INTERNATIONAL STANDARD

ISO 8573-5

First edition
2001-12-15

Compressed air —

Part 5: Test methods for oil vapour and organic solvent content

Air comprimé —

Partie 5: Méthodes d'essai pour la teneur en vapeurs d'huile et en solvants organiques

Reference number
ISO 8573-5:2001(E)

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Printed in Switzerland

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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 3.

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 part of ISO 8573 may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

International Standard ISO 8573-5 was prepared by Technical Committee ISO/TC 118, *Compressors, pneumatic tools and pneumatic machines*, Subcommittee SC 4, *Quality of compressed air*.

ISO 8573 consists of the following parts, under the general title *Compressed air:*

— *Part 1: Contaminants and purity classes*

— *Part 2: Test methods for aerosol oil content*

— *Part 3: Test methods for measurement of humidity*

— *Part 4: Test methods for solid particle content*

— *Part 5: Test methods for oil vapour and organic solvent content*

— *Part 6: Test methods for gaseous contaminant content*

— *Part 7: Test methods for viable micro biological contaminant content*

The following parts are under preparation:

— *Part 8: Test methods for solid particle content by mass concentration*

— *Part 9: Test methods for liquid water content*

Annex A forms a normative part of this part of ISO 8573. Annex B is for information only.

Compressed air —

Part 5:
Test methods for oil vapour and organic solvent content

1 Scope

This part of ISO 8573 specifies the gas chromatography test method for determining the content of oil vapour (hydrocarbons of six or more carbon atoms) in compressed air, regardless of the source of the compressed air, as well as of any organic solvents in the vapour, difficult to separate from the other hydrocarbons. It also gives guidelines on the use of chemical indicator tubes as an initial indication of the presence of oil vapour.

This part of ISO 8573 elaborates sampling, measurement, evaluation, uncertainty considerations and reporting in respect of the compressed air purity class parameter, oil vapour, in accordance with ISO 8573-1.

NOTE Lighter hydrocarbons composed of five or less carbon atoms are dealt with as gaseous contaminants in 8573-6.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this part of ISO 8573. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this part of ISO 8573 are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies. Members of ISO and IEC maintain registers of currently valid International Standards.

ISO 2591-1, *Test sieving — Part 1: Methods using test sieves of woven wire cloth and perforated metal plate*

ISO 3857-1, *Compressors, pneumatic tools and machines — Vocabulary — Part 1: General*

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

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

ISO 8573-2:1996, *Compressed air for general use — Part 2: Test methods for aerosol oil content*

ISO 8573-3, *Compressed air — Part 3: Test methods for measurement of humidity*

ISO 9486, *Workplace air — Determination of vaporous chlorinated hydrocarbons — Charcoal tube/solvent desorption/gas chromatographic method*

ISO 9487, *Workplace air — Determination of vaporous aromatic hydrocarbons — Charcoal tube/solvent desorption/gas chromatographic method*

3 Terms and definitions

For the purposes of this part of ISO 8573, the terms and definitions given in ISO 3857-1, ISO 5598 and ISO 8573-1, and the following apply.

3.1
mesh
indication of particle size resulting from the grading of solids by the use of sieves with defined hole sizes

3.2
oil
mixture of hydrocarbons composed of six or more carbon atoms (C_6)

3.3
organic solvent
mixture of one or a combination of the following identified groups: alcohols, halogenic hydrocarbons, esters, esters/etheralcohols, ketones, aromatic/alfatic hydrocarbons

NOTE These compounds are characterized by a considerable vapour pressure under given conditions, when air samples are analysed.

4 Oil vapour classes

Oil vapour is included in the total oil concentration figure used for classification in Table 4 of ISO 8573-1:2001.

5 Test methods

Selection of the available test methods depends on the range of oil vapour content in the compressed air.

— Gas chromatography (see clause A.1) is applicable for oil vapour content in the range 0,001 mg/m^3 to 10 mg/m^3.

— Chemical indicator tubes (see clause A.2) are to be used as a preliminary method only, for checking purposes and as an initial investigation, after which the gas chromatography method shall be employed.

6 Sampling

6.1 General

The quantification of the oil vapour content in a compressed air system shall be carried out within the following constraints.

The sample shall be free from interfering contaminants, for example, water vapour, oil aerosol.

The sampling and analysis of the oil vapour shall be performed using a constant flow rate.

Air flow is normally diverted through the test equipment via suitable in-line valves. These shall have been checked to ensure they do not contribute to the level of contamination already present. Particular attention shall be given to the cleanliness of the test equipment, and other precautions shall be taken, for example, valve purging and stabilization to constant test conditions. Good analytical techniques help improve the confidence level of the measurements.

