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ANALYTICAL SOLUTIONS OF FRACTIONAL WALTER'S B FLUID WITH APPLICATIONS

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ABSTRACT:
The phenomenon of natural convection resulting from the combined effects of temperature and concentration gradients is often known in academic literature as 'double diffusive convection', 'thermosolutal convection', or 'thermohaline convection'. The main aim of the study Analytical Solutions of Fractional Walter's B Fluid with Applications. Mass concentration, temperature distribution, and velocity field solutions for the presence and absence of porous and magnetic field impacts are derived using an analytical solution to the issue. The generic answers are written as generalized Mittag-Lefer functions. $\mathbf{M}^{\Omega_1}_{\Omega_2,\Omega_3}(\chi)$ *and Fox-H function* $\mathbf{H}^{1,p}_{p,q+1}$ *resolving the issue by meeting the predetermined criteria.*

Keywords: Concentration, Convection, Source. Modulation, Oldroyd-B

1. INTRODUCTION

Engineers and applied mathematicians need to understand how Newtonian and non-Newtonian fluids move along a porous surface channel. Over the last several decades, scientists and engineers interested in nonlinear dynamical systems have paid a great deal of attention to these fluids. Research was conducted thinking about all the ways it may be used in industry. The removal of reactants in chemical processes, boundary layer control (in which fluid particles are expelled via holes in the wall into the interior of the body), and transpiration cooling are all examples of uses for such systems.

There are several mathematical models for studying Newtonian and non-Newtonian fluids' behaviors. Few models exist for these fluids that account for their elastic and viscous characteristics. Several research have utilized the motion of Walters' viscoelastic fluid to represent a variety of events. For instance, Chen et al. investigated the flow and heat transfer in the boundary layer of a viscoelastic fluid with a short memory (Walters' liquid B' model) across a stretched surface at a constant temperature or with a uniform heat flux. Bariş in explores the steady three-dimensional flow of a Walters' B' fluid in a vertical conduit. Numerical methods were used to solve the fundamental equation describing the heat and mass transport processes, with the elastic number serving as the perturbation parameter.

Using Walters' B' fluid as a model, examines the continuous laminar flow of a viscoelastic fluid in the vicinity of a revolving disk. The answer in this research accounts for and corrects for the inaccuracy caused by the use of a finite number in place of numerical infinity. With a flat deformable surface extended in its own plane, explores the steady two-dimensional stagnation point flow of an incompressible viscoelastic fluid (according to Walters' B model). Postelnicu examines the impact of the Soret and Dufour influences on the heat and mass transmission properties across a plate in in a finite difference transient model for free convective mass transfer in Walters-B viscoelastic flow with wall suction is provided and investigated. Walters' B fluid peristaltic flow in an asymmetric conduit is studied in. After introducing the governing equations, we derive the perturbation solutions using the wave number as a minor parameter. The stagnation-point flow, the Blasius flow, and the Sakiadis flow for a viscoelastic Walters' B fluid have all been studied in. Using stream functions and the assumption of boundary layer flow, Cauchy equations are transformed into non-dimensional differential equations for each of these issues. The two-equation model for a Walters type B" viscoelastic liquid flowing down an inclined plane was suggested by Amatousse et al. The study only considered propagating waves. The movement of a thin layer of viscoelastic fluid is studied using the weighted-residual integral technique. In, the authors explore the spin coating stability of a thin incompressible viscoelastic fluid called Walters' B." To obtain a universal kinematic model of thin film flow, it is suggested to use the long-wave perturbation technique. In, we examine the impact of Soret and Dufour effects on the flow of a viscoelastic MHD fluid across a vertical cone and a flat plate saturated with a non-Darcy porous medium. This issue is addressed by using the Crank-Nicolson technique.

2. LITERATURE REVIEW

Almeida, Felicita & Berrehal, Hamza & Venkatesh, Pilli & Gireesha, B. & G., Sowmya. (2022) This study elucidates the flow of Walter's B fluid via a magnetohydrodynamic conduit. The channel's walls have been strained. The boundary condition of slip velocity is taken into account. These equations are very non-linear, and the semi-analytic OHAM technique is used to solve them. Graphs provide the description of the important parameters. When a viscoelastic fluid and magnetic field are present, the velocity of the fluid decreases toward the channel's end and increases in its middle. The temperature distribution decays as a function of the viscoelastic constant. Bejan number graphs highlight, for larger values of magnetic parameter and Prandtl number, that irreversibility owing to fluid friction is strong along the walls of the channel and low in the middle of the channel.

