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Scientific

CAMSIZER IIP4
Particle Analyzer

Retsch
TECHNOLOGY

dual camera technology

CAMSIZER IIP4

Particle Size and Particle Shape Analysis with Dynamic Image Analysis

Exact Measurement of Particle Size & Shape with CAMSIZER® P4

The CAMSIZER P4 has been developed to comprehensively characterize dry, free flowing bulk materials. Whereas traditional sieve analysis, for example, can only determine the approximate particle size, the CAMSIZER P4 simultaneously measures both particle size and shape – with much more detail and at a higher resolution.

100% Quality Control

The CAMSIZER P4 is a time and cost-saving alternative whenever continuous quality control of the production process is required. It is also suitable for checking incoming and outgoing goods and generally for measurements of a wide range of different sample materials. The CAMSIZER P4 reliably analyzes all size and shape parameters of a great variety of bulk materials and granulates including spherical and irregularly shaped grains and crystals, spray-dried and fluid bed granular materials, pellets and extrudates.

Thanks to the robust construction and a measuring technique that is not sensitive to disturbances, the CAMSIZER is also suitable for operation under challenging industrial conditions. The analyzer is available as an online version for the continuous monitoring of critical production processes.

Key Features

- Measuring range from 20 µm to 30 mm with no hardware adjustments
- Excellent dynamic range for measuring wide particle size distributions
- High resolution for narrow mono-modal or multi-mode distributions
- Reliable detection of smallest amounts (< 0.01 %) of oversized grains
- Particle shape analysis (e.g. detection of agglomerates, broken particles or contaminations)
- Flexible data evaluation thanks to the particle library and 3D Cloud
- Fully comparable to sieve analysis results
- Excellent reproducibility

Typical Applications

- Abrasives
- Catalysts
- Chemicals
- Coal/coke
- Coffee
- Construction materials
- Fertilizers
- Food granulates
- Glass/ceramics
- Metal powders/silicon granulates
- Pesticides
- Pharmaceutical pellets
- Plastic granulates
- Proppants
- Refractory materials
- Salt/sugar
- Sand
- Washing powder
- Wood chips

CAMSIZER® P4 REPLACES SIEVE ANALYSIS
Faster, more precise, and more information

Results are 100% compatible with sieve analysis

Traditional sieve analysis frequently forms the basis for quality standards and product specifications between suppliers and customers. A rapid and efficient alternative to sieve analysis must take this into account and be able to produce **results that are fully comparable**. This is why the CAMSIZER P4 software is provided with algorithms for emulating sieve analysis.

In this way many users have been able to replace time-consuming sieve analysis by using the CAMSIZER P4 without having to sacrifice familiar quality features. The automated and wear-free measurement means that the results obtained are more reliable and reproducible over time.

Smooth changeover from sieve analysis to CAMSIZER® P4
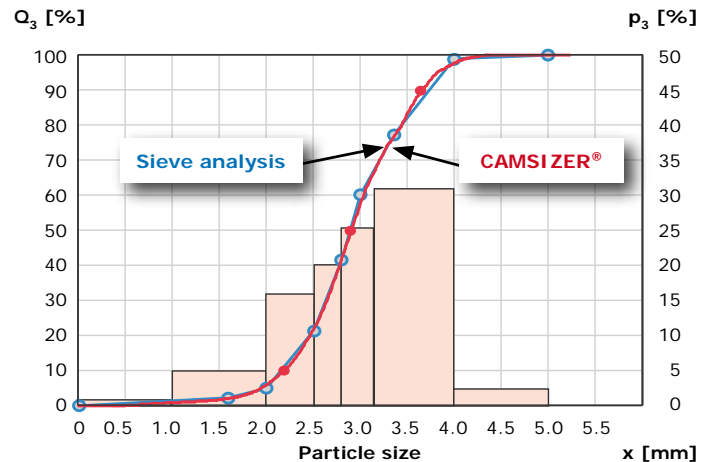
Perfect compliance of sieve analysis and CAMSIZER P4 measurement results for granulated fertilizer.

SIEVE ANALYSIS

✘ MAXIMUM EFFORT

- Assemble sieve stack
- Weigh/tare sieves
- Feed in sample material
- Start sieving
- Weigh fractions
- Evaluate
- Clean sieves

✘ ANALYSIS

- Particle size distribution from few sieve fractions
- Sample fractionation
- High reproducibility
- Established measuring technique

✘ MINIMUM BENEFIT

- Further analysis of individual fractions possible
- Wet sieving possible

CAMSIZER® P4

✔ MINIMUM EFFORT

- Feed in sample material
- Start measurement
- Remove sample material

✔ ANALYSIS

- Detailed particle size analysis
- Simultaneous analysis of particle shape and volume
- Highest degree of accuracy and reproducibility
- Very fast; results in real time
- Avoidance of random errors by extremely simple handling/automization

