INTERNATIONAL STANDARD

ISO 15106-5

First edition
2015-04-15

Plastics — Film and sheeting — Determination of water vapour transmission rate —

Part 5: Pressure sensor method

Plastiques — Film et feuille — Détermination du coefficient de transmission de vapeur d'eau —

Partie 5: Méthode en pression différentielle

Reference number
ISO 15106-5:2015(E)

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Published in Switzerland

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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 documents 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 on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the WTO principles in the Technical Barriers to Trade (TBT) see the following URL: Foreword - Supplementary information

The committee responsible for this document is ISO/TC 61, *Plastics*, Subcommittee SC 11, *Products*.

ISO 15106 consists of the following parts, under the general title *Plastics — Film and sheeting — Determination of water vapour transmission rate*:

— *Part 1: Humidity detection sensor method*

— *Part 2: Infrared detection sensor method*

— *Part 3: Electrolytic detection sensor method*

— *Part 4: Gas-chromatographic detection sensor method*

— *Part 5: Pressure sensor method*

— *Part 6: Atmospheric pressure ionization mass spectrometer method*

— *Part 7: Calcium corrosion method*

Plastics — Film and sheeting — Determination of water vapour transmission rate —

Part 5:
Pressure sensor method

1 Scope

This part of ISO 15106 specifies a method for determining the water vapour transmission rate of plastic film, plastic sheeting, and multi-layer structures including plastics, using a pressure sensor.

NOTE The method provides rapid measurement over a wide range of water vapour transmission rates.

2 Terms and definitions

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

2.1
water vapour transmission rate
amount of water vapour transmitted through unit area of test specimen per unit time under specified conditions

Note 1 to entry: Water vapour transmission rate is expressed in grams per square metre per 24 h [g/(m^2 · 24 h)].

3 Principle

A test specimen is mounted in a transmission cell (see Figure 1) forming a sealed barrier between two chambers. The upstream chamber is usually the high-pressure side and the downstream chamber is usually the low-pressure side. The downstream chamber and the upstream chamber are evacuated after introducing the test specimen into the transmission cell. After the evacuation, water vapour is introduced into the upstream chamber. The water vapour permeates from the upstream chamber to the downstream chamber. The amount of water vapour which permeates through the test specimen is determined by the increase of the pressure in the downstream chamber.

4 Test specimens

4.1 The specimens shall be representative of the material, free from wrinkles, creases and pinholes, and have uniform thickness. Each specimen shall have a larger area than the transmission area of the cell.

NOTE Uneven final products are not suitable for the specimens to avoid water vapour leakage.

4.2 Three specimens shall be tested unless otherwise specified or agreed between the interested parties.

5 Conditioning

The specimens shall be conditioned at the same temperature and humidity as specified for the test for a length of time appropriate to the material under test, unless otherwise agreed between the interested parties.

6 Apparatus

6.1 General

Figure 1 shows an example of an apparatus for determining the water vapour transmission rate using a pressure sensor.

The apparatus consists of a water vapour transmission cell designed to allow the water vapour to permeate through a specimen, a pressure sensor to detect the pressure change due to the permeation of the water vapour through the specimen, a water vapour generator to supply the water vapour to the transmission cell, a cell volume-control device, and a vacuum pump.

6.2 Transmission cell

The transmission cell shall consist of an upstream chamber and a downstream chamber designed so that the water vapour transmission area is constant for any specimen mounted in the transmission cell. The upstream chamber shall have an inlet for the water vapour and the downstream side shall be connected to a pressure sensor. The surfaces in contact with the specimen shall be smooth and flat so that leakage does not occur. The diameter of the water vapour transmission area shall typically be 5 mm to 200 mm.

The size of non-circular samples shall be agreed upon by the interested parties.

6.3 Pressure sensor

The sensor shall be capable of determining the change in pressure on the downstream side. A minimum sensitivity of 0,2 Pa (0,001 5 mmHg) would be sufficient for most measurements. A vacuum gauge with no mercury, an electronic diaphragm-type sensor or another suitable type of sensor shall be used.

6.4 Water vapour generator

The water vapour generator is a device to create and store water vapour. The water vapour is fed into the upstream chamber of the cell from the generator. In order to determine the pressure in the reservoir, a pressure sensor with a minimum sensitivity of 20 Pa (0,15 mmHg) shall be fitted. The water vapour generator shall have sufficient capacity such that permeation of the water vapour through the specimen does not cause any drop in pressure on the upstream side.

