International Journal of Engineering, Science and Mathematics
Vol.8Issue 9, September2019,
ISSN: 2320-0294 Impact Factor: 7.875
Journal Homepage: http://www.ijmra.us, Email: ijesmj@gmail.com
Double-Blind Peer Reviewed Refereed Open Access International Journal - Included in the International Serial Directories Indexed & Listed at: Ulrich's Periodicals Directory ©, U.S.A., Open J-Gage as well as in Cabell's Directories of Publishing Opportunities, U.S.A

FORMULATION OF FLOWS OF VISCO ELASTIC FLUID IN TUBES

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ABSTRACT:

The expansion of a needle in a vertical plane is the mechanism that gives rise to the development of a flow. In order to turn leading partial differential equations, such as those requiring the conservation of energy, mass, and momentum, into the form of ordinary differential equations, dimensionless transformations are utilised. This allows for the successful conversion. Finding solutions to newly formed equations and boundary limits may be accomplished with the help of the Bvp4c function, which can be found in the MATLAB toolbox. In addition, graphical assessments of the concentration distribution, fluid velocity distribution, and energy distribution are done on the solutions that have been found. The mass, flow, and heat transfer characteristics are all influenced by the thermo-physical embedded components such as the magnetic parameter, variable thickness parameter, second-grade fluid parameter, small parameter, variable diffusivity parameter, and Prandtl number. Other embedded elements include the small parameter. In addition to these factors, there are others such as the tiny parameter and the variable diffusivity parameter..

***Keywords**: fluid flow, MATLAB, Mass*

INTRODUCTION:

Flow problems have a wide variety of practical applications in a variety of industries, including manufacturing and engineering, which is why they continue to excite the interest of academics in the modern era. The flow of non-Newtonian fluids created by stretched surfaces is utilised in a variety of manufacturing processes, including the production of papers, plastics, and food components as well as the synthesis of lubricants and organic fluids. Second-grade fluids are utilized in a broad variety of different physical problems, including the production of lubricants, the flow of slurry, and diluted extrusion solutions, amongst others. Since the beginning of time, non-Newtonian fluids, which may be discovered in a wide variety of everyday things, have fascinated scientists.

fluid flow of the second grade that is unidirectional, transitory, and restricted in volume. what happens to the heat of a moving sheet when a fluid that does not behave like water goes over it. In addition, the volatile nature of the fluid that is utilised in Couette's machines that are of a lower quality. In a similar manner, a modified differential approach was utilised in order to address the issue of heat transmission for a fluid of a lesser quality that was moving through a material that absorbed heat. issue of a viscoelastic fluid moving across a stretched sheet, as well as the computing of the answer, by recommending an approach that is only semi-analytical. a great number of analytical solutions for the motion of fluid in the cylinder at the second order.

The answer to the convergent series problem in order to induce the flow of a viscoelastic fluid using a vertically stretchable cylinder that also transmits heat. studying the relationship between fluid flow and temperature in the second order along translational axes. The circular flow of a fluid of the second order between two infinite coaxial cylinders has numerical solutions. Because of the circular cylinder's torsion and longitudinal oscillations, the fluid in question does not behave like a Newtonian fluid would.

VISCOSITY

One way to think of viscosity is as the ratio of shear stress to shear strain; this is the definition of viscosity. The action of temperature-dependent viscosity, which operates on the fluid, may be responsible for the variation in the characteristics of the viscous fluid. This viscosity may be ascribed to the fluid. In the case of many liquids, including water and oils, the change in thickness (viscosity) that happens as a result of changes in temperature is more effective than any other change. This is because temperature variations cause the thickness to fluctuate. In a purely physical sense, the temperature and the viscosity of liquids are directly proportional to one another in an inversely direct manner, but the temperature and the viscosity of gases are directly proportional to one another. There are many different types of thermal transportation systems, and not one of them maintains a steady temperature distribution across the flow zone. This indicates that there will be a considerable change in the viscosity of the liquid in the event that there is a temperature variation inside the system. Therefore, if we want to accurately predict flow behaviours, it is essential for us to take into account the fact that the viscosity changes as a function of temperature.

A FLUID THAT HAS VARIABLE VISCOSITY AND DOES NOT FOLLOW THE NEWTONIAN FORM.