A Singh, Jitendra & Seth, Gauri & Joshi, Naveen & C T, Srinivasa. (2020). Here we give a mathematical study of the mixed convection hydromagnetic flow of a chemically reacting, electrically and thermally conducting, viscoelastic fluid down a vertical porous channel. Besides gravity and rotation, other factors like Hall and ion-slip currents, heat radiation, and chemical reactions are taken into account. An external magnetic field is being supplied to the flow system and is traveling at the same speed as the right wall of the channel. The pressure gradient, right wall motion, and buoyancy forces all contribute to the development of the MHD flow in the rotating fluid system. Solutions for the velocities, temperatures, and concentrations arising from the governing coupled partial differential equations are provided in closed form. Numerical results for velocity, fluid temperature, and concentration are calculated and displayed graphically to illustrate the effects of flow governing parameters, and numeric results for skin friction, rate of heat and mass transfer in terms of Nusselt and Sherwood numbers are presented in tables for easy discussion. It has been found that the drag force produced by a moving magnetic field is less than that produced by a stationary magnetic field. The fluid velocity in the major flow direction is increased in the left half of the channel due to the magnetic field, while it is decreased in the right half due to the fact that the magnetic field remains stationary in relation to the moving right wall of the channel.

Abdulhadi, Ahmed & Ahmed, Tamara. (2017). Under long-wave length and low â€"Reynolds number assumptions, the peristaltic transport problem of an incompressible non-Newtonian fluid in a tapered asymmetric channel through a porous medium is presented; the fluid is assumed to be a Walters â€" B fluid and electrically conductive by a transverse magnetic field. The talking peristaltic wave forced on the non-uniform boundary walls causes the tapered asymmetric channel in the flow to have varying amplitudes and phases. Using the regular perturbation method, we provide series solutions for the stream function, axial velocity, and pressure gradient. The pressure increases per wave length has been calculated numerically. These distributions are explained, and the impact of the problem's physical characteristics on them is visually shown in a series of graphics.

Govindarajan, A. & Rajesh, K. & Vidhya, Mohanakrishnan & Parthasarathy, Siva. (2019). In this study, we discuss the influence of heat source and radiation on mass transfer and slip parameter in the context of an oscillating stream of anelectrically and viscoelasticleading liquid across a porous media bounded by two infinite vertical comparable plates. These plates are placed in two different environments: one with a slip-stream and one without. The channel's weight slant fluctuates over time. The route perpendicular to the plates is linked to an appealing field of consistent quality. Because of doubts about its attractive Reynolds number, the initial attractive field is neglected. It is also believed that the temperature difference between the two plates is great enough to initiate heat transfer due to radiation. An in-depth, closed-form solution to the problem is found. The effects of different relevant limitations on the problem are discussed in part via a statistical evaluation of the investigation results, which are then shown visually. The profiles of the speeds change whenever there is an increase in either the attractive parameter or the heat source parameter, and it is established that the profiles of the speeds increase due to increment in Reynolds number or there is increment in Grashof number for mass transfer.

Singh, Jitendra & Seth, Gauri & Begum, Shaik. (2020) The Reason Why Under the influence of a strong externally applied magnetic field and rotation, the current study presents hydromagnetic boundary layer flow of Walters'-B fluid across a vertical porous surface implanted in a porous material. Hall and ion-slip currents are generated when an external applied magnetic field is strong enough in a number of industrial applications. Hall and ion-slip currents' effects are therefore taken into account. The time-varying velocity of the free stream and buoyancy action produce the flow through configuration. Design/methodology/approach the system of coupled partial differential equations utilized as the mathematical model is solved using a regular perturbation approach. The velocity field, temperature field, species concentration, skin friction, and rate of heat and mass transfer were all calculated numerically in order to see the shift in flow behaviour. Findings It has been observed that the free-stream's exponentially fluctuating speed over time causes a reverse flow in the transverse direction. It is possible that the exponential motion of the free stream causes an increase in fluid velocity near the vertical surface as the intensity of the applied magnetic field increases. Darcy's drag acts on fluids in a way similar to how a magnetic field affects motion. Originality/value the literature on Walters'-B fluid, in which the system is unstable due to the free-stream's time-varying motion, is sparse. The purpose of this research is to investigate the hydromagnetic boundary layer flow of Walters'-B fluid along a vertical surface implanted in a porous material under the influence of Hall and ion-slip currents, rotation, and an externally supplied magnetic field.

