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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

1 Scope 1

2 Normative references 1

3 Terms and definitions 1

4 Units 1

5 Selection guide and available methods 2

6 Sampling techniques 2

7 Measurement methods 3

8 Evaluation of test results 5

9 Conversions from non-standard humidity units to standard format and vice versa 5

10 Uncertainty 6

11 Expression of results 6

12 Test report 6

Annex A (informative) **Example of compressed air humidity statement** 7

Annex B (informative) **Calculation of vapour pressure** 8

Annex C (informative) **Preferred methods of humidity measurement** 10

Annex D (informative) **Non-preferred methods of humidity measurement** 13

Bibliography 14

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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 m³

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.

Annex B
(informative)

Calculation of vapour pressure

B.1 Calculation of actual vapour pressure over water based on dry and wet bulb temperature measurement

Psychrometer equation:

$$p_{\mathrm{w}} = p_{\mathrm{wsat}} - C \cdot p_{\mathrm{tot}} \cdot (T - T_{\mathrm{w}})$$

where

p_{w} is the actual partial vapour pressure, in pascals;

p_{wsat} is the saturation vapour pressure, in pascals;

p_{tot} is the total pressure of the gas , in pascals;

T is the dry bulb temperature, in kelvin;

T_{w} is the wet bulb temperature, in kelvin;

C is the factor depending on the type of meter used and is of the order 10^{-3}. The value shall be calculated based on calibration values.

B.2 Calculation of the saturation vapour pressure over water based on temperature measurement

See reference [4].

$$p_{\mathrm{wsat}} = e^{\left[B \cdot \ln T_{\mathrm{w}} + \sum_{i=0}^{9} F_i \cdot T_{\mathrm{w}}^{(i-2)}\right]}$$

where

B = −12,150 799

F_i = see Table B.1.

Other symbols as under B.1.

Table B.1 — Values for factor F_i

Factor $F_{i = 1..9}$	Value	Factor	Value
F_0	− 8 499,22	F_5	− 1,146 05 × 10^{-8}
F_1	− 7 423,186 5	F_6	2,170 13 × 10^{-11}
F_2	96,163 514 7	F_7	− 3,610 26 × 10^{-15}
F_3	0,024 917 646	F_8	3,850 45 × 10^{-18}
F_4	− 1,316 × 10^{-5}	F_9	− 1,431 7 × 10^{-21}

B.3 Calculation of dew point at reference pressure based on measurement at non-reference pressure

For dew points over water:

$$t_{\mathrm{D,rp}} = \frac{243{,}12 \cdot \ln\left[\dfrac{p_{\mathrm{w,nrp}} \cdot p_{\mathrm{tot,rp}}}{6{,}112 \cdot p_{\mathrm{tot,nrp}}}\right]}{17{,}62 - \ln\left[\dfrac{p_{\mathrm{w,nrp}} \cdot p_{\mathrm{tot,rp}}}{6{,}112 \cdot p_{\mathrm{tot,nrp}}}\right]} = t_{\mathrm{D(w),rp}} \quad \text{if} \quad \frac{p_{\mathrm{w,nrp}} \cdot p_{\mathrm{tot,rp}}}{6{,}112 \cdot p_{\mathrm{tot,nrp}}} > 1$$

For dew points over ice:

$$t_{\mathrm{D,rp}} = \frac{272{,}46 \cdot \ln\left[\dfrac{p_{\mathrm{w,nrp}} \cdot p_{\mathrm{tot,rp}}}{6{,}112 \cdot p_{\mathrm{tot,nrp}}}\right]}{22{,}46 - \ln\left[\dfrac{p_{\mathrm{w,nrp}} \cdot p_{\mathrm{tot,rp}}}{6{,}112 \cdot p_{\mathrm{tot,nrp}}}\right]} = t_{\mathrm{D(i),rp}} \quad \text{if} \quad \frac{p_{\mathrm{w,nrp}} \cdot p_{\mathrm{tot,rp}}}{6{,}112 \cdot p_{\mathrm{tot,nrp}}} < 1$$

where

$t_{\mathrm{D,rp}}$ is the dew point temperature at reference pressure, in degrees Celsius;

$t_{\mathrm{D(w),rp}}$ is the dew point temperature at reference pressure over water, in degrees Celsius;

$t_{\mathrm{D(i),rp}}$ is the dew point temperature at reference pressure over ice, in degrees Celsius;

$p_{\mathrm{tot,rp}}$ is the total reference pressure, in pascals;

$p_{\mathrm{tot,nrp}}$ is the total pressure at non-reference pressure, in pascals;

$p_{\mathrm{w,nrp}}$ is the partial water vapour pressure at non-reference pressure, in pascals.

