SETTLING AND BREAK-UP OF SUSPENSION DROPS

Thorsten Bosse [a] , Carlos Härtel [b] and Leonhard Kleiser [a]

[a] Institut für Fluiddynamik, ETH, Sonneggstrasse 3, CH-8092 Zürich
[b] GE Global Research - Europe, Freisinger Landstrasse 50, D-85749 Garching

Particle suspensions are a special class of multiphase flow systems that are frequently encountered in nature as well as in engineering applications. Natural occurences range from large-scale phenomena, such as toxic particle sedimentation in river beds due to environmental pollution, or dust particle transport in the atmosphere, to small-scale phenomena such as atherosclerotic deposits in human blood vessels. Engineering applications are numerous in the chemical and pharmaceutical industries including mixing, drying, and transport processes. Due to this wide variety of applications a considerable effort has been directed to developing numerical methods for the simulation of particle-laden flows. However, many phenomena observed in particulate two-phase flows are still poorly understood including fundamental aspects of particle fluid interaction.
A simple yet fundamental example of particle sedimentation is the settling and break-up of suspension drops. A suspension drop is a swarm of particles that are suspended in initially still fluid. When settling under the influence gravity a suspension drop may undergo a complex shape evolution including the formation of a torus and eventual disintegration. The settling process of initially spherical suspension drops is investigated numerically for low and moderate drop Reynolds numbers. In the case of low Reynolds numbers ($Re_d < 1$) the suspension drop retains its spherical shape while settling, a few particles leak away into a tail emanating from the rear of the drop. In the Reynolds number range $1 < Re_d < 100$ the suspension drop deforms into a torus that becomes unstable and breaks up into a number of secondary blobs. It is shown that the instability mode (number of secondary blobs) is primarily determined by the Reynolds number and the particle distribution inside the initial drop. In the simulations a pseudospectral method is used for the liquid phase combined with a Lagrangian point-particle model for the particulate phase.