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Paints and varnishes — Determination of resistance to abrasion —

Part 3: Reciprocating test panel method

*Peintures et vernis — Détermination de la résistance à l'abrasion —
Partie 3: Méthode de panneau d'essai animé d'un mouvement de
va-et-vient*



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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 3.

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 part of ISO 7784 may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

International Standard ISO 7784-3 was prepared by Technical Committee ISO/TC 35, *Paints and varnishes*, Subcommittee SC 9, *General test methods for paints and varnishes*.

ISO 7784 consists of the following parts, under the general title *Paints and varnishes — Determination of resistance to abrasion*:

- *Part 1: Rotating abrasive-paper-covered wheel method*
- *Part 2: Rotating abrasive rubber wheel method*
- *Part 3: Reciprocating test panel method*

Annex A forms a normative part of this part of ISO 7784. Annex B is for information only.

Introduction

This document is one of three parts of ISO 7784 dealing with determination of resistance to abrasion of a dried film of paint, varnish or related product.

Parts 1 and 3 both specify a method using abrasive paper for determination of the resistance to abrasion. In part 2, a method using rubber wheels is described. The user of ISO 7784 should note that the methods using abrasive paper (parts 1 and 3) are the preferred methods.

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Paints and varnishes — Determination of resistance to abrasion —

Part 3: Reciprocating test panel method

1 Scope

This part of ISO 7784 is one of a series of standards that deals with the sampling and testing of paints, varnishes and related products.

It specifies a method of determining the resistance to abrasion of a dried film of paint, varnish or related product by rubbing the film against a strip of abrasive paper attached to a stationary wheel.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this part of ISO 7784. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this part of ISO 7784 are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies. Members of ISO and IEC maintain registers of currently valid International Standards.

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

ISO 1514:1993, *Paints and varnishes — Standard panels for testing.*

ISO 2808:1997, *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 15528:—¹⁾, *Paints, varnishes and raw materials for paints and varnishes — Sampling.*

3 Principle

A dried paint or varnish film on a test panel is abraded, under specified conditions, by rubbing the panel against a strip of abrasive paper attached to the circumference of a stationary wheel. The wheel is weighted so that the abrasive paper is pressed against the panel with a specified force. After each complete reciprocating movement (double stroke, DS) of the panel, the wheel is advanced through a small angle to bring an unused portion of the abrasive strip into contact with the test surface.

1) To be published. (Revision of ISO 842:1984 and ISO 1512:1991)

Either the resulting loss in mass of the test panel is measured after a specified number of double strokes, and the loss in mass for one double stroke (mg/DS) and the abrasion resistance (DS/mg) are calculated, and/or the mean number of double strokes required for wearthrough of the coating (or the topcoat of a multicoat system) is determined (see clause 9).

4 Required supplementary information

For any particular application, the test method specified in this part of ISO 7784 needs to be completed by supplementary information. The items of supplementary information are given in annex A.

5 Apparatus and materials

5.1 Abrasion tester (see Figure 1)²⁾

The tester shall consist of a clamping device or pressure plate for holding the test specimen level and rigid and a $(50 \pm 0,05)$ mm diameter wheel, to the outer circumference of which a 12-mm-wide strip of silicon carbide paper is attached. The force between the wheel and the test surface shall be capable of being varied from zero to at least $(6,9 \pm 0,05)$ N.³⁾

The abrasive action shall be produced by rubbing a test panel in a reciprocating manner (stroke length 30 mm) against a stationary wheel. Other types of instrument in which the panel and the wheel are moved relative to one another in a reciprocating manner may also be used, providing they give the same results.

After each double stroke, the wheel shall be advanced through a small angle to bring a fresh area of the silicon carbide paper into contact with the test surface before making the next double stroke.

The angle of rotation shall be such that, after 400 double strokes, the wheel will have made one complete revolution. On completion of this cycle, the strip of silicon carbide paper shall be replaced.

