

Five factors to consider when choosing a laser diffraction particle size analyzer

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This article covers five criteria for choosing a laser diffraction particle sizing instrument that will meet your needs.

选择激光衍射粒子分析仪应该考虑的五个因素

本文将详释您在选择所需要的激光衍射粒子分析仪时应该考虑的五个标准。

レーザー回折式粒度分布測定装置を選択する際の5つの決め手

この記事ではニーズに合ったレーザー回折式粒度分布測定装置を選ぶ際の5つのポイントを載せています。

Cinco factores que hay que considerar al escoger un analizador de tamaño de partículas por difracción láser.

Este artículo revisa cinco aspectos que debe tener en cuenta para escoger un analizador de tamaño de partículas por difracción láser que satisfaga sus necesidades.

Cinq facteurs à considérer dans le choix d'un granulomètre à diffraction laser

Cet article présente cinq critères à prendre en compte dans le choix d'un granulomètre à diffraction laser pour satisfaire vos besoins spécifiques.

Fünf Faktoren die beachtet werden sollten wenn man einen Laser-Diffraktions-Teilchenanalysator auswählt

Diese Artikel beschreibt fünf Kriterien für die Auswahl eines Laser-Diffraktions-Teilchenanalysator Instruments, welches ihren Bedürfnissen entspricht.

Measuring particle size is an indispensable step in understanding a material's physical and chemical properties. Of the many particle sizing methods on the market, laser diffraction is one of the most popular because it's a fast, non-destructive technique that can analyze wet and dry samples.

Choosing a particular instrument from the range of available laser diffraction particle size analyzers can be a daunting task, however. The following information describes five criteria for helping you choose a laser diffraction instrument that will provide the sizing accuracy and performance you need.

1 Compliance with ISO 13320

The laser diffraction analyzer you select should comply with the new International Organization for Standardization (ISO) standard *ISO 13320:2009 Particle Size Analysis—Laser Diffraction Methods*.¹ This 2009 standard, which replaces the

1999 version, provides guidance on instrument qualification and particle size distribution measurements via analysis of particles' light-scattering properties. The standard applies to laser diffraction instruments measuring particle sizes between about 0.1 and 3,000 microns. Topics covered in the standard include laser diffraction analyzer hardware, particle size measurement methods, and optical model selection, as well as guidance in understanding the analyzer's sizing results.

One of the standard's most useful portions is a list of acceptable errors for particle size measurement of certified reference materials (such as glass beads) of a known size distribution. When you're considering a particular laser diffraction instrument, you need to compare the instrument's particle size measurement errors for sizing the reference materials with the acceptable errors listed in the standard. This will help you certify the accuracy, repeatability, and reproducibility of the in-

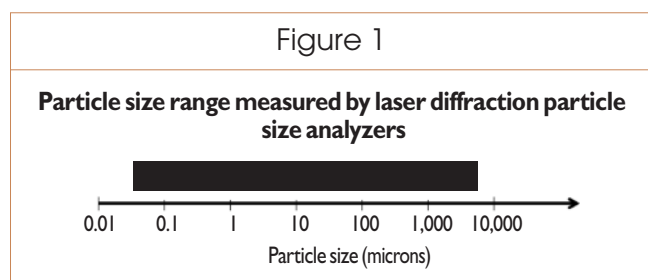
strument's results. The standard lists the acceptable errors in terms of the cumulative distribution of undersize particles (where, for instance, the 10th percentile, or D_{10} , indicates that 10 percent of the particles in the sample have a diameter less than a given particle diameter). The acceptable measurement errors listed are:

- From the 10th to 30th percentile of cumulative undersize particles, ± 3.0 percent relative error
- From the 30th to 70th percentile, ± 2.5 percent relative error
- From the 70th to 90th percentile, ± 4.0 percent relative error

Find more detailed information in ISO 13320:2009.

