
**Rigid cellular plastics —
Determination of water vapour
transmission properties**

*Plastiques alvéolaires rigides — Détermination des propriétés de
transmission de la vapeur d'eau*

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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.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO document should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 61, *Plastics*, Subcommittee SC 10, *Cellular plastics*.

This fourth edition cancels and replaces the third edition (ISO 1663:2007), which has been technically revised.

The main changes are as follows:

- in the Scope ([Clause 1](#)):
 - the unit ng has been changed to µg;
 - the upper limit has been changed from 200 µg/(m²·s) to 1 400 µg/(m²·s);
- [Clause 9](#) has been modified as follows:
 - [9.2](#), "Blank specimen" has been added;
 - [9.3.2](#) "Corrections" has been added;
 - in [9.5](#), [Formula \(8\)](#) has been modified;
- in [Clause 11](#), a new item (k) has been added;
- [Formula \(B.8\)](#) has been modified.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Rigid cellular plastics — Determination of water vapour transmission properties

1 Scope

This document specifies a method of determining the water vapour transmission rate, water vapour permeance, water vapour permeability and water vapour diffusion resistance index for rigid cellular plastics.

This method is applicable for the testing of rigid cellular materials that have thicknesses from 10 mm upwards and can, as an integral part of the material, contain natural skins or adhered facings of some different material.

Three different sets of temperature and humidity conditions are provided, as follows:

- a) 38 °C and a relative-humidity gradient across the test specimen of 0 % to 88 %
- b) 23 °C and a relative-humidity gradient across the test specimen of 0 % to 85 %
- c) 23 °C and a relative-humidity gradient across the test specimen of 0 % to 50 %

The results obtained by this method are suitable for design purposes and production control, and for inclusion in product specifications.

The method is suitable for materials which have water vapour transmission rates in the range 3 µg/(m²·s) to 1 400 µg/(m²·s).

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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 291, *Plastics — Standard atmospheres for conditioning and testing*

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

3 Terms and definitions

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

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

- ISO Online browsing platform: available at <https://www.iso.org/obp>
- IEC Electropedia: available at <https://www.electropedia.org/>

3.1

water vapour transmission rate

quantity of water vapour transmitted through unit area of a test specimen in unit time under specified conditions of temperature, humidity, and thickness

Note 1 to entry: It is expressed in micrograms per square metre per second (µg·m⁻²·s⁻¹).

Note 2 to entry: The values obtained for the water vapour transmission rate are specific to the thickness of the test specimen.

3.2

water vapour permeance

ratio of the *water vapour transmission rate* (3.1) for a test specimen to the vapour pressure difference between the two specimen faces during the test

Note 1 to entry: It is expressed in nanograms per square metre per second per pascal ($\text{ng}\cdot\text{m}^{-2}\cdot\text{s}^{-1}\cdot\text{Pa}^{-1}$).

Note 2 to entry: Water vapour permeance values are specific to the thickness at which the specimen was tested.

3.3

water vapour permeability

numerical value of the product of permeance and thickness

Note 1 to entry: It is the quantity of water vapour transmitted per unit time through a given area of the material per unit vapour pressure difference between its faces for a unit thickness.

Note 2 to entry: It is expressed in nanograms per metre per second per pascal ($\text{ng}\cdot\text{m}^{-1}\cdot\text{s}^{-1}\cdot\text{Pa}^{-1}$).

Note 3 to entry: For homogeneous materials, values obtained for water vapour permeability are a property of the material.

3.4

water vapour diffusion resistance index

ratio of the *water vapour permeability* (3.4) of air to that of the material concerned

Note 1 to entry: It indicates how much less permeable the material is than an equally thick layer of stationary air at the same temperature.

Note 2 to entry: It is dimensionless.

Note 3 to entry: For homogeneous materials, values obtained for water vapour diffusion resistance index are a property of the material.

4 Principle

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

5 Apparatus and materials

5.1 Shallow circular open containers, made of a material impermeable to water vapour, such as glass or metal, of 65 mm minimum diameter and with tops slightly belled out to admit a wax seal. See [Annex A](#) for typical assemblies and [5.3](#) for assemblies requiring a template.

5.2 Measuring instruments, capable of determining linear dimensions in accordance with the requirements of ISO 1923.

5.3 Circular template (with edge tapered to facilitate removal after use), to duplicate the exposed area of the specimen to the nearest $0,1\text{ cm}^2$. The template shall have an area that is at least 90 % of the exposed surface of the specimen to reduce the edge effect due to a non-linear vapour seal.

