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List of Publications

1. Heat and Mass Transport for Elastico-viscous Fluid with Partial Slip Boundary over a Flat Permeable Plate, Latin America Applied Research ISSN: 1851-8796, Vol. 53(2), 89-94, February 2023
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5. Mixed Convective Slip Flow and Heat Transport for Visco-elastic Fluid Past a Vertical Plate, Mathematical Forum, ISSN: 0972-9852, Vol.28, 17-29, 2020, UGC Care listed.

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Latin American Applied Research 53(2):89-94 (2023)

HEAT AND MASS TRANSPORT FOR ELASTICO-VISCOUS FLUID WITH PARTIAL SLIP BOUNDARY OVER A FLAT PERMEABLE PLATE

K. DEBNATH and S. SINGHA

Department of Mathematics, The Assam Royal Global University, Guwahati-781035, Assam, India.
debnathtura@gmail.com; sibraj.158@gmail.com

Abstract— **The elastico-viscous boundary layer fluid motion over a flat permeable plate having a slip boundary is considered. The transition of thermal energy and mass transport mechanism has been analyzed. The elastic and viscous characteristic in the fluid is exhibited by Walters Liquid (Model B'), a non-Newtonian fluid model. The permeable plate at which suction is applied is placed in the porous medium. The fluid domain receives thermal energy from the permeable plate. The governing equations of fluid motion with satisfying imposed boundary conditions are reduced to self-similar type by similarity transformation. The finite difference method-based solver 'bvp4c' of MATLAB code is employed to perform numerical computation. The impact of different involved flow parameters is illustrated from obtained graphs for discussions from a physical point of view.**

Keywords— **Boundary layer, Elastico-viscous fluid, Heat transfer, Mass transfer, Partial slip.**

I. INTRODUCTION

Elastico-viscous fluid belongs to the class of non-Newtonian fluids exhibiting viscous and elastic properties. During the motion of such type of fluid, elasticity helps to store strain energy in the material while viscosity is responsible for energy dissipation. The application of such fluid is often noticed in chemical, mechanical, and petroleum industries. The technological importance of this fluid draws the attention of many researchers. Extensive research work in this field is going on for the last few decades (Ariel, 2003; Hayat *et al.*, 2016; 2017; Sheremet and Pop, 2018).

The transport of heat along with mass in the fluid has lots of applications in science and engineering fields. In nature, it helps in the formation of fog. The thermal and mass diffusion arising from buoyancy forces initiated many transport processes. Examples include catalytic reactors, nuclear reactors, heat exchangers, cooling devices, solar collectors, petroleum resources, metallurgical and chemical resources, etc. Choudhury *et al.* (2013) investigated the hydromagnetic visco-elastic fluid flow taking inclined surface and studied the heat and mass transport phenomena with viscous dissipation. Rashidi *et al.* (2014) presented the heat flow for mixed convective hydromagnetic visco-elastic fluid over a permeable wedge. He considered the homotopy method to analyze the thermal radiation effect on the flow field. Hayat *et al.* (2015) examined the heat transport for mixed convective elastic-viscous fluid past a stretching cylinder. Nayak *et al.* (2016) presented the thermal and mass transport impact on hydromagnetic elastic-viscous fluid past a stretching porous sheet. The viscous and Joule dissipation along with chemical reaction is also taken into account in this study. Farhangmehr *et al.* (2019) demonstrated the mechanism of enhancement of heat transition and mass transfer for magnetohydrodynamic nanofluid over a sheet taking nonlinear boundary conditions. The relevant recent studies on heat and mass transport are evident from the literature of the reference papers: Turkyilmazoglu (2012, 2015a), Aziz *et al.* (2014), Lavanya (2019), Yasmin *et al.* (2020).

The dynamics of fluids are triggered from the bounding surface and thus boundary layer fluid flow plays an important role in fluid dynamics. The application of such flow is often observed in engineering and technological processes for the evaluation of drag produced by the friction of bodies in the fluid domain. Blasius (1908), firstly studied the progress of velocity in the boundary layer when fluid flows over a flat surface. Pohlhausen (1921) investigated the heat transport phenomenon of Blasius result. The numerical investigation of Blasius's findings of flow problems was further carried out by Howarth (1935).

