Numerical simulation of turbulent flow in Taylor-Green vortex decay

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In large eddy simulation (LES) methods the quality of the numerical solution strongly depends on the properties of the subgrid dissipation. Here we present the results of numerical simulation of Taylor-Green vortex decay for low-Reynolds turbulent case. Simulation is based on quasi, or regularized gas dynamic (QGD) equation system, that generalizes the Navier-Stokes system and differs from it by additional nonlinear dissipative τ- terms, e.g. [1]. This mathematical model can be regarded as a nice alternative to existing filter models for LES methods and can be used for unified simulations of both laminar and low-Reynolds turbulent flows. In turbulent flow simulation τ-terms play the role of subgrid dissipation, in laminar flow calculations they stabilize the numerical solution, e.g. [2].

Figures below show the vorticity contours in numerical simulation of the Green-Taylor vortex flow decay for Reynolds numbers Re = 1600 for time t=0 and t=15. In the last figure the comparison of the kinetic energy (E) dissipation rate $\varepsilon = -\frac{dE}{dt}$ with the etalon data from [3] are demonstrated for Re = 1600 and 280. Here Mach number is equal to 0.1, computational grid is 65^3, working gas is nitrogen in normal conditions.

References

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