International Standard 1663

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Cellular plastics — Determination of water vapour transmission rate of rigid materials

Plastiques alvéolaires — Détermination du taux de transmission de la vapeur d'eau des matériaux rigides

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards institutes (ISO member bodies). The work of developing International Standards is carried out through ISO technical committees. Every member body interested in a subject for which a technical committee has been set up 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.

Draft International Standards adopted by the technical committees are circulated to the member bodies for approval before their acceptance as International Standards by the ISO Council.

International Standard ISO 1663 was developed by Technical Committee ISO/TC 61, *Plastics*, and was circulated to the member bodies in April 1980.

It has been approved by the member bodies of the following countries :

Australia	India	Romania
Belgium	Ireland	South Africa, Rep. of
Brazil	Israel	Spain
Canada	Italy	Sweden
Czechoslovakia	Japan	Switzerland
Egypt, Arab Rep. of	Korea, Rep. of	United Kingdom
Finland	Netherlands	USA
Germany, F. R.	Philippines	USSR
Hungary	Poland	

The member body of the following country expressed disapproval of the document on technical grounds :

France

This International Standard cancels and replaces ISO Recommendation R 1663-1970, of which it constitutes a technical revision.

Printed in Switzerland

Cellular plastics — Determination of water vapour transmission rate of rigid materials

1 Scope and field of application

This International Standard specifies a method for determining the water vapour transmission rate, water vapour permeance and water vapour permeability of rigid cellular plastics.

The scope of this method provides for the testing of rigid cellular materials that have thicknesses from 3 mm to 80 mm and which may, as an integral part of the material, contain natural skins or adhered facings of some different material.

The results obtained by this method are suitable for design purposes, production control and as a basis for establishing or determining conformance to product specifications.

2 References

ISO 291, *Plastics — Standard atmospheres for conditioning and testing.*

ISO/R 483, *Plastics — Methods for maintaining constant relative humidity in small enclosures by means of aqueous solutions.*

ISO 1923, *Cellular plastics and rubber — Determination of linear dimensions.*

3 Definitions

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

3.1 water vapour transmission rate : The quantity of water vapour transmitted per unit time through unit area of material under specified conditions of temperature, humidity and thickness.

In this International Standard it is expressed in micrograms per square metre per second [μg/(m^2·s)].

3.2 water vapour permeance : The quotient of the water vapour transmission rate of the material divided by the vapour pressure difference between the two specimen faces during the test.

In this International Standard it is expressed in nanograms per pascal of vapour pressure difference per second per square metre [ng/(Pa·s·m^2)].

3.3 water vapour permeability : The product of the permeance and thickness. The water vapour permeability of a homogeneous material is a property of the material. It is the quantity of water vapour transmitted per unit of time through a given area of the material per unit of vapour pressure difference between its faces for a unit thickness.

In this International Standard it is expressed in nanograms per pascal of vapour pressure difference per second per metre [ng/(Pa·s·m)].

4 Principle

A test specimen is hermetically sealed to the open mouth of a test dish containing a desiccant. The assembly is placed in an atmosphere, the temperature and humidity of which are controlled. Periodic weighings of the assembly are made to determine the rate of water vapour transmission through the specimen into the desiccant.

5 Apparatus and materials

5.1 Beakers or **dishes,** of capacity 250 ml minimum, low form, of non-corroding material and impermeable to water and water vapour.

5.2 Measuring instruments, complying with the requirements of ISO 1923.

5.3 Circular metal template, of sufficient diameter to duplicate the area of the specimen being used to the nearest 0,1 cm^2.

5.4 Pot or **dish** for melting the sealant (5.8).

5.5 Analytical balance, capable of weighing specimen-mounted beakers or dishes with an accuracy of 1 mg.

5.6 Equipment, for providing constant temperature or humidity.

5.6.1 Constant-temperature, constant-humidity chamber or **room** capable of being maintained within ± 2 % of the required relative humidity and within ± 1 °C of the required temperature.

