Abstract

Energy transfer mechanism in most technical flows is through turbulent natural convection due to low viscosity of the fluids used in technical applications. Consequently, there is need to establish the parameters that influence the flow field of turbulent flow regime in order to enhance the energy-efficacy of many thermal applications. In order to establish the influence of the geometrical configuration of the flow domain on the flow field, we obtain and analyze the distribution of the velocity and temperature fields of a Boussinesq buoyancy-driven turbulent flow field in a locally heated and cooled enclosure for 0.5 1 AR ≤≤ while maintaining the Rayleigh number of the flow at 10 5.5 10 ×. To filter out the enormous turbulent scales inherent in the turbulent flow regime, we decompose the flow variables present in the instantaneous equations governing a viscous Boussinesq buoyant flow and subject the resulting equations to the Reynolds averaging process to obtain equations that governs the turbulent flow field. We resolve the turbulent quantities emanating from this process using the SST k w − turbulence model coupled with the Boussinesq approximation. To ensure the satisfaction of the conservation laws at the discrete level and over the entire solution domain, the non-dimensionalized equations are discretized using the robust finite volume method. The method possesses the ability to adapt a grid structure that captures the local features of the flow domain and imposes the integral form of the governing equations to each finite volume of the discretized solution domain so that the final mathematical formulation has an intimate connection to the actual physical situation. Since the equations are coupled, a segregated pressure-based iterative method is used to obtain the solution. The results revealed that the velocity and temperature fields are non-uniformly distributed in the enclosure and their magnitude and distribution significantly depend on the Aspect ratio of the enclosure. The results are consistent with the experimental results of Markatos and Pericleous (Markatos & Pericleous, 1984).