.$$

Here α denotes the coefficient of pseudoplasticity: the nonlinear factor accountable for non-Newtonian behavior of the fluid and exhibits a fundamental part in knowing the nature of the fluid, and μ denotes the viscosity of the fluid. The model stated above acts as a Dilatant, Newtonian and pseudoplastic fluid according as $\alpha < 0$, $\alpha = 0$ and $\alpha > 0$. The expressions for variable viscosity and thermal conductivity are given by

$$(18) \quad \mu(y) = 1 - \alpha_1 y \quad \text{for } \alpha_1 \ll 1,$$

$$(19) \quad k(\theta) = 1 + \phi \theta \quad \text{for } \phi \ll 1,$$

where the coefficient of viscosity is α_1 and the coefficient of thermal conductivity is ϕ .

3. Method of Solution

To get a solution for the velocity field, Eq. (12) along with boundary conditions (15) and (16), are solved analytically and obtained as

$$(20) \quad u = \frac{1}{6\alpha_1^4} \left(6(P-B)^2 \alpha (\log(1-h\alpha_1)) - \log(1-y\alpha_1) \right) + \alpha_1 \left(6(P-B)^3 (h-y)\alpha + \alpha_1 \left(3(P-B) \left(\frac{(P-B)^2 (h-y)(h+y)\alpha}{+ 2\log(1-h\alpha_1) - 2\log(1-y\alpha_1)} \right) + \left(3(P-B)(h-y) + (P-B)^2 (h^2 - y^2)\alpha - 3\alpha_1 \right) \alpha_1 \right) \right)$$

where

$$P = \frac{\partial p}{\partial x} = 8\varepsilon\pi^3 \left[\frac{E_3}{2\pi} \sin 2\pi(x-t) - \left(E_1 + E_2 - 4\pi^2 E_4 - \frac{E_5}{4\pi^2} \right) \cos 2\pi(x-t) \right]$$

$$\text{and } B = \frac{\sin \beta}{F}.$$

The temperature equation is nonlinear and hence it is not simple to solve the problem and obtain a closed-form solution. As a result, the perturbation technique is applied to obtain the solution. We use variable thermal conductivity (ϕ) as perturbation parameter for finding temperature profile.

$$(21) \quad \theta = \theta_0 + \phi\theta_1 + \phi^2\theta_2 + O(\phi^3)$$

3.1. Zeroth order system

$$(22) \quad \frac{\partial}{\partial y} \left((1 + \phi\theta_0) \frac{\partial \theta_0}{\partial y} \right) + N\tau_{xy} \frac{\partial u}{\partial y} = 0,$$

$$(23) \quad \theta_0 = 1 \quad \text{at } y = h$$

$$(24) \quad \frac{\partial \theta_0}{\partial y} = 0 \quad \text{at } y = 0.$$

3.1.1. Zeroth order solution

$$(25) \quad \theta_0 = \frac{1}{60\alpha_1^6} \left[10\alpha_1^3 \left(6\alpha_1^3 + (P-B)^2 N \left(\frac{6(h-y) + 3\alpha_1(y^2 - h^2)}{+ \alpha_1^2(y^3 - h^3)} \right) \right) + \alpha_1(P-B)^4 N \left(-h(-60 + \alpha_1 h(30 + \alpha_1 h(10 + \alpha_1 h(5 + 3h)))) - \left(60y + 30\alpha_1 y^2 + 10\alpha_1^2 y^3 + 5\alpha_1^3 y^4 + 3\alpha_1^4 y^5 \right) \alpha + 60(P-B)^2 N(\alpha_1^2 + (P-B)^2 \alpha) \right. \right. \\ \left. \left. ((1 - \alpha_1 h)\log(1 - \alpha_1 h) - (1 - \alpha_1 y)\log(1 - \alpha_1 y)) \right) \right]$$

3.2. First order system

$$(26) \quad \frac{\partial}{\partial y} \left((1 + \phi \theta_1) \frac{\partial \theta_1}{\partial y} \right) + N \tau_{xy} \frac{\partial u}{\partial y} = 0,$$

$$(27) \quad \theta_1 = 1 \quad \text{at} \quad y = h,$$

$$(28) \quad \frac{\partial \theta_1}{\partial y} = 0 \quad \text{at} \quad y = 0$$

