AS 4863.1—2000
ISO 13320-1:1999

AS 4863.1

Australian Standard™

Particle size analysis—Laser diffraction methods

Part 1: General principles

Standards Australia

This Australian Standard was prepared by Committee CH/32, Particle Size Analysis. It was approved on behalf of the Council of Standards Australia on 31 May 2000 and published on 23 June 2000.

The following interests are represented on Committee CH/32:

Australian Pre-Mixed Concrete Association
CSIRO Land and Water
Queensland University of Technology
Royal Australian Chemical Institute
Scientific Suppliers Association of Australia
Sydney University
University of South Australia

Keeping Standards up-to-date

Standards are living documents which reflect progress in science, technology and systems. To maintain their currency, all Standards are periodically reviewed, and new editions are published. Between editions, amendments may be issued. Standards may also be withdrawn. It is important that readers assure themselves they are using a current Standard, which should include any amendments which may have been published since the Standard was purchased.

Detailed information about Standards can be found by visiting the Standards Australia web site at www.standards.com.au and looking up the relevant Standard in the on-line catalogue.

Alternatively, the printed Catalogue provides information current at 1 January each year, and the monthly magazine, *The Australian Standard*, has a full listing of revisions and amendments published each month.

We also welcome suggestions for improvement in our Standards, and especially encourage readers to notify us immediately of any apparent inaccuracies or ambiguities. Contact us via email at mail@standards.com.au, or write to the Chief Executive, Standards Australia International Ltd, PO Box 1055, Strathfield, NSW 2135.

This Standard was issued in draft form for comment as DR 99470.

Australian Standard™

Particle size analysis—Laser diffraction methods

Part 1: General principles

First published as AS 4863.1—2000.

Published by Standards Australia International Ltd
PO Box 1055, Strathfield, NSW 2135, Australia

ISBN 0 7337 3462 6

PREFACE

This Standard was prepared by the Standards Australia Committee CH/32, Particle Size Analysis. This Standard is identical with and has been reproduced from ISO 13320-1:1999, *Particle size analysis—Laser diffraction methods*, Part 1: *General principles*.

The objective of this Standard is to provide guidance on the measurement of size distributions of particles in any two-phase system, for example powders, sprays, aerosols, suspensions, emulsions and gas bubbles in liquids, through analysis of their angular light scattering patterns. It does not address the specific requirements of particle size measurement of specific products. This Standard is applicable to particle sizes ranging from approximately 0.1 µm to 3 mm.

For non-spherical particles, an equivalent-sphere size distribution is obtained because the technique uses the assumption of spherical particles in its optical model. The resulting particle size distribution may be different from those obtained by methods based on other physical principles (e.g. sedimentation, sieving).

As this Standard is reproduced from an International Standard, the following applies:

(a) Its number appears on the cover and title page while the International Standard number appears only on the cover.

(b) In the souce text, 'this part of ISO 13320' should read 'this Australian Standard'.

(c) A full point substitutes for a comma when referring to a decimal marker.

(d) Substitute 'mL' for 'ml' wherever it appears.

This ISO document listed as a normative reference in Clause 2 has not been adopted as an Australian Standard.

CONTENTS

Page

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;

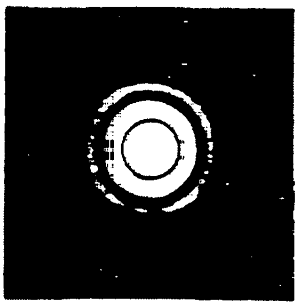
— (near-) forward light scattering;

— low-angle laser light scattering (LALLS).

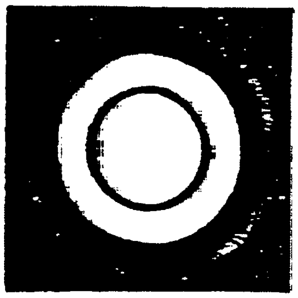
However, the technique has been broadened to include light scattering in a wider angular range and application of the Mie theory in addition to approximating theories such as Fraunhofer and anomalous diffraction.

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.

NOTES

AUSTRALIAN STANDARD

Particle size analysis—Laser diffraction methods

Part 1:

General principles

1 Scope

This part of ISO 13320 provides guidance on the measurement of size distributions of particles in any two-phase system, for example powders, sprays, aerosols, suspensions, emulsions and gas bubbles in liquids, through analysis of their angular light scattering patterns. It does not address the specific requirements of particle size measurement of specific products. This part of ISO 13320 is applicable to particle sizes ranging from approximately 0,1 μm to 3 mm.

For non-spherical particles, an equivalent-sphere size distribution is obtained because the technique uses the assumption of spherical particles in its optical model. The resulting particle size distribution may be different from those obtained by methods based on other physical principles (e.g. sedimentation, sieving).

2 Normative reference

The following normative document contains provisions which, through reference in this text, constitute provisions of this part of ISO 13320. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this part of ISO 13320 are encouraged to investigate the possibility of applying the most recent edition of the normative document indicated below. For undated references, the lates edition of the normative document referred to applies. Members of ISO and IEC maintain registers of currently valid International Standards.

ISO 9276-1:1990, *Representation of results of particle size analysis — Part 1: Graphical representation.*

3 Terms, definitions and symbols

For the purposes of this part of ISO 13320, the following terms, definitions and symbols apply.

3.1 Terms and definitions

3.1.1
absorption
reduction of intensity of a light beam traversing a medium through energy conversion in the medium

3.1.2
coefficient of variation
relative measure (%) for precision: standard deviation divided by mean value of population and multiplied by 100 (for normal distributions of data the median is equal to the mean)