



**Designation: D1500 – 12 (Reapproved 2017)**



**Designation: 196/97**

## **Standard Test Method for ASTM Color of Petroleum Products (ASTM Color Scale)<sup>1</sup>**

This standard is issued under the fixed designation D1500; 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.

*This standard has been approved for use by agencies of the U.S. Department of Defense.*

### **1. Scope**

1.1 This test method covers the visual determination of the color of a wide variety of petroleum products, such as lubricating oils, heating oils, diesel fuel oils, and petroleum waxes.

NOTE 1—Test Method **D156** is applicable to refined products that have an ASTM color lighter than 0.5.

1.2 This test method reports results specific to the test method and recorded as “ASTM Color.”

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, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.4 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

### **2. Referenced Documents**

#### **2.1 ASTM Standards:<sup>2</sup>**

**D156 Test Method for Saybolt Color of Petroleum Products (Saybolt Chromometer Method)**

**D938 Test Method for Congealing Point of Petroleum Waxes, Including Petrolatum**

<sup>1</sup> This test method is under the jurisdiction of ASTM Committee **D02** on Petroleum Products, Liquid Fuels, and Lubricants and is the direct responsibility of Subcommittee **D02.05** on Properties of Fuels, Petroleum Coke and Carbon Material.

Current edition approved Oct. 1, 2017. Published November 2017. Originally approved in 1957. Last previous edition approved in 2012 as D1500 – 12. DOI: 10.1520/D1500-12R17.

This is also a standard of Energy Institute issued under the fixed designation IP 196. The final number indicates the year of last revision. This test method was adopted as a joint ASTM-IP standard in 1966. In the IP, this test method is under the jurisdiction of the Standardization Committee.

<sup>2</sup> For referenced ASTM standards, visit the ASTM website, [www.astm.org](http://www.astm.org), or contact ASTM Customer Service at [service@astm.org](mailto:service@astm.org). For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

**D2500 Test Method for Cloud Point of Petroleum Products and Liquid Fuels**

**D4057 Practice for Manual Sampling of Petroleum and Petroleum Products**

### **3. Summary of Test Method**

3.1 Using a standard light source, a liquid sample is placed in the test container and compared with colored glass disks ranging in value from 0.5 to 8.0. When an exact match is not found and the sample color falls between two standard colors, the higher of the two colors is reported.

### **4. Significance and Use**

4.1 Determination of the color of petroleum products is used mainly for manufacturing control purposes and is an important quality characteristic, since color is readily observed by the user of the product. In some cases, the color may serve as an indication of the degree of refinement of the material. When the color range of a particular product is known, a variation outside the established range may indicate possible contamination with another product. However, color is not always a reliable guide to product quality and should not be used indiscriminately in product specifications.

### **5. Apparatus**

5.1 *Colorimeter*, consisting of light source, glass color standards, sample container housing with cover, and viewing piece as listed in **Annex A1**.

5.2 *Sample Container*—For referee work, use the glass sample jar as shown in **Fig. 1**. For routine tests, it is permissible to use a cylindrical, clear glass jar with a flat bottom of 30 mm to 32.4 mm internal diameter, 115 mm to 125 mm in external height, and a wall thickness no greater than 1.6 mm as specified in Test Method **D2500**, or an ordinary 125 mL oil sample bottle if it meets these requirements.

5.3 *Ultrasonic Bath, Unheated (optional)*—of suitable dimensions to hold container(s) placed inside of bath, for use in effectively dissipating and removing air or gas bubbles that can be entrained in viscous sample types prior to analysis.

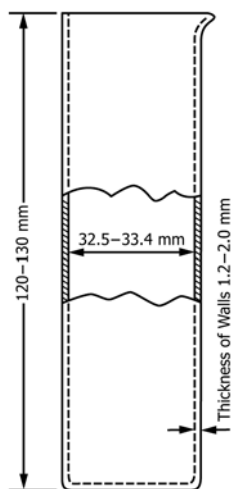


FIG. 1 Standard Glass Sample Jar

## 6. Sampling

6.1 Samples shall be taken in accordance with the instructions in Practice D4057.

6.2 For some sample types, such as viscous lube oils that are prone to having entrained air or gas bubbles present in the sample, the use of an ultrasonic bath (see 5.3) without the heater turned on (if so equipped), has been found effective in dissipating bubbles typically within 10 min.

## 7. Diluent

7.1 *Solvent Kerosene*—(Warning—Combustible. Vapor harmful.) Having a color lighter than +21 Saybolt color by Test Method D156, this material is used for diluting dark samples for the test. As an alternative, other solvents, such as white oil or solvent neutral 100 of satisfactory purity that meet the color requirements specified here in 7.1, are also acceptable.