The effect that a variation in thickness has on the free convective flow that occurs across a vertical plate that has a number of distinctive characteristics. The solution is a fluid that does not obey the Newtonian equations and has a viscosity that varies. The outcomes of the application of the third-grade fluid, which took into consideration variations in boundary-layer thickness in the surrounding area. The movement of a fluid that has a magnetic field, as well as a changeable viscosity, via a porous border that is in motion. In order to discover how to deal with the problem of viscous fluid flow when the viscosity of the fluid varies, mathematical approaches were applied. The analytical response to the question of how well one can forecast the viscosity of a fluid of the second grade. The non-uniform thickness of the fluid and its thermal conductivity both have an impact on the manner in which mixed convective heat is transmitted across a spinning cone in the vertical plane. Fluid flow below the rotating disc in two dimensions via a surface with thermal characteristics and variable thickness and changes in the amount of internal energy that mutually reinforce one another.

AN EXAMINATION OF THE WORKS THAT ARE APPROPRIATE:

Vachagina, Ekaterina (2022). Because of the complexity of the flows themselves, it is challenging to develop analytical approaches that may be used to study the flow of viscoelastic fluids. This problem has been addressed in the past, but only for certain cases of multimode differential rheological equations that apply to the medium condition. These particular circumstances include the Giesekus equation, the exponential form of the Phan-

Tien-Tanner equation, and the eXtended Pom-Pom equation. We provide a parametric method that can generate results without the requirement for any extra assumptions to be established in advance in any of the preceding steps. The method is utterly meaningless if it does not include a coordinate-dependent parametric representation of the unknown velocity functions and the stress tensor components. An experimental visualisation of the flow was carried out using the smoke image velocimetry (SIV) method in order to validate the reliability of the data. This was done in order to better understand the flow. The eXtended Pom-Pom model performs significantly better than the Giesekus model when it comes to reliably predicting the outcomes of experiments.

By Fan Xijun (2022) The majority of research that has been done in this area in the past has mainly focused on predicting the flow of fibre suspensions in Newtonian fluids. This is the one and only method that has been tried so far. The vast majority of short fibre composites are made up of polymers; nevertheless, it is difficult to estimate the flow of these suspensions since there are no suitable constitutive equations for fibres suspended in viscoelastic fluids. This makes it difficult to predict how these suspensions will behave. This is because the viscoelasticity of the fluid that these suspensions are surrounded by has an effect on the flow of the suspensions. As a consequence of the preliminary research that the author did, a constitutive equation has been obtained for semi concentrated fibre suspensions in the Oldroyd-B fluid. This equation was derived as a result of the author's work. In this investigation, we cover both the mathematical formulation of the flow concerns that arise for such a suspension and the numerical approach that is used to solve those problems in order to get to the bottom of the matter. This is due to the fact that both are required in order to have a complete understanding of the circumstance. In addition to this, there are some numerical discoveries presented for the flow that happens around a sphere even though it is confined within a tube.

Nikolay Kudryashov (2016) is the author of the work. When fluid moves through a viscoelastic tube, there is a change in pressure, as well as fluctuations in the tube's radius. These changes may be represented by a set of nonlinear equations that can be developed. There may be a connection between a differential equation and the fluid's pressure and the tube's radius when it is being transported via a viscoelastic tube. It is feasible to construct nonlinear evolutionary equations in order to characterise the pressure and radius changes that take place during fluid flow. This may be done in a variety of different ways. It is possible to do this in order to achieve the goal. Some of the equations that may be used to depict pressure pulses on a variety of length scales are the Burgers equation, the Korteweg-de Vries equation, and the nonlinear fourth-order evolutionary equation. These equations can be found in the reference section. In this part of the article, we will detail exactly how the equations may be solved using the information found. In this investigation, numerical solutions for the Burgers equation and the fourth-order nonlinear evolutionary equation are contrasted and compared with one another.

THE OBJECTIVES OF THIS STUDY

1. examine how viscoelastic fluid flows in tubes are conceptualized.
2. it is important to study how the viscosity of the fluid impacts the process.

