# INTERNATIONAL STANDARD

# ISO 13320-1

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# Particle size analysis — Laser diffraction methods —

## Part 1:
General principles

*Analyse granulométrique — Méthodes par diffraction laser —*

*Partie 1: Principes généraux*

Reference number
ISO 13320-1:1999(E)

## Contents





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## Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 3.

Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

International Standard ISO 13320-1 was prepared by Technical Committee ISO/TC 24, *Sieves, sieving and other sizing methods*, Subcommittee SC 4, *Sizing by methods other than sieving*.

ISO 13320 consists of the following parts, under the general title *Particle size analysis — Laser diffraction methods*:

— *Part 1: General principles*

— *Part 2: Validation of inversion procedures*

Annexes A to E of this part of ISO 13320 are for information only.

## Introduction

Laser diffraction methods are nowadays widely used for particle sizing in many different applications. The success of the technique is based on the fact that it can be applied to various kinds of particulate systems, is fast and can be automated and that a variety of commercial instruments is available. Nevertheless, the proper use of the instrument and the interpretation of the results require the necessary caution.

Therefore, there is a need for establishing an International Standard for particle size analysis by laser diffraction methods. Its purpose is to provide a methodology for adequate quality control in particle size analysis.

Historically, the laser diffraction technique started by taking only scattering at small angles into consideration and, thus, has been known by the following names:

— Fraunhofer diffraction;

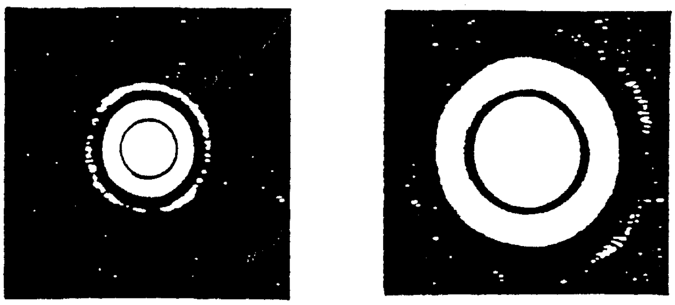
— (near-) forward light scattering;

— low-angle laser light scattering (LALLS).

However, the technique has been broadened to include light scattering in a wider angular range and application of the Mie theory in addition to approximating theories such as Fraunhofer and anomalous diffraction.

The laser diffraction technique is based on the phenomenon that particles scatter light in all directions with an intensity pattern that is dependent on particle size. All present instruments assume a spherical shape for the particles. Figure 1 illustrates the characteristics of single particle scattering patterns: alternation of high and low intensities, with patterns that extend for smaller particles to wider angles than for larger particles [2-7, 10, 15 in the bibliography].

Within certain limits the scattering pattern of an ensemble of particles is identical to the sum of the individual scattering patterns of all particles present. By using an optical model to compute scattering patterns for unit volumes of particles in selected size classes and a mathematical deconvolution procedure, a volumetric particle size distribution is calculated, the scattering pattern of which fits best with the measured pattern (see also annex A).



a) b)

**Figure 1 — Scattering pattern for two spherical particles: the particle generating pattern a) is twice as large as the one generating pattern b)**

A typical laser diffraction instrument consists of a light beam (usually a laser), a particulate dispersing device, a detector for measuring the scattering pattern and a computer for both control of the instrument and calculation of the particle size distribution. Note that the laser diffraction technique cannot distinguish between scattering by single particles and scattering by clusters of primary particles forming an agglomerate or an aggregate. Usually, the resulting particle size for agglomerates is related to the cluster size, but sometimes the size of the primary particles is reflected in the particle size distribution as well. As most particulate samples contain agglomerates or aggregates and one is generally interested in the size distribution of the primary particles, the clusters are usually dispersed into primary particles before measurement.

Historically, instruments only used scattering angles smaller than 14°, which limited the application to a lower size of about 1 µm. The reason for this limitation is that smaller particles show most of their distinctive scattering at larger angles (see also annex A). Many recent instruments allow measurement at larger scattering angles, some up to about 150°, for example through application of a converging beam, more or larger lenses, a second laser beam or more detectors. Thus, smaller particles down to about 0,1 µm can be sized. Some instruments incorporate additional information from scattering intensities and intensity differences at various wavelengths and polarization planes in order to improve the characterization of particle sizes in the submicrometre range.