MHD mixed convection boundary layer stagnation-point flow on a vertical surface with induced magnetic field: a stability analysis

ABSTRACT

Purpose – This study aims to perform a stability analysis on a steady magnetohydrodynamic (MHD) mixed convection boundary-layer stagnation-point flow of an incompressible, viscous and electrically conducting fluid over a vertical flat plate. The effect of induced magnetic field is also considered. Design/methodology/approach – The governing boundary layer equations are transformed into a system of ordinary differential equations using the similarity transformations. The system is then solved numerically using the "bvp4c" function in MATLAB. Findings – Dual solutions are found to exist for a certain range of the buoyancy parameter for both the assisting and opposing flows. The results from the stability analysis showed that the first solution (upper branch) is stable and valid physically, while the second solution (lower branch) is unstable. Practical implications – This problem is important in many metallurgical processes, namely, drawing, annealing and tinning of copper wires. The results obtained are very useful for researchers to determine which solution is physically stable, whereby mathematically more than one solution exists for the skin friction coefficient and the heat transfer characteristics. Originality/value – The present results of the stability analysis are original and new for the problem of MHD mixed convection stagnation-point flow of viscous conducting fluid over a vertical flat plate, with the effect of induced magnetic field.

Keyword: MHD; Mixed convection; Boundary layer; Stability analysis; Dual solutions; Eigenvalue