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Dispersion of Solute in Pulsatile Blood Flow of Power Law Fluid through Artery with the Effect of Magnetic Field

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Abstract
Blood flow is a fluid dynamics problem in the human vascular system and dispersion of solute (medicine) in blood (solvent) flow is one of the practical problems in biomedical engineering. The purpose of this study is to analyse the effect of magnetic field on the dispersion of solute in pulsatile blood flow through an artery by modelling the blood as power law fluid. The integration and perturbation methods are utilised to find the solution for the unsteady blood flow velocity. The concentration of solute, dispersion function and mean concentration are obtained by solving the unsteady convective-diffusion equation with the Generalized Dispersion Model (GDM) and applying the integration approach. The presence of magnetic field produces magnetic force, which influences blood velocity and solute dispersion. The effects of the magnetic field on blood velocity and solute dispersion are graphically represented. The results show that when the fluid magnetization, magnetic field gradient and magnetic parameter rise, the blood velocity, mean concentration and dispersion function decrease. However, if the pressure gradient increases, the blood velocity, mean concentration and dispersion function increase. As a result, it is investigated that the magnetic field lowers the blood velocity and solute of dispersion function. The current research can assuredly be used to predict changes of blood flow behavior with the presence of magnetic field and helps people in need of study to comprehend the mechanism of solute dispersion process in pulsatile blood flow.
Keywords: Magnetic field; Perturbation method; Power law fluid; Solute dispersion; Generalized Dispersion Model

1. Introduction

The investigation of the physical mechanisms of blood flow via blood vessels in the cardiovascular system is essential for understanding cardiovascular disorders such as atherosclerosis and post-stenotic dilatation. Nicholas *et al.* [1] stated that the cardiovascular system, also known as the circulatory system, is made up of blood arteries, the heart and blood itself. The cardiovascular system's role is to transport blood throughout the body. The blood, as a medium, transports oxygen, nutrients and hormones to all sections of the human tissues, as well as carbon dioxide and other waste items out of the body. Furthermore, the cardiovascular system protects the body from infections and disorders [2].

Cardiovascular system relies heavily on the arterial pulse [3]. Human cells are capable of detecting and adapting to cyclic pressure and flow variations. Dincau *et al.* [4] mentioned that one of the flow variations is pulsatile flow which causes shear and strain forces on the endothelium, smooth muscle and fibroblast cells in both the large scale and microcirculation. At the cellular level, the mechanical strengths of pulsatility always initiate different cellular signalling pathways and have critical impacts on endothelium control of vasodilation and vascular remodelling, counting framework statement, programed cell passing, smooth muscle cell multiplication and atherosclerosis. In liquid elements, a flow with occasional varieties is known as pulsatile flow.

Magnetic treatment is now routinely utilised to treat a variety of ailments. Magnetic therapy is the use of magnetic fields to assist the body in reducing muscular inflammation and discomfort. Marcinkowska-Gapinska and Nawrocka-Bogusz [5] stated that magnetic fields are used in a variety of medical professions, including neurology, orthopaedics, rheumatology and psychiatry. The magnetic treatment may be beneficial for ischemic tissue reperfusion or during sepsis. Necrosis occurs gradually if blood supply to a tissue is restricted or diminished. A magnetic field applied locally might cause blood vessel relaxation and enhanced blood flow.

The influence of a magnetic field on the rheological characteristics of whole blood is a poorly understood phenomena that has received little attention. Nobody conducts the research on solute dispersion in blood flow while accounting for the influence of a magnetic field using a power law fluid model. Therefore, the goal of this study is to develop a power law fluid model and theoretically examine the effects of magnetic fields on the solute dispersion of blood flow in a power law fluid. Solute dispersion research in blood flow can aid in the medical profession by producing an effective fluid model, blood velocity, solute dispersion, solute concentration and time for taking medicine.

2. Mathematical Formulation

2.1 Non-dimensional variables

Consider the non-dimensional variables as below:

$$r=\frac{\bar{r}}{\bar{a}},\ u=\frac{\bar{u}}{\bar{U}},\ u_0=\frac{\bar{u}_0}{\bar{U}},\ t=\frac{\bar{t}\bar{u}}{\bar{a}},\ p=\frac{\bar{p}\bar{a}}{\bar{\mu}\bar{U}},\ \tau=\frac{\bar{\tau}\bar{a}}{\bar{\mu}\bar{U}},\ z=\frac{\bar{z}}{\bar{a}},$$
$$\rho=\frac{\bar{\rho}\bar{a}\bar{U}}{\bar{\mu}},\ g=\frac{\bar{g}\bar{a}}{\bar{U}^2},\ \alpha=\frac{\bar{a}\,\bar{u}\,\bar{\rho}}{\bar{\mu}},\ C=\frac{\bar{C}}{\bar{C}_0},\ D_m=\frac{\bar{D}_m}{\bar{U}\bar{a}},\ H=\frac{\bar{H}}{\bar{H}_0}, \tag{1}$$

where $\bar{\mu}=\bar{\mu}_P\left(\bar{a}/\bar{U}\bar{\mu}\right)^{n-1}$ has the dimension of Newtonian fluid viscosity. Meanwhile, $r,u,u_0,t,p,\tau,z,\rho,g,\alpha,C,D_m$ and H are the radius, velocity, first term of the perturbation series of velocity, time, pressure, shear stress, density of the fluid, gravitational acceleration, Reynolds number, solute concentration, constant molecular diffusion and magnetic field intensity respectively.

