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Compressed-air dryers — Specifications and testing

Sécheurs à air comprimé — Spécifications et essais

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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 7183 was prepared by Technical Committee ISO/TC 118, *Compressors and pneumatic tools, machines and equipment*, Subcommittee SC 4, *Quality of compressed air*.

This second edition of ISO 7183 revises and replaces the first edition (ISO 7183:1986), together with ISO 7183-2:1996, which have been technically revised.

Introduction

The scope has been expanded to cover most current types of dryers but also to allow the use of this International Standard and its test methods for any emerging technologies. Any new technologies can then be incorporated at a later revision.

Exclusions to this International Standard are generally identified by reference to the definition of a dryer. Specific exclusions have been identified, however, for absorption dryers and dryer processes involving "over-compression" as the means of removing water from compressed air.

The process of over-compression employs the principle that water can be removed by compressing the air to a pressure higher than the intended working pressure thereby forcing out the water from the compressed air and then subsequently expanding the air back to the working pressure.

Absorption dryers are now considered to be of minor importance as a drying technique and are, therefore, not considered in this International Standard.

Compressed-air dryers — Specifications and testing

1 Scope

This International Standard specifies the performance data that are necessary to state and applicable test methods for different types of compressed air dryers. It is applicable to compressed air dryers working with an effective (gauge) pressure of more than 50 kPa (0,5 bar), but less than or equal to 1 600 kPa (16 bar) and include the following:

— adsorption dryers;

— membrane dryers;

— refrigeration dryers (including drying by cooling);

— or a combination of these.

NOTE A description of the principles of operation of the dryers within the Scope of this International Standard is given in Annex A.

This International Standard identifies test methods for measuring dryer parameters that include the following:

— pressure dew point;

— flow rate;

— pressure drop;

— compressed-air loss;

— power consumption;

— noise emission.

This International Standard also provides partial-load tests for determining the performance of energy saving devices or measures.

The mounting, operating and loading conditions of dryers for the measurement of noise are given in Annex C.

This International Standard is not applicable to the following types of dryers or drying processes:

— absorption dryers;

— drying by over-compression;

— integral dryers.

2 Normative references

The following referenced documents are indispensable for the application of this International Standard. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 261, *ISO general purpose metric screw threads — General plan*

ISO 228-1, *Pipe threads where pressure-tight joints are not made on the threads — Part 1: Dimensions, tolerances and designation*

ISO 1179 (all parts), *Connections for general use and fluid power — Ports and stud ends with ISO 228-1 threads with elastomeric or metal-to-metal sealing*

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 3744, *Acoustics — Determination of sound power levels and sound energy levels of noise sources using sound pressure — Engineering method for an essentially free field over a reflecting plane* [1)]

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

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

ISO 9614-2, *Acoustics — Determination of sound power levels of noise sources using sound intensity — Part 2: Measurement by scanning*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1
absorption
chemical process of attracting one substance into the mass of another, so that the absorbed substance combines with the absorbent

3.2
actual vapour pressure
partial pressure exerted by the water vapour under the actual temperature condition of the environment

3.3
adsorption
physical process in which the molecules of a gas or a vapour adhere to the surface of a solid

3.4
ambient
area surrounding the dryer under test

1) To be published. Revision of ISO 3744:1994

3.5
integral
equipment which is either physically integrated and/or functionally interlinked with the compressor

NOTE 1 Interlinking can be in terms of energy exchange, controls or sharing of other components.

NOTE 2 Typically, some of the performance characteristics, such as energy consumption or pressure drop, deviate substantially from those of free-standing air-treatment equipment.

3.6
desiccant
⟨adsorbent⟩ substance with the ability to retain water without change of state

EXAMPLES Silica gel, activated alumina or molecular sieves.

NOTE The term excludes deliquescent substances.

3.7
dew point
temperature at which the vapour pressure of the vapour in a humid gas is equal to the saturation vapour pressure over the pure liquid and at which condensate forms as a liquid on cooling the gas

3.7.1
pressure dew point
pdp
dew point measured at the actual pressure

3.8
dryer
device which lowers absolute moisture content of compressed air by reducing water vapour content such that the exit relative humidity is lower than 100 %

NOTE "Separating" devices that remove only bulk water, such as a cyclone separator, are not dryers.