3. RESEARCH METHODOLOGY

This study's goal is to provide information on the consequences of fractionalized The Caputo-Fabrizio fractional derivative method is used to analytically study Walter's Liquid Model-B for heat and mass transport in a porous medium. Mass concentration, temperature distribution, and velocity profile solutions are analyzed both with and without the influence of a porous media and a magnetic field.

4. RESULTS

Mittag-Lefer functions are used to express the generic solutions. $\mathbf{M}^{\Omega_1}_{\Omega_2,\Omega_3}$ and Fox-H function $\mathbf{H}^{1,p}_{p,q+1}$ resolving the issue by meeting the predetermined criteria. The physical representation of the issue. The impacts of the physical factors on the flow are shown graphically in Figures 1 to 8, which are listed below.

(i) The results of the Caputo-Fabrizio fractional derivative for three distinct values are shown in Figure 1. α = 0.3, 0.5, 0.7 on the mass distribution profiles. Concentration profiles are shown to improve with raising the fractional derivative parameter of the Caputo-Fabrizio distribution.

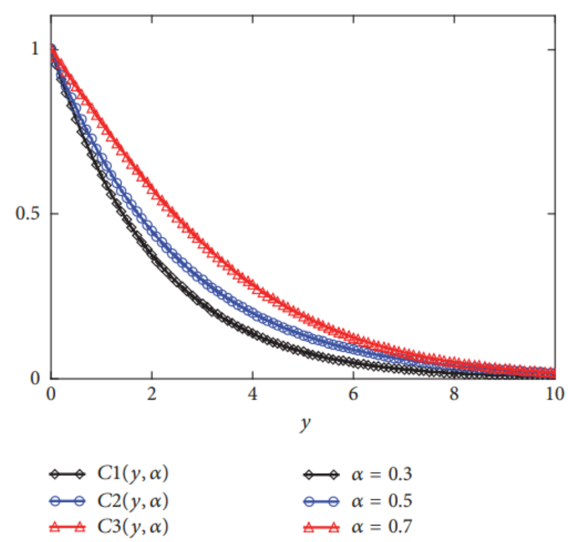

Figure 1: Plot of Mass Concentration for Diferent Values of Caputofabrizio Fractional Parameter α.

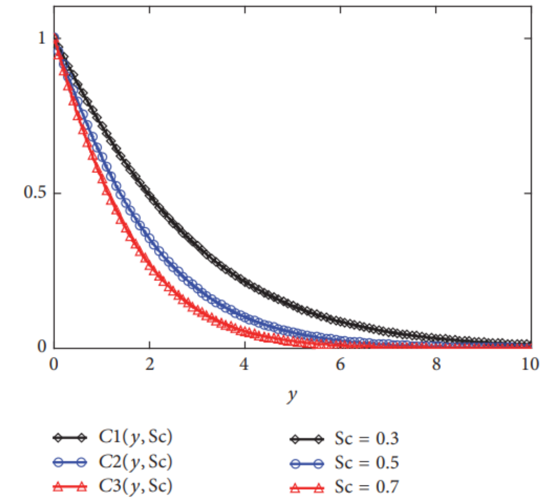

Figure 2: Plot of Mass Concentration for Different Values of Schmidt Number Sc.

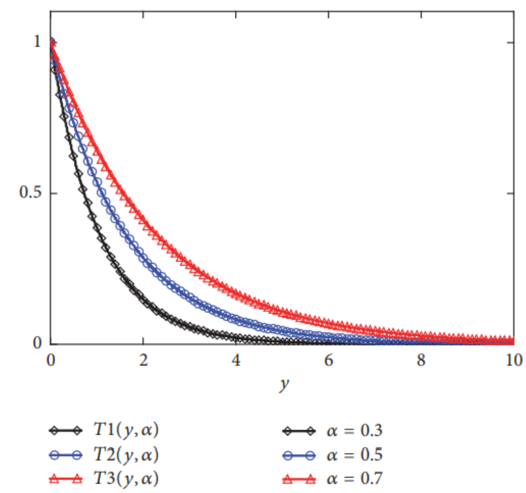

Figure 3: Plot of Temperature Distribution for Different Values of Caputo-Fabrizio Fractional Parameter α.

