Direct Numerical Simulations and Large Eddy Simulations of the Turbulent Flow in a Baffled Tank Driven by a Rushton Turbine

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Abstract

The Lattice Boltzmann technique was used for carrying out both Direct Numerical Simulations (DNS) and Large Eddy Simulations (LES) for the case of a turbulent flow inside a cylindrical, baffled tank, driven by a six-bladed Rushton turbine. The Reynolds number was about 7,300 while in the DNS the number of grid points inside the tank amounted to some $2.9\ 10^9$. The latter number is shown to be adequate to fully resolve the smallest length scales in the flow.

The DNS data have been used to evaluate the performance of a LES on $3.6\ 10^6$ grid points where the LES makes use of several models for the sub-grid scale contributions to the momentum redistribution. The evaluation was carried out for both averaged velocity profiles and velocity fluctuations data. Among other options, it was studied whether or not applying a filter to the DNS data would reproduce the same velocity field as found by means of a LES.

The DNS data are incredibly detailed and may be more accurate than experimental LDA data. As a result, doubts may be raised as to the level of confidence of LDA data reported in the literature.