NOTE 2—Solvent kerosene complies with this requirement if it is lighter in color than potassium dichromate ( $K_2Cr_2O_7$ ) solution formed by dissolving 4.8 mg of pure anhydrous  $K_2Cr_2O_7$  in 1 L of distilled water.

## 8. Preparation of Sample

8.1 *Liquid Petroleum Products such as Lubricating Oils*—Fill the sample container to a depth of 50 mm or more and observe the color. When the sample is not clear, heat it just sufficiently enough to make it clear to perform the color measurement at that temperature. A sample heated to a temperature of 6 °C (10 °F) above its cloud point (see Test Method D2500) has been found suitable to test samples using this test method. When the sample is darker than 8 color, one may either stop the test and report “D8 ASTM Color” (see 10.2) or continue the test and mix 15 volumes of sample into 85 volumes of solvent kerosene or alternative material (see 7.1) and observe the color of the mixture.

8.2 *Petroleum Waxes, Including Petrolatum*—Heat the sample just sufficiently enough to make it fluid and clear to perform the color measurement at that temperature without heating the wax excessively, because oxidation can occur, along with consequent discoloration of the test specimen. A sample heated to a temperature of 11 °C to 17 °C (20 °F to

30 °F) above its congealing point, as determined in accordance with Test Method D938, has been found suitable to test samples using this test method. When the sample is darker than 8 color, one may either stop the test and report “D8 ASTM Color” (see 10.2) or continue the test and mix 15 volumes of melted sample with 85 volumes of solvent kerosene or alternative material (see 7.1) brought to the same temperature and test the mixture at that temperature.

## 9. Procedure

9.1 Place a sample container or containers, filled to a depth of at least 50 mm with distilled or deionized water, in the compartment or compartments of the colorimeter through which the standard glasses will be observed. Place the sample in its container in the other compartment. (When using a three-field comparator, this will be the middle compartment.) Cover the containers to exclude all exterior light.

9.2 Switch on the light source and compare the color of the sample with that of the standard glasses. When using a three-field comparator, the sample must be bracketed by darker and lighter discs or by an exact match and a darker disc. Determine for two-field comparators which glass matches the color of the sample; or if an exact match is not possible, then use that glass which possesses the next darker color.

## 10. Report

10.1 Report as the color of the sample, the designation of the glass producing a matching color (for example, “7.5 ASTM Color.”)

10.2 If the color of the sample is intermediate between those of two standard glasses, report that the sample is less than the darker glass designation. As an example, report the designation of the darker glass preceded by the letter “L” (for example, “L7.5 ASTM Color”) or with a “<” symbol (for example, “<7.5 ASTM Color”). Never report the color as being darker than a given standard except those darker than 8 (for example, “D8 ASTM Color” or “>8 ASTM Color.”)

10.2.1 If the color of the sample is less than the 0.5 glass color standard, report that the sample is less than the 0.5 glass color standard. As an example, report the designation as “L0.5 ASTM Color” or “<0.5 ASTM Color.”

10.3 If the sample has been diluted in accordance with 7.1, report the color of the mixture followed by the abbreviation “Dil” (for example, “L7.5 Dil ASTM Color” or “<7.5 Dil ASTM Color”). See Note 3.

NOTE 3—For samples that are diluted in 10.3, it is permissible for the laboratory to annotate the report in any suitable manner, provided that the information clearly conveys to the data recipient that the sample analyzed was diluted.

## 11. Precision and Bias<sup>3</sup>

11.1 *Precision*—The precision of this test method as obtained by statistical examination of interlaboratory test results is as follows:

<sup>3</sup> Supporting data have been filed at ASTM International Headquarters and may be obtained by requesting Research Report RR:D02-1234.

**11.1.1 Repeatability**—The difference between successive test results obtained by the same operator with the same apparatus under constant operating conditions on identical test material would, in the long run, in the normal and correct operation of the test method, exceed the following value only in one case in twenty: 0.5 color units.

**11.1.2 Reproducibility**—The difference between two single and independent test results obtained by different operators working in different laboratories on identical test material

would, in the long run, in the normal and correct operation of the test method exceed the following value only in one case in twenty: 1 color unit.

**11.2 Bias**—The procedure in this test method has no bias because the value of ASTM Color is subjective and can only be defined in terms of this test method.

## 12. Keywords

12.1 ASTM Color; color; petroleum products

## ANNEX

### (Mandatory Information)

#### A1. DESCRIPTION OF COLORIMETER AND ASSOCIATED APPARATUS

**A1.1 Colorimeter**—Use an instrument that will illuminate and permit observation of the sample and any one of the color standards (or in the case of a three-field instrument, any two of the color standards) simultaneously, either by direct viewing or with an optical eyepiece.

