INTERNATIONAL STANDARD

ISO 7783-1

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Paints and varnishes — Determination of water-vapour transmission rate —

Part 1: Dish method for free films

Peintures et vernis — Détermination du coefficient de transmission de la vapeur d'eau

Partie1: Méthode de la capsule pour feuils libres

Reference number
ISO 7783-1:1996(E)

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.

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.

International Standard ISO 7783-1 was prepared by Technical Committee ISO/TC 35, *Paints and varnishes*, Subcommittee SC 9, *General test methods for paints and varnishes*.

L'ISO 7783 consists of the following parts, under the general title *Paints and varnishes — Determination of water-vapour transmission rate*:

— *Part 1: Dish method for free films*

— *Part 2: Method for films supported by a porous substrate*

Annexes A to D form an integral part of this part of ISO 7783.

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Introduction

This part of ISO 7783 is one of a series of standards dealing with the sampling and testing of paints, varnishes and related products. It describes a method for determining the water-vapour transmission rate of an unsupported paint film. ISO 7783-2[1)] describes a method for determining the water-vapour transmission rate of a paint film supported by a porous substrate.

Water-vapour transmission rate is most commonly of interest when the coating is applied to a porous substrate. Depending on the conditions of use, water vapour may be expected to pass in either direction through the coating.

The procedure is commonly used to compare the transmission rates of two or more different paint films and not to obtain absolute results. In the latter case, it may be preferable to carry out the determination on a coated test piece of the appropriate permeable substrate. The procedure for carrying out that determination forms the subject of ISO 7783-2.

1) To be published.

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Paints and varnishes — Determination of water-vapour transmission rate

Part 1:
Dish method for free films

1 Scope

This part of ISO 7783 specifies a method for the determination of the water-vapour transmission rate[2] of an unsupported film of paint, varnish or related product. The test method is applicable to the transmission of water vapour in either direction through a paint film.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this part of ISO 7783. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this part of ISO 7783 are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 209-1:1989, *Wrought aluminium and aluminium alloys — Chemical composition and forms of products — Part 1: Chemical composition.*

ISO 483:1988, *Plastics — Small enclosures for conditioning and testing using aqueous solutions to maintain relative humidity at constant value.*

ISO 1512:1991, *Paints and varnishes — Sampling of products in liquid or paste form.*

ISO 1513:1992, *Paints and varnishes — Examination and preparation of samples for testing.*

ISO 2528:1995, *Sheet materials — Determination of water vapour transmission rate — Gravimetric (dish) method.*

ISO 2808:—[3], *Paints and varnishes — Determination of film thickness.*

ISO 3270:1984, *Paints and varnishes and their raw materials — Temperatures and humidities for conditioning and testing.*

ISO 3696:1987, *Water for analytical laboratory use — Specification and test methods.*

3 Definition

For the purposes of this part of ISO 7783, the following definition applies.

3.1 water-vapour transmission rate (of a coating): The mass of water vapour that is transmitted over a given period through a test piece of a given surface area under specified constant conditions of relative humidity at each face of the test piece.

NOTE 1 Water-vapour transmission rate is expressed in grams per square metre per day [g/(m^2·d)] at the conditions of relative humidity defined at the two faces of the coating.

2) This term is often confused with permeability or permeance, which have distinct definitions (see note 9 in subclause 11.3).

3) To be published. (Revision of ISO 2808:1991)

4 Principle

4.1 Dishes containing a saturated solution of ammonium dihydrogen phosphate, producing an atmosphere immediately above it of 93 % relative humidity, and closed by a film of the product to be tested are placed in an enclosure at a controlled temperature. The relative humidity on the outside of the product film is varied according to the requirements. The dishes are weighed at suitable intervals of time and the water-vapour transmission rate is determined from the change in mass when the change has become directly proportional to the time interval.

4.2 In the referee method, the temperature of the enclosure is maintained at (23 ± 2) °C and its relative humidity at (50 ± 5) % (see annex B).

4.3 Alternative conditions, including placing a desiccant in the dish, which is then placed in the enclosure, are permitted by agreement (see annex C).

5 Significance of the test

The test is intended to give consistent values of water-vapour transmission rate by means of simple apparatus, but the use of the results for any particular application will be based upon experience.

Because the water-vapour transmission rate is not necessarily a linear function of film thickness, temperature or relative-humidity difference, a determination carried out under one set of conditions may not necessarily be comparable with one carried out under other conditions. Therefore, it is essential that the conditions of test are chosen so as to be as close as possible to the conditions of use.

6 Required supplementary information

For any particular application, the test method specified in this part of ISO 7783 needs to be completed by supplementary information. The items of supplementary information are given in annex A.

7 Apparatus and equipment

7.1 Dishes, preferably made of glass or a light metal (see note 2) that is resistant to corrosion under the test conditions. They shall be sufficiently rigid to withstand handling without undue distortion.