3.9
peak
point at which the measured parameter takes its highest, instantaneous value

3.10
permeate
compressed air and water vapour that diffuses through a membrane

NOTE The greater the selectivity of the membrane for moisture, the lower the permeate loss.

3.11
purge air flow
volume-flow of compressed air entering the dryer minus the compressed air leaving the dryer during regeneration cycle

NOTE 1 Typically, purge air is expanded to atmospheric pressure.

NOTE 2 For membrane dryers, purge air flow is the sum of "sweep-gas" plus permeate.

3.12
regeneration
process of preparation of drying media to enable it to enter a new period of operation

3.13
relative humidity
ratio of the actual vapour pressure to the saturation vapour pressure over a plane liquid water surface at the same temperature

3.14
saturation vapour pressure
partial pressure of water vapour that is in neutral equilibrium with a plane surface of pure, condensed-phase water or ice at a given temperature

3.15
sweep gas
compressed air used in a membrane dryer to carry away moisture from the region outside the membrane

3.16
stabilization period
time taken to reach a steady state condition of an average value

3.17
test time
time taken after the stabilization period to record dryer performance

4 Symbols

4.1 Figure symbols

The symbols used in Figures 1 to 3 are in accordance with ISO 1219-1.

4.2 Symbols and units

Symbol	Term	SI unit	Other practical units
d	actual internal diameter of the tube		millimetres
l	thread length		millimetres
m	mass	kilogram	gram, milligram
P	power	watt	megawatt, kilowatt
p	pressure	kilopascal	bar
q	flow rate	cubic metres per second	cubic metres per hour cubic metres per minute litres per second
L	latent heat	joules	megajoules, kilojoules
n	number	(dimensionless)	
t	time	second	minute, hour, day
V	volume	cubic metre	cubic decimetre, cubic centimetre, cubic millimetre
W	work	joule	megajoule, kilojoule, kilowatt-hour
$\bar{X}$	average of a series of measured values, x_i of a parameter		

4.3 Subscripts

Subscript	Term
AL	air loss
Av	average
BL	blow-down loss
sum	sum
DC	dryer cycle
i	interval number
PF	purge flow
PL	purge air loss
E	electrical energy
v	vessel
ref	reference
regn	regeneration
S	steam energy
s	system
TOT	total

5 Reference conditions

Reference conditions for volume statements shall be as given in Table 1.

Table 1 — Reference conditions

air temperature	20 °C
absolute air pressure	100 kPa [1 bar (a)]
relative water vapour pressure	0
NOTE Bar(e) is used to indicate effective pressure above atmospheric.	

6 Standard rating parameters

Standard rating parameters are necessary in defining the performance of an air dryer and in comparing one dryer with another. The standard rating parameters are given in Table 2.

The standard rating parameters are assumed to be 100 % rated flow operating at 24 hours per day and seven days per week.

Table 2 — Standard rating parameters

Quantity	Unit	Value [a]			Tolerance [b]
		Option A1 [c]	Option A2 [c]	Option B	
Inlet temperature	°C	35	38	45	± 2
Inlet pressure	kPa gauge [bar(e)]	700 (7)	700 (7)	700 (7)	± 14 (0,14)
Inlet relative humidity	%	100	100	100	$^{0}_{-5}$
Cooling air inlet temperature (where applicable)	°C	25	38	35	± 3
Cooling water inlet temperature (where applicable)	°C	25	29	25	± 3
Ambient air temperature	°C	25	38	35	± 3
Flow of dryer inlet	% of rated flow	100	100	100	± 3

a Maintain within actual gauge value.

b The choice between options A and B is influenced by the intended geographical location of the equipment.

c Option A1 applies to a temperate climate zone and Option A2 applies to a sub-tropical zone.

