



MEASURE UP TO 5x FASTER WITH OPTIMIZED SETTINGS

Context

Dynamic image analysis with the CAMSIZER 3D is an innovative and efficient method for particle size and particle shape analysis in real time. Despite the ease of application and the speed with which results can be obtained, there are several important aspects to consider when working out the measurement conditions to make routine operation as efficient as possible. In this example, we show how to reduce the duration of an analysis by a factor of 5 without compromising the quality of the results.

Task

Two samples of limestone pellets produced during drinking water treatment (rapid decarbonization) were analyzed. Each sample contained about 450 g of material, which was to be analyzed with the CAMSIZER 3D regarding size distribution and particle shape. During the application development, the measurement conditions could be optimized in such a way that a reduction of the required measurement time from 15 minutes to 3 minutes was realized. As a result, significantly higher sample throughput can be achieved in routine operation and seamless quality control can be realized. The procedure described here can be transferred analogously to other applications and particle measuring devices of the CAMSIZER series.

The results are presented below as a cumulative volume-related size distribution Q_3 . In each case, it is a measurement based on the three-dimensional particle thickness.

First Attempt

First, the complete amount of Sample 1 was analyzed using the recommended default settings using the CAMSIZER 3D. An important parameter in dynamic image analysis is the feed speed of the sample into the measurement zone. This is done via a vibrating feed chute, which continuously adjusts its amplitude during the measurement to achieve a constant coverage of the images with particle projections as possible ("obscuration"). If this obscuration is too high, particles can overlap on the image and lead to incorrect measurements. If the obscuration is low, the risk of overlapping is very small, but the analysis takes longer because the sample will be conveyed more slowly. In the

measurement settings, the user sets a target value for obscuration, which the chute then tries to keep constant by adjusting the amplitude during the measurement run. The recommended obscuration for a CAMSIZER 3D measurement is 0.5% (i.e. on average, 0.5 % of the image frame is to be taken up by particle projections). Experience has shown that this fulfils the two requirements of "no overlaps" and "short measurement time" very well. Another option is the width of the vibratory feeder. In the special case of 3D measurement, each particle is recorded several times as it falls. The rotation of the particle results in many different views and thus a statement about the three-dimensional shape (length, width, thickness) is possible. The wider the chute (and thus the particle stream analyzed), the narrower the field of view and the greater the achievable image acquisition rate. Thus, with a narrower feeder, there are more projections per particle and thus a more accurate measurement, but at the price of an extended measurement time.



Fig.1: Limestone pellets during the measurement with the CAMSIZER 3D.

The diagram shows the result of the measurement of 450 g of limestone pellets with 0.5 % obscuration on a 40 mm feeder. The measurement time is 15 min 41 s.

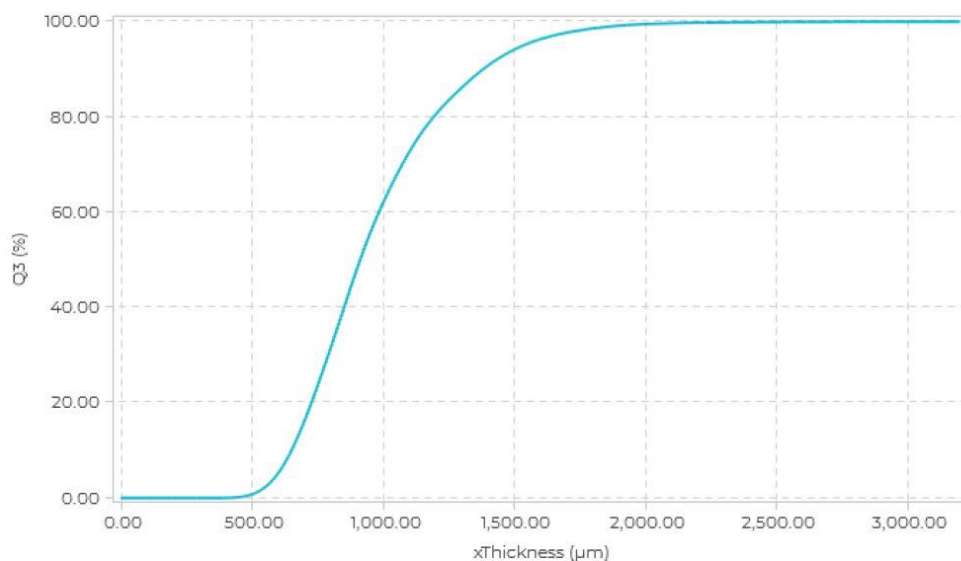


Fig.2: Measurement result of limestone pellets, the size distribution is 500 µm – 2000 µm.

