



Standard Test Method for Color of Pine Chemicals and Related Products (Instrumental Determination of Gardner Color)¹

This standard is issued under the fixed designation D6166; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ϵ) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This test method covers the quantitative determination of the color of clear, yellow/brown, liquid materials using color measuring instruments. The results may be invalid if other materials are used. The test uses the Gardner color scale described in Test Method [D1544](#). This test method applies to pine chemical products including tall oil, tall oil fatty acids, rosin, and related products.

1.2 The values stated in SI units are to be regarded as standard. No other units of measurement are included in this standard.

1.3 *This standard does not purport to address all of the safety concerns, if any, problems associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*²

[D1544](#) Test Method for Color of Transparent Liquids (Gardner Color Scale)

[E177](#) Practice for Use of the Terms Precision and Bias in ASTM Test Methods

[E308](#) Practice for Computing the Colors of Objects by Using the CIE System

[E691](#) Practice for Conducting an Interlaboratory Study to Determine the Precision of a Test Method

3. Summary of Test Method

3.1 The color of a liquid sample is measured using an instrument capable of measuring transmitted color and reporting in Gardner colors or in a color system that can be converted to Gardner colors.

¹ This test method is under the jurisdiction of Committee [D01](#) on Paint and Related Coatings, Materials, and Applications and is the direct responsibility of Subcommittee [D01.34](#) on Pine Chemicals and Hydrocarbon Resins.

Current edition approved Dec. 1, 2016. Published December 2016. Originally approved in 1997. Last previous edition approved in 2012 as D6166 – 12. DOI: 10.1520/D6166-12R16.

² For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

4. Significance and Use

4.1 This test method provides a more precise way of measuring Gardner color than described in Test Method [D1544](#). It is applicable to pine chemical products having colors from Gardner 1 to Gardner 18. The Gardner scale is not applicable to materials with colors lighter than 1 or darker than 18.

5. Apparatus

5.1 An instrument capable of measuring transmitted color and reporting the results in the Gardner color scale described in Test Method [D1544](#). If such an instrument is not available, one may be used which is capable of measuring transmitted color and reporting in tristimulus values or chromaticity coordinates using standard illuminant C and the 2° observer, described in Practice [E308](#).

5.2 *Glass Cuvets*, 10-mm path length, unless a different path length is specified by the manufacturer, or

5.3 *Glass Tubes*, clear. Standard Gardner tubes, as described in Test Method [D1544](#), or other glass tubes designed for a specific instrument may be used. Gardner tubes may provide less accuracy than glass cuvetts and should be used only when a decrease in accuracy is acceptable. Glass cuvetts should be used for referee situations.

6. Calibration and Standardization

6.1 Calibrate the instrument following the manufacturer's recommendations.

6.1.1 Test sample preparation for rosin and rosin derivatives.

6.1.1.1 As most rosins and rosin derivatives are solids it is necessary to introduce a molten sample into the tube or cuvet.

6.1.1.2 If the sample is available in molten form the test sample should be poured into the cuvet or tube and the color measured while the rosin is still molten.

6.1.1.3 If the sample is in solid form it has to be melted in order to be introduced into the tube or cuvet. The sample to be tested shall consist of freshly broken lumps and free of dust and finely divided material. Select a quantity at least twice that necessary required to fill the test tubes or cuvetts and melt it in a clean container using an oven, hot plate, heat gun, sand bath or oil bath taking care to avoid overheating. Stir slowly

avoiding the formation of bubbles. Melt the sample completely, but do not heat it above the temperature necessary for the sample to pour readily. The time from the beginning of heating to the pouring of the sample should not exceed 15 min. Pour the molten test sample into the cuvet or tube and measure the color while the rosin is still molten.

7. Procedure

7.1 Taking care not to touch the measurement area of the sample cell, fill a clean tube or cuvet with the material to be tested. If the material is cloudy, first filter it.

7.2 Insert the glass tube or cuvet in the instrument and measure the color, following the manufacturer’s recommended procedure.

8. Report

8.1 Report the color in Gardner color units to a tenth of a Gardner unit as given by the instrument or as calculated by the method in the appendix. Note if the material was filtered.

9. Precision and Bias³

9.1 *Interlaboratory Test Program*—An interlaboratory study of the color of three materials was run in 1996. Each of 13

³ Supporting data have been filed at ASTM International Headquarters and may be obtained by requesting Research Report: RR:D01-1106. Contact ASTM Customer Service at service@astm.org.

laboratories tested each of the three materials. The design of the experiment, similar to that of Practice E691 and a within-between analysis of the data are given in ASTM Research Report.

9.2 *Test Result*—The precision information given below for Gardner color is for the comparison of three test results, each of which is the average of three test determination as follows:

9.2.1 *Repeatability Limit, 95 %* (within laboratory) = 0.06 Gardner units.

9.2.2 *Reproducibility Limit, 95 %* (between laboratories) = 0.50 Gardner units.

9.3 These terms (repeatability limit and reproducibility limit) are used as specified in Practice E177. The respective standard deviations among test results, related to the above numbers by the factor of 2.8, are as follows:

9.3.1 Repeatability standard deviation = 0.02 Gardner units.

9.3.2 Reproducibility standard deviation = 0.18 Gardner units.

9.4 *Bias*—Since there is no accepted reference material suitable for determining the bias for the procedures in this test method, bias has not been determined.