NOTE 2 Aluminium of grade Al 99,5 in accordance with ISO 209-1, protected by chemical or anodic oxidation, is suitable, and sheet aluminium of thickness 1 mm has been found to be satisfactory.

The exact surface area of the test piece exposed is defined by the design of the dish. The diameter of the exposed surface shall be not greater than 113 mm (area = 100 cm^2) and not less than 35,7 mm (area = 10 cm^2). The area shall be known to within 1 %.

The dish shall be so designed that an efficient seal may be made between it and the test piece. The most usual arrangement is for the dish to be fitted with an annular cap with a mechanical clamping or screw device which may incorporate a sealing ring of a suitable impervious polymeric material. Alternatively, molten wax may be used as a sealant, a suitable procedure being described in annex D.

NOTE 3 A mechanical sealing device is generally easier to use. It may not be suitable if the test piece has a rough surface or if it is very fragile. In those cases, the use of molten wax is more satisfactory, but it is necessary to ensure that the wax is accurately contained. Spread of the molten wax on to the measured test area will reduce the effective area of the test piece and lead to erroneous results.

The surface area of the bottom of the dish where it is filled with the saturated solution (7.2) shall be similar to that of the exposed surface and there shall be no obstruction within the dish which might interfere with the movement of water vapour. The internal depth of the dish below the plane of the test piece shall not be less than 15 mm.

Each dish shall be clearly identified and shall be provided with a lid to close the dish assembly sufficiently well to allow it to be brought out from the enclosure for weighing without loss of water vapour (see note 8 in 10.1). The lids shall be identified to correspond with each dish.

7.2 Saturated solution of ammonium dihydrogen phosphate (analytical grade), prepared using water of at least grade 3 purity as defined in ISO 3696, to produce 93 % relative humidity.

7.3 Enclosure, in which both temperature and relative humidity can be controlled at the levels required for the test (see annex B).

The control shall be such that, when dishes have to be removed for weighing, the specified conditions are re-established not more than 15 min after the door of the enclosure has been closed. The door shall be open for the shortest possible time: this is specially important with materials having high transmission rates.

NOTES

4 If a suitable controllable enclosure is not available, it may be possible to achieve the specified conditions by means of equilibrium with selected aqueous solutions. Guidance on this procedure is given in ISO 483.

5 It may be possible to achieve the specified conditions by enclosing the dishes in a suitable closed vessel containing a desiccant or the selected aqueous solution and placing that vessel in a suitable temperature-controlled chamber or room.

7.4 Balance, capable of weighing to 0,1 mg for dishes of area 50 cm^2 or less, or weighing to 1 mg for dishes with areas greater than 50 cm^2.

7.5 Cutting template, suitable for the dish (see figure D.1). This template may have a handle in the centre.

8 Sampling

Take a representative sample of the product to be tested (or of each product in the case of a multi-coat system), as specified in ISO 1512.

Examine and prepare each sample for testing, as specified in ISO 1513.

9 Preparation of test pieces

NOTE 6 The test pieces consist of a film of the material or system under test, unsupported by any substrate.

9.1 Choose a suitable substrate [see annex A, item a)]. High-density polyethylene which is free from surface defects and from which the product under test can be easily detached when dry has been found to be suitable.

NOTE 7 Other substrate arrangements may be used (see annex A), for example precoating a substrate with a soluble material such as poly(vinyl alcohol) which will permit the coating to be removed easily by soaking in water. This latter method should be used with caution since water-soluble material may affect the water-vapour transmission rate of the film.

Coat the substrate by the specified method and allow it to dry for the specified time under the specified conditions. (If stoving is required, care shall be taken to ensure that the chosen substrate is not affected at the relevant temperature.) Unless otherwise agreed [see annex A, item b)], condition the specimens in the standard atmosphere as defined in ISO 3270 for at least 24 h before test.

Remove the coating carefully from the substrate. If further conditioning is required, this may be agreed [see annex A, item b)].

9.2 Prepare at least three test pieces of suitable size for each determination, preferably using the cutting template (7.5). Visually examine the test pieces and discard any which appear to have pinholes.

10 Procedure

10.1 Preparation of dishes

Clean and dry the dishes (7.1) together with any ancillary fittings.

Fill each dish with the saturated solution (7.2) to approximately 10 mm below the final position of the test piece. Fit the test piece to the dish, with the appropriate face exposed to the ambient atmosphere, as specified, and make a vapour-tight seal (see 7.1) between the test piece and the dish.

NOTE 8 If the dish assemblies are removed from the enclosure for weighing, it may be necessary to cover the asembly with a lid marked to correspond with the identification of the assembly.

10.2 Determination

10.2.1 Weigh the dish assemblies on the balance (7.4). Place the dish assemblies in the enclosure maintained at the conditions of the test (see 7.3 and annex B).

