

ISO

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION

ISO RECOMMENDATION

R 483

PLASTICS

METHODS FOR MAINTAINING CONSTANT
RELATIVE HUMIDITY IN SMALL ENCLOSURES
BY MEANS OF AQUEOUS SOLUTIONS

1st EDITION

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BRIEF HISTORY

The ISO Recommendation R 483, *Plastics — Methods for Maintaining Constant Relative Humidity in Small Enclosures by Means of Aqueous Solutions*, was drawn up by Technical Committee ISO/TC 61, *Plastics*, the Secretariat of which is held by the American Standards Association, Inc. (ASA).

Work on this question by the Technical Committee began in 1958 and led, in 1962, to the adoption of a Draft ISO Recommendation.

In July 1963, this Draft ISO Recommendation (No. 597) was circulated to all the ISO Member Bodies for enquiry. It was approved by the following Member Bodies:

Argentina	Germany	New Zealand
Australia	Hungary	Poland
Austria	India	Portugal
Belgium	Israel	Romania
Canada	Italy	Sweden
Colombia	Japan	Switzerland
Czechoslovakia	Korea, Rep. of	U.S.A.
Finland	Netherlands	U.S.S.R.

Two Member Bodies opposed the approval of the Draft:

France
United Kingdom

The Draft ISO Recommendation was then submitted by correspondence to the ISO Council which decided, in April 1966, to accept it as an ISO RECOMMENDATION.

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PLASTICS

METHODS FOR MAINTAINING CONSTANT RELATIVE HUMIDITY
IN SMALL ENCLOSURES BY MEANS OF AQUEOUS SOLUTIONS

1. SCOPE

- 1.1 This ISO Recommendation establishes methods for obtaining atmospheres of constant relative humidity in small enclosures using aqueous salt solutions or glycerol-water mixtures. Chambers large enough to accommodate personnel or enclosures requiring frequent opening to ambient atmosphere are specifically excluded from the scope of these methods.
- 1.2 Techniques for obtaining relative humidities at the temperatures specified in ISO Recommendation R 291 — *Plastics — Standard Atmospheres for Conditioning and Testing*, are described.
- 1.3 Information is given and reference is made to a bibliography (page 11) concerning the methods of producing desired humidities in these enclosures at temperatures from 5 to 60 °C.
- 1.4 The procedures described are intended for conditioning small quantities of plastics materials prior to test and for such tests as may be carried out entirely within a small enclosure, e.g., electrical tests.

2. DEFINITIONS

- 2.1 *Relative humidity*. Ratio of the actual pressure of water vapour existing in the atmosphere to the maximum possible (saturation) pressure of water vapour in the atmosphere at the same temperature, expressed as a percentage.
- 2.2 *Dew point*. Temperature to which water vapour should be reduced to obtain saturation vapour pressure, that is, 100 per cent relative humidity.

NOTE. — These definitions should be considered as tentative. Any decision reached by ISO/ATCO* deviating from this wording will be valid.

3. APPARATUS

The apparatus consists of the following:

- 3.1 **A suitable container** for volumes less than 14 dm³.
Container of simple shape which is easily cleaned and inert with regard to the saturated solutions which are used; the temperature should be kept constant and uniform at all points by placing it in an oven, a water bath or a laboratory conditioned at constant temperature (see 3.2.2).

Air circulation is generally recommended, particularly when hygroscopic materials are being tested. A fan whose blades are located just above the aqueous solution should preferably be used.

* Co-ordinating Committee on Atmospheric Conditioning for Testing.

However, if the enclosure is intended only for conditioning practically nonabsorbent products or for conditioning over a long enough time in relation to the water absorption capacities of the specimens that are placed there, air circulation need not be installed.

Without air circulation, the height of the container should not exceed the smallest dimension of the free surface of the solution. In containers with air circulation, this height may reach 1.5 times the smallest dimension of this free surface.

3.2 A conditioning enclosure for volumes exceeding 14 dm³.

Conditioning enclosure constructed on the inside from material nonabsorbent and inert with regard to the saturated solutions which are used, and thermally insulated on the outside. It is fitted with thermostatic control of temperature and a fan for forced circulation of air through the enclosure and past a tray of saturated salt solution. Cooling coils may be fitted, if required, but their temperature should not be below the dew point.

3.2.1 The temperature should be kept constant in accordance with the tolerances required by specifications on the temperature itself, or according to the tolerances on this temperature determined by the tolerances on the relative humidity, whichever is the closer. The free surface of the solution should always be as large as possible. A means of measuring temperature should be provided, as well as means of measuring relative humidity, such as wet and dry bulb thermometers. If wet and dry bulb thermometers are used, the air should circulate around them at not less than 3 m/s.

3.2.2 Temperature variations and fluctuations should usually be controlled to $\pm 0.5^\circ\text{C}$ or better since, without any change in the moisture content of the air, differences in air temperature from point to point in the working space will produce differences in relative humidity. The relative humidity will be low at points where the temperature is high, and it will be high at points where the temperature is low.

For example, for the standard test atmospheres,* a difference of 0.5°C causes a difference of nearly 2 per cent relative humidity. At 90 per cent relative humidity, the corresponding difference is approximately 3 per cent. Fluctuations with time in the temperature at a given point will tend to produce a similar effect. If the fluctuations are slow, the changes in relative humidity will be reduced by the action of the solutions.

3.3 A refractometer

Refractometer which covers the range of 1.330 to 1.470 with an accuracy of ± 0.001 , for use only with glycerol solutions.

4. CHEMICAL REAGENTS

4.1 *Glycerol*, industrial grade.

