Accuracy and Precision of Microtrac Particle Analyzers

S35500 / Bluewave / SYNC / Nanotrac

Introduction

Accuracy and precision have distinct meanings. Generally, accuracy refers to the ability of an analytical device to provide a measurement that is within a defined error from an established, true, and verifiable value. Precision is a measure of the recurrence of a value whether it is accurate or not. Two types of precision can be described: repeatability and reproducibility. In terms of particle size measurement, repeatability refers to the ability of an instrument to repeat its own measurement while the same sample resides in the circulating system. Reproducibility, on the other hand, is related to the comparison of two or more instruments in which representative (repeatable sampling assumed) samples are introduced to each of the instruments. Repeatability is statistically more variation-free than reproducibility because a single instrument measures the same recirculating sample.

Figure 1: Diagram showing possible combinations of accuracy and precision. The cases with "high precision" provide better quality and process control.

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Accuracy

Accuracy is a concept that is difficult to define for particle size measurement of irregularly shaped particles. For a sphere, one can easily define its surface and diameter using the radius of the particle and the basics of geometry. If 100% of the particles are spherical and are the same size, an instrument can be calibrated and designed to measure that size. Probably 99% of the industrial particles measured are not spherical - they are usually irregularly shaped. One cannot use simple geometry to define the size since many dimensions will exist for each particle. This situation is made more complex since most powder processes do not produce particles of the same shape and size. Since there are billions upon billions of particles in a sample, it is very difficult, if not impossible, to accurately determine the size of acicular particles. The irregular particle shapes and the fact that shape has a different effect on each measurement method also contribute to variations among the data reports by various instruments and methods. Fortunately, methods that have a strong scientific foundation can be correlated, meaning that although the data do not entirely agree, there is a mathematical relationship between them that allows conversion from one data report to another. We have found in our 50-year history that our data demonstrate a regression that is linear with other methods such as sieves, counters, and surface area with correlation coefficients as high as 0.9999. Thus, while it is difficult to define the accuracy of measuring the size of a non-spherical particle, the data are quite valid and usable.

It is also valuable to note that Microtrac instruments are designed according to first-principle physics, meaning that instrument design is based upon pure forms of optics that dictate the location of the laser, lenses, cell, detector, etc. Thus, calibration is not necessary. If calibration were necessary, perfect spheres would be required since exact dimensions would be required. Any deviation from sphericity could interfere with calibration. Since it is well documented that perfectly spherical, mono-size particles can only be prepared in outer space, where there are no gravitational effects, the availability of mono-size, perfect spheres is severely limited. This, in turn, limits the ability to have a ***truly accurate*** material to use for calibration to gain scientifically defined accuracy. Thus, instruments can be performance tested with non-spherical materials of known behavior to assure repeatability of measurements, to report particle size changes, to establish similarity to data from other methods, and to demonstrate robustness of design. Therefore, while it is not possible, at present, to provide an accuracy statement that conforms to strict scientific definition for laser diffraction technology, many materials are available for performance tests.

Precision

Usually, important to customers are reproducibility and repeatability of measurements and the ability of instrumentation to respond to product not meeting documented specifications. These measurements depend upon the stability and design robustness of the analyzer. Repeatability in this context means the ability of the method to obtain the same answer for the same sample of material. Such robust measurements allow a process to be controlled.

Repeatability will vary depending upon the challenge placed on the instrument, and most light-scattering instrument manufacturers use very narrow, mostly spherical particles to provide an answer. Since we already know that such materials are the exception rather than the rule, the accuracy and repeatability statements may not fully address the repeatability question. Thus, broader, non-spherical distributions may give a better indication of repeatability. The data supplied represents the measurement of "spherical" and non-spherical particles.

While Microtrac considers integrity our highest order of business, we offer the data below to demonstrate reproducibility of all aspects of instrument manufacturing where data variations are a result of the combination of operator variations, sampling opportunity variations, sample preparation variations, normal instrumental variations (data for at least 20 instruments are used), circulating systems variations, and materials variations. As explained above, repeatability can be expected to show a variety of materials and sizes are employed for proper and full testing of each Microtrac model. The materials shown represent only a portion of the materials used in our manufacturing operations. In addition, note that because the reproducibility information includes all possible variations, the percent variation represents a worst-case situation.

Reproducibility of the Microtrac S3500 and Sync

Microtrac Model	Material	Parameter	Value	%Variation
S3500	650 µm Spherical	%10	591 µm	1.8
Water Dispersion	Glass Beads	%50*	648 µm	0.9
		%90	709 µm	3.4
		Volume Mean Diameter (MV)	653 µm	1.4

* %50 is the median diameter of the volume distribution

Microtrac Model	Material	Parameter	Value	%Variation
S3500	100 nm	%10	105 nm	5.5
Water Dispersion	Polystyrene	%50	109 nm	4
		%90	122 nm	5
		Volume Mean Diameter (MV)	110 nm	3

Reproducibility of the Microtrac Nanotrac

Microtrac Model	Material	Parameter	Value	%Variation
Nanotrac Series	Certified 0.460 µm	%10	0.411 µm	2.3
	Polystyrene	%50	0.481 µm	1.2
		%90	0.567 µm	2.5

For further information please contact us at:

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