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Granulometrijska analiza - Metode analize slike - 1. del: Statične metode analize slike

Particle size analysis - Image analysis methods - Part 1: Static image analysis methods

Analyse granulométrique - Méthodes par analyse d'images - Partie 1: Méthodes par analyse d'images statiques

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INTERNATIONAL STANDARD

ISO 13322-1

Second edition
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Particle size analysis — Image analysis methods —

Part 1: Static image analysis methods

Analyse granulométrique — Méthodes par analyse d'images —

Partie 1: Méthodes par analyse d'images statiques

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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.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the WTO principles in the Technical Barriers to Trade (TBT) see the following URL: Foreword - Supplementary information

The committee responsible for this document is ISO/TC 24, *Particle characterization including sieving*, Subcommittee SC 4, *Particle characterization*.

This second edition cancels and replaces the first edition (ISO 13322-1:2004), which has been technically revised.

ISO 13322 consists of the following parts, under the general title *Particle size analysis — Image analysis methods*:

— *Part 1: Static image analysis methods*

— *Part 2: Dynamic image analysis methods*

Introduction

The purpose of this part of ISO 13322 is to give guidance when using images for particle size analysis.

Image analysis is a technique that has gained popularity in different applications. The aim of this part of ISO 13322 is to give a standardized description of the technique used and its validation. This part of ISO 13322 does not describe specific instruments and is restricted to those parts of the acquisition of images that are relevant to the accuracy of the particle size analysis.

This part of ISO 13322 includes methods of calibration verification and recommends using a certified standard as a reference scale. However it is sensible to make some measurements on particles under study, or other reference objects, of known size so that the likely systematic uncertainties introduced by the equipment can be assessed.

Errors introduced at all stages of the analysis from sub-division of the sample to generation of the final result add to the total uncertainty of measurements and it is important to obtain estimates for the uncertainty arising from each stage.

Essential operations are identified to ensure that measurements made conform to this part of ISO 13322 and are traceable.

Particle size analysis — Image analysis methods —

Part 1: Static image analysis methods

1 Scope

This part of ISO 13322 is applicable to the analysis of images for the purpose of determining particle size distributions where the velocity of the particles against the axis of the optical system of the imaging device is zero. The particles are appropriately dispersed and fixed in the object plane of the instrument. The field of view may sample the object plane dynamically either by moving the sample support or the camera provided this can be accomplished without any motion effects on the image. Captured images can be analysed subsequently.

This part of ISO 13322 concentrates upon the analysis of digital images created from either light or electron detection systems. It does not address the method of creating the image although the detection settings chosen together with its calibration are important to particle sizing accuracy. This part of ISO 13322 considers only image evaluation methods using complete pixel counts.

Both the type of distribution, (by number or by volume) together with the width of the particle size distribution has a very material influence upon the number of particles to be measured to secure the desired accuracy within the specified confidence limits. An example is shown in Annex A.

Automation of the analysis is possible in order to measure sufficient particle numbers for a required degree of precision.

This part of ISO 13322 does not address the sample preparation. However, the sub sampling, dispersion and presentation of particles to be measured are a vital part of the operational chain of actions necessary to ensure accuracy and precision of any final result.

NOTE Further details about sampling and sample preparation can be found in ISO 14887 and ISO 14488.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. 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*

ISO 9276-2, *Representation of results of particle size analysis — Part 2: The calculations of average particle sizes/diameters and moments from particle size distributions*

ISO 14488, *Particulate materials — Sampling and sample splitting for the determination of particulate properties*

3 Terms and definitions and list of symbols

3.1 Terms and definitions

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

3.1.1
area equivalent diameter
diameter of a circle having the same area as the projected image of the particle

Note 1 to entry: It is also known as the Heywood diameter or as the equivalent circular diameter.

3.1.2
binary image
digitized image consisting of an array of pixels, each of which has a value of 0 or 1, whose values are normally represented by dark and bright regions on the display screen or by the use of two distinct colours

3.1.3
contrast (of an image)
<particle size analysis> difference between the intensity of the particle image with respect to the background near to the particle

3.1.4
edge detection
methods used to detect transition between objects and background

Note 1 to entry: See *segmentation method* (3.1.13).

3.1.5
Feret diameter
distance between two parallel tangents on opposite sides of the image of a particle

3.1.6
field of view
field which is viewed by the viewing device

Note 1 to entry: The full image frame of a digital imaging device corresponds to its field of view.

SEE: Figure 1.

