INTERNATIONAL STANDARD

ISO 15105-1

Second edition
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Plastics — Film and sheeting — Determination of gas-transmission rate —

Part 1: Differential-pressure methods

Plastiques — Film et feuille — Détermination du coefficient de transmission d'un gaz —

Partie 1: Méthodes en pression différentielle

Reference number
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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.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. 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.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 15105-1 was prepared by Technical Committee ISO/TC 61, *Plastics*, Subcommittee SC 11, *Products*.

This second edition cancels and replaces the first edition (ISO 15105-1:2002), which has been revised to include a second method which uses a gas chromatograph to measure the amount of gas which permeates through the test specimen.

ISO 15105 consists of the following parts, under the general title *Plastics — Film and sheeting — Determination of gas-transmission rate*:

— *Part 1: Differential-pressure methods*

— *Part 2: Equal-pressure method*

Plastics — Film and sheeting — Determination of gas-transmission rate —

Part 1:
Differential-pressure methods

1 Scope

This part of ISO 15105 specifies two methods for determining the gas transmission rate of single-layer plastic film or sheet and multi-layer structures under a differential pressure. One method uses a pressure sensor, the other a gas chromatograph, to measure the amount of gas which permeates through a test specimen.

2 Normative references

The following referenced documents are indispensable for the application 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 4593, *Plastics — Film and sheeting — Determination of thickness by mechanical scanning*

3 Terms and definitions

For the purposes of this part of ISO 15105, the following terms and definitions apply.

3.1
gas transmission rate
GTR
volume of gas passing through a plastic material, per unit area and unit time, under unit partial-pressure difference between the two sides of the material

NOTE When the gas used is oxygen, the value obtained is the oxygen transmission rate (O_2GTR).

3.2
gas permeability
coefficient of gas permeability
P
volume of gas passing through a plastic material of unit thickness, per unit area and unit time, under unit partial-pressure difference between the two sides of the material

NOTE 1 The theoretical value of P is given by $P = \text{GTR} \times d$ [see Equations (A.2) and (B.2)].

NOTE 2 Although P is a physical property of a polymeric material, differences in film preparation affecting polymer orientation and crystal structure will have an effect on the permeation properties.

4 Principle

A test specimen is mounted in a gas transmission cell (see Figures A.1 and B.1) so as to form a sealed barrier between two chambers. The lower-pressure chamber is evacuated, followed by evacuation of the higher-pressure chamber. A gas is introduced into the evacuated higher-pressure chamber and permeates into the lower-pressure chamber. The amount of gas which permeates through the specimen is determined by the increase in pressure on the lower-pressure side or by gas chromatography.

5 Test specimens

5.1 Test specimens shall be representative of the material under investigation, free from shrivelling, folds and pinholes, and of uniform thickness. They shall be larger than the gas transmission area of the measurement cell and be capable of being mounted airtight.

5.2 Use three specimens unless otherwise specified or agreed upon among the interested parties.

5.3 Mark the side of the material facing the permeating gas.

NOTE In principle, the test should replicate the actual conditions of use, with the gas passing from the inside to the outside of e.g. packaging material, or *vice versa*.

5.4 Measure the thickness of each specimen in accordance with ISO 4593, to the nearest 1 µm, at at least five points distributed over the entire test area, and record the minimum, maximum and average values.

6 Apparatus, procedure and calculation

Of the several methods available for measuring the amount of gas permeating through a specimen, two are described in the annexes:

— Annex A: pressure sensor method;

— Annex B: gas chromatography method.

7 Expression of results

Express the test result as the arithmetic mean of the results obtained for all the specimens, rounding to three significant figures.

8 Precision

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

9 Test report

The test report shall include the following information:

a) a reference to this part of ISO 15105;

b) the method of measurement used (pressure sensor or gas chromatography);

c) all details necessary for identification of the test apparatus used (make, manufacturer, etc.), including, when a pressure sensor is used, the type of pressure sensor;

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 permeating gas;

g) the pressure, composition and purity of the gas used;

h) the average, minimum and maximum thickness of each specimen;

i) the number of specimens tested;

j) details of test specimen conditioning;

k) the temperature and humidity of the laboratory;

l) the test results;

m) the date of the test.

Annex A
(normative)

Method using a pressure sensor

A.1 Applicability

This method can be used to determine the gas transmission rate of any plastic material.

A.2 Apparatus and materials

A.2.1 General

Figure A.1 shows an example of an apparatus for determining gas transmission rate using a pressure sensor. The apparatus consists of a gas transmission cell designed to allow a gas to permeate through a specimen, a pressure sensor to detect the pressure change due to the permeation of the gas through the specimen, a gas feeder to supply the gas to the transmission cell, a cell volume-control device and a vacuum pump.

A.2.2 Transmission cell

The transmission cell shall consist of an upper (high-pressure) chamber and a lower (low-pressure) chamber, designed so that the gas transmission area is constant for any specimen mounted in the cell. The high-pressure chamber shall have an inlet for the gas and the low-pressure chamber 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 gas transmission area shall be 10 mm to 150 mm.

A.2.3 Pressure sensor

The sensor shall be capable of determining the change in pressure on the low-pressure side with a minimum sensitivity of 5 Pa (0,038 mmHg). A vacuum gauge with no mercury, an electronic diaphragm-type sensor or another suitable type shall be used.

