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Simulation of finite-size particles in turbulent flows using the lattice Boltzmann method. (English) Zbl 07414926

Summary: Particle laden turbulent flows occur in a variety of industrial applications. While the numerical simulation of such flows has seen significant advances in recent years, it still remains a challenging problem. Many studies investigated the rheology of dense suspensions in laminar flows as well as the dynamics of point-particles in turbulence. Here we will present results on the development of numerical algorithms, based on the lattice Boltzmann method, suitable for the study of suspensions of finite-size particles under turbulent flow conditions. The turbulent flow is modeled by the lattice Boltzmann method, and the interaction between particles and carrier fluid is modeled using the bounce-back rule. Direct contact and lubrication force models for particle-particle interactions and particle-wall interaction are taken into account to allow for a full four-way coupled interaction. The accuracy and robustness of the method is discussed by validating the velocity profile in turbulent pipe flow, the sedimentation velocity of spheres in duct flow and the resistance functions of approaching particles. Preliminary results from the turbulent pipe flow simulations with particles show that the angular and axial velocities of the particles are scattered around values of mean axial velocity and shear rate obtained from the Eulerian velocity field.

MSC:
76F10 Shear flows and turbulence
76F25 Turbulent transport, mixing
76F65 Direct numerical and large eddy simulation of turbulence
74F10 Fluid-solid interactions (including aero- and hydro-elasticity, porosity, etc.)

Keywords:
lattice Boltzmann method; moving bounce-back; turbulent pipe flow; particles in turbulence; finite-size particles; stresslet

Full Text: DOI

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