Alternatively :

5.6.2 Desiccator, in which the required humidity can be produced. This desiccator shall be able to hold at least five beakers with their test specimens and be placed in a constant-temperature chamber. ISO/R 483 is a guide for the choice of the desiccator. The solution for use in the desiccator shall be one of the following :

a) for testing at 38 °C and a relative humidity gradient of 0 to 88,5 % : potassium nitrate solution, saturated at 38 °C, which contains a large excess of undissolved potassium nitrate;

b) for testing at 23 °C and a relative humidity gradient of 0 to 85 % : potassium chloride solution, saturated at 23 °C, which contains a large excess of undissolved potassium chloride;

c) for testing at 23 °C and a relative humidity gradient of 0 to 50 % : sodium dichromate dihydrate solution, saturated at 23 °C, which contains a large excess of undissolved sodium dichromate dihydrate.

5.7 Desiccator, containing anhydrous calcium chloride and large enough to hold five beakers or dishes (5.1) for the purpose of sample transfers.

NOTE — This piece of equipment is not necessary if the test and the weighings are to be carried out in a constant- temperature and humidity room set at the required conditions.

5.8 Sealant, unaffected by test conditions. The following are examples of suitable sealants :

a) a mixture of 90 % microcrystalline wax and 10 % of a plasticizer — for example low relative molecular weight polyisobutylene;

b) 60 % microcrystalline wax with 40 % refined crystalline paraffin wax.

5.9 Anhydrous calcium chloride desiccant, particles about 5 mm in diameter, free of fines that will pass a No. 30 (nominal aperture size 600 µm) sieve.

6 Sample

The sample shall be representative of the material. The sample may, as an integral part of the material, contain natural skins or adhered facings of some different material.

7 Test specimens

7.1 Dimensions

Each test specimen shall be in the form of a cylinder, with a diameter cut to fit exactly (push fit) the beaker or dish (5.1) which is used. The thickness of the test specimen shall not be less than 3 mm nor greater than 80 mm. The minimum specimen exposure area shall be 32,0 cm^2. A groove may be cut in the edge of the test specimen to facilitate the escape of air when mounting the specimen in the beaker or dish.

7.2 Number

A minimum of five specimens shall be tested.

When the material to be tested is suspected of being anisotropic, the test specimens shall be cut such that the parallel faces are normal to the direction of vapour flow of the product in its intended use.

When the materials are faced with natural skins or adhered facings which are different for the two sides, the test specimens shall be tested with the vapour flow in the same direction as in the intended use. If the direction of intended use relative to the facings is not known, a duplicate set of specimens shall be prepared so that tests can be made and reported for each direction of vapour flow.

7.3 Conditioning

The test specimens shall be conditioned in one of the atmospheres specified in ISO 291.

8 Test conditions

Three different temperature and humidity conditions are provided as follows :

a) 38 °C and a relative humidity gradient of 0 to 88,5 %;

b) 23 °C and a relative humidity gradient of 0 to 85 %;

c) 23 °C and a relative humidity gradient of 0 to 50 %.

Because the values obtained under one set of test conditions may differ from the values under a different set of conditions, the test conditions selected should be those most closely approaching the conditions of use.

The water vapour transmission rate and permeance values are specific to the specimen thickness tested; this thickness shall be stated in the test report. For homogeneous materials, the water vapour transmission rate and permeance are independent of the specimen thickness, enabling water vapour permeability to be calculated as a property of the material.

NOTE — Because the calcium chloride desiccant may become saturated rapidly when cellular plastics with open cells are tested, results above 3 000 $\mu g/(m^2 \cdot s)$ may not be valid.

9 Procedure

In accordance with ISO 1923, measure the average thickness of the test specimen at each quadrant to the nearest 0,1 mm and average the results.

Place a layer of anhydrous calcium chloride, of approximately 20 mm depth, in the bottom of each beaker or dish (5.1) (see the figure).

