Superabsorbent Polymers (SAP)

CAMSIZER applications for polymer powders

Application

Superabsorbent polymers (SAP) are granulated polymers with the capacity to absorb liquids up to five hundred times their own weight.

Superabsorbents are used in sanitary products such as baby diapers, in the packaging industry, e.g. to absorb moisture escaping from fish, vegetables or meat, for water storage in agriculture, for technical applications like cable wrapping tape, and even for firefighting.

Depending on the application, different sized polymer granules are required which makes the control of the particle size an important step in the quality management process.

The particles should neither be too small nor too big: dust particles can be a problem for product packaging, for example, or particularly large particles change the "look and feel" of diapers. Furthermore, the absorption rate depends on the surface area of the particles so that finer particles generally absorb water faster than large ones.

Manufacturing process of superabsorbent polymers

Of the various ingredients or functional components used to manufacture superabsorbents, the primary raw material is acrylic acid.

A monomer solution is polymerized to produce polyacrylic acid/sodium polyacrylate.

The gel block is broken up into pieces.

The crushed gel is dried.

After drying, the pieces are granulated.

The granulate is sifted to produce a fine powder.

The result of this process is a white, powdery granulate with astounding capabilities.

Pictures courtesy of Evonik Degussa; BASF

Example 1 - Comparison of different particle sizing methods: Sieve Analysis, Laser Diffraction and Dynamic Image Analysis

The particle size distribution of superabsorbent polymers can be analyzed by sieve analyis, laser diffraction or Dynamic Image Analysis, a method which is used by the CAMSIZER P4.

Figure 1 shows a comparison of results obtained by measuring the same sample with the aforementioned methods. The result of sieve analysis is represented by the black curve. The process required 15 min sieving time plus another 10 minutes for weighing, calculating and sieve cleaning. The same result is obtained by Dynamic Image Analysis (DIA) with the CAMSIZER P4 in less than 3 minutes (red curve). DIA measures the length, width and "equivalent circle diameter" of every particle which is captured by the cameras - simultaneously and fully automatically. The result of the width measurement perfectly matches the sieve analysis result, not only for the average particle size but also for the amount of oversized and undersized material ("dust").

The result obtained by laser diffraction (LD) is represented by the dark green curve. LD calculates the size distribution of the sample on the assumption that all particles are spherical. Superabsorbents, however, usually consist of irregularly shaped granules so that the laser diffraction results differ dramatically from the results of sieve analysis, particularly the amount of oversized particles around 0.8 mm. DIA shows comparable results to LD for the average particle size based on the size definition "equivalent circle diameter"; for particles >0.9 mm the LD curve moves closer to the particle length curve calculated by DIA.