6.5 Cell volume-control device

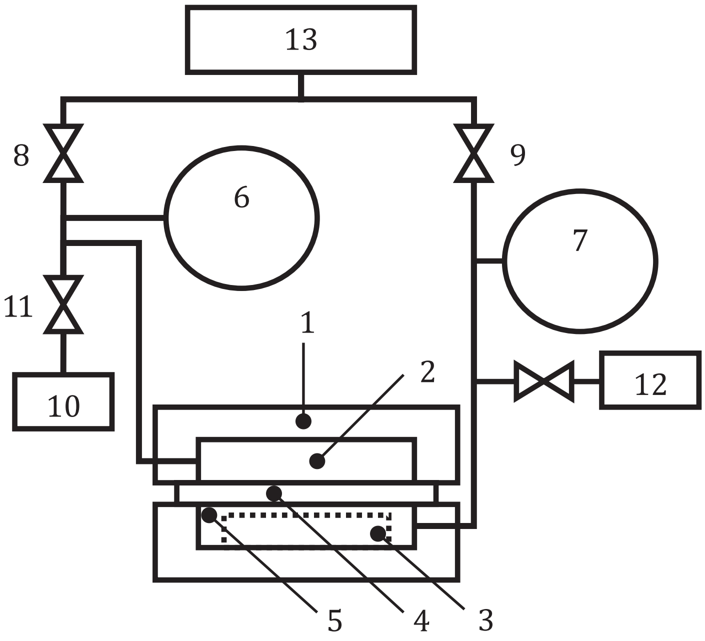
In order to extend the transmission rate measurement range, the volume of the downstream chamber can be adjusted by a cell volume control device such as an additional reservoir or an adapter.

6.6 Water

The water used should preferably have a purity greater than 99,99 %. The use of water of other purities shall be subject to agreement between the interested parties.

6.7 Vacuum pump

A vacuum pump capable of producing an ultimate vacuum of 1 Pa (0,007 5 mmHg) or better shall be used.



Key

1 transmission cell
2 upstream volume
3 downstream volume
4 test specimen
5 support
6 upstream pressure sensor
7 downstream pressure sensor
8 upstream valve
9 downstream valve
10 water vapor generator
11 control valve
12 volume control device with valve
13 vacuum pump

Figure 1 — Example of a water vapour transmission rate measurement apparatus using a pressure sensor

7 Test conditions

The test conditions should preferably be chosen from those given in Table 1.

Table 1 — Choice of test conditions

Test conditions	Temperature °C	Relative humidity %
1	25 ± 0,5	90 ± 3
2	40 ± 0,5	90 ± 3
3	60 ± 0,5	90 ± 3
4	85 ± 0,5	85 ± 3

Test conditions other than these shall be agreed upon by the interested parties.

8 Procedure

8.1 Set a permeable support (see 5 in Figure 1) with the diameter and the height of the downstream chamber.

8.2 Coat the flat edges of the two halves of the transmission cell thinly and uniformly with vacuum grease for hermetical sealing, and mount the specimen over the downstream chamber so that no creasing or slackness occurs.

8.3 Place a rubber sealing ring on the specimen, followed by the upper part of the cell. Clamp the two halves of the cell together with uniform pressure so that the specimen is completely sealed.

8.4 Open the upstream valve and the downstream valve (see 8 and 9 in Figure 1) and start the vacuum pump to evacuate the air from the downstream chamber and the upstream chamber.

NOTE The downstream chamber is evacuated first to ensure that the specimen fits close to the support.

8.5 When a sufficiently low-pressure has been achieved, close the downstream valve and the upstream valve. Switch off the vacuum pump.

8.6 Repeat 8.4 to 8.5 if necessary.

8.7 Introduce the water vapour into the upstream chamber by opening control valve (11), shutting off the water vapour supply when the water vapour pressure corresponding to the relative humidity of the test condition has been reached. The pressure in the upstream chamber shall be controlled by the control valve (11) associated with the water vapour generator (10).

An increase in pressure in the downstream chamber will confirm transmission of the water vapour.

8.8 Plot a curve of the pressure in the downstream chamber versus time, continuing until steady-state has been reached as indicated by a straight line.

8.9 Determine the slope of the straight-line portion of the transmission curve (dp/dt, see Clause 10). An automatically recorded transmission curve can also be used.

9 Background measurement

From time to time a measurement of the background WVTR of the testing cell without sample can be made. For this purpose, a metal plate is put onto the downstream chamber instead of a test specimen.

Thickness of the plate shall be 3 mm to 10 mm and the same material as the testing cell is preferable.

10 Calculation

Calculate the water vapour transmission rate of the test specimen using Formula (1):

$$\mathrm{WVTR} = \frac{Vc}{A} \times \frac{M}{R \times T} \times \frac{dp}{dt} \qquad (1)$$

where

WVTR is the water vapour transmission rate of the test specimen, expressed in grams per square metre per 24 h [g/(m^2 · 24 h)];

V_c is the volume of the downstream chamber, expressed in cubic metres;

A is the transmission area of the specimen, expressed in square metres;

M is the molecular weight of water (= 18,0) [g/mol];

R is the gas constant (= 8,31) [J/(K · mol)];

T is the test temperature, expressed in kelvins;

dp/dt is the change in pressure per unit time in the downstream chamber, expressed in pascals per 24 h.

11 Test result

Express the test result as the arithmetic mean of the results obtained for each test specimen, rounding to two significant figures.

If the measured value of the specimens is near the background value, both values shall be reported.

12 Precision

The precision of this test method is not known because interlaboratory data are not available. When interlaboratory data are obtained, a precision statement will be added at the following revision.

13 Test report

The test report shall include the following information:

a) a reference to this part of ISO 15106, i.e. ISO 15106-5;

b) the test conditions;

c) the name of the apparatus used;

d) all details necessary for identification of the sample tested;

e) the method of preparation of the test specimens;

f) the side of the specimen which faced the supply of water vapour, if necessary;

g) the transmission area of the specimen;

h) the mean thickness of the specimen;

i) the number of specimens tested;

j) details of specimen conditioning;