2.2 Governing equations

2.2.1 Momentum and constitutive equations

The non-dimensionalized momentum and constitutive equations are defined as

$$\alpha\frac{\partial u}{\partial t}=-\frac{dp}{dz}-\frac{1}{r}\frac{\partial}{\partial r}\left(r\tau\right)-F_1\frac{\partial H}{\partial z}, \tag{2}$$

where α is the Reynolds number defined by $\alpha=\bar{a}\,\bar{u}\,\bar{\rho}/\bar{\mu},\ F_1=\dfrac{\mu_0 M\bar{H}_0\bar{a}}{\bar{\mu}\bar{U}}$ and

$$\frac{du}{dr}=-\tau^n, \tag{3}$$

where *n* is the power law index.

The non-dimensionalized boundary conditions for Equations (2) and (3), respectively are given as

$$\tau \text{ is finite at } r=0 \tag{4}$$

and

$$u=0 \text{ at } r=1. \tag{5}$$

2.3 Method of solution

The series expansion of the perturbation method is obtained by applying the Reynolds number α as the single variable (where $\alpha << 1$). In the perturbation series, velocity u and shear stress τ are extended as follows:

$$u(r,z,t) = u_0(r,z,t) + \alpha u_1(r,z,t) + ... \tag{6}$$

and

$$\tau(r,z,t) = \tau_0(r,z,t) + \alpha \tau_1(r,z,t) + ... \quad . \tag{7}$$

The perturbation series expansion of u in Equation (6) and τ in Equation (7) are substituted into Equations (2) and (3), respectively and integrated with respect to r to get

$$\tau_0 = \frac{r}{2}\left(-\frac{dp}{dz} - F_1\frac{\partial H}{\partial z}\right) \tag{8}$$

and

$$\tau_1 = \frac{1}{t}\left(\frac{1}{2}\left(-\frac{dp}{dz} - F_1\frac{\partial H}{\partial z}\right)\right)^n \left[\frac{r^{n+2}}{(n+1)(n+3)} - \frac{r}{2(n+1)}\right], \tag{9}$$

Which are the first term of the perturbation series of shear stress τ_0 and the second term of the perturbation series of shear stress τ_1. After that, it formed the first term of the perturbation series of velocity u_0 and the second term of the perturbation series of velocity u_1 respectively as

$$u_0 = -\left(\frac{1}{2}\left(-\frac{dp}{dz} - F_1\frac{\partial H}{\partial z}\right)\right)^n \left[\frac{r^{n+1}-1}{(n+1)}\right] \tag{10}$$

and

$$u_1 = \frac{1}{t}\left(\frac{1}{2}\left(-\frac{dp}{dz} - F_1\frac{\partial H}{\partial z}\right)\right)^{2n-1} \left[-\frac{n(n+2)}{2(n+1)^2(n+3)} + \frac{n}{2(n+1)^2}r^{n+1} - \frac{n}{(n+1)(n+3)(2n+2)}r^{2n+2}\right]. \tag{11}$$

u_0 and u_1 in Equations (10) and (11) are substituting respectively into the perturbation series of velocity in Equation (6), the unsteady velocity in the outer flow region is obtained as

$$u_o = \frac{1}{(n+1)}\left(\frac{1}{2}\left(-\frac{dp}{dz} - F_1\frac{\partial H}{\partial z}\right)\right)^n \left[1 - r^{n+1}\right] + \frac{\alpha}{t}\left(\frac{1}{2}\left(-\frac{dp}{dz} - F_1\frac{\partial H}{\partial z}\right)\right)^{2n-1} \left[-\frac{n(n+2)}{2(n+1)^2(n+3)} + \frac{n}{2(n+1)^2}r^{n+1} - \frac{n}{(n+1)(n+3)(2n+2)}r^{2n+2}\right]. \tag{12}$$

