Analisys of turbulent flow with LBM: $\kappa - \epsilon$ and Smagorinsky models with law-wall and upwind scheme

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Abstract

In this work we discuss Large Eddy Simulation (LES) using $\kappa - \epsilon$ and Smagorinsky models to predict and investigate the flow around a sphere at high Reynolds numbers ($\simeq 10^6$).

The $\kappa - \epsilon$ turbulent model consists in two equations involving scalar quantities κ and ϵ. Moreover we talk about upwind scheme for propagation of κ and ϵ. This scheme is founded to variational criterion depending on velocity between lattice nodes. However upwind method approxes very well exact solution only when $Pe < 1$. Sometimes Pe can be greater then 1. Therefore we use power-law scheme with general value.

In $\kappa - \epsilon$ model both convergence and C_{Drag} result more accurate than Smagorinsky model; this is due to the local phenomena, tipical in turbulent regime, that are rapresented by convective, diffusive and source terms, while Smagorinsky considers only the strain tensor.

As a consequence the eddy viscosity, that works as a fluid dynamic filter, is expressed as function of κ and ϵ. Every turbulent model needs precise form of velocity near the wall. In this paper we talk about law-wall that modifies populations in grid nodes around the object. This law is founded on implicit equation in velocity unknown and it will be solved through Newton-Raphson method. The final result is very satisfactory especially in convergence, although computational time is greater then Smagorinsky turbulent model.