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Air filters for general ventilation - Part 3: Determination of the gravimetric efficiency and the air flow resistance versus the mass of test dust captured (ISO/DIS 16890-3:2023)

Luftfilter für die allgemeine Raumlufttechnik - Teil 3: Ermittlung des gravimetrischen Wirkungsgrades sowie des Durchflusswi-derstandes im Vergleich zu der aufgenommenen Masse von Prüfstaub (ISO/DIS 16890-3:2023)

Filtres à air de ventilation générale - Partie 3: Détermination de l'efficacité gravimétrique et de la résistance à l'écoulement de l'air par rapport à la quantité de poussière d'essai retenue (ISO/DIS 16890-3:2023)

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Air filters for general ventilation —

Part 3:
Determination of the gravimetric efficiency and the air flow resistance versus the mass of test dust captured

Filtres à air de ventilation générale —

Partie 3: Détermination de l'efficacité gravimétrique et de la résistance à l'écoulement de l'air par rapport à la quantité de poussière d'essai retenue

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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 of 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 www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 142, *Cleaning equipment for air and other gases* in collaboration with the European Committee for Standardization (CEN) Technical Committee CEN/TC 195*, Cleaning equipment for air and other gases*, in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

This second edition cancels and replaces the first edition (ISO 16890-3:2016), which has been technically revised.

The main changes compared to the previous edition are as follows:

— revised the initial loading step from 30 g to 60 g throughout the document.

Introduction

The effects of particulate matter (PM) on human health have been extensively studied in the past decades. The results are that fine dust can be a serious health hazard, contributing to or even causing respiratory and cardiovascular diseases. Different classes of particulate matter can be defined according to the particle size range. The most important ones are PM_{10}, $PM_{2,5}$ and PM_1. The U.S. Environmental Protection Agency (EPA), the World Health Organization (WHO) and the European Union define PM_{10} as particulate matter which passes through a size-selective inlet with a 50 % efficiency cut-off at 10 µm aerodynamic diameter. $PM_{2,5}$ and PM_1 are similarly defined. However, this definition is not precise if there is no further characterization of the sampling method and the sampling inlet with a clearly defined separation curve. In Europe, the reference method for the sampling and measurement of PM_{10} is described in EN 12341. The measurement principle is based on the collection on a filter of the PM_{10} fraction of ambient particulate matter and the gravimetric mass determination (see EU Council Directive 1999/30/EC of 22 April 1999).

As the precise definition of PM_{10}, $PM_{2,5}$ and PM_1 is quite complex and not easy to measure, public authorities, like the U.S. EPA or the German Federal Environmental Agency (Umweltbundesamt), increasingly use in their publications the more simple denotation of PM_{10} as being the particle size fraction less or equal to 10 µm. Since this deviation to the above mentioned complex “official” definition does not have a significant impact on a filter element’s particle removal efficiency, the ISO 16890 series refers to this simplified definition of PM_{10}, $PM_{2,5}$ and PM_1.

Particulate matter in the context of the ISO 16890 series describes a size fraction of the natural aerosol (liquid and solid particles) suspended in ambient air. The symbol $e\mathrm{PM}_x$ describes the efficiency of an air cleaning device to particles with an optical diameter between 0,3 µm and x µm. The following particle size ranges are used in the ISO 16890 series for the listed efficiency values.

Table 1 — Optical particle diameter size ranges for the definition of the efficiencies, $e\mathrm{PM}_x$

Efficiency	**Size range**, µm
$e\mathrm{PM}_{10}$	$0,3 \leq x \leq 10$
$e\mathrm{PM}_{2,5}$	$0,3 \leq x \leq 2,5$
$e\mathrm{PM}_1$	$0,3 \leq x \leq 1$

Air filters for general ventilation are widely used in heating, ventilation and air-conditioning applications of buildings. In this application, air filters significantly influence the indoor air quality and, hence, the health of people, by reducing the concentration of particulate matter. To enable design engineers and maintenance personnel to choose the correct filter types, there is an interest from international trade and manufacturing for a well-defined, common method of testing and classifying air filters according to their particle efficiencies, especially with respect to the removal of particulate matter. Current regional standards are applying totally different testing and classification methods, which do not allow any comparison with each other, and thus hinder global trade with common products. Additionally, the current industry standards have known limitations by generating results which often are far away from filter performance in service, i.e. overstating the particle removal efficiency of many products. With the ISO 16890 series, a completely new approach for a classification system is adopted, which gives better and more meaningful results compared to the existing standards.

The ISO 16890 series describes the equipment, materials, technical specifications, requirements, qualifications and procedures to produce the laboratory performance data and efficiency classification based upon the measured fractional efficiency converted into a particulate matter efficiency (ePM) reporting system.

Air filter elements according to the ISO 16890 series are evaluated in the laboratory by their ability to remove aerosol particulate expressed as the efficiency values $e\mathrm{PM}_1$, $e\mathrm{PM}_{2,5}$ and $e\mathrm{PM}_{10}$. The air filter elements can then be classified according to the procedures defined in ISO 16890-1. The particulate removal efficiency of the filter element is measured as a function of the particle size in the range of 0,3 µm to 10 µm of the unloaded and unconditioned filter element as per the procedures defined in ISO 16890-2. After the initial particulate removal efficiency testing, the air filter element is conditioned according to the procedures defined in ISO 16890-4 and the particulate removal efficiency is repeated on the conditioned filter element. This is done to provide information about the intensity of any electrostatic removal mechanism which may or may not be present with the filter element for test. The average efficiency of the filter is determined by calculating the mean between the initial efficiency and the conditioned efficiency for each size range. The average efficiency is used to calculate the $e\text{PM}_x$ efficiencies by weighting these values to the standardized and normalized particle size distribution of the related ambient aerosol fraction. When comparing filters tested in accordance with the ISO 16890 series, the fractional efficiency values shall always be compared among the same $e\text{PM}_x$ class (ex. $e\text{PM}_1$ of filter A with $e\text{PM}_1$ of filter B). The test dust capacity and the arrestance of a filter element are determined as per the test procedures defined in this document.