✔ MINIMUM BENEFIT

- Drastic reduction of workload and time
- Automatic individual evaluation of size, shape, density, transparency and particle number
- Contact-free, non-destructive analysis
- Online measurement for optimum process and quality monitoring
- Self-cleaning and virtually wear-free
- Recalibration is a matter of seconds

dual camera technology
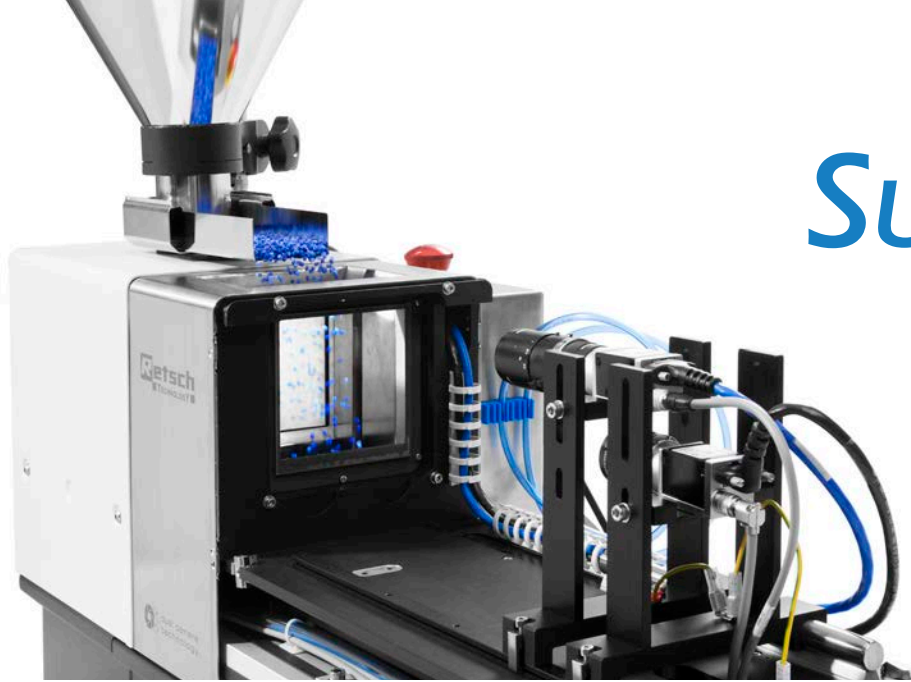
The innovative CAMSIZER P4 measuring system is based on the Dynamic Image Analysis principle. The bulk material falls between light source and cameras. Each particle is detected by the cameras with a high frame rate, and is then digitalized and processed by the connected computer.

Dual Camera Technology

The dual camera system of the CAMSIZER P4 is superior to any other dynamic image analyzer in terms of width of size range, analysis speed, accurate shape detection and resolution. It provides optimized analysis conditions for small and large particles without compromising resolution or detection probability. Therefore, wide range measurements with no hardware adjustments can be reproduced with precision.

The vibratory chute feeds the samples to the CAMSIZER P4 and all particles fall individually through the measurement field. During the measurement procedure the two digital cameras (low noise CCDs) operate simultaneously. The basic camera detects large particles and the zoom camera detects the small ones.

The combination of the varying image scale on each of these cameras allows both small and large particles to be captured at a high resolution. The frame rate and the area where the particles are detected determine the speed in which the particles can be measured.

Long Life Light Source

The high intensity of the CAMSIZER P4's new LED strobe light source (90 Hz) allows for extremely short exposure times and very sharp images with optimum depth of focus and strong contrast. In this way the CAMSIZER ensures precise shape analyses even for very fine particles.

Automatic Hopper Adjustment

The motorized height adjustment of the filling hopper ensures optimum feeding of the sample every time and eliminates manual adjustment steps. This enables the CAMSIZER P4 to provide measurements with excellent reproducibility.

Controlled Sample Feeding

The sample reaches the measurement area via a vibratory feed chute. The speed is controlled by the software, keeping the covered area produced by the particles in the images at a constant level. Instrument contamination is avoided even with very dusty samples.

Certified Calibration Standard

Compatible with national and international standards, and other analytical methods. The CAMSIZER can be recalibrated in seconds by using a high precision reference object made by lithography which produces various particle sizes. This means that the requirements of modern validation testing are fulfilled.

Evaluation and Documentation

A major advantage of the CAMSIZER P4 is the evaluation of the results in real-time. Graphical representation of the results is available while the measurement is still running. At the same time, the measurement process can be checked visually by observing the digital images. All particle images and parameters are evaluated directly during measurement and are also saved to the particle library.

Immediately after the measurement is finished, results can be displayed in various forms. The CAMSIZER P4 is supplied with a powerful, process-oriented control and evaluation software which offers flexible data export to the customer's LIMS. By using the particle library, it is possible to clarify particular questions at a later time.

