



Designation: **D4890—06 D4890 – 13**

Standard Test Methods for Polyurethane Raw Materials: Determination of Gardner and APHA Color of Polyols¹

This standard is issued under the fixed designation D4890; 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 These test methods measure visually the color of clear polyester and polyether liquids. They apply only to materials whose colors have light-absorption characteristics similar to those of the standards. An alternative method is Test Method **D1209** (see **Note 1**).

1.2 *Units*—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, 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.*

~~NOTE 1—Although Test Method A of these test methods and ISO 4630-1:2004 differ in some details, data obtained using either are technically equivalent. Although this standard is equivalent to ISO 6271-1. Test Method B of these test methods and ISO 6271-1981 differ in some details, data obtained using either are technically equivalent, this standard is equivalent to ISO 4630-1.~~

2. Referenced Documents

2.1 ASTM Standards:²

[D883 Terminology Relating to Plastics](#)

[D1193 Specification for Reagent Water](#)

[D1209 Test Method for Color of Clear Liquids \(Platinum-Cobalt Scale\)](#)

[D5386 Test Method for Color of Liquids Using Tristimulus Colorimetry](#)

[D6166 Test Method for Color of Pine Chemicals and Related Products \(Instrumental Determination of Gardner Color\)](#)

[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](#)

[E1164 Practice for Obtaining Spectrometric Data for Object-Color Evaluation](#)

2.2 ISO Standards:³

~~ISO 4630-1:2004~~[ISO 4630-1 Estimation Clear Liquids—Estimation of Colour by the Gardner Colour Scale—Part 1: Visual Method](#)

~~ISO 4630-2:2004~~[ISO 4630-2 Clear Liquids—Estimation of Colour by the Gardner Colour Scale—Part 2: Spectroscopic Method](#)

~~ISO 6271-1981~~[ISO 6271-1 Clear Liquids—Estimation of Color by the Platinum-Cobalt Scale—Part 1: Visual Method](#)

[ISO 6271-2 Clear Liquids—Estimation of Color by the Platinum-Cobalt Scale—Part 2: Spectroscopic Method](#)

3. Terminology

3.1 For definitions of terms used in these test methods see Terminology **D883**.

4. Summary of Test Method

4.1 In Test Method A, the color of the material to be tested is compared to a series of color standards with defined chromicity coordinates, prepared on one of three ways. The results are reported as the color standard, which best matches the sample.

¹ These test methods are under the jurisdiction of Committee **D20** on Plastics and are the direct responsibility of Subcommittee **D20.22** on Cellular Materials - Plastics and Elastomers.

Current edition approved Sept. 1, 2006 April 1, 2013. Published September 2006 April 2013. Originally approved in 1988. Last previous edition approved in 1998 2006 as ~~D4890-98~~**D4890 - 06 (2003)**. DOI: ~~10.1520/D4890-06~~**10.1520/D4890-13**.

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.

³ Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY ~~10036~~**10036**, <http://www.ansi.org>.

*A Summary of Changes section appears at the end of this standard

4.2 In Test Method B, the color of the material to be tested is compared to a series of platinum-cobalt color standards, designated by mg of Pt/mL of standard solution. The results are reported as the color standard, which best matches the sample (see [Note 2](#)).

NOTE 2—Color of liquids are also ~~can be~~ measured by visible spectroscopy and the results converted to any of several color scales. These results ~~can be~~ are converted to the APHA scale by appropriate manipulations, as for example in Test Method [D5386](#), and ISO 6271-2. These results are converted to the Gardner scale by appropriate manipulations, as for example in Test Method ISO 4630-2.

5. Significance and Use

5.1 These test methods are suitable for quality control, as specification tests, and for research. Color is an important property of urethane products.

6. Sampling

6.1 Polyesters and polyethers usually contain molecules covering an appreciable range of molecular weights. These have a tendency to fractionate during solidification. Unless the material is a liquid or finely ground solid it is necessary to melt (using no higher temperature than necessary) and mix the resin well before removing a sample for analysis. Many polyols are hygroscopic and care should be taken to provide minimum exposure to atmospheric moisture during the sampling.

7. Purity of Reagents

7.1 *Purity of Reagents*—Reagent-grade chemicals shall be used in all tests. Unless otherwise indicated, it is intended that all reagents shall conform to the specifications of the Committee on Analytical Reagents of the American Chemical Society, where such specifications are available.⁴ Other grades may be used, provided it is first ascertained that the reagent is of sufficiently high purity to permit its use without lessening the accuracy of the determination.

7.2 *Purity of Water*—Unless otherwise indicated, references to water shall be understood to mean reagent water as defined by Type IV or better of Specification [D1193](#).