The velocity in the outer flow region in Equation (12) is dimensionalized using the non-dimensional variables in Equation (1) to determine the solution for concentration. The velocity in the outer flow region is obtained in dimensional form as

$$\bar{u}_o = \frac{\bar{a}^{n+1}}{(n+1)\bar{\mu}_H}\left(\frac{1}{2}\left(-\frac{d\bar{p}}{d\bar{z}} - \mu_0 M\frac{\partial \bar{H}}{\partial \bar{z}}\right)\right)^n + \frac{\bar{a}^{2n+2}\bar{\rho}}{\bar{\mu}_H^2 \bar{t}}\left(\frac{1}{2}\left(-\frac{d\bar{p}}{d\bar{z}} - \mu_0 M\frac{\partial \bar{H}}{\partial \bar{z}}\right)\right)^{2n-1} \left[-\frac{n(n+2)}{2(n+1)^2(n+3)} + \frac{n}{2(n+1)^2}\frac{\bar{r}^{n+1}}{\bar{a}^{n+1}} - \frac{n}{(n+1)(n+3)(2n+2)}\frac{\bar{r}^{2n+2}}{\bar{a}^{2n+2}}\right]. \tag{13}$$

Applying Equation (13) to solve for mean velocity $\bar{u}_m$ by using integral method gives

$$\bar{u}_m = \frac{\int_0^{2\pi}\int_0^{\bar{a}} \bar{u}_o(\bar{r})\bar{r}d\bar{r}d\bar{\psi}}{\int_0^{2\pi}\int_0^{\bar{a}} \bar{r}d\bar{r}d\bar{\psi}}, = \frac{\bar{a}^{n+1}}{(n+3)\bar{\mu}_H}\left(\frac{1}{2}\left(-\frac{d\bar{p}}{d\bar{z}} - \mu_0 M\frac{\partial \bar{H}}{\partial \bar{z}}\right)\right)^n - \frac{n\bar{a}^{2n+2}\bar{\rho}}{2(n+2)(n+3)\bar{\mu}_H^2\bar{t}}\left(\frac{1}{2}\left(-\frac{d\bar{p}}{d\bar{z}} - \mu_0 M\frac{\partial \bar{H}}{\partial \bar{z}}\right)\right)^{2n-1}. \tag{14}$$

The velocity in the outer flow region in Equation (13), as well as the mean velocity in Equation (14) are used to calculate the relative velocity in the outer flow region based on its definition of $\hat{u}_o = \bar{u}_o - \bar{u}_m$ and the result is as follows:

$$\hat{u}_o = \frac{2\bar{a}^{n+1}}{(n+1)\bar{\mu}_H}\left(\frac{1}{2}\left(-\frac{d\bar{p}}{d\bar{z}} - \mu_0 M\frac{\partial \bar{H}}{\partial \bar{z}}\right)\right)^n \left[\frac{1}{(n+3)} - \frac{1}{2}\frac{\bar{r}^{n+1}}{\bar{a}^{n+1}}\right] + \frac{n\bar{a}^{2n+2}\bar{\rho}}{2(n+1)\bar{\mu}_H^2\bar{t}}\left(\frac{1}{2}\left(-\frac{d\bar{p}}{d\bar{z}} - \mu_0 M\frac{\partial \bar{H}}{\partial \bar{z}}\right)\right)^{2n-1}\left[-\frac{(2n+3)}{(n+1)(n+2)(n+3)} + \frac{1}{(n+1)}\frac{\bar{r}^{n+1}}{\bar{a}^{n+1}} - \frac{1}{(n+1)(n+3)}\frac{\bar{r}^{2n+2}}{\bar{a}^{2n+2}}\right]. \tag{15}$$

Generalized Dispersion Model (GDM) is used in the convective-diffusion equation to calculate the dispersion function, longitudinal diffusion coefficient and mean concentration. GDM is a derivative series extension of Gill and Sankarasubramanian [6] technique, which is given by $C_m(z_1,t)$ as

$$\frac{\partial C_m}{\partial t}(z_1,t) = \sum_{i=1}^{\infty} K_i(t)\frac{\partial^i C_m}{\partial z_1^i}(z_1,t), \tag{16}$$

where $K_i(t)$ is the transport coefficient derived as

$$K_i(t) = \frac{\delta_{i2}}{Pe^2} + 2\frac{\partial f_i}{\partial r}(1,t) - 2\int_0^{R(z)} f_{i-1}(r,t)u(r)rdr, \quad i = 1,2,3,... \tag{17}$$

with the Kronecker delta δ_{ij} stated as

$$\delta_{ij} = \begin{cases} 0 \text{ if } i \neq j, \\ 1 \text{ if } i = j. \end{cases} \tag{18}$$

The coefficient of $\partial C_m / \partial z_1$ is the dispersion function $f_1(r,t)$, which is used to measure the departure of the local concentration $C(r,z_1,t)$ from the mean concentration $C_m(z_1,t)$. The dispersion function is given as follows

$$f_1(r,t) = f_{1s}(r) + f_{1t}(r,t), \tag{19}$$

where $f_{1s}(r)$ is the steady state dispersion function and $f_{1t}(r,t)$ is the unsteady state dispersion function, which represents the time-dependent nature of solute dispersion. The boundary conditions of $f_{1s}(r)$ and $f_{1t}(r,t)$ are given by

$$\frac{df_{1s}}{dt}(0) = 0, \tag{20}$$

$$\frac{df_{1s}}{dr}\left(R(z)\right) = 0, \tag{21}$$

$$\frac{\partial f_{1t}}{\partial r}(0,t) = 0 \tag{22}$$

and

$$\frac{\partial f_{1t}}{\partial r}(R(z),t) = 0. \tag{23}$$

The differential equation of dispersion function at the steady state in outer flow region is given by

$$\frac{1}{r}\frac{\partial}{\partial r}\left(r\frac{\partial f_{1s_+}}{\partial r}\right) - (u_o - u_m) = 0 \;\text{ if }\; 0 \le r \le R(z). \tag{24}$$