Feeder width

In the next step, the 40 mm chute was replaced by a 60 mm chute. This means that fewer images are taken per particle, but the measurement time is reduced to 12 min 13 s. The result is identical to the one on the narrow feeder. The 60 mm channel can therefore be used for this application!

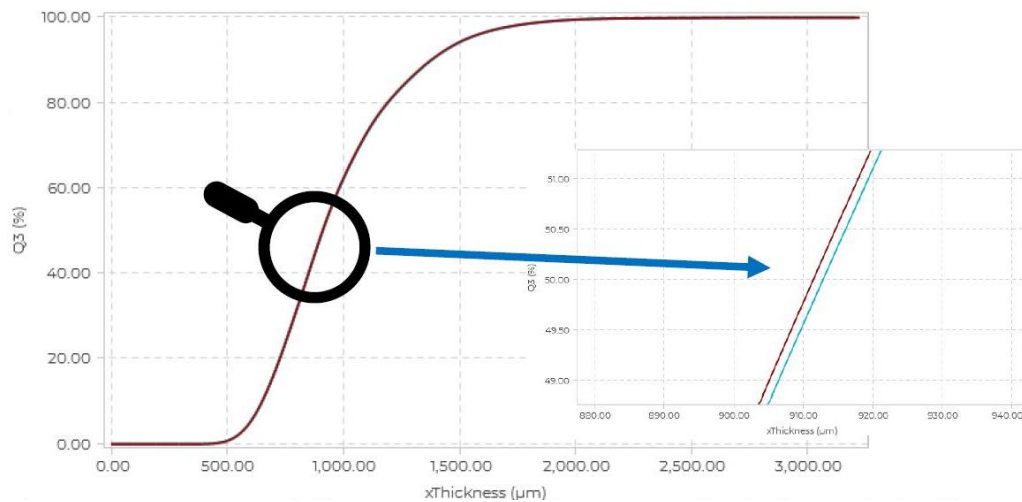


Fig.3: Measurement result limestone pellets with on 40 mm feeder (turquoise) and on 60 mm feeder (brown). The curves are almost congruent.

Obscuration

To further optimize the measurement speed, the nominal obscuration was increased from 0.5 % to 1 %. As a result, the sample is conveyed faster, as more particles in the image are permissible. This reduces the measurement speed to 6 min 18 s. The size distribution is still identical to the two previously measured. An obscuration of 1 % is therefore applicable for this sample!

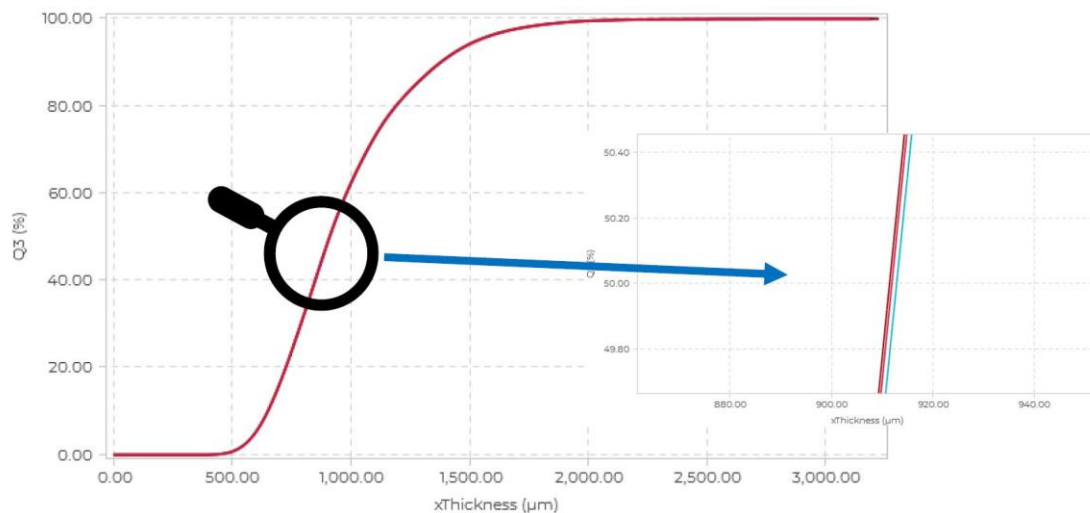


Fig.4: Measurement result limestone pellets with on 40 mm chute (turquoise) and on 60 mm chute (brown) and with 1 % obscuration (red). The curves are almost congruent.

Sample splitting

Finally, it should be checked whether the amount of 450 g is really needed to achieve a meaningful result. With a simple riffle splitter, the sample quantity was gradually reduced to 1/2, 1/4, 1/8, and 1/16 of the initial quantity. The results are shown in the figure below. The distributions are very consistent down to 1/4 of the initial quantity, only at lower sample quantities of 1/8 or 1/16 significant deviations do occur. With half the sample quantity, the analysis takes 3 min 13 s, which is a "normal" measurement time for dynamic image analysis. The recommendation here would be to measure half the sample quantity, because the measurement time of approx. 3 min with one dividing step is easy to handle and we are sure to achieve a good result with the amount. The table shows the percentiles at 10%, 50% and 90% for the different sample quantities.