## Simple and Reliable Operation

The user can easily select individual measurement and evaluation parameters and save product-specific settings. This simplifies the change between different repetitive measuring tasks, also known as standard operating procedures (SOPs). These SOPs can be protected against manipulation by a password that ensures that the same instrument settings and output formats are always used with the highest degree of reliability. This effectively eliminates operator-induced errors.
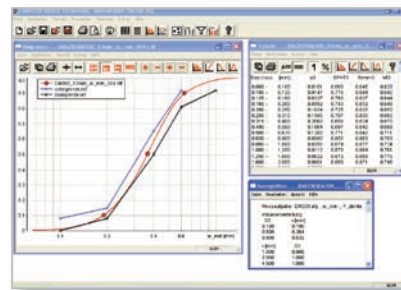
Quality control during measurement
Comparison of the measurement result with upper and lower specification limits

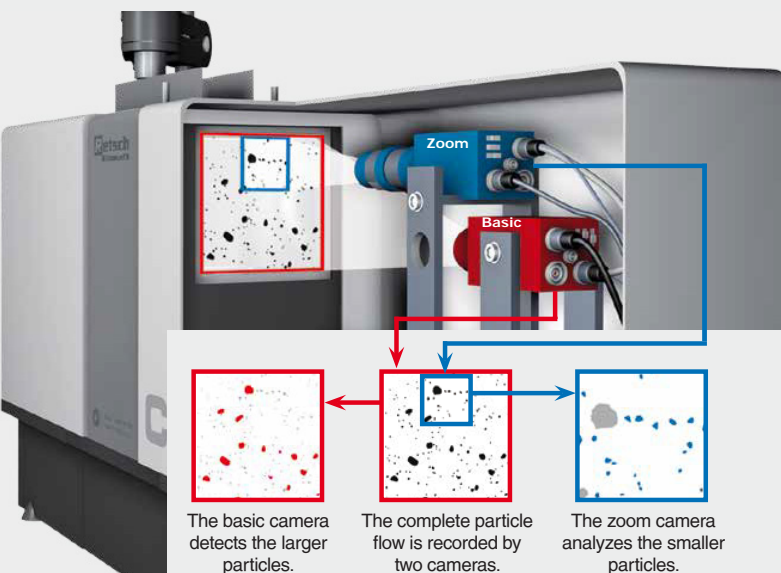**Trend analysis of production processes**
Up to 4 selectable parameters of the sample material can be continuously monitored
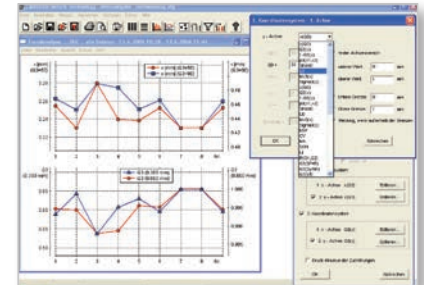
More Detailed Information

Measurement results are displayed as graphics, tables, characteristics, or digital images. The results obtained can be presented graphically and in tabular form as size fractions, frequency distribution, or cumulative distribution. In addition, the CAMSIZER P4 can determine the number of particles in the sample as well as the specific surface area, the density and transparency of the sample material.

The software also allows for daily reports, trend analyses, mean value calculations, and much more. A clear, individually configurable measuring protocol based on international standards is produced for each analysis. It is optionally possible to store product specifications with regards to particle size and shape. If the measurement result deviates, the software automatically produces a warning message.

Particle Shape Applications

Depending on the application, the CAMSIZER P4 measures various areas, perimeters and lengths of the particle projections, determining up to 50 different parameters per particle. Typical results obtained include:

- Chord length
- Straight length
- Feret diameter
- Martin diameter
- Aspect ratio
  (width/length)

- Convexity
- Roundness
- Symmetry
- Transparency
- Angularity

The basic camera detects the larger particles.

The complete particle flow is recorded by two cameras.

The zoom camera analyzes the smaller particles.

NEW: Particle Library and 3D Cloud

The new structure of the CAMSIZER P4 software not only allows for data evaluation in real time but also for the storage of large amounts of image data in the particle library. Particle images with particular characteristics can be extracted from the particle library and displayed or processed off-line.

Similar image libraries are well known from conventional static microscopes which only analyze a few particles at a time. The CAMSIZER P4 particle library, however, handles millions of single particle images incredibly fast!

In addition to the well-known two-dimensional display of results, the CAMSIZER P4 features a new 3D Cloud (3 dimensional graph) which allows for simultaneous display of 3 parameters (for example particle size, aspect ratio, and transparency).

