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Compressed air —

Part 3:
Test methods for measurement of humidity

Air comprimé —

Partie 3: Méthodes d'essai pour mesurer le taux d'humidité

Reference number
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Contents

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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.

International Standard ISO 8573-3 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 quality 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: Test methods for oil vapour and organic solvent content*

— *Part 6: Test methods for gaseous contaminant content*

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

Annexes A, B, C and D are for information only.

Introduction

This part of ISO 8573 is one in a series of International Standards (planned or published) with the aim of harmonizing air contamination measurements. It is also intended to be used for reference when stating air purity class according to ISO 8573-1.

Compressed air —

Part 3:
Test methods for measurement of humidity

1 Scope

This part of ISO 8573 provides guidance on selection from the available suitable methods for measurement of humidity in compressed air and specifies the limitations of the various methods.

It does not provide methods for measurement of water content in states other than vapour.

This part of ISO 8573 specifies sampling techniques, measurement, evaluation, uncertainty considerations and reporting for the air contamination parameter humidity.

It gives guidance for the conversion of humidity statements to the standard format.

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 editions of the normative documents referred to applies. Members of ISO and IEC maintain registers of currently valid International Standards.

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

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

ISO 7183:1986, *Compressed air dryers — Specifications and testing.*

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

3 Terms and definitions

For the purposes of this part of ISO 8573, the terms and definitions given in ISO 3857-1 and ISO 5598 and the specific humidity terms and definitions given in ISO 7183 apply.

4 Units

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

1 bar = 100 000 Pa

NOTE Bar(e) is used to indicate effective pressure above atmospheric.

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

5 Selection guide and available methods

The methods available for measuring humidity, their grade of uncertainty and their preferred range of use are listed in Table 1.

Table 1 — Methods available for measuring humidity

Methods in order of increasing uncertainty		Uncertainty ±°C	Range for humidity level expressed as pressure dew point [c], °C								Remarks
Method	Table		−80	−60	−40	−20	0	+20	+40	+60	
Spectroscopic	2	[a]	⊢				⊣				Detection limit for water vapour is about $0{,}1 \times 10^{-6}$ to 1×10^{-6} [b]
Condensation	3 and 4	0,2 to 1,0	⊢						⊣		
Chemical	5	1,0 to 2,0			⊢				⊣		
Electrical	6, 7 and 8	2,0 to 5,0	⊢						⊣		
Psychrometer	9	2,0 to 5,0				⊢				⊣	

[a] The uncertainty is not yet available in °C.

[b] Volume fraction.

[c] Pressure dew point is defined in ISO 7183.

6 Sampling techniques

6.1 General

Dew point can be measured at atmospheric pressure or under actual pressure conditions. The pressure to which the dew point is referred shall be stated. It is important that the air flow is controlled within the upper and lower limits to prevent damage to the probe and to ensure that a representative measurement is made.

6.2 Probe installation

6.2.1 Full flow measurement

The probe is inserted in the main air flow stream, but protected against free water and other contaminants and used within the stated lower and upper limits of flow velocity for the measurement system.

6.2.2 Partial flow measurement

6.2.2.1 Bypass

The probe is installed in a small bypass tube. In this way the flow velocity to which the probe is exposed may be controlled.

6.2.2.2 Extraction

The probe is installed in a small extraction tube which conducts an air sample from the main air flow stream into the measurement chamber, where the measurement is made under system pressure.

6.2.3 Reduced-pressure measurement

The probe is installed in a chamber into which an air flow is fed from the main air stream. Before measurement, the pressure is reduced to a suitable measuring pressure (normally atmospheric).

6.3 Requirements on sampling and measurement conditions

6.3.1 The measurements carried out depend on the reproducibility of the method and the experience of the parties involved in the provision of measurement facilities.

6.3.2 Materials used for conducting the air into the sampling system shall not affect the water vapour content of the sample. See C.2 in annex C.