3.2.1. First order solution

$$(29) \quad \theta_1 = \theta_0^2.$$

Further, the stream function is obtained from the expression $u = \frac{\partial \psi}{\partial y}$ with the

condition $\psi = 0$ at $y = 0$, which yields

(30)

$$\psi = \frac{1}{12\alpha_1^5} \left[\alpha_1 \left[12(P-B)^3 \alpha \log(1-y\alpha_1) + \right. \right. \\ \left. \left[12(P-B)^3 y\alpha + (1 + \log(1-h\alpha_1) - \log(1-y\alpha_1)) \right. \right. \\ \left. \left[6(P-B)^3 (2h-y)y\alpha + 12(P-B) \log(1-y\alpha_1) + \right. \right. \\ \left. \left[2(P-B) \left(6 + (P-B)^2 (3h^2 - y^2) \alpha \right. \right. \right. \\ \left. \left. \left. + 6 \log(1-h\alpha_1) - 6 \log(1-y\alpha_1) \right) \right] + \right. \\ \left. \left. \left. (P-B) (12h - 6y + (P-B)^2 (4h^3 - y^3) \alpha) \alpha_1 \right. \right. \right. \\ \left. \left. \left. - 12\alpha_1^2 \right] \right] \right] \right]$$

4. Graphical Results and Discussion

The impact of important pertinent parameters on velocity, temperature, and stream functions are depicted through graphs. Notably, the behavior of wall parameters E_1, E_2, E_3, E_4, E_5 , variable viscosity α_1 , nonuniform parameter k , angle of inclination β and variable thermal conductivity ϕ are discussed. The Rabinowitsch model considered for study act as a pseudoplastic fluid for $\alpha > 0$, Newtonian fluid for $\alpha = 0$ and Dilatant fluid for $\alpha < 0$. The nature of the velocity and temperature profile are observed for fixed values of coefficient of pseudoplasticity $\alpha = -0.02$, $\alpha = 0$ and $\alpha = 0.02$ along with the parameters

$\varepsilon = 0.6$; $k = 0.05$; $E_1 = 0.09$; $E_2 = 0.04$; $E_3 = 0.4$;
 $E_4 = 0.02$; $E_5 = 0.01$; $\alpha_1 = 0.02$; $N = 0.02$; $x = 0.2$; $F = 2$;
 $\beta = \pi / 4$; $t = 0.1$; $\phi = 0.02$.

Figs. 2(a)-2(d) shows the velocity behavior with radial coordinate displaying the effects of coefficient of variable viscosity, nonuniform parameter, angle of inclination, and amplitude ratio when the pseudo plasticity parameter takes the values $-0.02, 0, 0.02$. The velocity profile increases with an increased coefficient of variable viscosity but decreases later, as shown in Fig 2(a). In other words, velocity behaves oppositely near the upper and lower walls. Usually, physiological organs are nonuniform ducts, and Fig. 2(b) reveals that the velocity profile enhances with the nonuniform parameter. Fluid velocity increase with the increase in the inclination angle due to the increased effect of gravity and is inferred from Fig. 2(c). The results of the amplitude ratio are plotted in Fig. 2(d), which exhibits a considerable increase in the velocity profile with the amplitude ratio.

