Approximation Theory and Special Functions
ATSF 2026 Conference - 9th Series
September 2-5, 2026, Ankara - Türkiye

Impact of Change in Thermal Conductivity on MHD Flow of Prandtl Ternary Hybrid Nanofluids

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Abstract

Ternary hybrid nanofluids are becoming more prevalent in modern thermal engineering including nuclear power plants, high-performance cooling units, and biological heating elements due to their better heat exchange abilities. These nanofluids can be used in modern engineering applications that involve non-Newtonian flows and temperature-dependent conditions. In this work, a ternary hybrid nanofluid containing Manganese Zinc Ferrite $MnZnFe2O_4$, zirconium dioxide (ZrO_2) and nickel zinc iron oxide ($NiZnFe_2O_4$) nanoparticles suspended in a standard base fluid is examined for its heat and momentum transfer properties. The Prandtl rheological fluid framework, which effectively demonstrates non-Newtonian behavior under a variety of flow conditions, is used for modeling the fundamental fluid dynamics. To approximate actual thermophysical characteristics, a temperature-dependent viscosity and thermal conductivity are incorporated. A comprehensive examination of the effects of velocity and thermal slip boundary conditions is conducted while considering fluid flow over an infinite flat plate. A similarity transformation is used to reduce the model to a dimensionless form in order to simplify the complex framework of governing partial differential equations (PDEs). After that, the transformed equations are numerically solved using the central finite difference method for spatial discretization and the Euler method for the temporal derivative. The numerical findings illustrate how important parameters impact temperature and velocity variations. The results offer helpful insights for sophisticated thermal management systems, such as energy-efficient cooling choices and biotechnological uses. We give a representative set of graphs and analyze the physical behavior of the reduced friction factor and Nusselt number for different values of the emerging parameters.