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ISO 4630-2

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Clear liquids — Estimation of colour by the Gardner colour scale —

Part 2: Spectrophotometric method

Liquides clairs — Évaluation de la couleur au moyen de l'échelle Gardner —

Partie 2: Méthode spectrophotométrique

Reference number
ISO 4630-2:2004(E)

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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.

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ISO 4630-2 was prepared by Technical Committee ISO/TC 35, *Paints and varnishes*, Subcommittee SC 10, *Test methods for binders for paints and varnishes*, in collaboration with ASTM D 01.34, *Naval Stores*. It has been harmonized with ASTM D 6166-97, *Standard Test Method for Color of Naval Stores and Related Products (Instrumental Determination of Gardner Color)*.

ISO 4630 consists of the following parts, under the general title *Clear liquids — Estimation of colour by the Gardner colour scale*:

— *Part 1: Visual method*

— *Part 2: Spectrophotometric method*

Clear liquids — Estimation of colour by the Gardner colour scale —

Part 2:
Spectrophotometric method

1 Scope

This part of ISO 4630 specifies a method for estimating, by means of the Gardner colour scale, the colour of clear, yellow/brown liquid products using colour-measuring instruments. The results might be invalid if other products are tested. The test uses the Gardner colour scale described in ISO 4630-1.

The method is applicable to drying oils, varnishes and solutions of fatty acids, polymerized fatty acids, resins, tall oil, tall oil fatty acids, rosin and related products.

The method described provides a more precise way of measuring Gardner colour than that described in ISO 4630-1. It is applicable to products having colours from Gardner 1 to Gardner 18. The Gardner scale is not applicable to products with colours lighter than 1 or darker than 18.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 4630-1, *Clear liquids — Estimation of colour by the Gardner colour scale — Part 1: Visual method*

ISO 15528, *Paints, varnishes and raw materials for paints and varnishes — Sampling*

CIE Publication No. 15.2, *Colorimetry*

3 Principle

The colour of a liquid sample is measured using an instrument capable of measuring transmitted colour and reporting in Gardner colours or in a colour system that can be converted into Gardner colours.

4 Apparatus and materials

4.1 Colour-measuring instrument, capable of measuring transmitted colour ($0^\circ/180^\circ$ geometry) and reporting the results in the Gardner colour scale described in ISO 4630-1. If such an instrument is not available, one may be used which is capable of measuring transmitted colour and reporting in tristimulus values or chromaticity coordinates using standard illuminant C and the 2° observer, described in CIE Publication No. 15.2.

4.2 Glass absorption cells, 10 mm path length, unless a different path length is specified by the instrument manufacturer.

Or

4.3 Glass tubes, clear. Glass test tubes, as decribed in ISO 4630-1, or other glass tubes designed for a specific instrument may be used. The test tubes might provide less accuracy than glass absorption cells and should be used only when a decrease in accuracy is acceptable. Glass absorption cells should preferably be used for referee purposes.

5 Sampling

Take a representative sample of the product to be tested, as described in ISO 15528.

6 Procedure

Baseline calibration of the instrument shall be performed following the instrument manufacturer's recommendations.

If the material to be tested is cloudy, first filter it (see Note). Then, using the same type of glass tube or absorption cell as used for the baseline calibration, fill the glass tube or absorption cell with the product. Take care not to touch the measurement area of the glass tube or absorption cell.

If the material shows any visual haziness, remove the haze by filtration, centrifugation, heating, ultrasonic treatment or any other suitable means. If the haziness cannot be removed, the measured value will be unreliable. Avoid creating air bubbles when filling the glass tube or absorption cell. If air bubbles are formed and remain trapped, remove them by heating, vacuum, ultrasonic treatment or any other suitable means (see Note).

NOTE Some sample pretreatments can change the colour.

Insert the glass tube or absorption cell in the instrument and measure the Gardner colour, following the instrument manufacturer's recommended procedure.

Regular checks as per the instrument manufacturer's recommendations should be carried out. These will normally be in the form of checks with certified reference materials.

7 Expression of results

Report the colour in Gardner colour units to the nearest tenth of a Gardner unit as given by the instrument or as calculated by the method given in Annex A.

8 Precision

8.1 General

The precision of the test method was determined by interlaboratory testing in accordance with ISO 5725-2. Three different materials were tested by 13 laboratories.

8.2 Repeatability limit (r)

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

The repeatability for three repeated measurements, made in accordance with this part of ISO 4630 and expressed as the repeatability limit r, is 0,1 Gardner units.

The repeatability standard deviation among test results, related to the above number by the factor 2,8, is 0,02 Gardner units.

8.3 Reproducibility limit (R)

The reproducibility limit R is 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 can be expected to lie with a probability of 95 %.

The reproducibility for three repeated measurements, made in accordance with this part of ISO 4630 and expressed as the reproducibility limit R, is 0,5 Gardner units.

The reproducibility standard deviation among test results, related to the above number by the factor 2,8, is 0,18 Gardner units.

8.4 Bias

Since there is no accepted reference material suitable for determining the bias of the procedure in this test method, bias has not been determined.