Annex C
(informative)

Preferred methods of humidity measurement

C.1 Description of method

C.1.1 Psychrometer (wet and dry bulb thermometers)

A psychrometer consists of two adjacent but thermally isolated temperature sensors over which a humid environment is drawn. One sensor is enclosed in a porous medium (wetsock) which is maintained wet by capillary action from a reservoir of water.

Water evaporates from the wetsock at a rate proportional to the humidity of the air. The evaporation causes the wet sensor to be chilled. The difference in temperatures of the wet and dry sensors is used to calculate the humidity of the air.

C.1.2 Chilled mirror (condensation)

C.1.2.1 With manual thermometer reading

In an optical condensation dew point meter, condensation of the humidity in the airstream is induced on a mirror exposed to the air by cooling the mirror. The temperature at which condensation starts, which can be observed by detecting changes in how the mirror reflects light, is recorded as the dew point.

C.1.2.2 With automatic condensation detection and temperature-measuring device.

Same as above, but with electronic devices to monitor condensation and temperature.

C.1.3 Measurement using electrical sensor

C.1.3.1 General

This type of sensor is fabricated from a hygroscopic material whose electrical properties alter as it absorbs water molecules. Changes in humidity are measured as a change in the sensor's electrical capacitance or resistance or some combination of the two. The probe shall be equipped with a filter to protect against contamination. (Response times are faster, though, without this protection.) Impedance hygrometers are usually also fitted with a temperature sensor. Readings are displayed directly, sometimes with a choice of units (e.g. relative humidity or dew point), and output of an electrical signal (e.g. analog voltage) may also be available.

There are several distinct types of electrical sensors.

C.1.3.2 Capacitive sensor

This type of sensor responds most closely to relative humidity, rather than dew point, with best linearity at low relative humidities. In general, capacitive sensors are not damaged by condensation (i.e. relative humidity of 100 %), though calibration may shift as a result.

C.1.3.3 Resistive sensor

This type of sensor responds most closely to relative humidity, rather than dew point, with best linearity at high humidities. Most resistive sensors cannot tolerate condensation. However, some are "saturation-guarded", with automatic heating to prevent condensation.

C.1.3.4 Dew point-type impedance sensor

This type of sensor is a special case of impedance hygrometer, used to measure in absolute units rather than relative humidity. Following a similar general principle, the sensor may feature aluminium oxide or other metal oxides, or a silicon base for the active element. This type of sensor responds to the partial pressure of water vapour. Commonly the signal is converted into other absolute units, resulting in values displayed by the instrument in dew point or in parts per million expressed as volume fraction.

C.1.4 Chemical reaction methods

Direct-reading (glass) tubes with chemically reactive content are used. The basis of direct-reading tubes is a chemical reaction between the water vapour in the air sample and the filling material in the tube, causing a colour change. The reaction is proportional to the total amount of water carried into the tube with the passage of a fixed volume of air. It is indicated as a length of stain and is readable on a scale.

C.1.5 Spectroscopic methods

In general, a spectroscopic technique is one in which the composition of a gas mixture is determined by analysing how substances absorb (or emit) light of particular wavelengths or frequencies. Every chemical substance has a characteristic frequency "signature", and these may lie in the ultraviolet or infrared part of the spectrum. Spectroscopic measurement can be a useful approach if concentrations of other substances are to be measured, as well as that of water vapour.

The spectroscopic technique used for high or moderate humidities is based on infrared absorbance. Water absorbs infrared radiation at several wavelengths in the range 1 µm to 10 µm. The intensity of transmitted radiation is measured at one of these wavelengths and compared with that for a reference wavelength, using a photocell for detection. The amount of this radiation absorbed by the gas is proportional to the spatial concentration (or partial pressure) of water vapour.

Spectroscopic techniques can also used to measure extremely low concentrations of water vapour, reportedly down to a few parts per billion (i.e. be parts in one thousand million). There are several versions of this sophisticated technology, including APIMS (atmospheric pressure ionization mass spectrometry), FT-IR (Fourier-transform infrared spectroscopy), and TDLAS (tunable diode laser absorption spectroscopy).

C.2 Recommendations specific to certain ranges of measurement

C.2.1 High humidities, above ambient range

Sample lines should be maintained above the dew point of the gas being measured, to avoid condensation. Electrical trace heating is often the most practical method.

