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Bioconvective Study on Flow Analysis of The MHD Falkner-Skan Flow of Williamson Nanofluid

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ABSTRACT

The bioconvective study on flow analysis of the MHD Falkner–Skan flow of Williamson nanofluid provides an advanced framework to explore the combined effects of non-Newtonian behavior, magnetic fields, and microorganism-induced convection. Williamson nanofluid, characterized by shear-thinning properties, better represents real-world industrial and biomedical fluids compared to Newtonian models. When subjected to a Falkner–Skan wedge flow, the analysis captures the impact of varying pressure gradients on velocity, temperature, and nanoparticle distribution within the boundary layer. The inclusion of magnetohydrodynamic (MHD) effects further enriches the model by accounting for the influence of externally applied magnetic fields, which are highly relevant in applications such as electromagnetic pumps, cooling of nuclear reactors, and targeted drug delivery. Bioconvection generated by motile microorganisms enhances stability by countering nanoparticle sedimentation, ensuring uniform dispersion. This combined framework is vital for studying heat and mass transfer, entropy generation, and flow regulation in microscale systems. Additionally, the interplay of MHD effects, bioconvection, and Williamson fluid rheology provides crucial insights into controlling thermal performance and flow resistance. Hence, this study holds significant promise for applications in biomedical engineering, energy systems, and nanotechnology, where efficient manipulation of fluid dynamics at micro and nanoscale levels is essential.