NOTE — In some cases it may be desirable to place a support made of dry material such as closed-cell cellular plastic in the bottom of the dish or beaker in order to bring the desiccant closer to the test specimen (see the figure).

Insert the test specimen into a beaker or dish. Place the metal template (5.3) centrally on the top surface of the test specimen and apply the melted sealant (5.8) along its circumference in order to give a complete seal between the test specimen and the wall of the beaker or dish and provide a well defined exposed area on top of the specimen. After the sealant has set, carefully remove the template. The figure illustrates a test assembly in a beaker.

Weigh, to the nearest 1 mg, each of the five beakers or dishes with test specimens mounted in position. Place the beakers either in a constant-temperature, constant-humidity chamber or room (5.6.1) maintained at the required test conditions, or in the desiccator (5.6.2) containing the recommended solution and placed in a constant-temperature chamber or room maintained at the required test temperature (38 ± 1 °C or 23 ± 1 °C respectively).

At intervals of approximately 24 h, quickly remove the beakers or dishes from the chamber or room (5.6.1) or the desiccator (5.6.2) and store them in the transfer desiccator (5.7) at room temperature for 30 ± 1 min; then weigh each specimen-mounted beaker or dish to the nearest 1 mg. After weighing, shake each beaker or dish assembly to mix the desiccant, then return the specimens to the chamber or room (5.6.1) or the desiccator (5.6.2) maintained at constant temperature.

NOTE — It is not necessary to place the beakers in the transfer desiccator (5.7) if the test and weighings are conducted in the same constant- temperature and humidity room.

Daily plot the observed mass against time and terminate the test when three consecutive points, excluding the initial weighing, lie on a straight line.

10 Expression of results

10.1 Water vapour transmission rate (WVT)

The water vapour transmission rate is given by the equation

$$\mathrm{WVT} = 11{,}57 \times \frac{\Delta m}{A} \times 10^4$$

where

WVT is the water vapour transmission rate, in micrograms per square metre per second;

Δm is the increase in mass, in grams, of the beaker and its contents per 24 h, determined from the linear part of the graph;

A is the exposed, sealant-free area, in square centimetres, of the test specimen, to the nearest 0,1 cm²;

11,57 is the conversion factor from grams per square metre per 24 h to micrograms per square metre per second;[1)]

10^4 is the conversion factor from square centimetres to square metres.

For samples having a water vapour transmission rate higher than 3 000 µg/(m²·s), the result shall be expressed as "greater than 3 000 µg/(m²·s)".

10.2 Permeance

Permeance is given by the formula

$$\frac{\mathrm{WVT}}{\Delta p} = \frac{\mathrm{WVT}}{S\,(R_1 - R_2)}$$

where

WVT is the water vapour transmission rate, in micrograms per square metre per second;

Δp is the vapour pressure difference between the specimen faces, in kilopascals;

S is the saturation vapour pressure at test temperature, in kilopascals;

R_1 is the relative humidity of the test chamber or room;

R_2 is the relative humidity in the beaker or dish.

NOTE — For condition 8 a), i.e. 38 °C/88,5 % relative humidity :

$\Delta p = S\,(R_1 - R_2) = 551$ kPa

For condition 8 b), i.e. 23 °C/85 % relative humidity :

$\Delta p = S\,(R_1 - R_2) = 239$ kPa

For condition 8 c), i.e. 23 °C/50 % relative humidity :

$\Delta p = S\,(R_1 - R_2) = 140$ kPa

Permeance is expressed by the formula in nanograms per pascal of vapour pressure difference per second per square metre [ng/(Pa·s·m²)].

