INTERNATIONAL STANDARD

ISO 8573-4

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Compressed air —

Part 4:
Test methods for solid particle content

Air comprimé —

Partie 4: Méthodes d'essai pour la détermination de la teneur en particules solides

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 3.

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 8573-4 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: Determination of oil vapour and organic solvent content*

— *Part 6: Determination of content of gaseous contaminants*

— *Part 7: Test methods for viable microbiological particle content*

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

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

Annexes A and B of this part of ISO 8573 are for information only.

Compressed air —

Part 4:
Test methods for solid particle content

1 Scope

This part of ISO 8573 provides a guide for choosing a suitable method to determine the solid particle concentration in compressed air, expressed as the number of solid particles in respective size classes. It describes the limitations of the various methods.

This part of ISO 8573 identifies sampling techniques and measurement methods based on the counting of particles, and describes the evaluation, uncertainty considerations and reporting of the air purity parameter, solid particles.

NOTE 1 The test methods described in this part of ISO 8573 are those suitable for determining the purity classes given in ISO 8573-1.

NOTE 2 Particle content determined as mass concentration is dealt with in ISO 8573-8.

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 1217, *Displacement compressors — Acceptance tests.*

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

ISO 5167-1, *Measurement of fluid flow by means of pressure differential devices — Part 1: Orifice plates, nozzles and Venturi tubes inserted in circular cross-section conduits running full*.

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

3 Terms and definitions

For the purposes of this part of ISO 8573, the terms and definitions given in ISO 5598, ISO 3857-1 and ISO 1217 and the following apply.

3.1
solid particle
discrete mass of solid matter

3.2
microbiological particle
solid particle that has the property of forming viable colony units

3.3
aerodynamic particle diameter
diameter of a sphere of density of 1 g/cm^3 with the same settling velocity, due to gravitational force in calm air, as the particle under the prevailing conditions of temperature, pressure and relative humidity

4 Units

For the purposes of this part of ISO 8573, the following non-preferred units are used:

1 bar = 100 000 Pa

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

bar(e) = effective pressure

5 Particle classes

5.1 Solid particles

Solid particles are characterized by their properties of shape, size, density and hardness. Solid particles include microbiological units. Reference is made to microbiological particles in this part of ISO 8573 to identify what problems may arise that can affect the discrimination of non-microbiological particles from microbiological particles and when to use this part of ISO 8573 or ISO 8573-7.

The influence of liquids on particle size and number must be eliminated in order to obtain a correct reading.

The influence of liquids other than water shall be given due consideration when selecting a test method.

In order to discriminate non-microbiological particles from microbiological particles, measurements must be taken within a period of 4 h.

5.2 Microbiological particles

This part of ISO 8573 should be used to count the number of microbiological particles present in a sample. The method used to count the particles does not identify microbiological particles directly, therefore if more information is required, ISO 8573-7 should be used to determine their viability.

5.3 Aerodynamic particle diameter

Aerodynamic particle diameter is a function of density. For the purposes of the test methods described in this part of ISO 8573, it is assumed that solid particles have uniform density.

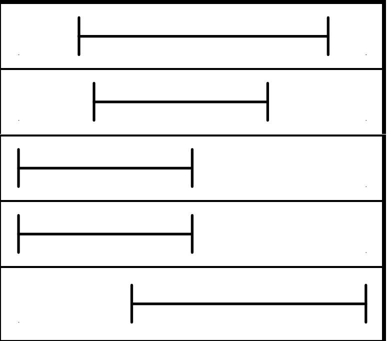
6 Selection of method

The method to be selected depends on the concentration range and the sizes of solid particles in the compressed air. For choosing the method most suitable for the concentration range and sizes of particles estimated to be present in the sample, see Table 1.

The applicability of particular measurement equipment to a method should be verified with the equipment manufacturer.

Table 1 — Guide to selection of method

Method	Applicable concentration range particles/m³	Applicable solid particle diameter *d* µm			
		⩽ 0,10	0,5	1	⩽ 5
Laser particle counter	0 to 10^5				
Condensation nucleus counter	10^2 to 10^8				
Differential mobility analyser	Not applicable				
Scanning mobility particle sizer	10^2 to 10^8				
Sampling on membrane surface in conjunction with a microscope	0 to 10^3				



7 Sampling techniques

7.1 General

Solid particles can be measured at atmospheric pressure or under ambient pressure conditions depending on the equipment used. Measurement can be carried out at partial or full flow.

a) Full flow — sampling of total airflow.

b) Partial flow — sample taken from a percentage of the airflow.

