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Paints and varnishes — Determination of reflection haze on paint films at 20°

Peintures et vernis — Détermination du flou spéculaire sur des feuils de peinture à 20°

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

International Standard ISO 13803 was prepared by Technical Committee ISO/TC 35, *Paints and varnishes*, Subcommittee SC 9, *General test methods for paints and varnishes*.

Annex A forms an integral part of this International Standard.

Paints and varnishes — Determination of reflection haze on paint films at 20°

1 Scope

This International Standard is one of a series of standards dealing with the sampling and testing of coating materials such as paints and varnishes, as well as coatings prepared from them.

It specifies a test method for measuring at 20° the reflection haze of paint coatings.

The use of this geometry means that the method is closely related to the measurement of specular gloss at 20° in ISO 2813. The application of this method is intended to give improved differentiation between high-gloss surfaces, for example in the field of assessment of dispersion characteristics. The method is therefore a useful complement to ISO 8781-3 which uses specular gloss measurements.

For decorative coatings (e.g. automotive coatings), reflection haze is also an important criterion in evaluating the quality of the coating, in addition to colour and specular gloss.

The results obtained often depend on the following properties of the paints:

a) the binder system used and the composition of the paint;

b) the wetting and dispersing properties of the pigments;

c) the method of application;

d) the orientation of the test sample with respect to the plane of measurement.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this International Standard. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this International Standard 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 2808:1997, *Paints and varnishes — Determination of film thickness.*

ISO 2813:1994, *Paints and varnishes — Determination of specular gloss of non-metallic paint films at 20°, 60° and 85°.*

ISO 7668:1986, *Anodized aluminium and aluminium alloys — Measurement of specular reflectance and specular gloss at angles of 20°, 45°, 60° or 85°.*

ISO 7724-2:—[1], *Paints and varnishes — Colorimetry — Part 2: Colour measurement.*

ISO 8781-3:1990, *Pigments and extenders — Methods of assessment of dispersion characteristics — Part 3: Assessment from the change in gloss.*

ISO 15528:—[2], *Paints, varnishes and raw materials for paints and varnishes — Sampling.*

3 Term and definition

For the purposes of this International Standard, the following term and definition apply.

3.1
reflection haze
ratio of the luminous flux reflected and diffusely scattered from an object adjacent to 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, this glass being assigned the value of 100 on the linear reflection haze scale.

NOTE The measurement of reflection haze is related to the measurement of specular gloss in accordance with ISO 2813. Therefore, this International Standard has been adapted, as closely as possible, to ISO 2813 and should be read in conjunction with ISO 2813. The main difference between the two standards is that specular gloss is measured in the specular direction and reflection haze is measured in slightly different directions.

4 Apparatus and materials

4.1 Substrate

The substrate should preferably be agreed on between the interested parties. In the absence of such an agreement, the substrate shall be plate glass of mirror quality, preferably of a thickness of at least 3 mm, and have a minimum test area of 150 mm × 100 mm. The larger dimension shall be at least equal to the length of the illuminated area.

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

4.2 Film applicator

Use a block applicator having a recess ground in the underface to form a gap (150 ± 2) μm deep when placed on an optically plane surface, or another suitable means, to apply the test coating.

