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NUMERICAL INVESTIGATION OF HIGH TEMPERATURE GRADIENT THERMOBUOYANT FLOWS WITH MAGNETIC FIELD

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ABSTRACT We propose an algorithm to solve thermobuoyant flows in the presence of magnetic field in enclosures with large temperature differences. The method is based on a staggered/non–staggered finite volume framework for incompressible flows which is modified to solve quasi-incompressible flows with heat transfer in the presence of applied magnetic field. The present framework is solves a single equation for normal momentum in the domain. This equation is discretized using a second–order convection scheme while central differencing is adopted for the viscous terms. An implicit solution approach which is first order accurate in time is employed and the resulting non–linear system of equations is solved using the Newton–Krylov approach. The momentum field at the cell centroids is then reconstructed using a defect–correction algorithm. The energy conservation equation is discretized similar to a collocated framework, with a first–order upwind scheme for the convective terms and implicit Euler time stepping. These equations are linearized by considering the velocity field at the latest available time step, and the resulting linear system of equations are solved using an ILU preconditioned GMRES solver using the LiS library. The approach is however still pressure–based with the energy equation employed to derive the divergence constraint to be used for solution of the pressure correction equation. Studies in enclosures over a range of temperature differences indicate that proposed approach can successfully simulate magneto-hydrodynamics convective flows with large density variation.

Keywords: Magnetic field, Finite Volume Method, Staggered/non-staggered, Non-Boussinesq.