7 Performance tests

7.1 Key performance parameters

Data for the following key performance parameters are required for all compressed air dryers when stating or rating product performance and for making comparisons of alternative dryers:

- pressure dew point;
- flow rate;
- pressure drop;
- power consumption;
- system air loss;
- outlet temperature;
- noise emission.

Measurement of the inlet pressure and temperature should be done at the dryer inlet in order to avoid errors caused by cooling or pressure drop between the measurement point and inlet whilst operating at full rated conditions. It is the responsibility of the manufacturer to supply the required data in Annex B.

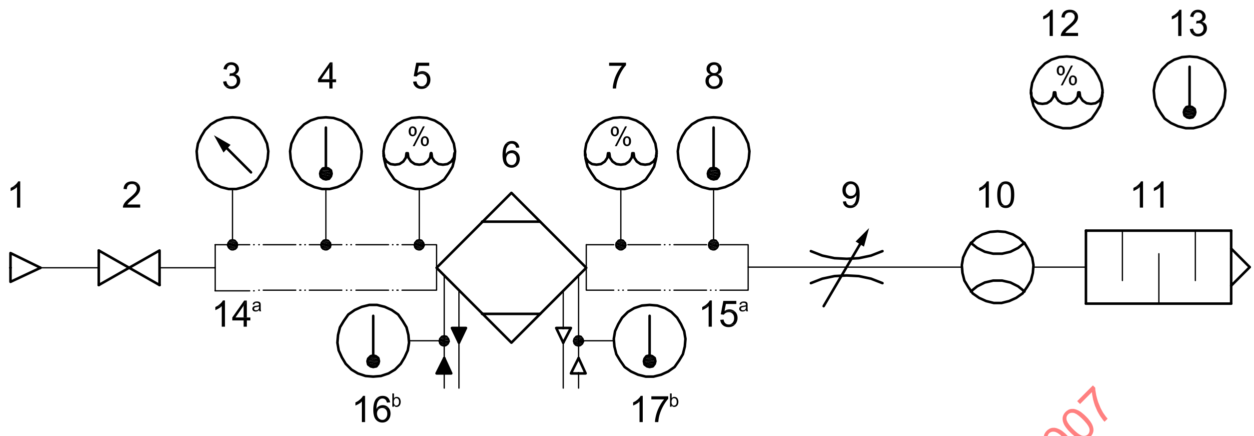
For all performance tests, the inlet air purity should be in accordance with ISO 8573-1:2001, class 4, for oil and class 4 for particles and the humidity shall be in accordance with Table 2 of this International Standard. If the dryer under test requires pre-filtration to operate reliably with this inlet air purity then these filters shall be included in all tests.

7.2 Pressure dew point, flow rate and outlet temperature

Measurement of the pressure dew point should be done at the stated rated flow of the dryer using the standard rating parameters selected from Table 2.

Measurement of the pressure dew point of the outlet air shall be in accordance with ISO 8573-3. Discharge temperature should also be measured.

Test equipment should be arranged as shown in Figure 1 however the arrangement may vary depending on the type of dryer being tested.



Key

1 conditioned compressed air supply
2 shut-off valve
3 inlet pressure sensing/measuring
4 inlet temperature sensing/measuring
5 inlet moisture content meter
6 dryer under test
7 pressure dew point sensing/measuring
8 outlet temperature sensing/measuring
9 multi-turn flow control valve
10 flow sensing/measuring
11 silencer
12 ambient relative humidity sensing/measuring
13 ambient temperature sensing/measuring
14 inlet pressure measuring tube
15 outlet pressure measuring tube
16 cooling water inlet temperature sensing/measuring (if applicable)
17 cooling air inlet temperature sensing/measuring (if applicable)

[a] Details of a pressure measuring tube are given in Annex D.

[b] The temperature gauges are fitted if the dryer under test has either a cooling air supply or a cooling water supply as a function of the dryer. These would generally be features related to a refrigerant dryer.

Figure 1 — Typical test set up for pressure dew point and flow rate

It should be recognized that where filters are included for the correct operation of the dryer, then these are included in the test set up shown in Figure 1 and the configuration of the test equipment recorded on the performance form given in Annex B.

