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Plastics — Standard atmospheres for conditioning and testing

Plastiques — Atmosphères normales de conditionnement et d'essai

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Contents

Page

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 291 was prepared by Technical Committee ISO/TC 61, *Plastics*, Subcommittee SC 6, *Ageing, chemical and environmental resistance*.

This fourth edition cancels and replaces the third edition (ISO 291:2005), of which it constitutes a minor revision. The main changes are as follows:

— in Table 1, the way in which the two standard atmospheres are used is now described in terms of non-tropical and tropical countries;

— a second note, concerning the unacceptability of wider tolerances on temperature and relative humidity, has been added at the end of Clause 6.

Plastics — Standard atmospheres for conditioning and testing

1 Scope

This International Standard sets out specifications relating to the conditioning and testing of all plastics and all types of test specimen at constant atmospheric conditions.

Special atmospheres applicable to a particular test or material or simulating a particular climatic environment are not included in this International Standard.

2 Normative references

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

ISO 62, *Plastics — Determination of water absorption*

3 Terms and definitions

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

3.1
standard atmosphere
preferred constant atmosphere for which specific air temperature and humidity values, as well as limit ranges for atmospheric pressure and air-circulation velocity, are specified, the air not having any significant additional constituents and the atmosphere not being subject to any significant additional radiation influences

NOTE 1 Standard atmospheres permit a defined state to be attained and maintained for samples or specimens.

NOTE 2 Standard atmospheres correspond to the average atmospheric conditions in laboratories and can be established in conditioning (controlled atmosphere) cabinets, chambers or rooms.

3.2
conditioning atmosphere
constant atmosphere in which a sample or test specimen is kept before being subjected to a test

3.3
test atmosphere
constant atmosphere to which a sample or test specimen is exposed throughout a test

3.4
conditioning
one or more operations intended to bring a sample or test specimen into a state of equilibrium with regard to temperature and humidity

3.5
conditioning procedure
combination of the conditioning atmosphere and the period of conditioning

3.6
ambient temperature
environmental conditions corresponding to the usual atmospheric conditions in laboratories with uncontrolled temperature and humidity

NOTE The phrase “at ambient temperature” refers to an environment the air temperature of which lies within a specified range, no consideration being given to relative humidity, atmospheric pressure or air-circulation velocity. In general, the air-temperature range extends from 18 °C to 28 °C and is stated as “at an ambient temperature of 18 °C to 28 °C”.

4 Principle

If a test specimen is exposed to a specific conditioning atmosphere or temperature, then a reproducible state of temperature and/or of moisture equilibrium is reached between the test specimen and the conditioning atmosphere or temperature.

It is not the intent of this International Standard to define procedures specifying how to determine sensitivity to moisture.

Some materials may have special conditioning requirements. Follow the relevant International Standards.

5 Standard atmosphere

Unless otherwise specified, use one of the sets of conditions given in Table 1 as the standard atmosphere.

Table 1 — Standard atmospheres

Symbol for standard atmosphere	Air temperature °C	Relative humidity (RH) %	Remarks [a]
23/50	23	50	For non-tropical countries
27/65	27	65	For tropical countries
[a] When obtaining comparative data on polymers, e.g. for databases, standard atmosphere 23/50 shall be used.			

NOTE The values in Table 1 apply to normal altitudes with an atmospheric pressure between 86 kPa and 106 kPa and an air-circulation velocity $\leqslant$ 1 m/s.

6 Classes of standard atmosphere

Table 2 gives the different classes of standard atmosphere corresponding to different tolerance levels for the temperature and relative humidity. The tolerances given in Table 2 apply to the specimen-storage space in a test enclosure or conditioning enclosure. Class 1 cabinets will require more frequent calibration. Follow the manufacturer’s recommendations for calibration. Cabinets shall be calibrated at least once per year.

Table 2 — Standard atmosphere classes corresponding to different permitted deviations

Class	Permitted deviations in temperature °C	Permitted deviations in relative humidity (RH) %	
		23/50	27/65
1	± 1	± 5	± 5
2	± 2	± 10	± 10

NOTE 1 Usually, the tolerances are coupled in pairs, i.e. class 1 tolerance for both temperature and relative humidity or class 2 tolerance for both.

