
**Compressed air — Contaminant
measurement —**

**Part 2:
Oil aerosol content**

Air comprimé — Mesurage de contaminants —

Partie 2: Teneur en aérosols d'huile
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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. www.iso.org/directives

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For an explanation on the voluntary nature of standard, 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

This document was prepared by Technical Committee ISO/TC 118, *Compressors and pneumatic tools, machines and equipment*, Subcommittee SC 4, *Air treatment technology*.

This third edition cancels and replaces the second edition (ISO 8573-2:2007), which has been technically revised.

A list of all the parts in the ISO 8573 series can be found on the ISO website.

Introduction

This document requires the use of solvents to extract the oil captured on the sampling disc used in the sampling process. As a result of world-wide agreements such as the Montreal Protocol on the reduction of ozone depleting substances, a number of solvents used, for example 1,1,2 trichlorotrifluoroethane (TCTFE) have become subject to application restrictions. The revision of this document in 2007 did not identify a solvent but indicated the required characteristics.

This revision introduces the use of equipment that does not require the use of specific solvents and also an alternative solvent with reduced properties for the current method.

This revision will also include guidance to methods which provide an indication of oil aerosol content in compressed air.

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Compressed air — Contaminant measurement —

Part 2: Oil aerosol content

1 Scope

This document specifies test methods for the sampling and quantitative analysis of liquid oil and oil aerosols that can typically be present in compressed air. Test methods for oil vapour are excluded from this document as they are covered by ISO 8573-5.

Two different methods are described, Method A and Method B. Method B is subdivided into two parts to clearly distinguish between procedures for obtaining the quantity of oil for analysis.

Method A describes an oil collection technique using inline coalescing filters whereas Method B utilizes sampling discs in a holder from which the collected oil is extracted with a solvent and analysed by infrared spectrometry or gas chromatography with flame ionization detection.

This document also includes descriptions of alternative oil aerosol detection by the use of indicator type devices, see [Annex E](#).

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 3857-4, *Compressors, pneumatic tools and machines — Vocabulary — Part 4: Air treatment*

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

ISO 8573-5, *Compressed air — Part 5: Test methods for oil vapour and organic solvent content*

ISO 12500-1, *Filters for compressed air — Test methods — Part 1: Oil aerosols*

DIN 32645, *Chemical analysis — Decision limit, detection limit and determination limit under repeatability conditions - Terms, methods, evaluation*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 3857-4 and ISO 8573-1 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/>

4 Units

General use of SI units as given throughout this document is recommended, see ISO 80000-1. 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 m³

5 Reference conditions

Reference conditions for oil aerosol content volume statements are as follows:

- air temperature: 20 °C;
- absolute air pressure: 100 kPa [1 bar (a)];
- relative water vapour pressure: 0.

6 Guidance for selection of sampling method

The sampling methods can be used at any point in the compressed air system. The selection of Method A or B depends upon the actual level of oil contamination present in the compressed air system, as shown in [Table 1](#). Where wall-flow is present, then Method A shall be used.

Table 1 — Guidance for the selection of sampling method

Parameter	Method A Full flow	Method B1 Full flow	Method B2 Partial flow
Min/max detection limit	>1 mg/m ³	0,001 mg/m ³ to 10 mg/m ³	
Sampling time (typical)	50 h to 200 h	10 min to 10 h	
Filter construction	Coalescing line filter	Sampling disc	