If the particle diameter is greater than 1 µm, then sampling shall be isokinetic.

7.2 Full-flow sampling

7.2.1 General

For full-flow sampling using physical methods, if the particle diameter is greater than 0,5 µm, a gridded membrane shall be used.

The method detailed here deals with the sampling and analysis of airborne particles at constant flowrate, and permits the quantification and sizing of particles in a compressed air system.

Airflow is passed through the test equipment via suitable in-line valves, which have been previously checked to ensure they do not contribute to the level of contamination already present.

Particular attention shall be paid to the cleanliness of the test equipment, and other precautions shall be taken, e.g. valve purging and stabilization to constant test conditions.

Where air is directed to the atmosphere, means should be taken to ensure that the system pressure is maintained.

The temperature and velocity ranges shall be within the ranges specified by the manufacturer.

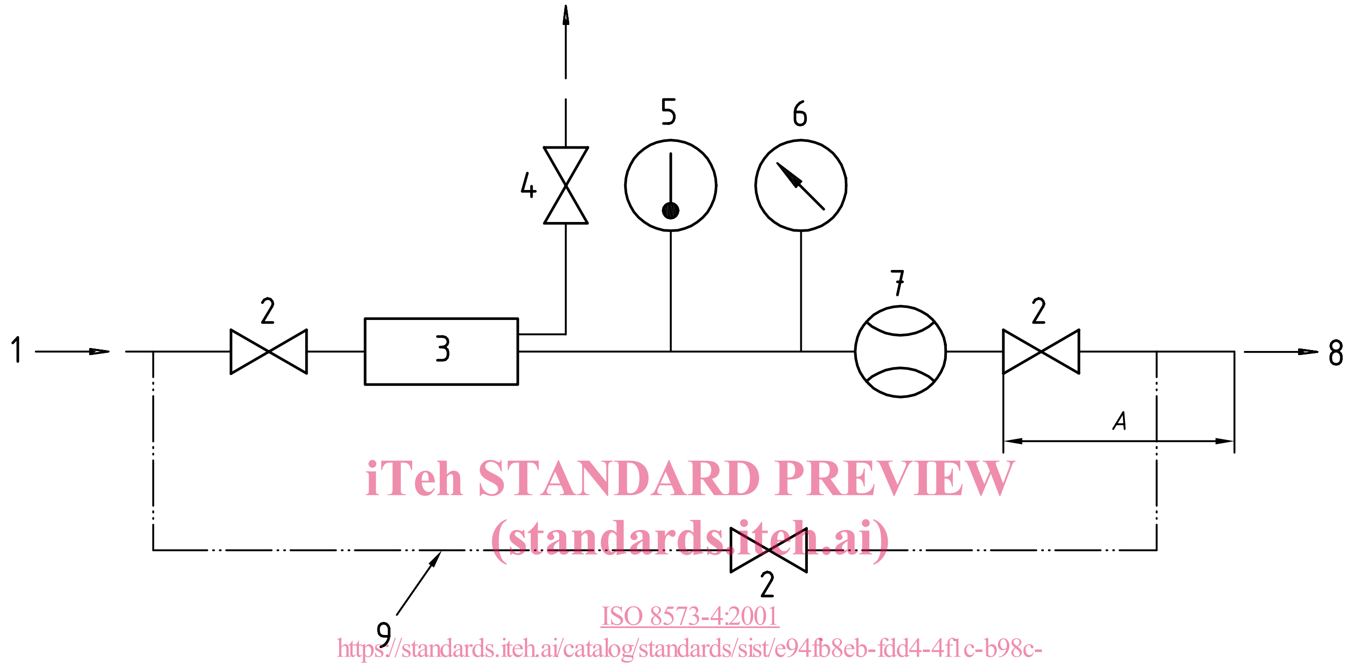
Using this method, the total airflow passes through the sampling equipment.

7.2.2 Test equipment

Full-flow sampling shall be carried out by gridded membrane only.

The general arrangement of the test equipment for full-flow sampling is shown in Figure 1. It is important that the test equipment does not affect the collected sample.

As the test apparatus is portable, different test locations may be chosen, provided the stated parameters are not exceeded and suitable valving for insertion of the test equipment into the circuit exists.



