

Flow Visualization of the Turbulent Jet by Direct Numerical Simulation*

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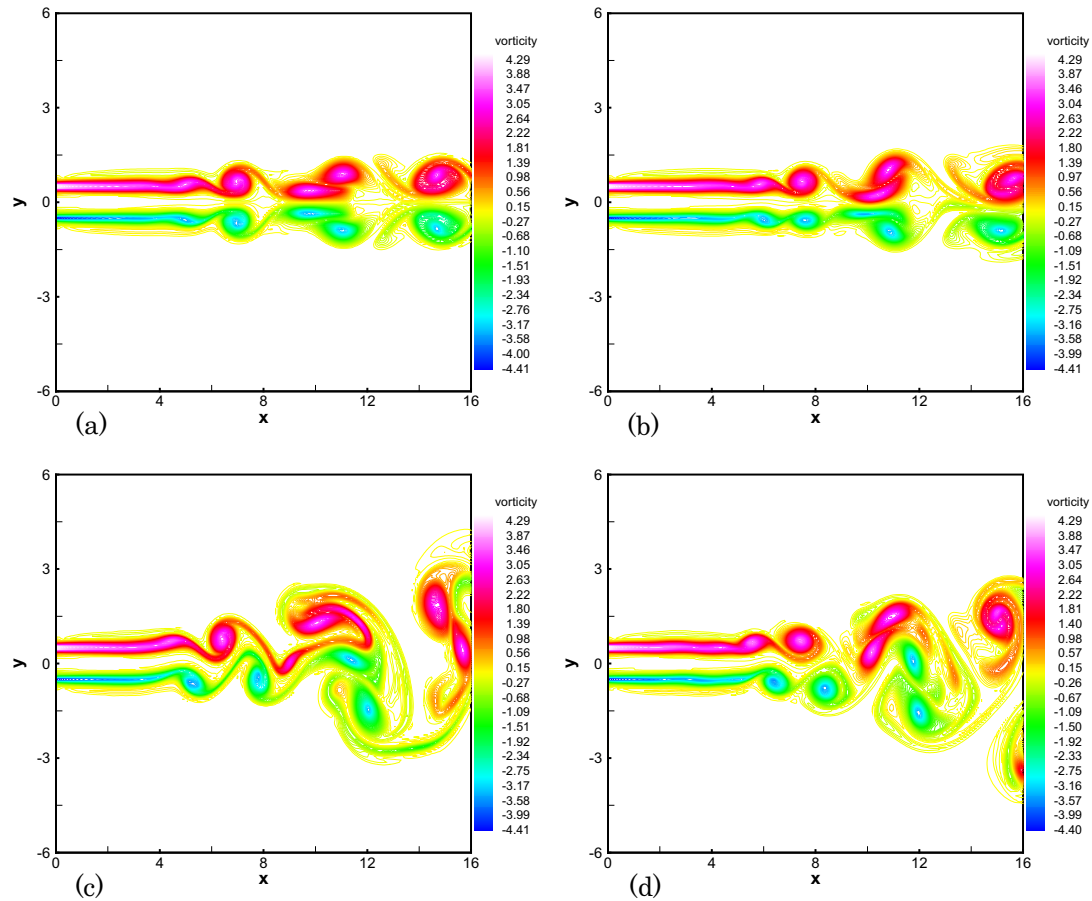


Fig. 1. The evolution of the large-scale coherent structures from symmetric mode to asymmetric mode in the jet flow-field. (a) $t=64.82$; (b) $t=93.62$; (c) $t=237.62$; (d) $t=381.62$;

A turbulent co-flow jet with flow Reynolds number of 6000 is studied numerically by using DNS technique. The flow is two-dimensional, compressible and spatial developing. The evolution of the coherent vortex structures in the near nozzle field is investigated. To solve the Navier-Stokes equations directly, a new fourth-order compact finite difference scheme is chosen to discretize the spatial derivatives in non-uniform meshes. The five-stage fourth-order Runge-Kutta integration scheme is adopted to march the Euler terms with sufficient numerical accuracy and lower memory requirement. In addition, the non-uniform fourth-order compact filter is utilized to eliminate the high wave number errors. Figure 1 shows the evolution of the coherent structures from symmetric mode to asymmetric mode. At first, the development of the large-scale coherent structures is symmetric pattern, as shown in Fig. 1(a). Then from the non-dimensional time $t=93.62$, the symmetry of the vortex structures is destroyed and the asymmetric coherent structures are dominant in the flow field, as shown in Fig. 1(b), (c) and (d).

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