TECHNICAL ARTICLE

A Novel Approach to Particle Size Analysis

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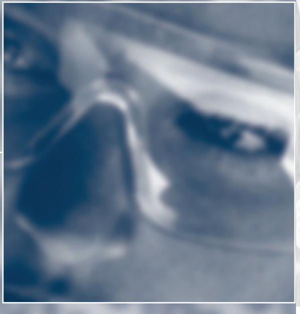

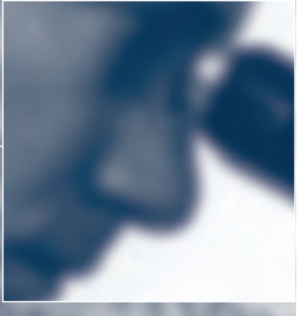

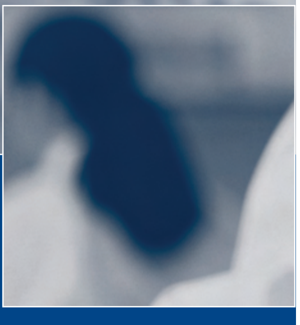

Particle size is an important parameter in many industries, as particle size affects many product characteristics such as strength, flow-ability, and surface area. Conventional Particle Size techniques measure an optical or physical property of the material and express the particle size as the diameter of a sphere having similar properties.

This method works very well for materials having spherical shapes and well defined properties. However, particles come in different sizes and shapes. Some particles are perfectly spherical; others are very irregular or even fiber-like. This is where most sizing techniques fail in their measurements and lead to inaccurate results.

Another major problem that many of the available techniques encounter, are the optical and physical properties of the particles under investigation. These properties are not always known or difficult to evaluate, especially for mixtures of different materials with very different properties.

To overcome these challenges, Ankersmid has developed an analyzer that brings together two different measurement channels for accurate size and shape measurement of spherical and non-spherical particles. The particle size is measured by a HeNe Laser Beam; the shape of the particles is analyzed by Dynamic Video Analysis of the particles' shape.

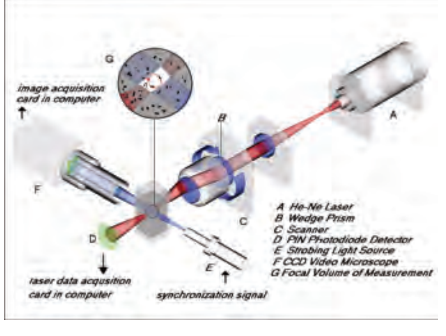

Figure 1: One System, Dual Measurement Channels

Size Analysis

The Laser Channel uses the unique Time of Transition (TOT) principle for measuring the diameter of relatively spherical particles in dynamic flow. As a particle passes through the analyzer it temporarily blocks the rotating laser beam. A detector measures the obscuration time of the individual particles in the laser beam. Since the rotation speed (V) of the laser beam and the time (T) the particle obscured the laser beam are known, the diameter (D) of the particle can be calculated:

D = V _ T.

As data is collected on single particles, size distribution results are of an exceptional high resolution. Another advantage of the TOT measurement is that the obscuration time is not influenced by optical or physical properties. In other words, the particle size is independent of refractive index, absorption, surface texture, porosity or electrical conductivity.

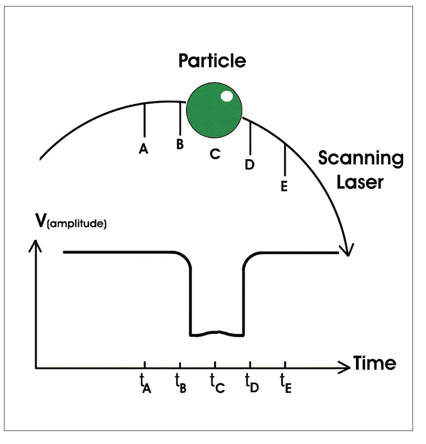

Figure 2: Particle Size is directly related to Time

Shape Analysis

The Video Channel analyzes the shape of non-spherical particles, including fibers, in dynamic flow. The shape analysis channel is equipped with a CCD video camera microscope for optimal image processing. Illumination is provided by a synchronized strobe light, and the acquired images are displayed and analysed. By means of image analysis software, the images are automatic processed and analysed and a series of size and shape parameters are evaluated In this way thousands of sample images are collected during a measurement cycle.