METHOD OF STUDY:

The mathematical approach that was used to solve the problem. Consider the motion of a Newtonian fluid that has incompressible characteristics, a circular cross section, and flows through a distensible cylinder of length L. The fluid has a circular cross section. The length of the tube is specified, and its radius is denoted by R0. If the amplitude of the wave is relatively small and the wave duration is relatively long in relation to the radius of the tube, then the assumption of one-dimensional flow is a good approximation. When a flow in only one dimension is assumed, this is the result that is obtained. Because of this, we can be absolutely assured that the slope of the warped wall will never be steeper than a mild one. The assumption of a one-dimensional flow could be an appropriate approximation if we take into account the fact that the flow pulse covers a considerable distanc.

Fluid dynamics equations

If we assume that the flow is axisymmetric, we can describe the x-component of the momentum equation as follows. The longitudinal axis is denoted by the letter x, while the radial axis is denoted by the letter r. Because of this, we are in a position to zero in on the x-factor and give it our full attention.

$$\frac{\partial w}{\partial t} + w\frac{\partial w}{\partial x} = -\frac{1}{\rho}\frac{\partial p}{\partial x} + \frac{\nu}{r}\frac{\partial}{\partial r}\left(r\frac{\partial w}{\partial r}\right)$$

where w represents the transmural pressure, k represents the kinematic viscosity, and p represents the velocity measured along the axial direction. The singular and exclusive word to describe it $\frac{\partial^2 w}{\partial x^2}$, as well as the other velocity components, are not very important and are often ignored (PEDLEY, 1980).

Permit me to elaborate on what I mean when I refer to "flow rate" and "average velocity across a cross section":

$$Q = 2\pi \int_0^R w\, r\, dr \qquad u = \frac{Q}{A}$$

And now, let us provide a group of variables that are not dimensional:

$$x \to \frac{x}{R_0} \qquad r \to \frac{r}{R_0} \qquad t \to \frac{t\, U_0}{R_0}$$
$$u \to \frac{u}{U_0} \qquad p \to \frac{p}{\rho U_0^2}$$

where U0 is the average speed and The initial radius is denoted by R0.

If we integrate across the whole cross section A of equation 2.1, we should be able to obtain the quasi-1D nondimensional version of the momentum equation:

$$\frac{\partial u}{\partial t} + u\frac{\partial u}{\partial x} = -\frac{\partial p}{\partial x} + f$$

friction is represented by the letter f.

By utilising the value that corresponds We are able to obtain a reasonable approximation of the friction component in equation (2.3) by applying it to the steady Poiseuille flow in a tube of a radius R.

$$f \simeq -\frac{8u}{Re\, R^2}$$

Where, $Re = \frac{U_0 R_0}{\nu}$, which stands for "Reynolds number," is an abbreviation. The wall shear stress may then be roughly estimated using this information:

$$\tau = \left.\frac{du}{dr}\right|_R \simeq -\frac{4u}{Re\,R}$$

The formulas (2.4) and (2.5) are correct when applied to a rigid tube exhibiting a constant flow. However, because we are interested in the influence that pulse propagation has on average, it is appropriate for us to take them into consideration when applied to the situation in which there is a pulse.

$\frac{\partial R}{\partial x} << 1$. 1 in addition to flows that are highly consistent. In point of fact, a large number of writers are in agreement that equations (2.4) and (2.5) are appropriate for use in the context of one-dimensional averaged flows. In addition to this, since Re is more easily detectable in bigger arteries,

, τ and f are both very insignificant and, in the great majority of contexts, provide very little to no noticeable effect. The continuity equation looks like this when applied to a tube that has some elasticity:

$$\frac{\partial A}{\partial t} + \frac{\partial (Au)}{\partial x} = 0$$

or alternative:

$$\frac{\partial R}{\partial t} + \frac{R}{2}\frac{\partial u}{\partial x} + u\frac{\partial R}{\partial x} = 0$$

A wall of maths problems In a steady situation, the system (2.3)-(2.7) will be solved by showing a mathematical connection between the local transmural pressure and the radius.