The cloud makes it possible to detect differences between samples which are not visible in a two-dimensional display. In addition, particle groups with specific characteristics can be selected and separately evaluated. Thus it is possible to recalculate, for example, the size distribution of all round and transparent particles in a sample.
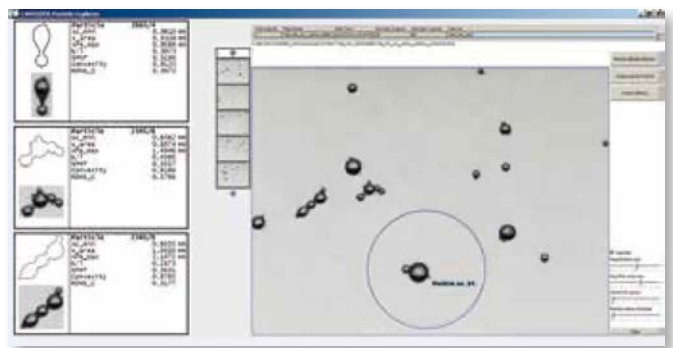
All particle images and corresponding measurement parameters can be optionally stored in the particle library.
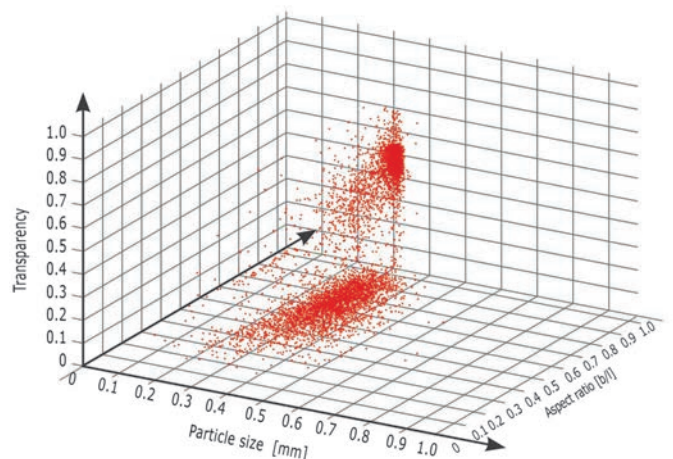
3D Cloud: Display of the 3 independent analysis parameters size, transparency, and aspect ratio for a mixture of road marking materials consisting of irregular shaped, non-transparent anti-skid aggregates and round, transparent glass beads.

CAMSIZER® P4 AutoSampler

When varying sample materials are to be analyzed or repeat measurements need to be carried out, the AutoSampler adapts perfectly. The user simply places a beaker with barcode on the conveyor belt and the software automatically loads the corresponding measurement settings. The sample is fed in by an electro-pneumatic robot arm which lifts the beakers and empties them into the feed hopper. The height of the feed hopper and the speed are automatically controlled. The sample beakers are collected in a container for reuse. The AutoSampler maximizes the benefits with minimal operator intervention.

Barcode Reader Increases Flexibility

The barcode reader ensures that defined instrument and measurement settings (SOPs) are read automatically for all products to be analyzed. Even specific analysis requirements defined by the product identification or batch number can also be carried out automatically. This effectively avoids operator errors and ensures constant measuring conditions for each analysis. The results can be transferred automatically to a laboratory information system (LIMS) via different interfaces.

Modular Design

The CAMSIZER P4 is suitable for both laboratory use and integration into the process line with identical configuration and results. The modular design of the CAMSIZER Online allows for a two step implementation. It is often the best choice to start with the laboratory instrument and upgrade to the online version as a next step. In the online system, the CAMSIZER is integrated into an industry standard housing with IP 54 protection and automatic cleaning options. The housing is mounted on vibration absorbers to avoid any influence from vibrations. Using available interfaces, it is possible to connect to process control systems, internal networks and transfer measurement data to almost any LIMS.

Process Integration

For online analysis, a representative sample of the bulk is taken out of the process and delivered to the CAMSIZER. The measurement can be automatically started by the system and results are available at the measuring station. Immediately after measurement is completed, the next batch is automatically transferred and analyzed. Thus, an up-to-the-minute status is available at all times, which guarantees uninterrupted quality control. The process parameters can then be continuously optimized through a control circuit so that production can react quickly. The components for the automatic feeding system can be designed and manufactured together with local specialists to meet customer's requirements.

Schematic diagram showing the inclusion of the CAMSIZER P4 in a continuous quality monitoring system.

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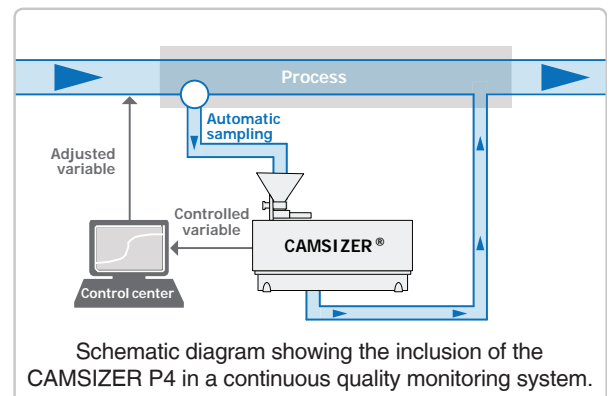
CAMSIZER® P4 ACCESSORIES

Push-fit Feed Chutes

The flow behavior of the sample can be considerably improved by a favorable choice of feed chute surface material and shape. Feed chutes made from high-quality stainless steel are used as standard. Cohesive materials such as coffee or cocoa can be fed uniformly and continuously. The push-fit attachment means that the feed chute can be exchanged within a few seconds whenever necessary. Chutes with different widths are available to effectively feed different sized particles.

Feed Hoppers

Different hopper sizes are available for different sample volumes. Hoppers can be supplied with a capacity of 0.5, 2.8, 3.5, and 7.8 liters. For optimum sample feeding these hoppers are available in different materials and with different coatings (stainless steel, hard-coat aluminum, etc.) just like the chutes.

Feed Guides

The use of a feed guide ensures that even the finest materials fall through the focusing range of the cameras without any unwanted turbulence. This assures that the particles can be measured accurately.

