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Filters for compressed air — Test methods —

Part 3: Particulates

Filtres pour air comprimé — Méthodes d'essai —

Partie 3: Particules

Reference number
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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 12500-3 was prepared by Technical Committee ISO/TC 118, *Compressors and pneumatic tools, machines and equipment*, Subcommittee SC 4, *Quality of compressed air*.

ISO 12500 consists of the following parts, under the general title *Filters for compressed air — Test methods*:

— *Part 1: Oil aerosols*

— *Part 2: Oil vapours*

— *Part 3: Particulates*

A Part 4 dealing with water removal is under development.

Introduction

Particulates are a typical contaminant found in compressed air streams. Particulate filters are designed to remove particulates from compressed air.

The most important performance characteristics are the ability of the filter to remove particulates from the air stream and the amount of pressure drop caused by the filter as compressed air flows through it.

This part of ISO 12500 provides a means of comparing the performance of filters.

Filters for compressed air — Test methods —

Part 3:
Particulates

1 Scope

This part of ISO 12500 provides a guide for choosing an appropriate method of determining the solid particulate removal efficiency rating by particle size of filters used in compressed air systems.

This part of ISO 12500 specifies the layouts and procedures for testing these filters. Measurement methods are recommended based on the size range of the particulates that the filter being tested has been designed to remove. The test is performed as a “type-test” on filters as being representative of a range.

The following two particle diameter size ranges are identified in this part of ISO 12500:

— fine filter range 0,01 µm to $<$ 5,0 µm;

— coarse filter range $\geqslant$ 5,0 µm to $\leqslant$ 40 µm.

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 1219-1, *Fluid power systems and components — Graphic symbols and circuit diagrams — Part 1: Graphic symbols for conventional use and data-processing applications*

ISO 5598, *Fluid power systems and components — Vocabulary*

ISO 8573-1:2001, *Compressed air — Part 1: Contaminants and purity classes*

ISO 8573-4:2001, *Compressed air — Part 4: Test methods for solid particle content*

ISO 12103-1, *Road vehicles — Test dust for filter evaluation — Part 1: Arizona test dust*

EN 1822-1, *High efficiency air filters (HEPA and ULPA) — Part 1: Classification, performance testing, marking*

EN 1822-2:1998, *High efficiency air filters (HEPA and ULPA) — Part 2: Aerosol production, measuring equipment, particle counting statistics*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 8573-1, ISO 5598 and the following apply.

3.1
channel
subset, defined by an upper and a lower limit, of data for the full spectral range of a particle counting instrument in which the particle counts are stored

3.2
efficiency
ratio of the particle concentration removed, i.e. upstream concentration minus downstream concentration, to the upstream particle concentration

3.3
filter
component for the removal of solid particles which includes the filter element and its housing and other components as required

3.4
most penetrating particle size
MPPS
particle size at which the minimum particle collection efficiency is found to occur and thus is the most difficult particle size for the filter to remove

4 Units and symbols

General use of SI units (Système international d'unités; see ISO 1000) as given throughout this part of ISO 12500 is recommended. However, in agreement with accepted practice in the pneumatic field, some non-preferred SI units, accepted by ISO, are also used.

1 bar = 100 000 Pa

NOTE bar (e) is used to indicate effective pressure above atmospheric.

1 L (litre) = 0,001 m^3

Symbols used are in accordance with ISO 1219-1.