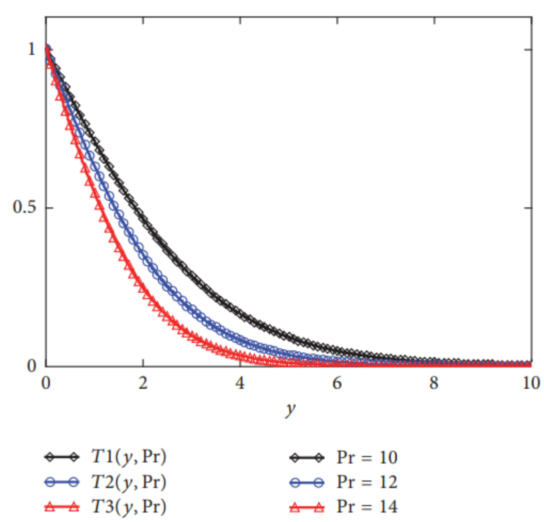

Figure 4: Plot of Temperature Distribution for Different Values of Prandtl Number Pr.

(ii) Figure 2 shows how the Schmidt number affects the mass concentration. It is observed that the mass concentration decreases as the Schmidt number rises.

(iii) The influence of the Caputo-Fabrizio fractional derivative is highlighted for three distinct values in Figure 3. α = 0.3, 0.5, 0.7 based on the temperature distribution characteristics. It is observed that a wider temperature distribution occurs when the Caputo-Fabrizio fractional parameter rises.

(iv) Figure 4 shows the temperature distribution profiles as a function of Prandtl number for Pr = 10, 12, and 14. As the Prandtl number rises, the rate of thermal diffusion throughout the whole boundary domain slows down, leading to a more uniform temperature distribution.

(v) The results of Caputo Fabrizio's fractional derivative are shown in Figure 5 $\alpha = 0.2, 0.4, 0.6$ about speed. As the fractional parameter is increased, the velocity is seen to decrease.

(vi) Figure 6 shows how the Reynold number affects things. It is known that when the Reynold number increases, the velocity drops.

(vii) Figures 7 and 8 show the effects of varying magnetic and porous parameters, respectively. The predicted magnetohydrodynamic and porous flows have been seen.

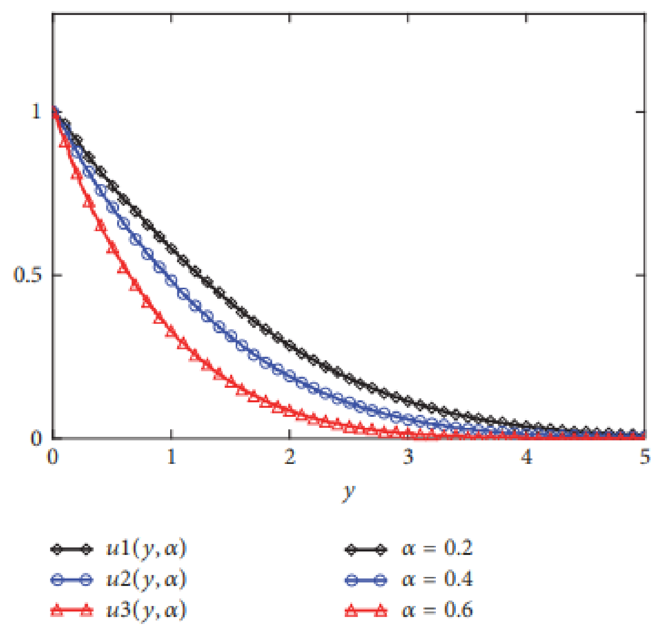

Figure 5: Plot of Velocity Field for Different Values of Caputo Fabrizio Fractional Parameter α.

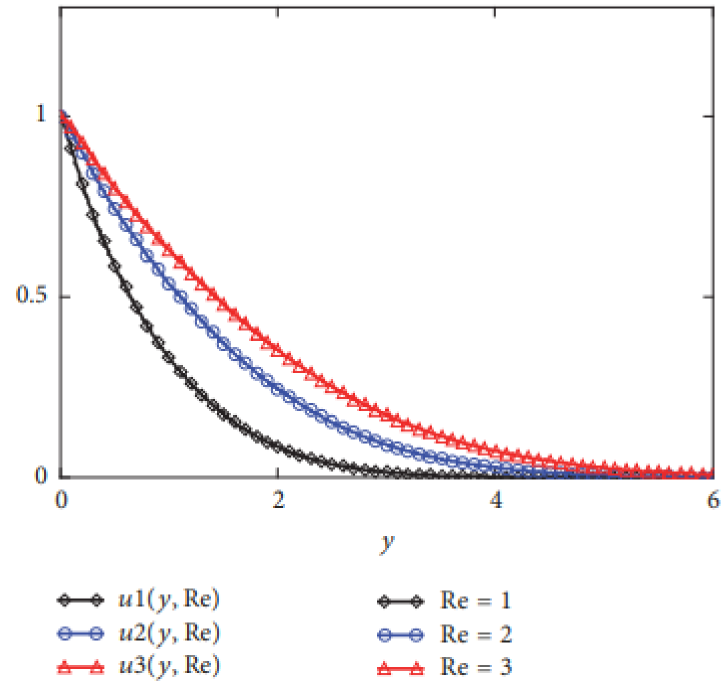

Figure 6: Plot of Velocity Field for Different Values of Reynold Number Re.

