INTERNATIONAL STANDARD

ISO 21501-4

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Determination of particle size distribution — Single particle light interaction methods —

Part 4:
Light scattering airborne particle counter for clean spaces

Détermination de la distribution granulométrique — Méthodes d'interaction lumineuse de particules uniques —

Partie 4: Compteur de particules en suspension dans l'air en lumière dispersée pour espaces propres

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.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. 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.

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.

ISO 21501-4 was prepared by Technical Committee ISO/TC 24, *Sieves, sieving and other sizing methods*, Subcommittee SC 4, *Sizing by methods other than sieving*.

This first edition of ISO 21501-4, together with ISO 21501-2 and ISO 21501-3, cancels and replaces ISO 13323-1:2000, which has been technically revised.

ISO 21501 consists of the following parts, under the general title *Determination of particle size distribution — Single particle light interaction methods*:

— *Part 2: Light scattering liquid-borne particle counter*

— *Part 3: Light extinction liquid-borne particle counter*

— *Part 4: Light scattering airborne particle counter for clean spaces*

The following part is under preparation:

— *Part 1: Light scattering aerosol spectrometer*

Introduction

Monitoring particle contamination levels is required in various fields, e.g. in the electronic industry, in the pharmaceutical industry, in the manufacturing of precision machines and in medical operations. Particle counters are useful instruments for monitoring particle contamination in air. The purpose of this part of ISO 21501 is to provide a calibration procedure and verification method for particle counters, so as to minimize the inaccuracy in the measurement result by a counter, as well as the differences in the results measured by different instruments.

Determination of particle size distribution — Single particle light interaction methods —

Part 4:
Light scattering airborne particle counter for clean spaces

1 Scope

This part of ISO 21501 describes a calibration and verification method for a light scattering airborne particle counter (LSAPC), which is used to measure the size and particle number concentration of particles suspended in air. The light scattering method described in this part of ISO 21501 is based on single particle measurements. The typical size range of particles measured by this method is between 0,1 µm and 10 µm in particle size.

Instruments that conform to this part of ISO 21501 are used for the classification of air cleanliness in cleanrooms and associated controlled environments in accordance with ISO 14644-1, as well as the measurement of number and size distribution of particles in various environments.

The following are within the scope of this part of ISO 21501:

— size calibration;

— verification of size setting;

— counting efficiency;

— size resolution;

— false count rate;

— maximum particle number concentration;

— sampling flow rate;

— sampling time;

— sampling volume;

— calibration interval;

— test report.

2 Terms and definitions

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

2.1
calibration particles
mono-disperse spherical particle with a known mean particle size, e.g. polystyrene latex (PSL) particle, that is traceable to an international standard of length, and where the standard uncertainty of the mean particle size is equal to or less than ± 2,5 %

NOTE The refractive index of calibration particles is close to 1,59 at a wavelength of 589 nm (sodium D line).

2.2
counting efficiency
ratio of the measured result of a light scattering airborne particle counter (LSAPC) to that of a reference instrument using the same sample

2.3
particle counter
instrument that counts the number of particles and measures their size using the light scattering method or the light extinction method

2.4
pulse height analyser
PHA
instrument that analyses the distribution of pulse heights

2.5
size resolution
measure of the ability of an instrument to distinguish between particles of different sizes

3 Requirements

3.1 Size calibration

The recommended procedure for size calibration is described in 4.1.

3.2 Verification of size setting

The error in the detectable minimum particle size and other sizes specified by the manufacturer of an LSAPC shall be equal to or less than ± 10 % when the test is carried out by the method described in 4.2.

3.3 Counting efficiency

The counting efficiency shall be (50 ± 20) % for calibration particles with a size close to the minimum detectable size, and it shall be (100 ± 10) % for calibration particles with a size of 1,5 times to 2 times larger than the minimum detectable particle size.

3.4 Size resolution

The size resolution shall be equal to or less than 15 % for calibration particles of a size specified by the manufacturer.

3.5 False count rate

The false count rate is determined by measuring the particle number concentration in the unit of counts per cubic meter at the minimum reported size range when sampling clean air.

3.6 Maximum particle number concentration

The maximum measurable particle number concentration shall be specified by the manufacturer. The coincidence loss at the maximum particle number concentration of an LSAPC shall be equal to or less than 10 %.

NOTE When the particle number concentration is higher than the maximum particle number concentration, the number of uncounted particles increases because of an enhanced probability of multiple particles existing in the sensing volume (coincidence error) and/or saturation of the electronic system.

3.7 Sampling flow rate

The standard uncertainty of volumetric flow rate shall be equal to or less than ± 5 %.

If the LSAPC does not have a flow rate control system this subclause does not apply, however the manufacturer shall specify the allowable limit of its flow rate of the LSAPC.

3.8 Sampling time

The standard uncertainty in the duration of sampling time shall be equal to or less than ± 1 % of the preset value.

If the LSAPC does not have a sampling time control system, this subclause does not apply.

3.9 Response rate

The response rate of the LSAPC obtained according to the test method given in 4.9 shall be equal to or less than 0,5 %.

3.10 Calibration interval

It is recommended that the calibration interval of an LSAPC be one year or less.

