INTERNATIONAL STANDARD

ISO 8573-1

First edition
1991-12-15

Compressed air for general use —

Part 1:
Contaminants and quality classes

Air comprimé pour usage général —

Partie 1: Polluants et classes de qualité

Reference number
ISO 8573-1:1991(E)

Contents

International Organization for Standardization
Case Postale 56 • CH-1211 Genève 20 • Switzerland

Printed in Switzerland

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.

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.

International Standard ISO 8573-1 was prepared by Technical Committee ISO/TC 118, *Compressors, pneumatic tools and pneumatic machines*, Sub-Committee SC 4, *Quality of compressed air*.

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

— *Part 1: Contaminants and quality classes*

— *Part 2: Test methods*

Annex A of this part of ISO 8573 is for information only.

Introduction

It is not possible using most test methods to measure the full flow area of a compressed-air stream and therefore it is necessary to take samples of the air. This method of testing has a major drawback in that oil, for example, is not evenly distributed over the flow area.

Measurements should preferably be carried out at the actual operating pressure and temperature of a compressor as otherwise the balance between contaminants in liquid, aerosol or gaseous form will be altered. Liquid oil and free water in particular tend to cling to pipe and tube walls where they form a film or thin rivulets.

The content of water, oil and particles in compressed air varies owing to sudden changes in the intake air, to the wear of components as well as to changes in flow, pressure, temperature and ambient conditions. Therefore the quality classes of a compressed-air system have to be based on the mean value of a number of measurements carried out over a specified period of time.

Recommended methods for measuring the oil content of compressed air will be given in ISO 8573-2.

Compressed air for general use —

Part 1:
Contaminants and quality classes

1 Scope

This part of ISO 8573 specifies quality classes of industrial compressed air for general use (e.g. for workshops, the construction industry, pneumatic transport, etc.) without consideration of the quality of the air when it is discharged from the compressor. The quality class of compressed air for a particular application has to be based on the mean value of several measurements carried out over a specific period of time and under defined operating conditions.

This part of ISO 8573 is not applicable to compressed air for direct breathing and for medical use.

2 Definitions

For the purposes of this part of ISO 8573, the following definitions apply.

2.1 abrasion: Surface wearing of material by mechanical action between solids.

2.2 absorption: Process of attraction of one substance into another, so that the absorbed substance disappears physically.

2.3 adsorption: Attraction and adhesion of gaseous and liquid molecules to the surface of a solid.

2.4 aerosol: Suspension in a gaseous medium of solid particles, liquid particles or solid and liquid particles having a negligible fall velocity (generally less than 0,25 m/s).

2.5 agglomerate: Group of two or more particles combined, joined or formed into a cluster by any means.

2.6 Brownian movement: Random movement of small particles suspended in a fluid.

2.7 coalescence: Action by which liquid particles in suspension unite to form larger particles.

2.8 compression drying: Drying of air by compressing it to a higher pressure, cooling it and extracting the water condensed, and finally expanding it to the required pressure.

2.9 contaminant: Any material or combination of materials (solid, liquid or gaseous) which adversely affects the system or the operator.

2.10 dewpoint: Temperature at which vapour begins to condense.

2.10.1 atmospheric dewpoint: Dewpoint measured at atmospheric pressure.

NOTE 1 The term atmospheric dewpoint should not be used in connection with compressed-air drying.

2.10.2 pressure dewpoint: Dewpoint at the actual pressure of the compressed air (this pressure should be stated).

2.11 diffusion: Movement of gas molecules or small particles caused by a concentration gradient.

2.12 direct interception: Filtration effect in which a droplet or a solid particle collides with an element of a filter medium (e.g. fibre or granule) which is in its direct path or is captured by pores of diameter smaller than the diameter of the droplet or particle.

2.13 effective particle diameter: Diameter of a circle having an area equivalent to the smallest projected area of the particle.

2.14 equivalent particle diameter: Diameter of a spherical particle having an equivalent "behaviour" to that of the considered particle with regard to a given characteristic (e.g. projected area or diameter).

2.15 erosion: Wearing of material caused by the mechanical action of a fluid system with or without solid particles in suspension.

2.16 filter: Apparatus for separation of contaminants from a fluid stream in which they are present.