For special applications, a patented motorized feed guide is available to preferentially orient the particles. For example, this allows the precise and direct measurement of both the length and diameter when analyzing extrudates. The specially developed motion mechanism allows for perfect alignment without any sample blockage. The motorized feed guide is also suitable for fully-automated online applications.

Rapid Analysis of Representative Samples

The sample volume required for a measurement can vary between a few grams and several kilograms and depends on the mean particle size and the width of the particle size distribution. If the particle sizes are small and the distribution is narrow, small quantities are already sufficient. However, if samples such as ore or sand contain particle sizes of a few centimeters, it might be necessary to h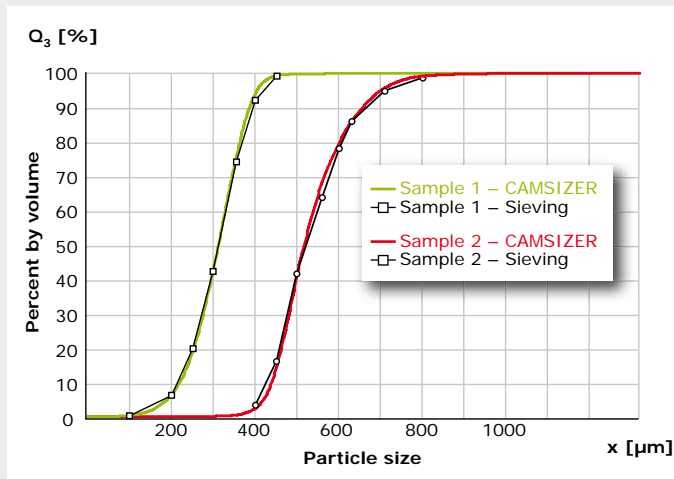ave 5 liters or more of the material to ensure a representative measurement. The CAMSIZER P4 can be easily adapted to a variety of applications thanks to a wide selection of hoppers and feed chutes. The average measuring time is 3 minutes, depending on the sample material. With the CAMSIZER P4, close monitoring of the production process is ensured at all times.

KEY FEATURES

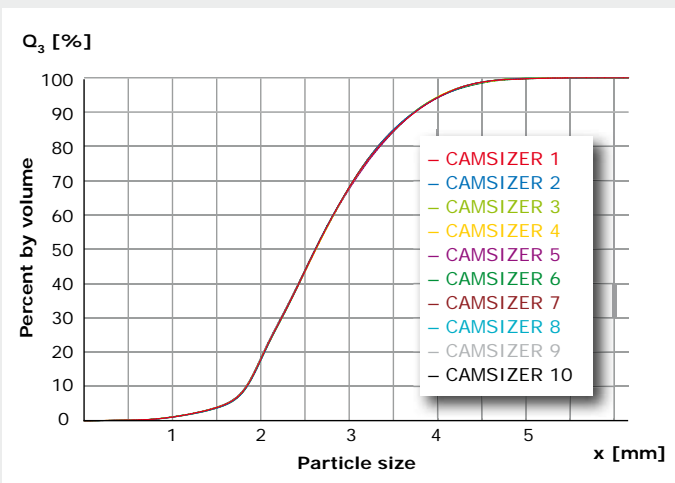## Results 100% Compatible with Sieve Analysis

Example sugar: Crude sugar is sieved into different size classes, depending on the final product. Powdered sugar, granulated sugar or special mixtures, e.g. for bakeries or beverage production are typical examples. As the CAMSIZER P4 measurement results perfectly match those of sieve analysis, product specifications of producers and customers can be directly compared, despite different measuring methods. The CAMSIZER P4 allows for the monitoring of wear (rips) of the production sieves and for analyzing the mixture during loading of trucks. Thus, the quality of each delivery is controlled and costly reclamations are avoided.

Q_3 [%]

Percent by volume

- Sample 1 – CAMSIZER
- Sample 1 – Sieving
- Sample 2 – CAMSIZER
- Sample 2 – Sieving

Particle size

x [µm]

Excellent Reproducibility

Example fertilizer: For many companies a consistent quality control process is of great importance, particularly if the production sites are located globally. Thanks to easy operation and extensive automation, the CAMSIZER provides perfectly reproducible results, even at different production sites. In round robin tests the CAMSIZER outperforms other methods, for example sieve analysis, partly due to the easy, quick and accurate calibration of the instrument.
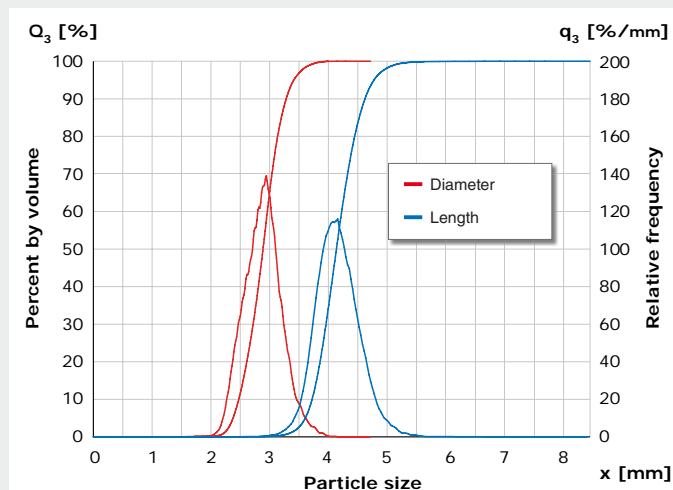
The graphic shows the excellent instrument-to-instrument agreement: 10 measurements of the same fertilizer sample with 10 different CAMSIZER systems. The curves perfectly match each other.