$$p = p(R, x)$$

It is vital to adhere to (what the majority of people in the region refer to as the tube legislation). Researchers working in the field of artery mechanics have developed a number of tube laws in order to provide further information on the deformation that takes place as a result of a certain pressure (for further information, see PORENTA ET AL, 1986). However, the majority of these models ignore the shear stress that develops along the wall surface since they employ pressure as a loading factor for the radial displacement (independent rings models). In this part, we are going to use a different method, one that is more suited to time-dependent flows and is founded in mechanical principles. This new technique will be described below. According to TIMOSHENKO (1940), the membrane theory may be used to simulate the vessel wall at any thickness. He contends that this is possible. This is a mathematical model of a shell that is flat on all sides. in two dimensions, free from bending forces, and having a mass that is small in comparison to the density of the fluid. According to HUMPHREY (1995), one would anticipate that stresses in the tangential plane would be distributed equally all the way through the thickness of the material. Because of this, the membrane is forced to deform as a result of the action of the forces, and it eventually finds itself in a condition of equilibrium. Let's write R(x; t) and S(x; t) in order to describe the Eulerian equivalents of the Lagrangian coordinates of a particle of the membrane. This will help us understand how the Eulerian coordinates relate to the Lagrangian coordinates. We will do this by following the lead given by PEDRIZZETTI (1998). PEDRIZZETTI (1998) is the author of the publication that contains the tangential and normal fluid-membrane equilibrium equations. In the interest of thoroughness, we have reproduced these equations here:

$$R'(T_1 - T_2) + RT_1' = \tau R(1 + R'^2)^{\frac{1}{2}}$$
$$\frac{-R''}{(1 + R'^2)^{\frac{3}{2}}}T_1 + \frac{1}{R(1 + R'^2)^{\frac{1}{2}}}T_2 = p$$

where the shear stress that is placed on the wall by the viscous fluid is denoted by the symbol T, and the nondimensional membrane stresses that are applied in the meridional and circumferential directions are identified by the letters T1 and T2 (please refer to (2.5) for more clarification). To model the equilibrium state of the wall at any given moment, the static membrane equations (2.8) are used as a simulation tool. Before we can get the equation that describes the wall's constitutive behaviour, we first need to have a solid understanding of the basic deformation ratios in the tangential plane, which are represented by:

$$\lambda_1 = \sqrt{\frac{1 + R'^2}{S'^2}} \qquad \lambda_2 = \frac{R}{R_u}$$

Using the radius that has not been altered, Ru:

To be able to give an accurate quantitative description of blood flow, one of the most significant criteria that must be met is to provide an acceptable characterization of the mechanical features of the blood vessels. This characterization is often done within the framework of wave propagation events. Because the characteristics Notwithstanding the fact that vascular tissues are very nonlinear, several models have been developed in order to replicate the dynamics of the artery wall in both healthy and diseased states (HUMPHREY, 1995). These models have been utilised in a variety of settings, including research as well as therapeutic settings. On the other hand, in a vessel that is subjected to typical stresses, it is more likely that a linear strain-stress law will be applied close to an equilibrium configuration. This is because the radial deformation near to the equilibrium configuration is frequently less than 10% and is thus not particularly meaningful. The reason for this may be found in the fact that. In order to describe the stresses, we employed a linear elastic two-dimensional model for the case of extremely minor deformations. T1 and T2 in equation (2.8). This model was used since the deformations were very small. Although there are a few nonlinear formulations that may be used for the constitutive equation, opting for this fundamental option that defines an elastic behaviour is a good place to start.

However, a number of researchers have recently brought attention to the significance of viscoelasticity when modelling artery walls. When viscoelasticity is ignored, both the phase velocity and the damping are predicted to be less than they really are.

Damping high-frequency oscillations with a dissipative wall will, in general, be more successful than doing so with a viscous fluid, and Viscoelastic wall models produce numerical findings that are more accurate representations of the real world.. The table that follows provides an illustration of both of these patterns. According to HORSTEN et al. (1989), the findings are more in accordance with experimental data because viscoelasticity damping prohibits substantial pressure and flow pulse peaks. This is the reason for the results being more in line with the experimental data. In this exploratory research, we add a viscous term that varies linearly in amplitude to complement the elastic component. The relationship between strain and stress that is described below may be obtained from this:

$$T_1(\lambda_1, \lambda_2, \dot{\lambda}_1, \dot{\lambda}_2) = K\left(\lambda_1 + \frac{\lambda_2}{2} - \frac{3}{2}\right) + C\left(\dot{\lambda}_1 + \frac{\dot{\lambda}_2}{2}\right)$$

$$T_2(\lambda_1, \lambda_2, \dot{\lambda}_1, \dot{\lambda}_2) = K\left(\lambda_2 + \frac{\lambda_1}{2} - \frac{3}{2}\right) + C\left(\dot{\lambda}_2 + \frac{\dot{\lambda}_1}{2}\right)$$

In equations (2.9) $K = \frac{E\,h}{\rho R_0 U_0^2} > 0$ (PEDRIZZETTI, 1998) states that is the time derivative, C > The value 0 represents the wall viscosity coefficient, whereas E and h stand for the undeformed artery thickness and the Young modulus, respectively.