7 Method A — Description, measuring procedure and calculation of results

7.1 Description of sampling equipment and method

7.1.1 General

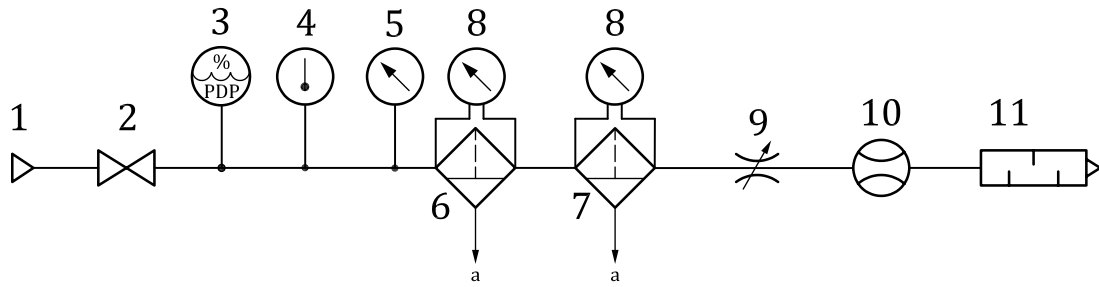
This sampling method is suitable for full flow only and samples all of the air flow that is passed through two high efficiency coalescing filters in series and measures oil in both aerosol and wall-flow forms.

This sampling method may be used at any point in a compressed air system where heavy contamination levels of oil are believed to exist.

7.1.2 Sampling equipment

7.1.2.1 General description

The typical arrangement of equipment used in Method A is shown in [Figure 1](#). The sampling equipment should not influence the collection sample. An explanation of the equipment is included in the listing as follows.

**Key**

1	compressed air sampling point	8	differential pressure sensing/measuring
2	full-flow ball valve	9	multi-turn flow control valve
3	pressure dewpoint sensing/measuring	10	flow sensing/measuring
4	temperature sensing/measuring	11	silencer
5	pressure sensing/measuring	a	To liquid collection.
6	sampling filter		
7	back-up filter		

Figure 1 — Typical arrangement for Method A

- a) Compressed air sampling point (see [Figure 1](#), key item 1).

The compressed air sampling point is a test point at a nominated location in the compressed air system under investigation. (standards.iteh.ai)

- b) Full-flow ball valve (see [Figure 1](#), key item 2).

This is an optional item for convenient connection to the compressed air sampling point and has the same bore as that of the pipe to which it is attached to prevent restrictions.

- c) Pressure dewpoint sensing/measuring (see [Figure 1](#), key item 3).

A pressure dewpoint sensing/measuring device is used to determine the moisture content of the compressed air being sampled.

- d) Temperature sensing/measuring (see [Figure 1](#), key item 4).

A temperature sensing/measuring device is used to indicate the compressed air sampling point temperature at the time of the test.

- e) Pressure sensing/measuring (see [Figure 1](#), key item 5).

A pressure-sensing/indicating device is used to confirm that the coalescing filters are operating within manufacturer's specifications.

- f) Sampling filter (see [Figure 1](#), key item 6).

The sampling filter is a high efficiency, coalescing filter capable of removing the oil whose concentration is being measured from the upstream concentration and of reducing the downstream concentration to 0,01 mg/m³ or less as determined by ISO 12500-1.

The sampling filter shall be operated within the manufacturer's recommendations.

The measurements are only valid once this filter has reached steady state conditions (see [Figure 2](#)).

- g) Back-up filter (see [Figure 1](#), key item 7).

This filter is identical to the sampling filter and, in the event of malfunction of the sampling filter, collects any oil that passes through it.

- h) Differential pressure gauge (see [Figure 1](#), key item 8).

These gauges determine the pressure drop across the sample and back-up filters.

- i) Flow control valve (see [Figure 1](#), key item 9).

In order to adjust the flow accurately, a valve with fine adjustment is required.

- j) Flow sensing/measuring (see [Figure 1](#), key item 10).

A suitable flow meter with an accuracy of $\pm 5\%$ of the actual value is used to determine the air sample volume, which shall be referred to reference conditions.

- k) Silencer (see [Figure 1](#), key item 11).

This is to limit the noise during the test and assist in meeting any local noise-reduction requirements.

7.2 Sampling procedure

7.2.1 Start-up

The user shall ensure that the equipment selected for the measurement is safe for use at the operational pressure and temperature at which the liquids are collected and compatible with the collected liquids.