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

4.3 Hazemeter

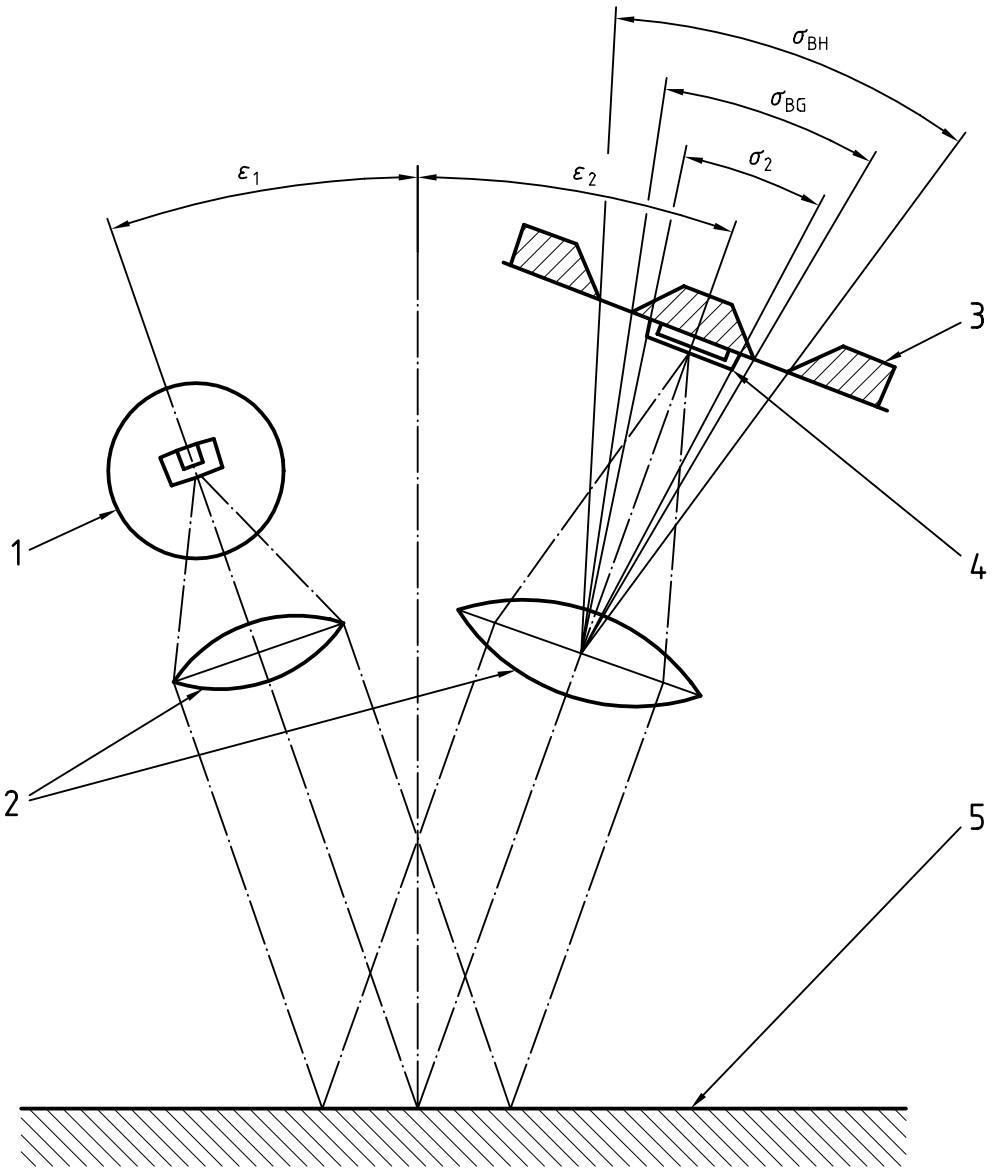
The hazemeter shall consist of a light source and a lens that directs a parallel beam of light onto the surface under test, plus a receptor housing containing a lens, field stop and photoelectric cell to receive the required cone of reflected light. The hazemeter shall have the following characteristics:

a) **Geometry:** The axis of the incident beam shall be at an angle $\varepsilon_1 = (20 \pm 0{,}1)°$ (see Figure 1) to the normal to the surface under test. The axis of the receptor shall be coincident 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-silvered mirror in the test panel position, an image of the light source shall be formed at the centre of the receptor field stop

1) To be published. (Revision of ISO 7724-2:1984)

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

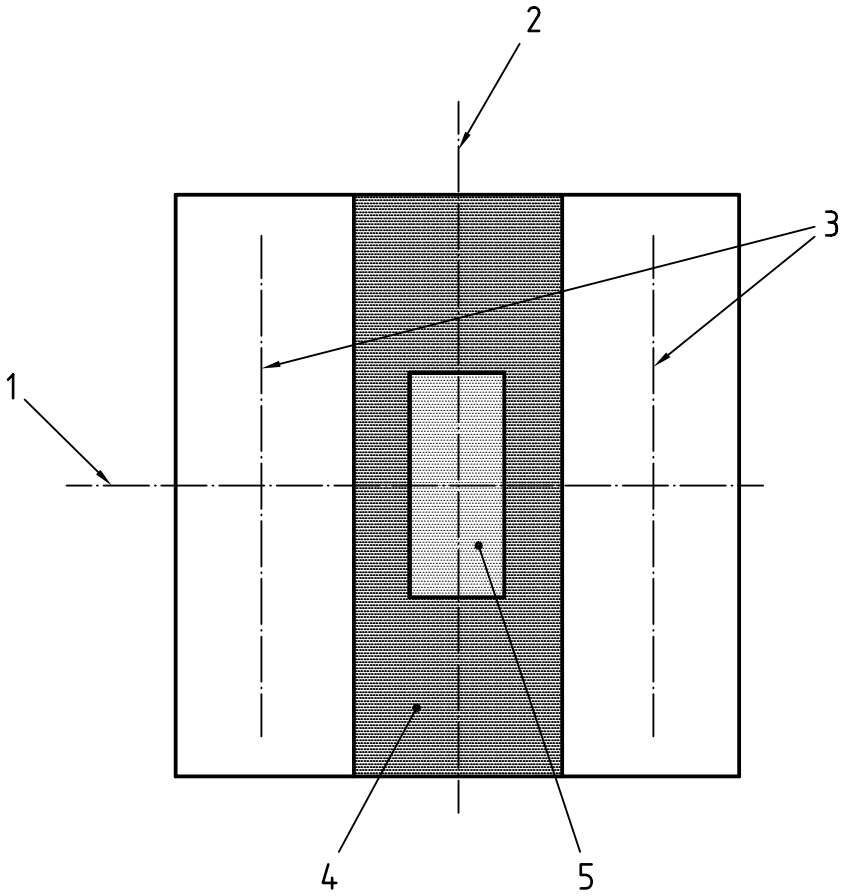
(see Figure 2 for the general disposition of the main features). To be certain of averaging out any surface uneveness, the width of the illuminated area on the test panel shall be significantly larger than possible surface irregularities: a generally accepted value is 10 mm. The dimensions of and tolerances on the image aperture and receptor aperture shall be as indicated in Table 1. The angular dimensions of the receptor field stop shall be measured from the receptor lens.