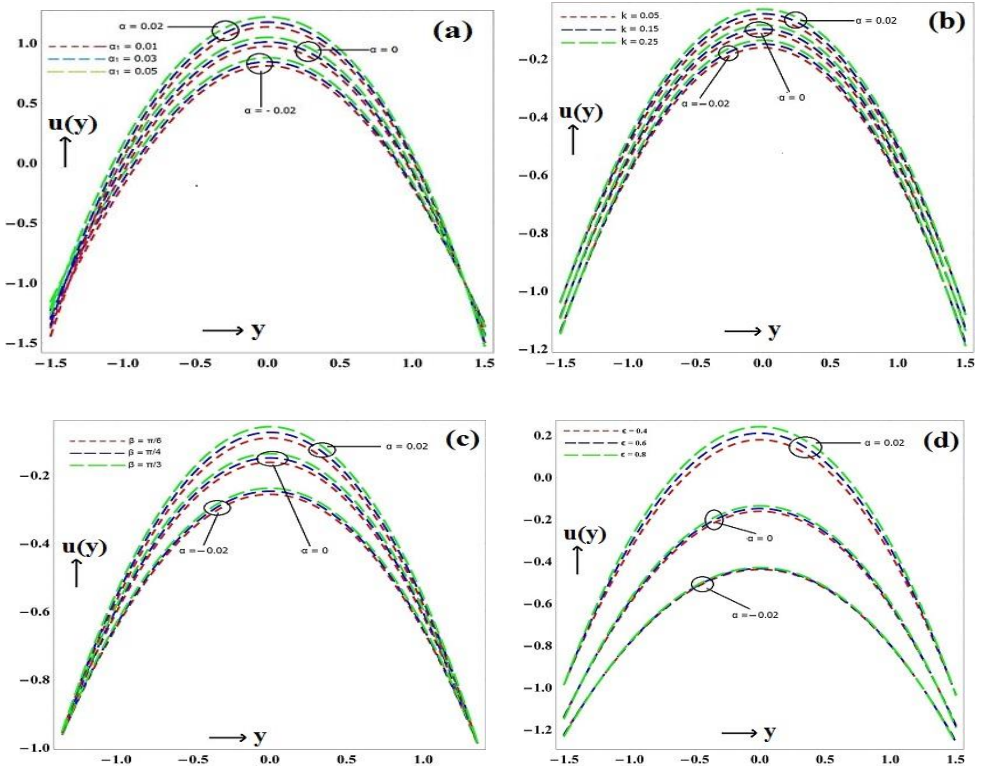


Fig. 2. Velocity plots for (a) variable viscosity α_1 , (b) nonuniform parameter k , (c) angle of inclination β and (d) amplitude ratio ε .

The velocity profiles are plotted to study the different wall parameters E_1, E_2, E_3, E_4, E_5 (Wall tension, Mass characterization, Wall damping, Rigidity and Wall elastic parameters) as depicted in Figs. 3(a)-(c). It is observed that for enhancement in E_1 and E_2 there is an increase in the velocity. Physically increasing values of E_1 and E_2 lessens the viscosity, which develops the flow rate. Wall parameters E_3, E_4, E_5 show that velocity reduces for increase in their values. It is because, for larger E_3 , viscous damping improves because of which velocity reduces.

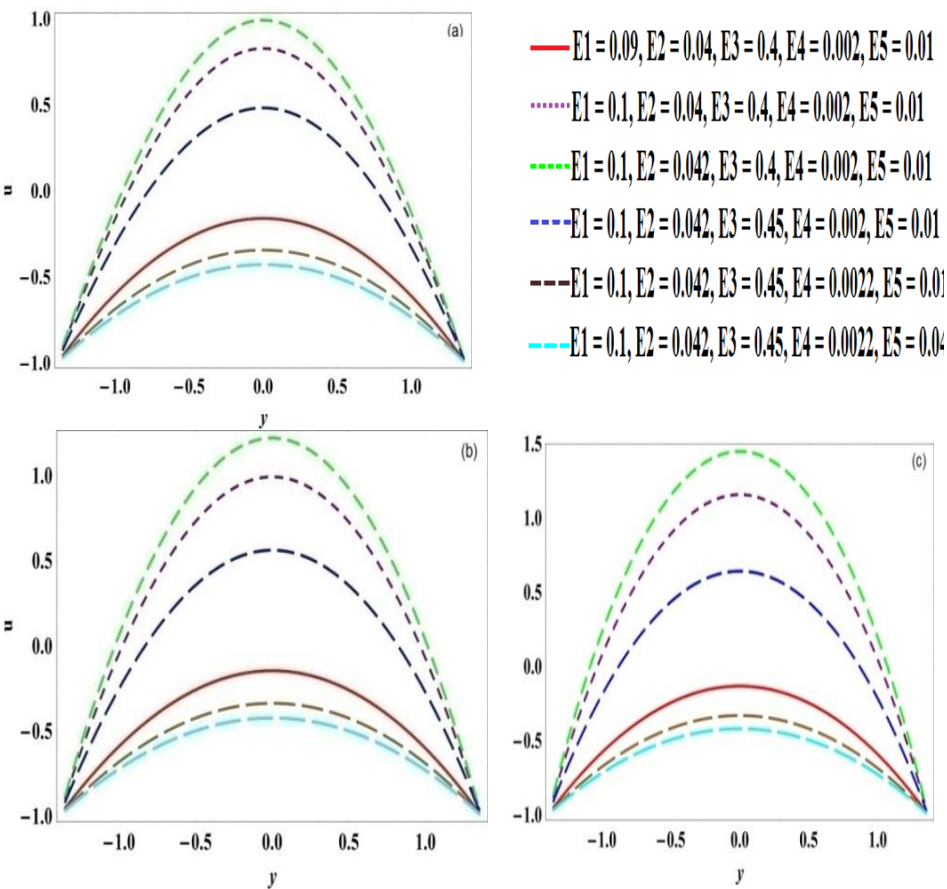


Fig. 3. Velocity Plots for variation in the values of wall parameters considering (a) $\alpha = -0.02$, (b) $\alpha = 0$ and (c) $\alpha = 0.02$

Figs. 4(a)-(d) depict the temperature profile graphs for various values of viscosity coefficient. Plots reveal that temperature gets larger with increasing variations in variable viscosity.

