ABSTRACT

Large eddy simulation of incompressible flow inside a lid driven cubic cavity for a range of Reynolds number (Re : 1000 - 15000) and different aspect ratio (Re = 11800) are carried out using dynamic Smagorinsky model (DSM). The governing equations were discretized using second-order central difference scheme on a staggered grid arrangement. A second-order time-accurate Adams-Bashforth fractional-step method was used for time integral, where the advective and diffusive terms were treated explicitly. The multi-processing is used to reduce the computational time with the OpenMP extension of C++ code. Center-line mean, RMS velocity profiles and Reynolds stresses are compared with the existing experimental and numerical results. Except for Re = 1000, the boundary layer slope at wall remains almost same up to the point of inflexion on the mid-bottom wall and on the mid-upstream wall. With increase in Re, the point of inflexion adjusts in such a way so as to make larger and larger volume of fluid a sluggishly-rotating central core. The number of TGL vortices increase with increase in span-wise aspect ratio. The turbulent quantities such as turbulent kinetic energy and turbulent production dissipation are found to be increasing with increase in Re and low depth-wise aspect ratio cavities at higher Re . The auto and cross correlation at low Re (= 3200) flow show periodic nature and as Re increases it becomes aperiodic implying shifting towards turbulent regime. The cross-correlation decreases with increase in Re. The Power spectra follows Kolmogorov's -5/3 slope in the inertial sub-range irrespective of the Re and aspect ratio, but the length of inertial sub-range increases as Re increases. Kolmogorov length scale (η) and Taylor micro scale (λ) both decrease towards the wall as dissipation is high at the walls. Anisotropic invariant map (AIM) has been plotted; nature of turbulence is found to be non-homogeneous and anisotropic even at low Re (= 3200) and non-homogeneity increases as Re increases. With increasing Re, the turbulence at the core region of the cavity shifts closer to isotropic.