Q_3 [%]

Percent by volume

- CAMSIZER 1
- CAMSIZER 2
- CAMSIZER 3
- CAMSIZER 4
- CAMSIZER 5
- CAMSIZER 6
- CAMSIZER 7
- CAMSIZER 8
- CAMSIZER 9
- CAMSIZER 10

Particle size

x [mm]

Determination of Length & Diameter

Example transparent plastic granulate:
Thanks to a new brighter light source and cameras with higher resolution, transparent particles can be captured with excellent contrast, permitting accurate and precise detection.

Diameter

Length

Q_3 [%]

q_3 [%/mm]

Percent by volume

Relative frequency

- Diameter
- Length

Particle size

x [mm]

Roundness and Sphericity According to Krumbein and Sloss

Example Sand and sediments: The roundness of sand and sediments is commonly determined in geological analyses, for example in the oil and gas industry. In co-operation with the University of Leuven and SCR Sibelco NV, Retsch Technology developed a new algorithm that provides automatic, statistically reliable and fully objective roundness and sphericity of particles. The new parameters roundness and sphericity are related to the work of Prof. Wadell and Prof. Krumbein from 1932 to 1965 which is still the basis of today's ISO 13503-2 or API RP 56/58/60 standards. The new algorithm generates identical values when compared to the previous, time-consuming manual analysis method. This has been tested on hundreds of samples.

Chart for visual inspection of Roundness and Sphericity according to Krumbein and Sloss
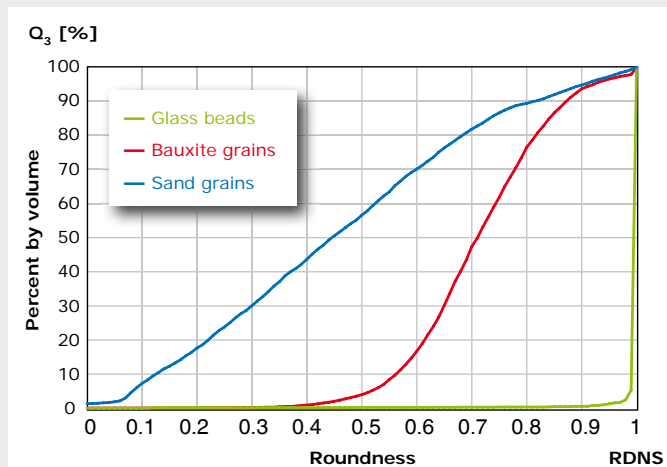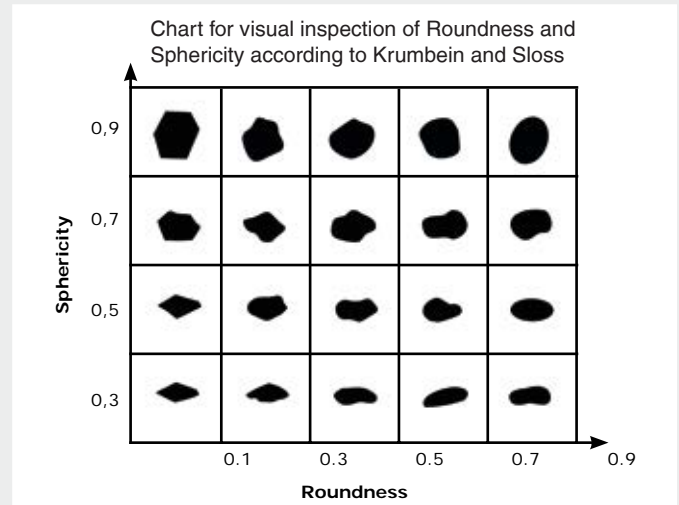
**Comparison of the angularity of 3 samples:** Almost perfectly round glass beads (green), industrially manufactured bauxite grains (red), and natural sand grains (blue). The roundness and sphericity of the glass beads lies above 0.9 which corresponds to the particles in the upper right corner of the Krumbein table. The bauxite grains are clearly more angular with a mean roundness of only 0.7. The sand grains come in a variety of shapes, ranging from angular to round.

Fast and Reliable

Example pharmaceutical granules and pellets: The CAMSIZER P4 is highly suitable for the characterization of the growth of granules, pellets or globules. Parameters such as mean particle size, distribution width, sphericity, transparency or surface roughness are typical examples. They promote information about the thickness and homogeneity of coatings during fluid bed granulation, or the percentage of dust or oversized grains (agglomerates). Complex parameters such as the time of release of drugs inside the human body can be predicted with these results.

