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Air intake filter systems for rotary machinery — Test methods —

Part 1:
Static filter elements

Systèmes de filtration d'air d'admission pour machines tournantes — Méthodes d'essai —

Partie 1: Éléments filtrants pour filtres statiques

ICS: 29.160.99

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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.*

This second edition cancels and replaces the first edition (ISO 29461-1:2013), which has been technically revised.

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

— New test method, referring to ISO 16890 and ISO 29463

— A classification table

— Deletion of Annex A, B, C and D

A list of all parts in the ISO 29461 series can be found on the ISO website.

Any feedback or questions on this document should be directed to the user’s national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

In rotating machinery applications, the filtering systems, typically a set of filter elements arranged in a suitable manner, are an important part of the whole turbine/compressor system. The development of turbine machinery used for energy production or others has led to more sophisticated equipment and therefore the importance of good protection of these systems has become more important in the recent years. It is known that particulate contamination can deteriorate a turbine power system quite substantially if not taken care of.

This event is often described as “erosion”, “fouling” and “hot corrosion” where salt and other corrosive particles are known as potential problems. Other particulate matters may also cause significant reduction of efficiency of the systems. It is important to understand that air filter devices in such systems are located in various environmental conditions. The range of climate and particulate contamination is very wide, ranging from deserts to humid rain forests to arctic environments. The requirements on these filter systems are obviously different depending on where they will be operating.

ISO 29461 has based the performance of the air intake filter systems not only upon heavy dust collection but also particulate efficiency in a size range that is considered to be the problematic area for these applications. Both ultra-fine and fine particles, as well as larger particles, should be considered when evaluating turbine fouling. In typical outdoor air, ultra-fine and fine particles in the size range from 0,01 µm to 1 µm contribute to > 99 % of the number concentration and to > 90 % of the surface contamination. The majority of the mass normally comes from larger particles (>1,0 µm).

Turbo-machinery filters comprise a wide range of products from filters for very coarse particles to filters for very fine, sub-micron particles. The range of products varies from depth to surface loading systems, which can be regenerated e.g. by pulse cleaning. The filters and the systems have to withstand a wide temperature and humidity range, very low to very high dust concentration and mechanical stress. The shape of products existing today can be of many different types and have different functions such as droplet separators, coalescing products, filter pads, metal filters, inertial filters, filter cells, bag filters, panel-type, cleanable and depth loading filter cartridges and pleated media surface filter elements.

ISO 29461 series of standards will provide a way to compare these products in a similar way and define what criteria are important for air filter intake systems for rotary machinery performance protection. The performance of products in this broad range must be compared in a good manner. Comparing different filters and filter types must be done with respect to the operating conditions they finally will be used in. For instance, if a filter or a filter system is meant to operate in an extreme, very dusty environment, the real particulate efficiency of such a filter cannot be predicted because the dust loading of the filter plays an important role. A further part of ISO 29461 will address the performance of cleanable and surface loading filters. Filters in turbo-machinery applications can also face very harsh operating conditions such as high air flow rates or water and salt ingress. Further parts of ISO 29461 will address the performance of filters under such harsh conditions.

Air intake filter systems for rotary machinery — Test methods —

Part 1: Static filter elements

1 Scope

ISO 29461 specifies methods and procedures for determining the performance of particulate air filters used in air intake filter systems for rotary machinery such as stationary gas turbines, compressors and other stationary internal combustion engines. It applies to air filters with an efficiency of 85 % or more for the MPPS (EPA and HEPA filters) which are tested according to ISO 29463 part 1 to 5 and filters with a lower efficiency which are tested according to ISO 16890 part 1 to 4. The procedures described in both, the ISO 16890 series and the ISO 29463 series, are applied and extended by this part of ISO 29461 to air filters which operate at flow rates within the range 0,24 m^3/s (850 m^3/h, 500 ft^3/min) up to 2,36 m^3/s (8500 m^3/h, 5000 ft^3/min).

