INTERNATIONAL STANDARD

ISO
2813

Paints and varnishes — Determination of specular gloss of non-metallic paint films at 20°, 60° and 85°

Peintures et vernis — Détermination de la réflexion spéculaire de feuils de peinture non métallisée à 20°, 60° et 85°

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 2813 was prepared by Technical Committee ISO/TC 35, *Paints and varnishes*, Subcommittee SC 9, *General test methods for paints and varnishes*.

This third edition cancels and replaces the second edition (ISO 2813:1978), the whole text of which has been technically revised.

Annex A forms an integral part of this International Standard. Annex B is for information only.

Paints and varnishes — Determination of specular gloss of non-metallic paint films at 20°, 60° and 85°

1 Scope

This International Standard is one of a series of standards dealing with the sampling and testing of paints, varnishes and related products.

It specifies a test method for determining the specular gloss of paint films using a reflectometer geometry of 20°, 60° or 85°. The method is not suitable for the measurement of the gloss of metallic paints.

a) The 60° geometry is applicable to all paint films, but for very high gloss and near-matt films 20° or 85° may be more suitable.

b) The 20° geometry, which uses a smaller receptor aperture, is intended to give improved differentiation between high-gloss paint films (i.e. films with a 60° specular gloss higher than about 70 units).

c) The 85° geometry is intended to give improved differentiation between low-gloss paint films (i.e. films with a 60° specular gloss lower than about 10 units).

NOTES

1 The same geometry should, of course, be retained for a series of measurements even if this means disregarding the suggested limits.

2 In some cases, the determination of specular gloss may not correspond to a visual assessment.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this International Standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this International Standard 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 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 2808:1991, *Paints and varnishes — Determination of film thickness.*

3 Definition

For the purposes of this International Standard, the following definition applies.

3.1 specular gloss: The ratio of the luminous flux reflected from an object in the specular direction for a specified source and receptor angle to the luminous flux reflected from glass with a refractive index of 1,567 in the specular direction.

NOTE 3 To define the specular-gloss scale, polished black glass with a refractive index of 1,567 is assigned the value of 100 for geometries of 20°, 60° and 85°.

4 Required supplementary information

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

5 Apparatus

Ordinary laboratory apparatus and glassware, together with the following:

5.1 Substrate for tests where a liquid paint sample is supplied

The substrate shall be glass of mirror quality, preferably of thickness at least 3 mm and of dimensions at least 150 mm × 100 mm. The largest dimension shall be at least equal to the length of the illuminated area.

NOTE 4   Although the method as written is restricted to paints, clear varnishes may be tested by using as the substrate either black glass or clear glass roughened and covered on the back and edges by black paint.

5.2 Film applicator

A block applicator, having a recess ground from the underface to form a gap 150 μm ± 2 μm deep when placed on an optically plane surface, or other means of applying a paint film, shall be used.

NOTE 5   The block applicator produces a wet-film thickness of approximately 75 μm.

5.3 Glossmeter

The glossmeter shall consist of a light source and a lens that directs a parallel beam of light onto the surface under test, and a receptor housing containing a lens, field stop and photoelectric cell to receive the required cone of reflected light. The glossmeter shall have the following characteristics.

a) Geometry

The axis of the incident beam shall be at 20° ± 0,1°, 60° ± 0,1° or 85° ± 0,1° (see table 1) to the normal to the surface under test. The axis of the receptor shall coincide with the mirror image of the axis of the incident beam to within ±0,1°. With a flat piece of polished black glass or a front-reflecting mirror in the test panel position, an image of the source shall be formed at the centre of the receptor field stop (receptor window). (See figure 1 for a general indication of the essential features.) To ensure averaging over the whole surface, the width of the illuminated area of the test panel shall be significantly larger than likely surface structures: a generally accepted value is 10 mm.