2 Particle size range

While ISO 13320:2009 applies to laser diffraction instruments that measure particles in the 0.1- to 3,000-micron range, most laser diffraction analyzers can measure sizes below this limit, as shown in Figure 1. While it may be tempting to choose an instrument with the widest particle size range, for



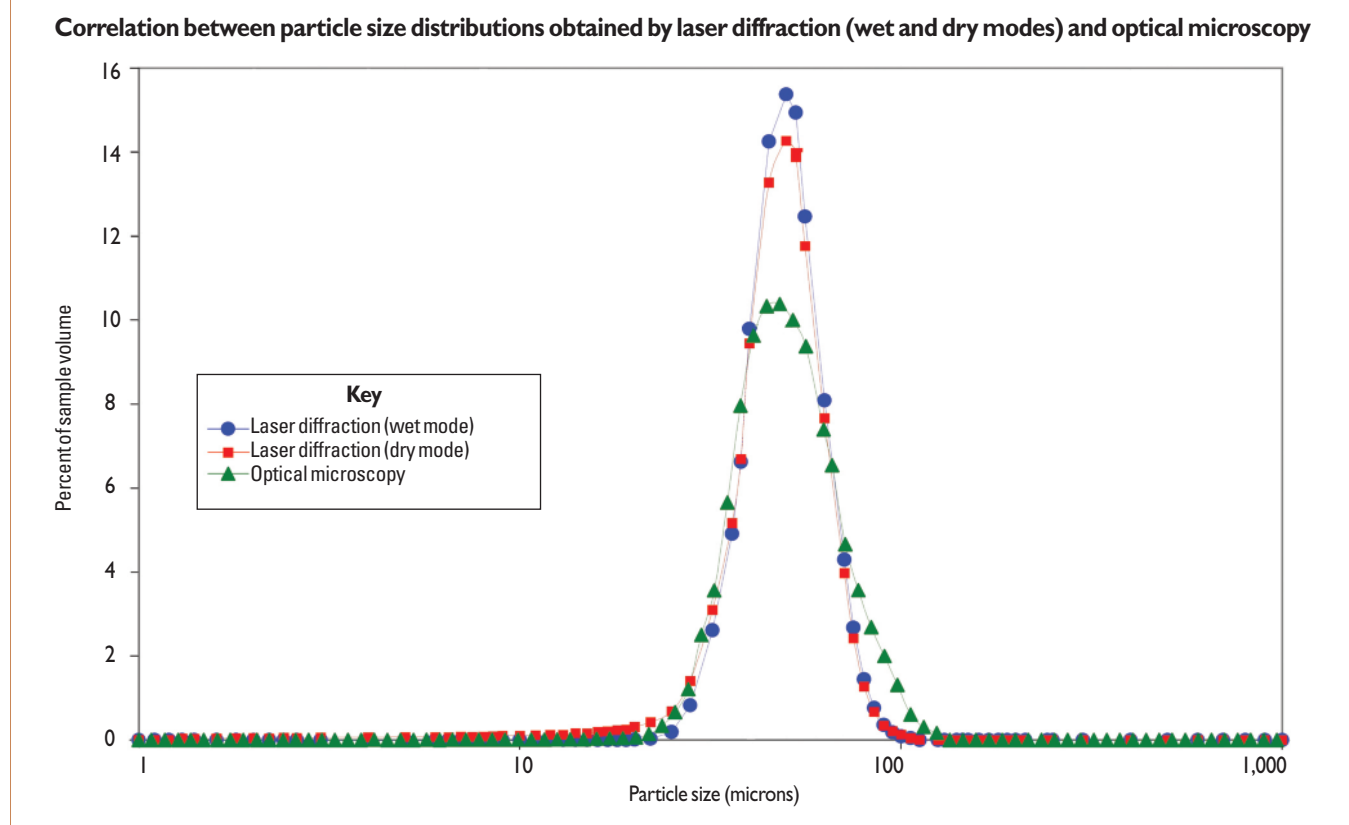
greater measurement resolution you should select the instrument that measures the size range closest to that of the powders you'll be sizing. Also avoid choosing a laser diffraction analyzer for measuring monodisperse particles (that is, particles with the same size and shape) between 0.02 and 0.10 microns (20 and 100 nanometers); other sizing methods, such as dynamic light scattering, capillary hydrodynamic fractionation, acoustic spectroscopy, and electron microscopy, provide better resolution for particles in this range.

3 Wet and dry sample dispersion modes

If your powder consists of fragile particles, such as polymers, biological materials, or hollow particles, you'll probably prefer to disperse the particles in a liquid sample (in *wet mode*) because it's gentler than measuring them in a dry sample. In other cases, such as when your powder is soluble in water and organic solvents or when you want to speed analysis and avoid taking the time to disperse samples in liquid, you may prefer to use a dry sample. Thus, if you'll size multiple powders with varying characteristics, you should choose a laser diffraction analyzer that can handle both wet and dry sample dispersion modes. To save analysis time, also make sure that the instrument can switch quickly between wet and dry modes.

