J. Ind. Geophys. Union, 29(1) (2025), 45-55
https://doi.org/10.71122/JIGU.29(1)2025.005

Finite Element solutions of Maxwell fluid flow towards a stretching surface with addition of thermal radiation, porous medium and magnetic field

Nagaraju Bathula* **and Kishan Naikoti**
Department of Mathematics, Osmania University, Hyderabad-500007, Telangana, India.
*Corresponding author: bnag2014@gmail.com

ABSTRACT

Numerical simulations were used to study the flow of a Maxwell fluid across a non-linear stretching sheet. The effects of thermal radiation, magnetic field, and porous media, were all taken into account within the parameters of the experiment. The non-linear governing equations and the associated boundary conditions were solved using an approach called the finite element technique. Several technical features were used to examine the effects of various factors on the temperature, concentration, and velocity profiles. This study considered parameters like, the magnetic field , permeability , non-linear stretching sheet, Prandtl number, and the thermal radiation. The study also examines the graphical depictions of how the physical elements affect the skin-friction coefficients along the x and y - directions and heat transfer rate. This was done in tandem with the findings, which are shown graphically.

Keywords: Maxwell fluid; Magnetic field; Thermal radiation; Porous medium; Finite element metho

INTRODUCTION

Fluids play a critical role in numerous industrial processes, with non-Newtonian fluids exhibiting particularly unique rheological properties. Applications such as plastic sheet extrusion, paper manufacturing, metal spinning, and glass fiber production, exemplify the widespread use of these materials. Maxwell's model, a cornerstone of non-Newtonian fluid theory, provides a framework for predicting stress relaxation behavior in these complex systems. Furthermore, magnetohydrodynamics (MHD) elucidates the interaction between magnetic fields and electrically conductive fluids in motion. This interaction generates forces within the fluid, enabling novel control mechanisms and applications in various industrial settings.

Sandeep and Sulochana (2018) conducted a comprehensive investigation into the stretching surface flows of Oldroyd-B, Jeffrey, and Maxwell fluids, considering the effects of nonuniform heat source/sink perturbations and radiation. In a subsequent study, Farooq et al. (2019) delved into the exponentially expanding sheet flow of Maxwell-type nanomaterials. Wang et al. (2019) and Sun et al. (2019) developed a model for incompressible Maxwell fluid flow through a tube with a triangular cross section, which could be either rectangular or isosceles. The unsteady flow of viscoelastic fluid with a fractional Maxwell model in a channel, was investigated by Haitao and Mingyu (2007). Wenchang et al. (2003) utilized the fractional Maxwell model to investigate the unsteady flows of a viscoelastic fluid between two parallel plates. Qi and Liu (2011) explored analogue duct flows of a fractional Maxwell fluid. On the other hand, Saleem et al. (2017) examined the 3D mixed convective Maxwell fluid, using mass and heat Catteneo-Christov heat flow models, while considering heat production. Similarly, Fetecau and Fetecau (2003) discovered an exact numerical solution for fluid flow in Maxwell's law.

Apart from the above studies , the propagation of Maxwell fluid in a porous medium was studied by Wang and Hayat (2008) and the behaviour of fraction Maxwell fluid in unsteady flow was investigated by Fetecau et al. (2014). A two-dimensional magnetohydrodynamic (MHD) Maxwell fluid was also studied by Hayat et al. (2009). Similarly, Heyhat and Khabzi (2011) investigated the upper-convicted Maxwell (UCM) fluid flow across a flat rigid region in a magnetohydrodynamic (MHD) system and series solutions for two-dimensional magnetohydrodynamic circulation with thermophoresis and Joule heating, were obtained by Hayat and Qasim (2010). Similarly, Jamil and Fetecau (2010) studied Maxwell fluid in relation to helical flows between coaxial cylinders. Zheng et al. (2011) found exact mathematical solutions for a rotating flow model based on a generalized Maxwell fluid. To better understand how Maxwell fluid behaves in the presence of porous media, double-diffusive convection, and Soret effects, Wang and Tan (2011) also undertook a stability study. Sivaiah et al. (2012a,b,c) modeled and analyzed heat and mass transfer effects on unsteady MHD convection flow via finite element method. Motsa et al. (2012) examined the UCM flow in a porous structure. Reddy et al. (2012) too studied heat and mass transfer effects on unsteady MHD free convection flow past a vertical permeable moving plate with radiation. Further, the dynamics of thermally radiative Maxwell fluid flow over a continuously permeable expanding surface were characterized by Mukhopadhyay et al. (2013). Ramesh et al. (2017) too examined the Maxwell fluid with nanomaterials for magnetohydrodynamic (MHD) flow in a Riga plate computationally. In addition to above mentioned studies, Deepa and Murali. (2014) and Deepa and Gundagani (2014)