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Determination of particle size distribution by gravitational liquid sedimentation methods —

Part 1: General principles, requirements and guidance

Détermination de la distribution granulométrique par les méthodes de sédimentation par gravité dans un liquide —

Partie 1: Principes généraux et orientation

Reference number
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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.

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This document was prepared by Technical Committee ISO/TC 24, *Particle characterization including sieving*, Subcommittee SC 4, *Particle characterization*.

This second edition cancels and replaces the first edition (ISO 13317-1:2001), which has been technically revised.

The main changes are as follows:

— core terms and definitions have been revised;

— the explanation of measurement principle and techniques has been revised and expanded;

— sedimentation velocity as measurand has been included;

— a guide for the determination of measurement uncertainty has been included.

A list of all parts in the ISO 13317 series can be found on the ISO website.

Any feedback or questions on this document should be directed to the user’s national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

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Introduction

Gravitational sedimentation has been an established principle of particle size analysis for several decades. It is employed in various academic and industrial fields of application. Numerous national and international standards address gravitational sedimentation techniques and analytical methods.

Although manifold new particle sizing techniques have emerged during the last two decades, sedimentation techniques have been recently rediscovered. This is due to substantial technical advancements and the fact that they are based on a first-principle measurement of the particles' directed motion (migration) under gravity.

The measurands of gravitational sedimentation techniques are the distributions of sedimentation velocity and corresponding particle size. They are derived from observations of phase separation – either by monitoring the deposition of particles or the depletion of dispersion. The physical principles employed to determine the quantity of particles differ widely, whereas sedimentation velocity is in each case computed from the vertically migrated distance and measurement time. This computation does not demand essential preconditions and theoretical assumptions. Yet, the transformation of velocity into particle size relies on the applicability of Stokes' law. As fractionating technique, sedimentation analysis can distinguish between particle fractions of close sedimentation velocity. Accordingly, particle size distributions can be very finely resolved, which is an advantage compared to spectroscopic ensemble techniques.

The ISO 13317 series covers the methods to determine the distributions of sedimentation velocities and particle size of particulate materials by gravitation-induced particle migration in liquids. The direction of this motion depends on the density difference (density contrast) between dispersed and continuous phase. During the measurement, particles should not undergo any physical or chemical change in the continuous phase (liquid).

The primary measurand is the particle velocity distribution, which is converted into size distribution based on established sedimentation theory. The measurement techniques described in the ISO 13317 series are applicable to liquid dispersions, like suspensions and emulsions. The measurable particle size range depends on material properties and typically reaches from 200 nm to 100 µm for aqueous samples, whereas sedimentation velocity can be quantified in the range from 0,6 µm/s to 10 mm/s. Sedimentation analysis is conducted for low particle concentrations. The maximum permissible value depends on the measurement technique and the analysis theory. In general, the volume fraction of particles is well below 1 %.

It is the responsibility of the user of this document to establish appropriate safety and health practices and to determine the applicability of the regulatory limitations prior to its use.

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Determination of particle size distribution by gravitational liquid sedimentation methods —

Part 1:
General principles, requirements and guidance

1 Scope

This document specifies the principles of particle size analysis by gravitational sedimentation, the principal types of measurement techniques as well as the general rules for conducting measurements, method validation, determination of the uncertainty budget and representation of results.

This document covers neither particle migration by centrifugal, electric or magnetic forces nor sedimentation at high particle concentrations (e.g. zone sedimentation). Moreover, this document does not deal with the determination of properties other than sedimentation velocity and particle size (i.e. neither particle concentration, particle shape, particle density, zeta-potential nor apparent viscosity).

NOTE This document can involve hazardous materials, operations and equipment. This document does not purport to address all the safety problems associated with its use. Explosion proof analysers are required when examining volatile liquids with a low flash point.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

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

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at https://www.electropedia.org/

3.1
sedimentation
directional motion of *particles* (3.7) in a viscous liquid under the action of gravity or centrifugal fields

Note 1 to entry: For a positive *density contrast* (3.17), sedimentation occurs in the direction of gravitational acceleration; it is counter directed to this acceleration for a negative density contrast.

Note 2 to entry: A downward motion under gravity is also called "settling" or "falling".

Note 3 to entry: An upward motion under gravity is also called "creaming" (e.g. droplets) or more generally, "rising" or "floating".

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