International Standard 3905

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION•МЕЖДУНАРОДНАЯ ОРГАНИЗАЦИЯ ПО СТАНДАРТИЗАЦИИ•ORGANISATION INTERNATIONALE DE NORMALISATION

Paints and varnishes — Determination of contrast ratio (opacity) of light coloured paints at a fixed spreading rate (using black and white charts)

Peintures et vernis — Détermination du rapport de contraste (pouvoir masquant) des peintures claires à un rendement surfacique déterminé (en utilisant des cartes à contraste de noir et de blanc)

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UDC 667.6 : 535.345.3 **Ref. No. ISO 3905-1980 (E)**

Descriptors : paints, tests, masking power, optical measurement, opacity, analysis methods, reflectrometric analysis, films, substrates, specific surface.

Price based on 3 pages

Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards institutes (ISO member bodies). The work of developing International Standards is carried out through ISO technical committees. Every member body interested in a subject for which a technical committee has been set up 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.

Draft International Standards adopted by the technical committees are circulated to the member bodies for approval before their acceptance as International Standards by the ISO Council.

International Standard ISO 3905 was developed by Technical Committee ISO/TC 35, *Paints and varnishes*, and was circulated to the member bodies in April 1978.

It has been approved by the member bodies of the following countries :

Australia	Italy	Romania
Brazil	Kenya	South Africa, Rep. of
Egypt, Arab Rep. of	Korea, Rep. of	Spain
France	Mexico	Sweden
India	New Zealand	Switzerland
Iran	Nigeria	Turkey
Ireland	Norway	United Kingdom
Israel	Poland	USSR

The member body of the following country expressed disapproval of the document on technical grounds :

Canada

Printed in Switzerland

INTERNATIONAL STANDARD ISO 3905-1980/AMENDMENT 1

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Paints and varnishes — Determination of contrast ratio (opacity) of light coloured paints at a fixed spreading rate (using black and white charts)

AMENDMENT 1

Amendment 1 to International Standard ISO 3905-1980 was developed by Technical Committee ISO/TC 35, *Paints and varnishes*. It was submitted directly to the ISO Council for acceptance, in accordance with sub-clause 5.10.1 of part 1 of the Directives for the technical work of ISO.

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3 Principle

Second paragraph, second and third line, replace "dry film mass per unit area" by "surface density of the dry film".

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Paints and varnishes — Determination of contrast ratio (opacity) of light coloured paints at a fixed spreading rate (using black and white charts)

0 Introduction

This International Standard is one of a series of standards dealing with the sampling and testing of paints, varnishes and related products. It should be read in conjunction with ISO 1512, ISO 1513, ISO 1515, ISO 2811 and ISO 2814.

ISO 2814 gives a simple method for comparison of opacity of paints of the same type and colour, based on measurement of the contrast ratio of films drawn down in a prescribed manner over black and white substrates. Alternative techniques for test film preparation and measurement are specified, namely :

a) direct application to black and white charts, for example Morest charts;

b) application to colourless, transparent polyester film, the coated film being subsequently placed in turn over black and white glass tiles.

Because different operators using the same draw-down device may obtain films differing significantly in thickness, the method in ISO 2814 is not satisfactory for absolute determination of opacity. Collaborative trials between groups of experts from a number of countries have shown that reproducible results can be obtained by determination of the contrast ratio corresponding to a precisely fixed spreading rate by interpolation between measurements at two or more measured film thicknesses. The spreading rate selected in this International Standard is 20 m^2/l (wet thickness 50 µm), considered an average for brush application of a free-flowing paint on a smooth, non-porous surface. However, for particular types of paints normally used at other film thickness ranges, for example industrial enamels and printing inks, the interested parties may agree another fixed spreading rate.

Further collaborative trials indicated that the highest reproducibility was obtained with films spread on polyester film [b) above], althrough the technique of spreading on and measuring a black and white card was simpler to operate. It was not considered appropriate to combine the two techniques as alternatives within one method as was done in ISO 2814 because of the major differences in reproducibility. Accordingly, two separate methods have been prepared : this International Standard deals with application to black and white charts, while ISO 3906 deals with application to polyester film.

1 Scope and field of application

This International Standard specifies a method to be used for determining the opacity (by contrast ratio measurement) given by paint films of white or light colours of reflectance value greater than 25 %, applied at a spreading rate of 20 m^2/l to an agreed black and white substrate.

