INTERNATIONAL STANDARD

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Filters for compressed air — Test methods —

Part 1: **Oil aerosols**

Filtres pour air comprimé — Méthodes d'essai —

Partie 1: Aérosols d'huile

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 12500-1 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*

Introduction

Oil aerosols are a typical contaminant found in compressed air streams. Coalescing filters are designed to remove oil aerosols from compressed air.

The most important performance characteristics are the ability of the filter to remove oil aerosols from the air stream and the amount of pressure drop caused by the filter as compressed air flows through it when the filter element is saturated with oil. This part of ISO 12500 provides a means of comparing the performance of filters.

Filters for compressed air — Test methods —

Part 1:
Oil aerosols

1 Scope

This part of ISO 12500 specifies the test layout and test procedures required for testing coalescing filters used in compressed-air systems to determine their effectiveness in removing oil aerosols.

This part of ISO 12500 provides the means to indicate performance characteristics of the pressure drop and the capability of removing oil aerosols.

This part of ISO 12500 defines one method of presenting filter performance as outlet oil aerosol concentration stated in milligrams per cubic metre from results obtained under standard rating parameters.

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 2602, *Statistical interpretation of test results — Estimation of the mean — Confidence interval*

ISO 2854, *Statistical interpretation of data — Techniques of estimation and tests relating to means and variances*

ISO 3649:1980, *Cleaning equipment for air or other gases — Vocabulary*

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

ISO 7000, *Graphical symbols for use on equipment — Index and synopsis*

ISO 7183[1)], *Compressed-air dryers — Specifications and test methods*

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

ISO 8573-2, *Compressed air — Part 2: Test methods for oil aerosol content*

ISO 14644-3:2005, *Cleanrooms and associated controlled environments — Part 3: Test methods*

1) To be published. (Revision of ISO 7183:1986)

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 7183, ISO 5598 and the following apply.

3.1
ambient temperature
temperature of the air surrounding the filter under test

3.2
coalescing
action by which liquid particles in suspension unite to give particles of greater volume

[ISO 3649:1980, definition 13]

3.3
contaminant
any solid, liquid or gas that adversely affects the system

3.4
filter
apparatus for separation or removal of contamination from a compressed air or gas stream

3.5
pressure drop
differential pressure
Δp
difference between inlet and outlet pressure of a component, measured under specified conditions

3.6
equivalent flow velocity
flow at which, when the test filter is operated at a 700 kPa [7 bar (e)] test pressure, an equal velocity to that for the device would be achieved when operated at a rated pressure and flow other than the test pressure

3.7
wall flow
that proportion of liquid contamination no longer suspended within the air flow of the pipe

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

The graphic symbols on diagrams are in accordance with ISO 1219-1 and ISO 7000.

5 Reference conditions

The reference conditions for gas volumes shall be:

a) air temperature 20 °C;

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

c) relative water vapour pressure 0.

6 Test requirements

6.1 Standard rating parameters

The standard rating parameters are as identified in Table 1.

Table 1 — Standard rating parameters

Reporting parameters	Units	Rating conditions [c]		Maintain within of actual gauge value	Instrument accuracy at test conditions
Inlet temperature	°C	20		± 5	± 2 °C
Inlet pressure	kPa [bar (e)]	700 (7)		± 10 (0,1)	± 10 kPa (± 0,1 bar)
Ambient temperature	°C	20		± 5	± 2 °C
Minimum air purity[a]	—	ISO 8573-1:2001, class 2 6 1[d]			
Air flow for testing	m^3/h	100 % rated flow		± 2 %	± 4 % of gauge reading
Inlet oil aerosol concentration[b c]	mg/m^3	10	40	± 10 %	± 10 % of gauge reading
Pressure drop	Pa (mbar)	not applicable		not applicable	± 10 % of gauge reading

[a] Minimum air purity to the inlet of the oil aerosol generator, to ensure there is no liquid water present on the inlet of the test filter.

[b] Mineral oil lubricants meeting the requirements of ISO 3448, Viscosity Grade 46 and which are typical of compressor oils may be used.

[c] Selection based on the type and performance of the compressor representative of those which may be found in use

[d] The first number represents the solid-particle classification; the second, the humidity classification; and the third, the total oil classification.

6.2 Inlet air velocity

Testing for aerosol removal shall be carried out at the flow rate which the manufacturer specifies as the maximum rated working flow for continuous operation for each particular filter model.

To maintain turbulent flow and minimise aerosol settling, the minimum Reynolds number in the air stream in the inlet pipe shall be 4 000.

The Reynolds number, Re, shall be calculated using Equation (1);

$$Re = \frac{Dv\rho}{\eta} \qquad (1)$$

where

D is the internal pipe diameter, expressed in metres;

v is the flow velocity, expressed in metres per second;

ρ is the density in kilogrames per cubic metres;

η is the dynamic viscosity, expressed in pascal-seconds.

If a filter employs multiple elements, testing carried out on a filter with an element at the maximum recommended flow rate for that particular element may be taken as representative of the results for a multi-element filter using the same element.

6.3 Inlet air flow

For the testing of filters that have their maximum flow rating quoted at a pressure other than 7 bar (e), the measurement for oil-aerosol removal can be made using equivalent flow velocity at rated pressure identified by the manufacturer for the filter under test.