Flow measurement is required to determine the volume of air used during the test, regardless of the method.

The temperature and velocity range shall be within the ranges specified by the manufacturer of the test equipment.

See clause A.1 for the sampling procedure.

6.2 Extraction

The probe shall be installed in a small extraction tube, which conducts an air sample from the main pipe into the measurement chamber, where the measurement shall be made under system pressure.

6.3 Sampling and measurement conditions

6.3.1 Repeatability

Depending on the repeatability of the method and the experience of the parties involved in the provision of measurement facilities, a number of sequential measurements may need to be carried out.

6.3.2 Sampling system

Materials used for conducting the air in the sampling system shall not affect the oil vapour content of the sample.

The sampling system pressure shall be recorded during measurement.

The sampling system temperature shall be higher than the prevailing dew-point and shall be recorded during measurement (see ISO 8573-3).

6.3.3 Measurement system

The compressed air system and sampling system shall have reached a steady state before any measurement is carried out and shall be kept steady during measurement. The readings from two consecutive measurements, having between them an interval of at least 20 minutes, may not differ by more than is implied by the accuracy of the measuring system.

6.3.4 Test equipment

The general arrangement of the test equipment for extracting a sample shall be as shown in Figure A.1. It is important that the test equipment not affect the collected sample.

Precautions shall be taken to ensure there is no temperature drop between the compressed air system and the collection point. Practical procedures as identified in ISO 8573-2 should also be considered.

7 Measurement

Consideration shall be given to the calibration requirements of the measurement equipment used, as described in applicable instructions, and to the degree of vapour concentration being measured.

The requirements on equipment handling, measurement and evaluation shall be according to Method B2 of ISO 8573-2:1996.

See clause A.1 for specification of the gas chromatography test procedure.

Prepare for measurement by cleaning and degreasing the measuring and stainless steel tubes with a solvent that does not add to the overall hydrocarbon content of the sample. Before measuring, flush the sample point and the stainless steel tube up to the membrane filter with compressed air from the system, for example, for 5 min.

Reference should be made to ISO 9486 and ISO 9487 with regard to methodology.

Check the standard reference conditions for the flow meter.

8 Evaluation of test results

8.1 Reference conditions

Unless otherwise agreed, the reference conditions for oil vapour concentration statements shall be the following.

— Compressed air temperature: 20 °C.

— Compressed air: 1 bar[1)] absolute.

— Relative water vapour pressure: 0.

8.2 Influence of humidity

The humidity shall be less than 75 % and within the limits of the measurement equipment as declared by the equipment manufacturer. The appropriate calibration procedure for the measurement, as given in the manufacturer's literature, should be followed.

8.3 Influence of pressure and temperature

Oil vapour concentration shall be recalculated to reference pressure conditions using the following formula:

$$c_{\text{ref}} = c_{\text{test}} \cdot \frac{p_{\text{ref}}}{p_{\text{test}}} \cdot \frac{t_{\text{test}}}{t_{\text{ref}}}$$

where

c_{ref} concentration at reference conditions;

c_{test} concentration at test conditions;

p_{ref} reference pressure (absolute);

p_{test} test pressure (absolute);

t_{ref} reference temperature (absolute);

t_{test} test temperature (absolute).

The volume flow rate of the air is influenced by temperature. See annex B.

9 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

1) 1 bar = 0,1 MPa = 10^5 Pa; 1 MPa = 1 N/mm^2

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 95 % confidence limit) constitutes a criterion of the accuracy of the particular measurement.

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

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

Quality classifications and limits of error are often invoked for ascertaining the uncertainty of 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.

The information about ascertaining the uncertainty of the measurement of the individual quantities measured and on the confidence limits of the gas properties are approximations. These approximations can only be improved at a disproportionate expense. See ISO 2602 and ISO 2854.

10 Test report

10.1 Statements

Statements of the oil vapour or organic solvent content in the compressed air, or both, shall only be used in conjunction with statements on oil aerosol content when made for classification purposes according to ISO 8573-1, and shall be made in such a manner that the values can be verified according to the procedures of the measurement methods specified in this part of ISO 8573.

Statements according to this part of ISO 8573 shall not be used to characterize oil content in air without mention that the total amount of oil is not considered.

