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FLOW OF SECOND GRADE HYBRID FERROFLUID OVER A STRETCHING VERTICAL SURFACE WITH JOULE HEATING AND VISCOUS DISSIPATION

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ABSTRACT

Modeling heat transfer in non-Newtonian hybrid ferrofluid when the effects of Joule heating and viscous dissipation are combined is a challenging task in the thermal engineering field, notably for applications that call for effective control of thermal and electromagnetic behavior of working fluid. However, only a small number of numerical studies investigating second-grade hybrid ferrofluid flow over a stretching vertical surface while simultaneously considering MHD effects, Joule heating, and viscous dissipation exist despite the increasing interest in hybrid ferrofluid. The study describes the boundary-layer flow and heat transfer of a second-grade hybrid ferrofluid on a linearly stretching vertical surface in the presence of magnetic field. The governing partial differential equations are transformed into a system of ordinary differential equations by similarity transformation variables. The corresponding boundary value problem is solved numerically by the BVP4C method in MATLAB. Model validation is achieved by comparing with published results for the limiting cases and verifying the accuracy of the numerical scheme. Results are shown in graphical form and tabulation to demonstrate the effect of several dimensionless factors on the velocity and temperature profiles and skin friction coefficient. Results regarding the influence of the magnetic parameter, Prandtl number, stretching parameter, Joule heating parameter, viscous dissipation and Eckert number are discussed. The strong magnetic field produced slows down the flow and raises the fluid temperature. When Joule heating and viscous dissipation parameters are increased, the temperature field is markedly raised and the heat transfer rate at the surface is reduced.