This part of ISO 29461 refers to static (barrier) filter systems but can also be applied to other filter types and systems in appropriate circumstances, for example to evaluate the initial efficiency of cleanable and surface loading filters.

The performance results obtained in accordance with this part of ISO 29461 cannot be quantitatively applied (by themselves) to predict performance in service with regard to efficiency and lifetime. Other factors influencing performance to be taken into account are described in the annexes.

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

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

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

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

ISO 29463-4, *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, *High-efficiency filters and filter media for removing particles in air — Part 5: Test method for filter elements*

ISO 29464:2017, *Cleaning of 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:

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

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

3.1
coarse filter
filtration device with particle removal efficiency $e\mathrm{PM}_{10}$ < 50 % in the PM10 particle range

Note 1 to entry: as per ISO 16890-1.

[SOURCE: ISO 29464:2017, 3.2.74, modified — Note 1 to entry has been added.]

3.2
efficient particulate air filter
EPA filter
filters with performance complying with requirements of filter class ISO T10 – ISO T12 as per this document

Note 1 to entry: EPA filters cannot be and shall not be leak tested.

3.3
initial gravimetric arrestance
A_{100}
ratio of the mass of a standard test dust retained by the filter to the mass of dust fed after the first 100 g of dust load

Note 1 to entry: This measure is expressed as a weight percentage.

3.4
high efficient particulate air filter
HEPA filter
filters with performance complying with requirements of filter class ISO 35 H – ISO 45 H as per ISO 29463-1

[SOURCE: ISO 29464:2017, 3.2.84]

3.5
particulate matter efficiency
ePMx
efficiency of an air cleaning device to reduce the mass concentration of particles with an optical diameter between 0,3 µm and x µm

[SOURCE: ISO 29464:2017, 3.2.140]

4 Symbols and abbreviated terms

For the application of this document, the following symbols and abbreviated terms apply:

A_{100}	Initial gravimetric arrestance, %
$ePM_{x, min}$	Minimum efficiency value with x = 1 µm, 2,5 µm or 10 µm of the conditioned filter element, % (see ISO 16890-1)
ePM_x	Efficiency with x = 1 µm, 2,5 µm or 10 µm, % (see ISO 16890-1)
ISO	International Organization for Standardization
MPPS	Most penetrating particle size

5 General requirements

Static filter systems normally use multiple stages of coarse, fine and optional also EPA or HEPA filter elements to protect the machinery. The scope of this part of ISO 29461 includes methods for performance testing of individual filter elements. It does not include methods for the direct measurement of the performance of entire systems as installed in service except in cases where they can meet the qualification criteria for the test assembly.

6 Testing and classification of filter efficiencies

Filters with an efficiency of 85 % or more for the MPPS (EPA and HEPA filters) are tested according to ISO 29463 part 1 to 5, while filters with a lower efficiency are tested according to ISO 16890 part 1 to 4. Filters are classified in Groups and Classes based on their efficiency as defined in Table 1.

Note: For the classification of ISO ePM_1 and ISO $ePM_{2,5}$ filters only the $ePM_{x, min}$ values are used.

HEPA filters (class T13) have to be individually tested and their efficiency determined at MPPS according to 29463-5. Filters shall be individually leak tested according to ISO 29463-4 where, in addition to the reference leak scan method, four alternate methods for leak testing are allowed. For HEPA filters with geometries which do not allow a scan testing, like e.g. cartridges or V-bank filters, the oil thread test method or one of the other suitable (non-scanning) methods described in ISO 29463-4 can be applied. Alternate norms used for leak testing should be clearly identified on the filter and certifications.

In order to extent the volume flow rate and the range of filter geometries (e.g. cylindrical filters) deviations and extensions to the test rig defined by ISO 16890-2 and ISO 29463-5, respectively, are described below.