10.2 Information

The test report used to declare oil vapour concentration according to this part of ISO 8573 shall contain the following information:

a) a description of the compressed air system and its working conditions, with sufficient detail to determine the applicability of the declared concentration value, including

   — pressure,

   — temperature, and

   — other contaminants;

b) a description of the sampling point at which the samples were taken;

c) a description of the sampling and measurement system used, in particular the materials used, and details of its calibration record;

d) the phrase “Declared content of oil vapour in mg/m^3 in accordance with ISO 8573-5”, followed by

   — the figure for the actual, average measured value evaluated according to clause 8, calculated in respect of the *reference* conditions,

— the figure for the actual, average measured value evaluated according to clause 8, calculated in respect of the *actual* conditions,

— the pressure to which the measurement refers,

— a statement, following the figure, in respect of the applicable uncertainty, and

— the date of the calibration record;

e) the date of the sampling and measurements.

Annex A
(normative)

Test procedures

A.1 Gas chromatography

A.1.1 Sampling procedure

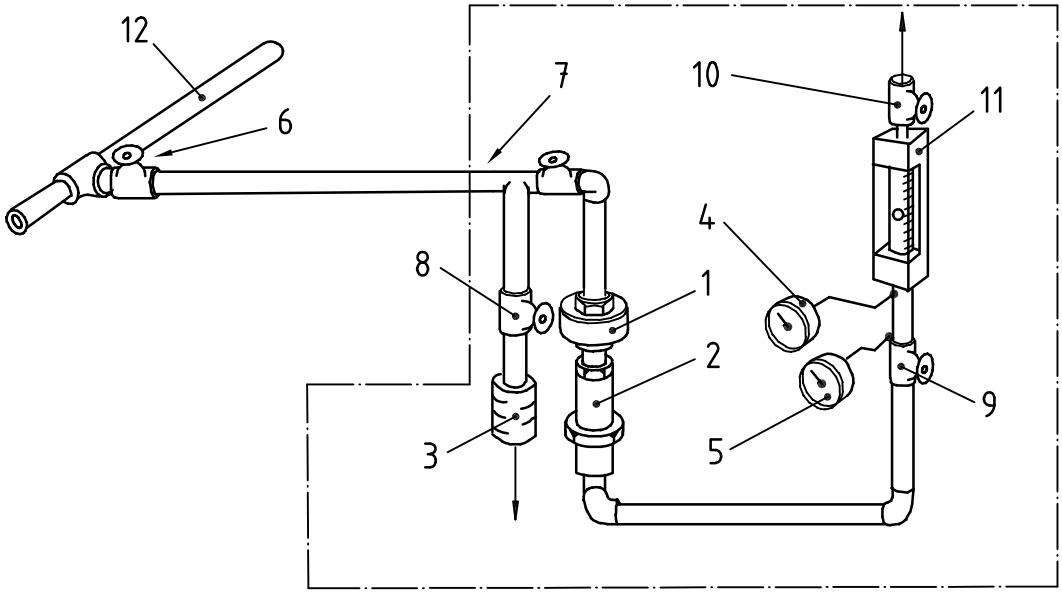
Carry out the procedure as follows, and as shown in Figure A.1.

a) Connect the extraction tube in Figure A.1 to the shut-off valve (6) at the measuring point.

b) Connect shut-off valves 7 and 8 with the silencer (3).

c) Close all valves.

d) Open shut-off valves 6, 7 and 8 slowly.



Key

1 Membrane holder [a]
2 Stainless steel tube (see Figure A.2) for collection of oil vapour and organic solvents
3 Silencer
4 Pressure gauge
5 Temperature gauge
6 Shut-off valve
7 Shut-off valve
8 Shut-off valve
9 Flow-control valve
10 Flow-control valve [b]
11 Flow meter
12 Main pipe

[a] The membrane is to protect the stainless steel tube from contamination by aerosols.
[b] This flow-control valve (10) is to be used only if the flow meter can operate under pressure.

Figure A.1 — Gas chromatography — Sampling procedure

e) Flush (cleaning process) the system for 5 min.

f) Close all valves.

g) Connect the rest of the measuring system according to Figure A1.

