PRODUCTION CONTROL OF POLYSTYRENE BEADS USING DIGITAL IMAGE ANALYSIS

Expanded polystyrene (EPS) can be found in many areas of our daily lives due to its unique properties. It is used for thermal insulation and noise dampening in building construction and for the manufacture of packaging for foodstuffs. The particle size of the EPS spheres ranges from 0.1 to approximately 3 millimeters.

Introduction

Pressure to reduce the manufacturing costs of chemical starting products increasingly forces the manufacturers of these materials to a highly specialized production and quality control system. Monitoring a product's physical properties, like particle size distribution, is of outstanding importance.

This property is, in many cases, crucial for the usability or the processibility of the product, and often defines whether the product is accepted or rejected. The following example of expandable polystyrene (EPS) manufacture shows how the use of the CAMSIZER® digital image analysis system can achieve production optimization.

A basic requirement for most applications is that the particles have a defined particle size distribution in order to obtain a product-specific density or to ensure that the end product has an accurate shape.

Manufacturing Method

EPS is manufactured from an aqueous suspension by polymerization and is fractionated when the manufacturing process has been completed. The product flow is fractionated by sieves that divide the product flow into the required size fractions, which are assigned to particular applications.

The coarse fractions are frequently used in the thermal insulation sector as they can be used for low density products. The fine fractions are used for molded parts, as the smaller particle sizes allow smoother surfaces and a more accurate fit.

The rapid recognition of tears in the sieves is of paramount importance. These occur as the result of mechanical stress on the sieve fabrics and are indicated by a continuous increase in the numbers of coarse particles in the individual fractions.

If this problem is not recognized in time, the product must either be fractionated again, if possible, or sold as poorer quality for a lower price. The large number of samples being processed means that conventional sieving is too time consuming and too cost intensive.

Sieve analysis includes, preparing and weighing the sample, the sieving time itself, weighing and recording the fractions, and also must include the time required for sieve cleaning and result calculation. Also, the larger EPS particles in each fraction can blind the sieves and must be removed by hand. All of this can be very time consuming. The CAMSIZER®, distributed by Horiba Instruments, is an alternative measuring procedure which analyzes the particles by image analysis.

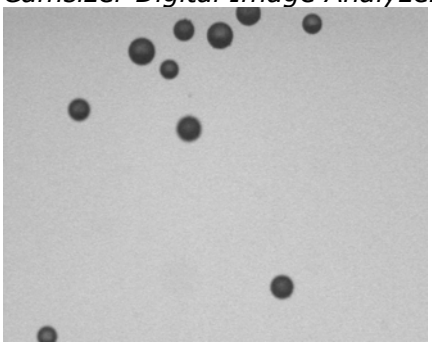
Applications Note

Polymer Beads

Measuring principle

The polystyrene spheres are fed into the measuring chamber by a sample funnel and a vibratory feeder. The particles fall in front of a light source and produce shadows (see illustration) that are recorded by two high-resolution digital matrix cameras. The software simultaneously determines the size distribution and shape of the particles.

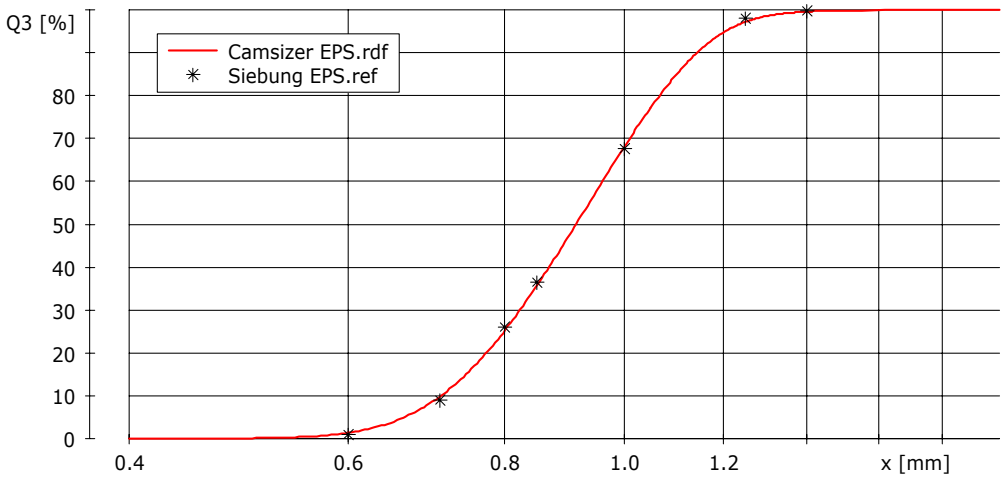
Camsizer Digital Image Analyzer



Particle Image Captured by the Camsizer

Several hundred thousand particles can be measured in a single run so that a high degree of statistical certainty is achieved in the results. The patented two-camera technology allows a measuring range between 30 µm and 30 mm without any adjustments to the optical system.

The software allows the user to achieve results that closely correlate to sieve analysis. The agreement between the CAMSIZER® results and sieve analysis is shown in the following illustration.



Results of EPS measurement by sieve (black stars) and CAMSIZER® (red line)

The particle size range of the material shown above is from 0.5 mm to 1.5 mm. The sieving results are shown as black stars. Agreement between the two analytical methods is excellent.

