INTERNATIONAL STANDARD

ISO 6504-3

First edition
1998-07-15

Paints and varnishes — Determination of hiding power —

Part 3:
Determination of contrast ratio (opacity) of light-coloured paints at a fixed spreading rate

Peintures et vernis — Détermination du pouvoir masquant —
Partie 3: Détermination du rapport de contraste (pouvoir masquant) des peintures claires à un rendement surfacique déterminé

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 Electronical Commission (IEC) on all matters of electronical standardization.

Draft International Standards adopted by 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 6504-3 was prepared by Technical Committee ISO/TC 35, *Paints and varnishes*

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Printed in Switzerland

Introduction

For determining the contrast ratio of paints, two alternative techniques for test film preparation and measurement are available:

a) application to colourless, transparent polyester foil, the coated foil being subsequently placed in turn over black and white glass panels;

b) direct application to black and white charts, for example Morest charts.

Because different operators using the same draw-down device will obtain paint films differing significantly in thickness, an absolute method for the determination of opacity is required. 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 part of ISO 6504 is 20 m^2/l (wet film 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 paint normally used at other film thickness ranges, for example industrial enamels and printing inks, the interested parties may agree another spreading rate.

Further collaborative trials indicated that a higher reproducibility was obtained with films spread on polyester foil than with films spread on a black and white chart, although the latter technique was simpler to operate. This part of ISO 6504 provides for both these options.

Paints and varnishes — Determination of hiding power —

Part 3:
Determination of contrast ratio (opacity) of light-coloured paints at a fixed spreading rate

1 Scope

This part of ISO 6504 is one of a series of standards dealing with the sampling and testing of paints, varnishes and related products. It specifies methods for determining the opacity (by contrast ratio measurement) given by paint films of white or light colours of tristimulus value *Y* greater than 25, applied at a spreading rate of 20 m^2/l to an agreed black and white chart or to colourless transparent polyester foil, in the latter case the tristimulus value *Y* being measured subsequently over agreed black and white glass panels.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this part of ISO 6504. 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 6504 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 2811-1:1997, *Paints and varnishes — Determination of density — Part 1: Pyknometer method.*

ISO 2811-2:1997, *Paints and varnishes — Determination of density — Part 2: Immersed body (plummet) method.*

ISO 2811-3:1997, *Paints and varnishes — Determination of density — Part 3: Oscillation method.*

ISO 2811-4:1997, *Paints and varnishes — Determination of density — Part 4: Pressure cup method.*

ISO 3251:1993, *Paints and varnishes — Determination of non-volatile matter of paints, varnishes and binders for paints and varnishes.*

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

3 Principle

The methods are based on the observation that contrast ratio is an approximately linear function of reciprocal spreading rate, 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, with satisfactory accuracy, between results obtained with films of different thicknesses.

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

Because wet film thickness cannot normally be determined with sufficient accuracy, the methods involve the 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 in accordance with ISO 3251 does not correspond exactly to the mass changes of a film during drying under the conditions of the present test method. Any errors introduced into results by this discrepancy should be common to all laboratories and should not affect comparisons of paints of similar types.

4 Apparatus

Ordinary laboratory apparatus and glassware, together with the following:

4.1 Substrate

4.1.1 For Method A (polyester foil): untreated, colourless transparent polyester foil between 30 µm and 50 µm in thickness and of dimensions not less than 100 mm × 150 mm. The use of thicker foils is permitted by agreement between the parties.

4.1.2 For Method B (black and white charts): 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 be of dimensions not less than 80 mm × 80 mm. The tristimulus value *Y* of the white areas of the charts shall be 80 ± 2 when measured over a white area using a reflectometer or spectrometer complying with 4.3, and that of the black area shall not be greater than 5, unless otherwise agreed.

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

4.2 Film applicators: a series of film applicators giving a range of uniform films of wet thicknesses usually ranging from 50 µm to 100 µm. The film laid down shall be at least 70 mm wide, with an area of uniform thickness measuring not less than 60 mm × 60 mm, regardless of the substrate used. The application of uniform films is facilitated by the use of automatic applicators, which are recommended.

4.3 Reflectometer or **spectrometer**, to measure the tristimulus value *Y* preferably for D65 standard illuminant, within an accuracy of at worst 0,3 %.