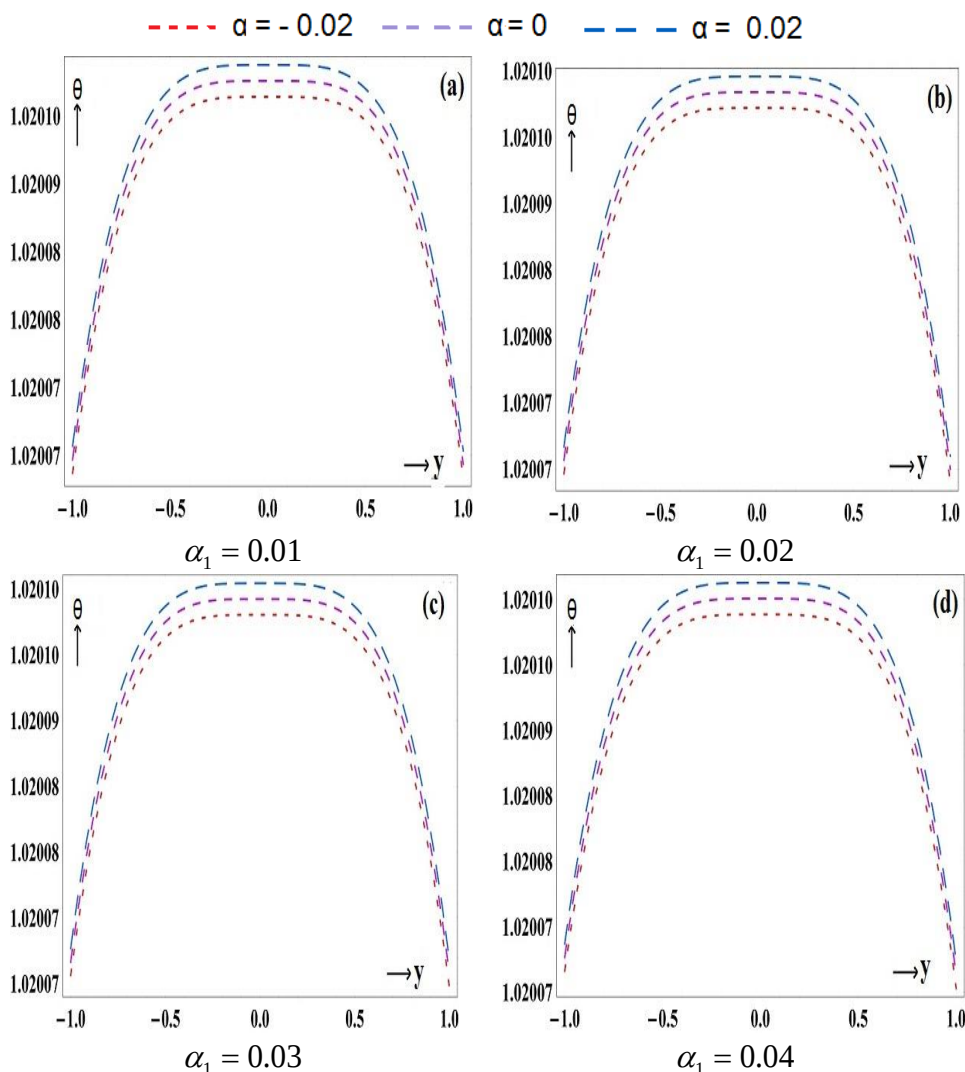


Fig. 4. Temperature plots for variation of coefficient of viscosity α_1 .

From Figs. 5(a)-(d), it is inferred that the temperature enhances rising inclination angle values in dilatants, Newtonian and pseudoplastic cases. It is inferred that the inclination angle reaches maximum value nearer to the center of the channel. From Figs. 6(a)-(d) the temperature profile increases with the growing Brinkman number for shear thinning, thickening, and viscous fluids, and the results are in good agreement with the results obtained by Singh *et al.*⁷ for some special cases. With growing values of Brinkmann number, there is a stronger heat generation because the

friction is utilized by shear in the motion that increases the temperature of the fluid. The heat conduction capability of a material is known as thermal conductivity. From Figs. 7(a)-(d), it is accountable that increasing the thermal conductivity parameter escalates the temperature profile for all three cases. Figs. 8(a)-(c) elucidates that the temperature profile rises for all the five elastic wall parameters.