5 Reference conditions

The reference conditions for gas volumes shall be as follows:

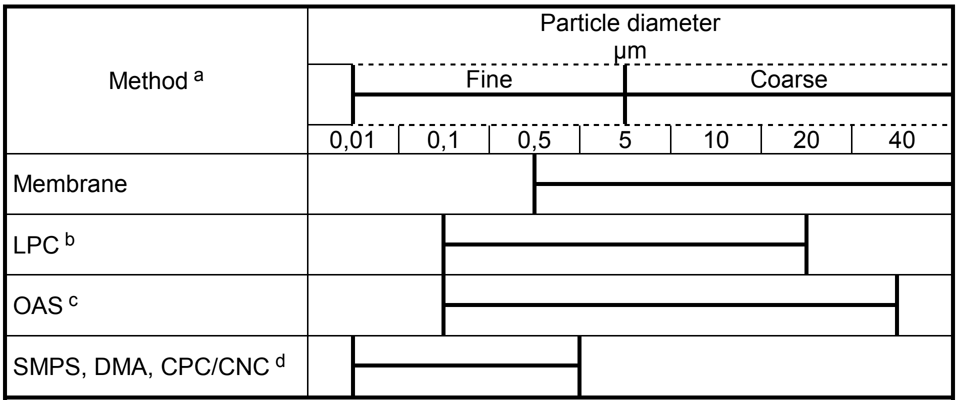
— air temperature 20 °C

— absolute air pressure 100 kPa (a) [1 bar (a)]

— relative water vapour pressure 0

6 Summary of test methods

A summary of the size ranges and recommended test methods that are covered by this part of ISO 12500 are shown in Figure 1.



[a] Refer to manufacturer's recommendation for suitability to cover range of particle concentration at the diameter of interest.

[b] LPC Laser particle counter.

[c] OAS Optical aerosol spectrometer.

[d] SMPS Scanning mobility particle sizer;
DMA Differential mobility analyzer;
CPC Condensation particle counter;
CN Condensation nucleus counter.

Figure 1 — Summary of recommended test methods

7 Test requirements

7.1 Standard rating parameters

The standard rating parameters are as identified in Table 1.

Table 1 — Standard rating parameters

Reporting parameters	Units	Rating conditions [a]	Maintain within actual gauge value	Instrument accuracy
Inlet temperature	°C	20	± 5	± 2
Inlet pressure	kPa (e) [bar (e)]	700 (7)	± 10 (0,1)	± 10 (0,1)
Ambient temperature	°C	20	± 5	± 2
Minimum compressed-air purity [b]	—	ISO 8573-1:—: 1 - 2		
Air flow for testing	L/s	100 % rated flow	± 2 %	± 4 % of gauge reading
Pressure drop	hPa (mbar)	Not applicable	Not applicable	± 10 % of gauge reading

[a] The reference conditions are as indicated in Clause 5.

[b] To ensure that there is no liquid water on the inlet of the test filter, the air quality shall satisfy class 4. To minimize electrostatic effects on the test dust, the air dewpoint shall be greater than the maximum dewpoint of class 3.

7.2 Alternative flow and pressure rating conditions

The preferred test pressure is 700 kPa (e) [7 bar (e)] but may be reduced where

a) the maximum pressure rating is other than 700 kPa (e) [7 bar (e)],

b) there is insufficient flow capacity to satisfy the flow rating at standard pressure,

c) it is desired to perform the test at a pressure other than 700 kPa (e) [7 bar (e)], or

d) there are pressure limitations for the aerosol generation.

In these cases, the test pressure can be reduced provided that the equivalent flow velocity is maintained.

The following relationship ensures that the flow velocity is correct. In this case, reference to this part of ISO 12500 includes pressure applied during the test; see Clause A.2. The test flow, q_{test}, at the test pressure, expressed in litres per second at reference conditions, is given by Equation (1):

$$q_{\text{test}} = K_{\text{T}}\ q_{\text{rated}}\left(p_{\text{test}} + 1/p_{\text{rated}} + 1\right) \tag{1}$$

where

K_{T} is the compressibility factor of air at rated pressure and 20 °C, generally equal to 1,000 for the rating conditions in Table 1;

q_{rated} is the rated flow at 700 kPa (e) [7 bar (e)] or at the manufacturer's rated pressure when other than 700 kPa (e) [7 bar (e)], expressed in litres per second;

p_{test} is the test pressure, expressed in kPa (e)[bar (e)];

p_{rated} is 700 kPa (e) [7 bar (e)], or the manufacturer's rated pressure when a pressure other than 700 kPa (e) [7 bar (e)] is used.

