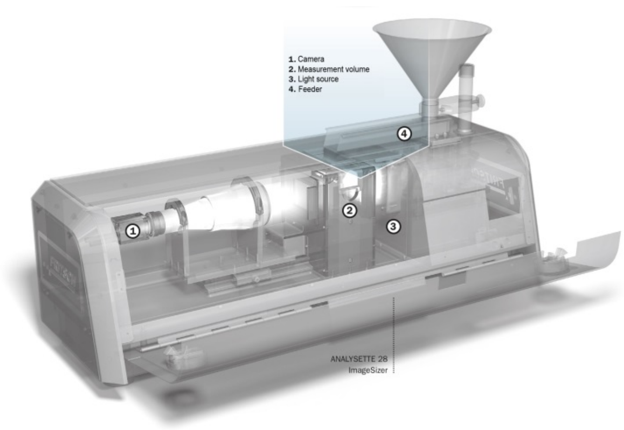
Particle Analysis with the Camera

Dynamic Image Analysis is a perfect method if not only the particle size of powders is to be determined, but if you also want to ascertain something about their shape. For this purpose the FRITSCH GmbH provides with the **Particle Sizer ANALYSETTE 28 ImageSizer** a functional, economically priced instrument, which is utilized for dry, free-flowing bulk solids.

Measuring principle

The underlying measuring principle is quickly explained: Via a controlled feeder the sample material is directly fed into a falling chute from which it falls down into a collection container.
On the way down the particle flow is flashed by a large-area LED array and photographed in fast sequences by a CCD camera arranged on the opposite side. Therefore, the optical set-up is comparable with transmitted light microscopy, where a high contrast is obtained between the homogeneously lit, light background and the particles shadowing the light.
All images are then analysed via software and the respective selected data is displayed after the conclusion of the measurement. More about this later though.



ill. 1: Measuring principle Particle Sizer ANALYSETTE 28 ImageSizer

Optical set-up

But at first let’s stay with the optical set-up: As with every microscope or common camera, the size of the generated image on the retina or camera sensor depends on the magnification of the utilised lens. In addition, the parameters of the camera sensor are important for the quality of attainable results. Substantial parameters are the complete size of the used sensor, the number of pixels and the maximum possible image acquisition rate.
For a certain combination of camera and lens, result from the magnification and the sensor data, the limits of the herewith obtainable size range. Inside the ANALYSETTE 28, runs a 5 mega pixel camera with a 2/3 inch CCD sensor. The pixel size is at 3.45 x 3.45 µm, which in combination with a lens magnification of 0.184 times, results in a lens size of 18.75 x 18.75 µm per pixel. Now if for the lower measuring range of the system images of at least 8 x 8 pixels are required, a lower measuring range of 150 µm is obtained. Through similar deliberations in this combination, the upper measuring range of 20 mm is achieved, i.e. the particle size range of 150 - 20000 µm is covered with one lens.

Altogether four different lenses are available for the ANALYSETTE 28 ImageSizer with which varying measuring ranges can be covered. The lens with the maximum magnification then achieves a lower measuring range of 20 µm.

Fritsch GmbH • Milling and Sizing
Industriestrasse 8 • 55743 Idar-Oberstein • Germany
Phone +49 67 84 70 0 • Fax +49 67 84 70 11
info@fritsch.de • www.fritsch-sizing.de

Particle characterization

Now how does the instrument recognize the particles? Actually it is relatively simple: the number of the available shades of grey of the camera is 2^8 = 256 (i.e. the dynamic range of the camera is 8 bit). Complete white corresponds with a value of 255, black is 0. In the software a threshold is set where it is decided whether a pixel belongs to the background or to a particle. As long as the appearance of the particle through the optical system generates images with a sharp contrast between black and white, is the choice of this threshold not very critical. But if an increasingly large number of particles are outside of the focus area of the utilised lens, a clear influence of this parameter on the results can be observed.

ill. 2: Standard lens

Depth of focus

An additional parameter of the optical system comes into play now, the depth of focus. It describes the distance area within which a particle appears sufficiently clear. Basically, the depth of focus decreases with increasing lens size. Maybe this is familiar from personal experiences in microscopy where with large magnifications it becomes increasingly difficult to create a well-focused image. This causes particles which do not exactly pass the focus area of the camera, to appear as more or less blurred smudges in the images. Now the software has to decide which particles appear sufficiently enough to be considered for the evaluation and where exactly the edge of the particle lies. This can lead to problems if lenses with varying magnifications are used.

Image acquisition speed

Besides the depth of focus, sensor and pixel size is the image acquisition speed another not unimportant factor, but for most applications it does not play a central role though. The image acquisition speed is usually given in frames per second “fps”. The CCD camera of the ImageSizer obtains up to 30 fps. With such high image rates enormously large volumes of data are generated within a short time period of time, demanding the corresponding specifications from the computer hardware in order to handle the measuring task. Furthermore if a large sample amount is to be completely measured, this easily leads to only hard to handle amounts of data and enormous measuring times, since the sample feed speed – how much material per minute can be conveyed - can only be increased in limits. The overlap of two particle images which coincidentally pass on the same visual axis of the camera shall be kept as low as possible.

On the other hand it has to be heeded though, that an important criterion for the exactness of the measurement is the total number of the obtained and evaluated particles. Is this too low, the statistical significance of the data decreases especially for particle sizes which do not occur too often.

