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Designation: D 2985 – 92 (Reapproved 2002)

Standard Test Method for Color of Asbestos[1]

This standard is issued under the fixed designation D 2985; 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 determination of color, whiteness, and yellowness of asbestos by means of a photoelectric reflectometer.

1.2 The test method is applicable to all grades and varieties of homogeneous milled asbestos.

1.3 This test method may be applied to samples that are not dry or homogeneous, or that contain impurities or adulterants. However, in such cases, results may not be comparable with those obtained on clean dry samples.

1.4 To obtain similar results from spectrophotometers, see Test Method E 308.

1.5 The values stated in SI (metric) units are to be regarded as standard. The inch-pound (customary) units are for information only.

1.6 *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.*

2. Referenced Documents

2.1 *ASTM Standards:*

D 2244 Test Method for Calculation of Color Differences from Instrumentally Measured Color Coordinates[2]

D 2590 Test Method for Sampling Chrysotile Asbestos[3]

D 2946 Terminology Relating to Asbestos[3]

D 3879 Test Method for Sampling Amphibole Asbestos[3]

E 3 Guide for Preparation of Metallographic Specimens[4]

E 259 Practice for Preparation of Pressed Powder, White Reflectance Factor Transfer Standards for Hemispherical and Bi-Directional Geometries[2]

E 308 Practice for Computing the Colors of Objects by Using the CIE System[2]

3. Terminology

3.1 *Definitions of Terms Specific to This Standard:* [5]

3.1.1 *black, adj, adj*—color name applied to opaque objects that are highly absorbing throughout the visible spectrum.

3.1.2 *CIE, n*—acronym for International Commission on Illumination, which in French is Commission Internationale de l'Eclairage.

3.1.3 *CIE observer, n*—See **observer, standard, CIE 1931** and **observer, supplementary, CIE 1964.**

3.1.4 *CIE source C, n*—See **standard source**.

3.1.5 *color, psychophysical, n*—characteristics of a color stimulus (that is, light producing a sensation of color) denoted by three dimension values such as three tristimulus values.

3.1.6 *daylight 0.785 rad, 0 rad (45°, 0°) luminous directional reflectance*—daylight 0.785 rad, 0 rad (45°, 0°) luminous directional reflectance (for brevity called reflectance) is the ratio of the luminous flux from a specimen illuminated at an angle of 0.785 rad (45°) by CIE standard source C[6] (average daylight) and viewed perpendicularly by the CIE standard observer, to the luminous flux from the standard magnesium oxide layer, similarly illuminated and viewed (Note 1). The combination of illumination at 0.785 rad (45°) and viewing at 0 rad (0°) (perpendicularly) has been selected as being representative of average conditions of illuminating and viewing. The property of reflectance determines which of two specimens will appear lighter when viewed in average daylight at an angle at which the observation of highlights is avoided.

NOTE 1—These conditions of illumination and observation may be interchanged without affecting the results.

3.1.7 *glos, n*—angular selectivity of reflectance of surface-reflected light responsible for the degree to which reflected highlights or images of objects may be seen as superimposed on a surface.

3.1.8 *gloss, specular, n*—ratio of flux reflected in a specular direction to incident flux for specific source and receptor apertures (usually measured relative to a standard of specified index of refraction).

[1] This test method is under the jurisdiction of ASTM Committee C17 on Fiber-Reinforced Cement Products and is the direct responsibility of Subcommittee C 17.03 on Asbestos–Cement Sheet Products and Accessories.

Current edition approved May 15, 1992. Published July 1992. Originally published as D 2985 – 71 T. Last previous edition D 2985 – 92 (1997).

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

[3] *Annual Book of ASTM Standards*, Vol 04.05.

[4] *Annual Book of ASTM Standards*, Vol 03.01.

[5] Taken in part from Procedure No. B5-9 of Socíeté Asbestos Ltée, with permission.

[6] CIE standard sources and functions are defined in Test Method E 308.

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3.1.9 *gray*, *n*—color name applied to achromatic stimuli of moderate relative luminance.

3.1.10 *green*, *adj*—hue name applied to light of wavelengths from 495 to 550 nm.

3.1.11 *hue*, *n*—attribute of color perception by means of which objects are judged to be red, yellow, blue or intermediate between some adjacent pair of these. Hue is a matter of social consensus as opposed to an assigned frequency range.

3.1.12 *ideal black*, *n*—object or material that absorbs all light impinging on it.

3.1.13 *illuminant*, *n*—incident luminous flux specified only by its spectral distribution. (The spectral composition of an illuminant may differ from the source because of spectral modification by such means as absorption or refraction by mediae enclosing the source or by reflection from other objects. See definition of **source**. The CIE standard illuminants are Illuminant C and Illuminant D6500, each representing average daylight, and Illuminant A, 2854K).

3.1.14 *light*, *n*—electromagnetic radiation in the spectral range detectable by the normal human eye (approximately 380 to 760 nm).