C.2.2 Low humidities, and very dry gases

If possible, prepare for measurements by flushing sample lines and hygrometers with dry gas, or by evacuating to low pressure. Drive off stray residual water by baking assemblies if possible (but not instruments — unless designed for this!). The lower the moisture content to be measured, the more dramatically the drying time multiplies.

Avoid hygroscopic materials. At low humidities (anything below a dew point of 0 °C) the amounts of water given off by organic and porous materials can dramatically affect the value of air humidity. The lower the level of air moisture, the more significant the effects.

Choose impermeable materials, to avoid inward diffusion of moisture through sampling tubes and enclosures. Steel and other metals are practically impermeable. Polytetrafluoroethylene (PTFE) is only slightly permeable and will usually be satisfactory for dew points above −20 °C, and sometimes below this level. Materials such as polyvinyl chloride (PVC), nylon and rubber are relatively permeable and so totally unsuitable at low humidities, and not really satisfactory in any humidity range.

Surface finish is important at very low humidities. Even the tiny quantities of water absorbed on the surfaces of non-hygroscopic materials can have significant effect. Polished or electropolished stainless steel is recommended for the best results.

Clean environments are always best for humidity measurements, but this is especially critical at very low humidities. Even fingerprints harbour water. High purity cleaning agents are recommended; Analytical Reagent quality solvents for oil-based contaminants, and purified water (distilled or deionized) for salts. Cleaning should be followed by thorough drying by a clean method.

Sample tubing should be as short in length as possible. The surface area should be minimized by using the narrowest tubing that the flow conditions will permit. Avoid leaks. Minimizing the number of connections (elbows, tees, valves, etc.) helps with this.

Adequate flow of the gas sample should be ensured, to minimize the influence of sources of stray water in the flow path.

"Dead ends" in tubing should be avoided, as they cannot easily be flushed.

Back-diffusion of moisture should be minimized, e.g. by fast flowrates of gas, long exhaust tubes after the sensor, or by valves which isolate the low humidity region from ambient air.

Annex D
(informative)

Non-preferred methods of humidity measurement

D.1 General

The following list contains some other known methods which are non-preferred for measuring moisture in compressed air systems and in connection with classification of contaminants as described in ISO 8573-1.

D.2 Mechanical methods

The sensing medium is hygroscopic and absorption of water causes a change in the mechanical properties. One example is the well-known hair hygrometer, where the length of a bundle of hair changes with humidity. The movement is magnified and displayed via a needle on a scale.

D.3 Saturated lithium chloride method

The sensing medium, which is a hygroscopic salt, absorbs water from the air. An electrical voltage is applied across the salt, and the amount of current which passes depends on the amount of water vapour that has been absorbed. At the same time, the current also heats the salt.

Eventually a balance is achieved between the absorption and the heating. The temperature at which this occurs is related to the water vapour pressure. The instrument is usually in probe form, with readings displayed in terms of dew point.

D.4 Electrolytic (phosphorous pentoxide) method

The sensor consists of a film of powerful desiccant, phosphorus pentoxide(P_2O_5), which strongly absorbs water vapour from the surrounding gas. A voltage is applied across the P_2O_5, and electrolysis takes place, dissociating the water into its constituents hydrogen and oxygen. The current that flows in this process is related (by Faraday's Law) to the amount of water electrolysed. Thus the amount of current indicates the humidity of the gas being measured. These sensors are suitable for measuring very low humidities, though they require a steady (known) flowrate of gas. This instrument measures water concentration by volume, with readings displayed in one of the absolute units, such as volume fraction in parts per million or vapour pressure. It is normally used in a flow sampling configuration, rather than in probe form.

D.5 Pressure swing cell dew point meter

A sample of air is compressed and, in theory, adiabatically expanded. Several trials at various pressures (increasing) are run. The pressure at which fog first forms upon pressure release is indexed to an expansion temperature and a dew point.

Bibliography

[1] ISO 2602, *Statistical interpretation of test results — Estimation of the mean — Confidence interval.*

[2] ISO 2854, *Statistical interpretation of data — Techniques of estimation and tests relating to means and variances.*

[3] *A Guide to the Measurement of Humidity.* Institute of Measurement and Control, National Physics Laboratory, 1996, ISBN 0-904457-24-9.

[4] A. Wexler and R. Greenspan, US Code of Federal Regulations, Part 40, § 86.344-79, Protection of the environment. *Humidity calculations.* National Bureau of Standards.

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