The rated flow rate of the dryer is the design/maximum flow rate through the dryer whilst the dryer maintains the outlet pressure dew point at the specified level. Standard outlet pressure dew points may be selected from the compressed air purity classes as shown in ISO 8573-1:2001, Table 3.

Conditioning of the compressed air supply to the dryer under test should be done such that the relative humidity of the inlet air is assured to be fully saturated or at least within the tolerance of Table 2. A wide variety of process equipment may be used to generate fully saturated air, e.g. air/water contactors, steam injection, etc. Care should be taken in the selection and use of the inlet relative-humidity meter to ensure its reliable and accurate operation.

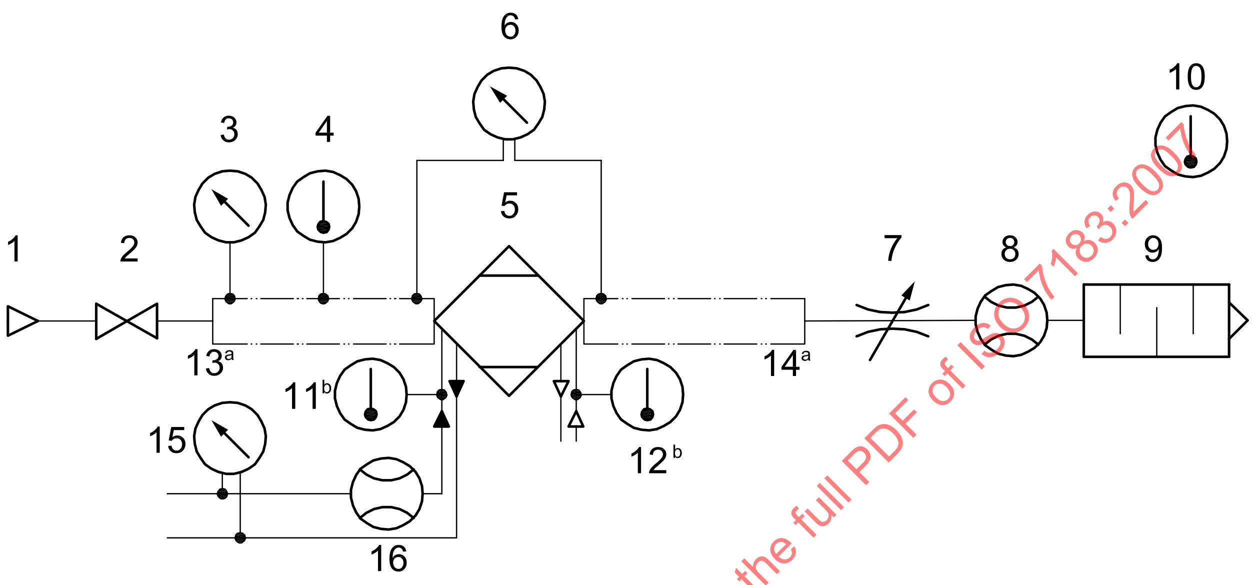
Before the outlet pressure dew point measurements are taken, the dryer should be allowed a stabilization period as recommended by the dryer manufacturer.

During this time, the pressure dew point, pdp, and flow rate should be monitored until cycle-to-cycle variations of consecutive minima and consecutive maxima are less than 0,5 °C pdp for dryers with an average pdp $\leqslant$ 0 °C and shall be $<$ 1 °C pdp with an average pdp of 0 °C.

When reporting pressure dew point, the wettest pressure dew point achieved during the test shall be recorded. For dryers with significant pressure dew point variations during a cycle (e.g. thermal swing adsorption dryers), the average pressure dew point may also be reported. The average pressure dew point shall be calculated in accordance with 7.6.2. The peak and average outlet temperature are also measured.

7.3 Differential pressure drop

Pressure drop is the loss in total pressure between inlet and outlet of the dryer. The pressure drop is measured at the rated flow of the dryer and the standard rating parameters selected from Table 2. Test equipment should be arranged as shown in Figure 2. Inlet and outlet filters should be included in the pressure drop (wet) measurement if they are part of the dryer. Stabilization should allow the filters to reach a saturated condition.