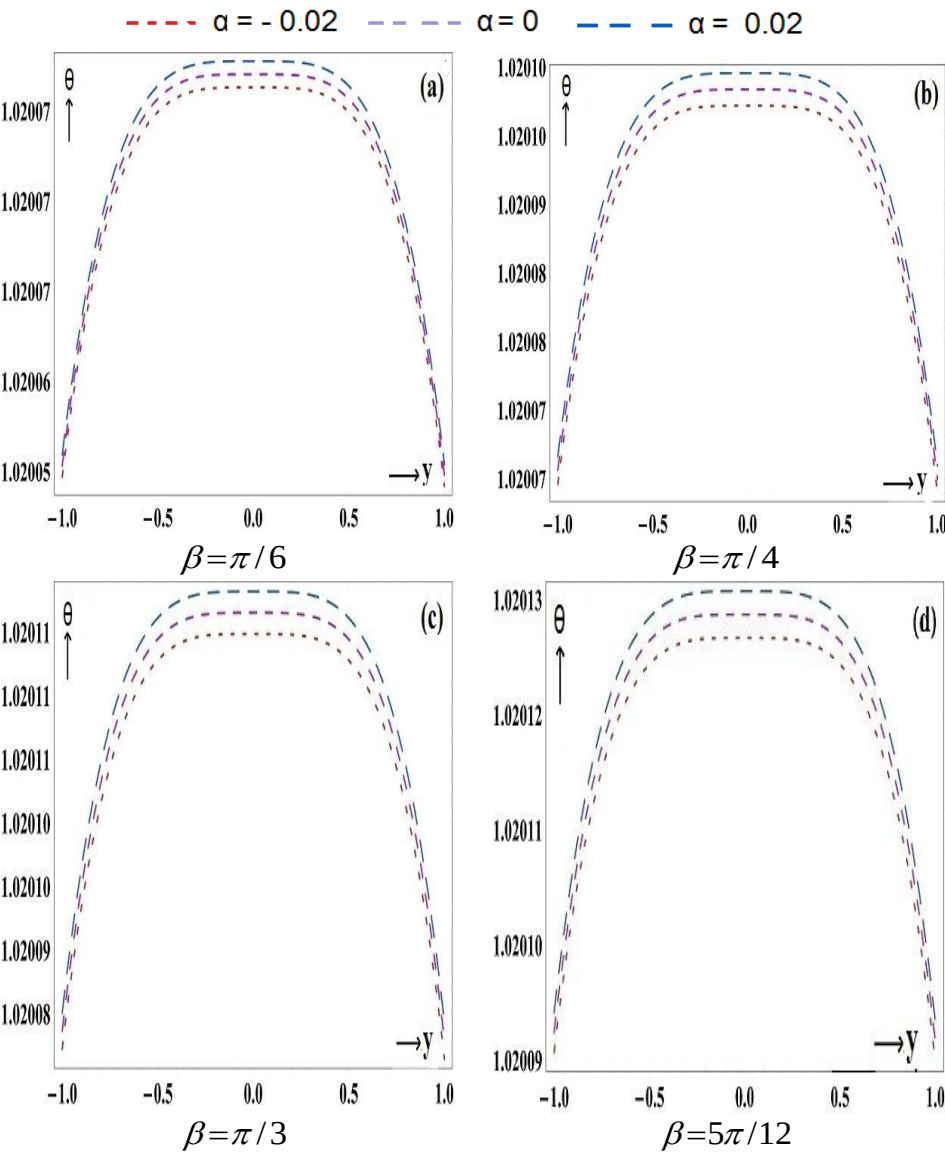


Fig. 5. Temperature plots for variation of angle of inclination β