7.3 Fine test conditions

The aerosol challenge for test shall be produced by the use of an aerosol generator that is capable of generating either solid particles of sodium chloride (NaCl), potassium chloride (KCl) or liquid aerosols of diethylhexylsebacat (DEHS) in accordance with EN 1822-1. In order for the results to be statistically valid, the generation rates of the challenge aerosol shall be in accordance with EN 1822-2. Tests performed to determine the location of the MPPS shall be performed using a monodisperse aerosol distribution.

7.4 Detection method

The sampling methods and equipment used for fine particles shall be in accordance with ISO 8573-4. For coarse filters, the method identified in 8.3 in this part of ISO 12500 shall be used.

7.5 Coarse test conditions

The test dust for determining the particle-removal efficiency shall be in accordance with ISO 12103-1, A4 coarse. Before use, the test dust shall be mixed for a minimum of 15 min and dried to constant weight at a temperature of 105 °C ± 5 °C. The test dust shall then be allowed to acclimatize to ambient conditions.

Prior to introducing the challenge test dust, the test filter shall be stabilized to the temperature and humidity conditions for at least 15 min. The test equipment, including the filter, shall be purged until such time that the upstream particle level has been reduced to < 1 % of the intended upstream particle concentration level.

7.6 Turbulent airflow determination

Turbulent flow conditions within the main air-stream are required for sampling (i.e. a Reynolds number greater than 4 000).

In normal industrial use, compressed air is in a state of turbulent flow when the conditions in Equation (2) for the pipe flow, q, expressed in litres per second, referenced in Clause 5, are met:

$$q > D/20 \tag{2}$$

where D is the pipe bore, expressed in millimetres.

8 Test methods

8.1 General

A minimum of three complete test cycles should be run and the efficiency results averaged for each particle size range under consideration. For efficiency measurement, a new filter shall be used each time. The measurement shall not be repeated with a filter element that has already been tested, as it is already loaded with either solid or liquid test agent.

The pressure drop of the test filter assembly shall be measured and recorded at the start and end of the test.

Care should be exercised to minimize any effects on the measured efficiency of the device due to particles from sources such as the device itself, test equipment or the cleanliness of the air supplied.

The filter shall be fitted and operated in the test stand in its intended final operating orientation. The bore of the pipe shall be continuous and of the same size as that connected to the filter under test, at least in the portion between the upstream sampling point and downstream sampling point. The test stand shall be designed to minimize particle losses. Dust-delivery tubing and sampling line lengths shall be kept to a minimum.

For fine-filter testing, the pipework shall be constructed from stainless steel and be electrically grounded to assist with particle transportation and prevent static charge.

8.2 Fine filter testing

8.2.1 Fine filter equipment arrangement

A typical test assembly for fine filters is shown in Figure 2.

The aerosol generation, sample counting and method statement can be found in EN 1822-2 and EN 1822-5.

If two different particle-measuring systems are used as represented in Figure 2, it is necessary that the counting efficiency of each particle-measuring system be known. If a particle-measuring system with a lower counting efficiency is used for the upstream measurement, then the evaluation of the filter efficiency is understated; if it used for the downstream measurement, then it is overstated. As a consequence, it is necessary to correct the results based on the counting efficiency of each particle-measuring system.

The zero counting rate of the particle-measuring system shall also be considered. Thus, for example, the particle-measuring system with the lower zero counting rates shall be used for downstream measurement.

If it is known that the upstream conditions are stable and/or are controlled by another measuring device, then the measurement can be carried out with only one particle-measuring system, which then avoids the problems mentioned earlier. The procedure then involves taking the upstream measurement first in order not to operate the particle-measuring system within coincidence and then taking the downstream measurement, both times using the same particle-measuring system.