Abstract

Mohamed Abd El Fatah Mohamed Teamah

Numerical Study of Mixed Convection Heat Transfer and Fluid Flow in Cubical Lid-Driven Cavity,

Flow and heat transfer analysis in lid-driven cavities is one of the most widely studied problems in thermo-fluids area. Mixed convection heat transfer and fluid flow is investigated in this study. The top and bottom walls of the cavity are assumed isothermal the bottom wall is fixed and at higher temperature while the top wall is movable and at a lower temperature, the rest of the walls are adiabatic. Through this investigation, a wide range of Richardson number was studied to cover forced dominant convection, mixed convection and natural dominant convection. The transport equations for continuity, momentum and energy are solved using the control volume technique that produces a set of algebraic equations. The validity of the numerical method used is ascertained and good agreement was found with recently published results. A parametric study illustrates the influence of Richardson number effect on the fluid velocity, temperature, as well as the Nusselt number. This study is done for constant Prandtl number, Pr = 0.7 aspect ratio, A = 1. Computations are carried out for Richardson number ranging from 0.00005 to 10 at five sections in the cavity which are at X/H equals ½, ¼, 1/8, 1/16 and 1/32. Also, to show the importance of using three dimensional solutions, comparison between two dimensional and three dimensional results were made. The results showed the streamlines distributions and isothermals at the five vertical planes in the direction of the motion of the lid. The concluding chapter illustrates the effect of Richardson number on the heat transfer and fluid flow inside the cavity. The results revealed that as Richardson number decreases the forced convection regime becomes more dominant causing higher heat transfer rates and that the heat transfer (Nusselt number) is always higher on the top wall than on the bottom wall. Maximum Nusselt number was reached always near the left for the top wall while for the bottom wall the maximum reached was on the right. Correlations were generated for average Nusselt number in terms of the Richardson number at the midsection of the cavity for both the top and bottom walls.