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High efficiency filters and filter media for removing particles from air —

Part 1: Classification, performance, testing and marking

Filtres et media à très haute efficacité pour la rétention particulaire —
Partie 1: Classification, essais de performance et marquage

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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 voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see the following URL: www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 142, *Cleaning equipment for air and other gases*.

This second edition cancels and replaces the first edition (ISO 29463-1:2011), which has been technically revised.

This edition includes the following significant changes with respect to the previous edition:

— Table 1 has been split into two tables;

— a definition for "particle diameter" has been added;

— it has been stated that the filter test certificate shall clearly indicate if the filter has been tested without seal fitted.

A list of all parts in the ISO 29463 series can be found on the ISO website.

Introduction

ISO 29463 (all parts) is derived from EN 1822 (all parts). 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 needs of different applications. The difference between this document 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 ISO 29463-5:2011, 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 ISO 29463-5:2011, Annex C. Specific requirements for testing method, frequency, and reporting requirements may be modified by agreement between supplier and customer. For lower efficiency filters (Group H, as described in Clause 5), alternate leak test methods noted in ISO 29463-4:2011, Annex A may 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 the annex. Although the methods prescribed in this document may be generally used to determine filter performance for nano-size particles, testing or classification of filters for nano-size particles are beyond the scope of this document (see Annex A for additional information).

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. A brief summary of these methods and their reference standards is provided in ISO 29463-5:2011, Annex A.

High efficiency filters and filter media for removing particles from air —

Part 1: Classification, performance, testing and marking

1 Scope

This document establishes a classification of filters based on their performance, as determined in accordance with ISO 29463-3, ISO 29463-4 and ISO 29463-5. It also provides an overview of the test procedures, and specifies general requirements for assessing and marking the filters, as well as for documenting the test results. It is intended to be used in conjunction with ISO 29463-2, ISO 29463-3, ISO 29463-4 and ISO 29463-5.

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

ISO 29463-3:2011, *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 leakage of filter elements-Scan method*

ISO 29463-5:2011, *High-efficiency filters and filter media for removing particles in air — Part 5: Test method for filter elements*

ISO 29464:2017, *Cleaning equipment for air and other gases — Terminology*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 29464 and the following apply.

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

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

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

3.1
filter medium
material used for filtering

3.2
folded pack
pack of the *filter medium* (3.1) formed by uniform individual folds

3.3
filter element
filter
folded pack (3.2) enclosed by a frame

3.4
efficiency
ratio of the number of particles retained by the filter to the number of the particles entering it

3.5
particle size efficiency
efficiency (3.4) for a specific *particle diameter* (3.6)

Note 1 to entry: The efficiency plotted as a function of the particle diameter gives the fractional efficiency curve.

3.6
particle diameter
geometric diameter (equivalent spherical, optical or aerodynamic, depending on context) of the particles of an aerosol

Note 1 to entry: Particle diameter is often referred to simply as "particle size".

[SOURCE: ISO 29464:2017, 3.2.124]

3.7
overall efficiency
efficiency (3.4), averaged over the whole *superficial face area* (3.11) of a *filter element* (3.3) under given operating conditions of the filter

3.8
local efficiency
efficiency (3.4) at a specific point of the *filter element* (3.3) under given operating conditions of the filter

3.9
nominal air volume flow rate
air volume flow rate at which the *filter element* (3.3) shall be tested as specified by the manufacturer

3.10
filter face area
cross-sectional area of the *filter element* (3.3) including the frame

3.11
superficial face area
cross-sectional area of the *filter element* (3.3) through which the air flow passed

3.12
effective filter medium area
area of the *filter medium* (3.1) contained in the *filter element* (3.3) (without areas covered by sealant, spacers, struts, etc.) which the air flow passes

3.13
nominal filter medium face velocity
nominal air volume flow rate (3.9) divided by the effective *filter medium* (3.1) area

3.14
quasi–monodisperse aerosol
aerosols whose distribution has a geometric standard deviation between σ_g = 1,15 and σ_g = 1,5

4 Symbols and abbreviated terms

d_p	particle diameter
E	efficiency
P	penetration
p	pressure
σ_g	geometric standard deviation
CPC	condensation particle counter
DEHS	Sebacic acid-bis (2 ethyl hexyl-) ester (trivial name: di-ethyl-hexyl-sebacate)
DMA	differential electric mobility analyser
DMPS	differential mobility particle sizer
MPPS	most penetrating particle size, that is the particle size for which the filtration efficiency is a minimum
OPC	optical particle counter
PAO	poly-alpha-olefin, mineral oil with Chemical Abstract Service Registry number of 68649-12-7
PSL	poly-styrene latex (solid spheres)

5 Classification

Filters and filter elements are classified in groups and classes based on their efficiency or penetration for the MPPS particles by testing as prescribed in Clause 6 and in ISO 29463-5. According to this document, filter elements fall into one of the following groups.

a) Group E: EPA filters (efficient particulate air filter), also commonly referred to as sub-HEPA.

   The efficiency of the filters is determined by statistical sample testing only in accordance with ISO 29463-5. Group E filters cannot and shall not be leak tested.

b) Group H: HEPA filters (high-efficiency particle air filter)

   Filters are individually tested and their efficiency is determined at MPPS in accordance with ISO 29463-5. The filter is leak tested in accordance with ISO 29463-4, where, in addition to the reference leak scan method, four alternate methods for leak testing are allowed. Alternate norms used for leak testing should be clearly identified on the filter and certifications.

c) Group U: ULPA filters (ultra-low penetration air filter)

   Filters are individually tested and their efficiency is determined at MPPS in accordance with ISO 29463-5. Filters are leak tested according to scan method in accordance with ISO 29463-4. No alternate leak testing is allowed.

