

Particle size analysis of calcium carbonates by laser diffraction



PARTICLE SIZE

Calcium carbonates fulfill a variety of different functions in a wide range of industries:

- Adhesives and sealants: as fillers and viscosity controller
- Animal and pet feeds: as a source of calcium and a digestion aid
- Construction: as a filler for concrete, grout, asphalt, and roofing materials
- Fertilizers: as a filler and a source of calcium
- Foods: as an additional source of calcium
- Household and hygiene products: as a mild abrasive
- Mining: as a bridging component in drilling muds
- Paints and surface coatings: as a pigment, filler, extender and finishing aid
- Paper: as a filler, coating pigment, and acidity controller
- Pharmaceuticals: as a filler or bulking agent
- Plastics: as a filler and rheology controller
- Rubber and elastomers: as a filler and extender.

Measuring the particle size of calcium carbonates

To provide this range of functionality, calcium carbonates are available in a wide range of different particle sizes, and with different surface coatings. The Mastersizer 3000 laser diffraction system can measure particle size from nanometers to millimeters, with measurements over the range being achieved in only a few minutes. This range and measurement speed enables the particle size of calcium carbonates to be tracked during production processes as well as in quality control of a final product.

How to disperse calcium carbonates

The Mastersizer 3000 has a range of accessories that enable measurements using liquid or dry dispersion. The processing method and particle size of the calcium carbonate will determine whether liquid or dry dispersion is preferable. Dry dispersion allows larger amounts of sample to be measured, providing reproducible results for coarser particle sizes. However, for the finest grades, liquid dispersion offers more control over the state of dispersion, and consequently produces more reproducible results. The flexibility to quickly change between liquid and dry dispersion units means that a wide range of samples types can be analyzed using a single Mastersizer 3000 installation.

The Aero S dry powder disperser uses compressed air to disperse the sample, and the appropriate air pressure must be selected to ensure dispersion [1]. In liquid dispersion, using the Hydro dispersion units, calcium carbonates are usually measured in water. A short duration of ultrasound is often required to disperse agglomerates, and additives, such as sodium pyrophosphate or sodium hexametaphosphate, are used to stabilize the dispersion [2].

Figure 1 shows the particle size distributions for a calcium carbonate sample measured using both liquid (after 1 minute of ultrasound) and dry dispersion (at 1bar). These results show good agreement between liquid and dry dispersion which verifies that the sample is fully dispersed in both states.

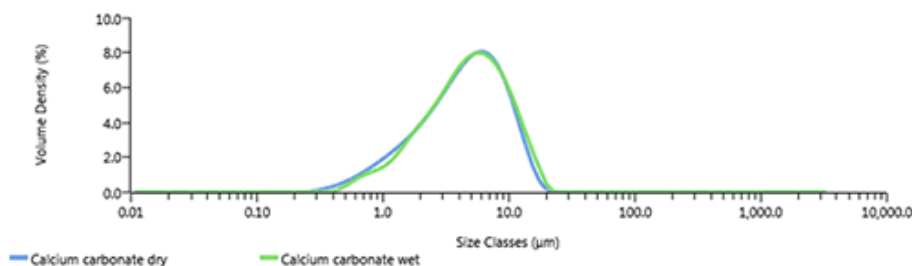


Figure 1: Overlay of a calcium carbonate sample measured in liquid (wet) and dry dispersion

Specifying the particle size of calcium carbonates

Laser diffraction produces volume based particle size distributions, from which a range of parameters can be specified. For example, the 10th percentile (Dv_{10}) can be used to track the fine particles in the distribution whereas the 90th percentile (Dv_{90}) can be used to track the coarse particles in the distribution. Calcium carbonates are also commonly specified on the percentage material in certain size ranges, for example the percentage below $1\mu\text{m}$ and $2\mu\text{m}$ for the finer grades and the percentage above $10\mu\text{m}$ or $45\mu\text{m}$ at the coarser end of the range. Figure 2 show the particle size distributions for four grades of calcium carbonate covering a size range from $0.1\mu\text{m}$ up to $1000\mu\text{m}$, and Table 1 shows the parameters for these samples.

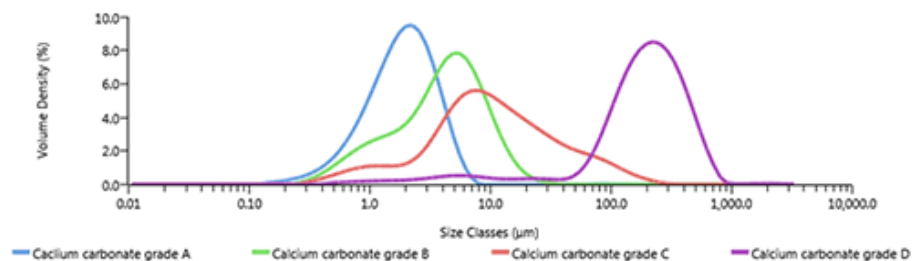


Figure 2: Particle size distributions for four grades of calcium carbonate

Table 1: Particle size parameters for four grades of calcium carbonate

Sample	Dv10 (µm)	%V < 1µm	Dv50(µm)	%V < 2µm	Dv90(µm)	%V > 10µm	%V > 45µm
A	0.71	19.18	1.88	53.96	3.89	0.12	0
B	0.95	10.75	4.15	24.35	10.2	10.47	0
C	1.96	5.13	9.73	10.17	55.5	49.05	12.82
D	52.6	0.79	199	1.80	450	93.69	90.49

Summary

Laser diffraction is a widely used technique for the analysis of calcium carbonate due to its wide dynamic range, flexible dispersion options, speed of measurement and reproducibility of results.

[1] Dry powder method development for laser diffraction particle size measurements, MRK1903-01

[2] Wet or liquid dispersion method development for laser diffraction particle size measurements, MRK1902-02



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