Development of a parallel multiphase Lattice-Boltzmann solver to study Stokes number effects on particle trajectories

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ABSTRACT

Particle-laden flows are important owing to their relevance to many engineering devices such as coal combustors, gasifiers and solar thermochemical reactors. In a recent experimental study by Lau and Nathan [1], it was found that particles in a turbulent pipe flow tend to migrate preferentially depending on their Stokes number (St). Particles with a high St (>10) are concentrated near the axis while those with low St (<1) move toward the walls. Anand et al. [2] have carried out Lattice-Boltzmann simulations of a particle in a laminar channel flow to investigate this behavior. In their work, they report a similar behavior where particles with low St migrates toward the wall while those with high St oscillates about the channel centerline. They have explained the migration of the particle in terms of various forces acting on the particle such as the Saffman lift, the Magnus lift and the wall repulsion. The present work extends upon previous work done by Anand et al. and aims to study the behavior of particles at intermediate St (~1). The transition of the mean position of the particle from a location near the wall to the centerline is also examined. The lattice Boltzmann method (LBM) is employed to carry out this study. The particle boundary is represented by the half-way bounce-back scheme supplemented by interpolation to preserve the particle representation as it moves through the fluid as proposed by Bouzidi et al. [3]. The drag force acting on the particle is found by the momentum exchange method and is used to update the velocity and position of the particle. The parallel multiphase Lattice-Boltzmann solver has already been developed. The mechanism of particle migration at intermediate St has been explained in this fundamental study and the relative contribution of various forces acting on the particle are presented.

KEYWORDS

Lattice Boltzmann method, particle-laden flow, Stokes number effects.

REFERENCE

