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Title:

Double Diffusive Natural Convection in Partially-Layered Cavity with Inner Square Conductive Body

Abstract:

The characteristics of heat and mass transfer (double – diffusive) in a square cavity driven by natural conviction is studied in this thesis. The cavity consists of two layers, porous layer on the left and clear layer on the right. A conductive solid body is included inside the cavity to control the natural convection. Heat is added by keeping the left wall at hot temperature. The right wall is kept at cold temperature. The horizontal walls of the cavity are assumed adiabatic. The walls of the cavity are assumed impermeable. The exchange of momentum within the porous medium has been simulated using Maxwell-Brinkman model.

The governing equations of the conservation of mass; momentum; energies; and mass were casted in vorticity-stream function procedure. These equations have been solved numerically using Under Successive Relaxation (USR) up-wind finite difference scheme. The variation of the dimensionless temperature, stream function and Nusselt number are analyzed for seven pertinent parameters, Lewis number Le (1-50), buoyancy ratio N (-10 – 10), Rayleigh number Ra (10^3 - 10^6), thermal conductivity ratio of the body to fluid Kr (0.44, 1, 5), Darcy number Da (10^{-9}-1), aspect ratio of the square body A (0.3, 0.5, 0.7) and different positions of body. In the present study, the values of Parndtl number and the porosity of the porous medium are fixed at Pr =6.26, and = 0.398, respectively.

The results have showed that the mass diffusivity ratio, which takes into account non-unity tortuosity ratio (Deff/D = 0.533) has a significant effect on the mass transfer than the unity value. Also, Sherwood number is minimal when the buoyancy ratio equals to -0.5, otherwise, it increases with increasing the buoyancy ratio absolutely.