A detailed specification for each filter group and class is given in Tables 1 and 2. Either of them can be used for filter classification purposes.

Detailed information about the permissible test methods in accordance with ISO 29463 (all parts) for each filter group and class of filters is given in Table B.1.

Table 1 — Filter classification: Allowed filter classes (5/10th filter efficiency)

Filter class and group	Overall value		Local value[a,b]	
	Efficiency (%)	**Penetration** (%)	**Efficiency** (%)	**Penetration** (%)
ISO 15 E	≥95	≤5	—[c]	—[c]
ISO 25 E	≥99,5	≤0,5	—[c]	—[c]
ISO 35 H[d]	≥99,95	≤0,05	≥99,75	≤0,25
ISO 45 H[d]	≥99,995	≤0,005	≥99,975	≤0,025
ISO 55 U	≥99,999 5	≤0,000 5	≥99,997 5	≤0,002 5
ISO 65 U	≥99,999 95	≤0,000 05	≥99,999 75	≤0,000 25
ISO 75 U	≥99,999 995	≤0,000 005	≥99,999 9	≤0,000 1

[a] See 7.5.2.4 and ISO 29463-4.

[b] Local penetration values lower than those given in this table may be agreed upon between the supplier and customer.

[c] Filters of Group E cannot and shall not be leak tested for classification purposes.

[d] For Group H filters, local penetration is given for reference MPPS particle scanning method. Alternate limits may be specified when photometer or oil thread leak testing is used.

Table 2 — Filter classification: Allowed filter classes (1/10th filter efficiency)

Filter class and group	Overall value		Local value[a,b]	
	Efficiency (%)	**Penetration** (%)	**Efficiency** (%)	**Penetration** (%)
ISO 20 E	≥99	≤1	—[c]	—[c]
ISO 30 E	≥99,90	≤0,1	—[c]	—[c]
ISO 40 H[d]	≥99,99	≤0,01	≥99,95	≤0,05
ISO 50 U	≥99,999	≤0,001	≥99,995	≤0,005
ISO 60 U	≥99,999 9	≤0,000 1	≥99,999 5	≤0,000 5
ISO 70 U	≥99,999 99	≤0,000 01	≥99,999 9	≤0,000 1

[a] See 7.5.2.4 and ISO 29463-4.

[b] Local penetration values lower than those given in this table may be agreed upon between the supplier and customer.

[c] Filters of Group E cannot and shall not be leak tested for classification purposes.

[d] For Group H filters, local penetration is given for reference MPPS particle scanning method. Alternate limits may be specified when photometer or oil thread leak testing is used.

6 Requirements

6.1 General

The filter element shall be designed or marked so as to prevent incorrect mounting.

The filter element shall be designed so that when correctly mounted in the ventilation duct, no leak occurs along the sealing edge.

If, for any reason, dimensions do not allow testing of a filter under standard test conditions, assembly of two or more filters of the same type or model is permitted, provided no leaks occur in the resulting filter.

If the filter is tested without the filter seal fitted, and if designed to have a filter seal, then the filter test certificate shall be clearly marked “filter efficiency tested without filter seal fitted”.

6.2 Material

The filter element shall be made of suitable material to withstand normal usage and exposures to those temperatures, humidity and corrosive environments that are likely to be encountered.

The filter element shall be designed so that it will withstand mechanical constraints that are likely to be encountered during normal use.

Dust or fibres released from the filter media by the air flow through the filter element shall not constitute a hazard or nuisance for the people (or devices) exposed to filtered air.

6.3 Nominal air volume flow rate

The filter element shall be tested at its nominal air volume flow rate for which the filter has been designed by the manufacturer.

6.4 Pressure difference

The pressure difference across the filter element is recorded at the nominal air volume flow rate.

6.5 Filtration performance

The filtration performance is expressed by the efficiency or the penetration as measured by the prescribed procedures in ISO 29463-5. After testing in accordance with Clause 7, filter elements are classified in accordance with Tables 1 and 2.

Filters with filter media having an electrostatic charge are classified in accordance with Tables 1 and 2, on the basis of their discharged efficiency or penetration in accordance with ISO 29463-5:2011, Annex C.

7 Test methods — General requirements and test procedures overview

7.1 General

The complete test method comprises the following three steps, which can be performed independently:

— test for flat sheet filter media, in accordance with ISO 29463-3;

— test for determining the leakage of filter elements (scan method), in accordance with ISO 29463-4;

— test for determining the efficiency of filters, in accordance with ISO 29463-5.

Clause 7 provides the general requirements for the features common to all tests, as well as an overview of the test procedures.

Detailed information about the permissible test methods for filter elements in accordance with ISO 29463 (all parts) for each filter group and class of filters is given in Table B.1.

7.2 Test rigs

Test rigs shall be in accordance with ISO 29463-3, ISO 29463-4 and ISO 29463-5 for the respective tests. The measuring equipment shall be in accordance with ISO 29463-2.

7.3 Test conditions

The air in the test channel used for testing shall comply with the following requirements:

— temperature: 23 °C ± 5 °C;

— relative humidity <75 %.

The temperature shall remain constant during the entire test procedure within ±2 °C, the relative humidity within ±5 %.