TEST METHOD A—GARDNER COLOR

8. Apparatus

8.1 *Gardner-Holdt Tubes*, of clear glass, with closed, flat, even bottoms, and having the following approximate dimensions and markings:

8.1.1 A uniform internal length of 112 mm,

8.1.2 A uniform internal diameter throughout the length of the tube of 10.75 mm, and

8.1.3 An etched line around the outside of the tube 5 mm from the open end and a second etched line around the outside of the tube 13 mm from the open end.

9. Reagents

9.1 *Cobalt Chloride Solution*—Prepare a solution containing 1 part by weight of cobalt chloride ($\text{CoCl}_2 \times 6\text{H}_2\text{O}$) to 3 parts of HCl (1 to 17).

9.2 *Ferric Chloride Solution*—Prepare a solution containing approximately 5 parts by weight of ferric chloride ($\text{FeCl}_3 \times 6\text{H}_2\text{O}$) and 1.2 parts of HCl (1 to 17). Adjust to exact color equivalence to a freshly prepared solution containing 3 g of $\text{K}_2\text{Cr}_2\text{O}_7$ in 100 mL of H_2SO_4 (sp gr 1.84).

9.3 *Hydrochloric Acid (1 to 17)*—Mix 1 volume of concentrated hydrochloric acid (HCl, sp gr 1.19) with 17 volumes of water.

9.4 *Hydrochloric Acid (0.1 N)*—Prepare 0.1 N HCl.

9.5 *Potassium Chloroplatinate* ($\text{K}(\text{PtCl}_2\text{Cr}_2\text{O}_7)$).

9.6 *Potassium Dichromate* ($\text{K}_2\text{Cr}_2\text{O}_7$).

9.7 *Sulfuric Acid* (sp gr 1.84)—Concentrated sulfuric acid (H_2SO_4).

10. Gardner Color Reference Standards⁵

10.1 The primary standards for color shall consist of solutions defined by their spectral transmittance in 1-cm cell with parallel sides. The chromaticity coordinates of these solutions shall conform to those given in [Table 1](#) when determined on a 1-cm layer of the solution in accordance with Practice [E1164](#) and Test Method/Methods [E308](#) and [D6166](#).

⁴ *Reagent Chemicals, American Chemical Society Specifications*, American Chemical Society, Washington, DC. For suggestions on the testing of reagents not listed by the American Chemical Society, see *Analar Standards for Laboratory Chemicals*, BDH Ltd., Poole, Dorset, U.K., and the *United States Pharmacopeia and National Formulary*, U.S. Pharmacopeial Convention, Inc. (USPC), Rockville, MD.

⁵ The sole source of supply of the glass color standards and color standard solutions known to the committee at this time is BYK-Gardner USA, 9104 Guilford Road, Columbia, MD 21046. If you are aware of alternative suppliers, please provide this information to ASTM International Headquarters. Your comments will receive careful consideration at a meeting of the responsible technical committee,¹ which you may attend.

TABLE 1 Gardner Reference Standard Color Solutions

| Gardner Color Standard Number | Chromaticity Coordinates ^A | | Potassium Chloroplatinate, g/1000 mL of 0.1 N HCl | Iron-Cobalt Solutions | | | Potassium Dichromate, g/100 mL Sulfuric Acid ^B |
|-------------------------------|---------------------------------------|--------|---|------------------------------|------------------------------|-----------------------|---|
| | x | y | | Ferric Chloride Solution, mL | Cobalt Chloride Solution, mL | Hydrochloric Acid, mL | |
| -1 | 0.3190 | 0.3274 | 0.550 | ... | ... | ... | 0.0039 |
| -2 | 0.3241 | 0.3344 | 0.865 | ... | ... | ... | 0.0048 |
| -3 | 0.3315 | 0.3456 | 1.330 | ... | ... | ... | 0.0071 |
| -4 | 0.3433 | 0.3632 | 2.080 | ... | ... | ... | 0.0112 |
| -5 | 0.3578 | 0.3820 | 3.035 | ... | ... | ... | 0.0205 |
| -6 | 0.3750 | 0.4047 | 4.225 | ... | ... | ... | 0.0322 |
| -7 | 0.4022 | 0.4360 | 6.400 | ... | ... | ... | 0.0384 |
| -8 | 0.4179 | 0.4535 | 7.900 | ... | ... | ... | 0.0515 |
| -9 | 0.4338 | 0.4648 | ... | 3.8 | 3.0 | 93.2 | 0.0780 |
| 10 | 0.4490 | 0.4775 | ... | 5.1 | 3.6 | 91.3 | 0.164 |
| 11 | 0.4836 | 0.4805 | ... | 7.5 | 5.3 | 87.2 | 0.250 |
| 12 | 0.5084 | 0.4639 | ... | 10.8 | 7.6 | 81.6 | 0.380 |
| 13 | 0.5395 | 0.4451 | ... | 16.6 | 10.0 | 73.4 | 0.572 |
| 14 | 0.5654 | 0.4295 | ... | 22.2 | 13.3 | 64.5 | 0.763 |
| 15 | 0.5870 | 0.4112 | ... | 29.4 | 17.6 | 53.0 | 1.041 |
| 16 | 0.6060 | 0.3933 | ... | 37.8 | 22.8 | 39.4 | 1.280 |
| 17 | 0.6275 | 0.3725 | ... | 51.3 | 25.6 | 23.1 | 2.220 |
| 18 | 0.6475 | 0.3525 | ... | 100.0 | 0.0 | 0.0 | 3.00 |