The frequency of motion of the test panel shall be (40 ± 2) DS/min.

The number of double strokes may be registered by means of a counter, and provision is normally made for the apparatus to switch off automatically after a preset number of double strokes has been reached (400 DS maximum). The test surface shall be kept free of loose powder or abrasion debris during the test.

5.2 Abrasive paper

The recommended abrasive paper is P180 grade silicon carbide paper (maximum grit size $150 \mu\text{m}$). The strip shall be 12 mm wide. Its length shall be such that it covers the abrasive wheel without any overlap or gap at the ends (a strip length of 157 mm should be sufficient). It shall be attached to the wheel by double-sided adhesive tape (5.3) or self-adhesive abrasive paper shall be used (see note 3).

NOTE 1 Other types of abrasive paper may be used by agreement between the interested parties.

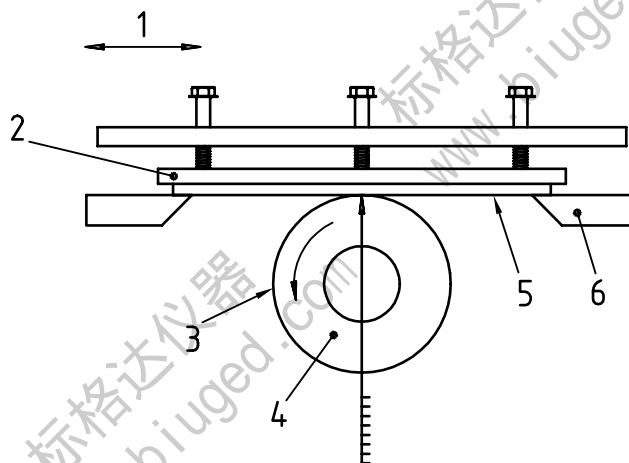
NOTE 2 Several grades of abrasive paper are specified in the P-series defined in the particle-size standard published by the Federation of European Producers of Abrasive Products (FEPA)⁴⁾.

NOTE 3 Self-adhesive abrasive paper is also available from some manufacturers.

2) A suitable abrasion tester is available from Suga Test Instruments Co Ltd, 5-4-14, Shinjuku, Shinjuku-ku, Tokyo 160, Japan.

3) $6,9 \text{ N} = 700 \text{ gf}$

4) FEPA Standard 43-GB-1984, obtainable from the British Abrasive Federation, P.O. Box 58, Trafford Park Road, Trafford Park, Manchester M17 1JD, United Kingdom.



Key

- 1 Reciprocating motion
- 2 Specimen press
- 3 Abrasive paper
- 4 Wheel
- 5 Specimen
- 6 Specimen support

Figure 1 — Abrasion tester — General description

5.3 Double-sided adhesive tape

Ordinary commercially available 12-mm-wide tape is suitable.

5.4 Reference panel

A recommended reference panel for the calibration of abrasive paper is the PMMA panel, which is described in annex B.

Other reference panels may be used by agreement between the interested parties.

5.5 Balance

Use a balance with an accuracy of 0,1 mg.

6 Sampling

Take a representative sample of the product to be tested (or of each product in the case of a multi-coat system), as described in ISO 15528.

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

7 Test panels

7.1 Substrate

The substrate shall be plane and, unless otherwise agreed, made of transparent glass, mild steel or aluminium in accordance with ISO 1514. However, paper sheeting which is suitable for the coatings under test may also be used.

It is important that each panel is flat and of low mass. If, during testing, the abrasion of the coating is found not to be uniform, examine the panel to see if it is planar.

7.2 Shape and dimensions

The shape and dimensions of the test panels shall be such that they can be fitted easily on to the apparatus. Typical dimensions for a test panel are 50 mm × 50 mm × (1 to 5) mm.

7.3 Preparation and coating

Prepare the test panels (or paper sheets) in accordance with ISO 1514.