Key

1 conditioned compressed air supply
2 shut-off valve
3 inlet pressure sensing/measuring
4 inlet temperature sensing/measuring
5 dryer under test
6 pressure drop gauge
7 multi-turn flow control valve
8 flow sensing/measuring
9 silencer
10 ambient temperature sensing/measuring
11 cooling water inlet temperature gauge (if applicable)
12 cooling air inlet temperature gauge (if applicable)
13 inlet pressure measuring tube
14 outlet pressure measuring tube
15 press drop gauge (water side)
16 flow sensing measuring (water side)

a Details of a pressure measuring tube are given in Annex D.

b The temperature gauges are fitted if the dryer under test has either a cooling air supply or a cooling water supply as a function of the dryer. These are generally features related to a refrigerant dryer.

Figure 2 — Typical test set up for pressure drop measurement

7.4 Power consumption

The power consumption of the dryer is the total energy requirement of the dryer and consists of the sum total of differing forms of energy input. For example, an adsorption dryer can use a flow of steam for heat input and an electrical supply for fan or blower power. The report, as far as applicable, should state the power consumption averaged over a representative number of complete operating cycles (one minimum); see 7.6.1.

7.4.1 Electrical energy

The electrical energy, W_E, expressed in kiloJoules, consumed by the dryer should be measured using a wattmeter having an accuracy of ± 1 % of the reading, and calculated as given by Equation (1):

$$W_E = P_{AV} \times t_{DC} \quad (1)$$

where

P_{AV} is the average power, calculated as given by Equation (3) over a complete dryer cycle, expressed in kilowatts;

t_{DC} is time of complete dryer cycle, expressed in seconds.

7.4.2 Steam energy

Collecting liquid water condensate over a complete dryer cycle and recording the inlet pressure should measure the energy input from a steam source. The steam energy, W_S, expressed in kilojoules, can then be calculated from Equation (2):

$$W_S = m \times L_v \tag{2}$$

where

m is mass of steam condensate collected over one complete dryer cycle, expressed in kilograms;

L_v is the latent heat of vaporization of steam at the steam temperature and pressure supply conditions, expressed in kilojoules per kilogram.

7.4.3 Average power requirement

The average power requirement, P_{AV}, expressed in kilowatts, is then given by Equation (3):

$$P_{AV} = \frac{W_{sum}}{t_{DC}} \tag{3}$$

where

W_{sum} is sum of all energy inputs (W_E, W_S and others, where applicable), expressed in kilojoules;

t_{DC} is dryer cycle time, expressed in seconds.

7.5 System air loss

Some dryers utilize compressed air diverted from the process to aid regeneration; this is normally lost from the compressed air system. It typically consists of two components:

— the blow-down loss, which consists of a volume of compressed air vented to atmosphere as part of the pressure swing adsorption process;

— the purge loss, which consists of a flow of depressurized, dried air through the off-line vessel.

In addition to the air lost by these processes, it should also be recognized that the amount of air loss through drains can be significant.

7.5.1 Blow-down air loss for regeneration dryers

The blow-down loss occurs when a pressurized vessel of the dryer is vented to atmospheric pressure, typically at the start of regeneration. The blow-down loss, V_{BL}, expressed in cubic metres, can be calculated as given in Equation (4):

$$V_{BL} = V_v \times \left[\frac{\left(p_s - p_{regn}\right)}{p_{ref}} \right] \times n \tag{4}$$

where

V_v is vessel volume expressed in cubic metres

p_s is system pressure expressed in bar absolute

p_{regn} is regeneration pressure expressed in bar absolute

p_{ref} is reference atmospheric pressure bar absolute

n is number of blow-down events for a complete dryer cycle

It is not recommended to measure the blow-down air loss but to calculate it as given in Equation (4).

NOTE The effect of the desiccant volume varies by type and has minimal effect on the volume used in calculations.

