INTERNATIONAL STANDARD

ISO 187

Second edition
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Paper, board and pulps — Standard atmosphere for conditioning and testing and procedure for monitoring the atmosphere and conditioning of samples

Papier, carton et pâtes — Atmosphère normale de conditionnement et d'essai et méthode de surveillance de l'atmosphère et de conditionnement des échantillons

Reference number
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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.

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 187 was prepared by Technical Committee ISO/TC 6, *Paper, board and pulps*.

This second edition cancels and replaces the first edition (ISO 187: 1977), which has been technically revised.

Annex A forms an integral part of this International Standard. Annexes B and C are for information only.

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Introduction

The physical properties of paper are affected materially by its moisture content which, in turn, is dependent on the humidity of the surrounding atmosphere. In order that tests may be made on paper in a defined physical state, it is brought into equilibrium with an atmosphere of standardized temperature and relative humidity, and tested in that atmosphere.

The moisture content of a given paper in equilibrium with a given atmosphere varies according to whether the equilibrium is reached by sorption or by desorption of moisture. This hysteresis influences those physical properties that change with moisture content. Unless otherwise specified the equilibrium condition should be attained by the sorptive process.

For a number of years three standard test atmospheres have been in common use:

20 °C/65 % r.h.; 23 °C/50 % r.h. and 27 °C/65 % r.h.

At the time of publication of this revision of ISO 187: 1977 the atmosphere 23 °C/50 % r.h. is used almost exclusively in most countries and after 1 January 1993 is to be considered the ISO standard test atmosphere for testing of pulp, paper and board. However, the 23 °C/50 % r.h. atmosphere is difficult to attain in some of the countries located in tropical zones, and in such countries the 27 °C/65 % r.h. atmosphere is permitted. Until 1 January 1993 the 20 °C/65 % r.h. atmosphere is acceptable as a standard test atmosphere.

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Paper, board and pulps — Standard atmosphere for conditioning and testing and procedure for monitoring the atmosphere and conditioning of samples

1 Scope

This International Standard specifies the standard atmosphere for conditioning, and for testing pulp, paper and board, and also the procedures for measuring the temperature and relative humidity.

For the conditioning of laboratory prepared handsheets in accordance with ISO 5269-1, the standard atmosphere is that defined in this International Standard but the procedure is different[1].

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this International Standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 554:1976, *Standard atmospheres for conditioning and/or testing — Specifications.*

ISO 4677-1:1985, *Atmospheres for conditioning and testing — Determination of relative humidity — Part 1: Aspirated psychrometer method.*

ISO 5269-1:1979, *Pulps — Preparation of laboratory sheets for physical testing — Part 1: Conventional sheet-former method.*

ISO 5269-2:1980, *Pulps — Preparation of laboratory sheets for physical testing — Part 2: Rapid-Koethen method.*

3 Definitions

For the purposes of this International Standard, the following definitions apply.

3.1 relative humidity (r.h.): The ratio, expressed as a percentage, of the actual water vapour content of the air to the water vapour content of air saturated with water vapour at the same temperature and pressure.

3.2 conditioning: A process of establishing a reproducible moisture content equilibrium between the sample and an atmosphere of specified temperature and relative humidity. This equilibrium is considered to be attained when the results of two consecutive weighings of the sample, carried out at an interval of time of not less than 1 h, do not differ by more than a specified amount.

NOTE 1 The interval between weighings is dependent on the grammage of the sample and the degree of agreement expected between successive weighings should take account of the known cycling characteristics of the particular test room. The establishment of moisture content equilibrium is accepted as ensuring that the paper is in a stable physical state, but in special circumstances, conditioning may have to be prolonged until the desired physical equilibrium is attained. Such circumstances are not within the scope of this International Standard.

4 Principle

Exposure of the sample to a specific conditioning atmosphere in such a manner that a reproducible state of moisture content equilibrium is reached between the sample and this atmosphere.

1) ISO 5269-1 requires pulp handsheets to be conditioned by desorption of moisture, whilst ISO 5269-2 requires drying followed by conditioning by sorption of moisture.

5 Standard atmosphere

The standard atmosphere for testing pulp, paper and paperboard shall be 23 °C ± 1 °C and (50 ± 2) % r.h. In tropical countries an atmosphere of 27 °C ± 1 °C and (65 ± 2) % r.h. may be used.

