



Standard Test Method for Color of Naval Stores and Related Products (Instrumental Determination of Gardner Color)¹

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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 D 1544. This test method applies to naval stores products including tall oil, tall oil fatty acids, rosin, and related products.

1.2 *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:

- D 1544 Test Method for Color of Transparent Liquids (Gardner Color Scale)²
- E 177 Practice for the Use of the Terms Precision and Bias in ASTM Test Methods³
- E 308 Practice for Computing the Colors of Objects by Using the CIE System³
- E 691 Practice for Conducting an Interlaboratory Study to Determine the Precision of a Test Method³

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.

4. Significance and Use

4.1 This test method provides a more precise way of measuring Gardner color than described in Test Method D 1544. It is applicable to naval stores 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 D 1544. 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 E 308.

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 D 1544, 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.

7. Procedure

7.1 Taking care not to touch the measurement area of the sample cell, fill a clean Gardner 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 Bias

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

¹ This test method is under the jurisdiction of Committee D-1 on Paint and Related Coatings, Materials, and Applications and is the direct responsibility of Subcommittee D01.34 on Naval Stores.

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² *Annual Book of ASTM Standards*, Vol 06.01.

³ *Annual Book of ASTM Standards*, Vol 14.02.

the experiment, similar to that of Practice E 691 and a within-between analysis of the data are given in ASTM Research Report.⁴

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 E 177. 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

⁴ Supporting data are available from ASTM Headquarters. Request RR:D01-1106.

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 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 E 308.

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

$$G_{TM} = G_I + G_F \quad (X1.1)$$

TABLE 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

^ASee Test Method D 1544.

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.

X1.5 By comparing the *x*-chromaticity coordinate of the test material with the *x*-chromaticity coordinate in Table 1 of Test Method D 1544, determine the integer portion of the test material's Gardner color using the relationship as follows:

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

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:

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

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.

so

$$G_F = 0.7 \quad (X1.5)$$

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

and

$$G_{TM} = 5.7.$$

$$G_F = \frac{(0.3767 - 0.3558)(0.3685 - 0.3558) + (0.4061 - 0.3840)(0.3998 - 0.3840)}{(0.3767 - 0.3558)^2 + (0.4061 - 0.3840)^2} \quad (X1.4)$$

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