3.1.15 *light*, *n*—radiant energy evaluated according to the CIE photopic spectral luminous efficiency function.

3.1.16 *light*, *adj*—highly reflecting, as in the term light green.

3.1.16.1 *Discussion*—For given conditions of illumination and surface texture, a more reflective surface is perceived as lighter in color than a less reflective but otherwise identical surface.

3.1.17 *luminous*, *adj*—indicates that the radiant flux is evaluated by weighting according to the luminous efficiency function of the CIE 1931 standard observer.

3.1.18 *luminous reflectance*, *n*—See **reflectance, luminous**.

3.1.19 *observer, standard,* CIE 1931,, *n*—hypothetical observer based on color mixture data obtained for a 2° field of view for 17 observers, adopted by the CIE in 1931.

3.1.20 *observer, supplementary, CIE 1964*, *n*—hypothetical observer based on color mixture data obtained for a 10° field of view for 76 observers, adopted by the CIE in 1964.

3.1.21 *photoelectric color meter*, *n*—color-stimulus-measuring instrument using photoelectric detectors in which source-filter-detector response characteristics are adjusted so that the instruments read directly the tristimulus values or related quantities.

3.1.22 *preferred white*, *n*—the white color, usually bluish, that is judged by a given group of observers looking at a given series of specimens to be the whitest color attainable.

3.1.23 *reflectance, luminous*, *n*—ratio of luminous flux reflected by a specimen to that incident on it.

3.1.24 *reflection*, *n*—processes by which incident flux leaves a surface or a medium from the incident side.

3.1.25 *reflection, diffuse*, *n*—process by which incident flux is distributed by reflection over a wide range of angles.

3.1.26 *regular*, *adj*—used to indicate flux transmitted or reflected in the image-forming state (the adjective specular is usually used to indicate regular mirror-reflected flux).

3.1.27 *source*, *n*—that which furnishes light or other radiation; real device by which radiant flux is produced. (See **illuminant**.)

3.1.28 *source, CIE standard*, *n*—See **standard source**.

3.1.29 *spectral*, *adj*—indicates either a function of wavelength as in spectral transmittance, or spectral concentration, as in spectral flux.

3.1.30 *specular*, *adj*—same as regular when applied to reflection.

3.1.31 *specular gloss*, *n*—See **gloss, specular**.

3.1.32 *standard observer*, *n*—See **observer, standard**.

3.1.33 *standard, primary*, *n*—one whose calibration is determined by measurement according to specified parameters.

3.1.34 *standard, secondary*, *n*—standard calibrated by reference to another standard such as a primary, reference, laboratory or working standard.

3.1.35 *standard source*, *n*—light source whose spectral energy distribution is known or defined. (The CIE standard sources to represent incandescent-lamp light, sunlight, and daylight, are designated A, B, and C, respectively.)

3.1.36 *texture*, *adj*—in evaluating the color of a surface, structural quality of a surface determined by the topography of its constituents.

3.1.37 *viewing conditions*, *n*—the conditions under which a visual observation is made, including the angular substance of the specimen at the eye; the geometric relationship of source, specimen and eye; the photometric and spectral character of the field of view surrounding the specimen; and the state of adaptation of the eye.

3.1.38 *white*, *adj*—color name most usually applied to opaque, highly reflecting, highly diffusing, visually hueless specimens.

3.1.39 *whiteness*—the term "whiteness" is widely used to designate the degree to which a near-white surface approaches "perfect white," defined as a 100 % reflectance over the whole visible spectrum. Other terms used for this property are "lightness" or" luminous apparent reflectance." The concept of whiteness is not only applicable to near-white surfaces but also to dark and colored surfaces. Whiteness may be defined as the grading which an observer would assign to the surface, irrespective of its color or hue, when compared under daylight conditions against a scale of grays ranging from white to black.

3.1.40 *yellow*, *adj*—hue name applied to light wavelengths from 572 to 783 nm and to visually similar stimuli.

3.1.41 *yellowness*—a yellowed or tan discolored asbestos may have the same degree of whiteness on the gray scale as a gray asbestos. It is thus necessary to measure an index of yellowness for such cases, and this may be calculated arbitrarily from reflectance measurements using tristimulus filters. Use the following relationship for asbestos:

$$\text{yellowness factor} = (A - B)/G \quad (1)$$

where:

A = reflectance with the amber tristimulus filter,[7]
B = reflectance with the blue tristimulus filter, and
G = reflectance with the green tristimulus filter.

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3.1.42 For terms relating to asbestos fibers, refer to Terminology D 2946.

4. Summary of Test Method

4.1 Specimens are pressed into a pellet and the luminous reflectance is measured by means of a simple reflectometer fitted with an incandescent source, and a photoelectric reflectometer.

4.2 Instructions are included for use of the suppressed zero technique to improve precision.

4.3 The use of tristimulus color filters permitting the determination of whiteness, yellowness, and CIE[8] color-order values, is covered.

