RBF solution of incompressible MHD convection flow in a pipe

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The steady convection flow of a viscous, incompressible and electrically conducting fluid is considered in a lid-driven cavity under the effect of a uniform horizontally applied magnetic field. The governing equations are the Navier-Stokes equations of fluid dynamics including buoyancy and Lorentz forces and the energy equation including Joule heating and viscous dissipation. These coupled equations are solved iteratively in terms of velocity components, stream function, vorticity, pressure and temperature by using radial basis function (RBF) approximation. Particular solution which is approximated by RBF to satisfy both differential equation and boundary conditions becomes the solution of the differential equation. The results are given for several values of Hartmann (M), Grashof (Gr) and the Reynolds (Re) numbers to visualize the effects on the solution. An increase in Gr moves the central vortex of the flow trough the center of the cavity emphasizing the movement of the top lid. Re increases the circulation of the fluid throughout the cavity. Heat is also circulated between the adiabatic walls when Gr or Re increases. The effect of increasing M is the boundary layer formation close to the moving lid for the flow and isotherms. The solution is obtained in a considerably low computational cost through the use of RBF approximation.

Keywords. MHD convection flow, RBF, viscous dissipation, lid-driven cavity