Open full-flow ball valve (see [Figure 1](#), key item 2) fully to pressurize the sampling equipment. Adjust flow using flow control valve (see [Figure 1](#), key item 9) to required flow conditions shown on the flow sensing/measuring device ([Figure 1](#), key item 10).

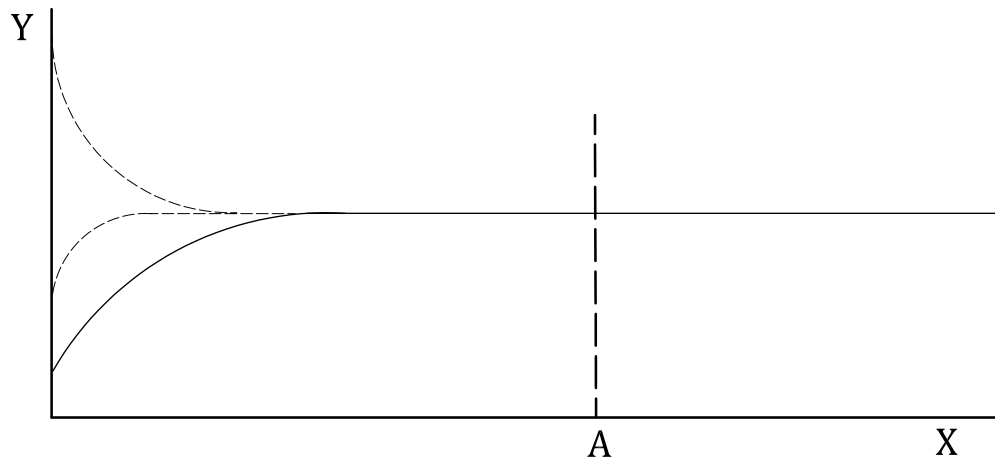
7.2.2 Stabilizing sampling filter

The sampling filter element (see [Figure 1](#), key item 6) operates in a saturated equilibrium condition and time shall be allowed for this condition to be reached. Equilibrium is considered to have been achieved when liquid oil is observed in the bottom of the filter housing in which the sampling filter is contained and the rate of change in pressure drop is less than 1 %/h of the measured pressure drop.

Starting from this point, the liquid collected from the drainage of the sampling and back-up filters (see [Figure 1](#), items 6 and 7, respectively), is discharged to a collection device and the mass or volume is measured with a suitable measuring device.

Necessary precautions when discharging the liquid, include taking care in controlling the liquid flow and any subsequent rapid escape of compressed air that can cause the collected oil to foam. In addition, if air bubbles appear in the collected liquid, then allow time for settling before taking a reading of volume. The mass of the oil can be directly measured in milligrams by weighing.

Measurement shall be taken only when the differential pressure of the sampling filter reaches the stable part of the graph (from point A to point X, see [Figure 2](#)) and oil is visible in the filter bowl of the sampling filter ([Figure 1](#), key item 6).

**Key**

X time

Y pressure drop across sampling filter

A position of pressure drop equilibrium (change in pressure drop is less than 1 %/h of the measured pressure drop)

———— characteristic curve for unused sampling filter

- - - - - characteristic curve for previously used sampling filters

Figure 2 — Typical characteristic curves for sampling filters

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A stable pressure drop is indicated by the differential pressure gauge (see [Figure 1](#), key item 8). An unused sampling filter may take longer to reach a stable condition than a filter that has previously been used. The time required to reach a stable pressure drop depends on the oil/water loading.

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7.2.3 Oil measurement

Drain the collected liquid for measurement from the sampling filter (see [Figure 1](#), key item 6) and transfer to a suitable volumetric measuring cylinder. Measuring intervals depend upon the amount of liquid collected. Allow the collected oil to separate in order to avoid incorrect readings due to foaming, and take care during measurement to account for the meniscus. Record the volume of oil collected, V , in millilitres. Alternatively, the collected oil may be weighed and the mass, m , recorded in milligrams.