For an incompressible and isotropic material, in which the principal directions of strain and stress coincide, the equations that were presented before (2.9) are valid. The phenomenon known as the instantaneous Young's modulus growing with strain is characterised by these correlations. However, this phenomenon can occur to varying degrees in both directions. It is possible for this impact to take place in either way. Even if the inertia of the membrane is ignored and a comprehensive theoretical framework is not yet available, it has been demonstrated that the fundamental functional dependence strain-stress in equations (2.9) may be applied to describe the viscous effects of a material in time-dependent motions. This is the case even if it has not yet been established that a broad theoretical framework is accessible. The use of equations allowed us to achieve this goal (2.9), which was our starting point. These equations not only indicate the reaction of the artery wall to the deformation, but also the rate of change that is occurring as a direct result of the distortion. In other words, the membrane reacts to forces through a dissipative process, analogous to that of a viscoelastic material, as shown by the solution to equation (2.9), rather than immediately, as it would if it were composed of a substance that was completely elastic. Note that although while time is directly involved in equations (2.3) and (2.7), the membrane equilibrium equations (2.8) are time dependent as well. This is due to the fact that the stresses T1 and T2 depend on the strain rates in equations.

Taking into consideration that the wall is immobile on both ends results in the following boundary condition:

$$R(0,t) = 1 \qquad S(0,t) = 0$$

$$R(L,t) = 1 \qquad S(L,t) = L_u$$

where Lu denotes the length of the membrane that is not deformed.

At both boundaries, the only values that are assigned are those for p(0; t) and p(L; t). in order to simulate the experimental setting of a distensible tube positioned at the two extremes. This is done so that the results will be comparable. This is done so that comparisons may be made between the results of the various experiments. The method that is outlined in (PEDRIZZETTI, 1998) differs from the one that is outlined in this article due to the fact that the value of the flow rate is assigned at one of the borders alongside the relative significance of the pressure. When utilising this approach, the computation of both of the values takes place concurrently. In this situation, the pressure is raised to the same level at both ends in order to conduct research on the process of transitioning to an equilibrium configuration:

$p(0,t) = p_{ref}$ $\quad\quad$ $p(L,t) = p_{ref}$

Where $\epsilon < p_{ref}$ and $S_t = \frac{R_0}{U_0 T}$, where T is a measure of time, are referred to as the amplitude of the excitation in a nondimensional space and the Strouhal number of the excitation, respectively. Both of these terms are used to describe the excitation. There is now work being done to construct boundary conditions that take into consideration a variety of different physiological characteristics (PONTRELLI, 2002). The starting state may be determined by taking into account a configuration of steady flow that has been infinitesimally disturbed. This arrangement is comparable to a wall that is totally elastic and has a pressure gradient that is constant. The configuration of the system is then either allowed to return to its equilibrium state on its own (see the formula for (2.11), below), or it is compelled to do so by an oscillating pressure. (see (2.12))

There are three different approaches to analysis, as well as numerical parameters.

Using the centred second order finite differences in space, the fluid evolution equations (2.3) and (2.7), the membrane equilibrium equation (2.8), and the constitutive equations (2.9) are all discretized.

Consider a square grid with n + 1 points that are uniformly spaced apart, where x0 = 0 and xn = L. This grid would be considered to be linear. Let's suppose that there are equal amounts of space between each item in the sequence. Calculating membrane stresses, strains, and the temporal derivatives of those quantities (see equations (2.9)) In n inner locations on a staggered grid with coordinates of the form i = xi + xi+1 2, we are able to construct the spatial discretization by taking into consideration the average values of neighbouring cells. This is done by placing the coordinates in the form i = xi + xi+1 2. On the other hand, the equations for fluid equilibrium (2.8) and fluid flow (2.3)-(2.7) may be found for the n-1 inner locations xi. Because the temporal discretization is based on the trapezoidal formula, the global scheme has a second order in both space and time (FLETCHER, 1988). This is because the trapezoidal formula is used for the temporal discretization. A Newton-type approach that converges worldwide might be used to solve the nonlinear system that was produced as a consequence of this.