NOTE 2 The temperature and relative humidity conditions are those specified in ISO 554. The tolerances quoted are the reduced or close tolerances specified in ISO 554.

A test atmosphere shall be deemed to be within the requirements of this International Standard if all the test results determined as described in annex A (see, in particular, A.4.2) are within the prescribed limits. Even short-term excursions of temperature or humidity beyond these limits, to the extent that the equilibrium moisture content of the sample will be affected, are not permitted. Whenever the test atmosphere is known to have been outside the limits and if there is any chance that the moisture content of samples has been changed by such excursions, all samples must be reconditioned (repeating clause 6) before any further testing is done.

NOTES

3 If it is known or suspected that the relative humidity has exceeded the upper limit to the extent that the moisture content may have increased, all samples except those prepared in accordance with ISO 5269-1, must be subjected to the preliminary low humidity treatment described in 6.1 before reconditioning.

If it is known or suspected that the relative humidity has fallen below the limit to the extent that the moisture content may have decreased, samples prepared in accordance with ISO 5269-1 should be discarded and new samples prepared. If this is not possible and the samples are tested, the circumstance must be reported.

4 A recording hygrometer, either independent of or part of the control system, should be in continuous operation in the room, but such hygrometer must not be used to assess whether the atmosphere meets the requirements of this International Standard unless it also meets the requirements of annex A of this standard. The hygrometer should respond rapidly to changes in relative humidity, for example, less than 1 min for a change in relative humidity of 10 %.

6 Conditioning procedure

6.1 Pre-conditioning of the sample

For tests in which the hysteresis of the equilibrium moisture content may lead to important errors, the sample shall be pre-conditioned before conditioning, for 24 h in air of relative humidity between 10 % and 35 % and a temperature not above 40 °C. If it is known that conditioning (6.2) will result in an equilibrium moisture content equivalent to that achieved by sorption (see Introduction) this preliminary treatment may be omitted.

NOTE 5 Since the effect of hysteresis may not be known until after the event, it is recommended that preconditioning be always carried out.

6.2 Conditioning

The specimens of the sample shall be held such that the conditioning air has free access to all their surfaces so that their moisture contents attain a state of equilibrium with the water vapour in the atmosphere. This equilibrium is considered to be attained when the results of two consecutive weighings at least 1 h apart do not differ by more than 0,25 % of the total mass (3.2). The interval between weighings needs to be longer for higher grammage products and the degree of agreement expected between successive weighings should take account of the known cycling characteristics of the test room.

NOTE 6 With good air circulation, a conditioning period of 4 h is usually sufficient for paper. A minimum time of 5 h to 8 h will be required for heavy papers. Boards of higher grammage and specially treated materials may require a conditioning period of 48 h or longer.

7 Test report

The test report of any testing which is required to be done in this standard atmosphere shall include the following particulars:

a) reference to this International Standard;

b) the nominal conditioning atmosphere used;

c) the time for which the sample was conditioned;

d) whether the paper or the board was pre-conditioned before conditioning.

Annex A
(normative)

Measurement of temperature and relative humidity

A.1 Scope

This annex is based on ISO 4677-1:1985 and describes the procedures for measurement of temperature and relative humidity to be used in determining compliance with this International Standard. It aims to specify those features which are essential for accurate measurement without specifying a particular type of instrument.

NOTE 7 Condensation type and impedance type hygrometers may be used provided they can be shown to be at least as accurate as the aspirated psychrometer.

A.2 Apparatus

Aspirated wet and dry bulb psychrometer, comprising the following essential components:

A.2.1 Thermometers

These may be liquid-in-glass (either solid stem or enclosed scale type), thermocouples or electrical resistance thermometers with a working range of 10 °C or more. They shall be accurate to within ± 0,1 °C and the pair used in any instrument shall agree to within 0,05 °C. Liquid-in-glass thermometers should be graduated in 0,1 °C scale divisions so that readings can be estimated to the nearest 0,05 °C. Thermocouples and electrical resistance thermometers are usually connected to a digital display panel meter which rounds off to 0,1 °C. However, a chart recorder with scale divisions of 0,05 °C may be connected to provide a permanent record of dry bulb readings and also either wet bulb temperature or preferably, relative humidity computed electronically within the instrument.