4.2 *Salts*, as required, of industrial grade.

4.3 *Distilled water*.

* See ISO Recommendation R 291.

5. PROCEDURE

- 5.1** The duration of conditioning indicated in specifications for the material is counted, or testing started, only from the time at which the enclosure has regained the specified conditions after the introduction of the specimens.
- 5.2** Overload in a small enclosure can lower the rate of establishing the humidity in the tray so that it may be necessary to wait a very long time for the specified conditions to be reached. In view of the fact that the load limit depends on the conditioned material's water absorption capacity and its moisture content, this limit cannot be specified.

In enclosures without air circulation and with specimens having a high ratio of $\frac{\text{volume}}{\text{surface area}}$ ($\frac{v}{s}$), the total surface areas of the specimens, should not exceed the surface area of the solution. For small values of $\frac{\text{volume}}{\text{surface area}}$ (film), the total surface area may be up to three times the surface area of the solution.

In enclosures with air circulation, the total surface area of specimens can be three times or more the area recommended for enclosures without air circulation, depending on the efficiency of the equipment.

5.3 Method A: Saturated salt solutions

The atmosphere over saturated salt solutions at constant temperature is maintained at definite relative humidities. This method is preferred whenever there is a salt whose saturated aqueous solution produces the desired relative humidity at the given temperature (see Table 3, page 10).

An excess of solid salt should be left in contact with the solution throughout the entire duration of conditioning or testing.

The enclosures should be cleaned frequently between the times they are used in order to remove salt deposits (creeping salts) outside the tray employed for holding the solution.

5.4 Method B: Glycerol solution

This method requires more attention than the preceding one, the concentration of the glycerol-water mixture having to be maintained practically constant. With materials which absorb a large amount of water, if the load in the enclosure is too large in relation to the amount of solution used, significant changes in the concentration may occur.

The concentration of glycerol solutions expressed as a value corresponding to the index of refraction at 25 °C is connected to the desired relative humidity and temperature, and may be calculated between 0 and 60 °C, by the following formula:

$$(R_1 + A)^2 = (100 + A)^2 + A^2 - (H + A)^2$$

$$R_1 = 715.3 (R - 1.3333)$$

where $A = 25.60 - 0.1950 T + 0.0008 T^2$

H = relative humidity, per cent

R = index of refraction of the glycerol solution

T = temperature of the solution in degrees Celsius.

This formula makes it possible to calculate the desired relative humidity with an accuracy of ± 0.2 per cent at a temperature of 25 °C.

The index of refraction of the solution is regularly checked with the refractometer indicated in clause 3.3 and in any case before and after each test or conditioning.

About 0.1 per cent by mass of copper sulphate is added to glycerol solutions to prevent fungus growth in the solution.

6. TOLERANCES

For obtaining standard atmospheres as defined in ISO Recommendation R 291, normal or closer tolerances may be required.

6.1 Normal tolerances

TABLE 1. — Normal tolerances

Temperature °C	Relative humidity per cent	Suitable salt	Index of refraction ($n_D^{25\text{ °C}}$) of glycerol solutions
20±2	65±5	Sodium nitrite	1.426±0.007
23±2	50±5	Sodium dichromate	1.444±0.005
27±2	65±5	Sodium nitrite	1.426±0.007

6.2 Close tolerances

TABLE 2. — Close tolerances

Temperature °C	Relative humidity per cent	Suitable salt	Index of refraction ($n_D^{25\text{ °C}}$) of glycerol solutions
20±1	65±2	Sodium nitrite	1.426±0.003
23±1	50±2	*	1.444±0.002
27±1	65±2	Sodium nitrite	1.426±0.003

* There appears to be no salt suitable for giving a relative humidity within the limits 50 ± 2 per cent.

NOTE. — In general, the permissible temperature variation in the oven is less than the tolerance given in column 1, if the relative humidity is to be maintained within the limits given in column 2.

ANNEX A

IMPORTANT FEATURES OF TYPICAL CONDITIONED ENCLOSURES
WITH VOLUMES EXCEEDING 14 dm³

The apparatus consists of an enclosure, usually rectangular, constructed from inert and non-absorbent material so fabricated that any joints are leakproof and not subject to corrosion. The interior surfaces should be easy to clean.

The portion of the enclosure, carrying the door which should have a double glazed observation window, and the door itself, should be rigid to withstand sufficient pressure to give an efficient seal when the door is closed. A sealing gasket should be provided which can easily be replaced when necessary.

The salt tray in the bottom of the enclosure should be made of impermeable material which does not craze and is unaffected by any saturated salt solution to be used. The area is made as large as possible to obtain the maximum rate of moisture transfer and the tray is readily washed completely free from solution, when necessary.

A suitable fan and air ducts should provide adequate air circulation over the surface of the salt solution and to all parts of the working space. If wet and dry bulb thermometers are used for measuring temperature and relative humidity, the air velocity at this point should not be less than 3 m/s.

It is recommended that the fan be switched off automatically when the door is opened.

Provision should be made for connections, such as leads used for electrical tests. Efficient seals should be provided at the entry points of such leads as well as of thermometers, fan shaft and so on.

Heating elements controlled by a thermostat and cooling tubes for water or other cooling agent should be provided. The enclosure should be thermally insulated from the external atmosphere.

Condensation should not occur on any surface exposed to the air stream inside the enclosure.

In one type of apparatus, the temperature is controlled by a thermostat in the air stream.

In another type of apparatus, the temperature is controlled by a thermostat in a water jacket surrounding the enclosure.