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EXPERIMENTS ON THE SETTLING OF HEAVY PARTICLES IN GRID-GENERATED TURBULENCE

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Particle settling in a turbulent flow remains an unsettled problem as the averaged settling velocity of the heavy particles can either be increased or decreased by the turbulence. Among different mechanisms, the fast tracking of particles in vortices containing flow is the only one that can lead to an increase of average particle settling velocity, thus having received considerable attention in theory. However, there were not many experiments reported on the detailed settling behaviors of heavy particles in a turbulent flow. In this study, the settling of sub-millimeter heavy particles in grid-generated turbulence is investigated experimentally and the attention is paid to the effects of the turbulent structures on the settling velocities of individual particles.

Two vertically mounted grids are oscillated horizontally to generate a turbulent flow in a water tank. The turbulence structures of the water flow are decided by the oscillating frequency, which is set to be 0.2~0.6 Hz. Glass particles of 0.22 mm in diameter are used in the experiment. The instantaneous velocities of individual particles are obtained by particle tracking velocimetry (PTV). The water flow field is monitored by particle image velocimetry (PIV).

It is observed that the average settling velocity of individual particles increases with the increase of oscillating frequency starting from a low frequency. For the present setup, the average settling velocity reaches at the maximum value at 0.4 Hz, which is about 40% more than that in still water. Fast tracking can be used to explain the effect. However, further increase of the oscillating frequency leads to the decrease of the average particle settling velocity as compared to the maximum value, indicating other mechanisms governing particle settling may be involved. The experimental results infer that the turbulence structures, i.e., vortices, decide the settling behaviors of the particles.

It is also observed that for large turbulence intensities, the particles diffuse at a larger rate in the flow. This may contribute to the decrease of particle settling velocity in an average sense.