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High-efficiency filters and filter media for removing particles in air —

Part 5:
Test method for filter elements

Filtres à haut rendement et filtres pour l'élimination des particules dans l'air —

Partie 5: Méthode d'essai des éléments filtrants

Reference number
ISO 29463-5:2011(E)

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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 29463-5 was prepared by Technical Committee ISO/TC 142, *Cleaning equipment for air and other gases*.

ISO 29463 consists of the following parts, under the general title *High-efficiency filters and filter media for removing particles in air*:

— *Part 1: Classification, performance, testing and marking*

— *Part 2: Aerosol production, measuring equipment, particle-counting statistics*

— *Part 3: Testing flat sheet filter media*

— *Part 4: Test method for determining leakage of filter element — Scan method*

— *Part 5: Test method for filter elements*

Introduction

ISO 29463 (all parts) is derived from EN 1822 (all parts) with extensive changes to meet the requests from non-EU p-members. It contains requirements, fundamental principles of testing and the marking for high-efficiency particulate air filters with efficiencies from 95 % to 99,999 995 % that can be used for classifying filters in general or for specific use by agreement between users and suppliers.

ISO 29463 (all parts) establishes a procedure for the determination of the efficiency of all filters on the basis of a particle counting method using a liquid (or alternatively a solid) test aerosol, and allows a standardized classification of these filters in terms of their efficiency, both local and overall efficiency, which actually covers most requirements of different applications. The difference between ISO 29463 (all parts) and other national standards lies in the technique used for the determination of the overall efficiency. Instead of mass relationships or total concentrations, this technique is based on particle counting at the most penetrating particle size (MPPS), which is, for micro-glass filter mediums, usually in the range of 0,12 µm to 0,25 µm. This method also allows testing ultra-low-penetration air filters, which was not possible with the previous test methods because of their inadequate sensitivity. For membrane filter media, separate rules apply, and are described in Annex B. Although no equivalent test procedures for testing filters with charged media is prescribed, a method for dealing with these types of filters is described in Annex C. Specific requirements for testing method, frequency, and reporting requirements can be modified by agreement between supplier and customer. For lower-efficiency filters (group H, as described below), alternate leak test methods described in ISO 29463-4:2011, Annex A, can be used by specific agreement between users and suppliers, but only if the use of these other methods is clearly designated in the filter markings as noted in ISO 29463-4:2011, Annex A.

There are differences between ISO 29463 (all parts) and other normative practices common in several countries. For example, many of these rely on total aerosol concentrations rather than individual particles. For information, a brief summary of these methods and their reference standards are provided in Annex D of this part of ISO 29463.

High-efficiency filters and filter media for removing particles in air —

Part 5: Test method for filter elements

1 Scope

This part of ISO 29463 specifies the reference test procedure for determining the efficiency of filters at their most penetrating particle size (MPPS). It also gives guidelines for the testing and classification for filters with an MPPS of less than 0,1 µm (Annex B) and filters using media with (charged) synthetic fibres (Annex C). It is intended for use in conjunction with ISO 29463-1, ISO 29463-2, ISO 29463-3 and ISO 29463-4.

2 Normative references

The following referenced documents are indispensable for the application 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 5167-1, *Measurement of fluid flow by means of pressure differential devices inserted in circular cross-section conduits running full — Part 1: General principles and requirements*

ISO/TS 21220:2009, *Particulate air filters for general ventilation — Determination of filtration performance*

ISO 21501-4, *Determination of particle size distribution — Single particle light interaction methods — Part 4: Light scattering airborne particle counter for clean spaces*

ISO 29463-1:2011, *High-efficiency filters and filter media for removing particles in air — Part 1: Classification, performance, testing and marking*

ISO 29463-2:2011, *High-efficiency filters and filter media for removing particles in air — Part 2: Aerosol production, measuring equipment, particle-counting statistics*

ISO 29463-3, *High-efficiency filters and filter media for removing particles in air — Part 3: Testing flat sheet filter media*

ISO 29463-4:2011, *High-efficiency filters and filter media for removing particles in air — Part 4: Test method for determining the leakage of filter elements — Scan method*

ISO 29464[1)], *Cleaning equipment for air and other gases — Terminology*

1) To be published.

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 29463-1, ISO 29463-2, ISO 29463-3, ISO 29463-4, ISO 29464 and the following apply.