Solving the differential equation of dispersion function at the steady state in outer flow region in Equation (24) using boundary condition in Equation (20) becomes

$$f_{1s_+} = CI - \frac{PF1^5 r^{10}\rho}{204800t} + r^6\left(-\frac{PF1^3}{1152} + \frac{PF1^5\rho}{12288t}\right) + r^2\left(\frac{PF1^3}{384} + \frac{9PF1^5\rho}{40960t}\right), \tag{25}$$

where $PF1$ and CI are defined as

$$PF1 = -\frac{dp}{dz} - F_1\frac{\partial H}{\partial z} \tag{26}$$

and

$$CI = PF1^3\left(-\frac{R^2 z}{768} + \frac{R^6 z}{4608}\right) + PF1^5\left(-\frac{9R^2 z\rho}{81920t} - \frac{R^6 z\rho}{49152t} + \frac{R^{10} z\rho}{1228800t}\right). \tag{27}$$

The general solution of $f_{1t}(r,t)$ is given as

$$f_{1t}(r,t) = \sum_{m=1}^{\infty} A_m e^{-\lambda_m^2 t} J_0(\lambda_m r), \tag{28}$$

where

$$A_m = -\frac{2}{J_0^2(\lambda_m)} \int_0^{R(z)} J_0(\lambda_m r) f_{1s}(r) r dr. \tag{29}$$

The solution of mean concentration of solute $C_m(z_1,t)$ is computed by using Inverse Fourier Transform (IFT) and gives

$$C_m(z_1,t)=\frac{1}{2}\left[\operatorname{erf}\left(\frac{z_s/2-z_1}{2\sqrt{\xi}}\right)+\operatorname{erf}\left(\frac{z_s/2+z_1}{2\sqrt{\xi}}\right)\right], \tag{30}$$

where erf is the error function.
From Equation (30), the local concentration is determined as below:

$$C(r,z_1,t)=C_m(z_1,t)+f_1(r,t)\frac{\partial C_m}{\partial z_1}(z_1,t). \tag{31}$$

3. Results and discussion

3.1 Velocity of the blood flow

The influence of several variables such as fluid magnetization M, pressure gradient P, induced magnetic field gradient $\partial H/\partial z$ and magnetic parameter F_1 on the variation of velocity u with radius r has been investigated in this study. To explore the variations in u, several parameters such as M = 0.0-0.8, P = 10-30, $\partial H/\partial z$ = 1-41 and F_1 = 0.00029-0.80029 were used.

Figure 1 shows how the velocity reduces progressively as M rises. This is due to the magnetic force acting in the opposite direction of the solute, causing the impact of velocity to be reduced. As the M value rises, the resistive forces that prevent fluid flow rise as well and lowering blood velocity. The result in Figure 2 shows that raising P causes an increase in blood velocity. The artery's blood flow rate and velocity vary in inverse proportion to the entire cross-sectional area of the blood vessel. As a result, increasing the vessel's total cross-sectional area causes the flow rate to drop. Next, in Figure 3, it can be observed that the $\partial H/\partial z$ increment caused the velocity to drop.

As far as is known, the magnetic field may induce a charged particle to move in a circular or spiral manner. When a particle advances along a magnetic field line into an area where the field grows stronger, it experiences a force that reduces the element of velocity parallel to the field. As seen in Figure 4, increasing F_1 causes a decrease in blood velocity.

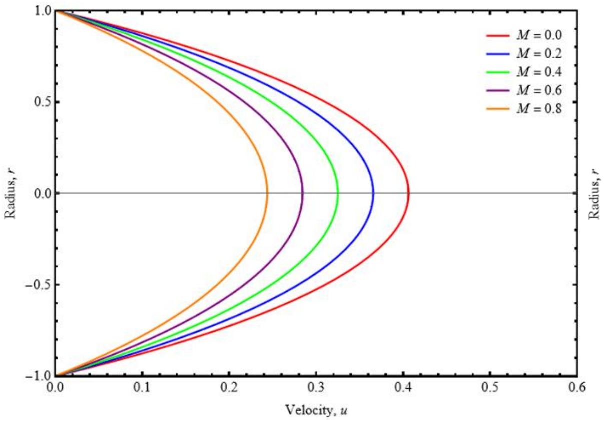

Figure 1 Variation of velocity with radius for fixed values of P = 2, $\partial H/\partial z$ = 1, μ_0 = 1, a = 1, H_0 = 1, U_0 = 1, μ = 1, n = 1, t = 1, α = 1 and different values of M = 0.0, 0.2, 0.4, 0.6, 0.8

