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Effect of Bi-Dispersity on Particle Clustering in Sedimentation

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Abstract : In free settling or sedimentation, particles form clusters at high Reynolds number and dilute suspensions. It is due to the entrapment of particles in the wakes of upstream particles. In this paper, the effect of bi-dispersity of settling particles on particle clustering is investigated using particle-resolved direct numerical simulation. Immersed boundary method is used for particle fluid interactions and discrete element method is used for particle-particle interactions. The solid volume fraction used in the simulation is 1% and the Reynolds number based on Sauter mean diameter is 350. Both solid volume fraction and Reynolds number lie in the clustering regime of sedimentation. In simulations, the particle diameter ratio (i.e. diameter of larger particle to smaller particle (d_1/d_2)) is varied from 2:1, 3:1 and 4:1. For each case of particle diameter ratio, solid volume fraction for each particle size (φ_1/φ_2) is varied from 1:1, 1:2 and 2:1. For comparison, simulations are also performed for monodisperse particles. For studying particles clustering, radial distribution function and instantaneous location of particles in the computational domain are studied. It is observed that the degree of particle clustering decreases with the increase in the bi-dispersity of settling particles. The smallest degree of particle clustering or dispersion of particles is observed for particles with d_1/d_2 equal to 4:1 and φ_1/φ_2 equal to 1:2. Simulations showed that the reduction in particle clustering by increasing bi-dispersity is due to the difference in settling velocity of particles. Particles with larger size settle faster and knockout the smaller particles from clustered regions of particles in the computational domain.

Keywords : dispersion in bi-disperse settling particles, particle microstructures in bi-disperse suspensions, particle resolved direct numerical simulations, settling of bi-disperse particles
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