6.3.3 The sampling system pressure shall be recorded during measurement.

6.3.4 The sampling system temperature shall be higher than the measured dew point.

6.3.5 The measurement system shall have reached a steady state before any measurement takes place and shall be kept steady during measurement. The readings from two consecutive measurements taken with at least 20 min interval shall not differ by more than the accuracy of the measuring system.

7 Measurement methods

Tables 2 to 9 list a number of methods for humidity measurement, including limitations on application, measurement pressure and temperature. Descriptions of the different methods can be found in annex C. Some non-preferred methods are described in annex D.

Consideration shall be given to the measurement system integrity and the calibration requirements of the measurement equipment which shall be used as described in applicable instructions and International Standards.

It shall be proven that the equipment used is capable of achieving the uncertainty required within the specified range and tolerance.

Any method shall only be used within the upper or lower limits of its range of operation.

Check and consider calibration records.

Table 2 — Spectroscopic methods — Laser diode

Characteristic applications	Atmospheric air and compressed air
Humidity range	−80 °C to +60 °C pressure dew point
Pressure range	Atmospheric pressure
Temperature range	0 °C to +40 °C
Contamination tolerance	Good

Table 3 — Chilled mirror (condensation) with manual thermometer reading

Characteristic applications	Atmospheric air and compressed air
Humidity range	−20 °C to +25 °C pressure dew point
Pressure range	0 bar(e) to 200 bar(e)
Temperature range	0 °C to +50 °C
Contamination tolerance	Poor

Table 4 — Chilled mirror (condensation) with automatic mist detection and temperature-measuring device

Characteristic applications	Atmospheric air and compressed air
Humidity range	−80 °C to +25 °C pressure dew point
Pressure range	0 bar(e) to 20 bar(e)
Temperature range	0 °C to +50 °C
Contamination tolerance	Poor

Table 5 — Chemical reaction method using direct-reading (glass) tubes with hygroscopic content

Characteristic applications	Atmospheric air and compressed air
Humidity range	−65 °C to +35 °C pressure dew point
Pressure range	Atmospheric pressure
Temperature range	0 °C to +40 °C
Contamination tolerance	Average

Table 6 — Measurement with electrical sensor based on capacitance

Characteristic applications	Atmospheric air and compressed air
Humidity range	−80 °C to +40 °C pressure dew point
Pressure range	0 bar(e) to 20 bar(e)
Temperature range	−30 °C to +50°C
Contamination tolerance	Average

Table 7 — Measurement with electrical sensor based on conductivity

Characteristic applications	Atmospheric air and compressed air
Humidity range	−40 °C to +25 °C pressure dew point
Pressure range	0 bar(e) to 20 bar(e)
Temperature range	−30 °C to +50 °C
Contamination tolerance	Average

Table 8 — Measurement with electrical sensor based on resistance

Characteristic applications	Atmospheric air and compressed air
Humidity range	−40 °C to +25 °C pressure dew point
Pressure range	0 bar(e) to 20 bar(e)
Temperature range	0 °C to +50 °C
Contamination tolerance	Average

Table 9 — Psychrometer (wet and dry bulb thermometers)

Characteristic applications	Atmospheric air
Humidity range	5 % to 100 % relative humidity
Pressure range	Atmospheric pressure
Temperature range	0 °C to +100 °C
Contamination tolerance	Poor

8 Evaluation of test results

8.1 Reference conditions

Unless otherwise agreed, the reference conditions for humidity statements are:

Compressed air temperature 20 °C

Compressed air pressure 7 bar(e)

8.2 Recalculation for deviating pressure

When necessary, the obtained value can be referred to another pressure (reference pressure) using the absolute pressure values and partial pressures. See annex B.

8.3 Recalculation for deviating temperature

Normally not required except in the case of relative humidity.