The CAMSIZER P4 is used for fast and precise monitoring of the API products. It allows for optimum setting of the process parameters, thus saving time and money. The example shows the original material as well as 4 coating steps (2 measurements of each).
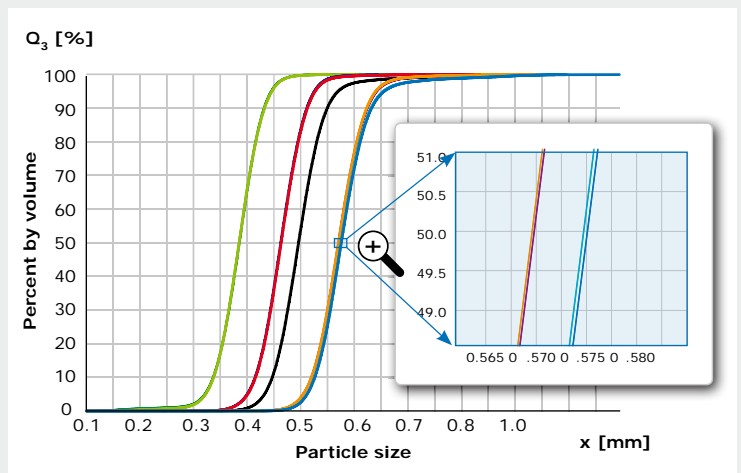
Even the layer thickness of the last process step, which is only 2.5 μm, is safely detected thanks to extremely good reproducibility. The CAMSIZER P4 can be validated according to GLP/GMP and can be optionally operated with a 21 CFR part 11 compliant software.

Quality Control of Particle Size and Shape

Example glass beads: Glass beads are used for a great variety of applications. They are added, for example, to paints used for road and airport markings to guarantee high retro-reflectivity at night and when the road or airport runway is wet. The size and shape of the glass beads are essential to ensure that the headlight is reflected directly back to the driver or pilot.

The graphic shows the measurement of the sphericity of glass beads. At least 80% of the beads need to be spherical to fulfill the high quality standards for retro-reflectivity.
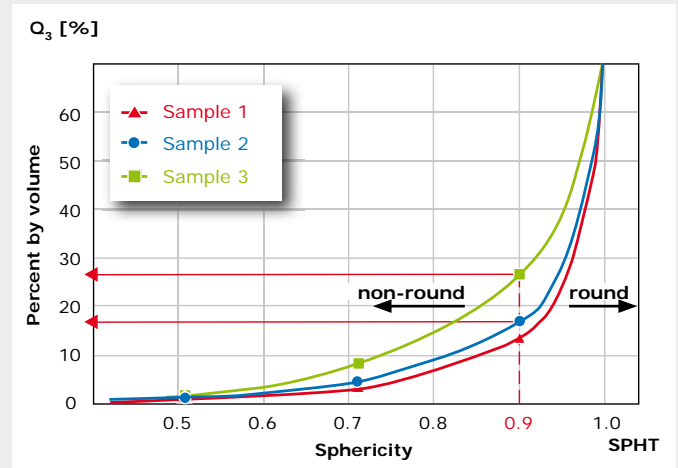
Old Analysis Specifications – New Method – Identical Results

Width/Length = 0.507
Sphericity = 0.779

Width/Length = 0.961
Sphericity = 0.993
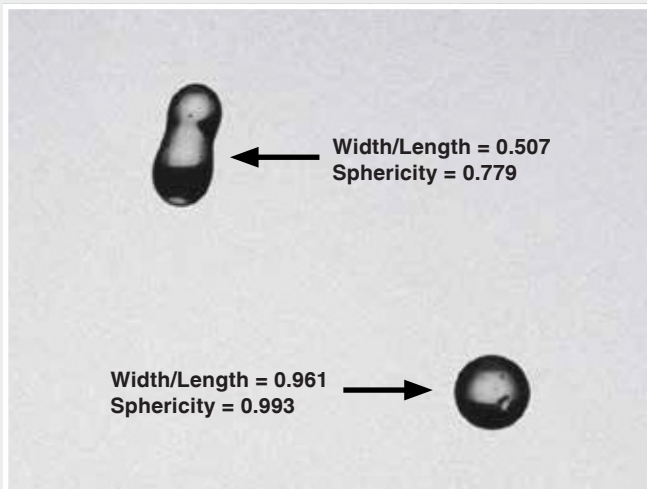
Example glass beads: The quality control of glass beads used in road markings is stipulated in standards ISO 1423 and ASTM D1155. The measurements are rather time-consuming, only a small number of beads are analyzed (poor statistics) and the results strongly depend on the instrument operator.
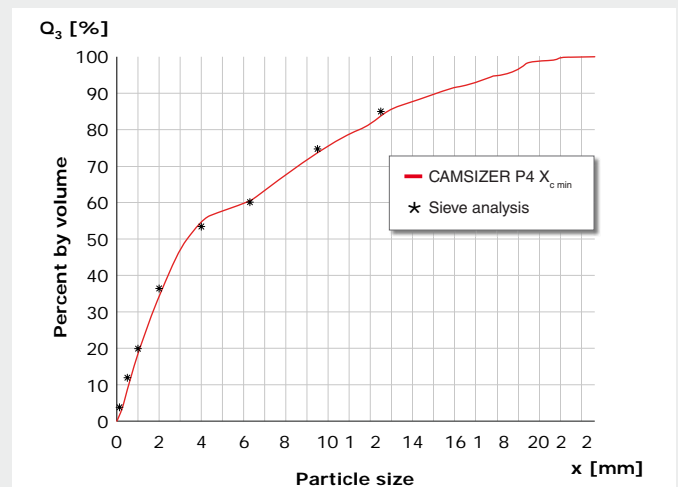
The CAMSIZER P4 allows for automated measurement of both particle size and particle shape. The measurement results can be validated against the methods described in the industrial standards, making the time-consuming manual methods obsolete.