The performance results obtained in accordance with ISO 16890 (all parts) cannot by themselves be quantitatively applied to predict performance in service with regard to efficiency and lifetime.

Air filters for general ventilation —

Part 3:
Determination of the gravimetric efficiency and the air flow resistance versus the mass of test dust captured

1 Scope

This document specifies the test equipment and the test methods used for measuring the gravimetric efficiency and resistance to air flow of air filter for general ventilation.

It is intended for use in conjunction with ISO 16890-1, ISO 16890-2 and ISO 16890-4.

The test method described in this document is applicable for air flow rates between 0,25 m^3/s (900 m^3/h, 530 ft^3/min) and 1,5 m^3/s (5 400 m^3/h, 3 178 ft^3/min), referring to a test rig with a nominal face area of 610 mm × 610 mm (24 in × 24 in).

This document refers to particulate air filter elements for general ventilation having an $e\text{PM}_1$ efficiency less than or equal to 99 % and an $e\text{PM}_{10}$ efficiency greater than 20 % when tested as per the procedures defined within ISO 16890 (all parts).

NOTE The lower limit for this test procedure is set at a minimum $e\text{PM}_{10}$ efficiency of 20 % since it will be very difficult for a test filter element below this level to meet the statistical validity requirements of this procedure.

Filter elements used in portable room-air cleaners are excluded from the scope of this document.

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 15957, *Test dusts for evaluating air cleaning equipment*

ISO 16890-2:2016, *Air filters for general ventilation — Part 2: Measurement of fractional efficiency and resistance to air flow*

ISO 16890-4, *Air filters for general ventilation — Part 4: Conditioning method to determine the minimum fractional test efficiency*

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

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

3 Terms and definitions

For the purposes of this document, the following apply.

ISO and IEC maintain terminological 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 Air flow and resistance

3.1.1
air flow rate
volume of air passing through the filter per unit time

[SOURCE: ISO 29464:2017, 3.1.24]

3.1.2
nominal air volume flow rate
air flow rate (3.1.1) specified by the manufacturer

[SOURCE: ISO 29464:2017, 3.1.25]

3.1.3
filter face velocity
volumetric *air flow rate* (3.1.1) divided by the nominal filter face area

Note 1 to entry: Filter face velocity is expressed in m/s.

[SOURCE: ISO 29464:2017, 3.1.15]

3.1.4
resistance to air flow
difference in absolute (static) pressure between two points in an air flow system at specified conditions, especially when measured across the *filter element* (3.2.2)

Note 1 to entry: Resistance to air flow is measured in Pa.

[SOURCE: ISO 29464:2017, 3.1.36, modified – The specific use "at specified conditions, especially when measured across the filter element (3.2.2)" has been added.]

3.1.5
recommended final resistance to air flow
maximum operating *resistance to air flow* (3.1.4) of the filter as recommended by the manufacturer

Note 1 to entry: Recommended final resistance to air flow is measured in Pa.

[SOURCE: ISO 29464:2017, 3.2.152]

3.1.6
final resistance to air flow
resistance to air flow (3.1.4) up to which the filtration performance is measured to determine the *average arrestance* (3.3.2) and *test dust capacity* (3.3.3)

Note 1 to entry: Final differential pressure to air flow is measured in Pa.

[SOURCE: ISO 29464:2017, 3.2.150]

3.1.7
initial resistance to air flow
resistance to air flow (3.1.4) of the clean filter operating at its test *air flow rate* (3.1.1)

Note 1 to entry: Initial resistance to air flow is measured in Pa.

[SOURCE: ISO 29464:2017, 3.2.151]

3.1.8
test air
air to be used for testing purposes

[SOURCE: ISO 29464:2017, 3.1.37]

3.2 Test device

3.2.1
test device
filter element (3.2.2) being subjected to performance testing

[SOURCE: ISO 29464:2017, 3.1.38]

3.2.2
filter element
structure made of the filtering material, its supports and its interfaces with the filter housing

[SOURCE: ISO 29464:2017, 3.2.77]

3.2.3
upstream
U/S
area or region from which fluid flows as it enters the *test device* (3.2.1)

[SOURCE: ISO 29464:2017, 3.1.39]

3.2.4
downstream
D/S
area or region into which fluid flows on leaving the *test device* (3.2.1)

[SOURCE: ISO 29464:2017, 3.1.11]

3.2.5
coarse filter
filtration device with particle removal efficiency <50 % in the PM_{10} particle range

[SOURCE: ISO 29464:2017, 3.2.74]

3.2.6
fine filter
filtration device with particle removal efficiency ≥50 % in the PM_{10} particle range

[SOURCE: ISO 29464:2017, 3.2.81]

3.2.7
final filter
air filter used to collect the *loading dust* (3.3.4) passing through or shedding from the filter under test

[SOURCE: ISO 29464:2017, 3.2.80]

3.2.8
effective filter media area
effective filter medium area
area of the filter medium contained in the filter through which air passes during operation

Note 1 to entry: Effective filter media area is expressed in m^2.

[SOURCE: ISO 29464:2017, 3.1.22]

3.2.9
filter media velocity
air flow rate (3.1.1) divided by the *effective filter media area* (3.2.8)

Note 1 to entry: Filter media velocity is expressed in m/s to an accuracy of three significant figures.