9 Test report

The test report shall contain at least the following information:

a) a reference to this part of ISO 4630 (ISO 4630-2);

b) all details necessary to identify the product examined;

c) whether any pretreatment of the product was necessary;

d) the result of the test as indicated in Clause 7;

e) any deviation from the test method specified;

f) the date of the test.

Annex A
(normative)

Calculating Gardner colour from chromaticity coordinates

A.1 For instruments reporting in tristimulus values or chromaticity coordinates, measure the tristimulus values or chromaticity coordinates using 10 mm absorption cells or glass test tubes as specified in ISO 4630-1 and using standard illuminant C and the 2° observer. Cells or tubes with larger or smaller path lengths will give tristimulus values and chromaticity coordinates that will not convert, using Table A.1, to the true Gardner colour of the test material.

Table A.1 — Chromaticity coordinates of Gardner colours (see ISO 4630-1)

Gardner colour standard number	Chromaticity coordinates		Luminous transmittance, Y	Tolerance on transmittance
	x	y	%	$(\pm)$ %
1	0,317 7	0,330 3	80	7
2	0,323 3	0,335 2	79	7
3	0,332 9	0,345 2	76	6
4	0,343 7	0,364 4	75	5
5	0,355 8	0,384 0	74	4
6	0,376 7	0,406 1	71	4
7	0,404 4	0,435 2	67	4
8	0,420 7	0,449 8	64	4
9	0,434 3	0,464 0	61	4
10	0,450 3	0,476 0	57	4
11	0,484 2	0,481 8	45	4
12	0,507 7	0,463 8	36	5
13	0,539 2	0,445 8	30	6
14	0,564 6	0,427 0	22	6
15	0,585 7	0,408 9	16	2
16	0,604 7	0,392 1	11	1
17	0,629 0	0,370 1	6	1
18	0,647 7	0,352 1	4	1

A.2 Record the tristimulus values X, Y, Z or the chromaticity coordinates x, y for the test material.

A.3 If the instrument reports tristimulus values, convert them to chromaticity coordinates using the procedure in CIE Publication No. 15.2.

A.4 The Gardner colour of the test material is determined as follows:

$$G_{\mathrm{TM}} = G_{\mathrm{I}} + G_{\mathrm{F}} \qquad \text{(A.1)}$$

where

G_{TM} is the Gardner colour of the test material;

G_{I} is the integral part of the value of the Gardner colour of the test material;

G_{F} is the decimal part of the Gardner colour value.

A.5 By comparing the x chromaticity coordinate of the test material with the x chromaticity coordinates in Table A.1, determine the integral part of the Gardner colour of the test material using the following relationship:

$$G_{\mathrm{I}} = G_n \qquad \text{for } x_n \leqslant x_{\mathrm{TM}} < x_{n+1} \tag{A.2}$$

where

G_n is the Gardner colour which is immediately lighter than the test material;

x_n is the x chromaticity coordinate for the Gardner colour which is immediately lighter than the test material;

x_{TM} is the x chromaticity coordinate of the test material;

x_{n+1} is the x chromaticity coordinate for the Gardner colour which is immediately darker than the test material.

A.6 Calculate the decimal part of the Gardner colour of the test material as follows:

$$G_{\mathrm{F}} = \frac{(x_{n+1} - x_n)(x_{\mathrm{TM}} - x_n) + (y_{n+1} - y_n)(y_{\mathrm{TM}} - y_n)}{(x_{n+1} - x_n)^2 + (y_{n+1} - y_n)^2} \tag{A.3}$$

where

y_n is the y chromaticity coordinate for the Gardner colour which is immediately lighter than the test material;

y_{TM} is the y chromaticity coordinate of the test material;

y_{n+1} is the y chromaticity coordinate for the Gardner colour which is immediately darker than the test material;

x_n, x_{n+1} and x_{TM} are as defined for Equation (A.2).

EXAMPLE A test material has chromaticity coordinates of $x_{\mathrm{TM}} = 0{,}368\ 5$, $y_{\mathrm{TM}} = 0{,}399\ 8$. In Table A.1, x_{TM} is between the chromaticity coordinates for Gardner colour values 5 and 6, therefore

$$G_{\mathrm{I}} = 5$$

and

$$G_{\mathrm{F}} = \frac{(0{,}376\ 7 - 0{,}355\ 8)(0{,}368\ 5 - 0{,}355\ 8) + (0{,}406\ 1 - 0{,}384\ 0)(0{,}399\ 8 - 0{,}384\ 0)}{(0{,}376\ 7 - 0{,}355\ 8)^2 + (0{,}406\ 1 - 0{,}384\ 0)^2} = 0{,}7 \tag{A.4}$$

Thus

$$G_{\mathrm{TM}} = 5{,}7$$

Bibliography

[1] EN 1557, *Surface active agents — Colorimetric characterization of optically clear coloured liquids (products) as X, Y, Z tristimulus values in transmission*

[2] ISO 5725-2, *Accuracy (trueness and precision) of measurement methods and results — Part 2: Basic method for the determination of repeatability and reproducibility of a standard measurement method*

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