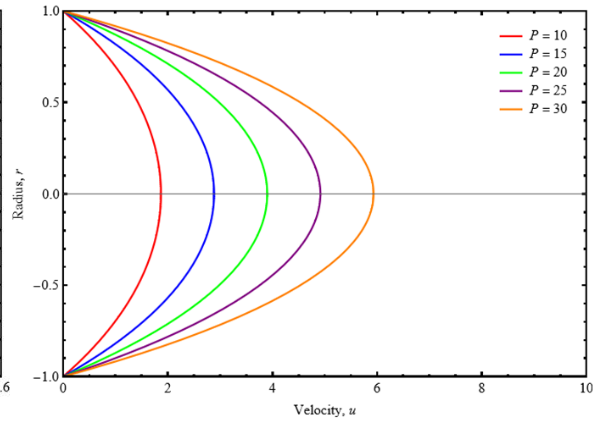

Figure 2 Variation of velocity with radius for fixed values of M = 2, $\partial H/\partial z$ = 10, μ_0 = 1, a = 0.25, H_0 = 0.2, U_0 = 36, μ = 0.035, n = 1, t = 1, α = 1 and different values of P = 10, 15, 20. 25. 30

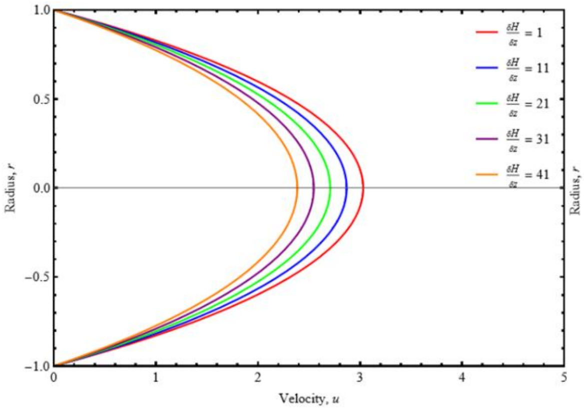

Figure 3 Variation of velocity with radius for fixed values of M = 2, P = 15, μ_0 = 1, a = 0.25, H_0 = 0.2, U_0 = 36, μ = 0.035, n = 1, t = 1, α = 1 and different values of $\partial H / \partial z$ = 1, 11, 21, 31, 41

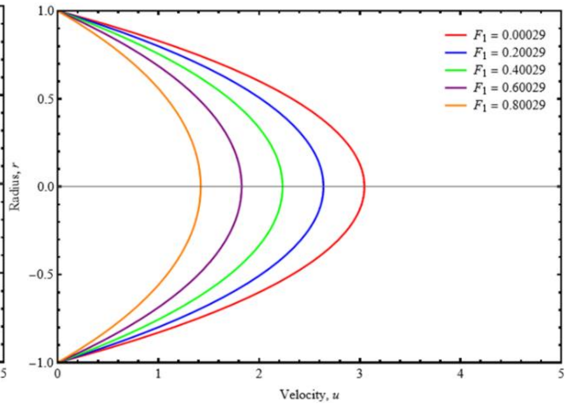

Figure 4 Variation of velocity with radius for fixed values of $\partial H / \partial z$ = 10, P = 15, n = 1, t = 1, α = 1 and different values of F_1 = 0.00029, 0.20029, 0.40029, 0.60029, 0.80029

3.2 Steady dispersion function

Figures 5-7 show the variation of steady dispersion function f_{1s} with radius for fixed value of n = 3 for different values of magnetic parameter F_1, induced magnetic field gradient $\partial H / \partial z$ and pressure gradient P respectively. From Figure 5 and Figure 6, the steady dispersion function decreases as F_1 and $\partial H / \partial z$ increase, however the steady dispersion function increases when P increases as shown in Figure 7.

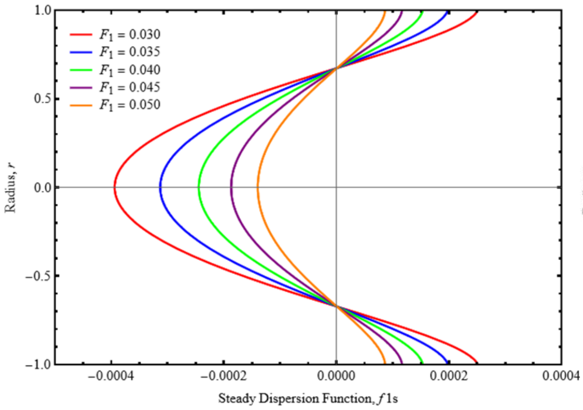

Figure 5 Variation of steady dispersion function with radius for fixed values of $\partial H / \partial z$ = 10, P = 1, n = 3, t = 1, a = 0.00001, ρ = 1, b = 0, z = 0.05 and different values of F_1 = 0.030, 0.035, 0.040, 0.045, 0.050