The fluid-particle when comes in contact with a solid boundary, is observed in many practical applications that it does not take the velocity of the surface and slips along the surface as it has a fixed tangential velocity. Such a flow is termed as partial slip flow at the boundary. The application of this type of flow is noticed in the chemical industry and in medical treatment. The mixed convective fluid flow past a vertical plate for unsteady case in parallel stream presented by Patil *et al.* (2013). The slip impact on the fluid motion taking pressure and buoyant forces into account over vertical plates investigated by many researchers: Aziz *et al.* (2014), Bhattacharyya and Layek (2012), Cao and Baker (2009), Turkyilmazoglu (2015b).

The present investigation aims to discuss the heat transition and mass transport mechanism for elastico-viscous fluid flow with slip effects over a flat permeable plate. The study also intended to analyze the impact of different involved flow feature parameters in the velocity, temperature, and concentration profiles. The non-Newtonian fluid model Walters Liquid (Model B') (Walters, 1960; 1962) is taken for Elastico-viscous fluid. The finite difference method-based solver 'bvp4c' of MATLAB code is employed for the mathematical computation of governing equations. The computed results are plotted with involved flow parameters for discussion to bring out physics insight into the fluid flow.

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Reactive Mass Diffusion in Viscoelastic Fluid Past a Stretchable Exponential Sheet Due to Variation in Wall Concentration

Kamal Debnath and Sankar Singha

Abstract An investigation is initiated to study the solute diffusion with chemical reaction of the first order in non-Newtonian viscoelastic fluid through boundary layer over a stretchable exponential sheet due to variation in wall concentration. Walter Liquid (Model B/), a model of non-Newtonian fluid, exhibits the fluid's viscoelastic nature. The chemical reaction rate and distribution of wall concentration for the species are taken in exponential form. Utilizing suitable similarity variables, the equations guiding fluid motion and relevant satisfying boundary conditions are simplified to self-similar forms. The MATLAB solver 'bvp4c' is used to evaluate the resultant equations. The concentration profiles computed numerically for different involved flow parameters are plotted. The impact of flow feature factors on the concentration profiles is analyzed from graphs from a physical point of view. The mass diffusion process due to chemical reaction in viscoelastic flow through boundary layer past a stretchable exponential sheet affected noticeably with the variation of wall concentration.

Keywords Boundary layer · Chemical reaction · Mass diffusion · Variable wall concentration · Viscoelastic fluid

1 Introduction

The viscous layer flow that extends to the expandable surface is an important problem arising from fluid mechanics as a result of its extensive applications in industrial manufacturing, such as polymer sheet extraction, paper production, fiber glass manufacturing, metal processing, wire drawing. Crane [1] firstly studied the exact solution in the closed-form of a steady flow boundary of the membrane of viscous fluid over a simple stretchable plate. Many scientists later built on Crane's work, including Pavlov [2], Gupta and Gupta [3], Chen and Char [4], who studied thermal and mass

K. Debnath - S. Singha (✉)
Department of Mathematics, The Assam Royal Global University, Guwahati, Assam 781035, India
e-mail: sibraj.158@gmail.com

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Hydromagnetic Visco-elastic Boundary Layer Slip Flow and Heat Transfer Over a Flat Plate

Kamal Debnath and Sankar Singha

Abstract The steady hydromagnetic visco-elastic boundary layer laminar electrically conducting fluid with slip effects past a flat plate characterized by Walter's Liquid (Model B') has been investigated. The heat transfer mechanism is also studied. Special forms of velocity and thermal slips are taken into account involving the local Reynolds number. The governing partial differential equations of fluid motion are transformed into ordinary differential equations by making use of suitable similarity variables. The transformed differential equations along with boundary conditions are solved with the help of bvp4c inbuilt MATLAB software. The computed numerical results of velocity, temperature and temperature gradient have been depicted graphically and discussed for different values of flow parameters involved in the solution. The skin friction coefficient is also evaluated and presented in tabular form for various values of magnetic parameters for discussion.