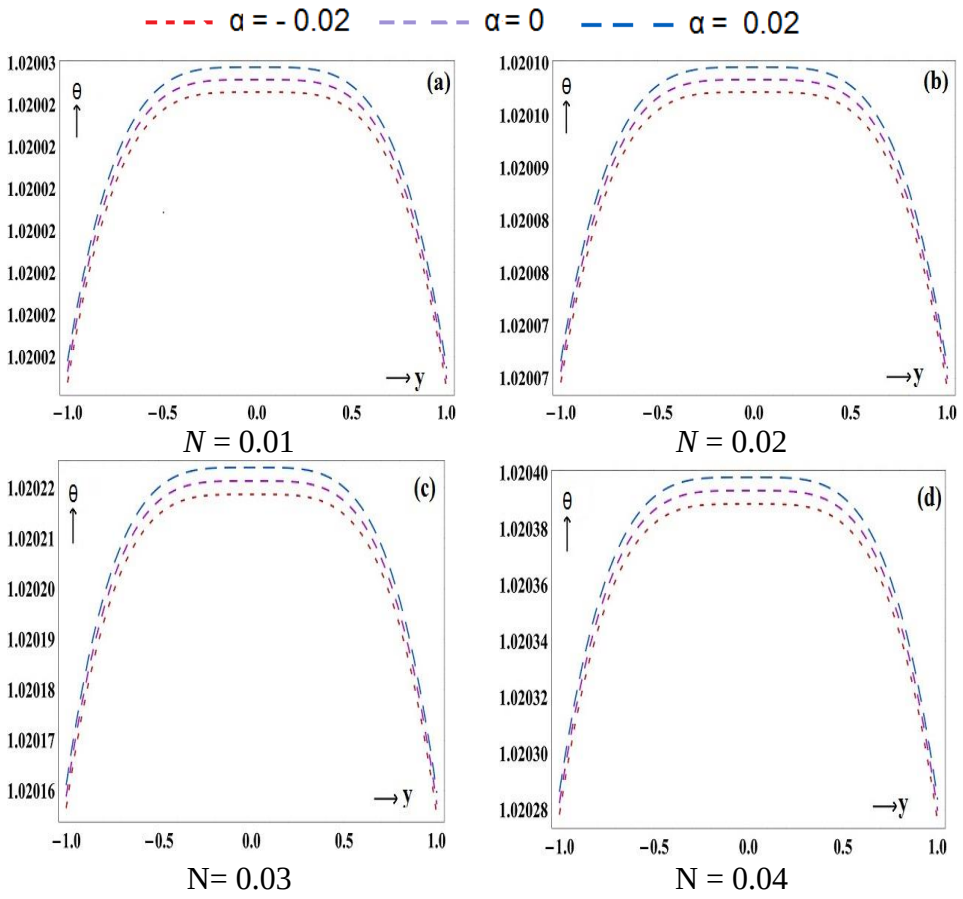
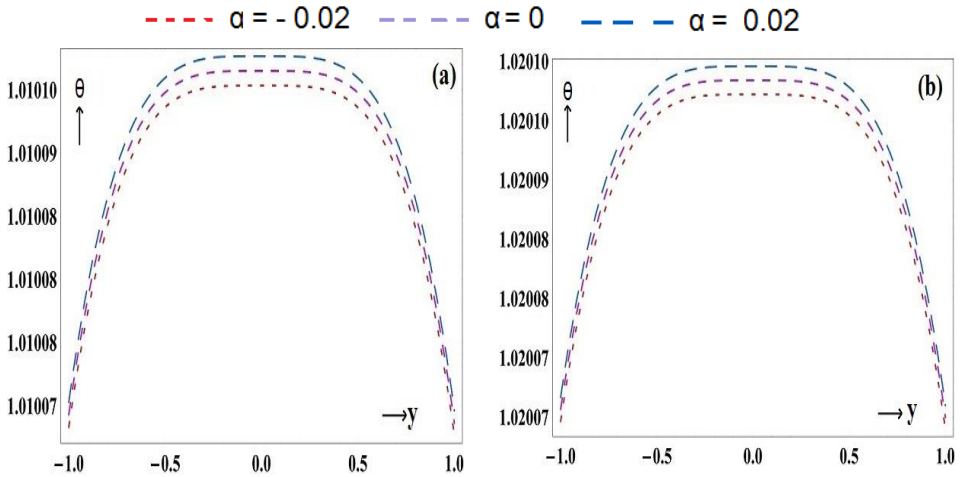