NOTE 2 Atmospheres with broader tolerances on temperature and relative humidity cannot be considered as constant atmospheres.

7 Standard and ambient temperatures

If humidity has no influence or only a negligible influence on the properties being examined, the relative humidity does not have to be controlled. The corresponding environments are designated “temperature 23” and “temperature 27”, respectively.

Similarly, if neither temperature nor humidity has any noticeable influence on the properties being examined, neither the temperature nor the relative humidity has to be controlled. In this case, the atmospheric condition is termed the “ambient temperature”.

8 Procedure

8.1 Conditioning

The period of conditioning shall be as stated in the relevant specifications for the material.

When the conditioning periods are not stated in the applicable standard, the following shall be adopted:

a) unless otherwise specified, a minimum of 88 h for atmospheres 23/50 and 27/65;

b) unless otherwise specified, a minimum of 4 h for temperatures of 18 °C to 28 °C.

NOTE 1 The length of time necessary for a plastics material to come to humidity equilibrium is in general much longer than the length of time necessary for it to come to temperature equilibrium.

NOTE 2 Samples conditioned in accordance with a) may not reach humidity equilibrium. A sufficient equilibrium is reached after conditioning longer than the time t_{70} as defined in ISO 62. t_{70} depends on the square of the thickness. More information about the time needed to reach equilibrium can be found in Annex A.

NOTE 3 For particular tests and for plastics or test specimens that are known to reach temperature and humidity equilibrium either very rapidly or very slowly, a shorter or longer time may be specified for the conditioning period in the appropriate International Standard (see Annex A).

8.2 Testing

Unless otherwise specified, specimens shall be tested in the same atmosphere or at the same temperature in which they have been conditioned. In all cases, the test shall be carried out immediately after the removal of the specimens from the conditioning enclosure.

Annex A
(normative)

Attainment of moisture equilibrium by plastics in a conditioning atmosphere

The amount of moisture absorbed by a test specimen conditioned in an atmosphere and the rate of moisture absorption or desorption vary significantly depending on the nature and the shape of the material of which the specimen is made.

The conditioning times given in 8.1 may not be satisfactory, especially in the following cases:

— specimen materials and specimen thicknesses that are known to reach equilibrium with their conditioning atmosphere only after a long period of time (for example, certain polyamides and thicknesses over 2 mm, see ISO 62);

— unfamiliar materials, for which neither the capacity for absorbing moisture nor the time required to reach equilibrium can be estimated beforehand.

In these cases, use one of the following procedures:

a) Dry the material at an elevated temperature that will not significantly or permanently change the material (for many materials, a temperature of 50 °C ± 2 °C is acceptable). Allow the specimens at least 2 h to cool to the test temperature in a desiccator. State in the test report that the conditioning did not conform to ISO 291 but was a recommended alternative for special cases.

b) Condition the specimens in atmosphere 23/50 or 27/65 until equilibrium has, to all intents and purposes, been reached. A sufficient time is the time t_{70} at which 70 % of the water content at saturation is reached, as defined in ISO 62. If the time t_{70} as defined in ISO 62 corresponds to a specimen of thickness d_0, calculate the conditioning time t'_{70} necessary for specimens of other thicknesses using Equation (A.1):

$$t'_{70} = t_{70} \times \frac{d^2}{{d_0}^2} \tag{A.1}$$

where

t'_{70} is the conditioning time necessary;

t_{70} is the time taken for moisture equilibrium to be reached, determined in accordance with ISO 62, with specimens of thickness d_0;

d is the thickness of the specimens to be conditioned in accordance with this International Standard.

Mention this in the test report.

c) Keep the specimens in a circulating-air oven or conditioning enclosure at a prescribed elevated temperature and defined humidity (preferred are 50 % RH or 65 % RH) until moisture equilibrium has, to all intents and purposes, been reached (the temperature and relative humidity used shall be agreed upon by all interested parties and shall be included in the test report).

Procedure a) has the disadvantage that the values of certain properties, in particular mechanical properties, are different in the dry state from those obtained after conditioning in atmosphere 23/50 or 27/65. It is for this reason that this conditioning procedure does not conform to ISO 291 but is a recommended alternative.