It is recognized that the relative geometrical arrangement of the illumination beam and the light detector can affect the measurement of *Y*, 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, diffuse/8° geometry, including surface reflection, shall be used. Surface reflection shall be taken into account by reducing the measured tristimulus value *Y* mathematically by 4 (see also ISO 7724-2).

4.4 Test panels: black and white glass panels, each with a plane, polished surface measuring at least 80 mm × 80 mm. The tristimulus value *Y* of the white area shall be 80 ± 2 when measured using a reflectometer or spectrometer complying with 4.3 and that of the black area not more than 5.

Both the black and the white areas shall be coated on the back and edges with black paint or adhesive tape to exclude light reflected from the back.

5 Sampling

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

6.1.1 Method A (polyester foil)

Retain (for use in 6.5.1) an uncoated sample of polyester foil from an area adjacent to the surface to be coated.

Prepare the polyester foil for coating by one of the following procedures:

Either

a) Spread it on a flat glass panel, at least 6 mm thick, which has first been moistened with a few drops of white spirit just sufficient to hold the foil in position by surface tension. Ensure that none of the liquid wets the upper surface of the foil and that no air bubbles are trapped under it.

Or

b) Fix it at one end and lay it over a flat rubber block (where spiral applicators are to be used).

6.1.2 Method B (black and white charts)

Store the black and white substrate charts, in single thickness, under the conditions of test [(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 finger marks 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 procedures:

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

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

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

6.2 Preparation of coated charts or foils

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 ml to 4 ml of paint, depending on the film thickness required, in a line across one end of the chart or polyester foil and spread it immediately be drawing down a suitable applicator at a steady speed to give a uniform layer. Prepare duplicate films with each of three different applicators, chosen to give a range of wet film thicknesses usually ranging from 50 µm to 100 µm.

Maintain the coated charts or foils 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 shall be agreed by the interested parties.

6.3 Conditioning

Unless otherwise agreed keep the dried coated charts or foils and the blank charts or foils at (23 ± 2) °C and a relative humidity of (50 ± 5) % for at least 24 h before the measurements of the tristimulus values Y are made.

6.4 Measurement of tristimulus value *Y*

6.4.1 Method A (polyester foil)

Fix each coated foil over a black and white glass panel, introducing a few drops of white spirit between the underside of the foil and the glass to ensure optical contact. Measure the tristimulus value Y of each coated foil at a minimum of four positions over the black (Y_b) and white (Y_w) areas, and calculate the average tristimulus values Y_b and Y_w respectively. Then calculate the contrast ratio Y_b/Y_w as a percentage for each coated foil.

6.4.2 Method B (black and white charts)

Measure the tristimulus values of each coated chart at a minimum of four positions over both the black and white areas of each chart and calculate the average tristimulus values Y_b and Y_w respectively. Then calculate the contrast ratio Y_b/Y_w as a percentage for each coated chart.

6.5 Determination of the surface density of the dry coating

6.5.1 Method A (polyester foil)

Remove the coated foil from the glass panel, wipe the foil to remove any traces of white spirit and allow to dry.

Cut an equal area with dimensions at least 60 mm × 60 mm, for example by means of a precision die stamp, from the centre of each coated polyester foil and two samples from the uncoated (blank) polyester foil.

Weigh the detached pieces to the nearest 1 mg.

Calculate the average mass for the coated polyester foil and the average mass for the two samples of uncoated polyester foil.

Calculate the surface density of the dry coating, ρ_A, in grams per square millimetre, using the equation

$$\rho_A = \frac{m_2 - m_1}{A}$$

where

m_1 is the average mass, in grams, of the two samples of uncoated polyester foil;

m_2 is the average mass, in grams, of the six samples of coated polyester foil;

A is the area, in square millimetres, of the area cut out in each case.

6.5.2 Method B (black and white charts)

Cut equal areas, for example by means of a precision die stamp, 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, using the equation

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

where

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

m_2 is the average initial mass, in grams, of the other six charts before coating;

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

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

A is the area, in square millimetres, of the area cut out in each case.

NOTE — This procedure 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 using the most appropriate part of ISO 2811, and the non-volatile matter content by mass using the method described in ISO 3251.

6.6.1 Wet film thickness

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

$$t = \frac{\rho_A}{\rho \times \mathrm{NV}} \times 10^5$$

where

ρ is the density of the wet paint, in grams per cubic millimetre;

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

6.6.2 Spreading rate

6.6.2.1 Method A (polyester foil)

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

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

and, using the equation for surface density in 6.5.1,

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