The sensing section of the thermometers shall not be less than 1 mm or more than 4 mm in diameter for transverse ventilation, and 6 mm for axial ventilation. Thermocouples and electrical resistance thermometers shall have a response rate sufficient to track a temperature gradient of 1 °C/min and a relative humidity gradient of 1,5 %/min.

A.2.2 Ventilation

The instrument shall provide means of drawing air over the sensing sections of the thermometers which may be mounted for either transverse or axial ventilation. The thermometers shall be mounted so that the axes of the sensors are parallel and separated by a distance of not less than three times the diameter of the wet bulb sensor.

In the case of transverse ventilation both sensors may be located in the same air stream with the dry bulb off-set on the upstream side of the wet bulb. In the case of axial ventilation the direction of air flow shall be from the free end of the sensor to the support end and a separate cylindrical radiation shield, of internal diameter 1,75 to 3 times the wet bulb diameter, shall be provided for each sensor.

The sensors shall be protected from all sources of heat radiation including that provided by the proximity of the operator. The air flow shall be provided by a fan located downstream from the sensors so that any heat generated by it will not affect the sensors, and exhaust air is directed away from the source of incoming air.

The air speed over the sensors shall not be less than 3 m/s. However, the air speed shall not be sufficiently high as to allow the wick to become less than fully saturated or to allow droplets of water to form in the air stream.

A.2.3 Wet wick

The wet wick shall be a seamless fabric sleeve made from cotton or non-acetate rayon. It shall fit the sensor snugly but not tightly and shall cover the sensor completely for such distance that any decrease in length covered does not change the temperature reading. This may be measured by operating both thermometers as wet bulbs and varying the distance covered on one of them.

A.2.3.1 Cleaning and care of wicking material

Cleanliness of wicks is essential for accurate results, particularly in the case of thermocouples and electrical resistance thermometers, and they should be changed frequently in service.

Even the slightest touch of the hand will affect wick performance. Wicks should be handled with tweezers or plastics gloves (or their equivalent) and it is important to ensure that any part of the tweezers or gloves to touch the wick has not been touched previously by the hand.

A new wick or a particularly dirty wick is best cleaned by boiling for 30 min in distilled water containing 20 g of sodium hydroxide per litre. Wash the freshly boiled wick thoroughly in distilled water and then boil it three times, for 15 min each time, in successive 400 ml portions of distilled water.

If organic contaminants are suspected of being present, wash with acetone and then successive portions of distilled water until free of odour. If the contamination is only loose particulate matter, a distilled water wash may be sufficient. After cleaning, the wick must pass the absorption test (A.2.3.2). With experience the user will be able to select the appropriate cleaning procedure.

A.2.3.2 Tests for wick cleanliness

A properly clean wick will instantly absorb a drop of water placed on it. Any delay indicates that the wick needs to be cleaned. One quantitative test for cleanliness of longer wicks is the following: Mount about 120 mm of dry wick on a glass rod with about 20 mm hanging free from one end. Secure the rod in a vertical position with the covered end 15 mm above a dish of distilled water and the free end submerged in the water. After 6 min the water should have risen at least 85 mm up the wick. Any lower reading indicates that the wick is not sufficiently clean.

Store clean wicks under distilled water or dry between clean blotters and store in a clean and sterile glass container.

A.2.4 Water supply

The end of the wick away from the sensor may dip into a reservoir of distilled or deionized water located so that it is completely isolated from the incoming air. Some instruments are not fitted with a water reservoir and, in using these instruments, it is necessary to thoroughly wet the wick before the test is started and to take particular care to repeat the wetting at frequent intervals to prevent the wick becoming too dry.

NOTE 8 The reservoir must be so located that water does not flow along the wick at a rate fast enough to result in water dripping or spraying from the wick.

A.3 Procedure

Locate the instrument in or close to the working area but away from any heat producing equipment and personnel. Turn on the fan and allow to run for a few minutes, monitoring the temperature reading, to achieve stable operation. During this period the wet bulb temperature should fall and then stabilize. Inspect the wick to ensure that it remains wet during testing. It should glisten when viewed in a beam of light and the addition of a few drops of water should not result in any change of wet bulb temperature.

