International Standard 7183

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Compressed air dryers — Specifications and testing

Sécheurs d'air comprimé — Spécifications et essais

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Foreword

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Draft International Standards adopted by the technical committees are circulated to the member bodies for approval before their acceptance as International Standards by the ISO Council. They are approved in accordance with ISO procedures requiring at least 75 % approval by the member bodies voting.

International Standard ISO 7183 was prepared by Technical Committee ISO/TC 118, *Compressors, pneumatic tools and pneumatic machines*.

Users should note that all International Standards undergo revision from time to time and that any reference made herein to any other International Standard implies its latest edition unless otherwise stated.

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Contents

Compressed air dryers — Specifications and testing

1 Scope and field of application

This International Standard specifies reference conditions, acceptance test methods and the most important characteristic data of different dryers.

It is applicable to compressed air dryers working in the effective (gauge) pressure range of 0,16 to 40 MPa (1,6 to 400 bar), but excluding:

a) liquid absorption types;

b) cooling with aftercooler;

c) overcompression.

2 Units

General use of SI units (Système International d'Unités, see ISO 1000) as given throughout this International Standard is recommended.

However, in agreement with accepted practice in the pneumatic field, some non-preferred SI units, accepted by ISO, are also used; these are given in table 1.

Table 1 — Non-SI units

Measurement	Unit name	Unit symbol	Definition
pressure	bar	bar	1 bar = 10^5 Pa
volume	litre	L	1 L = 1dm^3
time	minute hour	min h	1 min = 60 s 1 h = 60 min = 3 600 s

3 References

ISO 131, *Acoustics — Expression of physical and subjective magnitudes of sound or noise in air.*

ISO 266, *Acoustics — Preferred frequencies for measurements*

ISO 1000, *SI units and recommendations for the use of their multiples and of certain other units.*

ISO 1217, *Displacement compressors — Acceptance tests.*

ISO 1219, *Fluid power systems and components — Graphic symbols.*

ISO 5167, *Measurement of fluid flow by means of orifice plates, nozzles and Venturi tubes inserted in circular cross-section conduits running full.*

ISO 5388, *Stationary air compressors — Safety rules and code of practice.*

ISO 5389, *Turbocompressors — Performance test code.* [1]

ISO 5941, *Compressors, pneumatic tools and machines — Preferred pressures.*

IEC Publication 51, *Recommendations for direct acting indicating electrical measuring instruments and their accessories.*

IEC Publication 651, *Sound level meters.*

4 Definitions

4.1 moisture content (gram per cubic metre): Ratio of water and water vapour by mass to the total volume.

4.2 vapour concentration (gram per cubic metre): Ratio of water vapour by mass to the total volume.

NOTE — Vapour concentration was earlier called "absolute humidity" and has been used to describe what is more correctly termed "water load", i.e. the water content of the desiccant expressed as a mass ratio.

4.3 vapour ratio: Mass ratio of water vapour (gram) to dry air (gram).

NOTE — It is not recommended to express the vapour ratio in parts per million (PPM). When parts per million are used (at very low dew points) it should be clearly stated whether it is on a mass or a volume ratio basis.

4.4 partial pressure (millibar): Absolute pressure exerted by any component in a mixture.

4.5 saturation pressure (millibar): Total pressure at which moist air at a certain temperature can coexist in neutral equilibrium with a plane surface of pure condensed phase (water or ice) at the same temperature (see annex B).

1) At present at the stage of draft.

4.6 relative vapour pressure: Ratio of the partial pressure (millibar) of the water vapour to its saturation pressure (millibar) at the same temperature.

NOTE — Relative vapour pressure is often called "relative humidity".

4.7 relative vapour concentration: Ratio of the actual water vapour concentration (gram per cubic metre) (see 4.2) to its saturation value (gram per cubic metre) at the same temperature and pressure.

4.8 relative vapour ratio: Ratio of the actual vapour ratio (see 4.3) to the saturation vapour ratio at the same temperature.

NOTE — Relative vapour ratio was earlier called "degree of saturation".

4.9 dew point (degree Celsius): Temperature, referred to a specific pressure, at which the water vapour begins to condense.

4.9.1 atmospheric dew point: Dew point measured at atmospheric pressure.