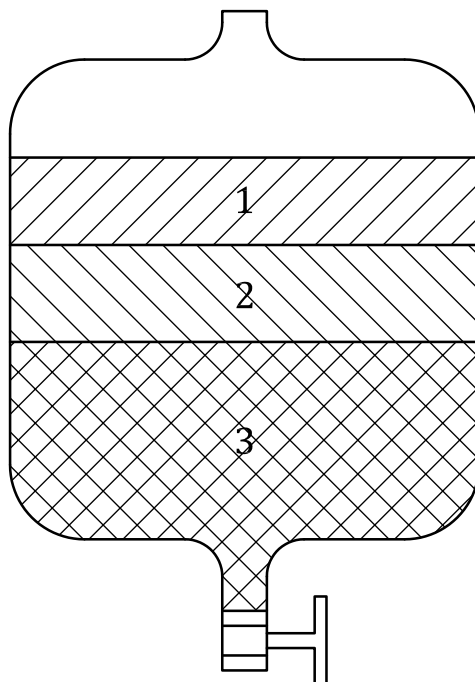
The first sampling filter (see [Figure 1](#), key item 6) collects the oil to the required accuracy. The back-up filter (see [Figure 1](#), key item 7) is used to ensure the first sampling filter has functioned correctly. Any sign of oil in the second filter may indicate that it is necessary to replace the first filter element.

7.2.4 Oil/water measurements

The liquid collected consists of water, oil/water emulsion and oil. Depending on the type of oil, separation of the oil/water emulsion can occur, allowing the water to be drained off and the oil to be measured; see [Figures 3](#) and [4](#).

If a water/oil emulsion zone occurs, drain the oil-free water then add a measured quantity of solvent and stir to dissolve the oil; see [Figure 4](#).

The collected oil and solvent may be weighed and the mass recorded in milligrams having subtracted the solvent mass.

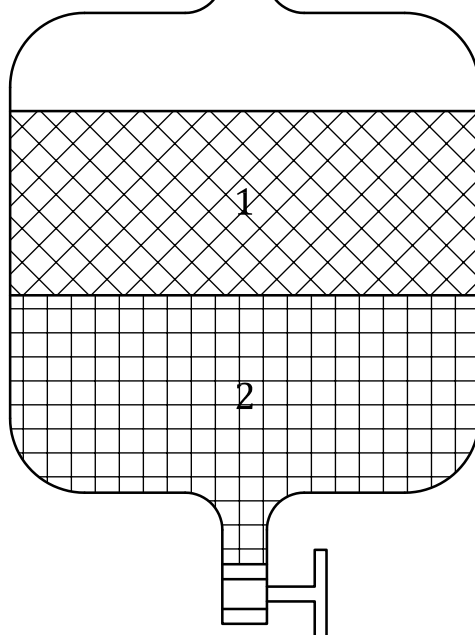


- Key**
- 1 oil
 - 2 oil/water emulsion
 - 3 water

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Figure 3 — Oil/water separator

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- Key**
- 1 water
 - 2 oil/solvent solution

Figure 4 — Oil-solvent/water separator

Drain the heavier oil/solvent solution and measure the actual quantity of oil collected by subtracting the measured quantity of solvent from the total. Record the volume of oil collected, V , in millilitres. Alternatively, the collected oil may be weighed and the mass, m , recorded in milligrams.

7.2.5 Air flow-rate (discharge)

The air flow-rate measurement should have an accuracy of better than 5 % at the actual flow being measured.

7.2.6 Temperature

The temperature is measured in degrees Celsius with an accuracy of better than 1 °C.

7.3 Calculation of test results

7.3.1 General

The accuracy of the test is dependent on the volume of oil collected and increases with increasing volume of oil and collection time. It is necessary to ensure that results are stable, repeatable and presented in a form that shows that this has been achieved.