3.1
sampling duration
time during which the particles in the sampling volume flow are counted (upstream or downstream)

3.2
measuring procedure with fixed sampling probes
determination of the overall efficiency using fixed sampling probes upstream and downstream of the test filter

3.3
total particle count method
particle counting method in which the total number of particles in a certain sample volume is determined without classification according to size

EXAMPLE By using a condensation particle counter.

3.4
particle counting and sizing method
particle counting method which allows both the determination of the number of particles and also the classification of the particles according to size

EXAMPLE By using an optical particle counter.

3.5
particle concentration method
method that can determine the total concentration of particles in the aerosol either by multiple particle counting or chemical concentrations

NOTE No particle size classification can be determined by this method.

4 Description of the method

In order to determine the efficiency of the test filter, it is fixed in the test filter mounting assembly and subjected to a test air volume flow corresponding to the nominal volume flow rate. After measuring the pressure drop at the nominal volume flow rate, the filter is purged with clean air and the test aerosol produced by the aerosol generator is mixed with the prepared test air along a mixing section, so that it is spread homogeneously over the cross-section of the duct.

The efficiency is always determined for the MPPS; see ISO 29463-3. The size distribution of the aerosol particles can optionally be measured using a particle size analysis system, for example, a differential mobility particle sizer, DMPS.

The testing can be carried out using either a mono-disperse or poly-disperse test aerosol. When testing with (quasi-) mono-disperse aerosol, the total particle counting method may be used with a condensation particle counter (CPC) or an optical particle counter (OPC; for example a laser particle counter). It shall be ensured that the number median particle diameter corresponds to the MPPS, i.e. the particle diameter at which the filter medium has its minimum efficiency.

When using a poly-disperse aerosol, the particle counting method, e.g. an optical particle counter or DMPS, shall be used, which, in addition to counting the particles, is also able to determine their size distribution. It shall be ensured that the count median diameter, D_M, of the test aerosol lies in the range given by Equation (1):

$$\frac{S_{MPPS}}{2} > D_M > 1{,}5 \cdot S_{MPPS} \tag{1}$$

where S_{MPPS} is the most penetrating particle size.

In order to determine the overall efficiency, representative partial flows are extracted on the upstream and downstream sides of the filter element and directed to the attached particle counter via a fixed sampling probe to measure the number of particles. It is necessary to have a mixing section behind the test filter to mix the aerosol homogeneously with the test air over the duct cross-section (see 6.1.4).

4.1 Alternate efficiency test method for groups H and U filters

The standard efficiency test method, as described above, uses downstream mixing and a fixed downstream probe. However, an alternate efficiency test method using scan test equipment with moving probe(s) is provided and described in Annex A.

4.2 Statistical efficiency test method for low efficiency filters — Group E filters

For filters of group E, the overall efficiency shall be determined by one of the statistical test procedures described below and it is not necessary to carry out the test for each single filter element (as is mandatory for filters of groups H and U). The overall efficiency of group E filters shall be determined by averaging the results of the statistical leak test as described below.

A record of the filter data in the form of a type test certificate or alternatively a factory test certificate is required. However, the supplier shall be able to provide documentary evidence to verify the published filter data upon request. This can be done by either:

a) maintaining a certified quality management system (e.g. ISO 9000), which requires the application of statistically based methods for testing and documenting efficiency for group E filters in accordance with this part of ISO 29463; or

b) using accepted statistical methods to test all of production lots of filters.

The skip lot procedure as described in ISO 2859-1 or any equivalent alternative method may be used.

The skip lot procedure as described in ISO 2859-1 implies that at the beginning, the test frequency is high and is, in the course of further testing, reduced as the production experience grows and the products produced conform to the target. For example, for the first eight production lots, 100 % of the produced filters are tested. If all the tests are positive, the frequency is reduced to half for the next eight production lots. If all the tests are positive again, the number is reduced by half again, and so on until it is necessary to test only one out of eight lots (e.g. the minimum test frequency). Each time one of the tested filters fails, the test frequency is doubled again. In any case, the number of samples per lot tested shall be greater than three filters.