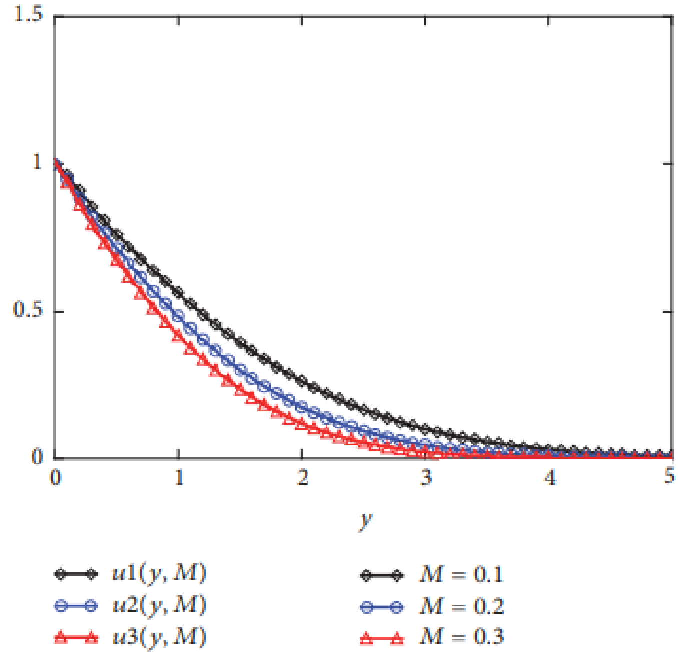

Figure 7: Plot of Velocity Field for Different Values of Magnetic Parameter M.

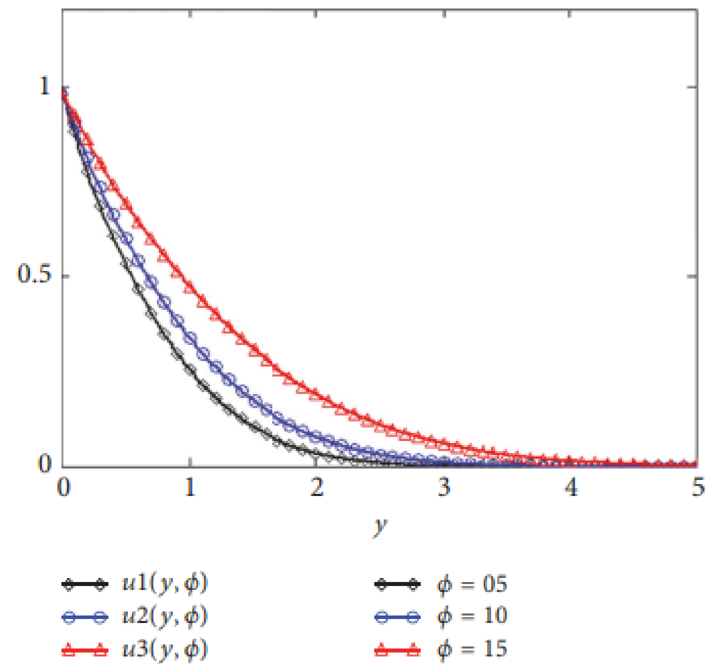

Figure 8: Plot of Velocity Field for Different Values of Porous Medium ϕ.

The fluid throughout the whole plate domain is affected in different ways by the fluxes. It is also observed that the impacts of the two relevant factors on fluid flow are relatively comparable.

5. CONCLUSION

Non-Newtonian fluids are becoming more useful in many fields, making it worthwhile to learn more about them. These solutions incorporate heat and mass transport effects because of free convection's uneven temperature and mass concentration distribution. The impact of several physical characteristics on fLow is shown to highlight their significance. In order to retrieve the well-known findings that have already been published in the literature, researchers have looked at generic solutions. Rheological parameters are explored in relation to graphs.

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