2.17 filter rating: Parameter expressing a particular characteristic of a filter. This parameter may be the filtration efficiency, the filtration ratio or the penetration.

2.17.1 filtration efficiency E: The change in concentration across the filter divided by the upstream concentration. It may also be expressed as

$$E = 1 - P$$

where P is defined in 2.17.3.

The filtration efficiency is usually expressed in per cent.

2.17.2 filtration ratio β: For each particle size class, the ratio of the number of particles upstream of the filter to the number of particles downstream. It may also be expressed as

$$\beta = 1/P$$

where P is defined in 2.17.3.

The particle size class is used as an index. For example, $\beta_{10} = 75$ means that the number of particles of 10 µm and greater is 75 times higher upstream of the filter than downstream.

2.17.3 penetration P: Ratio of the downstream particle concentration to the upstream particle concentration.

2.18 inertial interception: Process in which a particle impinges on a part of the filter owing to the momentum of the particle.

2.19 particle: A small discrete mass of solid or liquid matter.

2.20 relative vapour pressure φ: Ratio of the partial pressure of water vapour to its saturation pressure at the same temperature.

2.21 van der Waals' forces: Attractive or repulsive forces between any pair of molecules, caused by the electric fields of the electrons (negative) and nuclei (positive) of which molecules are built up.

2.22 vapour: Gas which is at a temperature below its critical temperature and which therefore can be liquefied by isothermal compression.

3 Units

The SI units of pressure and of volume are the pascal and the cubic metre respectively. However, for compliance with current practice in the pneumatic field, the non-preferred SI units bar[1)] for pressure and litre[2)] for volume are used in this part of ISO 8573. National standards organizations may convert these units into pure SI units. In addition, the non-preferred SI unit parts per million (ppm) is employed for concentration. A summary of the units used in the pneumatic field is given in table 1.

Table 1 — Units for various contaminants

Contaminant	Pressure dewpoint °C	Particle or droplet size µm	Vapour pressure mbar	Content[1)] mg/m³	Relative vapour pressure	Concentration ppm (by mass)	(by volume)
Solids:							
size		X					
content				X			
Water:							
liquid				X			
vapour	X		X	X	X		
Oil:							
liquid		X		X		X	
vapour			X	X			X

1) At 1 bar absolute pressure, + 20 °C and a relative vapour pressure of 0,6. It should be noted that at pressures above atmospheric, the contaminant concentration is correspondingly higher.

1) 1 bar = 10^5 Pa

2) 1 litre = 10^{-3} m³

4 The compressed-air system

4.1 A typical compressed-air generating system is shown in figure 1.

4.2 The maintenance and operation of compressors and their auxiliaries and prime movers shall be in accordance with the manufacturer's instructions and specifications.

4.3 The lubricant shall meet the specifications for the compressor.

4.4 The compressor or the remote intake pipe should be located in an uncontaminated area, i.e. in an area with the lowest possible contamination from engine exhaust, process discharge, etc. The intake air should preferably be as cool and dry as possible.

4.5 It is advisable to place a suitable filter in the compressed-air pipeline as close as possible to the point of use. Samples should whenever possible be taken at the point of use.

5 Contaminants

The three major contaminants in compressed air are solids (dust), water and oil. These contaminants have an influence on each other (e.g. dust particles agglomerate in the presence of oil or water to form larger particles, oil and water emulsify) and are sometimes deposited or condensed (e.g. oil vapour or water vapour) inside the pipework.

5.1 Solids

5.1.1 General

Dust is always ingested by the compressor with the intake air. In addition, further solid particles (wear debris, rust, etc.) may be added to the intake air during its passage through the compressor and its associated pipework, although some particles will be suspended in the lubricant and thus removed by the outlet filters.

When compressor pipework is in a good condition, the concentration of rust and scale does not usually exceed 2 mg/m^3 to 4 mg/m^3, but peak concentrations can occur when airflow starts or when the pipes are subjected to mechanical shock.

The average particle size of the dust tends to increase with the dust load, which can vary from a negligible value up to over 1,4 g/m^3.

The dust concentration may be limited by the use of appropriate filters, chosen in accordance with the concentration of dust in the intake air and the compressor technology.

In addition to the dust load, the dust characteristics are also important. Dust is characterized not only by its shape and size but also by its hardness.