The test flow rate, $q_{V\text{e,REF}}$, at reference conditions, expressed in cubic metres per hour, is calculated according to Equation (2):

$$q_{V\text{e,REF}} = \frac{q_{V\text{n,REF}} \times \kappa_\text{T} \times p_\text{e}}{p_\text{n}} \quad (2)$$

where

$q_{V\text{n,REF}}$ is rated flow rate, at reference conditions, expressed in cubic metres per hour;

p_e is absolute test pressure, expressed in bar (a);

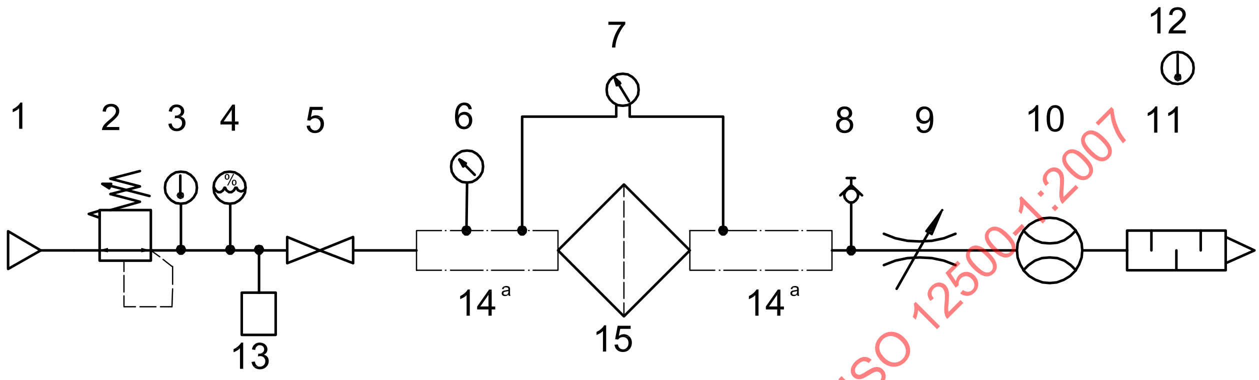
p_n is absolute rated pressure, expressed in bar (a);

κ_T is the compressibility factor of air at rated pressure and 20 °C, dimensionless.

7 Test method

7.1 Test equipment arrangement

The circuit diagram of the test equipment is shown in Figure 1.



Key

1 compressed air supply
2 pressure regulator
3 temperature sensing/measuring
4 dew point sensing/measuring
5 full-flow ball valve
6 pressure sensing/measuring
7 differential pressure gauge
8 sample test point
9 multi-turn flow control valve
10 flow sensing/measuring
11 silencer
12 ambient temperature sensing/measuring
13 aerosol generator
14 pressure measuring tube
15 filter under test

[a] Details of the construction of the measuring tubes are given in ISO 7183.

Figure 1 — Typical layout of test equipment

7.2 Test challenge concentration

Set all controls of the test rig to the standard rating parameters given in Table 1. The aerosol generator is designed to provide a poly-disperse oil-aerosol distribution having an average size in the range 0,15 µm to 0,4 µm by particle count. The aerosol generator is designed to give a normal mean particle-size distribution of between 0,15 µm and 0,4 µm by particle count to disperse aerosols and the output adjusted to give the test concentration required in Table 1.

Care shall be exercised to ensure that all of the challenge oil concentration delivered to the test filter is in aerosol form within the range detailed above and, where necessary, provision shall be made within the aerosol generator system to prevent wall flow into the test apparatus.

7.3 Test procedure

At least three examples of each model shall be tested. The test shall be repeated three times on the same filter element and the results averaged.

7.4 Conditioning of the filter element under test

The coalescing filter element shall reach a state of equilibrium before testing is started. Conditioning the filter under test using a challenge aerosol concentration greater than that given in Table 1 is permitted; however, the preferred procedure is to set the actual characteristics and allow the filter to become conditioned by setting the generator to provide the test challenge level. Concentrations above the test challenge levels can cause excessive oil concentration in the outlet air, possibly causing misleading results when the test program is undertaken.

Equilibrium is considered to have been achieved when liquid oil is observed in the bottom of the filter housing in which the filter under test is contained and the rate of change in pressure drop is less than 1 %/hr of the measured pressure drop.

The pressure drop across the test filter shall be recorded. If required, the air flow may be adjusted.

7.5 Determination of oil aerosol concentration

The determination of oil aerosol concentration shall be done in accordance with ISO 8573-2 or, alternatively, a suitable white-light-scattering aerosol photometer according to ISO 14644-3:2005, Annex C that is capable of sampling compressed air across the range of concentrations of interest can be used. Such an instrument will have previously been calibrated using the test oil and shall be capable of sampling the air at the test pressure. Care shall also be exercised to ensure that the compressed-air sampling method follows the requirements as detailed by ISO 8573-2, i.e. full-flow or iso-kinetic sampling.

7.6 Determination of wet pressure drop

The wet pressure drop is determined at 100 % of rated flow when equilibrium is achieved with the aerosol generator operating and set to the conditions identified in Table 1.

8 Uncertainty

NOTE A calculation of the probable error, according to this clause is not always necessary.

Due to the very nature of physical measurements, it is impossible to measure a physical quantity without error or, in fact, to determine the true error of any one particular measurement. However, if the conditions of the measurement are sufficiently well known, it is possible to estimate or calculate a characteristic deviation of the measured value from the true value, such that it can be asserted with a certain degree of confidence that the true error is less than the said deviation. The value of such a deviation (normally a 95 % confidence limit) constitutes a criterion for the accuracy of the particular measurement.

It is assumed that compensation can be made by corrections for all systematic errors that can occur in the measurement of the individual quantities measured and of the characteristics of the air. A further assumption is that the confidence limits in errors in reading and integration errors are negligible if the number of readings is sufficient.

The (small) systematic errors that can occur are covered by the inaccuracy of measurements.

Quality classifications and limits of error are often invoked for ascertaining the uncertainty of an individual measurement because apart from the exceptions (e.g. electrical transducers), they constitute only a fraction of the quality class or the limit of error.