The test rig consists of several square duct sections with typical 610 mm × 610 mm (24 in × 24 in) nominal inner dimensions except for the section where the filter is installed. This section has nominal inner dimensions between 616 mm (24,25 in) and 622 mm (24,50 in). The length of this duct section shall be at least 1,1 times the length of the filter, with a minimum length of 1 m as shown in Figure 1 (for more details on the test rig see ISO 16890-2, Figure 3). The filter shall be within the section and shall not protrude out of this section, either upstream or downstream. The test duct may need to have larger dimensions in cases when very large filters or integrated filter-system-element are to be tested. In those cases, other dimensions are allowed as long as the qualification procedures described in ISO 16890-2 are fulfilled. An example of a special (large) filter transition can be seen in Figure 2 and 3.

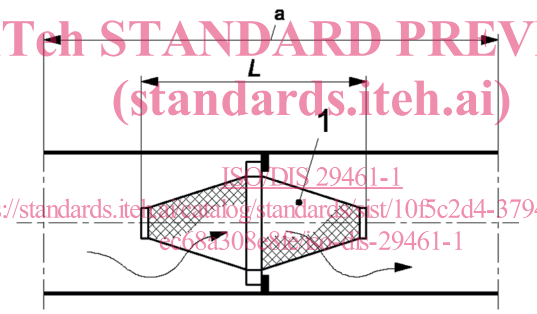
Table 1 — Filter Classification

Class	Group	ISO 29463	ISO 16890			
		MPPS efficiency	$ePM_{1, min}$	$ePM_{2,5, min}$	ePM_{10}	Initial gravimetric arrestance A_{100}
ISO T1	Coarse					20 % < A_{100} < 50 %
ISO T2						≥ 50 %
ISO T3						≥ 70 %
ISO T4						≥ 85 %

Table 1 *(continued)*

Class	Group	ISO 29463	ISO 16890			
		MPPS efficiency	$e\mathrm{PM}_{1,\,\mathrm{min}}$	$e\mathrm{PM}_{2,5,\,\mathrm{min}}$	$e\mathrm{PM}_{10}$	Initial gravimetric arrestance A_{100}
ISO T5	$e\mathrm{PM}_{10}$				≥ 50 %	
ISO T6	$e\mathrm{PM}_{2,5}$			≥ 50 %		
ISO T7	$e\mathrm{PM}_{1}$		≥ 50 %			
ISO T8			≥ 70 %			
ISO T9			≥ 85 %			
ISO T10	EPA	≥ 85 %				
ISO T11		≥ 95 %				
ISO T12		≥ 99,5 %				
ISO T13	HEPA	≥ 99,95 %				

In case of circular cartridges, the test setup (mounting of the filters in the test duct) shall be as close to the real application as possible. In cases of large cylinders, a mounting plate with an additional hole for the air inlet/outlet can be sufficient (see Figure 4). In terms of much smaller cylinders an additional transition could be inserted in the duct (see Figure 3). This shall however be analysed specifically for each construction, taking into consideration possible jetting effect that can affect the velocity and aerosol concentration in the test duct cross section.



Key

1 filter to be tested

L filter length

a duct section length (<1000 mm and/or 1,1 x L)

Figure 1 — Duct section including filter to be tested

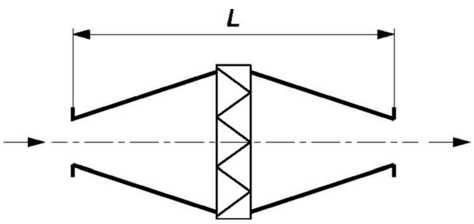


Figure 2 — Example of a filter section with transition for special filter constructions

