Fertilizer

Instrument: CAMSIZER P4

Application

Fertilizers are organic or inorganic nutrients for plants which may be either liquid or granular. They are used to enrich the soil in order to improve the quality and/or quantity of plant growth. Because of occupational health and safety (respirability of fertilizer powder) and environmental aspects (formation of dust) fertilizer manufacturers are forced to granulate the fertilizer powders. This improves the handling and does not affect the molecular structure of the product in any way. Fertilizers must be produced in similar sizes (e.g. 3mm) and within a close size range (narrow size distribution e.g. 2-4mm), so that they can be mixed (blended) without segregating. When the raw material is very fine (powders), the powders are pressed between two rollers to produce a 1-2 cm film of hardened fertilizer. This film is crushed, and the particles are sifted int size fractions. Only 50%-80% of the final product has the right size distribution. Smaller particles must be pressed again, whereas too big particles must be crushed again. Many fertilizer producers, such as Bulk Blending companies, mix different fertilizers to obtain a specific nutrient content of the soil. Common fertilizer materials are urea, potash, NPK (nitrogen, phosphorous, potassium), binary fertilizers (NP, NK, PK) or DAP (diammonium phosphate).
Fertilizers and fertilizer granulate need to have a very defined size distribution to ensure a certain dilution time and controlled release of nutrients. Quality control of fertilizer therefore requires measurement of the size distribution and sieve analysis has been the standard technique for many decades. Dynamic image analysis with the CAMSIZER P4 offers a powerful alternative with higher accuracy, better reproducibility and more sample throughput. Thanks to the fully automated measurement, the results are independent of the operator and even unskilled personnel can perform the measurement. The CAMSIZER P4 results are comparable with sieve analysis, so the changeover is easy and product specifications can remain unchanged.

Solution: CAMSIZER P4

The unique measuring setup of the CAMSIZER P4 – two digital cameras as an adaptive measuring unit – improves and optimises particle analysis by dynamic image analysis (Fig. 2). Therefore, it is possible to measure a wide range of particles from 20 µm to 30 mm with high accuracy, **without any hardware modifications**. The sample is conveyed into the instrument by a vibratory feeder where the particles fall through the measurement field. During the measurement procedure the two digital cameras perform different tasks. The basic camera (CCD-B) records large particles, the zoom camera (CCD-Z) records the small ones. The contact-free optical measurement is carried out in real time and simultaneously obtains all the required information about particle size and particle shape. The CAMSIZER P4 is suitable for all free-flowing, pourable bulk materials and is therefore suitable for the analysis of fertilizer granulate. The instrument evaluates 60 images per second and generates a robust dataset within a short measurement time.

Fig. 1: *The CAMSIZER P4 dynamic image analyzer (left). The CAMSIZER P4 can optionally be equipped with an AutoSampler. This allows the fully automatic measurement of up to 12 samples consecutively (right).*

Analysis of five fertilizer samples

Five fertilizer samples have been submitted for analysis by CAMSIZER P4. Sample 1 is a red, angular potash granulate, sample 2 are round urea beads, sample 3 is DAP, sample 4 and 5 are mixtures of different fertilizers.
The samples have been analysed with the CAMSIZER P4 and subjected to sieve analysis with a Retsch AS200 vibratory sieve shaker.

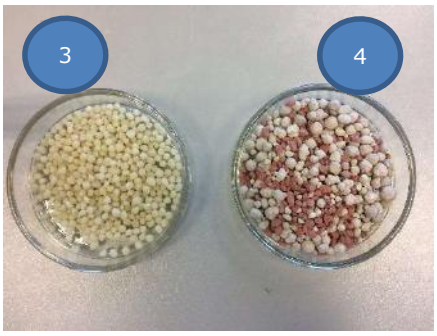
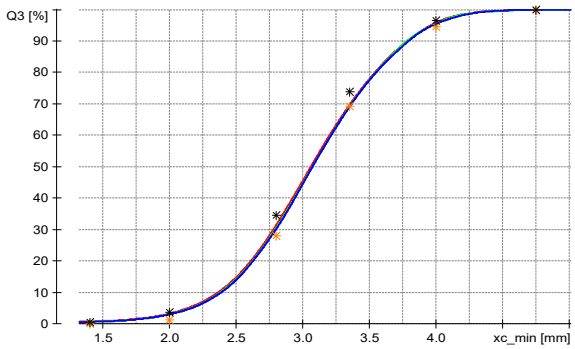


