CAMSIZER®
Dynamic Image Analysis
ISO 13322-2 conform

Catalyst Beads, Powders, Extrudates
Presentation

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Catalysts
CAMSIZER & CAMSIZER XT
Benefits for the Catalyst Industry using the CAMSIZER®

• Instead of size measurement with sieve shaker or roller grader and shape analysis by visual inspection you can do a CAMSIZER analysis of both in a much shorter time (reduce labour costs and get better results)

• Reproducible results because of high statistics and accurate calibration (less headaches)

• Measuring easily in compliance of specifications of grain size, oversize and dust (<0.1%), roundness and sphericity and measure the dust content before and after a crush resistance test

• Measure the increase of layer coating thickness of noble (precious) metals and change of roundness because of the layer coating of Al₂O₃, SiO₂ or ceramic catalyst carriers

• Additional benefit: Measuring different diameters and length of extrudates
Measuring Principle
CAMSIZER for Extrudated Catalysts

Measuring Principle

Feeder

CCD-Basic-Image and Particles

Falling direction
Evaluation of the Results
Two-Camera-System

Measuring Principle

Basic-Camera

Zoom-Camera
Particle Size

- $x_{cmin}$ “width”
- $x_{area}$ “diameter over projection surface”
- $x_{Fe\ max}$ “length”

CAMSIZER results are compatible with sieve analysis.

$A' = A$
Comparison of Size Definitions

Different size definitions → Different results

\[ x_{\text{c min}} \leftrightarrow x_{\text{Area}} \leftrightarrow x_{\text{Femax}} \]
Ellipsoid model leads to better results

\[ V_{\text{ellipsoid}} = \frac{\pi}{6} \cdot x_{Fe} \cdot x_c^2 \]

Ellipsoid model leads to better results
Roller Graders
See and Show Small Differences (Product 1, 2 and 3)
See and Show
Small Differences (3, 4, 5 and 6)
CAMSIZER
for elongated particles (extrudates)
Measurementg Results

Length and Width definitions for elongated extrudates

![Graph showing Q3 [%] vs x [mm] and q3 [%/mm] for CoMo2-0.1%Absch_xc_min_001.rdf and CoMo2-0.1%Absch_xFemax_001.rdf]
Particle Size of Extrudates

\( x_{length} = \sqrt{\left(x_{Fe\ max}\right)^2 - \left(x_{Ma\ min}\right)^2} \)

\( x_{stretch} = \frac{A}{x_{Ma\ min}} \)

Limits \( x_{length} > x_{Ma\ min} \)

Limits \( x_{stretch} > x_{Ma\ min} \)

\( x_{Fe\ min} \)

\( x_{c\ min} \)

\( x_{Ma\ min} \)

\( x_{Fe\ max} \)

\( x_{length} \)

\( x_{stretch} \)

\( A/2 \)

\( A \)

\( A/2 \)

\( x_{length} \) is the best length for extrudates
Particle Size of Extrudates

\[ X_{\text{Fe min}} \]

\[ X_{\text{C min}} \]

\[ X_{\text{Ma min}} \]

\[ X_{\text{Fe max}} \]

\[ X_{\text{stretch}} \]

\[ X_{\text{Ma min}} \text{ is best diameter for extrudates} \]

\[ \frac{A}{X_{\text{Ma min}}} \]

area / diameter
Diameters and Length
Quadralobes

Extrudate Diameters

Extrudate Length

L

CoMo2-Diameter_xc_min_001.rdf
CoMo2-Length_xFemax_001.rdf
CAMSIZER® length definitions for elongated particles (extrudates)

\[ \text{length} = \sqrt{X_{\text{Fe max}}^2 - X_{\text{Ma min}}^2} \]

\[ \text{stretch} = \frac{A}{X_{\text{Ma min}}} \]
CAMSIZER® length definitions for elongated particles (extrudates)

\[ X_{Fe \ max} = X_{Ma \ min} \]

\[ X_{Fe \ rec} = X_{length} \]
Reference Particles

Calibration validation with steel rods of the same dimensions as particles
Reference Particles
Reference Particles
CAMSIZER for Extrudated Catalysts

Feeder

CCD-Basic-Image and Particles

Falling direction
CAMSIZER for Extrudated Catalysts

Feeder

Motorized Feed Guide orients the extrudates

CCD-Basic-Image and Particles

Falling direction
Length + Diameter of Implants

Length measurement \( x_{\text{length}} \sim 26\text{mm} \)
Diameter measurement \( \varnothing \sim 0.85\text{mm} \)

validation and test
1. with plastic and
2. steel cylinders

measurements of produced implants (release time 1 month)
CAMSIZER® width definitions for elongated bended extrudates
Diameter 1 ~ \( x_{\text{max} 1} \), Dia 2 ~ \( x_{\text{max} 2} \)

\( x_{\text{max}} \) = volume based  
Dia = number based

Quadralobes
It's possible to recalculate the height from the width and the diameter of an equilateral trilobe (one peak in the $q_3$ frequency distribution). For this you need the width (result of mode value $x_{\text{max}}$) and the diameter of the lobes. It's also possible to see the height on the left side of the distribution at about $x(Q_3=0.5\%)$.