7.3.2 Oil content

When the volume of the collected oil is measured, the oil content, X , in milligrams oil per cubic metre air, is calculated using [Formula \(1\)](#):

$$X = \frac{V \times \rho}{q \times H \times 3,6} \quad (1)$$

where

V is the volume of oil collected, expressed in millilitres;

ρ is the specific density of the oil, expressed in kilograms per cubic metre;

q is the air flow-rate, expressed in litres per second at reference conditions; see [Clause 5](#);

H is the duration of the test, expressed in hours.

When the mass of the collected oil is measured, the oil content, X , is calculated using [Formula \(2\)](#):

$$X = \frac{m}{q \times H \times 3,6} \quad (2)$$

where m is the mass of oil, expressed in milligrams.

8 Method B — Description, measuring procedure and calculation of results

8.1 General description of sampling equipment and method

Method B deals with the sampling and analysis of oil aerosols at constant flow rate. Within the constraints detailed above, this method permits the quantification of oil aerosols present in a compressed air system, provided wall-flow contamination is not present.

The method is subdivided into procedures B1 and B2. Method B2 uses the same sampling equipment employed in Method B1; with the addition of a sampling probe to allow partial-flow sampling under isokinetic conditions from the main pipe flow if the velocity constraints of the air flowing through the sampling disc of Method B1 are exceeded. Accuracy and limitations are as stated in Method B1.

The optimum duration for sample measurement may be determined after an initial test to determine the approximate oil concentration present. When carrying out full-flow sampling, it is possible to route the air back into the compressed air system, preventing loss of the product. Conversely, it is also possible to vent the flow to the atmosphere. Flow measurement is required to determine the volume of air sampled, whichever method is adopted. As the sampling apparatus is portable, different sample locations may be chosen provided the stated parameters are not exceeded and suitable connections for insertion of the sampling equipment into the circuit exists. Obvious precautions to prevent shock depressurization, which can damage the sampling discs, or ingress of atmospheric contamination are necessary.

The sampling and analysing equipment used as described give an accuracy of better than $\pm 10\%$ over the range from $0,001 \text{ mg/m}^3$ to 10 mg/m^3 oil content with a minimum sampling time calculated to collect sufficient oil to meet the requirements of the oil mass-per-volume of solvent used when determining the response characteristics of the measuring equipment. The upper limit for the air velocity (at operating pressure) in front of the sampling disc is 1 m/s .

As this method concerns the measurement of relatively low concentrations of oil aerosol in air, particular attention shall be paid to the cleanliness of the sampling equipment and other precautions shall be taken, e.g. valve purging and stabilization to constant test conditions. Good analytical techniques help improve the confidence level of the measurements. At very low oil concentration the recommended sampling time should be increased.

8.1.1 Sampling disc

In order to obtain good measuring accuracy, a high-efficiency binder free microfibre sampling disc or similar shall be used. To achieve the accuracy specified for this method, three or more layers of sampling discs in series and in intimate contact shall be used and the individual sampling discs should meet the requirements given in [Table 2](#).

Table 2 — Typical high-efficiency microfibre glass sampling disc properties

Parameter	Specification
Particle removal efficiency (1 and 2) %	>99,995
Surface mass, g/m^2	130 to 150 (for glass fibre) 80 to 90 (for quartz fibre)

NOTE 1 The particle removal efficiency is typically measured according to EN 1822-3[3].

NOTE 2 An equivalent particle penetration rating is a $1 \mu\text{m}$ particle retention in liquid filtration. Suitable binder free glass fibre sampling discs typically have a thickness of $0,7 \text{ mm}$, a surface mass of 140 g/m^2 and air resistance of 95 mbar per disc, binder free quartz fibre sampling discs a thickness of $0,4 \text{ mm}$, a surface mass of 85 g/m^2 and air resistance of 50 mbar per disc.

