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Plastics — Standard atmospheres for conditioning and testing

Plastiques — Atmosphères normales de conditionnement et d'essai

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Foreword

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

This second edition cancels and replaces the first edition (ISO 291:1977), which has been technically revised.

Annex A forms an integral part of this International Standard. Annex B is for information only.

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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 specimens at constant atmospheric conditions which correspond to the average atmospheric conditions in laboratories.

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

2 Definitions

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

2.1 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.

2.2 conditioning atmosphere
Constant atmosphere in which a sample or test specimen is kept before being subjected to test.

2.3 test atmosphere
Constant atmosphere to which a sample or test specimen is exposed throughout the test.

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

2.5 conditioning procedure
Combination of the conditioning atmosphere and the period of conditioning.

NOTE 3: In this standard the conditioning atmosphere and the test atmosphere are usually selected as the standard atmosphere.

2.6 ambient temperature
Environmental conditions corresponding to the usual atmospheric conditions in laboratories with uncontrolled temperature and humidity.

3 Principle

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

4 Standard atmospheres

Unless otherwise specified, use the conditions given in table 1 as the standard atmosphere.

Table 1 – Standard atmospheres

Symbol for standard atmosphere	Air temperature t °C	Relative humidity U %	Remarks
23/50	23	50	Shall be used unless otherwise specified
27/65	27	65	May be used for tropical countries if agreed on by all parties

NOTE 4: The values in table 1 apply to normal altitudes with an atmospheric pressure between 86 kPa and 106 kPa and an air-circulation velocity $\geqslant$ 1 m/s.

5 Classes of standard atmosphere

Table 2 gives two 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-stowage space in a test enclosure or conditioning enclosure and include deviations both with respect to time and with respect to the position of the test specimen in the enclosure.

Table 2 – Standard atmosphere classes corresponding to different permitted deviations

Class	Permitted deviation in temperature Δt °C	Permitted deviation in relative humidity ΔU %	
		23/50	27/65
1	±1	±5	±5
2	±2	±10	±10

NOTE 5: Usually, the tolerances are coupled in pairs, i.e. class 1 tolerance for both temperature and relative humidity or class 2 tolerance for both.

6 Standard and ambient temperatures

If humidity has no influence or 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".

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 shall be stated as "at an ambient temperature of 18 °C to 28 °C".

7 Procedure

7.1 Conditioning

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

When the periods are not stated in the appropriate International Standard, the following shall be adopted:

a) a minimum of 88 h for atmospheres 23/50 and 27/65;
b) a minimum of 4 h for ambient temperatures of 18 °C to 28 °C.

NOTE 6: 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).

7.2 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 7.1 may not be satisfactory, especially in the following cases:

- materials that are known to reach equilibrium with their conditioning atmosphere only after a long period of time (for example, certain polyamides);

- 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);

b) condition the specimens in atmosphere 23/50 until equilibrium has been reached;

c) maintain the specimens in an circulating-air oven or conditioning enclosure at a prescribed elevated temperature until moisture equilibrium has 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 certain property values, in particular mechanical ones, are different in the dry state from those obtained after conditioning in atmosphere 23/50.

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 in a state of moisture equilibrium. This will be the case when the average moisture content of the material changes by less than 0,01 % during the conditioning period. Use the following criterion to estimate time to reach moisture equilibrium:

If the moisture diffusion coefficient, D_z, is known, the time to reach moisture equilibrium shall be taken as $0{,}02\ d^2/D_z t$, or 1 day, whichever is the greater (d being the thickness of the specimen, in millimetres, and t the conditioning time, in seconds).

Annex B

(informative)

Background information

B.1 General

The 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 any additional limitations (concerning the time constant of the hygrometer, for instance) made no physical sense.

B.2 New tolerances on relative humidity

In this edition of ISO 291, the broader tolerances given 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 take into consideration the fact that the minimum tolerances that can be achieved theoretically with the given temperature tolerances (i.e. if the permitted deviation for the dew point is ±0,0 °C) are broader than the tolerances given in ISO 291:1977.

The tolerance on the relative humidity is given by $\Delta U = k_t \times \Delta t + k_{td} \times \Delta t_d$ [1)2)]

where

Δt is the tolerance on the air temperature;
Δt_d is the tolerance on the dew point;
k_t is a coefficient depending on the air temperature;
k_{td} is a coefficient depending on the dew point.

Examples:

Tolerances on the relative humidity when Δt_d = 0,0 °C:
- atmosphere 23/50, class 2: $\Delta U = 3{,}03 \times 2{,}0 + 3{,}30 \times 0{,}0 = 6{,}06$ %
- atmosphere 27/65, class 1: $\Delta U = 3{,}82 \times 1{,}0 + 3{,}76 \times 0{,}0 = 3{,}82$ %

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[1] Strömsdörfer, G., Variations of air temperature and relative humidity, GUS-Jahrestagung Pfinztal, Germany, 1995

[2] ISO 187: 1990, Annex B based on CRC Handbook of Chemistry and Physics

Therefore, from a practical point of view, the relative humidity tolerance for class 2 atmospheres is given by ±10 % (and for class 1 atmospheres: ±5 %), including

- real tolerances on dew points
and
- allowance for the usual errors and drift in control equipment and hygrometers.