2 References

ISO 1512, *Paints and varnishes — Sampling.*

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

ISO 1515, *Paints and varnishes — Determination of volatile and non-volatile matter.*

ISO 2811, *Paints and varnishes — Determination of density.*

ISO 2814, *Paints and varnishes — Comparison of contrast ratio (hiding power) of paints of the same type and colour.*

ISO 3906, *Paints and varnishes — Determination of contrast ratio (opacity) of light coloured paints at a fixed spreading rate (using polyester film).*

3 Principle

The method is based on the observation that contrast ratio is an approximately linear function of reciprocal film thickness, over a restricted film thickness range which also corresponds to that used for normal application of white or light coloured paints. It is thus possible to interpolate graphically or by computation between results on films of different thicknesses, with satisfactory accuracy.

Because wet film thickness cannot be determined with sufficient accuracy, the method involves determination of dry film mass per unit area and a calculation of the corresponding wet film thickness. In this latter calculation, values for wet paint density and percentage of non-volatile matter content are required. Determination of these values by the methods complying with the relevant International Standards has been stipulated. However, it is recognized that for certain types of paint the non-volatile matter determination according to ISO 1515 does not correspond exactly to the mass changes of a film during drying under the conditions of the present test method. Any errors in results introduced by this discrepancy should be common to all laboratories and should not affect comparisons of paints of similar types.

4 Apparatus

4.1 Substrate

Charts, all the same size and measuring at least 100 mm × 200 mm, printed and varnished to give adjacent black and white areas readily wetted by, but impervious to, solvent- or water-thinned paints.

The black and white areas shall each be of dimensions not less than 80 mm × 80 mm. The reflectance of the white areas of the cards shall be 80 ± 2 % when measured over a white tile using a reflectometer complying with 4.3, and that of the black areas shall be not greater than 1 %, unless otherwise agreed.

To avoid errors due to variation from one batch of charts to another, the charts used for a given test should come from the same batch.

4.2 Film applicators

A series of film applicators giving a range of uniform films of wet thicknesses approximately 40 to 60 µm is required. The film laid down shall be at least 70 mm wide, with areas of dimensions not less than 60 mm × 60 mm and of uniform thickness over both black and white areas of the card. The application of uniform films is facilitated by the use of automatic applicators, which are recommended.

4.3 Reflectometer

A photoelectric instrument giving within 0,3 % an indicated reading proportional to the intensity of light reflected from the surface under test, and having a spectral response approximating to the product of the relative spectral energy distribution of CIE illuminant C or D 65 and the colour matching function $\bar{y}(\lambda)$ of the CIE standard observer. The value measured is Ry.

NOTE — It is recognized that the relative geometrical arrangement of the illuminating beam and the light detector can affect the measurement of Ry, but it is considered that variations arising from this factor in commercial reflectometers should be considerably less than the reproducibility figure stated in clause 7. In the event of dispute, 0°/diffuse geometry, excluding specular reflection, should be used.

4.4 Template or die stamp

A metal template or die stamp of dimensions not less than 60 mm × 60 mm is suitable for accurate removal of a closely defined area from a test chart.

5 Sample

Take a representative sample of the product to be tested as described in ISO 1512. Examine and prepare the sample for testing as described in ISO 1513.

6 Procedure

6.1 Preparation of substrate

Store the black and white substrate charts, in single thickness, under the conditions of testing (23 ± 2 °C and a relative humidity of 50 ± 5 %) for at least 24 h before coating; handle them at all times by the edges to avoid fingermarks on the areas to be coated. Weigh, to the nearest 1 mg, six charts for coating, and two charts to be kept as blank controls. Prepare the charts for coating by one of the following methods :

a) fixing one end, by clips or adhesive tape, to a flat glass plate at least 6 mm thick; or

b) using a vacuum suction plate, which should be flat to within ± 2 µm; or

c) fixing one end and laying it over a flat rubber block (where spiral applicators are to be used).

6.2 Preparation of coated charts

Immediately before application, mix the paint thoroughly by vigorous stirring to break down any thixotropic structure, taking care not to incorporate air bubbles.

Apply about 2 to 4 ml of paint, according to the film thickness required, in a line across one end of the chart and spread it immediately by drawing down a suitable applicator at a steady velocity to give a uniform layer. Prepare duplicate films with each of three different applicators, chosen to give a range of wet film thicknesses from approximately 40 µ to approximately 60 µm.