3.1.7
grey image
image in which multiple grey level values are permitted for each pixel

3.1.8
image analysis
processing and data reduction operation which yields a numerical or logical result from an image

3.1.9
measurement field
field which is composed by the set of all measurement frames

SEE: Figure 1.

3.1.10
measurement frame
selected area from the field of view in which particles are sized and counted for image analysis

SEE: Figure 1.

3.1.11
pixel
picture element
individual sample in a digital image that has been formed by uniform sampling in both the horizontal and vertical directions

3.1.12
raster pattern
scanning order of measurement frames in the total measurement field

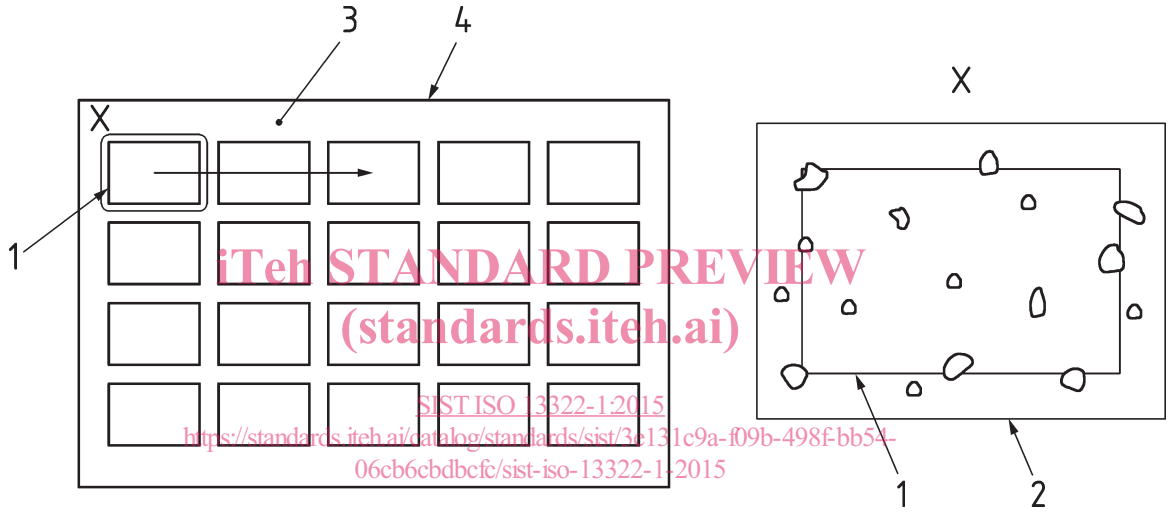
SEE: Figure 1.

3.1.13
segmentation method
strategy employed to separate the objects of interest from their surroundings

Note 1 to entry: Method of dividing the particle image from the background.

Note 2 to entry: See *edge detection* (3.1.4).

3.1.14
threshold
grey level value which is set to discriminate objects of interest from background



Key
1 measurement frame
2 field of view
3 raster pattern of measurement frames
4 measurement field
X enlarged view of a field of view

Figure 1 — Relationship between the terms "field of view", "measurement frame", "raster pattern" and "measurement field"

3.2 Symbols

A_i projected area of particle i

α_1 horizontal calibration factor

α_2 vertical calibration factor

d minimum feature length

d_c diameter of a circle

N number of particles to be measured

n_c measured number of pixels within a circle

n_j numbers of particles in size interval Δx_j

P_i probability that particle i exists in the measuring frame (also called Miles-Lantuéjoul factor)

φ_i shape descriptor

σ standard deviation

V_i volume of particle i

$x_{A,i}$ area equivalent diameter of particle i

x_{F1} horizontal Feret diameter of object

x_{F2} vertical Feret diameter of object

x_i dimension of particle i

$x_{Fmax,i}$ longest dimension of particle i, also called maximum Feret diameter

$x_{Fmin,i}$ shortest dimension of particle i, also called minimum Feret diameter

x_1 horizontal dimension of object

$x_{1,m}$ horizontal dimension of object in SI unit

$x_{1,p}$ horizontal dimension of object in pixel

x_2 vertical dimension of object

$x_{2,m}$ vertical dimension of object in SI unit

$x_{2,p}$ vertical dimension of object in pixel

$x_{10,3}$ particle size corresponding to 10 % of the cumulative undersize distribution by volume

$x_{90,3}$ particle size corresponding to 90 % of the cumulative undersize distribution by volume

Z_1 horizontal side length of the rectangular measurement frame

Z_2 vertical side length of the rectangular measurement frame