It has been discovered that the selection of the material properties that represent the particular flow issue is extremely influential on the behaviour of nonlinear models. For the variables U0 and R0, the formula (2.2) makes use of the conventional values of 50 cms-1 and 0:5cm, respectively. The other parameters have been selected in order to produce findings that have physiological significance, and the value 10 has been assigned to the nondimensional parameter pref. This was done so that the results would be comparable to real life. These additional parameters have also been updated within a typical range that may be used to determine how sensitive the system is to disturbances in its environment. Similar considerations led to the implementation of this change.

It is necessary for both p and K to be positive for the elasticity parameter K to have a value that is greater than p. p/K is roughly proportional to the membrane's radial deformation.

Within a Biological Framework, $\frac{h}{R_0} \approx 0.1$ As a consequence of this (NICHOLS and ROURKE, 1990),
$K \approx 200$. Despite this, the issue is explored for K values that span a larger range in order to have a more comprehensive comprehension of the capabilities of the model and the functional dependency of the solution. $200 \leq K \leq 6000$: It has been shown that by increasing K, the rigidity of the wall may be made very high. However, the system undergoes an unnaturally large deformation when K is less than 200, and the existing model does not faithfully portray the physics (see subsection 4).
Our standard operating procedure in all of our experiments was to $L = 2$, $\Delta x = 10^{-2}$ and $\Delta t = 10^{-3}$. For the studied set of parameters, the system is guaranteed to be numerically stable if these values are used. The validity of the solution was validated by using a more granular grid, which did not reveal any other possible solution structures or unsolved patterns. In each and every one of the tests, the very same baseline data was utilised. For the sake of this model inquiry, we will make the assumption that the Strouhal number of the forcing in the physiological flow is comparable to the natural frequency S t of the membrane (for additional details regarding this assumption, see below). Spectral analysis is used to calculate this when the system is first deformed and then allowed to develop towards the equilibrium configuration created by applying the same value of pressure at both extremes. This is done after the system has been exposed to an initial deformation..

RESULT

Here, we present the findings of a battery of numerical experiments designed to generate realistic flow fields with parameters that are relevant to biomechanical applications. After an initial transient, all the system's variables asymptotically converge to the equilibrium value they would have had the perturbation not occurred, has oscillations that are dampened, have a drop that is exponential, and a frequency that varies depending on the parameter. K. S_t^* (to oscillate at a frequency determined by nature. Because the wall is elastic, the ultimate condition at both ends involves a favourable deformation as well as an advantageous flow rate. Unless otherwise indicated, a fluid that moves through the system by convection. ($f \equiv 0$ in (2.3) and $\tau = 0$ in .

Because there is no quantitative data available for the dissipation of the wall during dynamical trials, the impact of the membrane viscosity is investigated by varying the value of C. This allows for an investigation into the relationship between the two. This is due to the fact that there is no data that can be accessed on the dissipation of the wall. Doing so will allow for a more accurate estimation of C's value, which is the aim of doing so. It has been shown that the attenuation factor rises with increasing C but stays the same with rising K (see figure 1 for more information). For $C \to 0$ The solution does not have any damping, and its behaviour tends to be similar compared to the performance of a system consisting just of an elastic wall.

In order to get a deeper comprehension of the the magnitude of the reference pressure, the impact of the reference p_{ref} is changed in the range [0:5; 200], given the two values of K and C that have been allocated. As a consequence of excessive deformations, instability arises in response to an increase in the applied pressure. In this scenario, the one-dimensional model is insufficient to adequately capture the occurrence. There is no variation in the value of u as a result of p_{ref} , On the other hand, as can be seen in Figure 2, the natural frequency has risen by a little amount, which is proportionate to the deformation. This increase was caused by the deformation. On the other hand, the initial inputs have a significant role in determining whether or not the system will converge during the transient.

On the other hand, neither C nor the initial data have any influence on the values of the deformation in its steady state, which continue to decrease as the value of K is increased. The natural frequency increases with K (in the sense of a functional dependency in the first example), which is another interesting fact to take into consideration.