Maintain the coated charts in a horizontal position until dry, for example by taping the edges to a flat substrate. The drying time (and/or stoving conditions) will depend on the type of paint material being tested, and should be agreed by the interested parties.

6.3 Conditioning

Keep the dried coated charts and the blank charts at 23 ± 2 °C and a relative humidity of 50 ± 5 % for at least 24 h and not more than 168 h before the reflectance measurements are made.

6.4 Measurement of reflectance factors

Measure the reflectances of each coated chart at a minimum of four positions over both the black and white areas of each chart, and calculate the average reflectance factors R_B and R_w respectively. Then calculate the contrast ratio R_B/R_w for each coated chart.

6.5 Determination of surface density of the dry coating

By means of the metal template and a sharp knife or precision die stamp, cut equal areas, of dimensions at least

60 mm × 60 mm, from the centres of the blank and the coated charts. Weigh the detached pieces to the nearest 1 mg.

Calculate the surface density of the dry coating, ϱ_A, in grams per square millimetre, by the formula

$$\varrho_A = \frac{m_4 - m_3 \times \frac{m_2}{m_1}}{A}$$

where

m_1 is the average initial mass, in grams, of the blank control charts;

m_2 is the initial mass, in grams, of the chart to be coated;

m_3 is the average mass, in grams, of the cut portions of the blank control charts;

m_4 is the mass, in grams, of the cut portion of the coated chart;

A is the area, in the square millimetres, of the cut portion of the chart.

NOTE — This technique eliminates the effect of changes in the masses of the charts due to variations in moisture content if it can be assumed that blank and coated charts change equally.

6.6 Calculation of wet film thickness and spreading rate

To calculate the wet film thickness from the surface density of the dry coating, it is necessary to know both the density of the wet paint, as obtained by the method described in ISO 2811, and the non-volatile matter content by mass using the method described in ISO 1515.

6.6.1 Wet film thickness

Calculate the thickness of the wet paint film, t, in millimetres, using the formula

$$t = \frac{\varrho_A}{\varrho \times \mathrm{NV}} \times 10^5$$

where

ϱ is the density of the paint, in grams per millilitre;

NV is the non-volatile matter content, as a percentage by mass.

6.6.2 Spreading rate

The spreading rate, SR, in square metres per litre, is the reciprocal of the wet film thickness, in millimetres, and is given by the formula

$$\mathrm{SR} = \frac{1}{t} = \frac{\varrho \times \mathrm{NV}}{\varrho_A} \times 10^{-5}$$

and, using the formula for surface density in 6.5 above,

$$\mathrm{SR} = \frac{A \times \varrho \times \mathrm{NV}}{m_4 - m_3 \times \frac{m_2}{m_1}} \times 10^{-5}$$

6.7 Determination of contrast ratio for a spreading rate of 20 m²/l

It is assumed that for a limited range of film thickness the contrast ratio is a linear function of the spreading rate. Therefore the values of contrast ratio and the corresponding spreading rates obtained for each of the six films should be plotted graphically and the contrast ratio at a spreading rate of 20 m²/l determined by linear interpolation. The calculation can of course be made less laboriously, where facilities are available, by computing a regression of contrast ratio on spreading rates from the experimental data.

7 Precision

7.1 Repeatability (r)

The value below which the absolute difference between two single test results on identical material obtained by one operator in one laboratory using the same equipment within a short interval of time using the standardized test method, may be expected to lie with a 95 % probability, is 2 %.

7.2 Reproducibility (R)

The value below which the absolute difference between two single test results on identical material, obtained by operators in different laboratories, using the standardized test method, may be expected to lie with a 95 % probability, is 4 %.

8 Test report

The test report shall contain at least the following information :

a) the type and identification of the paint under test;

b) a reference to this International Standard or to corresponding national standard;

c) the type of black and white chart used in the test and the reflectance of the black and white areas on an uncoated chart;

d) the drying time and/or stoving conditions;

e) the values of paint density and percentage by mass of non-volatile matter content used in calculation of the test result;

f) the contrast ratio determined for a spreading rate of 20 m²/l, or other agreed rate;

g) any deviation, by agreement or otherwise, from the test procedure specified;

h) the date of the test.