

Abstract

This comprehensive study investigates diverse fluid dynamics scenarios, exploring phenomena ranging from third-grade fluids with magneto-hydrodynamics and Cattaneo-Christov heat flux, to micropolar-Casson fluids and ferromagnetic Carreau fluids undergoing melting. The research employs advanced mathematical techniques, including similarity transformations and numerical solvers, to unravel the complexities of fluid behavior, heat transfer, and mass species transfer. Through meticulous analysis, this work uncovers crucial insights into the interplay of various physical parameters, shedding light on intricate dynamics and phase transitions within these materials. These findings not only deepen our understanding of complex fluids but also pave the way for innovative advancements in fluid dynamics and heat transfer research.