Key

1 Lamp
2 Lenses
3 Receptor field stop
4 Image of light source
5 Paint film

Figure 1 — Schematic diagram of the reflection hazemeter in the plane of measurement



Key

1 Plane of measurement
2 Plane perpendicular to plane of measurement
3 Receptor area
4 Central opaque zone
5 Image of light source

Figure 2 — Receptor field stop

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

$$\tau(\lambda) = k \frac{V(\lambda) \times S_{\mathrm{C}}(\lambda)}{s(\lambda) \times S_{\mathrm{S}}(\lambda)} \tag{1}$$

where

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

$S_{\mathrm{C}}(\lambda)$ is the spectral power distribution of CIE standard illuminant C;

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

$S_{\mathrm{S}}(\lambda)$ is the spectral power distribution of the illuminating source;

k is the calibration constant.

c) Vignetting: There shall be no vignetting of rays that lie within the angular fields specified in Table 1.

d) Receptor meter: The photoelectric cell shall give a reading proportional to the light flux passing the receptor field stop to within 1 % of the full-scale reading.

Table 1 — Source-image and receptor-aperture angles

	Angle in plane of measurement degrees	Angle perpendicular to plane of measurement degrees
Image of light source σ_2	$0{,}75 \pm 0{,}1$	$2{,}5 \pm 0{,}1$
Receptor aperture σ_{BH}	$5{,}5 \pm 0{,}25$	$5{,}5 \pm 0{,}25$
Central opaque part of receptor aperture σ_{BG}	$2{,}0 \pm 0{,}1$	$5{,}5 \pm 0{,}25$

4.4 Reference standards

4.4.1 Primary reference standard

The primary reference standard shall be in accordance with ISO 2813.

NOTE 1 Since no suitable primary reference standard for reflection haze is available, the corresponding primary gloss standard is chosen as a substitute.

NOTE 2 It is not intended that the primary reference standard be used for the daily calibration of hazemeters.

NOTE 3 The use of a quartz wedge as a primary reference standard is a recent technical improvement. In anticipation of its future use in ISO 2813, a quartz wedge may be used in this International Standard.

4.4.2 Working reference standards

Working reference standards may be of ceramic tile, vitreous enamel, opaque glass or other materials with uniform reflection haze and shall have been calibrated against a primary reference standard for an indicated area and direction of illumination. Working reference standards shall be uniform and stable and shall be calibrated by a technically competent organization. At least two standards of different reflection haze levels shall be available.

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

4.4.3 Zero reference standard

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

5 Sampling

Take a representative sample of the coating material 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.

6 Preparation of test panels

Prepare the test panels as described in ISO 2813.

7 Calibration of the hazemeter

7.1 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. The apparatus shall have a sensitivity control for setting the photocell current to any desired value on the instrument scale or digital indicator.

7.2 Zero point check

A black box or velvet shall be used for checking the zero point of the display. If the reading is not within $\pm 0{,}1$ of zero, subtract it arithmetically from subsequent readings.

7.3 Calibration

Using the primary reference standard or the higher of two working reference standards, adjust the instrument to the selected value for haze in the upper part of the scale. Calibration with a primary reference standard can be performed in two ways (the manufacturer of the instrument should recommend one of the two calibration methods to its customer):

a) by tilting the standard in the plane of measurement by an angle of 0,7° to 0,9° (in either direction) to project the image of the light source into a non-obscured part of the receptor aperture;

b) by removing temporarily the central obscuring part of the receptor aperture.

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

8 Procedure

8.1 General

Reflection haze measurements in accordance with this International Standard are only meaningful if determined on surfaces of good planarity; any curvature or local unevenness of the substrate will affect the test results. Unless agreed otherwise, the direction of brush marks, raised wood grain or similar regular texture effects shall be parallel to the plane of incidence and reflection of the instrument.