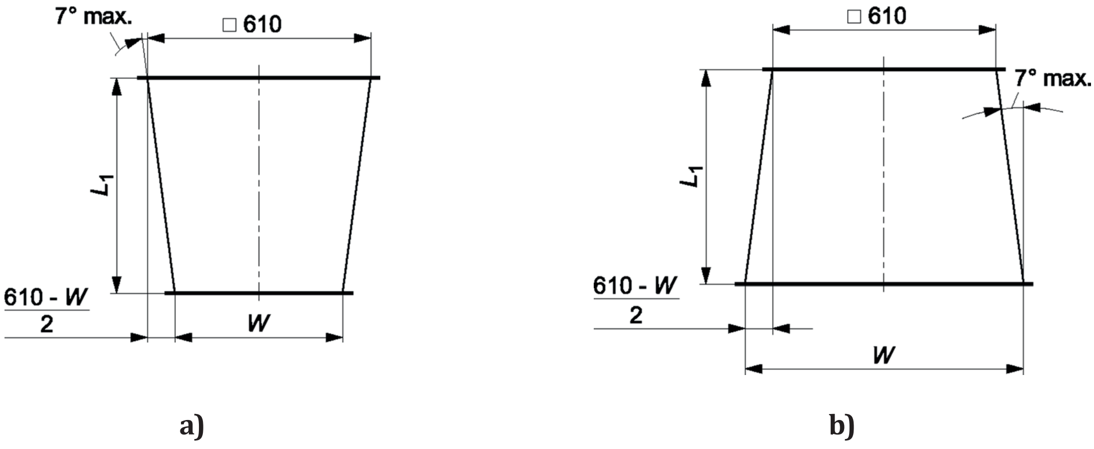


Figure 3 — Details of transition ducts for mounting filters which are smaller (a) or larger (b) than the test duct

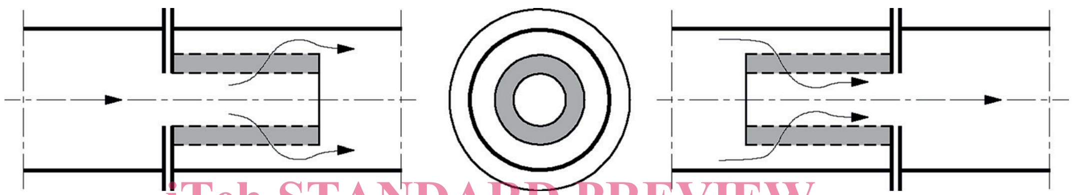


Figure 4 — Examples of mounting circular cartridges in the test duct

7 Determination of the air flow resistance versus the mass of test dust captured

For the determination of the air flow resistance versus the mass of test dust captured, the procedures described in ISO 16890-3 shall be applied. The synthetic loading dust as specified in ISO 15957 as L2 shall be used as a loading dust for reporting results. Filters with particle removal efficiency $e\text{PM}_{10} < 50$ % (ISO coarse according to ISO 16890-1) shall be loaded to a final resistance to air flow of 375 Pa (1,5 inch H_2O), while filters with a particle removal efficiency $e\text{PM}_{10} \geq 50$ % (fine filter groups ISO $e\text{PM}_{10}$, ISO $e\text{PM}_{2,5}$ and ISO $e\text{PM}_1$ according to ISO 16890) and EPA and HEPA filters up to ISO 45H according to ISO 29463-1 shall be loaded to a final resistance to air flow of 625 Pa (2,5 inch H_2O). As additional data points, higher values for the final resistance to air flow can be defined between vendor and buyer for information.

The first 100 g dust loading [or 15 Pa (0,04 inch H_2O) increase, whichever comes first] will give the initial gravimetric arrestance and the additional dust increments should give a smooth curve arrestance versus dust loading up to the final resistance

8 Conditioning method to determine the minimum fractional test efficiency

Certain types of filter media rely on electrostatic effects to achieve high efficiencies at low resistance to airflow. Exposure to some types of challenge, such as combustion particles or other fine particles, may inhibit such charges with the result that filter performance suffers. The test procedure described in ISO 16890-4 and ISO 29463-5 provides techniques for identifying this type of behaviour. This procedure is used to determine whether the filter particulate efficiency is dependent on the electrostatic removal mechanism and to provide quantitative information about the importance of the electrostatic removal. Applying these procedures is a mandatory part of the filter testing and classification of filters according to this standard.