Degrease the panels, using a suitable solvent.

Coat the panels by the specified method with the product or system under test.

7.4 Drying

Dry (or stove) and age, if applicable, each coated test panel for the specified time under the specified conditions.

7.5 Conditioning

Condition the coated test panels as described in ISO 3270 for at least 16 h.

7.6 Thickness of coating

Determine the thickness, in micrometres, of the dried coating by one of the procedures specified in ISO 2808.

8 Procedure

8.1 Test conditions

Carry out the test at a temperature of (23 ± 2) °C and a relative humidity of (50 ± 5) %, unless otherwise agreed (see also ISO 3270).

8.2 Preparation for the test

Condition the abrasive paper (5.2) and also the adhesive tape (5.3), if used, at a temperature of (23 ± 2) °C and a relative humidity of (50 ± 5) %, unless otherwise agreed (see also ISO 3270), for a minimum period of 16 h.

Attach a conditioned abrasive-paper strip to the circumference of the wheel, using the conditioned adhesive tape if necessary. Adjust the length of each strip so that it covers the whole circumferential surface of the wheel without overlap or gap.

NOTE It is recommended that the strips be cut at an angle of approximately 45° so that the joint is not at right angles to the direction of motion of the test panel (see Figure 2).

Adjust the load on the wheel to $(6,9 \pm 0,05)$ N or a value agreed on between the interested parties.

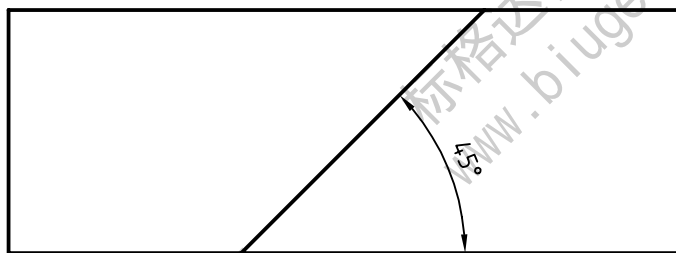


Figure 2 — Recommended method of joining the ends of the abrasive paper strip

8.3 Repeatability check

Before carrying out the actual determination, carry out trial runs on each test panel, following the procedure described in 8.4.1, but using 10, 30, 50 and 100 double strokes. Plot the loss in mass against the number of double strokes. The plot should be a straight line. If it is not, adjust the apparatus in one or both of the following ways:

- a) change the abrasive paper to a coarser grade;
- b) decrease the load on the test panel.

Repeat the check to ensure that the adjustment(s) made have had the desired effect.

NOTE The purpose of this check is to ensure that repeatability is not affected by the production of abrasion debris which can clog the abrasive paper and hence influence the results.

8.4 Determination

8.4.1 Loss in mass by abrasion

Carry out the determination for both the test panel and the reference panel six times, using the same load and using abrasive paper strips cut out of the same sheet.

Weigh the reference panel to the nearest 0,1 mg and mount it on the tester. Abrade the reference panel under the specified load and with the specified abrasive paper for 100 double strokes. Clean the panel with lint-free paper and reweigh it to the nearest 0,1 mg.

Carry out at least five further determinations on the same reference panel in test areas that do not overlap one another.

Carry out six determinations on a conditioned test panel which has been checked as described in 8.3, without overlap of the test areas.

If the coating shows loss of adhesion or is abraded through to the substrate or, in the case of a multicoat system, the topcoat is abraded through to an undercoat, then alter the test conditions so that this no longer occurs.

The following adjustments are recommended:

- a) decreasing the load on the specimen;
- b) changing the abrasive paper to a finer grit grade;
- c) increasing the thickness of the film on the test panel.