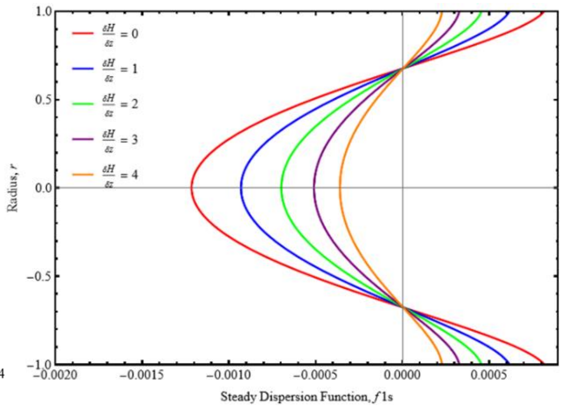

Figure 6 Variation of steady dispersion function with radius for fixed values of F_1 = 0.08, P = 1, n = 3, t = 1, a = 0.00001, ρ = 1, b = 0, z = 0.05 and different values of $\partial H / \partial z$ = 0, 1, 2, 3, 4

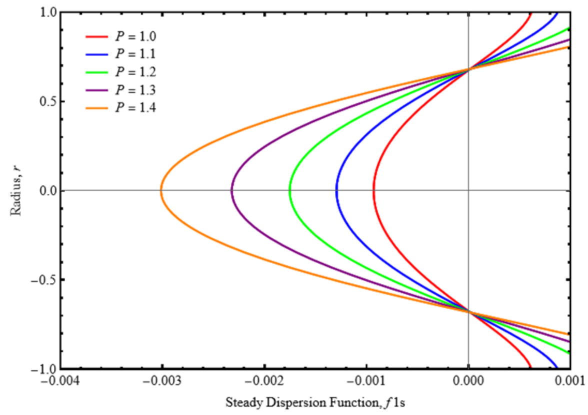

Figure 7 Variation of steady dispersion function with radius for fixed values of $F_1 = 0.08$, $\partial H / \partial z = 1$, $n = 3$, $t = 1$, $a = 0.00001$, $\rho = 1$, $b = 0$, $z = 0.05$ and different values of $P = 1.0, 1.1, 1.2, 1.3, 1.4$

3.3 Unsteady dispersion function

Figures 8-10 demonstrate the variation of the unsteady dispersion function f_{1t} with radius for a fixed value of $n = 3$ for different values of the magnetic parameter F_1, the induced magnetic field gradient $\partial H / \partial z$ and the pressure gradient P. According to Figures 8 and 9, the unsteady dispersion function drops as F_1 and $\partial H / \partial z$ grow, but it increases when P increases as illustrated in Figure 10.

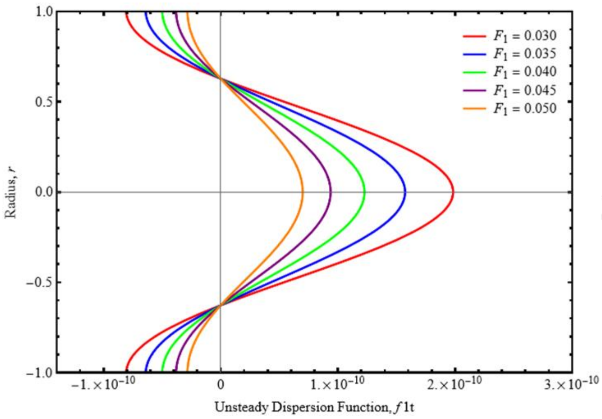

Figure 8 Variation of unsteady dispersion function with radius for fixed values of $\partial H / \partial z = 10$, $P = 1$, $n = 3$, $t = 1$, $a = 0.00001$, $\rho = 1$, $b = 0$, $z = 0.05$ and different values of $F_1 = 0.030, 0.035, 0.040, 0.045, 0.050$

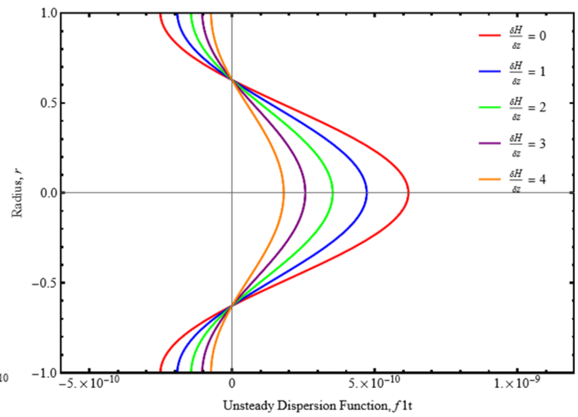

Figure 9 Variation of unsteady dispersion function with radius for fixed values of $F_1 = 0.08$, $P = 1$, $n = 3$, $t = 1$, $a = 0.00001$, $\rho = 1$, $b = 0$, $z = 0.05$ and different values of $\partial H / \partial z = 0, 1, 2, 3, 4$