Fig. 6. Temperature plots for variation of Brinkmann number N



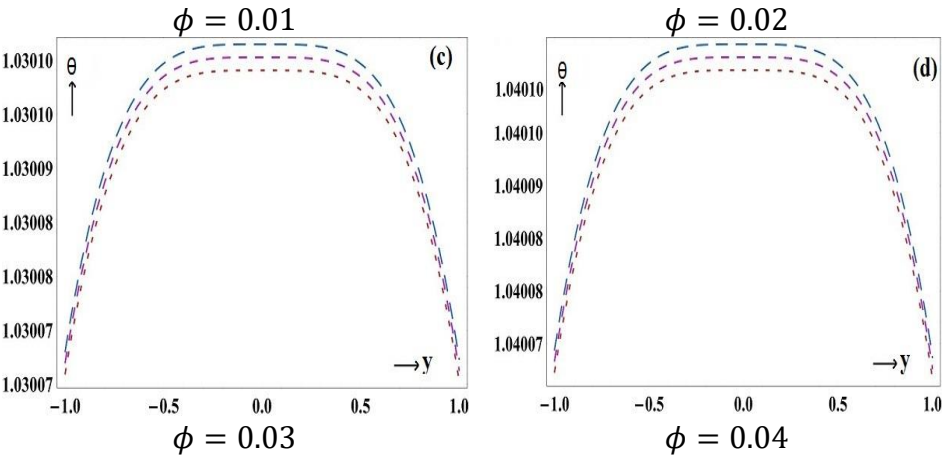


Fig.7. Temperature plots for variation of thermal conductivity ϕ

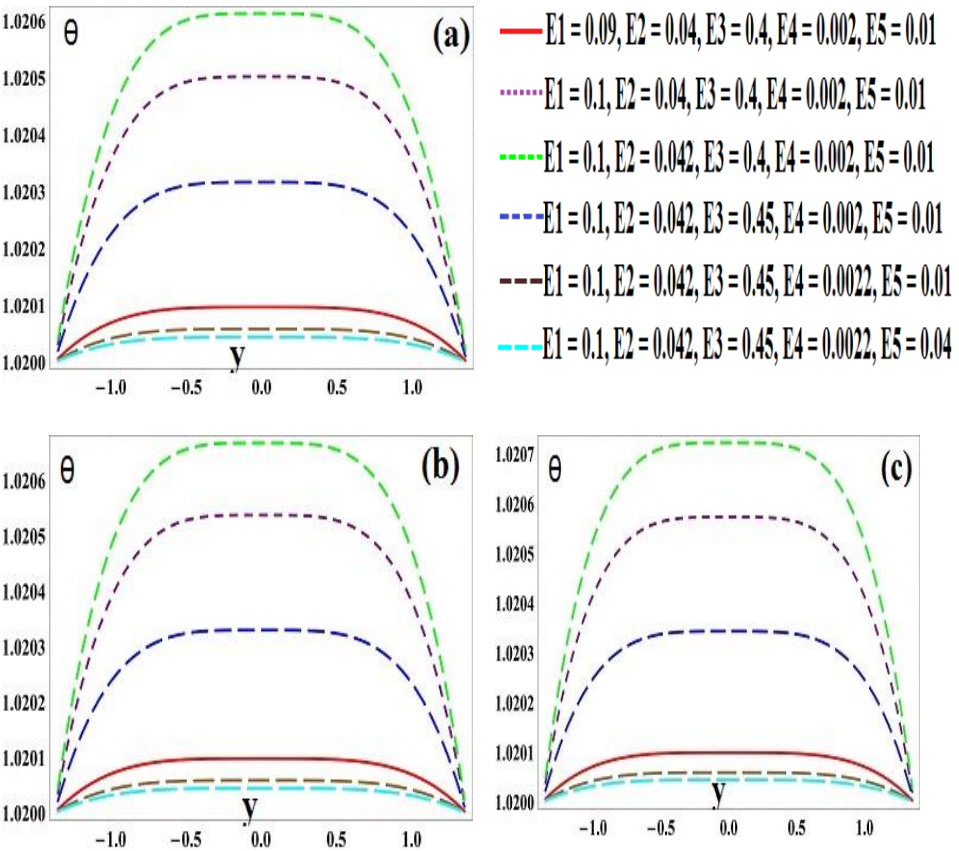


Fig. 8. Temperature plots for variation of wall parameters considering (a) $\alpha = -0.02$, (b) $\alpha = 0$ and (c) $\alpha = 0.02$

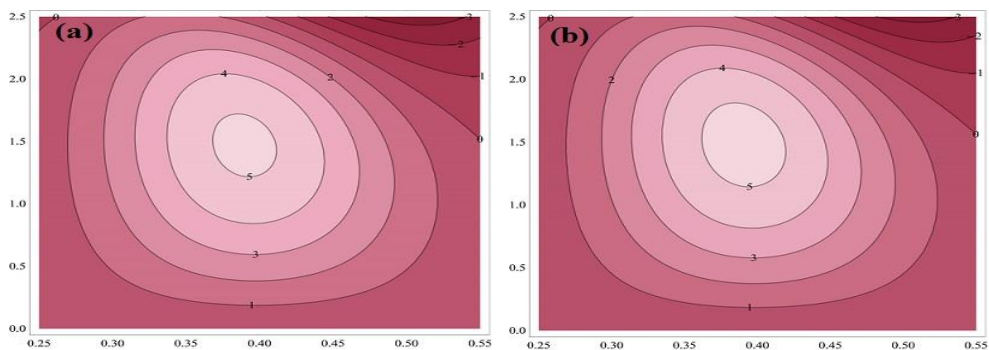


Fig. 9. Streamlines for varying non-uniform parameter:(a) $k = 0.03$ and (b) $k = 0.07$.