3.11 Test report

The following minimum information shall be recorded:

a) date of calibration;

b) calibration particle sizes;

c) flow rate;

d) size resolution (with the particle size used);

e) counting efficiency;

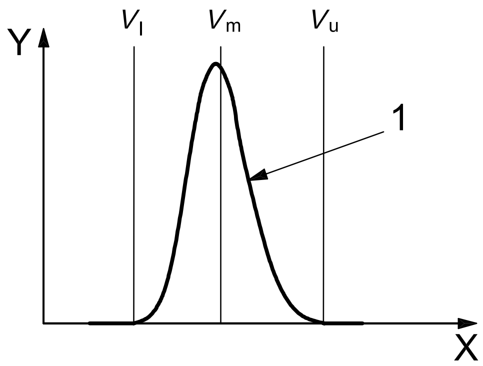
f) false count rate;

g) voltage limit or channel of an internal pulse height analyser (PHA).

4 Test method

4.1 Size calibration

When calibrating an LSAPC with calibration particles of known size, the median voltage (or internal PHA channel), corresponds to the particle size (see Figure 1). The median voltage (or internal PHA channel) should be determined by using a particle counter with variable voltage limit (or internal PHA channel) settings. The median voltage (or internal PHA channel) is the voltage (or internal PHA channel) that equally divides the total number of pulses counted. When a particle counter with variable voltage limit settings is not available, a PHA can be used in place of the counter.



Key

X pulse height voltage (or channel)

Y density

1 pulse height distribution with PSL particles

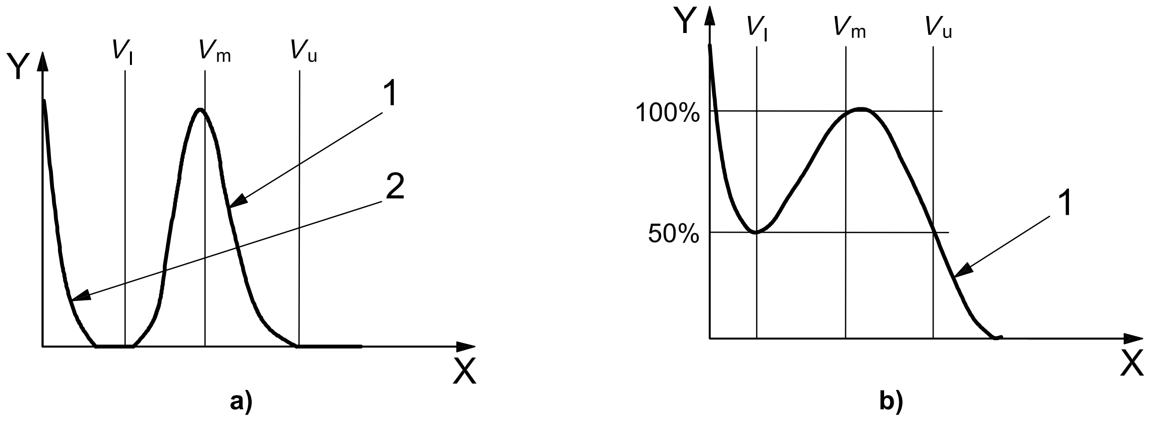
V_l lower voltage limit

V_m median voltage

V_u upper voltage limit

Figure 1 — Pulse height distribution of PSL particle signals

When noise signals appear as if there are many small particles in the sample, the median voltage (or internal PHA channel) shall be determined by discarding the pulses due to “false particles” [see Figure 2 a)]. The discarding should only be done when the density at the peak due to real particles is more than twice the density at the valley that separates it from the pulses due to “false particles” [see Figure 2 b)]. In this case, V_u is the voltage greater than the median voltage, V_m, where the density is the same as V_l. The median is calculated using only the population between the voltage limits V_l and V_u.



Key

X pulse height voltage (or channel)

Y density

1 pulse height distribution with PSL particles

2 noise (false particles, small particles and/or optical, electrical noise)

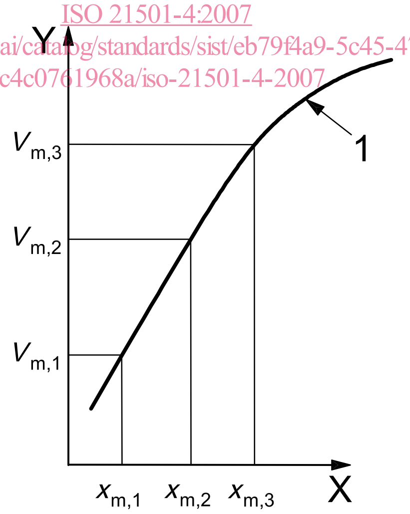
V_l lower voltage limit

V_m median voltage

V_u upper voltage limit

Figure 2 — Pulse height distribution of PSL particle signals with noise

The voltages of channels corresponding to particle size should be determined in accordance with the calibration curve provided by the manufacturer (see Figure 3).



Key

X particle size

Y median value of calibration particles

1 calibration curve

$V_{m,1}$ median voltage corresponding to particle size $x_{m,1}$

$V_{m,2}$ median voltage corresponding to particle size $x_{m,2}$

$V_{m,3}$ median voltage corresponding to particle size $x_{m,3}$

Figure 3 — Calibration curve

NOTE When the median voltage is determined by using an external PHA, the uncertainty in the voltage of PHA and the voltage uncertainty of the LSAPC are included in setting the voltage limits of the LSAPC (see Annex A).