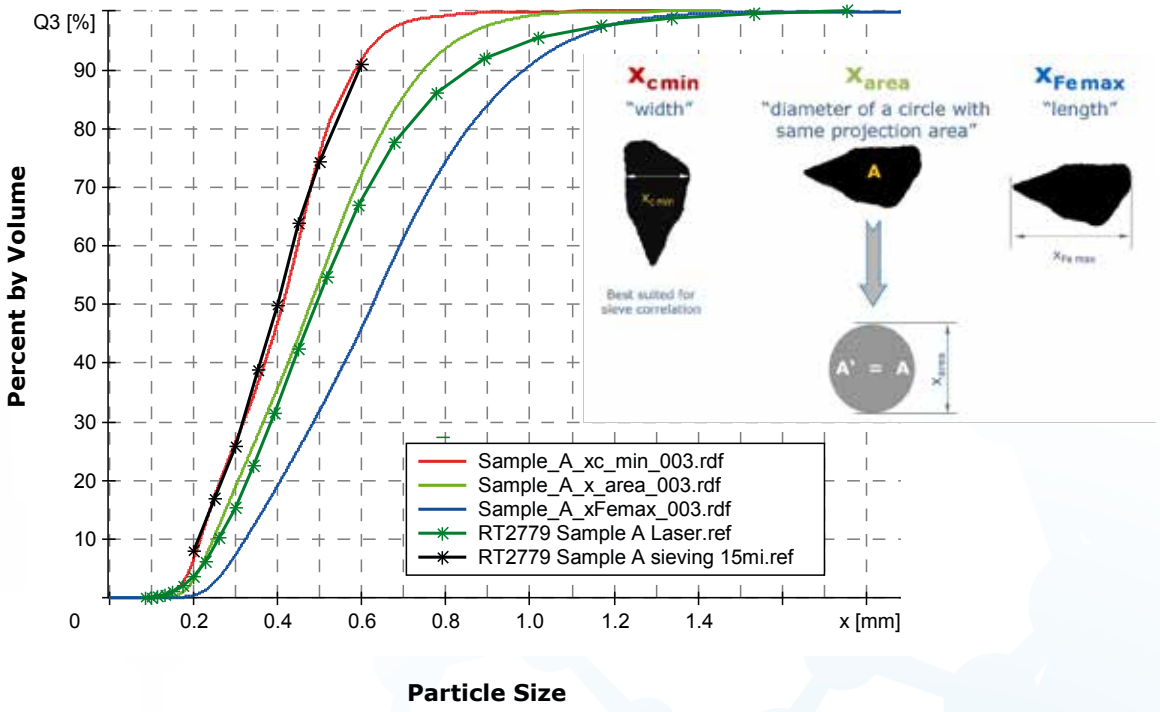

Fig. 1**: Comparison of sieve analysis (black**), and CAMSIZER P4 (length = **blue**, width / smallest diameter = **red**, equivalent circle diameter = **green**) for the same sample material*

The shape of the particles influences the different measuring techniques in different ways.

The sieving process orientates the particles, so that they will pass through the sieve mesh with their smallest diameters, independent of the particle length. The laser diffraction software does not recognize particle shape and simply assumes that all particles are spherical. In contrast, the Dynamic Image Analysis can measure the particle shape and get results comparable to sieve shakers, depending on the requirement of the operator. Thus, the understanding of the particle shape leads to a better size analysis.

Example 2: Reproducibility and calibration

Measurements with the CAMSIZER P4 are not only fast, they also offer an excellent reproducibility, even between units in different locations. This is due to the high degree of automation and the efficient and precise calibration.

The measurements are fully automated, therefore the results are independent of the operators. A calibration is carried out within 1 minute thanks to the calibration reticle which is provided with each instrument. As there are no moving parts in the optics, calibration on a yearly basis is sufficient.

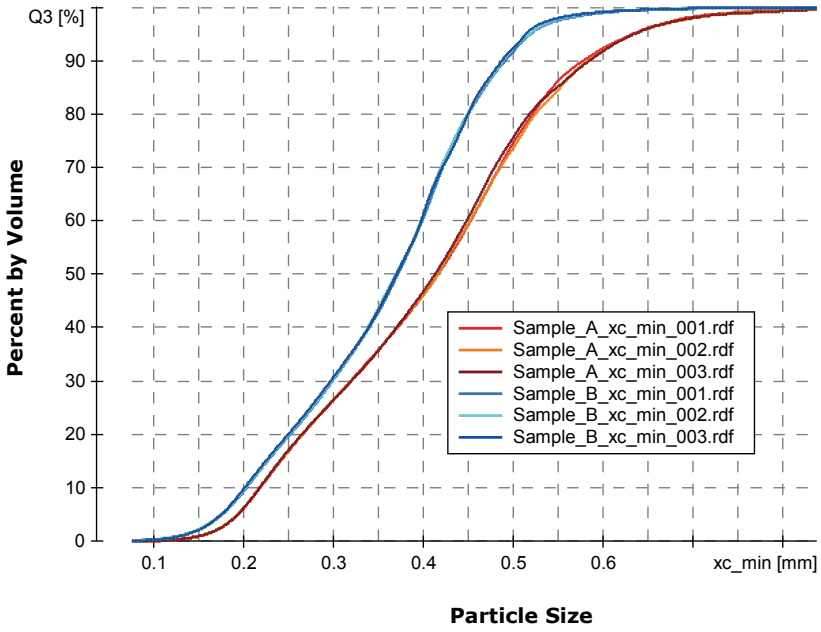

***Fig. 2**: Two different samples of superabsorbents, each measured 3 times. The reproducibility is excellent, the D50 is identical within ±1 µm. Each measurement took about 3 minutes.*

Example 3: Shape analysis

Recently the particle shape has become another important property of superabsorbent polymers.