Fig. 2: *Fertilizer samples that have been analysed with the CAMSIZER P4:*
Sample 1: red potash
Sample 2: urea beads
Sample 3: DAP
Sample 4: Potash-mix
Sample 5: Complex mixture

Sample 2 (urea beads) has been split with a Retsch PT 100 sample divider into several aliquots. Three sub-samples have been analyzed with three different CAMSIZER P4 instruments. The sieve analysis was carried out with two sub-samples on two different sieve stacks. The results are displayed in figure 2. The reproducibility of the CAMSIZER P4 results is excellent as the superposition of the Q3 curves is almost perfect. The two results of sieve analysis, however, differ considerably, although sample amount, sieving time and amplitude were the same. The reason for this is that two different sieve stacks have been used. Due to manufacturing tolerances of the wire mesh, the actual aperture can deviate in one direction or the other from the nominal aperture. The CAMSIZER P4 results lie between the data from both sieve stacks.
For the other four samples, the overall agreement of CAMSIZER P4 and sieve analysis is good (Fig. 4) although inaccuracies of the sieve data must be considered.



Q3 [%]	C 1	C 2	C 3	S 1	S 2
2.00 mm	3.0 %	3.0 %	3.2 %	3.5 %	1.3 %
2.80 mm	30.5 %	30.4 %	31.4 %	34.6 %	28.1 %
3.35 mm	69.1 %	69.0 %	69.6 %	73.9 %	69.3 %
4.00 mm	95.6 %	95.5 %	95.9 %	96.4 %	94.6 %

Sample 2, Q3 values (cumulative % passing) for 2.00mm; 2.8 mm; 3.35 mm; 4.00 mm
C1 / C2 / C3: CAMSIZER P4 measurement 1-3
S1 / S2: Sieve analysis with two different sieve stacks.

Fig. 3: *Fertilizer Sample 2 (urea). Three measurements of Sample 2 with three different CAMSIZER P4 instruments (**red** / **green** / **blue**). The reproducibility is excellent. Sieve analysis of Sample 2 with two different sieve stacks (**black *** and **orange ***).*

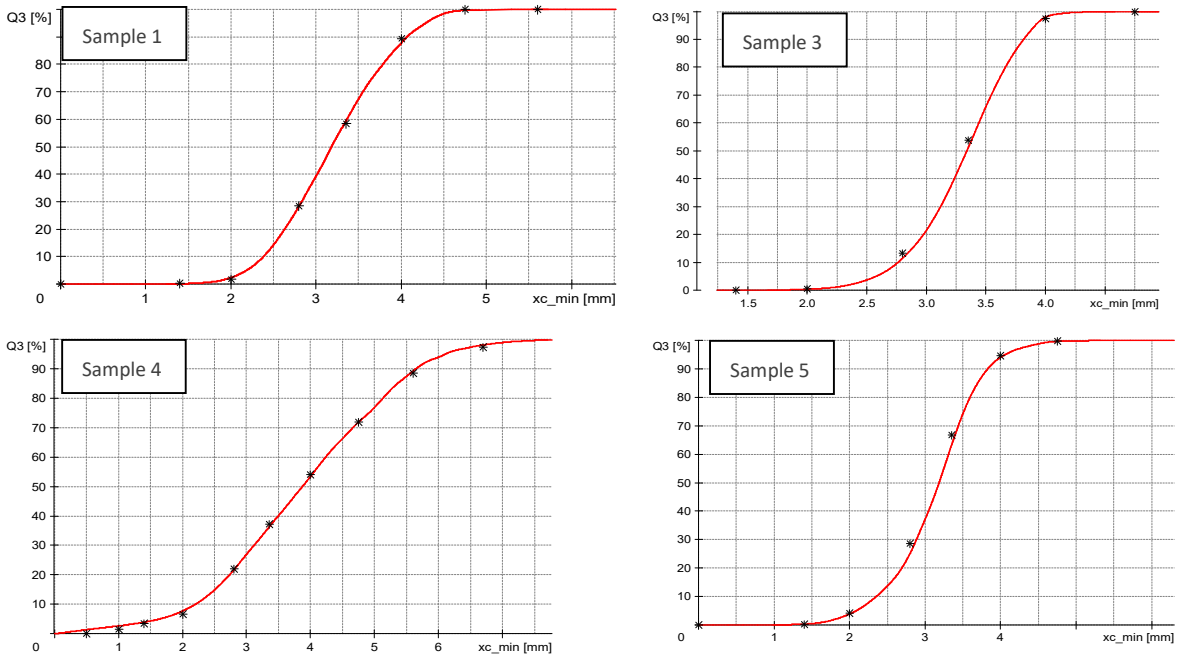


Fig. 4: CAMSIZER P4 measurements of fertilizer samples 1, 3, 4 and 5 (**red curves**) and corresponding sieve data (***black ****).