TABLE 1 Gardner Reference Standard Color Solutions

| Gardner Color Standard Number | Chromaticity Coordinates ^A | | | Potassium Chloroplatinate, g/1000 mL of 0.1 N HCl | Iron-Cobalt Solutions | | | Potassium Dichromate, g/100 mL Sulfuric Acid ^B |
|-------------------------------|---------------------------------------|--------|--------|---|------------------------------|------------------------------|-----------------------|---|
| | Y | x | y | | Ferric Chloride Solution, mL | Cobalt Chloride Solution, mL | Hydrochloric Acid, mL | |
| 1 | 80 | 0.3177 | 0.3303 | 0.550 | ... | ... | ... | 0.0039 |
| 2 | 79 | 0.3233 | 0.3352 | 0.865 | ... | ... | ... | 0.0048 |
| 3 | 76 | 0.3329 | 0.3452 | 1.330 | ... | ... | ... | 0.0071 |
| 4 | 75 | 0.3437 | 0.3644 | 2.080 | ... | ... | ... | 0.0112 |
| 5 | 74 | 0.3558 | 0.3840 | 3.035 | ... | ... | ... | 0.0205 |
| 6 | 71 | 0.3767 | 0.4061 | 4.225 | ... | ... | ... | 0.0322 |
| 7 | 67 | 0.4044 | 0.4352 | 6.400 | ... | ... | ... | 0.0384 |
| 8 | 64 | 0.4207 | 0.4498 | 7.900 | ... | ... | ... | 0.0515 |
| 9 | 61 | 0.4343 | 0.4640 | ... | 3.8 | 3.0 | 93.2 | 0.0780 |
| 10 | 57 | 0.4503 | 0.4760 | ... | 5.1 | 3.6 | 91.3 | 0.164 |
| 11 | 45 | 0.4842 | 0.4818 | ... | 7.5 | 5.3 | 87.2 | 0.250 |
| 12 | 36 | 0.5077 | 0.4638 | ... | 10.8 | 7.6 | 81.6 | 0.380 |
| 13 | 30 | 0.5392 | 0.4458 | ... | 16.6 | 10.0 | 73.4 | 0.572 |
| 14 | 22 | 0.5646 | 0.4270 | ... | 22.2 | 13.3 | 64.5 | 0.763 |
| 15 | 16 | 0.5857 | 0.4089 | ... | 29.4 | 17.6 | 53.0 | 1.041 |
| 16 | 11 | 0.6047 | 0.3921 | ... | 37.8 | 22.8 | 39.4 | 1.280 |
| 17 | 6 | 0.6290 | 0.3701 | ... | 51.3 | 25.6 | 23.1 | 2.220 |
| 18 | 4 | 0.6477 | 0.3521 | ... | 100.0 | 0.0 | 0.0 | 3.00 |

^A Chromaticity coordinates for CIE standard illuminant C and the CIE 1931 (2°) standard observer.

^B The dichromate color standards have been found to be less reliable than chloroplatinate or iron-cobalt color standards. They are included in Table 1 for reference only.

10.2 For comparison, permanent solutions of known color are more satisfactory. The approximate composition of solutions giving each of the 18 Gardner colors is also given in Table 1. The solutions shall be made from K₂PtCl₆ in 0.1 N HCl, or, in the darker colors, from stock solutions of FeCl₃, CoCl₂, and HCl (see 9.1, 9.2, and 9.3). Pre-prepared Gardner color standard solutions are commonly available for purchase.

10.3 ~~Solutions~~ If the solutions in 10.2 are unavailable, solutions of K₂Cr₂O₇ (sp gr 1.84) ~~may be~~ are used as reference standards. The approximate composition of these standards is also given in Table 1. Each solution must be freshly made for the color comparison, using gentle heat, if necessary, to effect solution.

10.4 Secondary reference standards may be obtained in the form of 18 colored glass disks, which are set into a pair of larger, plastic disks and the latter mounted to rotate in a housing for holding the sample tube and glass disk in close and fixed proximity.

11. Procedure

11.1 Fill the tube with sample, free of solid particles or air bubbles, so that the apparent upper edge of the liquid meniscus is even with the lower etched line on the tube.

11.2 Determine the color by comparison with the reference standard solutions prescribed in Table 1, by comparing the sample and the standard in Gardner-Holdt viscosity tubes as described. Make the comparison at 25 ± 5°C by placing tubes close together and looking through them against a white background or by comparison to the standards in a color disk.