**A1.1.1** A two-field instrument must show two illuminated areas of equal size and shape, one filled with light transmitted by color standard, the other with light transmitted by the sample. These illuminated areas shall be disposed symmetrically about a vertical median line and shall be separated in a horizontal direction so that the horizontal separation of the closest portions subtends the eye of the observer not less than 2° nor more than 3.6°.

**A1.1.2** A three-field instrument shall show three illuminated areas in the field of view. Two areas shall be filled with light transmitted by two different color standards, and these shall be disposed symmetrically about the third area which shall be filled with light transmitted by the sample. The rectangular dimensions of each of the three areas shall be the same, and the left- and right-hand corners of the full field of view shall be rounded with radius not exceeding half the vertical dimension. The illuminated areas shall be separated in a horizontal direction by vertical lines so that the closest portion of the sample area and any one of the color standards illuminated areas subtends the eye of the observer not less than 0.3° nor more than 0.6°.

**A1.1.3** Each illuminated area in the two-field instrument shall cover a circle of diameter subtending at least 2.2° and may be enlarged to any size provided that no two illuminated points in the field of view are separated by a distance

subtending more than 10°. In the case of the three-field direct viewing instrument, the subtending angles become 2.6° and 6.4°, respectively.

**A1.1.4** The angle subtended by a line of length  $d$ , in a plane perpendicular to the line of sight, and separated from the eye of the observer by a distance  $D$ , is given in degrees by  $57.3 d/D$ . The angle subtended by the image of this line, seen by viewing it through an eyepiece of magnification  $M$ , is given in degrees by  $57.3 Md/D_i$ , where  $D_i$  is the distance between the eye of the observer and the plane of the image.

**A1.2 Artificial Daylight Source**—This may be a separate unit or an integral part of the colorimeter where the combined system of a source lamp (A1.2.1), daylight filter glass (A1.3), and flashed opal glass (A1.2.2) are capable of producing spectral characteristics similar to northern daylight (that is, color temperature of 6700 K  $\pm$  300 K) for use in the test.

**NOTE A1.1**—When electric current is not available, the colorimeter may be designed to use diffused daylight provided that direct sunlight is avoided. Colored objects should be excluded from the immediate foreground when using diffused daylight.

**A1.2.1 Source Lamp**—Consisting of a lamp of color temperature of approximately 2750 K (or if a quartz halogen lamp is used, approximately 2900 K). A source lamp providing a translucent or opaque diffuse background of 900 lx  $\pm$  100 lx brightness against which the color standards and samples are viewed has been found satisfactory to produce the necessary spectral characteristics. The source lamp shall be designed so that there is no extraneous light interfering with the observation.

**A1.2.2 Flashed Opal Glass**—The background of illuminated opal glass shall be free from glare or shadows.

**A1.3 Filter**—An acceptable daylight filter, which has been used in combination with the artificial daylight source and flashed opal glass to produce the spectral characteristics similar to northern daylight, is one where a spectrometric test indicates a transmittance of radiant energy of not less than 0.60 at 410 nm with a smooth curve down to a transmittance below

**TABLE A1.1 Filter Characteristics**

Characteristic	Lamp Color Temperature, K	
	2750	3300
$T$	0.107 to 0.160	0.075 to 0.125
$x$	0.314 to 0.330	0.300 to 0.316
$y$	0.337 to 0.341	0.325 to 0.329
$z$	0.329 to 0.349	0.355 to 0.375

0.10 at 700 nm without the pronounced bump that is characteristic of excess cobalt having an increased transmittance at 570 nm above a straight line drawn between the points indicating transmittance at 540 nm and 590 nm, and also a transmittance band above 660 nm. The transmittance of an acceptable filter shall not, at 570 nm, exceed by more than 0.03 that indicated by a straight line drawn between the points indicating transmittance at 540 nm and 590 nm, nor shall the transmittance for 700 nm exceed that for any shorter wavelength (such as 660 nm) by more than 0.03.

A1.3.1 An acceptable daylight filter shall also possess such characteristics that the chromaticity coordinates,  $x$ ,  $y$ , and  $z$ , and luminous transmittance,  $T$ , when calculated from the spectral transmittance data using the 1931 CIE Standard Illuminant A,<sup>4</sup> shall be as shown in Table A1.1.

A1.4 *Glass Color Standards*—Use color standards as specified in Table A1.2. The standards shall be mounted in such a way that they may be conveniently manipulated. The width of the glass color standards shall not be less than 14 mm.

A1.5 *Glass Container*—The glass sample jar, Fig. 1, is a true cylinder of clear colorless glass, having the following dimensions:

<sup>4</sup> Judd, D. B., "The 1931 ICI Standard Observer and Coordinate System for Colorimetry," *Journal of the Optical Society of America*, Vol 23, No. 10, October 1953.