The dimensions of the source image and receptor apertures and the associated tolerances shall be as indicated in table 1. The angular dimensions of the receptor field stop shall be measured from the receptor lens.

b) Filtering at the receptor

Filtering at the receptor shall be done in such a way that the transmittance of the filter $\tau(\lambda)$ is given by

$$\tau(\lambda) = k \frac{V(\lambda) \cdot S_C(\lambda)}{s(\lambda) \cdot S_S(\lambda)}$$

where

$V(\lambda)$ is the CIE photopic luminous efficiency;

$S_C(\lambda)$ is the spectral power distribution of CIE standard illuminant C;

$s(\lambda)$ is the spectral sensitivity of the receptor;

$S_S(\lambda)$ is the spectral power distribution of the illuminating source;

k is a calibration constant.

NOTE 6   The tolerances have been chosen so that errors in the source and receptor apertures will not produce reading errors of more than one gloss unit at any point on a 100-unit scale (see 5.4.1).

By agreement, CIE standard illuminant A may also be used for a transition period. This shall be stated in the test report.

c) Vignetting

There shall be no vignetting of rays that lie within the field angles specified in 5.3 a).

d) Receptor meter

The receptor measurement device shall give a reading proportional to the light flux passing the receptor field stop to within 1 % of the full-scale reading.

NOTE 7   A commonly used receptor meter arrangement uses a barrier-layer photocell in conjunction with a high-resistance galvanometer. This is not satisfactory as the galvanometer output is markedly non-linear, but

this can be overcome by connecting a low-input-impedance electronic amplifier between the photocell and the galvanometer.

In addition, the apparatus shall have a sensitivity control enabling the photocell current to be set to any desired value on the instrument scale.

Table 1 — Angles and relative dimensions of source image and receptor aperture

Parameter	In plane of measurement[1]			Perpendicular to plane of measurement		
	angle σ [2]	2 tan σ/2	relative dimension	angle σ [2]	2 tan σ/2	relative dimension
Source image aperture	0,75° ± 0,25°	0,013 1 ± 0,004 4	0,171 ± 0,075	2,5° ± 0,5°	0,043 6 ± 0,008 7	0,568 ± 0,114
Receptor aperture (20° geometry)	1,80° ± 0,05°	0,031 4 ± 0,000 9	0,409 ± 0,012	3,6° ± 0,1°	0,062 9 ± 0,001 8	0,819 ± 0,023
Receptor aperture (60° geometry)	4,4° ± 0,1°	0,076 8 ± 0,001 8	1,000 ± 0,023	11,7° ± 0,2°	0,204 9 ± 0,003 5	2,668 ± 0,046
Receptor aperture (85° geometry)	4,0° ± 0,3°	0,069 8 ± 0,005 2	0,909 ± 0,068	6,0° ± 0,3°	0,104 8 ± 0,005 2	1,365 ± 0,068

1) The receptor aperture in the plane of measurement for the 60° geometry has been taken as unity.