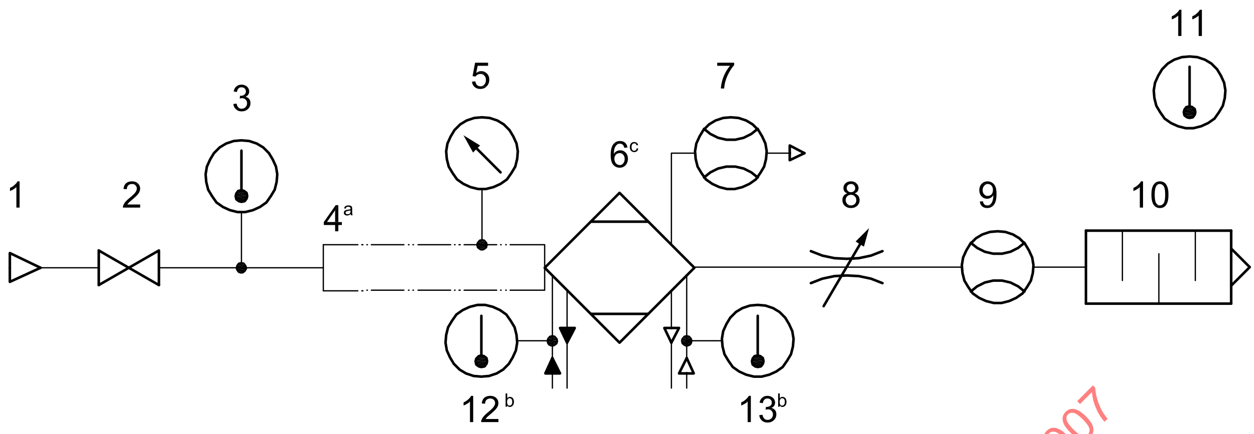
WARNING — A blow-down event, when a large volume of air is vented to atmospheric pressure during a very short time, generates high transient flow rates and gas velocities that can damage flow meters and create a safety hazard.

7.5.2 Purge air loss for regeneration dryers

The purge-air loss, the total volume of air diverted from the process stream and used for regeneration, is lost from the system. Where purge air is used, the outlet flow of a dryer is lower than the inlet flow.

Measurement of the purge flow rate should be done using the arrangements shown in Figure 3. This test should not be undertaken at the same time as the pressure dew-point measurement test, 7.2, as the addition of backpressure to the purging flow can affect its performance.

WARNING — It is important to take care to avoid a blow-down event when measuring purge-air loss from pressure-swing adsorption dryers, as the flow meter and purge measuring equipment can be damaged by the rapid discharge of air and/or a safety hazard can be created.



Key

1 conditioned compressed air supply
2 shut-off valve
3 inlet temperature sensing/measuring
4 pressure measuring tube
5 inlet pressure sensing/measuring
6 dryer under test
7 purge or sweep-gas flow meter
8 multi turn flow control valve
9 flow sensing/measuring
10 silencer
11 ambient temperature sensing/measuring
12 cooling water inlet temperature sensing/measuring (if applicable)
13 cooling air inlet temperature sensing/measuring (if applicable)

[a] The pressure measuring tube details are shown in Annex D.

[b] The temperature gauges are fitted if the dryer under test has either a cooling air supply or a cooling water supply as a function of the dryer. These are generally features related to a refrigerant dryer.

[c] The purge air flow source varies among dryer types such that the figure is only an indication that a flow meter (7) is connected to the appropriate discharge representing the purge flow.

Figure 3 — Typical test set-up for purge-air flow measurement

The purge air loss, V_{PL}, expressed in cubic metres, is then calculated from Equation (5):

$$V_{PL} = q_{PF} \times t_{PF} \tag{5}$$

where

q_{PF} is purge air flow rate, expressed in cubic metres per second;

t_{PF} is total time the purge flow is used, expressed in seconds, during one complete dryer cycle, expressed in seconds.

NOTE This calculation is not applicable for non-cycling dryers.

