Clouds of mono and polydisperse particles falling in a viscous liquid at finite Reynolds number: A numerical study using Oseen approximation

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Abstract:

Two-phase flows involving very fine particles are frequently encountered in engineering; examples include chemical and pharmaceutical processes, pneumatic conveying, dust dispersion in atmosphere and sediment transport in rivers and estuaries. The falling of a cloud of these particles under gravity in a quiescent fluid is much different from that of an isolated one. When both the particle and cloud Reynolds numbers, Rep and Rec, are much smaller than unity, Stokeslet has been found to be appropriate to capture the characteristic evolution of the cloud; it includes cloud flattening, transition from an initially spherical cloud to an open torus with a long tail, and eventually breakup into two (or occasionally three) secondary clouds, which then evolve in the same pattern if they contain enough number of particles [1-3]. However, when Rep << 1 but Rec = O(1), the inertia effect has to be taken into account and hence Oseen approximation should be adopted. The present work lies in the Oseen regime. The cloud evolution in this regime is different from that in the Stokes regime, e.g. there is no tail or the tail is much smaller with less number of particles in it, and the number of secondary clouds is mostly more than 2. Preliminary results show that the evolution depends on the initial number of particles in the cloud, the cloud Reynolds number, the polydispersity and/or the inertia length, $l^*=\varepsilon/Rep$ with $\varepsilon=a/R$. Discussion on this is provided.

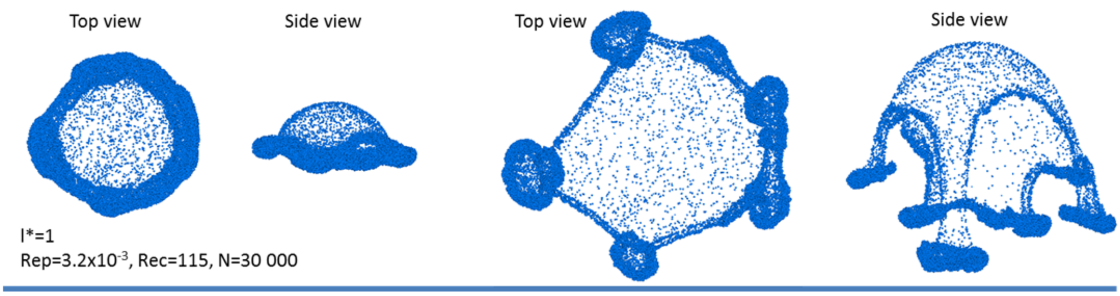

Figure 1: Evolution of a spherical cloud containing 30000 particles. Time increases from left to right.

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