2) Source image aperture angle: σ_S; receptor aperture angle: σ_B.
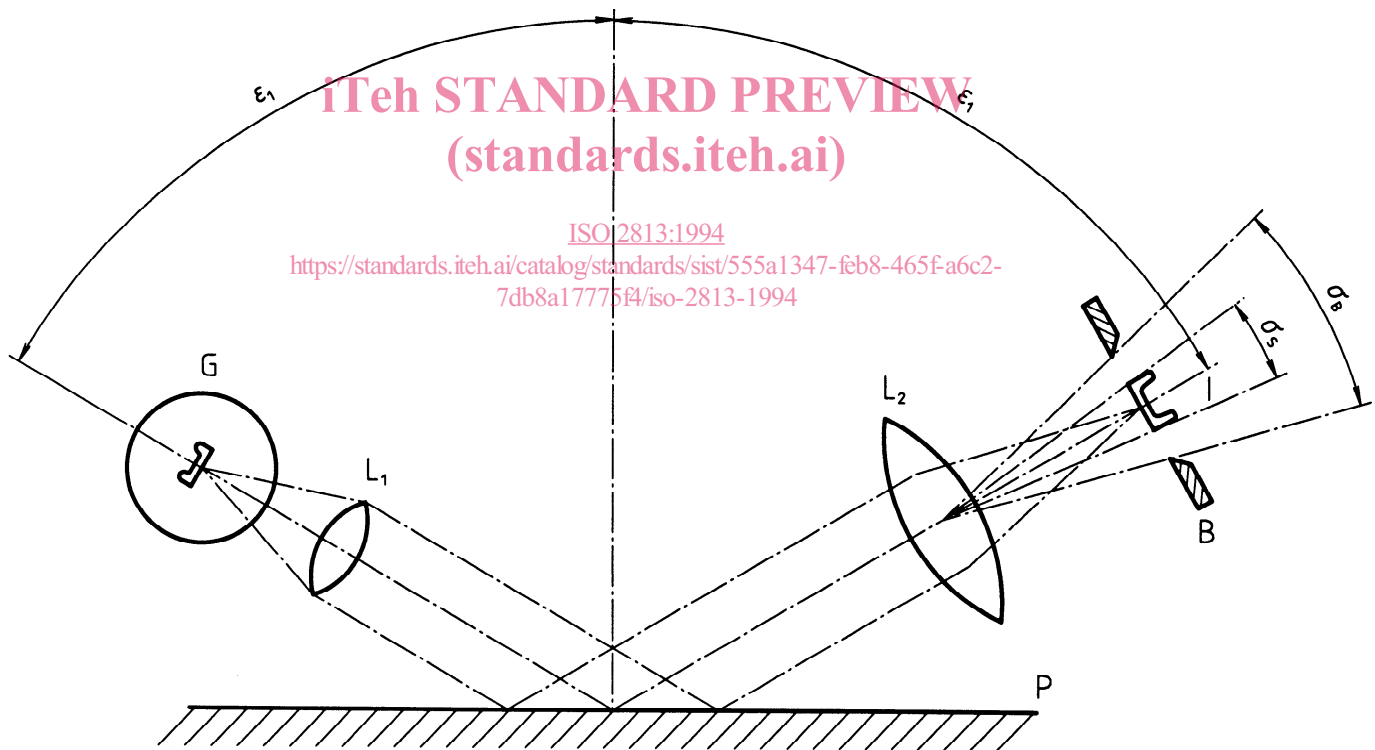
G = lamp
L_1 and L_2 = lens
B = receptor field stop
P = paint film
$\varepsilon_1 = \varepsilon_2$
σ_B = receptor aperture angle
σ_S = source image aperture angle
I = image of filament

Figure 1 — Schematic diagram of a glossmeter (section through the plane of measurement)

5.4 Reference standards

5.4.1 Primary reference standard

The primary reference standard shall be highly polished black glass, the top surface being plane to within two fringes per centimetre, as measured by optical-interference methods.

NOTE 8   It is not intended that the primary reference standards be used for daily calibration of glossmeters.

Glass with a refractive index, measured at a wavelength of 587,6 nm, of 1,567 shall be assigned the specular-gloss value of 100. If glass of this refractive index is not available, a correction is needed. Values of specular gloss for polished black glass of various refractive indices at the three angles of incidence are given in table 2.

The primary standard shall be checked at least every two years because of the possibility of ageing. In the event of degradation, the original gloss can be restored by optical polishing with cerium oxide.

NOTES

9   The most readily available glass of the required planarity is now manufactured by the "float" process. This glass is unsuitable for use as a primary reference standard because the refractive index of the bulk of the glass differs from that of the surface. It is preferable to use an optically plane glass made by some other process, or to remove the surface of the float glass and repolish to optical planarity.