Key

1 From process

2 Full-flow shut-off valve

3 Membrane holder

4 Device to depressurize membrane holder

5 Temperature indicator

6 Pressure indicator

7 Flow-measuring device

8 To atmosphere or process

9 Optional by-pass

A Minimum distance to discharge to atmosphere as specified in ISO 5167-1

Figure 1 — Test equipment for full-flow sampling

7.3 Isokinetic sampling

7.3.1 General

Accurate isokinetic sampling is not critical for small particles (less than 1 µm), although approximate isokinetic conditions are advisable.

Isokinetic sampling devices should exhibit the following characteristics.

a) The probe should be a minimum distance of 10 pipe diameters from upstream bends or restrictions and 3 diameters from downstream bends or restrictions.

b) The size of the probe should not influence the air stream. The nozzles may vary in shape and construction (see 7.3.3).

c) Impaction onto the internal surface of the probe should be taken into account.

d) Turbulent flow conditions within the main air stream are required (Reynolds number Re greater than 4 000). In normal industrial use, compressed air is in a state of turbulent flow, which occurs when the following conditions are met:

$$Q \geqslant \frac{D}{20}$$

where

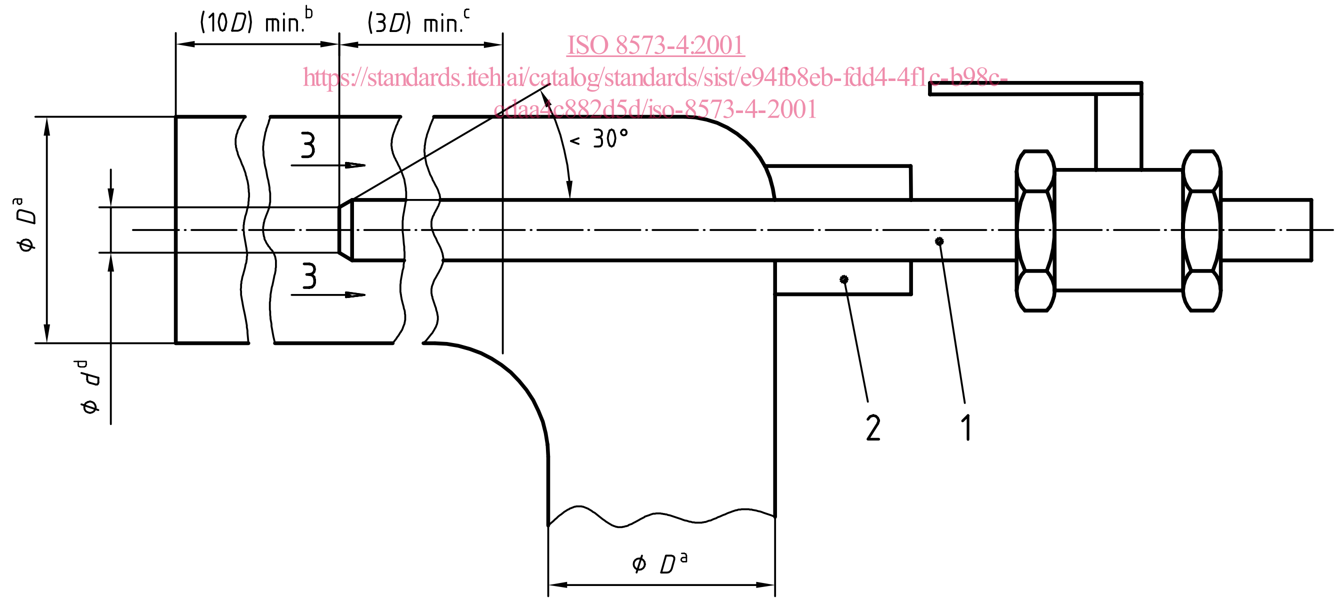
Q is the pipe flowrate, in litres per second (at reference conditions);

D is the actual compressed air pipe diameter, in millimetres.

NOTE Under the test conditions specified, scanning across the pipe diameter with a sampling probe is unnecessary.

7.3.2 Equipment set-up for isokinetic sampling

The set-up for the isokinetic sampling probe at the insertion point of the compressed air system under investigation is shown in Figure 2.



