Particle size analysis on the way from lab to process

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Traditional methods of particle size analysis

Particle size is the most obvious quality aspect of a wide range of disperse products, from cement over sugar or chocolate to pharmaceutical agents and carrier substances. Although fingers sensitivity or tongue testing may give quite meaningful information about the particle size, these subjective methods are usually not accessible for validation and objective reproducibility.
More adequate in this sense are sieving methods, which have been improved with sieving towers and air jet sieving during this century. Also sedimentation analysis, which uses the size-depending sinking velocity, has been further developed and imporved, e.g. to x-ray sedimentation.

The good and the better

In the last 25 years laser diffraction prevailed impressively against all competing methods not only because of the easy handling and the wide applicability for more or less all materials from under 0.1 microns up to the centimetre-region. Especially the qualitative characteristics like reliable reproducibility, high resolution, shortest analysis times and almost maintenance-free operation leave sieving and sedimentation methods far behind.
The breakthrough of laser diffraction came in the laboratory application because it is an absolute measuring method, i.e. no sample parameter for evaluation and running of the analysis is possible and necessary. As using directly the physical phenomenon of light scattering at the sample particles edges, there is no need for system adjustment or calibration.
Samples can be measured in air or a carrier gas, as suspensions or as sprays. All dispersing parameters are entered in the operating software, for different products, for instance, "standard operation procedures" (SOP) can be defined, which control the complete course of the measurement from the reference measurement, sample handling and dispersion, detection and evaluation to rinsing of the system and help to ensure identical measuring conditions for compared samples.

A chain of strong links

Every single component of the particle size analysis system has its quality relevant influence on the quality of results, the detector that should be circular or at least semicircular, the controlled and powerful dispersion as well as the evaluation algorithm, that should be sensitive and parameter-free. Because the Mie-theory cannot grasp mixtures of different components and in addition requires absolutely spherical particles with smooth surfaces as well as knowledge of the optical parameters, in praxis mainly the Fraunhofer evaluation is applied.
Also for the construction there are two approaches: a) the more exact, but more effort-taking approach to measure in the parallel laser beam and to use several lens systems of different focal lengths for different measuring ranges. b) the analysis in the focussing beam, which necessarily delivers blurred diffraction images because of the unavoidable width of the measuring zone.
With product-adequate dispersion one can protect the sample from outer influences and analyse it in less than a minute including sample preparation and cleaning procedure of the system. Only so the possible accuracy can really relate to the measured product.
Independent if the measuring system controls the product quality in-line in the process pipe or off-line in the lab, the results should be comparable and repeatable. The Sympatec HELOS-system applied to particle collective between 0.1 and 8750 microns guarantees system-to-system deviations of less than 1 %.
There are experiments though with a combination of laser diffraction with other methods like back-light-scattering or image analysis. But as a method mix always requires an arbitrary combination of different results, such combined results own reduced confidence and are hardly comparable to those of other systems.

Industrial requirements

For a short time the pharmaceutical industry has begun to control and adjust its production not only afterwards – off-line in the laboratory – but in the continuing process – in-line in a pipe or batch.

One reason for the gain in importance of the particle size analysis is that the size distribution is most relevant for product characteristics like solubility, flowability and bioavailability. But of the same influence is that the global competition and the increasing attempts towards continuous quality assurance have transformed the knowledge of the particle size distribution of a product from an internal characteristic into an external delivery guarantee.

Particle size analysis in-line

Today systems for particle size analysis offer a wide application range up to real in-line solutions. If a dry process flow is to big to be analysed completely a sample can be taken isokinetiсly with a small opening scanning the complete cross-section of the pipe on a spiral path. In this way even in pressurised pipes up to 10 bar of arbitrary orientation and with temperatures up to 100°C a representative sample down to 1/100000 of the throughput is taken. In the Sympatec MYTOS & TWISTER the following in-line measuring system with integrated reliable dry dispersion and established laser diffraction analysis ensures the full comparability to the respective off-line system, in the meantime even accessible to validation and conform to GMP requirements.

Suspensions and emulsions can hardly be measured with optical methods because of the typical concentration in the production process. For this type of application the acoustic particle size determination has been developed. With the ultrasonic-extinction method the damping of ultrasonic waves of different frequencies is recorded and from that the particle size distribution is deconvoluted with use of a material-dependent extinction function.

The ultrasonic spectrometer OPUS can be integrated directly into every process with pressure up to 40 bar and temperature to 120°C. The system is applicable with a volume concentration can between 1 and 70 % and the particle size between 0.01 and 3000 microns.