10. Keywords

10.1 instrumental Gardner color; rosin; tall oil; tall oil fatty acids

APPENDIX

(Nonmandatory Information)

X1. CALCULATING GARDNER COLOR FROM CHROMATICITY COORDINATES

X1.1 For instruments reporting in tristimulus values or chromaticity coordinates, measure the tristimulus values or chromaticity coordinates using 10–mm cuvetts or standard Gardner tubes. Sample cells with larger or smaller path lengths will produce tristimulus values and chromaticity coordinates that will not convert, using Table X1.1, to the true Gardner color of the test material.

X1.2 Record the tristimulus values *X*, *Y*, *Z*, or the chromaticity coordinates *x*, *y*, *Y* for the test material.

X1.3 If the instrument reports tristimulus values, convert them to chromaticity coordinates using the procedure in Practice E308.

X1.4 The Gardner value of the test material is determined as follows:

$$G_{TM} = G_I + G_F \tag{X1.1}$$

where:

- G_{TM} = the Gardner color of the test material,
- G_I = the integer portion of the test material’s Gardner color value, and
- G_F = the fractional portion of the Gardner color value.

TABLE X1.1 Chromaticity Coordinates of Gardner Colors^A

Gardner color	x	y	Y
1	0.3177	0.3303	80
2	0.3233	0.3352	79
3	0.3329	0.3452	76
4	0.3437	0.3644	75
5	0.3558	0.3840	74
6	0.3767	0.4061	71
7	0.4044	0.4352	67
8	0.4207	0.4498	64
9	0.4343	0.4640	61
10	0.4503	0.4760	57
11	0.4842	0.4818	45
12	0.5077	0.4638	36
13	0.5392	0.4458	30
14	0.5646	0.4270	22
15	0.5857	0.4089	16
16	0.6047	0.3921	11
17	0.6290	0.3701	6
18	0.6477	0.3521	4

^A See Test Method D1544.

X1.5 By comparing the *x*-chromaticity coordinate of the test material with the *x*-chromaticity coordinate in Table 1 of Test Method D1544, determine the integer portion of the test material’s Gardner color using the relationship as follows:

$$G_I = G_n, \text{ where: } x_n \leq x_{TM} < x_{n+1} \quad (\text{X1.2})$$

where:

- G_n = the Gardner color value which is lighter than the test material,
- x_n = the x chromaticity coordinate of the Gardner color value which is lighter than the test material,
- x_{TM} = the x chromaticity coordinate of the test material, and
- x_{n+1} = the x chromaticity coordinate of the Gardner color value which is darker than the test material.

X1.6 Calculate the fractional portion of the test material's Gardner color as follows:

$$G_F = \frac{(x_{n+1} - x_n)(x_{TM} - x_n) + (y_{n+1} - y_n)(y_{TM} - y_n)}{(x_{n+1} - x_n)^2 + (y_{n+1} - y_n)^2} \quad (\text{X1.3})$$

where:

- y_n = the y chromaticity coordinate of the Gardner color value which is lighter than the test material,

- y_{TM} = the y chromaticity coordinate of the test material, and
- y_{n+1} = the y chromaticity coordinate of the Gardner color value which is darker than the test material.
- $x_n, x_{n+1},$ and x_{TM} = definition of Eq X1.3.

Example 1. For a test material with chromaticity coordinates of $x_{TM} = 0.3685$, $y_{TM} = 0.3998$. From Table X1.1, x_{TM} is between the chromaticity coordinates for Gardner color values 5 and 6, therefore $G_I = 5$ and

$$G_F = \quad (\text{X1.4})$$

$$\frac{(0.3767 - 0.3558)(0.3685 - 0.3558) + (0.4061 - 0.3840)(0.3998 - 0.3840)}{(0.3767 - 0.3558)^2 + (0.4061 - 0.3840)^2}$$

so

$$G_F = 0.7 \quad (\text{X1.5})$$

and

$$G_{TM} = 5.7$$

ASTM International takes no position respecting the validity of any patent rights asserted in connection with any item mentioned in this standard. Users of this standard are expressly advised that determination of the validity of any such patent rights, and the risk of infringement of such rights, are entirely their own responsibility.

This standard is subject to revision at any time by the responsible technical committee and must be reviewed every five years and if not revised, either reapproved or withdrawn. Your comments are invited either for revision of this standard or for additional standards and should be addressed to ASTM International Headquarters. Your comments will receive careful consideration at a meeting of the responsible technical committee, which you may attend. If you feel that your comments have not received a fair hearing you should make your views known to the ASTM Committee on Standards, at the address shown below.

This standard is copyrighted by ASTM International, 100 Barr Harbor Drive, PO Box C700, West Conshohocken, PA 19428-2959, United States. Individual reprints (single or multiple copies) of this standard may be obtained by contacting ASTM at the above address or at 610-832-9585 (phone), 610-832-9555 (fax), or service@astm.org (e-mail); or through the ASTM website (www.astm.org). Permission rights to photocopy the standard may also be secured from the Copyright Clearance Center, 222 Rosewood Drive, Danvers, MA 01923, Tel: (978) 646-2600; http://www.copyright.com/