The measured linear reflection haze value H_{linear} will depend on the lightness of the sample. With samples of different lightness, comparable results can nevertheless be obtained by compensating for lightness differences and reporting as logarithmic reflection haze values $H'20$ as explained in annex A.

8.2 Haze measurement of coatings from liquid paints and powder coating materials on glass plates

After calibrating the hazemeter, for test coatings on a glass plate take three readings in different positions parallel to the direction of application. If the spread of results is less than 0,5 units, report the mean value as the H_{linear} value; otherwise take three further measurements and report the mean and range of all six values.

8.3 Haze measurement on other coated substrates

Proceed as in 8.2, taking six measurements in different areas or in different directions on the surface (except for coatings with directional texture, such as brush marks). Calculate the mean value. If the variation between extreme values is less than 1 unit or 20 % of the mean value, report the mean and range values. Otherwise reject the test panel.

9 Supplementary test conditions

For any particular application of the test method specified in this International Standard, more details, in addition to those given in preceding clauses, need to be given.

To enable the method to be carried out, the following test conditions shall be laid down as appropriate:

a) Substrate material and surface preparation of the substrate.

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

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 multicoat system.

These test conditions 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.

10 Precision (applicable to linear haze of high-gloss coatings on plate glass only)

10.1 Repeatability r

The repeatability r is the value below which the absolute difference between the mean values of two separate sets of three values, obtained on a coating of the same product on plate glass, can be expected to lie when this method is used under repeatability conditions. In this case, the results are obtained on identical material by one operator in one laboratory within a short interval of time using the same equipment and following the standardized test method. In this International Standard, r is 1 % of the mean values or 0,2 units, whichever is the larger, with a 95 % probability.

10.2 Reproducibility R

The reproducibility R is the value below which the absolute difference between the mean values of two separate sets of three values, obtained on a coating of the same product on plate glass, can be expected to lie when this method is used under reproducibility conditions. In this case, the results are obtained on identical material by operators in different laboratories following the standardized test method. In this International Standard, R is 5 % of the mean values or 1 unit, whichever is the larger, with a 95 % probability.

For some types of paint, particularly semi-gloss paints, haze is sensitive to variations in conditions and the method of coating preparation, so that the reproducibility of tests made from such liquid paints and powder coating materials will be poorer than that indicated above. In cases of dispute, when haze measurements for example differ by more than 10 %, prepared paint coatings shall be interchanged between laboratories.

11 Test report

The test report shall contain at least the following information:

a) a reference to this International Standard (ISO 13803);

b) all details necessary for complete identification of the coating tested (manufacturer, trade name, batch number, etc.);

c) the supplementary test conditions referred to in clause 9;

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

e) the results of the tests, expressed as the mean linear reflection haze value H_{linear} or, by agreement, as the mean logarithmic reflection haze value (H'20) and, where required, the number, mean value and extreme values of replicate results;

f) any deviation from the test method specified;

g) details of any specific points on which agreement between the interested parties was necessary;

h) the date of the test.

Annex A
(normative)

Additional calculations

Linear reflection haze values may be converted, by agreement, to logarithmic values using the following equations:

$$H_{\text{comp}} = H_{\text{linear}} - \frac{Y_{\text{sample}}}{Y_{\text{BaSO}_4}} \times H_{\text{linear,BaSO}_4}$$

$$H'20 = k \times \log\left(\frac{H_{\text{comp}}}{20} + 1\right)$$

where

H_{comp} is what is referred to as the lightness-compensated haze value;

$H'20$ is the logarithmic reflection haze of the sample;

H_{linear} is the linear reflection haze of the sample;

$H_{\text{linear,BaSO}_4}$ is the linear reflection haze of a $BaSO_4$ standard;

Y_{sample} is the tristimulus value Y of the sample (see note 1);

Y_{BaSO_4} is the tristimulus value of a $BaSO_4$ standard (see notes 1 and 2);

k is a constant (k = 1 285 is used in order to give an H' value of 1 000 at an H_{linear} value of 100).

Conversion using this empirically derived function gives the following advantages:

The lightness-compensated haze value H_{comp} gives comparable results on samples with different lightness levels, because the luminous flux entering the haze receptor is reduced by diffuse reflection in accordance with Lambert's law.

The logarithmic haze value $H'20$ gives good correlation with visual assessment, in accordance with Weber-Fechner's law.

NOTE 1 The tristimulus value Y, as defined in ISO 7724-2, gives a measure of the lightness. It is required that the conditions of measurement used are: 45°/0°, standard illuminant C and 2° observer. Slightly different conditions will not result in significant errors.

NOTE 2 $BaSO_4$ is used here as a good substitute for a perfectly reflecting diffusor (see ISO 7724-2). Other materials with similar properties may also be used.

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