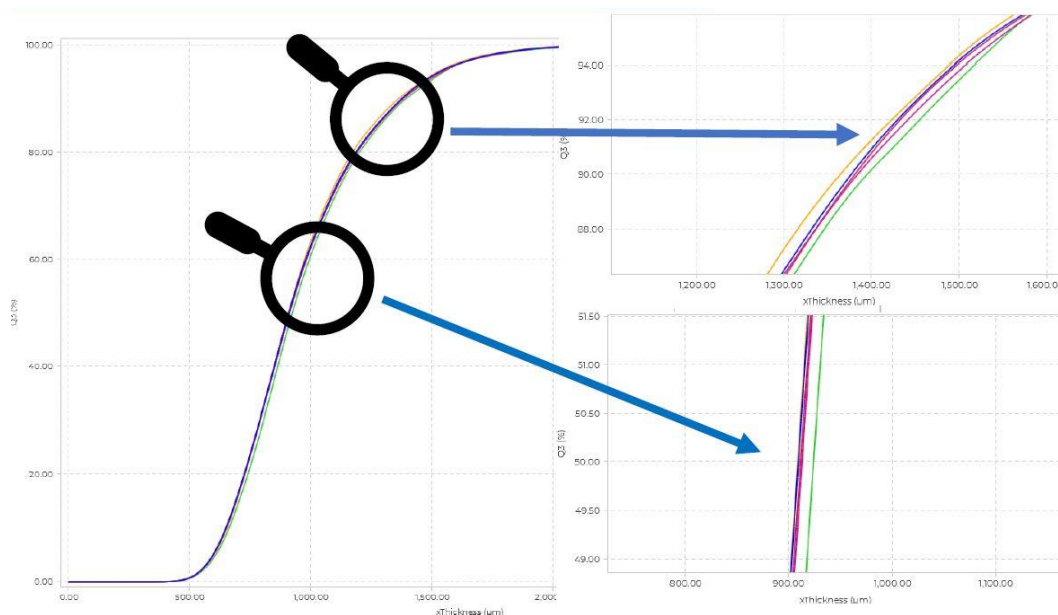


Fig.5: Measurement result limestone pellets Entire sample (red), 1/2 quantity (blue), 1/4 quantity (purple), 1/8 quantity (orange) and 1/16 quantity (green).

Feeder	40 mm	60 mm	60 mm	60 mm	60 mm	60 mm	60 mm
Obscuration	0,5 %	0,5%	1 %	1 %	1 %	1 %	1 %
Subsample	Total	Total	Total	1/2	1/4	1/8	1/16
D10 [μm]	651	651	651	650	652	655	663
D50 [μm]	913	912	912	909	913	909	924
D90 [μm]	1382	1378	1381	1377	1384	1365	1395

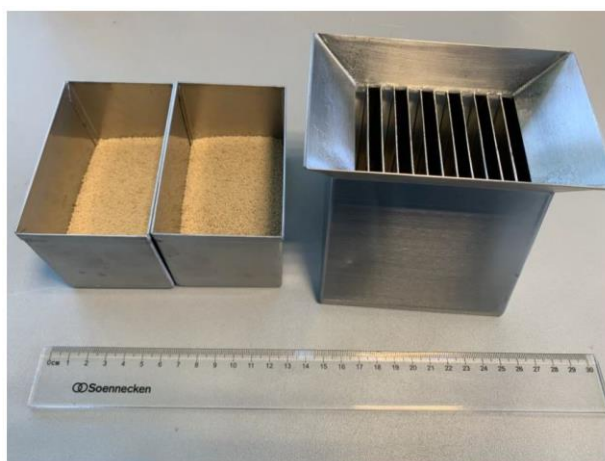


Fig.6: Divided sample in the riffle splitter.

Repeatability

With another sample of limestone pellets (sample 2), five consecutive measurements were carried out with identical measurement settings (60 mm feeder, 1 % obscuration and half sample quantity). The figure and the table show the excellent reproducibility of the measurements. In comparison, a measurement with random sampling is shown, which differs by about 6 μm in median size and by about 25 μm in d90. In this case, the sample division error is small, but demonstrable!