TABLE A1.2 Glass Color Standards

ASTM Color	Chromaticity Coordinates <sup>A</sup> (RGB USC system) <sup>B</sup>			Luminous Transmittance (CIE <sup>C</sup> Standard Source C) $T_w$
	Red	Green	Blue	
0.5	0.462	0.473	0.065	0.86 ± 0.06
1.0	0.489	0.475	0.036	0.77 ± 0.06
1.5	0.521	0.464	0.015	0.67 ± 0.06
2.0	0.552	0.442	0.006	0.55 ± 0.06
2.5	0.582	0.416	0.002	0.44 ± 0.04
3.0	0.611	0.388	0.001	0.31 ± 0.04
3.5	0.640	0.359	0.001	0.22 ± 0.04
4.0	0.671	0.328	0.001	0.152 ± 0.022
4.5	0.703	0.296	0.000	0.109 ± 0.016
5.0	0.736	0.264	0.000	0.081 ± 0.012
5.5	0.770	0.230	0.000	0.058 ± 0.010
6.0	0.805	0.195	0.000	0.040 ± 0.008
6.5	0.841	0.159	0.000	0.026 ± 0.006
7.0	0.877	0.123	0.000	0.016 ± 0.004
7.5	0.915	0.085	0.000	0.0081 ± 0.0016
8.0	0.956	0.044	0.000	0.0025 ± 0.0006

<sup>A</sup> Tolerances on the chromaticity coordinates are ±0.006.

<sup>B</sup> Judd, D. B., "A Maxwell Triangle Yielding Uniform Chromaticity Scales," *Journal of Research of the National Bureau of Standards*, Vol 14, 1935, p. 41. (RP 756); *Journal of the Optical Society of America*, Vol 25, 1935, p. 24.

<sup>C</sup> Commission Internationale de l'Eclairage (International Commission on Illumination).

Internal diameter, mm	32.5 to 33.4
Wall thickness, mm	1.2 to 2.0
Total height, mm	120 to 130

A1.6 *Sample Cover*—The sample cover can be made of any suitable material that is dull black on the inside and is designed to completely shield both containers as described in 9.1.

## APPENDIX

### (Nonmandatory Information)

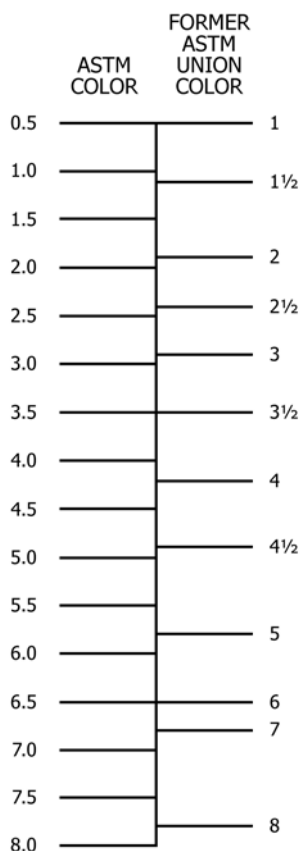
#### X1. INFORMATION CONCERNING THE CORRELATION OF ASTM COLOR SCALE AND THE FORMER ASTM UNION COLOR (D155)

X1.1 This test method has replaced the former Test Method D155. Test Method D155 was withdrawn as an ASTM Tentative on July 1, 1960. Test Method D1500 is better than the former Test Method D155 in three respects: (1) the glass standards are specified in fundamental terms; (2) the differences in chromaticity between successive glass standards are uniform throughout the scale; and (3) the lighter-colored standards more nearly match the color of petroleum products.

X1.2 A relationship between the ASTM Color Scale and ASTM Union Colors (former Test Method D155) could not be exactly expressed because of differences which were known to exist between ASTM Union Color standards that are in use. Subcommittee D02.05 is aware of significant differences between Union Color standards being used as official company standards.

X1.3 The ASTM Union Color standards were specified in terms of Lovibond Color Analysis. This means of specifying the color of the standard glasses had been found to be inadequate. When the ASTM Union Color was adopted in 1923, a set of Master Glass Standards was established. These standards were placed in the hands of the company which was licensed to manufacture the ASTM Union Colorimeter. Subcommittee D02.05 has had these Master Union Color standards analyzed spectrometrically. The correlation of these data and the ASTM Color Scale is shown in Fig. X1.1. Specifications for the ASTM Color Scale limit the maximum variation in the color to be approximately ±0.1 color. Variations in the Union Color Scale that are known to exist amount to as much as 0.5 color.

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**FIG. X1.1 Correlation Between the ASTM Color Scale and the former ASTM Union Color**

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