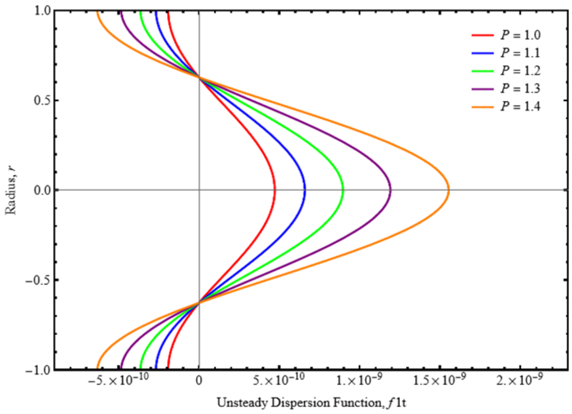

Figure 10 Variation of unsteady dispersion function with radius for fixed values of F_1 = 0.08, $\partial H / \partial z$ = 1, n = 3, t = 1, a = 0.00001, ρ = 1, b = 0, z = 0.05 and different values of P = 1.0, 1.1, 1.2, 1.3, 1.4

3.4 Dispersion function

Figures 11-13 show how the dispersion function f_1 varies with radius for a fixed number of n = 3 for different values of the magnetic parameter F_1, the induced magnetic field gradient $\partial H / \partial z$ and the pressure gradient P. According to Figures 11 and 12, the dispersion function decreases as F_1 and $\partial H / \partial z$ rise, but increases while P increases as seen in Figure 13.

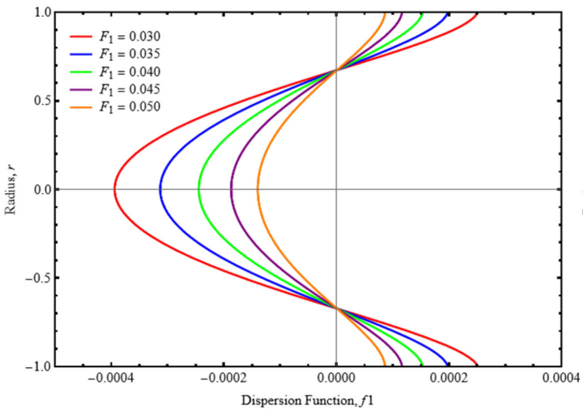

Figure 11 Variation of dispersion function with radius for fixed values of $\partial H / \partial z$ = 10, P = 1, n = 3, t = 1, a = 0.00001, ρ = 1, b = 0, z = 0.05 and different values of F_1 = 0.030, 0.035, 0.040, 0.045, 0.050

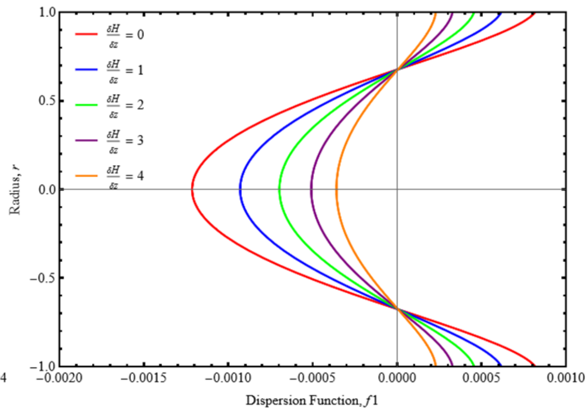

Figure 12 Variation of dispersion function with radius for fixed values of F_1 = 0.08, P = 1, n = 3, t = 1, a = 0.00001, ρ = 1, b = 0, z = 0.05 and different values of $\partial H / \partial z$ = 0, 1, 2, 3, 4

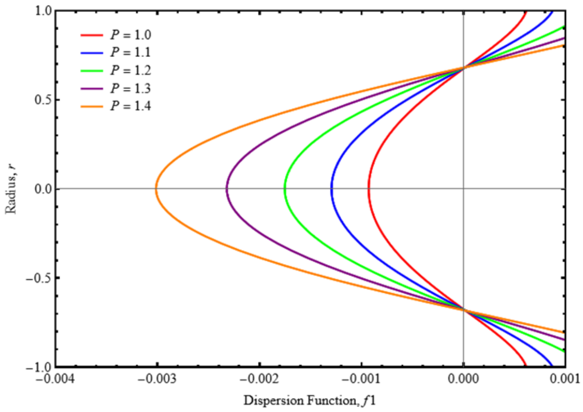

Figure 13 Variation of dispersion function with radius for fixed values of $F_1 = 0.08$, $\partial H / \partial z = 1$, $n = 3$, $t = 1$, $a = 0.00001$, $\rho = 1$, $b = 0$, $z = 0.05$ and different values of $P = 1.0, 1.1, 1.2, 1.3, 1.4$

3.5 Mean concentration

Figures 14-16 show how the mean concentration C_m varies with time for a fixed number of $n = 3$ for the magnetic parameter F_1, the induced magnetic field gradient $\partial H / \partial z$ and the pressure gradient P. According to Figures 14 and 15, the mean concentration decreases as F_1 and $\partial H / \partial z$ rise, but increases while P increases as seen in Figure 16.