NOTE — Atmospheric dew point should not be used in connection with compressed air drying.

4.9.2 pressure dew point: Dew point measured at the actual pressure, which should be stated.

4.9.2.1 pressure dew point, nominal value: Dew point obtained in a dryer, which would not normally be exceeded when operating under the stated conditions.

4.10 flow-rate of a dryer: Volume flow-rate of condensed gas referred to a standard reference atmosphere condition of an absolute pressure of 1 bar and a temperature of 20 °C (see ISO 1217).

4.10.1 volume flow at dryer inlet: Maximum volume of flow air accepted by the dryer (under the conditions given in 4.10) including air required for regeneration, pressurizing or cooling purposes.

4.10.2 volume flow at dryer outlet: Maximum volume flow of air delivered by the dryer (under the conditions given in 4.10) available for use, i.e. after purge air, pressurizing air and cooling air flows have been deducted.

4.11 desiccant: Substance with the ability to retain water without change of state; for example, silica gel SiO_2, activated alumina Al_2O_3. The term thus excludes deliquescent substances.

4.12 adsorption: Physical process in which the molecules of a gas or a vapour adhere to the surface of a solid.

4.13 desorption: Driving off of water held by a desiccant.

4.13.1 regeneration: Desorption and preparation of desiccant to enable it to enter a new period of operation.

4.14 absorption: Process of attracting one substance into the mass of another, so that the absorbed substance disappears physically.

4.14.1 liquid absorption: Drying of air or gas by means of a liquid desiccant (for example, triethyleneglycol or sulfuric acid).

4.14.2 deliquescence: Spontaneous process whereby a soluble solid material absorbs water and becomes liquid.

4.15 drying by cooling: Method of liquifying part of the condensable vapours by reducing the temperature.

4.16 drying by overcompression: Method of drying air by compressing it to a pressure higher than the intended working pressure.

5 Types of compressed air dryers

5.1 Absorption dryers

5.1.1 Compressed air dryers, which extract 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.

5.1.1.1 Liquid desiccant

5.1.1.2 Deliquescent substances

5.2 Adsorption dryers

5.2.1 Compressed air dryers, which extract 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.

5.2.1.1 heatless: Regeneration is achieved with non-heated, expanded, previously dried air.

5.2.1.2 directly heated: Regeneration is achieved by heating elements applied to or embedded in the desiccant.

5.2.1.3 regeneration air heated: Regeneration is achieved by passing heated ambient air through the desiccant.

5.2.1.4 regeneration: Achieved by adsorption and absorption.

5.3 Refrigeration dryers

5.3.1 Compressed air dryers, which extract water vapour by means of cooling with a refrigeration circuit.

5.3.1.1 chilled water: Drying is achieved by cooling the air in a heat exchanger using chilled fluid.

5.3.1.2 heat absorbing mass: Drying is achieved by indirect cooling via thermal storage.

5.3.1.3 direct expansion: Drying is achieved by evaporating the refrigerant at high velocity inside the heat exchanger tubes.

5.3.1.4 flooded evaporator: Drying is achieved by evaporating the refrigerant from a pool surface within a closed vessel.

5.4 Drying achieved by combination of several systems

6 Reference (standard rating) conditions and performance rating parameters

6.1 Reference (standard rating) conditions and performance rating parameters are both necessary in defining the performance of an air dryer and in comparing one make of dryer with another.

The reference conditions in table 2 shall form an invariable part of any statement that performance is to ISO 7183, option A or B also being quoted.

The performance rating parameters in table 3 shall form the second and variable part of such a statement.

Table 2 — Reference conditions

Quantity	Unit	Value[1]		Tolerance
		Option A	Option B	
Inlet temperature	°C	35	38	± 1
Inlet pressure	bar	7	7	± 7 %
Inlet pressure dew point	°C	35	38	± 2
Cooling air inlet temperature	°C	25	38	± 3
Cooling water inlet temperature	°C	25	30	± 3
Ambient air temperature	°C	25	38	± 3

1) The choice between options A and B will be influenced by the intended geographical location of the equipment.

