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Application note 16

Determination of the sedimentation rate of lime powder

Problem

The determination of the sedimentation rate in a liquid is a frequently used method in the quality control of the powder particle size. Doing so, it is decisive at which position of the measuring cylinder or vessel the sedimentation is going to be measured. Due to this fact it is important to focus on the decreasing density during the sedimentation process. If the particles are distributed regularly first, a homogenous density can be assumed at time t=0. When the sedimentation has started, the density decreases from top to bottom. The density gradient depends on measuring time. So, the density at the bottom of the cylinder is increasing consistently until the sedimentation is finished. Simultaneously, the density at the surface of the liquid is decreasing. During the measurement the probe within the cylinder is surrounded by changing densities. Therewith, the buoyancy of the probe is not a constant parameter and acts against the sedimentation cover close to the probe.

Method

Using the dynamic contact angle measuring device and tensiometer, DataPhysics DCAT, a lime powder was solved within water. The sedimentation rate was measured in a hollow cone with an outer diameter of 16.5 mm. The immersion depth was 30 mm. A vessel with a volume of 100 ml was used for the measurement. The powder was filled in with a height of 5 mm and stirred for 10 min with a magnetic stirrer. Before each measurement, each sample was stirred again for 10 s. Then, the sedimentation was evaluated 5 s after stirring. The measuring time was about 10 min.

Results

The experiment showed that the sedimentation of the lime powder was completed after 120 s and no increase in weight could be noticed (Figure 1). It was also noticed that the liquid was almost clear after finishing the measurements. Evaluating the sedimentation rate, an increase could be assumed after 60 s (Figure 2).

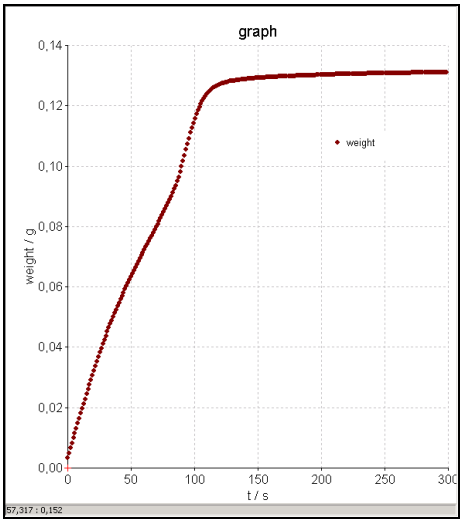

Figure 1: Weight over time

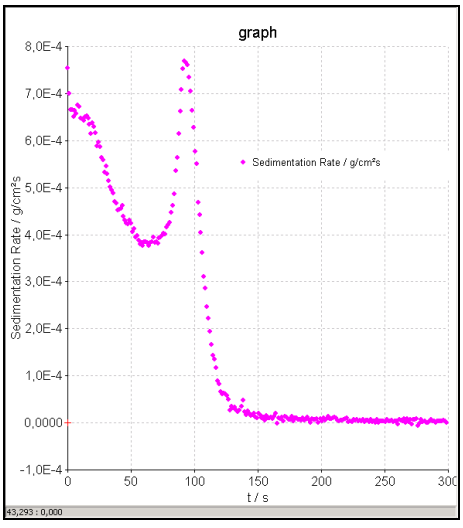

Figure 2: Sedimentation rate

The sedimentation rate increases consistently until t = 90 s and then, it decreases steep. As a reason for that it had to be proved that the density of the probe changes during measurement and also the buoyancy of the probe. At the bottom the density increases while it decreases at the top during the whole time of sedimentation.

In an additional experiment a ball was fixed in different heights to be able to describe the buoyancy in relation to the weight change. The sedimentation at the ball was so small that the size could be neglected. The ball had the position of 1 mm under the liquid surface (at the top), in the middle of the measuring cylinder (middle) and 6 mm above the glass ground (at the bottom) so that the ball could not touch the powder.

The measurements (Figure 3-5) show that the influence of the changing density to the bottom increases. While the effect is only small close to the surface, the buoyancy of the ball close to the bottom changes in that way that the ball is lightweight close to the bottom with its sedimentation covers. Only if the sedimentation is stronger, the buoyancy becomes less significant related to the lower density so that the ball "increases in weight" again. The sedimentation process of the particles close to the probe takes more time regarding the height, but after finishing the sedimentation the buoyancy becomes almost equal in all measurements.

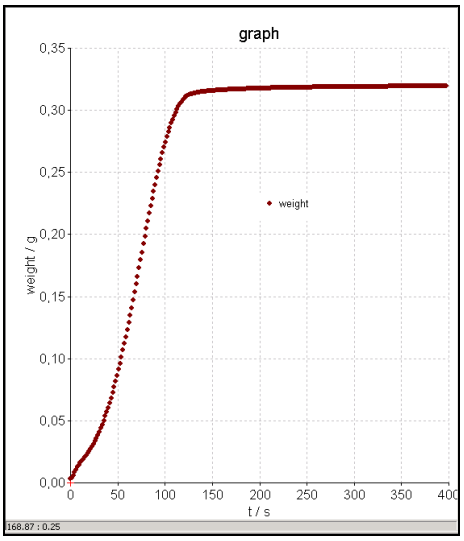

Figure 3: Ball buoyancy, position at the top

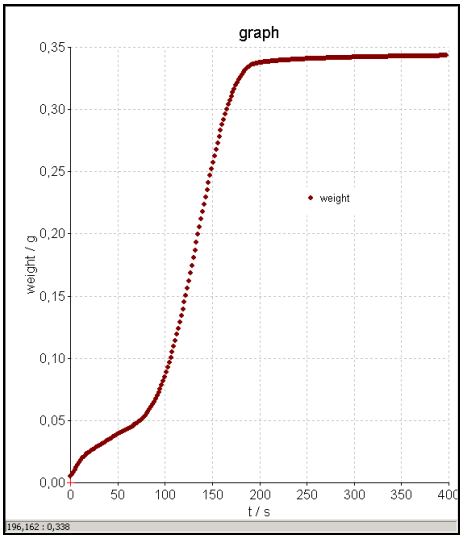

Figure 4: Ball buoyancy, middle position

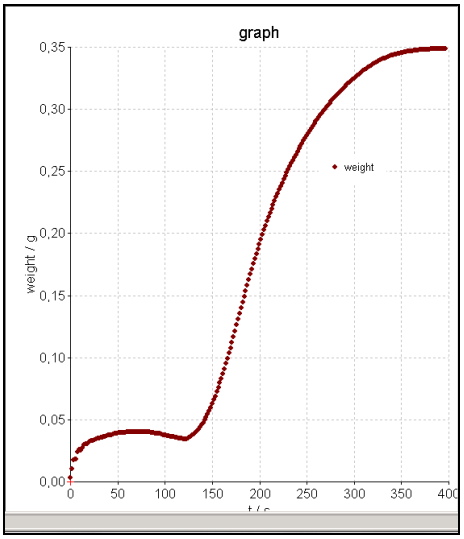

Figure 5: Ball buoyancy, position at the bottom

Conclusion

The measurement of the sedimentation depends on the position of the probe. Therefore it is recommended to dive only so deep that the effect of the density gradient acts as less as possible. The influence of the density may vary depending on the used powder, e. g. very slow sinking sediments. The effect is less significant using fast sinking sediments.