7.5.3 Calculation of dryer air loss for regeneration dryers

The dryer air loss rate, q_{AL}, expressed in cubic metres per second, is calculated as given by Equation (6):

$$q_{AL} = \frac{q_{sum}}{t_{DC}} \tag{6}$$

where

q_{sum} is the sum of all dryer-air losses (L_B, L_P and others where applicable), expressed in cubic metres per second;

t_{DC} is dryer cycle time, expressed in seconds

7.5.4 Air loss for non-regeneration dryers

This air is lost from the system and where sweep gas is generated by the compressed air, the outlet flow of a dryer is lower than the inlet flow. The flow rate of the sweep gas shall be measured as diagrammed in Figure 3.

7.6 Dealing with in-cycle variations

Several types of dryers, notably pressure- and thermal-swing adsorption dryers, are cyclical in nature. During a cycle, measured values of power consumption, purge loss, noise, etc., vary considerably.

The test data should be averaged and the average along with the peak instantaneous values reported. The user of the dryer can estimate, for example, air loss or power consumption over longer operating periods as part of ownership cost considerations using the average values, whereas the size of power connections, etc., can be estimated using peak values.

7.6.1 Averaging parameters excepting moisture

The average value, $\overline{X}$, of a series of measured values (except for moisture content/pressure dew point) should be calculated as given by Equation (7):

$$\overline{X} = \frac{\sum_{i=1}^{n} x_i \cdot t_i}{t_{\text{TOT}}} \tag{7}$$

where

x_i is the measured value at time interval, i;

t_i is the time interval, expressed in seconds;

t_{TOT} is the total time, expressed in seconds;

n is the number of samples.

The number of samples, n, should be greater than 30 for a reasonable estimation of the average.

7.6.2 Averaging moisture parameters

The average pressure dew point may also be reported in addition to the wettest pressure dew point. However, if an average pressure dew point value is reported, it should be recognized that the pressure dew point has a non-linear relationship with moisture content (e.g. expressed as grams per cubic metre) and should be converted to moisture content prior to being averaged over a complete dryer cycle as given in a) through c).

a) Convert pressure dew point (degrees Celsius) to moisture content (grams per cubic metre).

b) Calculate the average moisture content as given in 7.6.1.

c) Convert average moisture content back into a pressure dew point value, which can then be quoted as the average pressure dew point, expressed in degrees Celsius.

The saturation pressure, p_{WS}, expressed in pascal, over ice for the temperature range of −100 °C to 0 °C is given by Equation (8):

$$\ln(p_{\text{WS}}) = C_1/T + C_2 + C_3 T + C_4 T^2 + C_5 T^3 + C_6 T^4 + C_7 \ln T \tag{8}$$

where

T is the absolute temperature, numerically equal to the degrees Celsius plus 273,15, expressed in Kelvin;

C_1 = –5,6745359 E+03;

C_2 = 6,3925247 E+00;

C_3 = –9,6778430 E–03;

C_4 = 6,2215701 E–07;

C_5 = 2,0747825 E–09;

C_6 = –9,4840240 E–13;

C_7 = 4,1635019 E+00.

The saturation pressure over liquid water for the temperature range of 0 °C to 200 °C is given by Equation (9):

$$\ln(p_{\text{WS}}) = C_8/T + C_9 + C_{10}T + C_{11}T^2 + C_{12}T^3 + C_{13}\ln T \quad (9)$$

where

C_8 = –5,8002206 E+03;

C_9 = 1,3914993 E+00;

C_{10} = –4,8640239 E–02;

C_{11} = 4,1764768 E–05;

C_{12} = –1,4452093 E–08;

C_{13} = 6,5459673 E+00.

The coefficients, C_1 to C_{13}, in Equations (8) and (9) have been derived from the Hyland-Wexler equations.

7.7 Noise

The noise emission shall be measured in accordance with Annex C.

7.8 Tests for energy saving devices

Many dryers are fitted with energy saving devices of one type or another. This test allows the evaluation of dryer performance by testing at various partial flow rates.