10   The refractive index should preferably be determined by means of an Abbe refractometer.

11   If the absolute reflectance of the primary reference standard is required, the Fresnel equation may be used, inserting the refractive index of the standard in the equation.

5.4.2 Working reference standards

The working reference standards may be of ceramic tile, vitreous enamel, opaque glass, polished black glass or other materials with uniform gloss, but shall be of good planarity and have been calibrated against a primary reference standard over a given area and for a given direction of illumination. The working reference standards shall be uniform and stable and shall be calibrated by a technically competent organization. At least two standards of different gloss levels shall be available for each glossmeter geometry.

The working reference standards shall be checked periodically by comparison with primary standards.

Table 2 — Specular-gloss values for polished black glass

Refractive index n	Angle of incidence		
	20°	60°	85°
1,400	57,0	71,9	96,6
1,410	59,4	73,7	96,9
1,420	61,8	75,5	97,2
1,430	64,3	77,2	97,5
1,440	66,7	79,0	97,6
1,450	69,2	80,7	98,0
1,460	71,8	82,4	98,2
1,470	74,3	84,1	98,4
1,480	76,9	85,8	98,6
1,490	79,5	87,5	98,8
1,500	82,0	89,1	99,0
1,510	84,7	90,8	99,2
1,520	87,3	92,4	99,3
1,530	90,0	94,1	99,5
1,540	92,7	95,7	99,6
1,550	95,4	97,3	99,8
1,560	98,1	98,9	99,9
1,567 [1]	100,0 [1]	100,0 [1]	100,0 [1]
1,570	100,8	100,5	100,0
1,580	103,6	102,1	100,2
1,590	106,3	103,6	100,3
1,600	109,1	105,2	100,4
1,610	111,9	106,7	100,5
1,620	114,3	108,4	100,6
1,630	117,5	109,8	100,7
1,640	120,4	111,3	100,8
1,650	123,2	112,8	100,9
1,660	126,1	114,3	100,9
1,670	129,0	115,8	101,0
1,680	131,8	117,3	101,1
1,690	134,7	118,8	101,2
1,700	137,6	120,3	101,2
1,710	140,5	121,7	101,3
1,720	143,4	123,2	101,3
1,730	146,4	124,6	101,4
1,740	149,3	126,1	101,4
1,750	152,2	127,5	101,5
1,760	155,2	128,9	101,5
1,770	158,1	130,4	101,6
1,780	161,1	131,8	101,6
1,790	164,0	133,2	101,6
1,800	167,0	134,6	101,7

[1] Primary reference standard.

5.4.3 Zero reference standard

For checking the zero point of the reflectometer a suitable standard (for example black velvet, black felt of a black box) shall be used.

6 Sampling of liquid paints

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 1512.

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

7 Sampling of coated substrates

Take a planar area of coated substrate, if practicable, with dimensions of at least 150 mm × 100 mm.

NOTE 12   Gloss measurements made using the method specified in this International Standard are only meaningful if carried out on surfaces of good planarity; any curvature or local unevenness of the substrate affects the test results.

8 Preparation of test panels

8.1 Liquid paint samples

8.1.1 Preparation of test films

Apply the test film, preferably in a manner and at a film thickness corresponding to that normally used for the paint, by the method specified or agreed, for example brushing, roller-coating or spraying (see clause 4 and annex A).

In the absence of a specified or agreed method, and in cases of dispute, proceed as follows:

Mix the paint samples thoroughly by stirring vigorously immediately before application in order to break down any thixotropic structure but taking care not to incorporate air bubbles into the paint. Apply each paint at a spreading rate of approximately 15 m²/l to a freshly degreased substrate (5.1) by placing approximately 2 ml of paint in a line across one end of the glass plate and spreading, using the film applicator (5.2), to give a smooth film, drawing the film applicator down the plate with a firm pressure at a speed of approximately 100 mm/s. Dry the coated test panels at (23 ± 2) °C and (50 ± 5) % relative humidity (or stove them) for the specified or appropriate time. Before measuring the gloss, condition the films for 16 h at the same temperature and humidity without exposure to direct sunlight.