$S_t^* \propto \sqrt{K}$ (LIGHTHILL, 1978) is assumed, but neither C (see figure 3) nor the original data modifies this. This is the case due to the continuity between these two factors. Only in the transient domain is it possible to see the influence of the viscosity coefficient C, which is to induce energy loss and damp the oscillations at high frequencies (but not to change the oscillations' frequency). It was established that the longitudinal displacement R d was three orders of magnitude smaller than the longitudinal displacement S, hence it would not be displayed. When one takes into account the fluid friction that occurs close to the wall, however, the influence of such a variable becomes far more significant.

The force used was oscillating.

Condition (2.12), known as the boundary condition, which represents the fundamental physiological waveform at the outflow. What we have discovered as a result of performing simulations with varying amplitudes and Strouhal numbers

$\epsilon = 1(10\% \text{ of } p_{ref} = 10)$ Clearly show that the flow does not settle back into a steady state, but rather exhibits continuous sinusoidal oscillations at the same frequency as the input forcing1, and the amplitudes of the oscillations are nearly comparable to those of a steady state when they are at their largest.. $S_t = S_t^*$ (The phenomenon of resonance is illustrated in figures 4 and 5. The study of the radial velocity of the wall indicates that the propagation characteristics correspond to transverse waves, which do not propagate down the tube. This conclusion was reached as a result of the assessment of the radial velocity of the wall. These characteristics are attributed to the boundary conditions that produce reflections and spurious effects (fig. 6), which are produced by the fact that transverse waves do not propagate down the tube. These effects are generated by the fact that transverse waves do not propagate along the tube. The boundary conditions (2.10) of a flow of the Dirichlet type perform a decent job of duplicating a physical experiment, despite the fact that they may not be realistic in terms of the physiological fluxes. This phenomenon may be compared to waves moving down a stretched thread that only has a certain amount of distance to travel. Even if the excitation that was initially located at the right boundary is switched with one that was located at the left boundary, the results do not alter in any way.

The viscosity of the fluid has some bearing on the outcome.

The consequences of a flow that is dominated by inertia need to be explored in order to have a knowledge of the roles that viscosity and inertia play in the motion of the fluid and its contact with the wall. This is necessary in order to have a full comprehension of the roles that these two factors play.. (i.e. with $Re \to \infty$)and of a very viscous flow (i.e. with $Re = 1$ in (2.4) and (2.5)) (while keeping all of the other variables the same) comparisons have been made. When we do such a comparison, we are able to see that the mean velocities display a more substantial Figure 7 illustrates a non-monotonic envelope by showing a damping to zero during the transient, followed by a rise to the steady state values. After the initial transient, we are able to see that the mean velocities are increasing to the values of the steady state. The magnitude of the steady-state deformation and the frequency of oscillations remain the same, despite the fact that the frequency of the stimulus is changing. On the other hand, the wave speed only varies with Re when K is set to very low values. As a result, it would seem that the oscillation frequency of the wall is a feature that is constant and unaffected by the qualities of the fluid. This is because the vibrations are being caused by the wall itself, which is why you can feel them. On the other hand, because of the inherent viscosity of the fluid, a greater amplitude of pushing pressure may be applied without risking an explosion in the system. According to some other findings, the attenuation of the wall viscoelasticity is the most relevant component in bigger vessels, where the damping caused by the viscosity of the fluid is the most important component, whereas in smaller vessels the most important factor is the size of the vessel.

CONCLUSION

After doing a detailed analysis of the numerical data, it was found that the viscoelasticity of the fluid has a significant impact on the effectiveness of the lubricating system. This was one of the key takeaways from the analysis. If there is a way to improve the viscoelasticity of the flow, then there is a possibility that the load capacity of the inner cylinder can also be raised. This research investigates how the peristaltic transport of a viscoelastic fluid known as an Oldroyd fluid in a uniform tube is impacted by the slip velocity, heat transfer, and mass transfer that take place during the process. Specifically, the authors focus on how these three factors interact with one another. As it makes its way through the tube, the Oldroyd fluid demonstrates behaviour consistent with a peristaltic pump. There is a possibility that the issue is connected to the movement of chyme through the small intestine as there is where the problem may be originating. The perturbation approach allowed us to create analytical solutions for the fields of velocity, pressure gradient, temperature, and concentration. We were able to do this by allowing the fields to interact with one another. These analytical solutions are in no way affected by either the Reynolds number or the Weissenberg number. Neither of these numbers can be considered a factor.

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