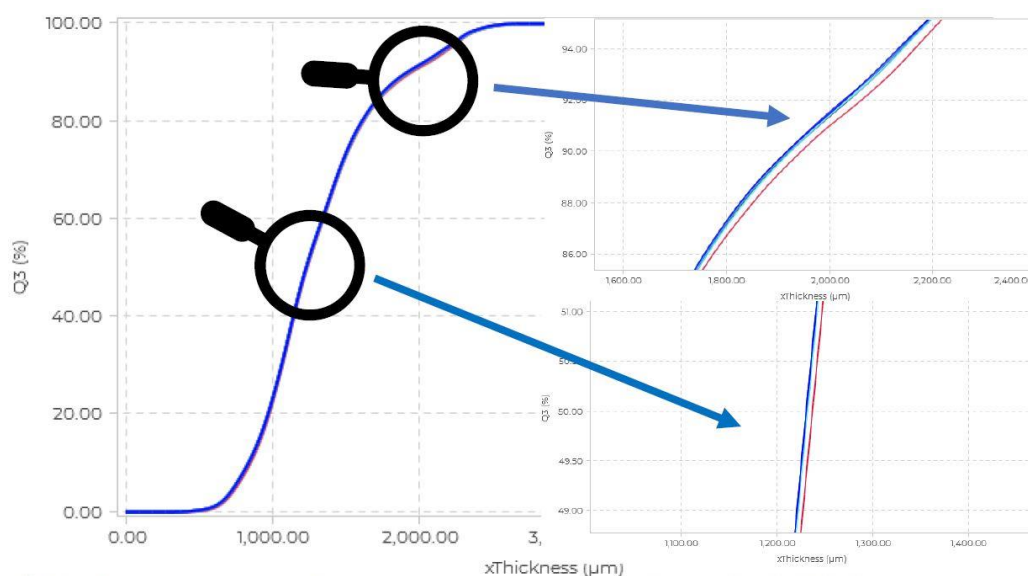


Fig.7: Measurement result limestone pellets Sample 2, subsamples 1-5 (blue) are measured in a perfectly repeatable manner. Random sampling leads to slightly different results (despite the same amount).

Subsample	#1	#2	#3	#4	#5	Random
D10 [μm]	837	836	837	837	836	851
D50 [μm]	1332	1231	1232	1231	1231	1237
D90 [μm]	1924	1918	1926	1919	1919	1945

Found Optimal Measurement Settings?

For the framework conditions considered, we have created a robust method for measuring the limestone pellets. However, the quality of this method also depends on the parameters measured. If you look at the shape, you will notice that the width-to-length ratio when measured at 0.5% obscuration is slightly different than for those with 1% obscuration. This is because length measurement is more prone to overlapping than thickness measurement. If two similarly sized particles touch each other in the image, they are measured at twice the length, while the thickness measurement is unaffected. For accurate length or shape measurement, a slower measurement should therefore be considered. However, the measurement error is still small and constant, so that consistent statements about the particle shape are possible in any case if the measurement settings remain the same.

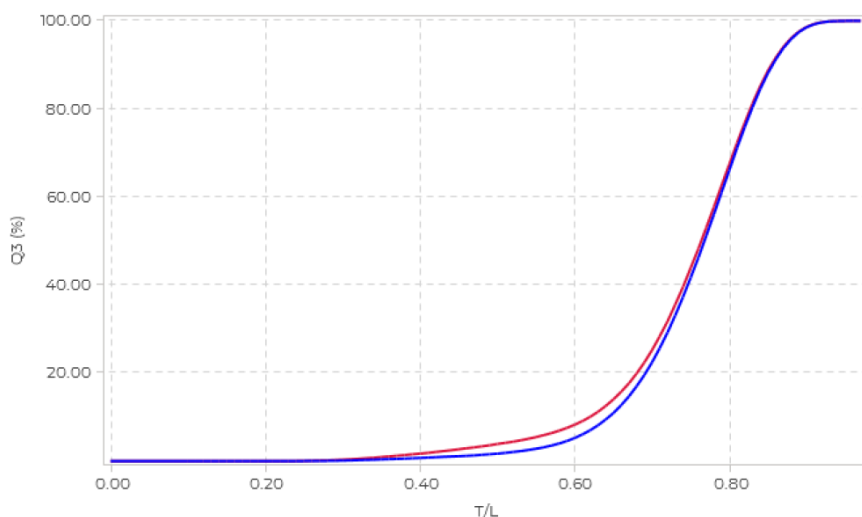


Fig.8: Measurement result of limestone pellets, Shape distribution Thickness / Length (T/L). Measurement with 0.5 % obscuration (blue) provides slightly higher values for the aspect ratio than the measurement with 1 % obscuration (red).

Summary

This example serves as a general guideline for the application development process. For other devices, other parameters may have to be considered that influence the measurement result, e.g. compressed air in the case of the CAMSizer X2, or pumping speed in wet measurements. The optimal settings always depend on the nature of the material, the size and distribution width, as well as on the size and shape parameters considered. MICROTRAC Application Support will be happy to assist you in finding the best solution for your requirements.