ABSTRACT

Large eddy simulation (LES) using the dynamic Smagorinsky model (DSM) of incompressible turbulent flow inside the cubic cavities have been carried out at Reynolds number 12000. 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 pressure Poisson equation has been solved by the conjugate gradient method in order to correct the pressure and velocity field. The multi-processing is used to reduce the computational time with the OpenMP extension of C++ code. The three configurations of cubic cavity have been considered for the present study: the cubic cavity flow driven by single lid; the cubic cavity flow driven by two parallel lids moving in opposite directions; the cubic cavity flow driven by two parallel lids moving in same direction. The time averaged properties of the flow field such as velocity, second-order turbulent statistics, turbulent production and turbulent energy dissipation rate have been presented two-dimension contour plots at different plane locations. The three-dimensional iso-surfaces have been presented to identify the zone of inhomogeneity of turbulence, large turbulent production and large turbulent energy dissipation rate inside the cavities. The shearing-swirling and the coherent structures involved in the cavity flow have been studied at the statistical symmetry plane. At the location of maximum turbulent production zone, the time history and the power spectra of fluctuation in the primitive variables have been presented and the size of turbulent structures which are passing through the maximum turbulent production zone have been estimated. The large values of turbulent production, turbulent energy dissipation rate, subgrid-scale eddy viscosity and inhomogeneity of turbulence are found in the cavity flow driven by two parallel lids moving in opposite directions. The largest area which shows negative turbulent production (back scattering) has been found near the collision zone of two opposing wall-jets in the case of cavity flow driven by two parallel lids moving in same direction.