8.4 Recalculation for influence of other contaminants

Some contaminants, particularly molecules which have a structure similar to water molecules, may disturb the measurements. Therefore these shall be eliminated from the sample before measurement takes place. If this is not possible, then an evaluation shall be made to determine the uncertainty caused by these contaminants.

9 Conversions from non-standard humidity units to standard format and vice versa

9.1 Relative humidity

The relative humidity value for a known air sample at a known temperature can be recalculated to a dew point temperature using the table in ISO 7183:1986, Annex C, which gives values for saturation pressures and densities of water vapour at different temperatures.

Read the saturation vapour pressure for the actual temperature and multiply this by the percentage relative humidity. In the table, read the dew point temperature corresponding to the actual partial vapour pressure.

9.2 Dew point

Dew point at atmospheric pressure (1 bar absolute) is erroneously but commonly referred to as "atmospheric dew point". It represents an imaginary dew point and is not an acceptable term for describing the water content.

9.3 Mixing ratio (or specific humidity)

Water to dry air mass mixing ratio: use the table in ISO 7183:1986, annex C.

Water to wet air mass mixing ratio: use the table in ISO 7183:1986, annex C.

10 Uncertainty

NOTE Calculation of the probable uncertainty according to this clause is not always necessary.

Due to the nature of physical measurements, it is impossible to measure a physical quantity without error or, in fact, to determine the true uncertainty 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, together with its confidence level (normally 95%), constitutes a criterion of the accuracy of the particular measurement.

It is assumed that all systematic uncertainties that may occur in the measurement of the individual quantities measured and of the characteristics of the gas may be compensated for by corrections. A further assumption is that the confidence limits in uncertainties in reading and integration errors may be negligible if the number of readings is sufficient. The (small) systematic uncertainties that may occur are covered by the inaccuracy of measurements.

Quality classifications and limits of uncertainty 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 uncertainty.

Information on 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 (see ISO 2602 and ISO 2854).

11 Expression of results

Statements of the concentration of water vapour in the compressed air under test shall be expressed as pressure dew point.

The statement shall be sufficiently detailed to allow the values to be verified according to the procedures of this part of ISO 8573.

12 Test report

The report used to declare humidity in accordance with this part of ISO 8573 shall contain the following information:

a) a description of the compressed air system and its working conditions, with sufficient detail to determine the applicability of the declared concentration value;

b) a description of the point at which the samples were taken;

c) a description of the sampling and measurement system used (particularly materials used) and details of its calibration record;

d) the words "Declared pressure dew point in accordance with ISO 8573-3", followed by:

   1) the actual, average measured value evaluated as described in clause 8 and expressed in degrees Celsius, referring to the **actual** conditions;

   2) the actual, average measured value evaluated as described in clause 8 and expressed in degrees Celsius, and calculated to refer to the **reference** conditions;

   3) the actual pressure to which the dew point refers, in bar(e);

   4) a statement regarding the applicable uncertainty;

e) the date of the sampling and measurements.

A sample test report is given in annex A.

Annex A
(informative)

Example of compressed air humidity statement

In the compressed air system at XX Industries, consisting of four air compressors, aftercoolers and refrigerant type dryers, with one compressor standby, two compressors working full load and one compressor loaded approximately 50% and working at 7 bar(e) network pressure, measurements on the humidity were made in the system where the supply pipe enters the B-shop.

Samples were taken regularly at 1 h intervals during 48 h during the days 1996-01-23 to 1996-01-25.

The pressure at the sampling point was 6,6 bar(e).

The measurements were made using a condensation-type dew point meter type XX with an uncertainty of ± 0,5 °C.

The measuring equipment was calibrated on 1995-11-30 as per record (enclosed).

The declared pressure dew point in accordance with ISO 8573-3 is:

Pressure dew point +1 °C ± 0,5 °C at actual conditions
6,6 bar(e), 26 °C

Recalculated pressure dew point + 3 °C ± 0,5 °C at reference conditions
7 bar(e), 20 °C.