Very generally, small dust particles will often form deposits, whereas particles larger than 5 µm will lead to erosion if the flow velocity is sufficiently high.

It should also be borne in mind that certain solids can have a catalytic effect and that corrosion can occur owing to their chemical properties.

5.1.2 Measuring methods

5.1.2.1 Particle size

The particle size of solid contaminants can be measured using the following methods:

a) cascade impactor, which can be operated at high pressures and temperatures;

b) particle counter, which employs microscopic scanning in combination with retention on a membrane of suitable pore size.

5.1.2.2 Concentration

The concentration of solid contaminants can be measured using the following methods:

a) gravimetric methods, which can be used at high pressures;

b) particle counters and light dispersion photometers, which are normally operated at atmospheric pressure.

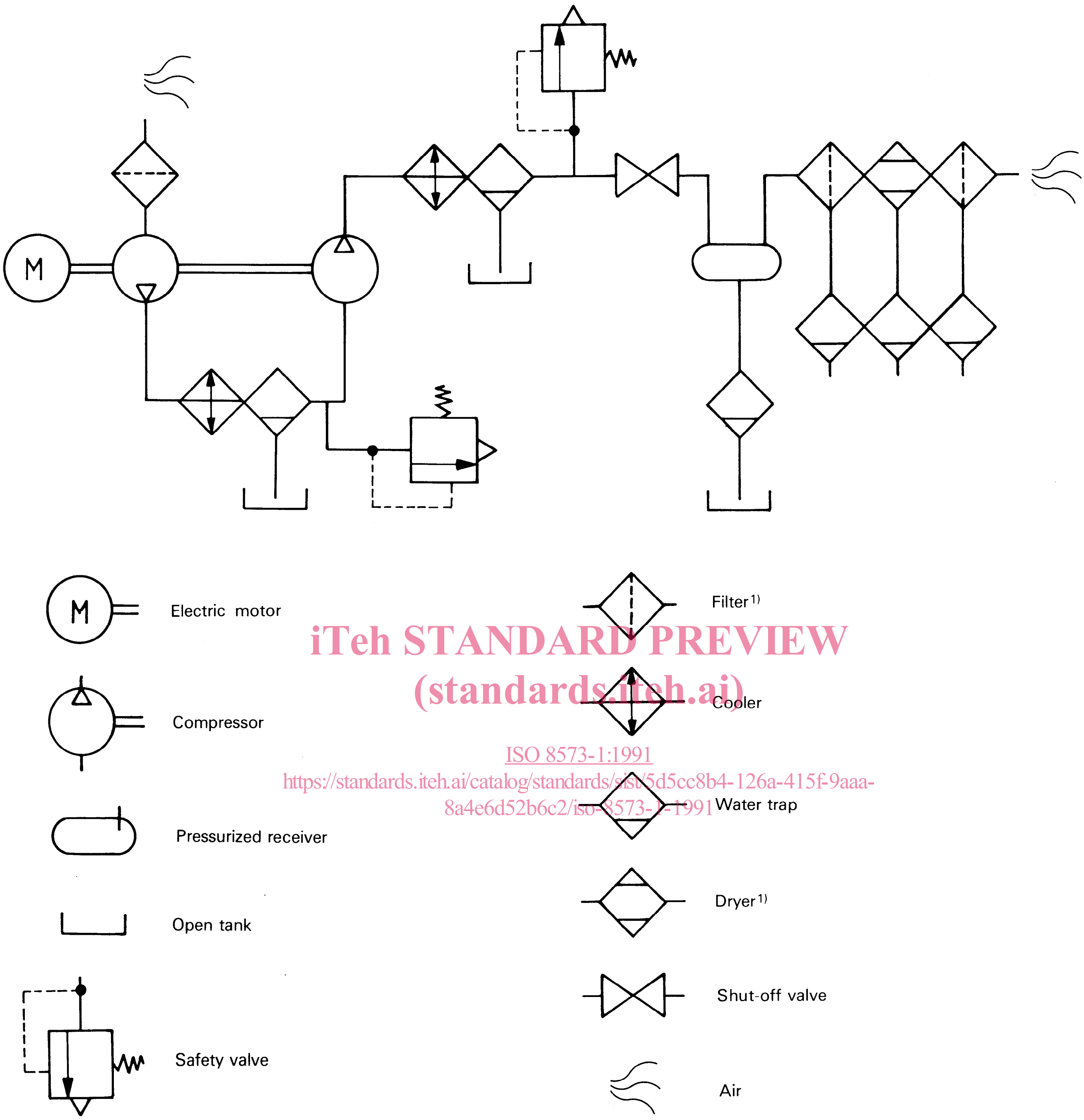
Various standardized test dusts may serve as references. Sampling carried out upstream and downstream of a test filter should be isokinetic and effected in such a way that the velocity distribution in the main pipe is not affected.

