Understanding the Shape Parameters Reported by the CAMSIZER

The CAMSIZER dynamic image analysis system reports distribution information on both the particle size and shape of a powder sample. Particle shape can be defined using a variety of calculations expressing different morphological characteristics. This technical note describes the various shape parameters reported by the CAMSIZER.

Introduction

Particle size analysis has become a routine step of the production process in many industries. In addition to measuring the size of a particle, shape analysis has become just as important in quality control, as it may have a huge influence on certain product characteristics. For example, flow behavior or abrasion can radically draw on flaws in the production process.

The knowledge of the particle shape facilitates the understanding of product characteristics, optimizes production processes and minimizes production costs. For that reason it is very important to have a convenient, reliable and fast particle analysis, so that you can have an immediate influence on the current production.

Measuring techniques

Particle shape can be measured using automated image analysis techniques that, in contrast to manual analysis techniques like microscopy, generate statistically relevant data. Due to the fact that image analysis can create number related distributions, it is also applicable for very small samples with very fine particles. The possibility to visually analyze the particles via the images from the camera additionally allows the user to easily identify agglomerates and contaminants that are automatically detected with the CAMSIZER.

Digital image processing in the CAMSIZER is done by recording particles that cast shadows from a light source with two CCD cameras, as shown in Figure 1. These images are then analyzed and particle shape parameters are displayed as defined numeric values. These values refer to defined parameters that describe different particle shape characteristics.

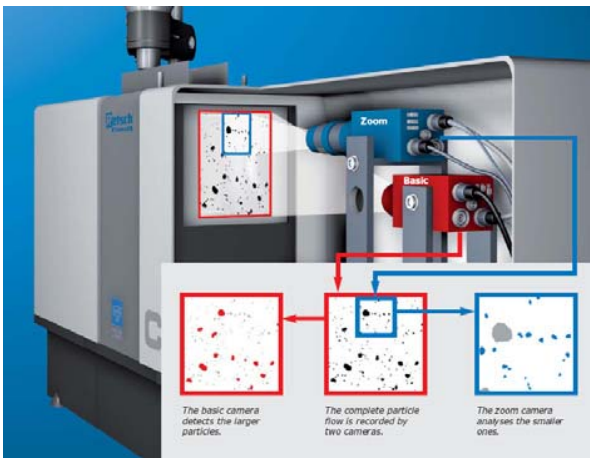


Figure 1: CAMSIZER configuration

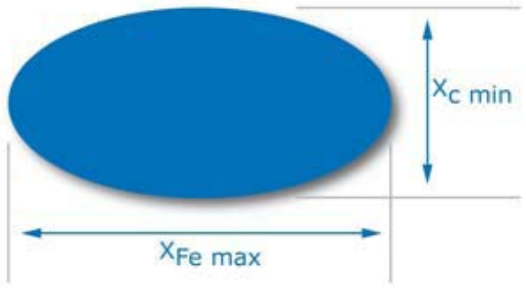
Shape Parameters

The following four particle shape parameters are most commonly used to define the morphology of powders analyzed by the CAMSIZER.

Elongation; Width / Length Ratio:

$$\frac{x_{c\min}}{x_{Fe\max}}$$

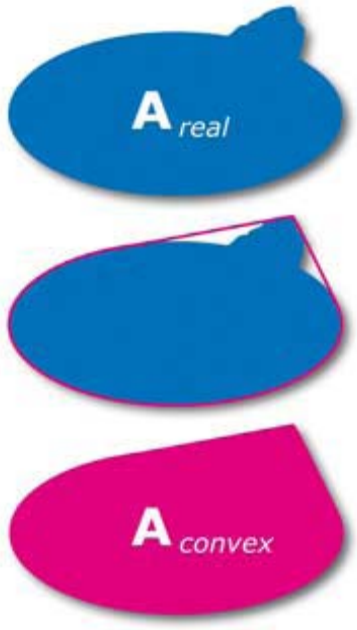
The elongation describes the ratio between the breadth and the length of a particle projection. Here, $x_{c\ min}$ corresponds with the width, while $x_{Fe\ max}$ is the maximal expansion of the particle. Globular particle images have an expansion near one; highly acicular particles have an expansion near zero. Therefore, this parameter gives a hint on the macro shape of the particle itself.



Convexity:

$$\sqrt{\frac{A_{real}}{A_{convex}}}$$

The convexity describes the surface properties of a particle and can be calculated by dividing the real projection area by the area of the "convex shell". The "convex shell" can be described best through an imaginary elastic strap that is wrapped around the particle. A smooth surface where all concavities are filled, for example, has a convexity value near one, while particles with an uneven or rough surface would reach a lower value.



Roundness, Sphericity:

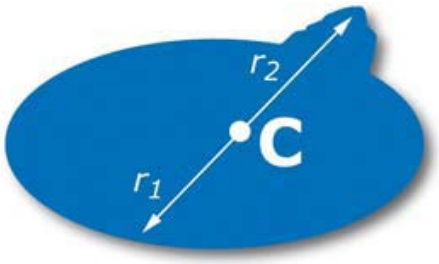
$$\frac{4\pi A}{P^2}$$

The roundness describes the ratio between the area of a particle image and the perimeter. Therefore, a globular particle would have a roundness near one, while an irregularly jagged particle has a lower roundness value. This form parameter is very important for quality surveillance, especially when the obtained particles need to be as round as possible.

Symmetry:

$$\frac{1}{2}\left(1+\min\left(\frac{r_1}{r_2}\right)\right)$$

The first step to determine symmetry is to define the center of the particle (C). Then lines are drawn in every measurement direction from particle edge to edge through the center. Afterwards, the ratio of the resulting segments (r_1 and r_2) is determined. The value for symmetry is calculated from the smallest of these ratios. For highly symmetrical particles like circles, ellipses or squares the value for symmetry nears one. Symmetry is a perfect parameter to define the amount of broken particles within a sample.



Conclusions

All of the parameters described in this document can be used to define the shape of particles analyzed by the CAMSIZER. The challenge of the user is often to connect the proper shape parameter with product quality or performance. The HORIBA applications team is always available to help customers properly interpret these results.

For further information on this document or our products, please contact:

HORIBA Ltd.
2, Miyanohigashi, Kisshoin
Minami-Ku Kyoto 601-8510 Japan
+81 75 313 8121

HORIBA Scientific
34 Bunsen
Irvine, CA 92618 USA
1-888-903-5001

HORIBA Jobin Yvon S.A.S.
16-18, rue du Canal - 91165 Longjumeau
France
Tel. +33 (0)1 64 54 13 00

www.horiba.com/us/particle
labinfo@horiba.com