The Ankersmid Shape software enables fully automatic features such as rejection of out-of-focus particles, separation of touching particles, automatic light correction and contrast enhancement that assist in optimizing sample measurement. Software algorithms enable automatic, programmed calculation of 36 different parameters, including Feret diameter, area, perimeter, shape factor and aspect ratio. The

Shape software also offers powerful shape filters that enable the measurement of specific particles within a complex mixture of different particles. All measurement results can be presented in multiple types of graphs and tables, and sample images can be stored for analysis at a later time.

- The CIS-100 can be fitted with eight easily interchangeable measurement cells that enable dynamic measurement of wet, dry, surface, heated, and airborne particles. This wide range of measurement cells ensures that samples do not need to be adapted to the analyzer, but that the analyzer is adjusted to the requirements of sample specifications. In practice this greatly reduces the need for sample dilution, giving the Ankersmid Analyzer an edge in many difficult applications such as inks, emulsions, and slurries. The CIS-100 provides the best particle sizing solution for a diversified spectrum of applications. Fast and easy to use, the CIS-100 is an optimal tool for Quality Control and R&D laboratories.

The unique capabilities of the CIS-100 are illustrated with some recent case studies.

Case 1: Particle Size & Shape of Chocolate

Measuring the particle size and shape of chocolate and cacao is critical. The refining and grinding time will determine particle size and shape. It relates directly to the quality of the product; processing develops not only the chocolate flavor, but texture as well.

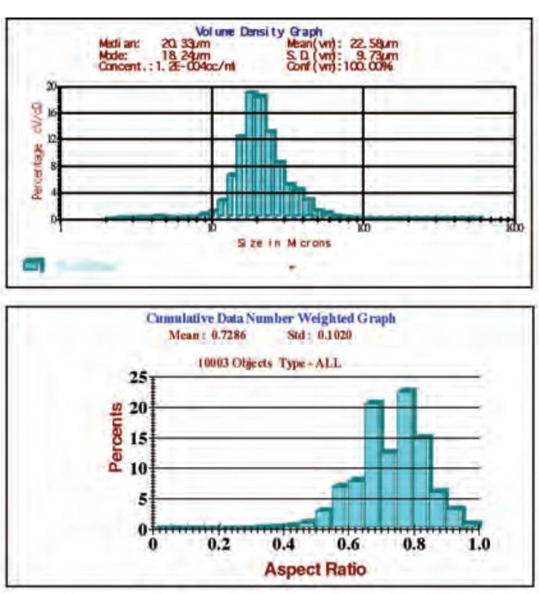

Figure 3: Particle Size and Aspect Ratio of Chocolate

The particle size gives a whole range of flavor, mouth feel and textural properties to the chocolate. Finer particle sizes require more fat, because more surface area is available. Therefore, it will be a smoother, creamier product as a result, and also more expensive; more time and effort are put into making the product. However, if the particle size is too small, the chocolate will feel sticky in the mouth.

Typically, the particle size of chocolate is about 20 microns. The human taste papillae are about 30 microns apart, cacao particles approaching this size will result in a sandy feeling in the mouth.

Moreover, processing doesn't only result in a finer particle size, but it may also round out some of the rough edges, giving the chocolate a smoother mouth feel. This will also affect its flow characteristics.

With the Ankersmid CIS-100 both particle size and shape can be measured and quantified. The TOT principle is independent of optical properties; hence the difference in optical properties between sugar, fats and cacao doesn't affect the measurement. With the video channel, the particles can be characterized on shape to obtain information about the sphericity.

Case 2) Fibre Width Measurement by Laser

Analysing physical properties of fibres is an important and fundamental requirement in many industries such as pulp & paper, insulation materials, construction and telecommunications. Important product characteristics like sheet formation, strength, and tear resistance are affected by fibre width. For this reason, fiber width analysis is important to the researcher in the R&D lab and the operator in production.

Electro-optical methods for measuring particle size assume that the particles measured are spherical in shape. As a result, it is common convention that in order to measure fibers, image analysis techniques are required. Since these techniques are more complex and time consuming comparing with laser based systems, there is a real need at the production line for a simple, fast and easy to use method for fibers characterization.

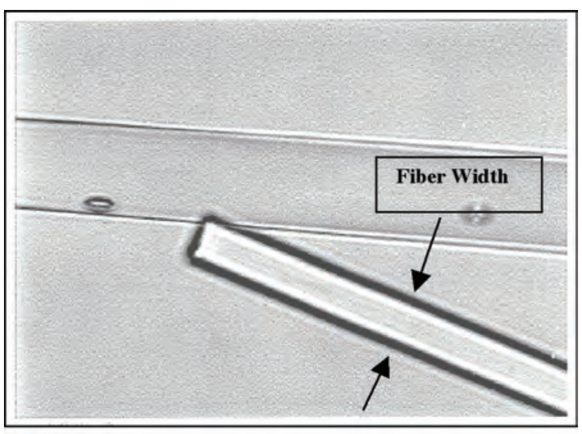

Figure 4: Fiber Width of a Glas Fiber

The TOT technique is successfully employed to analyse fibre width. When the circling beam encounters fibres, interactions of the beam with the fibre will lead to acceptable pulses, asymmetric pulses are rejected.