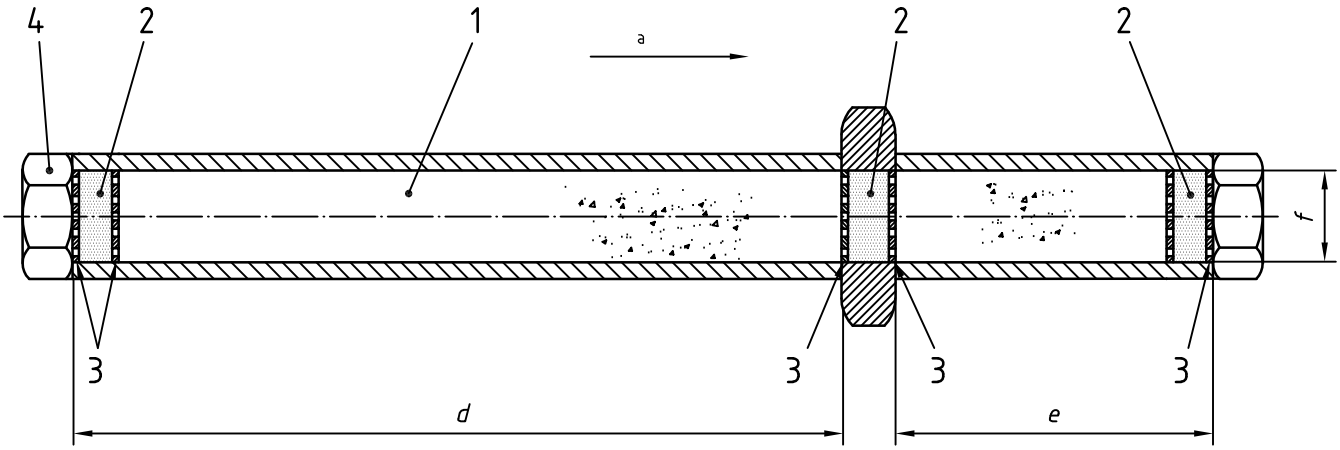
h) Close all valves.

i) Open shut-off valves 6, 7 and 8 fully to pressurize the test equipment.

j) Adjust the flow, using the flow-control valves (9, 10) on the flow meter (11).

k) After the sampling time, close the shut-off valve (6) at the inlet of the extraction tube. The sampling time shall be long enough so that 0,001 mg to 1 mg mass is adsorbed per tube in the main zone. The minimum contat time shall be 0,1 s, where the contact time is the volume of the charcoal of the main zone divided by the actual flow rate of the compressed air.

l) Disconnect the membrane holder (1) and the stainless steel tube (2), and plug open the ends. The stainless steel tube shall be as shown in Figure A.2.



Key

1 Stainless steel tube
2 Quartz wool separator
3 Perforated stainless steel disc
4 1/4-inch connection
d Length of main zone, with 3 g charcoal: 100 mm
e Length of back-up zone, with 1 g charcoal: 40 mm
f Internal diameter of steel tube: 10 mm

a Flow direction.

Figure A.2 — Stainless steel tube

A.1.2 Sample preparation

The stainless steel measuring tube shall contain 3 g coconut charcoal (< 75 % relative humidity) in the main zone and 1 g coconut charcoal in the back-up zone (see Figure A.2). The maximum content of the adsorbed oil vapour or organic solvent in the back-up zone shall be in the region of 10 % to 25 % by mass. The sorbent is 20/40 mesh coconut charcoal in accordance with ISO 2591-1.

Although the most widely available adsorbent for this application is coconut charcoal, where an alternative adsorbent exists that provides the same performance, it may be substituted.

A.1.3 Determination

Analyse the main zone and the back-up zone separately, together with a “blind-test”, using the following procedure.

a) Extract the main zone and the back-up zone using carbon disulphide. Use benzene-d6, toluene-d8, ethylbenzene-d10 and octane-d18 as internal standards.

b) Extract the sorbent sample tube for 30 min on a shaker.

c) Analyse the extract using a gas chromatograph with mass-spectroscopic detection in full scan mode, analysing both blind tests and standards in the same way.

d) Identify dominant single components as far as possible. Characterize, sum and calculate other single components (e.g. aliphatic and aromatic compounds) semi-quantitatively as toluene.

The detection limits shall be 0,1 µg to 0,5 µg per tube.

A.1.4 Calculation

The principles given in ISO 8573-2 regarding analytical methods and related calculations should be applied.

A.2 Chemical indicator tubes

For the purposes of this part of ISO 8573, detector tubes may be employed to provide an initial indication of the presence of oil vapour. Once identified, the gas chromatography method according to clause A.1 shall be used to identify the quantitative aspect of the oil vapour present in the compressed air.

For detailed information regarding the application of detector tubes refer to the manufacturer's literature.

Annex B
(informative)

Dalton's law of partial pressure

$$c_{\text{oil}} = \frac{M_{\text{r,oil}} \cdot p_{\text{oil}}}{M_{\text{r,air}} \cdot p_{\text{abs}}}$$

where

c_{oil} is the oil concentration ratio;

$M_{\text{r,oil}}$ is the molecular weight of oil;

$M_{\text{r,air}}$ is the molecular weight of air;

p_{oil} is the vapour pressure of oil, in bar;

p_{abs} is the absolute pressure, in bar.

Bibliography

[1] ISO 2602, *Statistical interpretation of test results — Estimation of the mean — Confidence interval*

[2] ISO 2854, *Statistical interpretation of data — Techniques of estimation and test relating to means and variances*

ICS 71.100.20

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