5 Test filter

The filter element being tested shall show no signs of damage or any other irregularities. The filter element shall be handled carefully and shall be clearly and permanently marked with the following details:

— designation of the filter element;

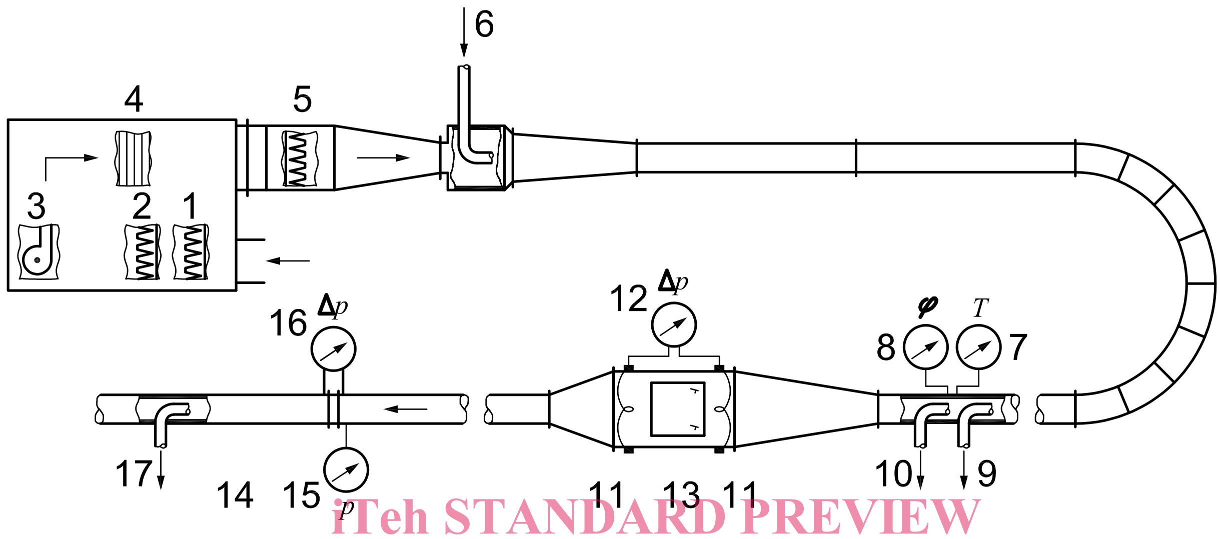
— upstream side of the filter element.

The temperature of the test filter during the testing shall correspond with that of the test air.

6 Test apparatus

A flow sheet showing the arrangement of apparatus comprising a test rig is given in ISO 29463-1:2011, Figure 4. An outline diagram of a test rig is given in Figure 1.

The fundamentals of aerosol generation and neutralization with details of suitable types of equipment as well as detailed descriptions of the measuring instruments required for the testing are given in ISO 29463-2.



Key

1 coarse dust filter
2 fine dust filter
3 fan
4 air heating
5 high-efficiency air filter
6 aerosol inlet to the test duct
7 temperature measurement
8 hygrometer
9 sampler, particle size analysis
10 sampler, upstream
11 ring pipe for differential pressure measurement
12 manometer
13 test filter mounting assembly
14 measuring damper (see ISO 5167-1)
15 measurement of absolute pressure
16 manometer measuring differential pressure
17 sampler, downstream

Figure 1 — Example of a test rig

6.1 Test duct

6.1.1 Test air conditioning

The test air conditioning equipment shall be comprised of the equipment required to control the condition of the test air so that it can be brought in compliance with the requirement of Clause 7.

6.1.2 Adjustment of the volume flow rate

Filters shall always be tested at their nominal air flow rate. It shall be possible to adjust the volume flow rate by means of a suitable provision (e.g. by changing the speed of the fan, or with dampers) to a value ±5 % of the nominal flow rate, which shall then remain constant within ±2 % throughout each test.

6.1.3 Measurement of the volume flow rate

The volume flow rate shall be measured using a standardized or calibrated method (e.g. measurement of the differential pressure using standardized damper equipment, such as orifice plates, nozzles, Venturi tubes in accordance with ISO 5167-1.

The limit error of measurement shall not exceed 5 % of the measured value.

6.1.4 Aerosol mixing section

The aerosol input and the mixing section (see Figure 1 for an example) shall be so constructed that the aerosol concentration measured at individual points of the duct cross-section, directly in front of the test filter, do not deviate by more than 10 % from the mean value of at least nine measuring points over the channel cross-section.

6.1.5 Test filter mounting assembly

The test filter mounting assembly shall ensure that the test filter can be sealed and subjected to flow in accordance with requirements.

It shall not obstruct any part of the filter cross-sectional area.

6.1.6 Measuring points for the pressure drop

The measuring points for pressure drop shall be so arranged that the mean value of the static pressure in the flow upstream and downstream of the filter can be measured. The planes of the pressure measurements upstream and downstream shall be positioned in regions of an even flow with a uniform flow profile.

