Abstract

Numerical analysis of fluid flow is anchored on the laws of conservation. A challenge in solving the momentum equation arises due to the unavailability of an explicit pressure equation. To circumvent this problem most researchers, use the vorticity-stream function method to eliminate the pressure term in the momentum equation. This approach introduces more variables to be solved than those in the original equations. In addition, vorticity does not exist in three dimension. Moreover, pressure is crucial in obtaining various fluid flow properties such as density hence its elimination is a serious limitation in the numerical analysis of flow characteristics. In order to overcome this challenge, the pressure equation is obtained in terms of the primitive variables using various forms of pressure-velocity coupling schemes. In this study, pressure equation is obtained from the continuity equation using the SIMPLE, SIMPLER and SIMPLEC pressure-velocity schemes. The schemes are used in analysing flow characteristics for a laminar buoyancy driven flow in order to establish the scheme that gives results consistent with bench mark data. The domain of the flow is a rectangular enclosure differently heated on two horizontal opposite sides. The cavity has two insulating baffles attached to the vertical walls and is full of air of Prandtl number of 0.71. The horizontal cavity walls are assumed to be isothermal while the vertical walls are adiabatic. The equations governing the flow are solved iteratively using finite volume method together with the central difference interpolating scheme. The solutions are presented for Rayleigh numbers of 10 (power3, 4 and 5). The results obtained showed that the two baffles trap some air in the enclosure and affect the flow fields. The velocity and temperature profiles for the SIMPLE SIMPLER and SIMPLEC algorithm for a Rayleigh number of 10 (power4 and 5) converge to the same path. At a Rayleigh number of 10 (power 3) however, SIMPLER behaves as the SIMPLE and SIMPLEC in the baffle free regions but undergoes a degradation in convergence with grid refinement at the baffle region. Results predicted by using the SIMPLEC algorithm are thus able to effectively compute the velocity and temperature of fluid flow in a differentially heated square enclosure with baffles for both low and higher Rayleigh numbers irrespective of the grid size. The results are consistent with Zeng & Tao (2003) study on the convergence comparison of four algorithm namely; the SIMPLE, SIMPLER, SIMPLEC and SIMPLEX algorithm.