CAMSIZER P4: shape analysis

Simultaneously with the size, the shape of the particles is determined. Various shape parameters are available, such as aspect ratio, circularity, symmetry, convexity and compactness. Comparative plots can be used to identify samples with predominantly round or angular particles (Fig. 5).

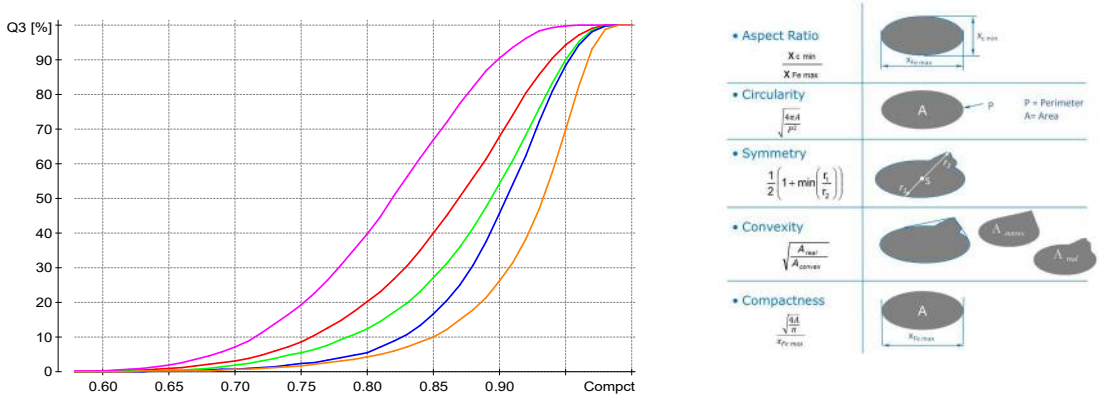
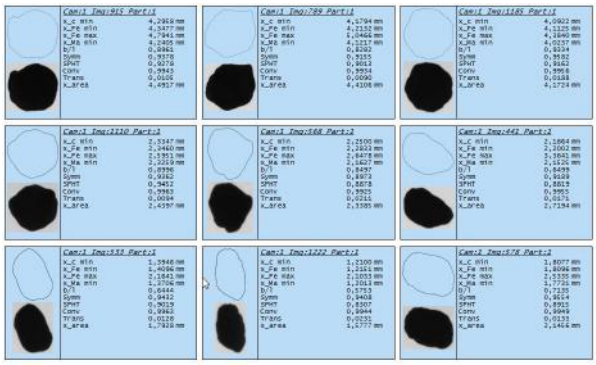


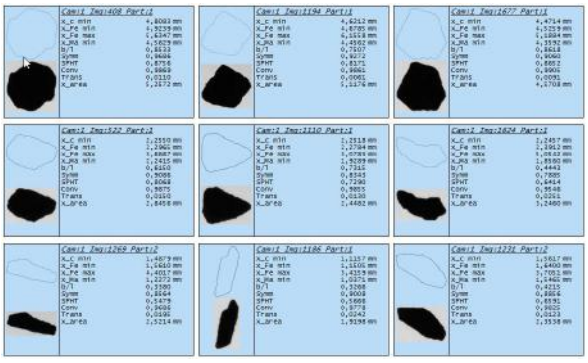
Fig. 5: *Particle shape analysis of the five fertilizer samples. Cumulative distribution Q3 of the shape parameter compactness. Samples with many round particles will plot on the right side of the diagram. Sample 1 (**purple**), sample 2 (**orange**), sample 3 (**blue**), sample 4 (**green**) and sample 5 (**red**). The urea beads of sample 2 are the most compact particles, the potash (sample 1) has the most irregular particles. These plots can help identify components of different shape in a mixture.*
The most commonly used shape parameters are displayed on the right.

CAMSIZER P4: Benefits at a glance

- Results comparable to sieve analysis
- Non-destructive measurement
- Great reproducibility: identical results at different sites
- Short measureing time, usually < 3 minutes
- Easy to use, maintenance free
- Suitable for laboratory and production environment
- Autosampler available for further automation
- Analysis of particle shape
- Analysis of mixtures



Particle Images of DAP (sample 3)



Particle images of Potash (sample 1)

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