5.4 Pot or dish, for melting the sealant wax ([5.8](#)).

5.5 Analytical balance, capable of weighing the test assembly to an accuracy of 0,1 mg.

5.6 Constant-temperature, constant-humidity chamber, capable of being maintained within $\pm 5\%$ of the required relative humidity and within $\pm 1\text{ }^{\circ}\text{C}$ of the required temperature, and with a provision for continuous monitoring of the temperature and humidity during the test period. The chamber may be a room. Alternatively, if the chamber corresponds to that shown in [Figure 1](#), then the air circulation shall be capable of being switched off to permit accurate weighing.

NOTE If a conditioned room is used for the test, then it is not necessary to use the chamber shown in [Figure 1](#).

5.7 The following solutions can be used with non-injection-type humidity cabinets:

5.7.1 For testing at $38\text{ }^{\circ}\text{C}$ and a relative humidity of 88% : **saturated potassium nitrate solution** containing a large excess of the undissolved salt at $38\text{ }^{\circ}\text{C}$.

5.7.2 For testing at $23\text{ }^{\circ}\text{C}$ and a relative humidity of 85% : **saturated chloride solution** containing a large excess of the undissolved salt at $23\text{ }^{\circ}\text{C}$.

NOTE For testing at $23\text{ }^{\circ}\text{C}$ and a relative humidity of 50% , there is no suitable salt which meets the tolerance required by [8.1](#).

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

5.8.1 A mixture of 90% microcrystalline wax and 10% of a plasticizer (for example low-molecular-mass polyisobutylene).

5.8.2 A mixture of 60% microcrystalline wax and 40% refined crystalline paraffin.

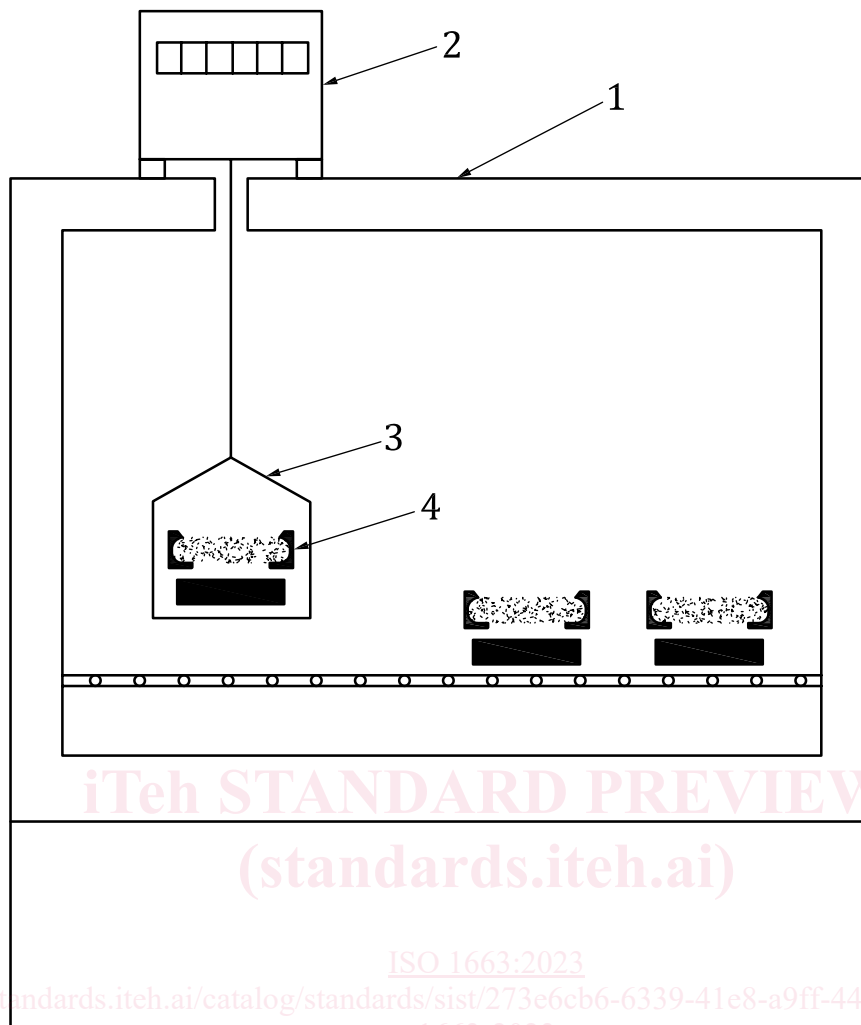
5.9 Anhydrous calcium chloride desiccant, with particles about 5 mm in diameter, free from fines, which would pass a No. 30 ($600\text{ }\mu\text{m}$) sieve.