Table 3 — Performance rating parameters

Quantity	Unit	Value
Outlet pressure dew point	°C	As specified
Outlet air flow	L/s or m^3/s	As specified
Pressure drop across dryer	bar	As specified
Frequency of electrical power supply	Hz	As specified

7 Specification

The data given in table 4 shall, when applicable, be stated when specifying and inspecting a compressed air dryer. Other relevant details such as explosion proof properties, hazardous area, etc. shall also be included.

Table 4 — Use and specification data

Clause	Description	Symbol	Unit	Remarks	Explanatory notes
7.0	Compressor type	—	—		State the type of compressor(s) (for example, displacement or turbo-compressor), the type of lubrication (non-lubricated, minimum lubrication or oil flooded) and the type of coolant (air, water, oil). See ISO 5388.
7.1	Mode of operation of compressor plant	—	—	Continuous/Intermittent	Details should be given of the operating intervals ("on periods") and the position of the compressed air dryer in the compressed air pipework system.
7.2	Volume of air receiver	V	L, m^3		State the volume of the air receiver.
7.3	Air volume flow rate related to the intake conditions in compliance with 4.10.1	q_{V1}	L/s or m^3/s		The maximum compressed air volume flow accepted by the dryer under the reference conditions including air required for regeneration, pressurizing or cooling purposes.
7.4	Effective (gauge) pressure of the compressed air	p_1	bar		The inlet air pressure shall be stated.
7.5	Temperature of compressed air	t_1	°C		The temperature of compressed air at the inlet of the dryer will affect its performance and shall be stated.
7.6	Pressure dew point of compressed air	t_{pd1}	°C		If the dryer is installed immediately following the compressor aftercooler, the compressed air may be assumed to be saturated. However, the humidity of the air should be measured if the dryer is installed downstream of the air receiver or in the pipework remote from the aftercoolers.
7.7	Pressure drop across dryer	Δp	bar		—
7.8	Oil presence in compressed air	—	g/m^3		The supplier should state the type and amount of compressor lubricant that can be expected at the dryer inlet.
7.9	Aggressive components in air	—	—		Any pollution of incursive (aggressive) contaminants should be stated.
7.10	Coolant	—	—	Water/Air	
7.11	Coolant temperature	t_{c1}	°C		The coolant temperature shall be measured.
7.11.1	Coolant quality	—	—		Any aggressive component in the coolant should be stated.
7.11.2	Coolant pressure	—	bar		
7.12	Position of air dryer	—	—	Before/After air receiver	When designing and specifying the air dryer the position of the air receiver is important and shall be stated.
7.13	Dryer location	—	—	Indoors/Outdoors	It is necessary to state the location of the dryer (for example indoors, outdoors, hazardous area).
7.14	Ambient conditions (maximum and minimum)	—	—		Any special ambient conditions shall be stated in the enquiry.
7.15	Power available	—	—		To include supply voltage, frequency and number of phases.

NOTE — The useful lives of desiccants and filter inserts are important; this is however beyond the control of the supplier as their lives are influenced by, for example, pressure drop and the content of water, oil and solid pollutants in the compressed air.

8 Data for performance comparisons

The data to be stated for performance comparisons and for technical acceptance are listed in table 5.

Table 5 — Supplier's data for performance comparisons

Description	Symbol	Unit	Explanatory notes
Type of compressed air dryer	—	—	Specific details with regard to operation and design/type of the compressed air dryer should be given as well as a specification of the equipment included in the delivery.
Mode of operation of compressed air dryer	—	—	Details should be provided of the mode of operation of the compressed air dryer, for example, continuous operation, on-off operation (for refrigeration dryers) alternating operation (in the case of adsorption dryers) as well as automatic, semi-automatic or manual.
Cycle time	—	s	—
Air volume flow rate related to the intake condition	q_{V2}	L/s or m^3/s	The volume of air delivered by the dryer under the reference conditions i.e. after maximum bleed air, pressurizing air and cooling air flows have been deducted.
Mass flow of compressed air (if required)	q_{m2}	kg/s	If required, the manufacturer of the dryer should calculate the mass of flow from the volume flow and state the value in the tender.
Temperature of dried compressed air	t_2	°C	The temperature shall be measured.
Pressure drop across dryer	Δp	bar	If the dryer is delivered with integral filters, they shall be included in the pressure drop.
Highest pressure dew point under operating condition	t_{pd}	°C	The maximum pressure dew point shall be stated for operating conditions.
Nominal pressure dew point as requested by purchaser	t_{pd}	°C	—
Coolant flow	q_{Vc2}	L/s	—
Energy requirements:			
Electric power at dryer terminals including all components (this includes cooling air fans), max. and average	P	kW	—
Bleed air, dump losses, etc., max. and average	$q_{V\,loss}$	L/s	—
Steam consumption	—	L/s (or kg/h)	—
Steam condition			
pressure	—	bar	—
temperature	—	°C	—
Water (for cooling according to coolant temperature which is used at any heat exchanger of dryer)	q_V	L/s	Pressure, quality inlet temperature and temperature rise should also be stated.
Noise level of air dryer	—	dB	—