The CAMSIZER P4 provides identical results – but faster, with considerably improved statistics and better reproducibility because it is user-independent.

Extremely Wide Particle Size Distribution

Example refractory raw material: The CAMSIZER P4 provides precise measuring results even for samples with an extremely wide size distribution and a high fines content. It is also possible to produce results which are identical to those obtained by sieve analysis.

Thus, the CAMSIZER P4 can replace this labor intensive method in the laboratory without the need to redefine product specifications.

Technical Data

CAMSIZER® P4

Measuring Range	Recommended range 20 µm to 30 mm (with no hardware adjustment)
Parameters	Particle size, shape, density, transparency and number
Measurement	60 images/s with more than 1,300 pixels each (corresponds to more than 78 million pixels per second)
Measuring Time	Approx. 1 to 3 min (depends on required measurement statistics)
Instrument Data	Dimensions (H x W x D)	Approx. 650 x 850 x 350mm
	Weight (without PC)	Approx. 40 kg

The CAMSIZER P4 is CE-tested and follows the relevant guidelines and standards. It can be supplied with software complying with FDA rule **21 CFR Part 11**.

Compressed Air Supply	6-8 bar	
Compressed Air Consumption	Max. 10 l/min	
Instrument Data	Dimensions (H x W x D):	Approx. 900 x 1450 x 490mm
	Weight:	Approx. 60 kg
Sample Feed	Control of the conveyor belt by light beam interruption during sample container positioning, sample feed by electro-pneumatic robot arm, emergency stop-button	

The AutoSampler is CE-tested and complies with the relevant guidelines and standards.

CAMSIZER® P4 Online

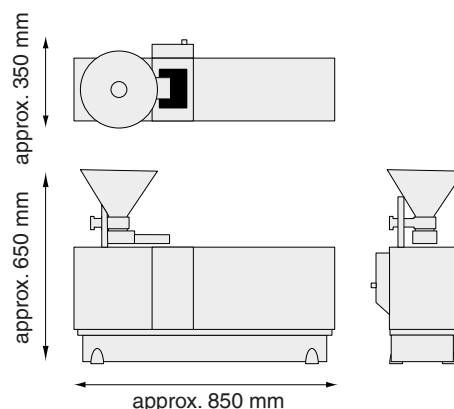|		
Measuring Data	see CAMSIZER P4	
Working Range	Temperature range -20 °C to +50 °C (air-conditioned), (-5 to +120 °F) enclosed for rough surroundings by housing (IP 54), shock and vibration-absorbing installation	
Instrument Data	Dimensions (H x W x D):	Approx. 800 x 1600 x 600 mm
	Weight:	Approx. 250 kg
	Compressed Air Supply	4-8 bar
Interfaces	Ethernet, Profibus, various digital and analog contacts and signals (e.g. 4-20 mA)	

Fields of Application

Scope and Purpose	Rapid and exact particle size and shape analysis of all dry, flowable bulk materials and powders
Sample Material	f. ex. abrasives, catalysts, chemicals, coffee, construction materials, coal/coke, fertilizer, food granulate, glass/ceramics, metal powders/silicon granulate, pesticides, pharmaceutical pellets, plastic granulate, proppants, refractory products, salt/sugar, sand, washing powder, wood chips etc.
Operating Sites	Factory laboratories, research institutes, locations close to the production line as well as online for optimal quality control of products and processes

CAMSIZER® P4 at a Glance

With more than 1000 installations, the CAMSIZER is the most successful particle size analyzer using Dynamic Image Analysis. It is not only characterized by precision, robustness and convenient operation but also by its wide measuring range from 20 µm to 30 mm. The patented 2-camera principle provides an unrivaled combination of high measuring speed with high resolution, making the CAMSIZER P4 indispensable for a great variety of applications. The almost 100% comparability to the results of sieve analysis allows for a smooth transition to this new method without the need to introduce new particle size specifications.

Thanks to easy operation and short measuring times, the use of the CAMSIZER P4 not only reduces the labor costs of the laboratory, but also helps to monitor and optimize the production process. More accurate and faster analyses of particle size and shape improve the product quality, reduce rejects, and saves both energy and raw materials.

The main areas of application of the CAMSIZER P4 are quality control, research and production monitoring. Together with solutions for the partial or complete automation of the measuring process, a continuous sample analysis process can be realized in an economically efficient way.

approx. 350 mm
approx. 650 mm
approx. 850 mm

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