In practice

In practice it is to be deliberated that sufficiently enough material has to be used to allow dependable measurements. But not too much, in order not to waste unnecessary time, computing capacity and memory space. It is also important to know that especially samples with a wider particle size range easily segregate on the feeder during the conveyance, so it is recommended to always measure the complete sample volume. In order to avoid the mentioned problems of a too large analysis amount, a very good sample division should be conducted. For this, can for example a FRITSCH Rotary Cone Sample Divider

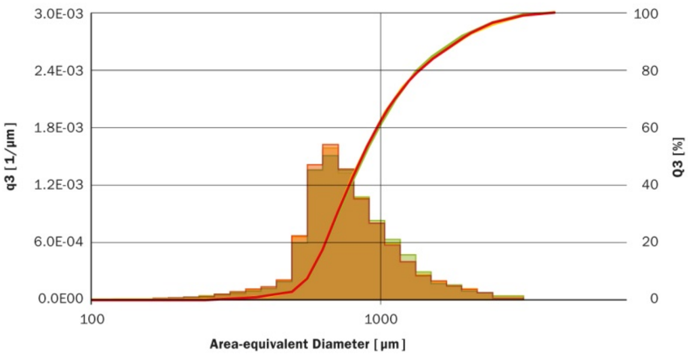
Fritsch GmbH • Milling and Sizing
Industriestrasse 8 • 55743 Idar-Oberstein • Germany
Phone +49 67 84 70 0 • Fax +49 67 84 70 11
info@fritsch.de • www.fritsch-sizing.de

LABORETTE 27 be used, which divides a larger total amount into sufficiently small individual samples with a correspondingly identical, representative particle spectrum.

Evaluation

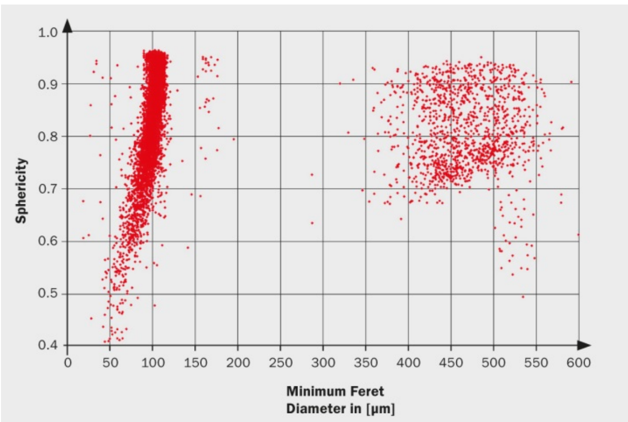
Now what can you do with all these obtained images? Initially of course the particle size can be determined. However here begins the agony of choice: For example during static light scattering only one value is given for the particle diameter, offers an imaging system of course different possibilities to define the diameter of a mostly irregularly shaped particle. Examples for this can be the surface equivalent diameter (the diameter of a sphere, which its cross section displays the same area as the evaluated particle), the diameter calculated from the particle circumference, or the so called Feret diameter, where two parallel lines on opposing sides of a particle are arranged so that they meet the particle, but on no area intersect the particle border.

A decisive advantage of the Dynamic Image Analysis lies of course in the possibility besides the basic determination of the diameter, also obtaining information about the geometry of the particles. As one of the simplest shape parameter, the aspect ratio shall be mentioned here, which is yielded as the quotient from minimum to maximum Feret diameter.

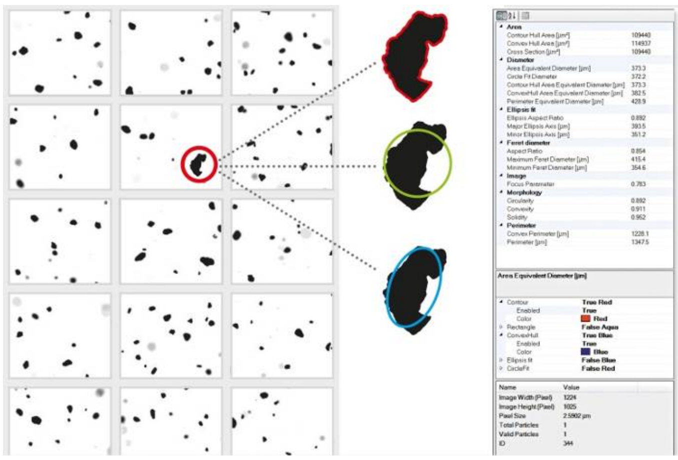


ill. 3: Reliable reproducibility through pixel exact evaluation

With the ImageSizing-Software ISS of the ANALYSETTE 28, it is possible, to generate distributions and correlations in any random combination of particle data clusters. Whether this is only a simple size distribution or the connection between the particle size and the aspect ratio. Such correlations can be displayed simple and fast in a Cloud presentation. Each analysed particle is shown here as a point, its coordinates in the Cloud depend on values of the correspondingly selected parameters.



ill. 4: Minimum Feret - Diameter in [µm]



ill. 5: Single image analysis from the image gallery

Application

And where can all this be applied at now? Generally always when particles are measured which initially can be obtained with the utilised measuring range and which do not agglomerate or stick to the feeder, i.e. all free-flowing, dry and fat-free powers.

Test the FRITSCH Particle Sizers!

Send us your sample for a free of charge **sample measurement** – we will send you a detailed analysis protocol. Compare for yourself!

Up-dated information on FRITSCH particle sizing technology – from Dynamic Image Analysis to Static Light Scattering with videos at www.fritsch-sizing.com.

Author: Dr. Günther Crolly, Product-Manager Particle Sizers, Fritsch GmbH • Milling and Sizing,
E-Mail: **crolly@fritsch.de**, Phone 00 49 06784 70 138