10.2.2 Carry out successive weighings of the dish assemblies at suitable intervals of time using the following procedure:

Remove the dish assemblies from the controlled enclosure. Leave them to reach ambient temperature. Weigh the assemblies on the balance (7.4) and return the assemblies to the enclosure.

Carry out the weighing without delay, taking the dish assemblies in small groups of about the same number. Remove, weigh and replace each group of assemblies in the same period of time, but not exceeding 30 min.

The interval between weighing should preferably be 24 h, 48 h or 96 h, but shorter time intervals (for example 3 h, 4 h or 8 h) may be necessary for films with a high transmission rate. The choice depends on the transmission rate of the product being tested: the change in mass between two successive weighings shall be at least 5 mg. If the first weighing shows a change in mass which is too large or too small, the subsequent time interval for weighing shall be modified.

10.2.3 Continue the weighings until the change in mass per unit time of exposure to the selected atmosphere becomes constant (see 11.1.1).

11 Expression of results

11.1 Calculate the test results using one of the following methods:

11.1.1 For each test piece, represent the total change in mass graphically as a function of time of exposure, the test being completed when three or four points lie on a straight line (see 10.2.3), showing a constant rate of passage of water vapour.

Using this straight line, calculate the water-vapour transmission rate for each test piece, in grams per square metre per day, from the formula

$$\frac{240 \times m_1}{A} \quad \ldots (1)$$

where

m_1 is the rate of change in mass of the dish assembly, in milligrams per hour, determined from the graph;

A is the area, in square centimetres, of the test surface of the test piece.

11.1.2 If weighings are made at identical time intervals, it is possible to calculate the transmission rate for each test piece directly from the results, without preparing a graph, by modifying formula (1) as follows:

$$\frac{240 \times m_2}{A \times t} \quad \ldots (2)$$

where

m_2 is the change in mass, in milligrams, of the dish assembly during time t;

t is the total duration, in hours, of the last two exposure periods (see 10.2.3).

11.2 For the three or more test pieces corresponding to a single sample of test product, and to a single face, calculate the arithmetic mean of the results obtained by either formula (1) or formula (2). Discard any result which differs from the mean by more than 10 %, then recalculate the mean. If two or more results are discarded then repeat the determination.

11.3 Report the mean water-vapour transmission rate to two significant figures.

NOTE 9 If the water-vapour permeability [expressed in moles per metre per second per pascal (mol·m^{-1}·s^{-1}·Pa^{-1})] is required, it can be calculated using the formula

$$\frac{m_1 \times d \times 1{,}54 \times 10^{-12}}{A \times \Delta p} \quad \ldots (3)$$

where

m_1 is the rate of change in mass, in milligrams per hour, of the dish assembly, determined from the graph;

d is the thickness, in micrometres, of the test piece;

A is the area, in square centimetres, of the test surface of the test piece;

Δp is the difference, in pascals, at 23 °C between the partial pressure of water vapour in the dish and that of the water vapour in the ambient air, taken from table 1.

Table 1

Relative humidity in dish %	Pressure difference Pa
⩽ 50	1 400
50 to 93	1 210

12 Precision

12.1 Repeatability

The value below which the absolute difference between either of two test results, each the mean of duplicates, and the mean of the two test results may be expected to lie within a 95 % probability is 10 % when the test results have been obtained on identical material by one operator in one laboratory within a short interval of time using the referee method (see annex B).

12.2 Reproducibility

The value below which the absolute difference between either of two test results, each the mean of duplicates, and the mean of the two test results may be expected to lie within a 95 % probability is 15 % when the test results have been obtained on identical material by operators in different laboratories using the referee method (see annex B).

13 Test report

The test report shall contain at least the following information:

a) all details necessary to identify the product tested;

b) a reference to this part of ISO 7783 (ISO 7783-1);

c) the items of supplementary information, including the coating thickness, referred to in annex A;

d) a reference to the international or national standard, product specification or other document supplying the information referred to in c);

e) the test conditions (see annex B), including which face of the test piece was exposed to the higher relative humidity and the type of desiccant (if used);

f) the method of securing the test piece and the size of the waxing template (D.1.2), if used;

g) the results of the test, as indicated in 11.1;

h) the arithmetic mean of a valid set of results (see 11.2 and 11.3);

i) any deviation from the test method specified;

j) the date of the test.

Annex A
(normative)

Required supplementary information

The items of supplementary information listed in this annex shall be supplied as appropriate to enable the method to be carried out.

The information required should preferably be agreed between the interested parties and may be derived, in part or totally, from an international or national standard or other document related to the product under test.

a) The nature of the test pieces and the method used for their preparation.

b) The duration and conditions of drying (or stoving) and ageing (if applicable) of the test pieces before testing (see also 9.1).

c) The thickness, in micrometres, of the dry coating and the method of measurement in accordance with ISO 2808, and whether it is a single coating or a multicoat system.

d) The temperature and humidities used for the test (see annexes B and C).

e) The face of the test piece exposed to the atmosphere of higher relative humidity.