# Modeling Solid-Liquid Settling System As a Two-Phase Flow Problem

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## Abstract

Sedimentation is a challenging two-phase problem to model and simulate. Many applications in the industry use sedimentation for separation. For example treatment of wastewater often carried out in settling basins. Different types of the sedimentation process include independent and zone settling. Independent type could be modeled by for instance level set method, although it is not the most effective way of modeling in case of micro- and millimeter scale particles.
The food industry uses the process of sedimentation as well. Most dairy products made by separate dense parts of milk out of less dense leftover. A device for sedimentation can be equipped by a rotating motor which enhances the effect of gravitation via centrifugation force. However in milk and cheese industry both the continuous and the disperse phases are liquid, the same model can be applied to the liquid-solid system by varying the properties of the second fluid.
The CFD module of COMSOL Multiphysics® offers opportunities to handle immiscible phases. Disperse methods include bubbly flow, mixture model and Euler-Euler model, however bubbly flow can handle only bubbles as a dispersed phase and thus for sedimentation is improper. Level set and phase field approaches beside of moving mesh method seem more appropriate for the purpose, so investigations to model solid particles settling in liquid are performed by these interface tracking methods. 2D axisymmetric model is used as a good and computationally economic approximation of the real 3D system. As a starting point, we opened the rising bubble model from COMSOL's Application Library. After studying this example, we tailored it to our needs. Solid dispersed phase is treated as a liquid with high density and viscosity to imitate solid behavior while keeping the ability to use the same flow equation by solving an additional transport equation. Level set and phase field methods use fixed mesh, and the difference of the properties of the two phases at the interface is described by a step-like color function. Moving mesh method gives an alternative way to model two-phase flows with an importance to interface tracking. In this study, all possible methods are tried to find out how can COMSOL Multiphysics® help in this task of settling individual particles in a given liquid.
In our investment 5.86 mm sphere shaped solid particles are dropped into a 100 mm diameter and 700 mm high column of liquid (water, silicone oil, paraffin oil or gear oil). The aim of the simulation is to predict the settling velocity of the particles. The properties which influence the settling can also be explored by modeling. The built CFD models will be validated by experimental measurements.