INTERNATIONAL STANDARD

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Air filters for general ventilation —

Part 2: Measurement of fractional efficiency and air flow resistance

Filtres à air de ventilation générale —

Partie 2: Mesurage de l'efficacité spectrale et de la résistance à l'écoulement de l'air

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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 World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see the following URL: www.iso.org/iso/foreword.html.

The committee responsible for this document is ISO/TC 142, *Cleaning equipment for air and other gases*.

This first edition of ISO 16890-2, together with ISO 16890-1, ISO 16890-3 and ISO 16890-4, cancels and replaces ISO/TS 21220:2009, which has been technically revised.

ISO 16890 consists of the following parts, under the general title *Air filters for general ventilation*:

— *Part 1: Technical specifications, requirements and classification system based upon particulate matter efficiency (ePM)*

— *Part 2: Measurement of fractional efficiency and air flow resistance*

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

— *Part 4: Conditioning method to determine the minimum fractional test efficiency*

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 simple 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 ePM_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, ePM_x

Efficiency	**Size range**, µm
ePM_{10}	0,3 ≤ × ≤10
$ePM_{2,5}$	0,3 ≤ × ≤2,5
ePM_1	0,3 ≤ × ≤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 this new 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 ePM_1, $ePM_{2,5}$ and ePM_{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 this part of ISO 16890. 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 $e\mathrm{PM}_x$ 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 $e\mathrm{PM}_x$ class (ex. $e\mathrm{PM}_1$ of filter A with $e\mathrm{PM}_1$ of filter B). The test dust capacity and the initial arrestance of a filter element are determined as per the test procedures defined in ISO 16890-3.

Air filters for general ventilation —

Part 2: Measurement of fractional efficiency and air flow resistance

1 Scope

This part of ISO 16890 specifies the aerosol production, the test equipment and the test methods used for measuring fractional efficiency and air flow resistance of air filters for general ventilation.

It is intended for use in conjunction with ISO 16890-1, ISO 16890-3 and ISO 16890-4.

The test method described in this part of ISO 16890 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 (24,0 inch × 24,0 inch).

ISO 16890 (all parts) refers to particulate air filter elements for general ventilation having an ePM_1 efficiency less than or equal to 99 % and an ePM_{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 ePM_{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.

Air filter elements outside of this aerosol fraction are evaluated by other applicable test methods, (see ISO 29463 (all parts)).

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

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.

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 16890-1, *Air filters for general ventilation — Part 1: Technical specifications, requirements and efficiency classification system based upon Particulate Matter (PM)*

ISO 16890-3, *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 16890-4, *Air filters for general ventilation — Part 4: Conditioning method to determine the minimum fractional test efficiency*

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 21501-1, *Determination of particle size distribution — Single particle light interaction methods — Part 1: Light scattering aerosol spectrometer*

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