Keywords Hydromagnetic · Similarity variables · Skin friction · Velocity slip · Visco-elastic

1 Introduction

The study of boundary layer flow is very significant in fluid mechanics as the whole dynamics is triggered from the boundary surface. The application of such flow is often observed in modern engineering and industrial processes for the calculation of frictional drag of bodies. Blasius [1] firstly investigated the structure of evolution of boundary layer fluid velocity over a flat plate. The heat conduction phenomenon of the Blasius problem was analyzed by Pohlhausen [2]. The numerical computation of Blasius problems was carried out by Howarth [3]. Abu-Sitta [4] established the

K. Debnath (✉) · S. Singha
Department of Mathematics, The Assam Royal Global University, Guwahati 781035, Assam, India
e-mail: debnathtura@gmail.com

S. Singha
e-mail: sibraj.158@gmail.com

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IMPACT OF SUCTION OR BLOWING ON ELASTICO-VISCOUS HYDROMAGNETIC FLUID FLOW PAST A STRETCHING PERMEABLE SHEET

KAMAL DEBNATH[1], SANKAR SINGHA, AND BIMALENDU KALITA

ABSTRACT. The analytical study using Homotopy perturbation technique has been initiated for two-dimensional steady elastico-viscous hydromagnetic fluid flow past a stretching permeable sheet. The elastico-viscous property in the fluid exhibited by Walters Liquid (Model B'). The stretching permeable sheet is exposed to suction or blowing. Similarity solutions are obtained by careful inspection to convert the governing equations of fluid motion into self-similar solvable ordinary differential equations. The velocity expression and shear stress at the stretching permeable sheet have been retrieved and numerically evaluated for different values of elastico-viscous, magnetic and suction or blowing parameters. The velocity distribution and skin friction expression are plotted to study the effects of involved flow feature parameters.

1. INTRODUCTION

The stretching sheet problem in fluid dynamics find its place in industry because of it's numerous important applications. This type of problem often noticed in industry in manufacturing unit, such as rolling of artificial fibres, extraction of polymer sheet, glass-fibre production, crystal growing, paper production, crystal growing and so on.

[1]*corresponding author*

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MIXED CONVECTIVE SLIP FLOW AND HEAT TRANSPORT FOR VISCO-ELASTIC FLUID PAST A VERTICAL PLATE

K. Debnath[1], and S. Singha[2]

[1,2]*Departmen of Mathematics, The Assam Royal Global University, Guwahati -781035, Assam, India*

Email: [1]debnathtura@gmail.com, [2]sibraj.158@gmail.com

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Abstract

The heat transport with combined interaction of pressure and buoyancy forces for visco-elastic fluid past a vertical plate along with slip condition is investigated. Visco-elastic nature of the fluid is explored by the Walters Liquid (Model B′), a fluid model for non-Newtonian fluid. The fluid motion is guided by highly non-linear coupled differential equations. The governing differential equations are reduced to solvable self-similar form by employing relevant similarity transformation. The self-similar resultant governing equations are evaluated by inbuilt MATLAB solver 'bvp4c'. The numerically evaluated results of velocity component, temperature, and temperature gradient are represented graphically. The impacts of involved flow feature parameters on the fluid domain are illustrated from graphs for discussions to bring out physical insight. The fluid motion and the heat transition are substantially affected by the involved flow parameters.

Keywords: Boundary layer, Heat transfer, Mixed convection, Velocity slip, Visco-elastic.

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List of Presentations

1. “Reactive Mass Diffusion in Viscoelastic Fluid Past a Stretchable Exponential Sheet Due to Variation in Wall Concentration” presented in the 3rd International Conference on Emerging Technologies in Data Mining and Information Security (IEMIS-2022), Institute of Engineering & Management Group, Department of Computer Application and Sciences, Kolkata, February 23-25, 2022.
2. “Mixed Convective Slip Flow and Heat Transport for Visco-elastic Fluid Past a Vertical Plate” presented in the 3rd International Conference on Mathematical Modelling, Applied Analysis and Computation-2021 (ICMMAAC-21) JECRC University, Jaipur, August 5-7, 2021.
3. “Heat and Mass Transport for Elastico-viscous Fluid with Partial Slip Boundary over a Flat Permeable Plate” presented in the International Conference on “Emerging Areas in Science and Technology (EAST-2021), Royal School of Applied & Pure Sciences, The Assam Royal Global University, Guwahati, June 1-2,2021.
4. “Impact of Suction or Blowing on Elastico-Viscous Hydromagnetic Fluid Flow Past a Stretching Permeable Sheet” presented in the tInternational Conference on New Frontiers in Engineering, Science, Law, Management, Humanities and Social Science 2020 (INFES-2020) Eudoxia Research Centre at Guahati University, February 22-23, 2020.