Before choosing a laser diffraction instrument, also confirm that the instrument can properly disperse your samples to eliminate particle clusters (agglomerates). (For a wet sample, the instrument applies ultrasonic vibration to disperse the particles; for a dry sample, it applies high-pressure air.) You

Figure 2



can confirm that the dispersion is adequate by correlating the wet and dry sample sizing results with those from an optical microscope for the same sample. Optical microscopy directly measures each particle in the sample, providing accurate information about particle size and shape, while laser diffraction analysis approximates the particle size by analyzing the particles' light-scattering properties. When laser diffraction sizing results for a wet or dry powder sample correlate well with optical microscopy results for a sample of the same powder, as shown in Figure 2, you'll know that the wet and dry samples have been well dispersed. As illustrated in the figure, the particle size distributions for the three sizing modes are similar and each mode obtains a median particle diameter of 50 microns.

4 Control particle size in real time

A laser diffraction analyzer that permits you to evaluate how dispersion affects the particle size distribution of a sample in real time — that is, from second to second — will help you select the best dispersion level for the sample. Once you've checked the effect of applying ultrasound vibration or high-pressure air to your sample in real time, you'll know how long to apply the vibration or air to a sample before conducting the laser diffraction particle size analysis. In Figure 3, you can see the effect of ultrasonic vibration on a wet sample's particle size distribution as measured by optical microscopy; here, dispersing the particles eliminates agglomerates and yields a more accurate size distribution.

5 Laser source and optical performance

The laser source is the most important component in a laser diffraction particle size analyzer. Choosing an analyzer

with a long-lasting laser source will help you avoid frequent downtime and expensive repairs.

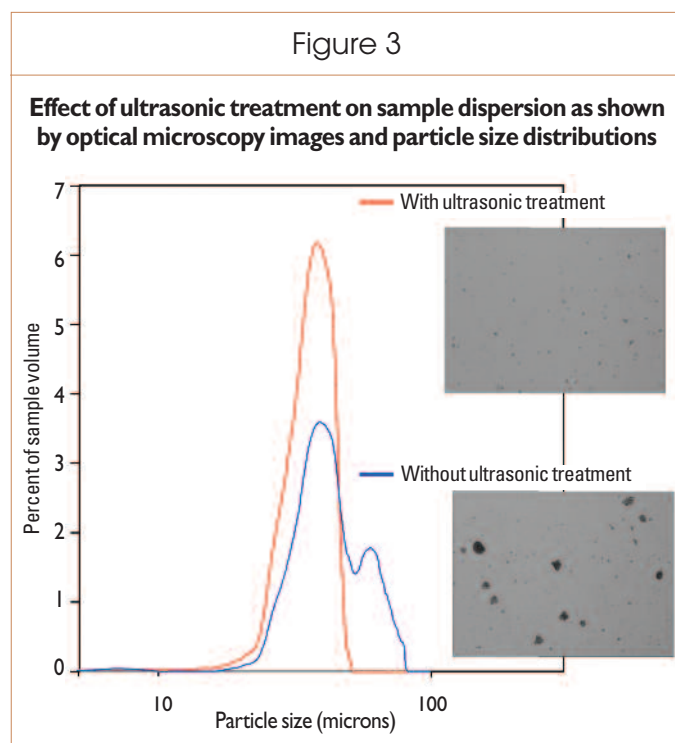
The type of laser source also affects how the analyzer is operated, and some laser sources are available with various options that can improve optical performance. If the instrument has a gas laser, such as a helium-neon laser, you must allow the laser to warm up for an adequate time (as described in ISO 13320:2009) to let the gas temperature stabilize before conducting an analysis; otherwise, the laser intensity won't be stable and the particle size measurement can be false. If the analyzer has a diode laser, the laser source should be a fibered diode so that the laser beam is well collimated (well focused), or the diode laser should have a spatial filter to collimate the laser beam. If the analyzer has a light-emitting diode (LED) laser, make sure that the instrument has an interferential optical filter to improve the wavelength profile (that is, prevent the analyzer's optics from receiving unwanted wavelength signals) and achieve more accurate sizing results.

If your analyzer's location will be subject to vibration effects, such as near the production area in a cement plant with grinding equipment, ensure that the analyzer's optical components (or *optical bench*, including the laser source, lenses, sample cell, and detectors) are robust to resist the transmitted vibration and thus avoid misalignment problems. **PBEI**

Reference

1. Available from International Organization for Standardization (go to www.iso.org and click on Products).

Figure 3



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