5.10 Limiting ring, for use with thin specimens (see [Figure A.1](#)).

6 Sample

The sample shall be representative of the material. It may contain the natural skin or facings adhered to it which constitute part of the material.

Some cellular plastics have skins of a density significantly different from that of the core material. If it is intended to determine the permeability of the material, the specimen shall be homogeneous and tested without the skin and facing.



Key

- 1 controlled-environment test chamber with “glove box” type access door
- 2 balance
- 3 suspended weighing platform
- 4 test assembly during weighing

Figure 1 — Recommended specimen exposure and measurement when operator cannot enter controlled environment

7 Test specimens

7.1 Dimensions

7.1.1 Shape and fit

Specimens shall be cut to fit the dimensions of the test assembly used (see [Annex A](#)).

7.1.2 Thickness

The thickness of specimens shall not be less than 10 mm, except for materials produced thinner than 10 mm which shall be tested at the manufactured thickness. A specimen thickness of 25 mm is preferred.

7.1.3 Exposed area

The diameter of specimens shall not be less than four times the specimen thickness. The minimum exposed area shall be 50 cm².

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 through the material in its intended use.

When the material is 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 that in the intended use. If the direction of vapour flow in the intended use 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

For precise measurement, test specimens shall be conditioned in one of the atmospheres specified in ISO 291.

8 Procedure

8.1 Select the desired test environment from the following sets of conditions:

- (38 ± 1) °C and a relative humidity of 0 % on one side of the specimen and (88 ± 5) % on the other side;
- (23 ± 1) °C and a relative humidity of 0 % on one side of the specimen and (85 ± 5) % on the other side;
- (23 ± 1) °C and a relative humidity of 0 % on one side of the specimen and (50 ± 5) % on the other side.

NOTE A tolerance is not applied to the 0 % RH condition because it is the condition deemed to be generated using the desiccant.

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

8.2 The environment in the test chamber (5.6) shall be monitored continuously and the temperature maintained within ±2 °C of that of the test room.

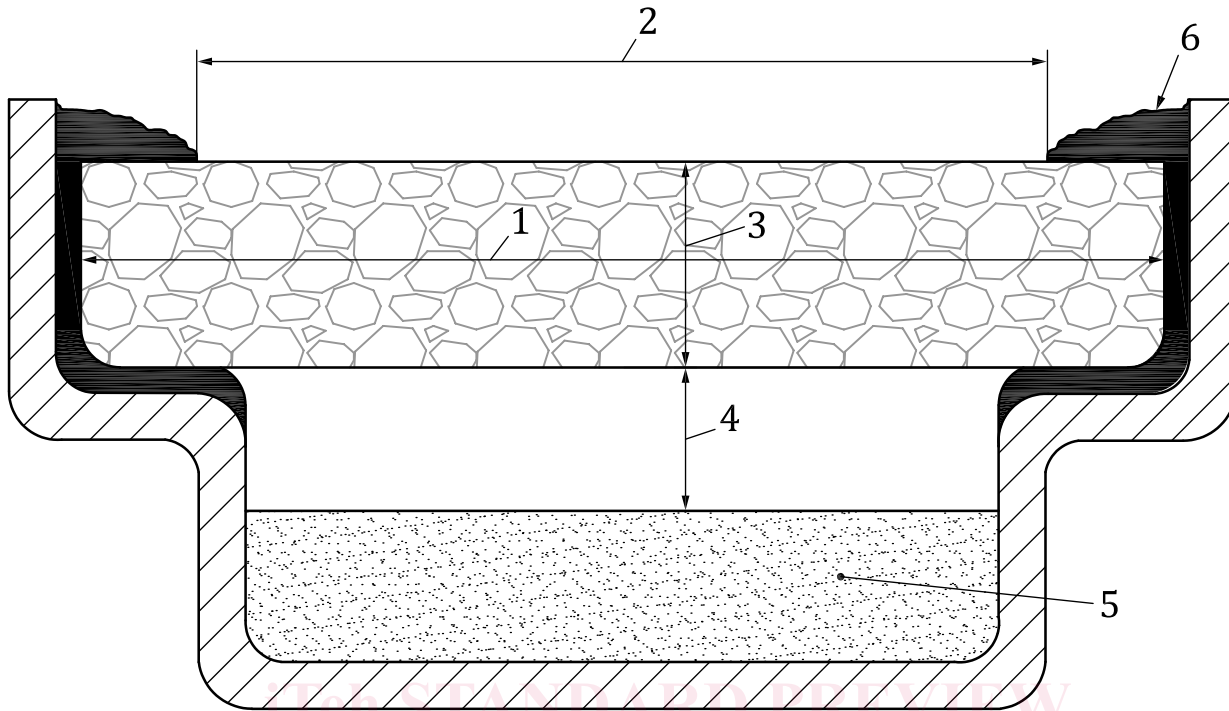
8.3 Select a test assembly from the configurations given in [Figure A.1](#).