In the case of non-recording psychrometers, both liquid-in-glass and electronic, make simultaneous (as close as possible) readings of the two thermometers, or dry bulb temperature and relative humidity readings, at intervals of about 2 min over a period of about 10 min. Average the dry bulb readings and the wet bulb or relative humidity readings. In rooms where the sample storage and working areas are separate or large, repeat the test at sufficient locations to ensure that the test results are properly representative of the areas under test. Repeat all tests at irregular intervals over a period of 2 h or 3 h to assess the medium-term stability of systems which have relatively long control cycles.

In the case of recording psychrometers make a chart recording of dry bulb temperature and either web bulb temperature or relative humidity over a period of about 10 min. From the chart note the dry bulb temperature and either wet bulb temperature or relative humidity at exactly 2 min intervals during the period. In selecting points on the chart at which to take readings, do not allow actual values to influence the selection. If wet bulb temperature is recorded instead of relative humidity the wet bulb readings noted must be at times identical to the times at which the dry bulb temperatures are noted. Average the dry bulb readings and either wet bulb readings or relative humidity readings.

If the results are in the form of pairs of dry bulb and wet bulb temperatures, determine relative humidity, in accordance with clause A.4.

In the case of recording psychrometers, the test room shall be deemed to conform to this International Standard if the chart indicates that both the dry bulb temperature and humidity are within the prescribed limits at all times.

Ensure that the operation of the instrument is not affected by the proximity of personnel whilst readings are being taken. Body heat can affect both temperatures, and the operator's breathing can significantly affect the wet bulb temperature. Therefore, always note the wet bulb reading first when taking readings in pairs.

A.4 Expression of results

A.4.1 Conversion formula

If the instrument does not give relative humidity as a direct reading, convert the average dry bulb temperature and the average wet bulb temperature over each single 10 min period to relative humidity using the formula given below or by using tables or charts based on this formula.

Relative humidity expressed as a percentage is given by

$$\frac{100p}{p_W(t)}$$

where

$$p = p_W(t_W) - A p_T(t - t_W)$$

$p_W(t_W)$ is the saturation vapour pressure of water at the wet bulb temperature;

$p_W(t)$ is the saturation partial pressure of water vapour at the dry bulb temperature;

p_T is the atmospheric pressure (all pressures expressed in the same units);

t is the dry bulb temperature, in degrees Celsius;

t_W is the wet bulb temperature, in degrees Celsius;

A is the psychrometric coefficient in reciprocal kelvins.

NOTE 9 The atmospheric pressure p is an important modifier of the psychrometric coefficient. Normal fluctuations at altitudes close to sea level are too small to affect the result significantly but at high altitudes the effect of atmospheric pressure may have to be taken into account.

The value of A is dependent on the design of the psychrometer used and on the atmospheric temperature, and varies from $6{,}5 \times 10^{-4}$ K^{-1} to $6{,}9 \times 10^{-4}$ K^{-1}. Ascertain the correct value of A for the particular design of psychrometer used and the nominal air temperature (mid-point of the specified range). Ensure that instruments which read directly in relative humidity are using the correct psychrometric coefficient for computation within the instrument. Such computations using the wet and dry bulb signals are usually based on a linear approximation equation developed from knowledge of the appropriate psychrometric coefficient for the instrument. If the psychrometric coefficient is known the accuracy of computation can be checked by comparing the relative humidity reading with that calculated from the above equation.

NOTE 10 A useful reference [4] for information on the determination of the psychrometric coefficient is listed in annex C.

Linear approximation equations may also be used to construct psychrometric tables and charts, assuming a linear relationship between dry bulb temperature, wet bulb temperature and relative humidity over a small range of temperature (about 6 °C). Such tables and charts are valid for the particular design of instrument at temperatures close to the standard temperature and at atmospheric pressures close to normal. In practice, this is a convenient and widely used means of estimating relative humidity for instruments which are not direct reading.

All psychrometric instruments must be checked periodically (at about five-yearly intervals) by a competent laboratory to verify non-temperature measurement aspects such as the appropriateness of the psychrometric coefficient used for construction of charts or tables or in computing the humidity value, the mounting of thermometers, the condition of radiation shields, the air speed, etc. Temperature measuring devices must be calibrated more frequently in-house, with single point checks preferably at intervals not exceeding one month, and the condition of wicks should be monitored continuously.

A.4.2 Test results

The average dry bulb temperature and the average relative humidity over a 10 min period constitute a test result and the values for each 10 min period constitute a separate test result.