Benefits of Modern Measurement Techniques

The close agreement means that specifications that have previously been determined by sieve analysis can still be utilized. In many cases these specifications still form the basis of the quality checks carried out by the manufacturer and the customer.

Where sieve analysis allows a maximum of 10 fractions, the CAMSIZER® provides a high-resolution measurement of the entire particle size distribution in 1000 size classes. This also permits the opportunity to study the particle size distribution between the conventional sieve cuts.

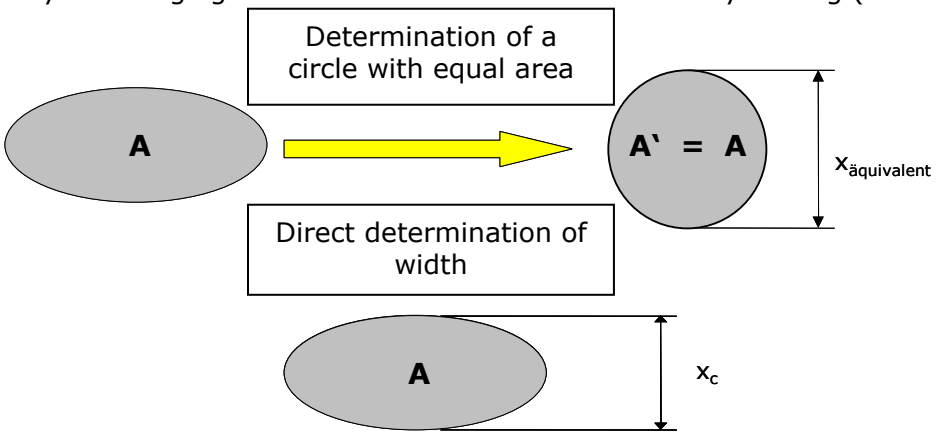
Conventional particle measurement systems evaluate each particle as if it were a perfect sphere. However, if the particle shape is not exactly spherical, this leads to differences from the sieving results. In this case the particles are interpreted as being larger than they actually appear from sieving.

In contrast, the CAMSIZER® software, using the minXc model, determines the minimum chord of the particles, and therefore the dimension which passes through the sieve.

Beyond the standard measurement software, the CAMSIZER® program offers built-in trend analysis. In addition, the result files can be automatically exported in ASCII or MS-Excel formats, giving the user a wide range of possibilities for making individual presentations.

Rapid calibration of the instrument can be performed with a calibration reticle. Calibration results can be printed out for documentation of internal quality procedures.

In most traditional measurement methods, evaluation is made by assuming all particles are spherical (equivalent spherical diameter). However, if the particle shape is not spherical, the diameter of the particle will be interpreted as being larger than it actually is. The result is that the determined results are coarser than those of obtained by sieving (upper illustration).
In contrast, the CAMSIZER® software determines the smallest diameter (width) of the particle. This corresponds to particles actually passing through the sieve mesh. In this way the imaging results correlate to those obtained by sieving (lower illustration).



Applications Note

Polymer Beads

For production facilities the CAMSIZER® has considerable advantages when compared to other measuring systems:

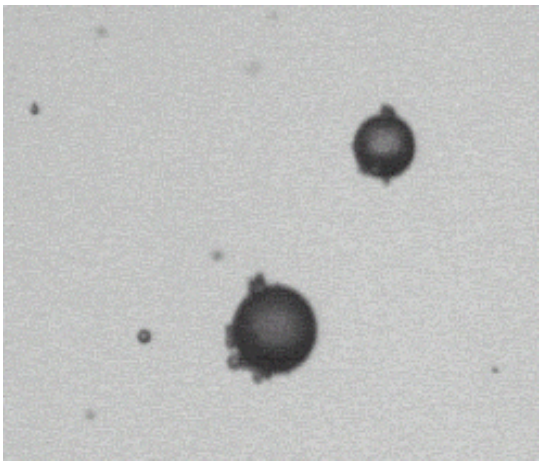
- Shorter measurement times mean workload and related costs can be considerably reduced
- New presentation of measurement results, using different size classes, is possible at any time without making a new measurement
- The CAMSIZER® system is maintenance-free
- The measured sample can be recovered
- Operation can also be carried out by semi-skilled personnel
- Security is guaranteed through multi-level password protection

Summary

For free-flowing materials in the range of 30 µm to 30 mm, the CAMSIZER® represents a superior alternative to traditional particle size analyzers. The measurement system is greatly suitable for use in production, as it guarantees rapid measurements, simple operation and robustness to vibration and dust. Recognition of reject material, from the determination of the altered particle size distribution or altered particle shape, guarantees comprehensive quality monitoring. Apart from carrying out these routine checks, the CAMSIZER® is also suitable for sophisticated analyses in the R&D sector.

Additional uses of particle shape analysis

In addition to particle size analysis, the CAMSIZER® simultaneously determines particle shape. This offers considerable advantages, even for particles with a high degree of roundness. Calculations for roundness, symmetry and aspect ratio allow certain particles to be filtered out from the measurement and ignored. Frequently, with electrostatically charged materials (see illustration), incorrect results can be caused by agglomerated particles. As the adhesion of smaller particles to larger particles results in a reduced



roundness, this condition can be effectively monitored and non-round particles removed from the data.

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