1) 1 g/(m²·24 h) ≈ 11,57 µg/(m²·s)

1 µg/(m²·s) = 0,086 4 g/(m²·24 h)

10.3 Permeability

Permeability is expressed by the equation :

permeability = permeance × thickness

where

permeance is expressed in nanograms per pascal of vapour pressure difference per second per square metre [ng/(Pa·s·m^2)];

thickness is the specimen thickness, in metres, to the nearest 0,1 mm;

permeability is expressed by the equation in nanograms per pascal of vapour pressure difference per second per metre [ng/(Pa·s·m)].

11 Test report

The test report shall contain the following information :

a) reference to this International Standard;

b) identification and description of the material tested, including its thickness and the presence of any facings;

c) temperature and relative humidity gradient used for the determination;

d) conditioning used;

e) the water vapour transmission property [water vapour transmission rate (WVT), permeance or permeability] including the direction of the vapour flow relative to the facings, if the two facings are different, for which the results have been calculated; if desired, all three properties may be reported;

f) individual test results;

g) arithmetic mean of the five test results expressed to two significant figures;

h) any deviation from the method specified.

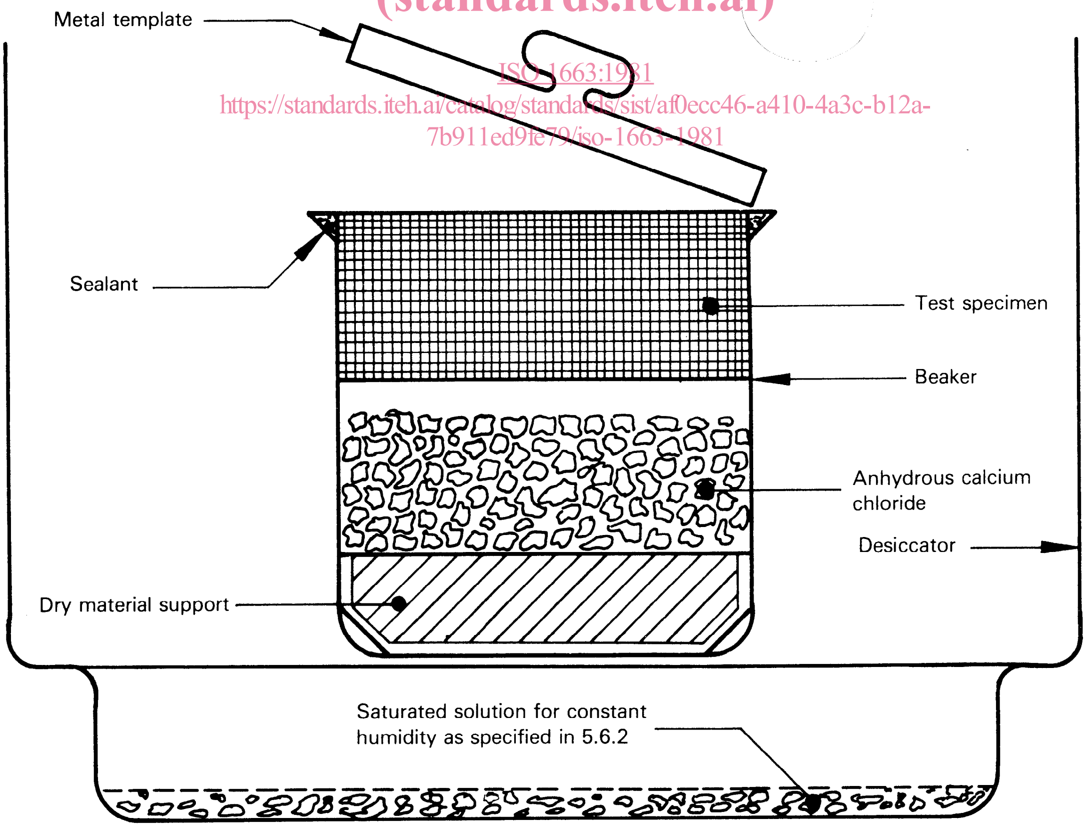

Figure — Example of mounted specimen in test beaker and constant-humidity desiccator

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