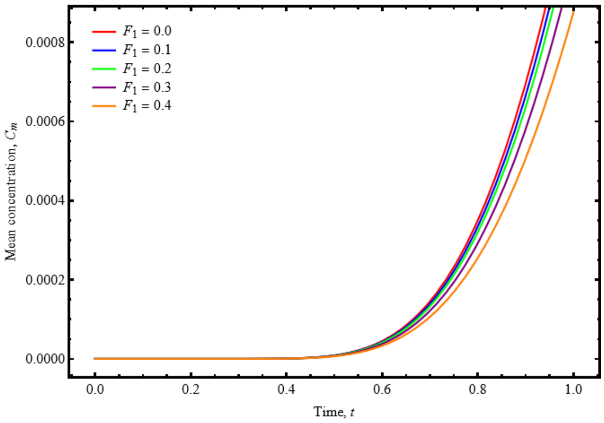

Figure 14 Variation of mean concentration with time for fixed values of $\partial H / \partial z = 10$, $P = 1$, $n = 3$, $t = 1$, $a = 0.00001$, $\rho = 1$, $b = 2.5$, $z = 5$, $Pe = 1$ and different values of $F_1 = 0.0, 0.1, 0.2, 0.3, 0.4$

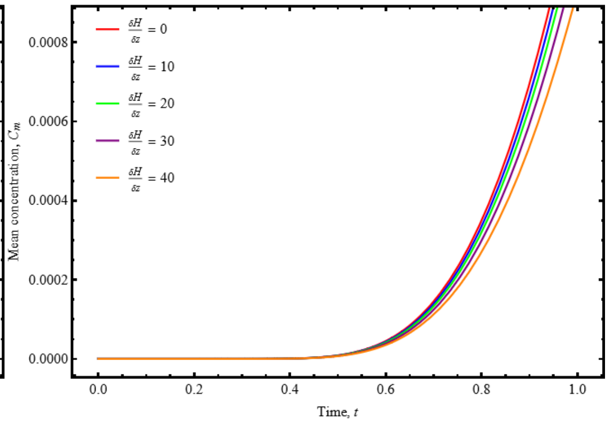

Figure 15 Variation of mean concentration with time for fixed values of $F_1 = 0.08$, $P = 1$, $n = 3$, $t = 1$, $a = 0.00001$, $\rho = 1$, $b = 2.5$, $z = 5$, $Pe = 1$ and different values of $\partial H / \partial z = 0, 10, 20, 30, 40$

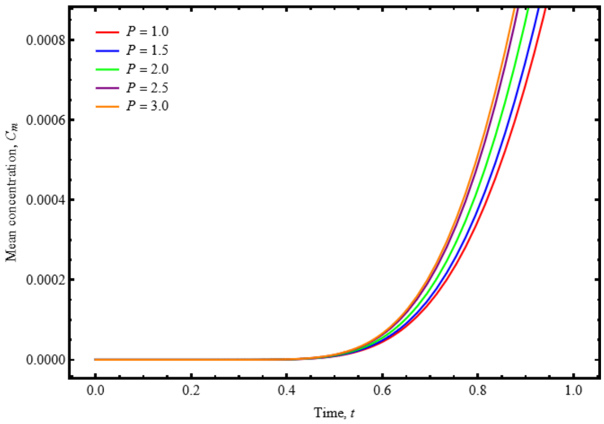

Figure 16 Variation of mean concentration with time for fixed values of $\partial H / \partial z = 1$, $F_1 = 0.08$, $n = 3$, $t = 1$, $a = 0.00001$, $\rho = 1$, $b = 2.5$, $z = 5$, $Pe = 1$ and different values of P = 1.0, 1.5, 2.0, 2.5, 3.0

Conclusion

The influence of magnetic field on unsteady solute dispersion through an artery is studied analytically using the perturbation method in an unsteady blood flow. The findings of this study revealed that the power law fluid model is an appropriate fluid model for predicting blood flow behavior in a small straight circular pipe (artery) with moderate strain rate. The Generalized Dispersion Model (GDM) and integration approach can be used to solve the unsteady convective-diffusion equation analytically and yield the solute concentration, dispersion function and mean concentration. When the pressure gradient increases, all three major of solute problems which are velocity, concentration and dispersion function increase, however when the fluid magnetization, magnetic field gradient and magnetic parameter all increase, the velocity, concentration and dispersion function of the solute all drop.

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