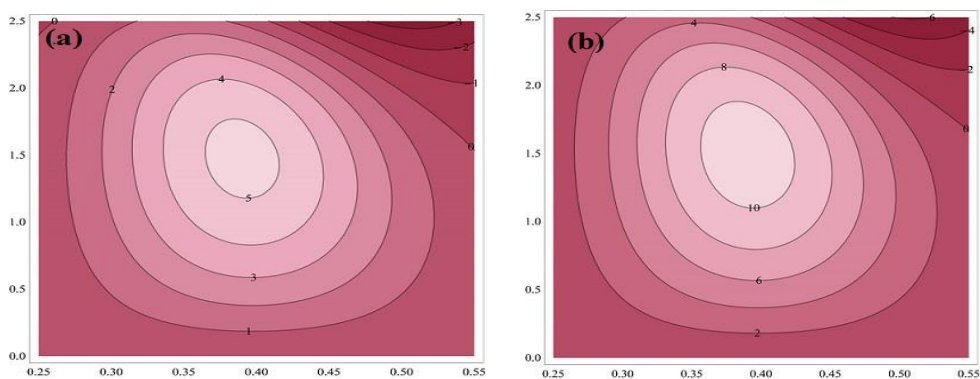


Fig. 10. Streamlines for varying variable viscosity: (a) $\alpha_1 = 0.02$ and (b) $\alpha_1 = 0.04$

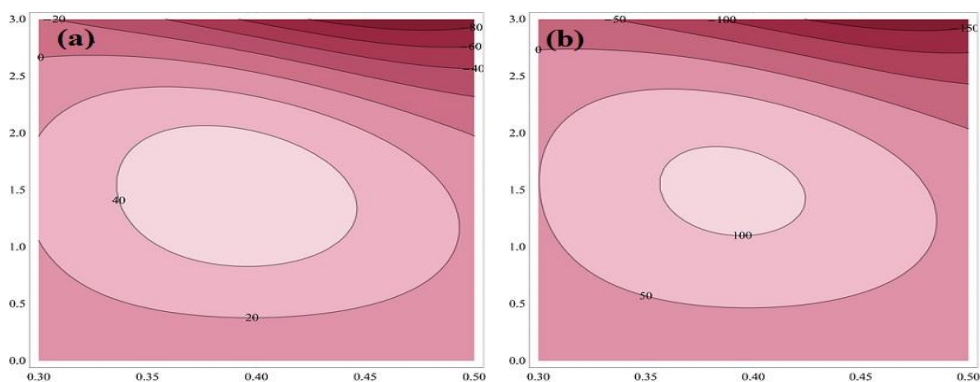


Fig.11. Streamlines for varying pseudoplastic parameter: (a) $\alpha = 0.02$ and (b) $\alpha = 0.04$

A cellular flow pattern is developed by the streamlines forming a closed loop that flows in the channel as a trapped bolus, and the trapped bolus moves forward through the sinusoidal waves at the same speed as the wave. Figures 9-11 show the impact of nonuniform parameters, variable viscosity, and coefficient of pseudoplastic parameter on trapping. From Fig. 9, it is noticed that an increase in the value of the nonuniform parameter enhances the size of the trapped bolus and thereby increases the number of bolus formations. Further, similar behavior is noticed for an increase in the value of variable viscosity and coefficient of pseudo-plasticity (See Figs. 10 and 11).

5. Conclusions

The influences of variable liquid properties and wall properties on the peristaltic flow of Rabinowitsch fluid through a nonuniform channel are analyzed. MATLAB 2020a programming is utilized to obtain velocity, temperature, and streamline solutions. The findings of the current model help in understanding numerous applications arising in medicine and industry. The main results of the current model are summarized as follows:.

- As the coefficient of variable viscosity, nonuniform parameter, inclination angle, and amplitude ratio rise, so does the velocity profile.
- The velocity profile increases as the elastic wall parameters increase.
- The temperature profile exhibits an increasing coefficient of variable viscosity, angle of inclination, Brinkman number, and thermal conductivity.
- As the elastic wall parameters are increased, the temperature profile rises.
- Variable viscosity, nonuniform parameter and coefficient of pseudoplasticity on streamlines enhances the volume of the trapped bolus.

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