NOTE — In addition to the reference conditions (see table 2, including options A or B) and the performance rating parameters (see table 3), additional data should be available when making performance comparisons. Table 4 sets out those items which may be relevant.

9 Performance measuring and testing

9.1 Test conditions

To obtain valid test results, constant operating conditions (inlet air pressure, inlet temperature, inlet pressure dew point, etc.) are required. These conditions shall be listed in the test report. Testing should be carried out under operating conditions specified in table 2. Performance data should then be compared to selected performance rating parameters, with adequate consideration given to measuring instrument tolerances.

9.2 Conversion of test results

Test conditions and results sometimes do not agree exactly with the reference conditions and the selected performance rating parameters. The precise conversion details shall therefore be agreed between the supplier and user.

9.3 Test report

The test report form is given in annex A.

9.4 Test system for air dryers

A diagram of a typical testing system for air dryers (see figure 1) and notes on the symbols used are given in annex B.

9.5 Saturation pressure and density of pure water vapour

Extracts from the *Smithsonian Meteorological Tables* and the *National Bureau of Standards and National Research Council of Canada: Steam Tables* are given in annex C.

9.6 Measuring equipment and accuracy

9.6.1 Flow

Flow-rates shall be measured to an accuracy of ± 3 %, for example

a) with calibrated flow meter;

b) with orifice or nozzles in accordance with ISO 5167 or with nozzles in accordance with ISO 1217, annex E;

c) by observing the time needed to fill a vessel of known volume (for liquids only).

9.6.2 Temperature

Temperature shall be measured to an accuracy of ± 1 K.

9.6.3 Pressure and pressure drop

Pressure drop is the loss in total pressure between inlet and outlet, as delivered. If the dryer is delivered with integral filters, they shall be included.

Pressure and pressure drop shall be measured to accuracies of ± 0,07 bar and ± 0,035 bar respectively.

9.6.4 Pressure dew point

The pressure dew point (see 4.9.2) shall be measured at the dryer outlet. The measuring instrument used shall have the accuracy indicated in table 6.

Table 6 — Accuracy of dew point measurement

Dew point range °C	Accuracy K
− 100 to below − 40	± 2
− 40 to below − 10	± 1
− 10 and above	± 0,5

NOTE — If requested by one of the parties, the measuring method shall be described.

9.6.5 Electric power

Electric input power, including all parts and components of the dryer, shall be included in the electric power consumption test, and shall be measured with a calibrated wattmeter or, in the case of three-phase electric motors, in accordance with the two-wattmeter method. The instrument(s) shall at least be of class 1 according to IEC Publication 51. The circuit diagram for the two-wattmeter method is shown in figure 2.

9.6.6 Other requirements

Consumption of steam, water, etc. which are needed for working purposes shall be measured in accordance with 9.6.9.

9.6.7 Refrigeration dryers

The total input power to the complete unit shall be measured in accordance with 9.6.5 over a suitable period.

9.6.8 Heatless dryers

The bleed air volume and the dump losses together with other energy requirements shall be measured while operating under constant working conditions.

9.6.9 Heat regenerated dryers

When electricity, steam, hot water, etc. are used as source of regeneration heat, the energy consumption shall be reported in kilowatt hours per full drying cycle, and the nominal cycle time stated. Bleed flow rate and total consumption of bleed air shall be stated.

9.6.10 General examination

The unit under pressure shall be examined for resistance to damage and leakage and the results shall be included in the report in conformity with relevant national regulations.