BASF is launching a new SAP product called SAVIVA, advertising the spherical particle shape as an important feature. DIA offers the possibility to analyze and compare the particle shape of different samples, for example with respect to the aspect ratio (width to length ratio) of the particles. Round particles have an aspect ratio of "1", meaning length and diameter are identical. The example below shows the aspect ratio against the sample amount for an extruded material with an aspect ratio of about 0.5 (red curve), typical superabsorbent particles (blue curve), and almost perfect round particles (green).

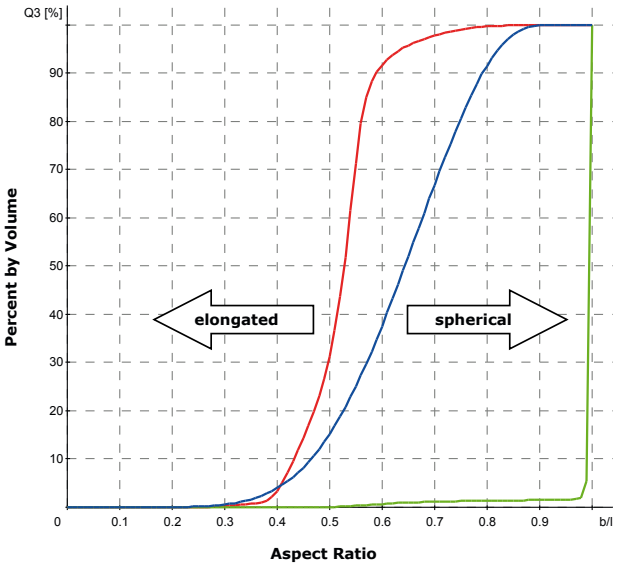

***Fig. 3**: Example for the shape analysis with CAMSIZER P4. The diagram shows the aspect ratio versus sample amount for three different types of particles. The **blue** curve shows typical irregular shaped SAP, the **green** curve is typical for totally spherical particles, and the **red** curve shows extrudates with an aspect ratio of about 0.5.*

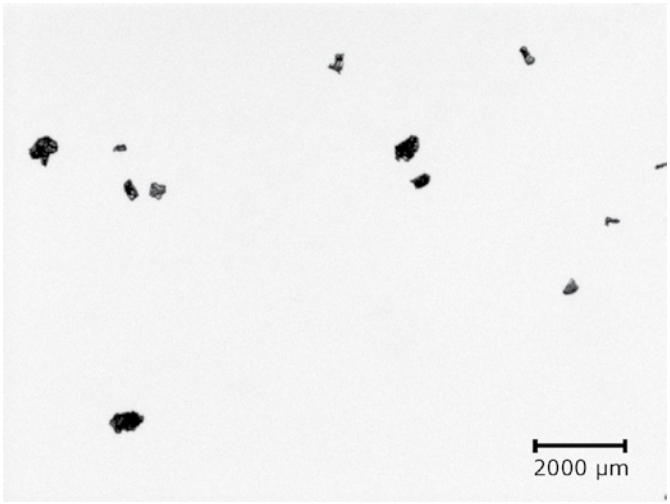

***Fig. 4**: Typical CAMSIZER P4 image showing SAP particles with different shapes and sizes.*

CAMSIZER P4 - Benefits at a glance

- faster results, measurement time typically 1-3 minutes
- less manpower required
- excellent agreement with sieve results, but more reliable and reproducible
- higher resolution than sieving
- high sample throughput
- excellent reproducibility
- larger sample quantities provide better statistics
- more objective, operator–independent results
- non-destructive measurement
- high sensitivity for oversized particles
- shape analysis: roundness, sphericity, symmetry, aspect ratio, etc.
- length and diameter of particles
- easy to use
- low maintenance, robust design
- wide dynamic size range from 20 µm to 30 mm in one measurement run