Carry out the test procedure as soon as possible.

8.1.2 Thickness measurement

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

8.2 Paint films on substrates

8.2.1 General

The direction of brush marks, if discernable, raised wood grain or similar regular texture effects shall be parallel to the plane of incidence and reflection of the instrument.

8.2.2 Thickness measurement

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

9 Calibration of the glossmeter

9.1 Preparation of the apparatus

Calibrate the apparatus at the start of every period of operation and during operation at intervals sufficiently frequent to ensure that the instrument response is essentially constant.

9.2 Zero-point check

Use the zero reference standard (5.4.3) to check the zero point on the scale. If the reading is not within ±0,1 of zero, subtract it arithmetically from subsequent readings.

9.3 Calibration

Using a working reference standard with a specular gloss close to 100, adjust the instrument to the correct value, with the pointer in the upper half of the scale.

Next take a second (lower) working reference standard and make a measurement with the same control settings. If the reading is within one scale division of the correct value, the proportionality requirement of 5.3 d) is met, but if the reading is outside the specified tolerance, carry out an additional measurement with a further working reference standard. If both readings differ by more than one scale unit from the correct values, the instrument shall be adjusted by the manufacturer, or in accordance with the manufacturer's instructions, and the calibration procedure repeated until the working reference standards can be measured with the required accuracy. If the repeat reading is within one scale unit, tests may be carried out but calibration checks shall be carried out before each determination.

10 Procedure

10.1 Gloss measurement of films from liquid paints

After calibrating the glossmeter, for test films on glass plates take three readings in different positions parallel to the direction of application, checking after each series against the higher-gloss working reference standard to ensure that there is no drift in calibration. If the spread of the readings is less than five units, report the mean value as the specular gloss value; otherwise take three further readings and report the mean and range of all six values.

For measurement of films on substrates other than glass, take six readings, three in each of two directions at right angles, and report the mean and the range. Check the reading of the higher-gloss working reference standard after three readings to ensure the instrument has not drifted.

10.2 Gloss measurement on coated substrates

Proceed as in 10.1, taking six readings in different areas or in different directions on the surface (except for films with directional texture, such as brush marks). Check the reading of the higher-gloss working reference standard after three readings to ensure the instrument has not drifted. Calculate the mean value. If the variation between the extreme values is less than 10 units or 20 % of the mean value, report the mean and range values. Otherwise, reject the test panel.

11 Precision (applicable to films on glass plates only)

11.1 Repeatability

The values below which the absolute difference between the means of two separate sets of three readings for a film on a glass plate, obtained by one operator in one laboratory within a short interval of time using the standardized test method, may be ex-

pected to lie with a 95 % probability are one unit for the 60° and 85° geometries and two units for the 20° geometry.

11.2 Reproducibility

The values below which the absolute difference between the means of two separate sets of three readings for a film of the same product on a glass plate, obtained by operators in different laboratories using the standardized test method, may be expected to lie with a 95 % probability are six, four and seven units for the geometries of 20°, 60° and 85°, respectively.

For some types of paint, particularly semi-gloss paints, the specular gloss is sensitive to variations in drying conditions and the method of film preparation, so that the reproducibility of tests made on such liquid paints will be poorer than that specified above. In cases of dispute, when specular-gloss measurements differ by more than 10 %, prepared paint films shall be exchanged between laboratories.

12 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 International Standard (ISO 2813);

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 angle of incidence used;

f) the results of the test, as indicated in clause 10;

g) any deviation from the test method specified;

h) 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) Substrate material, substrate thickness and sur-
   face preparation of the substrate.

b) Method of application of the test coating to the substrate.

   NOTE 13   Application by brushing can lead to vari-
   ability of gloss readings.

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.