5. Significance and Use

5.1 The color of asbestos is of commercial significance when it is to be incorporated into products, the color of which is affected by the color of the asbestos, and for which color specifications must be met.

5.2 Whiteness is required of asbestos for use in white or pale-colored products.

5.3 Yellowness is significant in asbestos for use in pastel-colored products where discolored asbestos may prevent attainment of certain shades and hues detector.

6. Apparatus

6.1 The apparatus[9] shall consist of a photoelectric reflectometer having source, filter, and receptor characteristics such that it will measure reflectance accurately to within 1.0 % of full-scale reading. The reflectometer shall have the following characteristics:

6.1.1 *Spectral Characteristics*—The spectral energy distribution of the illuminator and the spectral sensitivity of the receptor, in combination, shall provide the equivalent of illumination by CIE standard source C and observation by the CIE standard observer.

6.1.2 *Geometric Characteristics*—Illumination shall be within 0.0698 rad (4°) of, and centered about, a direction of 0.785 rad (45°) from the perpendicular to the test surface; viewing shall be within 0.262 rad (15°) of, and centered about, the perpendicular (Note 1).

6.1.3 Any instrument that meets the apparatus specifications and the precision requirements stated in Section 13 may be used. In general, commercial instruments do not conform exactly to the apparatus requirements. The suitability of a given instrument depends in large measure on its response to the spectral selectivity range of asbestos, and on the availability of standards of similar reflectance and spectral character. Instruments that have been found satisfactory include: the Hunter Multi-purpose Reflectometer; the Gardner (Hunter) Photometric Unit with 0.785 rad, 0 rad (45°, 0°) reflectance head; and the General Electric Reflection Meter.

6.2 *Standards*:

6.2.1 *Primary Standard*—The primary standard for reflectance measurements is a layer of MgO freshly prepared in accordance with Practice E 259. It is assigned a value of 100 for the conditions of 0.785 rad (45°) illumination and perpendicular view (Note 1).

6.2.2 *Secondary Standards*—Porcelain enameled metal plaques or other materials known to be reasonably permanent in reflectance, and of uniform surface, may be calibrated and used as secondary reflectance standards.

NOTE 2—Secondary standards of porcelain enamel may be obtained from the National Bureau of Standards,[10] the Henry A. Gardner Laboratory,[11] or the Photovolt Corp. Experience has shown that these secondary reflectance standards are reasonably permanent if abrasion is avoided. Plaques stored for a year or more may develop efflorescence (bloom) noticeable on black plaques, which can be removed by washing with mild soluble soap and water.

6.2.3 Standards with reflectance values as close as possible to the values of the unknowns are recommended.

6.3 *Tristimulus Filters,*[7] including amber, blue, and green, to fit the reflectometer source and detector.

6.4 *Piston and Cylinder Mold*, for pressing the asbestos specimens into pellets with a diameter of approximately 28.6 mm (1.125 in.). The height of the mold cavity may be approximately 63 mm (2.5 in.). The piston face must be polished. Any slight texture or presence of oxidation at the piston face may impress a texture onto the asbestos specimen (particularly to very highly fiberized grades of asbestos), and such texture may affect light reflectance significantly. The polish of the piston face may be restored by rubbing with successively finer abrasive papers as described in Methods E 3.

6.5 *Press,*[12] for molding specimens, capable of applying and holding a load of 7250 kg (16 000 lb).

6.6 *Blackbody Cavity*.

6.7 *Polished Black Glass Standard*, 50 by 50 mm (2 by 2 in.).

7. Sampling

7.1 Take a sample in accordance with Test Methods D 2590 or D 3879 for chrysotile or amphibole types of asbestos, respectively, as defined by Terminology D 2946. Twenty grams are required for duplicate specimens. (**Warning—**When handling asbestos fibers, use reasonable precautions to avoid creating dust. Prolonged or frequent breathing of significant concentrations of airborne asbestos dust may cause serious bodily harm.)

8. Test Specimen

8.1 Weigh out 10 g of asbestos and press at 70 kN (15 000 lbf) in the pellet mold for 60 s.

8.2 Note which side of the pellet was against the polished piston face since only that surface is suitable for color testing.

[7] Tristimulus filters are described in the following reference: Lih, M. M., *Chemical Engineering*, Vol 75, No. 17, August 12, 1968, pp. 146–156.

[8] Commission International de l'Eclairage (International Commission on Illumination). The CIE color-order system is the most important of those used in connection with instruments for color measurement. Refer to Test Method E 308.

[9] Photovolt Reflection Meter, Model 670, available from Photovolt Corp., 1115 Broadway, New York, NY 10010, or its equivalent, has been found suitable for this purpose.

[10] National Bureau of Standards, Washington, DC 20234.

[11] Gardner Laboratory Inc., Box 5728, Bethesda, MD 20014.

[12] The Carver laboratory press supplied by F. S. Carver Inc., 1 Chatham Road, Summit, NJ, or its equivalent, has been found suitable for this purpose.

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