A.2.4 Gas feeder

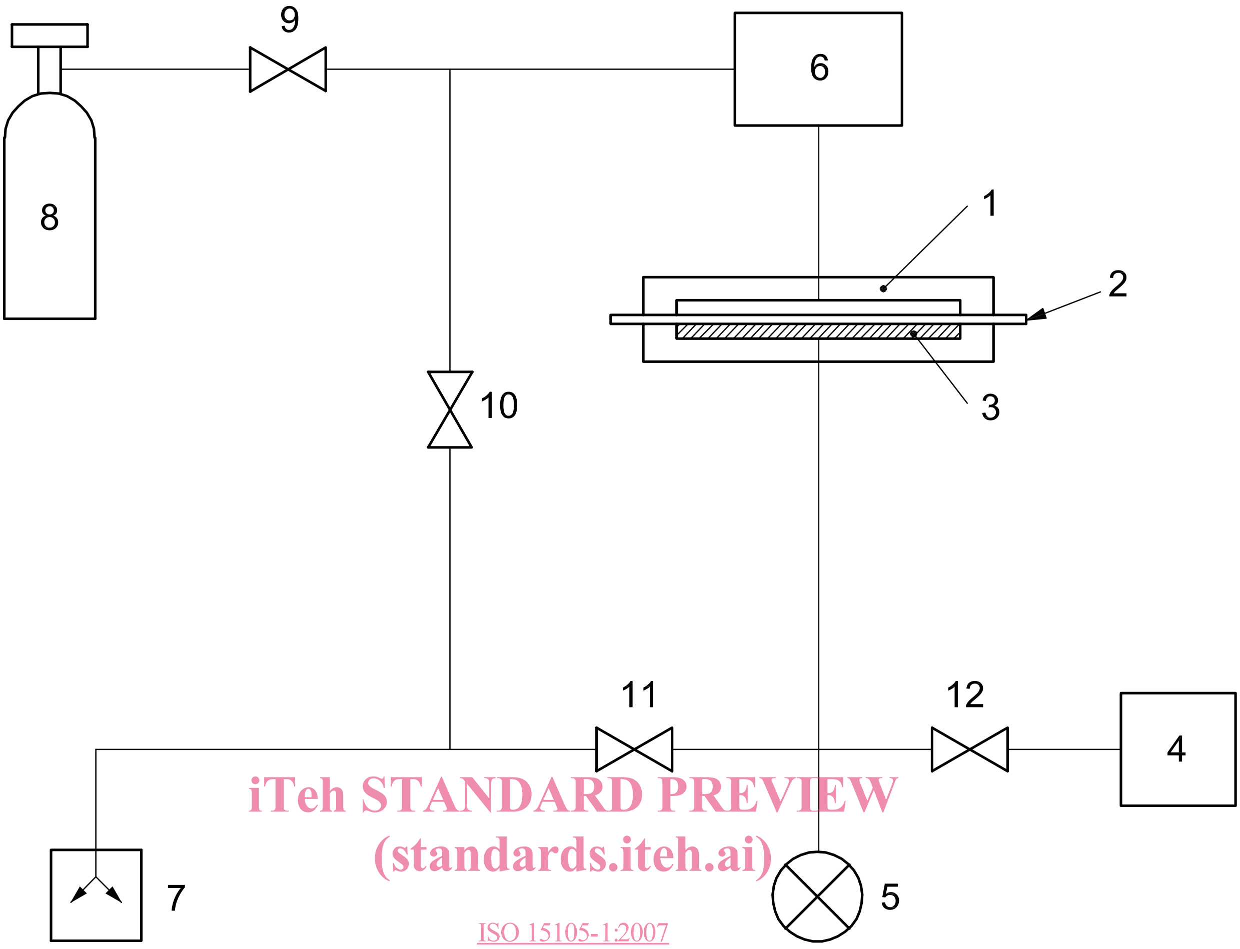
The gas feeder is basically a reservoir designed to store the gas. The gas is fed to the high-pressure side of the cell from the feeder. In order to determine the pressure in the reservoir, a manometer with a minimum sensitivity of 100 Pa (0,75 mmHg) is fitted. The reservoir shall have sufficient capacity such that permeation of the gas through the specimen does not cause any drop in pressure on the high-pressure side.

A.2.5 Cell volume-control device

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

A.2.6 Gas

The gas used should preferably have a purity greater than 99,5 %. The use of gases of other purities shall be subject to agreement between the interested parties.



Key

1 transmission cell
2 specimen
3 filter paper
4 cell volume-control device
5 pressure sensor
6 gas feeder
7 vacuum pump
8 gas supply
9 valve 1
10 valve 2
11 valve 3
12 valve 4

Figure A.1 — Example of gas transmission rate measurement apparatus using a pressure sensor

A.2.7 Vacuum pump

A vacuum pump capable of producing a vacuum better than 10 Pa (0,075 mmHg) in the low-pressure chamber shall be used.

A.3 Conditioning and test temperature

A.3.1 Conditioning

Dry the specimens for not less than 48 h at the same temperature as that at which the test is to be carried out, using calcium chloride or another suitable drying agent in a desiccator. Drying will not normally be required for non-hygroscopic materials.