8.4 Prepare the test specimens such that they fit the selected test assembly configuration.

8.5 In accordance with ISO 1923, measure the thickness of the test specimens at each quadrant to the nearest 0,1 mm, or to an accuracy of 5 %, whichever is the more precise. Calculate the average result for each test specimen.

8.6 Place the desiccant (5.9) in a layer (20 ± 5) mm thick at the bottom of each container. Heat the sealant wax (5.8) in its container until liquid. Then follow the procedure in [Annex A](#) which corresponds to the configuration selected. The air space between the desiccant and the specimen shall be

(15 ± 5) mm. The diameter of the exposed area shall be at least 90 % of the diameter of the specimen. See [Figure 2](#), which shows a typical test assembly.



Key

- 1 specimen diameter d
- 2 diameter of exposed area ($\geq 0,9d$)
- 3 specimen thickness (> 10 mm)
- 4 air gap [width (15 ± 5) mm]
- 5 desiccant [depth (20 ± 5) mm]
- 6 sealant wax

Figure 2 — Typical test assembly

8.7 If it is intended to determine the water vapour diffusion resistance index, the atmospheric pressure shall be measured and recorded daily.

8.8 Condition each test assembly in the selected environment for a period of 24 h and weigh to the nearest 100 µg.

8.9 At regular intervals of 24 h, weigh each test assembly. If a test assembly is removed from the test environment for weighing, then it shall be returned to the test environment with a minimum delay.

8.10 Continue the weighing until five successive determinations of change in mass per unit time are constant, within ±2 % of the mean value (see [9.1](#)). A plot of mass change against time will indicate when the state of constant rate of change is reached.

9 Expression of results

9.1 Calculation of constant rate of change of mass

9.1.1 If $m_2 - m_1$ is the difference in mass between any two successive weighing of the test assembly, in μg , and $t_2 - t_1$ is the time interval between two successive weighing of the test assembly, in h, then [Formula \(1\)](#) is the change in mass per unit time for the two successive weighing, in $\mu\text{g}/\text{h}$.

$$G_{12} = \frac{m_2 - m_1}{t_2 - t_1} \quad (1)$$

where G is the average of five successive values of G_{12} , in $\mu\text{g}/\text{h}$.

The test is completed when each of five successive values of G_{12} is within the range $0,980G$ to $1,020G$.

9.1.2 Blank specimen

The use of a blank specimen will balance out the test specimen mass changes and atmospheric pressure changes throughout the duration of the test.

Blank specimens are prepared in the same way as test specimens but without desiccant material used in the pan.

Let $m_{b,0}$ be the initial mass of the blank specimen. Subsequent weighing are labelled 1, 2, 3, ... i. The blank adjustment is shown as [Formula \(2\)](#)

$$M_{b,a} = m_{b,0} - m_{b,i} \quad (2)$$

For each weighing, the adjusted mass for the pan is given by adding $m_{b,a}$ to each measurement.

9.2 Calculation of water vapour transmission rate

The water vapour transmission rate g , in $\mu\text{g}/(\text{m}^2 \cdot \text{s})$, is given by [Formula \(3\)](#):

$$g = \frac{G}{A} \times \frac{100}{36} \quad (3)$$

where A is the area of the side of the test specimen exposed to humidity, in cm^2 . Calculation of water vapour permeance

9.3 Uncorrected calculation of water vapour transmission rate

9.3.1 The water vapour permeance W_p , in $\text{ng}/(\text{m}^2 \cdot \text{s} \cdot \text{Pa})$, is given by [Formula \(4\)](#):

$$W_p = \frac{G}{AP} \times \frac{10^5}{36} \quad (4)$$

where P is the water vapour pressure difference, in pascals, and has one of the following values:

5 860 Pa at 38 °C and 0 to 88 % RH

2 390 Pa at 23 °C and 0 to 85 % RH

1 400 Pa at 23 °C and 0 to 50 % RH