8.4.2 Calibration factor for the abrasive paper

Determine the calibration factor F for the abrasive paper used in the test by the following equation:

$$F = W_R / (11,0 \times f)$$

where

W_R is the mean loss in mass, in mg, of the reference panel for 100 double strokes by the abrasive paper used in the test;

11,0 is the measured mean loss in mass, in mg, of the reference panel for 100 double strokes by the standard abrasive paper;

f is a correction factor for the reference panel, which is written on the reference panel (see annex B).

9 Expression of results

9.1 Loss in mass by abrasion

When the abrasion test is carried out for 100 double strokes (usually, 100 double strokes is recommended), the loss in mass for 100-double-stroke abrasion W_L , expressed in mg/100 DS, is given by the following equation:

$$W_L = W_S / F$$

where

W_S is the mean loss in mass of the tested specimen, in mg, for 100 double strokes;

F is the calibration factor for the abrasive paper (determined in 8.4.2).

9.2 Abrasion resistance.

The abrasion resistance R_A , in DS/mg, is given as follows:

$$R_A = F \times 100 / W_S$$

9.3 Wearthrough

If the test was continued to wearthrough, calculate the mean number of double strokes required for wearthrough of the coating, or the topcoat of a multicoat system, to occur.

NOTE After wearthrough of the coating, loss in mass is affected by abrasion of the substrate.

10 Precision

10.1 General

The precision of the method depends on the characteristics of the product tested. For the PMMA reference panels described in annex B, the following values are valid:

10.2 Repeatability (r)

The value below which the absolute difference between two single test results, each the mean of duplicates, obtained on identical material by one operator within one laboratory within a short interval of time using the standardized test method may be expected to lie with a 95 % probability is 10 %.

10.3 Reproducibility (R)

The value below which the absolute difference between two test results, each the mean of duplicates, obtained on identical material by operators in different laboratories using the standardized test method may be expected to lie with a 95 % probability is 22 %.

These figures are based on round-robin testing in Japan. A report of this round robin is available from the secretariat of ISO/TC 35 (NNI).

11 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 7784 (ISO 7784-3);
- c) the items of supplementary information 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 load used;
- f) the grade of abrasive paper used and its calibration factor (determined in 8.4.2);
- g) the number of double strokes used in the determination of the loss in mass of the test panel and reference panel;
- h) the results of the test, as indicated in clause 9;
- 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) Thickness and surface preparation of the substrate.
- b) Method of application of the test coating to the substrate, including duration and conditions of drying between coats in the case of a multi-coat system.
- c) Duration and conditions of drying (or stoving) and ageing, if applicable, of the coating before testing.
- d) Thickness, in micrometres, of the dry coating and method of measurement in accordance with ISO 2808, and whether it is a single coating or a multi-coat system.
- e) Temperature and humidity used for the test, if different from those specified in 8.1 (see also ISO 3270).

Annex B (informative)

Recommended reference panel for the calibration of abrasive paper

B.1 Material

Poly(methyl methacrylate) (PMMA) with the following physical properties at 20 °C:

Universal hardness $HU_{251,7/0,5}$: (220 ± 5) N/mm² (determined in accordance with ISO/TR 14577:1995, *Metallic materials — Hardness test — Universal test*)

Abrasion resistance R_A : $(9,09 \pm 1,0)$ DS/mg

Density: 1,19 g/cm³

Refractive index n_D^{20} : 1,49

Tensile strength: 760 kg/cm²

Modulus of elasticity: 3×10^4 kg/cm²

Elongation: 4,5 %

Molecular mass (by gas permeation chromatography): 100 000

f -values for PMMA reference panels from different batches are not always the same, as shown in the annex to the report on the round-robin testing carried out on these panels (see 10.3).

The f -value for a reference panel (which is provided on request, usually together with the tester, by the manufacturer of the tester) is written on each reference panel.

The value stated has been determined by the abrasion test, using abrasive paper with an F -value which is already known. Abrasive paper of known F -value can also be obtained from the manufacturer of the tester.

B.2 Standard size and shape

Flat panel measuring 50 mm × 50 mm × 2 mm.

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