The dryer inlet flow rate may be set to any one of the following values: 75 %, 50 %, 25 % or 0 % of rated flow. No other test parameter should be altered from the values given in Table 2. The tests described in 7.2 to 7.7 should be repeated. The results can be recorded on the performance form given in Annex B.

7.9 Instrument accuracy

The accuracy of the instruments used during testing is given in Table 3.

Table 3 — Instrument accuracy

Parameter		Range	Accuracy [a]
Pressure dew point	°C	−100 to below −40	± 2
		−40 to below −10	± 1
		−10 and above	± 0,5
Pressure	kPa gauge [bar(e)]	$0,5 \leqslant p \leqslant 2$	± 1,00 (± 0,01)
		$2 < p \leqslant 16$	± 10 (± 0,1)
Differential pressure	kPa (bar)	Any	± 1,00 (± 0,01)
Temperature	°C	0 to 100	± 1
Flow rate	l/s	Any	± 3 %
Power	W	Any	± 1 %
Water flow meter	L/s	Any	± 5 %

[a] At test conditions.

All electrical readings should be measured with an accuracy of 2 % of readings.

8 Uncertainties

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 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 measured 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 in accordance with ISO 2602 and ISO 2854.

9 Test report

9.1 Statement

Performance data shall be stated at reference conditions and as a minimum shall include the data in Table 2. The results shall include those obtained under test conditions.

9.2 Technical data

Technical data presentation shall include at least the following:

a) pressure dew point at rated flow rate;

b) pressure drop;

c) compressed air loss;

d) power consumption;

e) noise emission for all dryers other than adsorption dryers:

— blow-down sound pressure level,

— purge-gas sound pressure level;

f) pressure drop across the cooling water circuit;

g) flow rate of cooling water.

A sample test report form is found in Annex B.

Annex A
(informative)

Types of compressed-air dryers

A.1 Absorption dryer

An absorption dryer is a compressed-air dryer that extracts water vapour from the compressed air, where the absorbent combines chemically with the water vapour and goes into solution. The hydrous solution is drained off; the absorbent is normally not recovered.

A.2 Adsorption dryer

An adsorption dryer is a compressed-air dryer that extracts water vapour from the compressed air by attraction and adhesion of molecules in a gaseous or liquid phase to the surface of a solid. The adsorbent can be regenerated by removing the adsorbed water.

A.2.1 Heatless regenerative dryer

Regeneration is achieved by passing a non-heated volume of air through the desiccant to be regenerated. The air may be either expanded, previously dried compressed air or ambient air that has passed through the desiccant bed via a blower or vacuum.

A.2.2 Heated regenerative dryer

Regeneration is achieved by passing heated air through the desiccant. The heating effort may be provided via electrical heaters, steam or a process heat exchanger. The heaters may be located within or external to the desiccant bed. The air may be either expanded, previously dried compressed air or ambient air that has passed through the desiccant bed via a blower or vacuum.

A.2.3 Heat-of-compression dryer

A heat-of-compression dryer is a desiccant dryer that uses the hot compressed air prior to an after-cooler to regenerate the desiccant. After this hot air has regenerated the desiccant, it is cooled and dried with no purge loss.

A.3 Membrane dryer

A membrane dryer is a compressed air dryer that consists of a semi-permeable membrane through which water vapour, and possibly some of the air, can permeate. The membrane material is selected to promote water diffusion whilst limiting the progress of other gas molecules that make up the compressed air. The water vapour that has diffused through the membrane layer is then conducted away to atmosphere through an exhaust passage in a protective casing surrounding the membrane layer. Typically a small amount of the dried compressed air, often called sweep gas, is used in ejecting the collected water vapour to atmosphere.

A.4 Refrigeration dryer (includes drying by cooling)

A refrigeration dryer is a compressed-air dryer that extracts water vapour by the application of cooling and subsequent condensation. Condensation of water vapour occurs on internal cooling surfaces and is then separated and drained. The exit relative humidity is lower than 100 %. Refrigeration dryers are often designed to deliver pressure dew points above 0 °C to prevent freezing on the internal cooling surfaces.