3D Mixed Convection in a Porous Cavity

B. V. Rathish Kumar[1], Mohit Nigam[2,] and S. V. S. S. N. V. G. Krishna Murthy[3]
Department of Mathematics & Statistics, Indian Institute of Technology, Kanpur-208016, India[1]
SAG, DRDO, Metcalfe House Complex, N.Delhi-110054, India[2]
Department of Applied Mathematics, DIAT, Pune-411025, India[3]

ABSTRACT

This work is focused on the numerical investigation of steady 3D mixed convection process in a fluid saturated porous cavity. The coupled nonlinear partial differential equations governing the steady mixed convection in a 3D porous enclosure are solved by Galerkin Finite Element Method (FEM). The forced flow conditions are imposed by providing an inlet with injection at the bottom surface and an outlet with suction on the top surface. The inlet/outlet windows are of varying dimensions and may even be as large as the bottom and top faces. The free convection is induced by one or many internally buried isothermal cubical body/bodies together with Boussinesq approximation on density variable. The double diffusive process is also investigated both for aiding and opposing force conditions. In view of the large size of the linear systems encountered in the 3D FE computations, a numerical scheme based on segregated variable approach is employed in carrying out the related numerical calculations. Detailed numerical simulations are carried out for a wide range of governing parameters such as Rayleigh Number (Ra), suction/injection velocity (a), suction /injection width (D/H), cubical hot object of length (L) as fraction of the length of the square enclosure, Lewis Number (Le), Bounacy Ratio (B), and the results are analyzed by tracing the isotherms, streamlines, vector plots on different horizontal and vertical cross sections of the domain. Also local heat/mass fluxes along the isothermal buried structure are presented in the form of Nusselt/Sherwood Numbers for different values of the governing parameters.