8.1.2 Sampling disc support

In order to prevent the collection sampling disc from bursting, it shall be supported by a robust, inert material that is sufficiently strong to withstand the differential pressures of the discs in use during sampling. The pressure drop losses from the support should be minimized to allow the sampled compressed air flow to pass with a minimum of resistance; see [Annex B](#).

8.1.3 Pipes and valves

It is important that the pipe inner diameter from the connection point in the compressed air system to the sampling disc holder be constant and crevice free to minimize system loss.

The valves (for example see [Figure 5](#), key item 8) should be full-flow ball type and the hole in the ball should have approximately the same diameter as the bore of the pipe.

The bypass pipe (see [Figure 5](#), key item 6) may consist of a flexible tube and although a full-flow ball valve (see [Figure 5](#), key item 8) is indicated, this may be of any convenient type.

8.1.4 Sampling disc holder

The design of the sampling disc holder shall be such that the air flow is evenly distributed across the surface to prevent jetting which can cause an uneven oil loading or even damage to the sampling disc surface. One such design of sampling disc holder can be seen in [Figure B.3](#).

In circumstances where only a portion of the sampling disc is to be analysed by solvent extraction, tests shall establish that the oil is distributed evenly throughout and the measured oil quantity corrected for the ratio of the analysed area to the total area used during sampling.

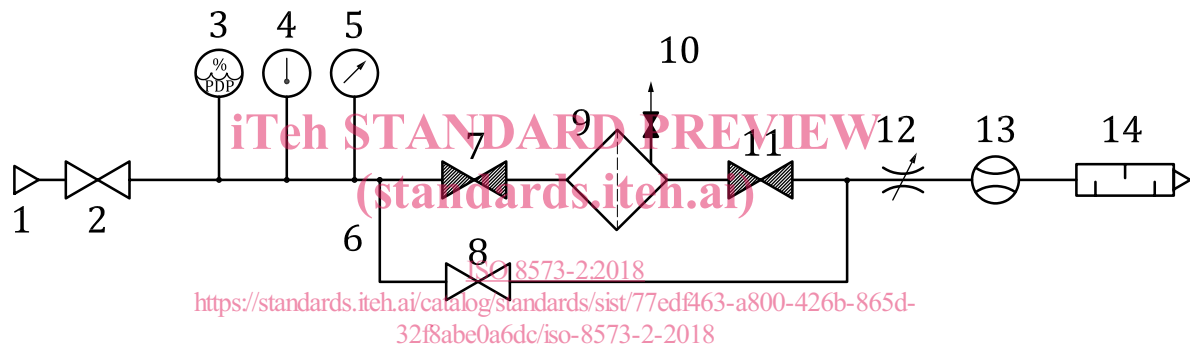
8.1.5 Construction materials

Aluminium and its alloys shall not be used for any component that can come into contact with the analysis solvent.

8.2 Sampling equipment arrangement

8.2.1 Sampling equipment Method B1 — Full flow sampling

A general arrangement of typical sampling equipment is shown in [Figure 5](#).



Key

1	compressed air sampling point	8	full-flow ball valve (open)
2	full-flow ball valve (open)	9	sampling disc holder
3	pressure dewpoint sensing/measuring	10	sampling disc holder depressurising valve
4	temperature sensing/measuring	11	full-flow ball valve (closed)
5	pressure sensing/measuring	12	multi-turn flow control valve
6	bypass pipe	13	flow sensing/measuring
7	full-flow ball valve (closed)	14	silencer

Figure 5 — Typical arrangement for Method B1

In Method B1 all of the sampled air flow is diverted through the sampling equipment via suitable in-line valves, which have been previously checked to ensure they do not contribute to the level of oil contamination already present.

8.2.2 Sampling equipment Method B2 — Partial flow sampling

A general arrangement of typical sampling equipment is shown in [Figure 6](#).