In rectangular or square test ducts, smooth holes with a diameter of 1 mm to 2 mm for the pressure measurements shall be bored in the middle of the channel walls, normal to the direction of flow. The four holes shall be interconnected with a circular pipe.

6.1.7 Sampling

In order to determine the efficiency, partial flows are extracted from the test volume flow by sampling probes and led to the particle counters. The diameter of the probes shall be chosen so that isokinetic conditions are maintained in the duct at the given volume flow rate for the sample. In this way, sampling errors can be neglected due to the small size of the particles in the test aerosol. The connections to the particle counter shall be as short as possible. Samples on the upstream side are taken by a fixed sampling probe in front of the test filter. The sampling shall be representative, on the basis that the aerosol concentration measured from the sample does not deviate by more than ±10 % from the mean value determined in accordance with 6.1.4.

A fixed sampling probe is also installed downstream, preceded by a mixing section that ensures a representative measurement of the downstream aerosol concentration. This is taken to be the case when, in event of an artificially made big leak in the test filter, the aerosol concentration measured downstream the filter does not at any point deviate by more than ±10% from the mean value of at least nine measuring points over the duct cross-section. It is necessary, however, to verify beforehand that the artificially made leak is big enough to increase the filter penetration by at least a factor of five relative to the penetration of the non-leaking filter.

The mean aerosol concentrations determined at the upstream and downstream sampling points without the filter in position shall not differ from each other by more than 5 %.

6.2 Aerosol generation and measuring instruments

The operating parameters of the aerosol generator shall be adjusted to produce a test aerosol whose number median diameter is in the range of the MPPS for the sheet filter medium.

The median size of the mono-disperse test aerosol shall not deviate from the MPPS by more than ±10 %. A deviation of ±50 % is allowed when using a poly-disperse aerosol.

The particle output of the aerosol generator shall be adjusted according to the test volume flow rate and the filter efficiency, so that the counting rates on the upstream and downstream sides lie under the coincidence limits of the counter (maximum coincidence error of 10 % in accordance with ISO 21501-4), and significantly above the zero count rate of the instruments.

The number distribution concentration of the test aerosol can be determined using a suitable particle size analysis system (e.g. a differential mobility particle sizer, DMPS) or with a laser particle counter suitable for these test purposes. The limit error of the measurement method used to determine the number median value shall not exceed ±20 % relative to the measurement value.

The number of counted particles measured upstream and downstream shall be sufficiently large to provide statistically meaningful results, without the concentration exceeding the measuring range of the upstream particle counter. If the upstream number concentration exceeds the range of the particle counter (in the counting mode), a dilution system shall be inserted between the sampling point and the counter.

The particle counting may be carried out using either a pair of counters operating in parallel on the upstream and downstream sides, or using a single counter to measure the number concentrations on the upstream and downstream sides alternately. If measurements are made with only one counter, it shall be ensured that the relevant properties of the test aerosol (for example, the number concentration, particle size distribution, homogeneous distribution over the channel cross-section) remain constant over time. If two counters are used in parallel, both should be of the same type and calibrated as dual devices.

6.2.1 Apparatus for testing with a mono-disperse test aerosol

For technical reasons, the particle size distribution produced by the aerosol generator is usually quasi-mono-disperse.

When using a mono-disperse aerosol for the efficiency testing of the filter element, not only optical particle counters but also condensation particle counters may be used.

When using a condensation particle counter, it shall be ensured that the test aerosol does not contain appreciable numbers of particles that are very much smaller than the MPPS. Such particles, which can be produced, for example, by an aerosol generator that is no longer working properly, are also counted by a condensation particle counter and can lead to a considerable error in the determination of the efficiency. One way of checking for this error is to determine the number distribution of the test aerosol with a measuring device that stretches over a range from the lower range limit of the condensation particle counter up to a particle size of approximately 1 µm. The number distribution thus determined shall be quasi-mono-disperse and without the large concentration of very small particles.

The apparatus for testing with mono-disperse aerosol is shown in Figure 2.

6.2.2 Apparatus for testing with a poly-disperse test aerosol

When determining the efficiency of a filter element using a poly-disperse test aerosol, the particle number concentration and size distribution shall be determined using an optical particle counter (e.g. laser particle counters).

The test apparatus for testing with a poly-disperse aerosol is shown in Figure 3.