\[
\begin{align*}
\sin 60^\circ &= ih/iw \\
\sin 60^\circ &= ih \\
\sin 60^\circ &= (w-d) \\
\sin 60^\circ &= w \\
h &= w \cdot 0.866 - d \cdot 0.866 + d \\
h &= w \cdot 0.866 + d \cdot 0.134
\end{align*}
\]
Irregular Trilobes

\[ sh = sih + d \]
\[ lw = liw + d \]
\[ sw = siw + d \]

\[ siw^2 = sih^2 + \left( \frac{liw}{2} \right)^2 \]
\[ sh = \sqrt{siw^2 - \left( \frac{liw}{2} \right)^2} + d \]
\[ sh = \sqrt{(sw - d)^2 - \left( \frac{lw - d}{2} \right)^2} + d \]

It’s possible to recalculate the height from the width and the diameter of a non equilaterial trilobe (two peaks in the q3 frequency distribution). For this you need the result values of the two peaks and the diameter of the lobes.
length measurement methods
without and with motorized feed guide (sample director)

Without Guidance Sheet

With Guidance Sheet

length measurement
for non orientated minipellets

correct length
short length

length measurement
for orientated rods + extrudates

correct length

Without Guidance Sheet

With Guidance Sheet
Length measurement
without guidance sheet (sample director)
CAMSIZER® length measurements for elongated particles (extrudates)

\[ X_{\text{length}} = \sqrt{X_{Fe \text{ max}}^2 - X_{Ma \text{ min}}^2} \]

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a VERDER company
Length Measurement
without feed guide (sample director)

Right side of distribution

Correct length

Short length

Characteristics of measurement:

<table>
<thead>
<tr>
<th>Measurement</th>
<th>160H</th>
<th>200H</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q3 [%] at x=100 mm</td>
<td>0.91</td>
<td>1.01</td>
</tr>
<tr>
<td>Q3 [%] at x=200 mm</td>
<td>2.526</td>
<td>3.424</td>
</tr>
<tr>
<td>Q3 [%] at x=400 mm</td>
<td>2.565</td>
<td>3.626</td>
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<tr>
<td>Sigma3 [%]</td>
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<td>0.39</td>
</tr>
<tr>
<td>U3</td>
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Shape Measurement

Sharp ⇔ Rounded
Particle Shape

- **width/length = aspect ratio**
  \[
  \frac{x_{c \text{ min}}}{x_{\text{Fe max}}}
  \]

- **Roundness**
  \[
  \frac{4\pi A}{P^2}
  \]

- **Symmetry**
  \[
  \frac{1}{2}\left(1 + \min\left(\frac{r_1}{r_2}\right)\right)
  \]

- **Convexity**
  \[
  \sqrt{\frac{A_{\text{real}}}{A_{\text{convex}}}}
  \]
CAMSIZER - Advantages

- measurement range 30 µm – 30 mm
- easy operation
- very direct particle definition
  - via particle width (analogue to sieving)
  - via particle length
  - or projection surface
- insensitive, maintenance-free, robust
- particle shape- density measurement, counting of particles
- high density of information
Online-Applications
Online Application (Process Control)

**Diagram:**
- **Process**
- **CAMSIZER**
- **LIMS**
- **Control center**

**Labels:**
- Part of Sample Partial flow
- Manipulated variable
- Controlled variable

**Description:**
The diagram illustrates an online application control circuit for process control. It shows the flow of information and control between the process, CAMSIZER, and LIMS system, with control centers managing the flow of partial flow and variables.
CAMSIZER® online (housing open)

- Double Housing
- Industrial PC
- UPS (uninterruptable power supply)
- 4-20mA interface
- Profibus interface
- Analogue + digital I/O
- Automatic cleaning
- Lab or test measurements possible
CAMSIZER® OnLine (closed)

- Double safe
- Overpressure or negative pressure
- Air condition
- Bulk bypass
- Remote control or direct control
CAMSIZER® Online (housing closed)

- Dust protected by compressed air
- Air condition
- Funnel shaker
- Automatic cleaning
- Remote control
- Communication tests with portable PC

CAMSIZER-online (final check at manufacturer)
Automatic Sampling from a Pipe

- Sampling
- Product stream to big bag
- Sample dividing
- Pipeline to the CAMSIZER®
Customized sample feeding solution

- Automatic sampling (from right)
- Manual sampling (on the left)
- Level control
- Dust protection
- Vacuum (negative pressure)
Online applications with automatic sample taking

- Sample from pipe
- Sample from belt
- Sample from pipe
CAMSIZER online
Dust protection / Ionization

- Air filters
- Exhaustion
- Cleaning
- Ionisation
Interfaces for CAMSIZER Online

- **Profi-Bus Interface**
- **Digital in- and outputs**
  - 18 CAMSIZER® internal signals
  - External connection to facilitate control and status reports
- **Analog 4-20mA interfaces to connect the device to the PCS**
- **LAN Network connection**
  - Supplementary data export to LIMS
  - Task file configuration
  - Calibration
  - Service
CAMSIZER Application Fields

- Catalysts
- Extrudates
- Sand, Refractory
- Glass
- Ceramics
- Coal
- Plastics
- Food
- Metal powders
- Drugs
- Carbon black
- Salt
- Abrasives
- Detergents
- Sugar
- Fertilizer

Field installations for CAMSIZER®

- Quality laboratories
- Industrial environment locations
- Research and development / Universities
- Automatic process control and interaction
Thank you for your attention!
Counting with CAMSIZER®

Sphere 1

Falling Direction

Sphere 2

Correct Particle Counting possible with CAMSIZER
CAMSizer for Extrudated Catalysts

Feeder

CCD-Basic-Image and Particles

Falling direction
CAMSIZER for Counting

Feeder, CCD-Basic-image and particles in reality

particles counted and measured

particles not counted and not measured

Falling direction