NOTES

2 Such methods of measurement require special equipment and operator skills and are therefore normally only carried out by filter manufacturers or scientific institutions.

3 The measurements are as a rule carried out at atmospheric pressure.

4 When stating the contaminant concentrations determined using these methods, the test method used should be specified because different methods do not necessarily give comparable results.



1) Depending on the application, the dryers and filters may be located upstream of the receiver to allow dry air to be stored.

NOTE — The symbols used, with the exception of that for air, are in accordance with ISO 1219-1. The symbol for air is in accordance with ISO 7000.

Figure 1 — Typical compressed-air generating system

5.1.3 Influence of other contaminants

Oil and water will cause dust to agglomerate and to adhere to surfaces. If several contaminants are present simultaneously, special care needs to be taken for their individual determination.

5.1.4 Methods of removal

The following methods of solids removal may be employed:

a) pipeline strainers (for particle sizes above 100 µm);

b) separators of the cyclone or impingement type, for particle sizes of 15 µm and 20 µm, respectively;

c) granular porous filters (e.g. sintered metal, glass, porous plastic and ceramic), for particle sizes about 5 µm;

d) fibrous depth type filter, for particle sizes of 1 µm;

e) submicronic fibre coalescer, for particle sizes of 0,01 µm.

5.2 Water

5.2.1 General

Atmospheric air always contains water vapour. When atmospheric air is compressed the partial pressure of the water vapour is increased but, owing to the increase in temperature caused by the compression, no water precipitates. When the air is subsequently cooled (e.g. in an intercooler or aftercooler, in the distribution pipework or during the expansion process in a pneumatic tool) water will condense to liquid, but the air will be fully saturated with water vapour.

Moisture can lead to corrosion, freezing, etc. and adversely affect the final product, e.g. in spray painting.

5.2.2 Measuring methods (for water vapour)

The concentration of water vapour can be measured using the following methods:

a) psychrometers;

b) electric or electronic hygrometers (see ISO 7183), in which a change in resistance or the temperature of a mirror surface is measured at the time that frost formation begins;

c) piezoelectric sorption hygrometers.

When using such instruments, care shall be taken as water droplets, supersaturated vapour and oil can produce erroneous readings.

NOTE 5 Such methods of measurement require special equipment and operator skills and are therefore normally only carried out by compressor and filter manufacturers or scientific institutions.

5.2.3 Influence of other contaminants

Oil has an adverse influence on some types of air-dryers (e.g. cooling surfaces become fouled, or the pores of the adsorbent become clogged and cannot be reactivated). Some hygrometers are similarly affected.

5.2.4 Methods of removal

The following methods of removal of water may be employed:

a) condensation with separation (by cooling or compression drying);

b) sorption (absorption or adsorption) (see ISO 7183);

c) filtration (only for water in the liquid phase).

5.3 Oil (mineral or synthetic)

5.3.1 General

In compressors with a lubricated compression space, the air unavoidably picks up some oil. Also, the air from non-lubricated (dry) compressors may contain traces of oil aspirated with the intake air. In some industrial applications (e.g. bakeries) a non-toxic lubricant (e.g. white liquid paraffin) is used.

Oil in compressed air can belong to one of three categories as follows:

a) bulk liquid;

b) aerosol;

c) vapour.

Only a small fraction of the oil fed to the compression space of a displacement compressor remains in the delivered air. A considerable portion is drained off with the condensate from the intercoolers and aftercoolers. Whether oil degradation products and any oil entrained in the compressed air can be filtered out depends on the type of compressor and on the type of oil and its treatment inside the compressor, as these factors influence the size of the oil particles and their composition.