Key

1 Sampling probe in the main pipe

2 Adjustable gland to allow adjustment of probe

3 Direction of air flow

a Main pipe diameter, D

b Minimum straight length before probe, $10 \times D$

c Probe insertion point at minimum of $3 \times D$

d Internal probe diameter, d

Figure 2 — Equipment set-up of probe insertion for isokinetic sampling

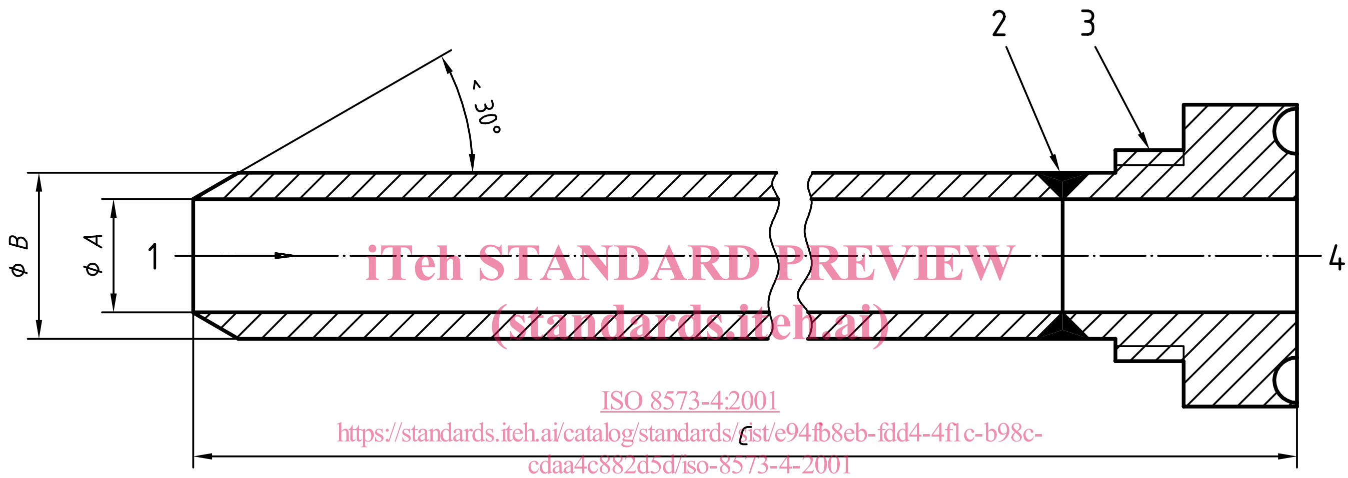
7.3.3 Design of the isokinetic sampling probe

The general construction of the probe is shown in Figure 3.

The probe shall be of circular cross-section, the open end of the tube having a wall thickness of less than 1,3 mm and the internal and external surfaces having an inclination not greater than 30° (see Figure 2).

The angle at the nozzle minimizes the effect of impact onto the end of the probe. The probe dimension shall be selected to give the appropriate flow for the measurement device applied, based on prevailing flow conditions in the main pipe.

The probe should be designed to be compatible with the measuring instrument being used. If the sampling is carried out in stages, isokinetic conditions should be maintained where possible. If isokinetic sampling is not possible, then this shall be agreed.



Key

1 Direction of flow

2 Crevice-free joint

3 Suitable pressure-tight thread connection

4 To membrane holder

Probe size	*A* mm	*B* mm	*C* mm
1	7	9,6	200
2	10	12,6	200
3	17	19,6	400

Figure 3 — Isokinetic sampling probe

7.3.4 Compressed air flowrates

The air velocities within the main pipeline Q and within the probe q shall be identical throughout the sampling period. This is accomplished through adjustment of the flow controllers to provide appropriate readings on the flow meters.

Both Q and q shall be measured and maintained.

Identical pipe and probe velocities exist when the pressures are constant and identical, i.e.:

$$\frac{Q}{q} = \frac{D^2}{d^2}$$

where

- Q is the total pipe discharge, in litres per second;
- q is the probe discharge, in litres per second;
- D is the internal actual main pipe diameter, in millimetres;
- d is the internal probe diameter, in millimetres.

7.4 Reducing system pressure before measurement

If the system pressure is reduced before the measurement, the reduction method shall not influence the resulting particle count and particle distribution.

7.5 Average values

Depending on the reproducibility of the method, the measurement facility and the experience of the parties involved in the provision of the measurement facility, the average value of consecutive measurements at the sampling point shall be used.

7.6 Operating conditions

Actual operating conditions shall be described in the test report.

8 Measurement methods

8.1 General

Below are listed a number of preferred methods for measurement of solid particle content by counting. This list is not exhaustive and other methods are available for use by agreement.

Consideration shall be given to the calibration requirements of the measurement equipment used as described in manufacturers' instructions.

Estimated particle concentration shall be within the measurement limits of the equipment, as given by the equipment manufacturer.

The sampling and test equipment shall not influence the particle distribution being measured.

For more detailed information see annex B.