When a fibre passes through the circling beam, interactions perpendicular to the length of the fiber will lead to acceptable pulses; the size recorded corresponds to the width of the fibre.

Additionally, the video channel characterises fibres on length, width and curl index. Hence, the TOT technique offers fast, easy and reproducible measurements of fibre width for QC and production control; Dynamic Shape Analysis provide more in-depth information of fibre characteristics for R&D purposes.

Case 3: Biological floc characterization and flocculation dynamics

With a proper design, analysis and control, almost all the wastewater can be treated by using biological processes. Among these processes, the activated sludge process is the most widespread. The effectiveness of this process is highly dependent on the ability of the micro organisms to form a flocculated biomass (flocs) which settles and compact well, producing a clean effluent. Due to the fragile biological nature, irregular shape and heterogeneous composition of the flocs, the measurement procedure and technique used is highly important as it may affect the results and lead to a misinterpretation of the data.

By using a CIS-100 device and its flow trough cell capabilities, it become possible to measure and characterize the structural properties of the activated sludge flocs and steady state conditions as well as to quantify the flocculation dynamics under the influence of different process parameters.

In this direction by using video channel, features related to the structural properties of the flocs (shape factor, Ferets diameter, fractal dimension etc.) can be easily evaluated by using a fully automated image analysis procedure (Figure 5).

Moreover the possibility to visualize the samples represent a great advantage of this technique as it allows to directly observe the process, the flocs structure and the role played by some constituents (micro organisms) in processes such as flocs aggregation and breakage.

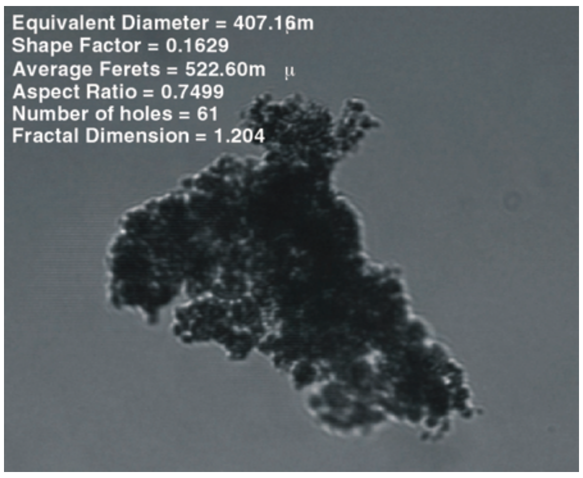

Figure 5. Image analysis of an activated sludge floc performed with video channel (CIS-100)

By using the laser channel (TOT principle) the flocculation process dynamics can be quantified on-line as it occurs under the variation of different environmental conditions. The available time sequence procedure allows an automatic measurement of the sample for long time and with a time frequency able to catch the floc size dynamics. An example is given in Figure 6 in which the aggregation effect created by the calcium addition was evaluated. The process was evaluated on-line and each 30seconds a distribution was recorded.

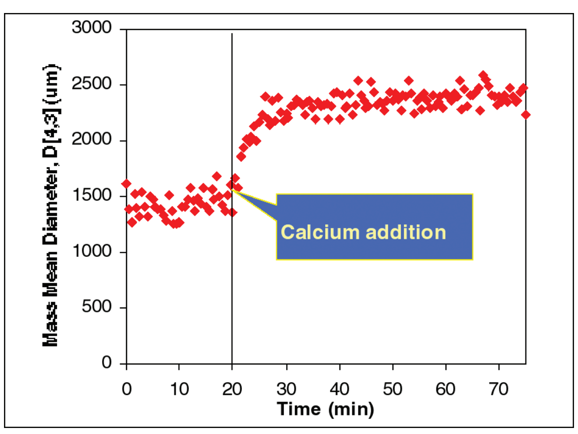

Figure 6. The activated sludge floc size dynamics measured with laser channel (CIS-100)

To conclude, CIS-100 device was successfully used and could represent a solution for evaluating the complex process of activated sludge flocculation and for evaluation of the structural properties of the bioflocs.