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Numerical studies of the effects of neutrally buoyant large particles on turbulent channel flow at the friction Reynolds number up to 395[1]

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A direct-forcing fictitious domain method was employed to perform fully-resolved numerical simulations of turbulent channel flow laden with large neutrally buoyant particles at constant pressure gradients. The effects of the particles on the turbulence (including the fluid-phase average velocity, the root-mean-square (rms) of the velocity fluctuation, the probability density function of the velocity and the vortex structures) at the friction Reynolds number of 180 and 395 were investigated. The results show that the drag-reduction effect caused by the spherical particle at low particle volumes is very small. The presence of particles decreases the maximum rms of streamwise velocity fluctuation near wall via weakening the large-scale streamwise vortices, and on the other hand increases the rms of transverse and spanwise fluctuating velocities in vicinity of the wall via inducing smaller-scale vortices. The effects of the particles on the fluid velocity PDF (probability density function) normalized with the rms velocity are small, irrespective of the particle size, particle volume fraction and Reynolds number.

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