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ALIGNED MAGNETOHYDRODYNAMIC MIXED CONVECTION FLOW OF CASSON HYBRID NANOFLUID OVER A VERTICAL PLATE WITH NEWTONIAN HEATING

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ABSTRACT - This study focused on investigating mixed convection flow of a Casson hybrid nanofluid over a vertical plate with Newtonian heating, under the influence of aligned magnetohydrodynamics. The Cassson hybrid nanofluid consisted of Copper and Alumina nanoparticles dispersed in Blood, serving as the base fluid. Mathematical models in partial differential equations were formulated to describe the fluid flow and heat transfer, and these equations were then transformed into ordinary differential equations using similarity transformation. The resulting equations were solved numerically using the Range-Kutta fourth-order method in Maple, considering various physical parameters such as the aligned angle of magnetic field, interaction of magnetic field, Casson parameter, mixed convection parameter, nanoparticle volume fraction parameter, Newtonian heating parameter, and nanoparticle shape factor towards the effect on fluid velocity, temperature, skin friction coefficient, and Nusselt number. Among the nanoparticle shapes considered, it was observed that blade-shaped nanoparticles had the highest values of skin friction coefficient and Nusselt number. The velocity profiles experience a positive enhancement when parameters α , M , β_c , λ , and ω are increased. On the other hand, temperature profile decreases as a result of the negative impact of parameters α , M , β_c , and λ .

Keywords: Magnetohydrodynamic, mixed convection, casson hybrid nanofluids, vertical plate, newtonian heating

1. INTRODUCTION

Heat transfer refers to the transmission of heat between surfaces with different temperatures, primarily through convection, where fluid movement plays a significant role. Hybrid nanofluid, which combines various nanoparticles with cutting fluid, is a recent development in clean machining and is expected to have a significant impact on machinability. Magnetohydrodynamics (MHD) is a research field that combines electromagnetic and fluid mechanics to study the movement of electrically conducting fluids. Newtonian heating is commonly used in various industries, including petroleum, solar radiation, heat exchangers, and heat transfer around fins. This study specifically focused on Casson hybrid nanofluids, as they have shown to be more effective than regular nanofluids in enhancing heat transfer rates. Additionally, the research investigated the interaction between hybrid nanofluids and magnetic fields to understand how it further improves heat transfer.

2. METHODOLOGY

The study of heat transfer could not have been done using experimentation or observation alone as it was an abstract concept that required a mathematical model to explain it. Therefore, this study was conducted by utilizing the mathematical model for fluid dynamics, which was expressed in terms of partial different governing equations. The governing equations needed to be in the form of ODEs to enable their numerical solution. Thus, similarity transformation method is employed to PDEs in order to the ODEs. Runge-Kutta fourth order method in the MAPLE software had been applied to ODEs numerically solved the problem to various physical parameter towards.

3. RESULTS AND DISCUSSION

The outcomes of this study were acquired by implementing the non-dimensional governing equation in Maple software using the Runge-Kutta fourth order method. By doing so, velocity and temperature profiles were generated to examine the influence of various parameters, including the inclination angle of the magnetic field, the interaction of the magnetic field, Casson parameter, mixed convection parameter, nanoparticle volume fraction parameter, conjugate heat transfer parameter, and nanoparticle shape factor. Furthermore, numerical results were obtained for the skin friction coefficient and Nusselt number to investigate the enhancement of heat transfer. These results contribute to the analysis and understanding of the heat transport characteristics and demonstrate the impact of different parameters on the flow and heat transfer behavior in the system under investigation

4. NOVELTY OF RESEARCH / PRODUCT

This study proposes the use Runge-Kutta fourth-order method in Maple software to investigated the behavior of Casson hybrid nanofluids towards various parameters such as the aligned angle of magnet field parameter, the interaction of magnet field parameter, Casson parameter, mixed convection parameter, nanoparticle volume fraction parameter, conjugate heat transfer parameter and nanoparticle shape factor. This study could have aided the inventor or developer in the development of a new technology that utilized the concept of heat transfer. With the data obtained, the inventor would have been able to design a device that effectively transmitted heat and was suitable for the intended purpose of the produced gadget. This solution would have been the optimal choice for them as it could have reduced expenses while also conserving energy.

5. CONCLUSION

In this study, the aligned MHD mixed convection flow of Casson hybrid nanofluid over a vertical plate with Newtonian heating was solved Runge-Kutta fourth-order method in Maple software. The outcomes of the analysis are presented as graphical and tabulated data, including velocity and temperature profiles, skin friction coefficient and Nusselt number for six different physical condition parameters. Among the nanoparticle shapes considered, it was observed that blade-shaped nanoparticles had the highest values of skin friction coefficient and Nusselt number. The velocity profiles experience a positive enhancement when parameters α , M , β_c , λ , and ω and are increased, resulting in an increase in their values. Conversely, velocity profiles are negatively affected by parameter ϕ , causing them to decrease. On the other hand, temperature profile decreases as a result of the negative impact of parameters α , M , β_c , and λ . However, temperature profile shows a positive improvement due to the favorable influence of parameters ϕ and ω .

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