In the case of procedure b), the following rule of thumb may be useful: equilibrium can be assumed to have been reached if two weighings made at an interval of d^2 weeks differ by only 0,1 % (d being the thickness, in millimetres, of the specimen).

Procedure c) is used when the moisture diffusion characteristics of the polymer are known and can be used to determine appropriate exposure periods and conditions. The specimens shall be kept in the oven or conditioning enclosure until they are, to all intents and purposes, in a state of moisture equilibrium. This may be assumed to be the case when the average moisture content of the material changes by less than 0,01 % during a conditioning period of at least 1 day, determined by loss in mass as specified in ISO 62.

If the moisture diffusion coefficient D is known, the time necessary for moisture equilibrium to effectively be reached is determined using Equation (A.2) or taken as 1 day, whichever is the longer.

$$t_{70} = \frac{d^2}{\pi^2 \times D} \tag{A.2}$$

where

t_{70} is the time taken for moisture equilibrium to effectively be reached (see ISO 62);

d is the specimen thickness, in millimetres (mm);

D is the moisture diffusion coefficient, in mm^2/s.

Annex B
(informative)

Background information

B.1 General

A previous edition of this International Standard, ISO 291:1977, was based on ISO 554:1976, *Standard atmospheres for conditioning and/or testing — Specifications*, prepared by ISO/TC 125.

ISO 291:1977 did not represent the state of the art, and some terms used in it were out of date, e.g.

— there were terms for environments with uncontrolled humidity, e.g. “atmosphere 23”, which could be confused with “atmosphere 23/50” (with controlled humidity);

— the tolerances on temperature and relative humidity included only deviations with respect to time;

— the tolerances on relative humidity were below the theoretically possible values, e.g. the relative humidity tolerance of ± 5 % for class 2 atmospheres without additional limitations (concerning the time constant of the hygrometer, for instance) made no physical sense.

B.2 New tolerances on relative humidity

The broader tolerances given in the editions of ISO 291 since 1997 include deviations with respect to time *and* with respect to the position of the specimen in the enclosure.

The tolerances on the humidity specified in Table 2 are based on the minimum tolerances that can theoretically be achieved with the given temperature tolerances, assuming that the permitted deviation for the dew point is zero, and are broader than the tolerances given in ISO 291:1977.

The tolerance on the relative humidity ΔU is given by Equation (B.1)[1],[2]:

$$\Delta U = k_A \times \Delta\theta + k_D \times \Delta\theta_D \qquad \text{(B.1)}$$

where

$\Delta\theta$ is the tolerance on the air temperature;

$\Delta\theta_D$ is the tolerance on the dew point;

k_A is a coefficient depending on the air temperature;

k_D is a coefficient depending on the dew point.

EXAMPLES

Tolerances on the relative humidity when $\Delta\theta_D$ = 0,0 °C:

— atmosphere 23/50, class 2 ($\Delta\theta$ = 2,0 °C):

$$\Delta U = 3{,}03 \times 2{,}0\ \%\ \text{RH} + 3{,}30 \times 0{,}0\ \%\ \text{RH} = \pm 6{,}06\ \%\ \text{RH}$$

— atmosphere 27/65, class 1 ($\Delta\theta$ = 1,0 °C):

$$\Delta U = 3{,}82 \times 1{,}0\ \%\ \text{RH} + 3{,}76 \times 0{,}0\ \%\ \text{RH} = \pm 3{,}82\ \%\ \text{RH}$$

Therefore, from a practical point of view, the relative-humidity tolerance for class 2 atmospheres is given by ± 10 % RH (and for class 1 atmospheres ± 5 % RH), including real tolerances on dew points and allowance for the usual errors and drift in control equipment and hygrometers.

Bibliography

[1] STRÖMSDÖRFER, G. Realistische Umweltsimulation, *F&M — Zeitschrift für Elektronik, Optik und Mikrosystemtechnik*, Carl Hanser Verlag, Munich, **103** (1995), 11-12, pp. 713-716

[2] Annex B of ISO 187:1990, *Paper, board and pulps — Standard atmosphere for conditioning and testing and procedure for monitoring the atmosphere and conditioning of samples*

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