Turbulence effect on the bubble-particle collision efficiency

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Understanding bubble-particle collisions is essential for the flotation process in the mining industry. Here, we numerically investigate the role of turbulence on the collision efficiency between the fully contaminated bubble and small inertial particles in a moderately turbulent flow. The bubble is represented by a sphere moving at constant velocity through homogeneous, isotropic turbulence. The coupling of the bubble with the fluid is fully resolved by the immersed boundary method, whereas the colliding small particles are modelled as point particles. We consider a bubble Reynolds number of $Re_b = 120$, particles with Stokes numbers $1e - 2 \leq St_p \leq 5.2$ at a Taylor Reynolds number $Re_\lambda = 32$. Even though the mean flow field around the bubble differs only slightly between quiescent and turbulent surroundings, collisions in the latter case occur for particles coming from a much wider region ahead of the bubble (see Fig.1). This generally leads to an enhancement of the collision efficiency which reaches up to 100% compared to the results in the quiescent flow. We further find that the mean collision angle slightly increases for all considered particle Stokes numbers due to the turbulent fluctuation. To elucidate these findings, we compare our results to those obtained from a simple two-dimensional turbulent dispersion model. It turns out that the particle transport towards the bubble is enhanced by the turbulent dispersion which counteracts the lateral mean flow induced by the presence of the bubble thereby increasing the collision efficiency.

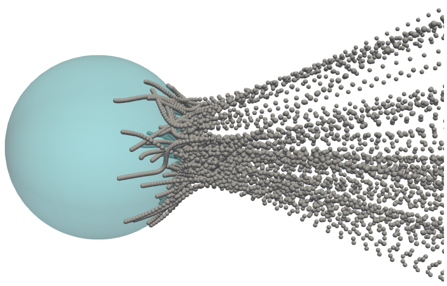

Figure 1: Visualization of the particle trajectories colliding on the bubble in the bubble frame at $Re_\lambda = 32$. The size ratio of particle to bubble is 0.025 and the turbulent intensity is 25%.

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