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An American National Standard

AMERICAN SOCIETY FOR TESTING AND MATERIALS
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Standard Test Method for Accelerated Testing for Color Stability of Plastics Exposed to Indoor Fluorescent Lighting and Window-Filtered Daylight[1]

This standard is issued under the fixed designation D 4674; 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 an accelerated procedure intended to determine the resistance to color change of plastics in typical office environments, where overhead fluorescent light and window-filtered daylight are used for illumination, and where temperature and humidity conditions are in accordance with American Society of Heating, Refrigerating, and Airconditioning Engineers (ASHRAE) recommendations for workers' comfort.

1.2 *This standard does not purport to address all of the safety concerns, is 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.* Specific precautionary statements are given in Section 6.

2. Referenced Documents

2.1 *Specification for ASTM Standards:*

D 1729 Practice for Visual Evaluation of Color Differences of Opaque Materials[2]

D 2244 Method for Calculation of Color Differences from Instrumentally Measured Color Coordinates[3]

2.2 *Other Document:*

American Society of Heating, Refrigerating, and Airconditioning Engineers, Applications Handbook 1981, Section 1 on Comfort, Chapter 3.9[4]

3. Summary of Test Method

3.1 This test method provides for the exposure of specimens to the radiant energy from an array of eleven very-high output (VHO) cool, white fluorescent lamps and, simultaneously, to intermittent energy from two soda-lime glass-filtered fluorescent UV sunlamps. The extent of UV irradiation (nominal UV actinic exposure or UVAE) from both sources is determined separately as the product of UV irradiance at the start of the test and exposure time, in Watt-hours/m^2 (W–h/m^2).

3.1.1 The contribution of sunlamp irradiation to the total UV actinic exposure is maintained constant by adjusting the on/off cycle time of the sunlamps.

3.1.2 The average nominal sunlamp UV actinic exposure is set at 12 % of the value for the VHO lamps.

NOTE 1—Although office machines see some UV exposure due to sunlight, most originates from fluorescent lighting. The 12 % is an estimate of a representative office environment.

3.2 Color change is determined periodically throughout the course of the exposure by comparison of the exposed to the masked or unexposed specimens, using either visual or instrumental procedures.

3.3 The final color change should be evaluated in less than 24 h after the test is completed, preferably in less than 1 h, to eliminate possible misleading consequences of postactinic reaction. (Color change initiated by accelerated exposure may continue after removal of specimens from exposure to radiation.)

4. Significance and Use

4.1 This test method is intended to produce the color changes that may occur in plastics upon exposure to irradiation from typical office lighting by simulating these office conditions.

4.1.1 It is recognized that the rate of photodegradation of plastics will vary significantly due to factors such as processing conditions, initial color, pigment loading, the presence/type of flame retardants and other additives, etc. Consequently, correlation of accelerated test results with actual end-use performance must be determined individually for each resin system.

4.1.2 Variations in exposure time, temperature and humidity may also affect results.

5. Apparatus [5]

5.1 The test chamber shall be constructed of UV reflective aluminum with a clear, chromate conversion coating. An arched reflector with a radius of 330 mm serves as the chamber

[1] This test method is under the jurisdiction of ASTM Committee D–20 on Plastics and is the direct responsibility of Subcommittee D20.50 on Permanence Properties.

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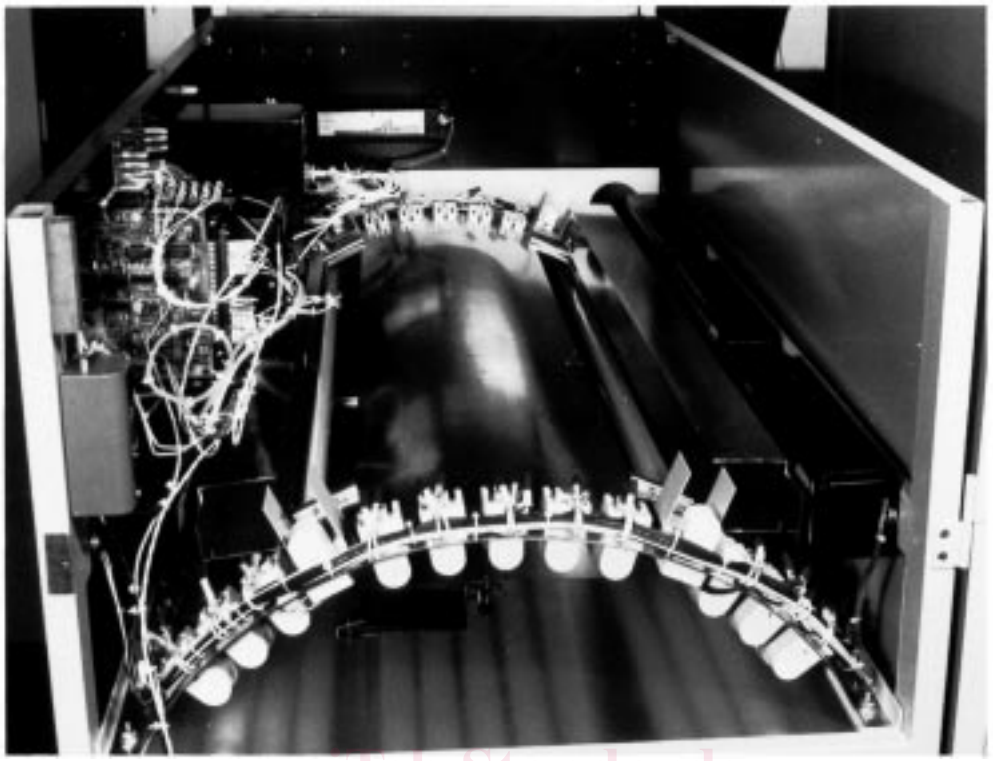
[2] *Annual Book of ASTM Standards*, Vol 14.02.

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

[4] Available from the American Society of Heating, Refrigerating, and Airconditioning Engineers 1791 Tullie Circle Northeast, Atlanta, GA, 30329.

[5] Apparatus available from Atlas Electric Devices Co., 4114 Ravenswood Ave., Chicago, IL 60613 has been found satisfactory.



NOTE 1—Inside view showing curved reflecting roof (tunnel) and fluorescent lamps. The two 40-W fluorescent sunlamps are on the upper portion of the reflecting tunnel directly above the soda-lime glass filters placed in the apertures in the tunnel. The eleven VHO fluorescent lamps are mounted on the underside of the tunnel. The sensor for the high-temperature thermostatic switch is below the center fluorescent lamp and at the right edge of the specimen drawer.

FIG. 1 Inside View Showing Curved Reflecting Roof (Tunnel) and Fluorescent Lamps

roof. The reflector also contains two apertures that hold soda-lime glass panels which filter the sunlamps. The vertical distance from the exposed surface of the specimen to the lamp surface shall be 140 ± 3 mm at the midpoint of the arch. See Figs. 1 and 2.

5.1.1 Eleven 1500-mA cool white VHO fluorescent lamps (CW)[6] shall be mounted in three groups on the inner surface of the reflector. The angular spacing between lamps in each group shall be 8°, 45 min. See Figs. 1 and 2.

5.1.2 A 430-mA fluorescent sunlamp (FS)[7] shall be mounted directly above each of the two apertures at a position 26° 15 min from the vertical plane intersecting the longitudinal axis of the test chamber. Each lamp must be mounted behind a soda-lime glass filter (2.4 ± 0.2 mm thick). (See Fig. 1, lamps 12 and 13).

5.2 The specimen table shall have the same reflecting surface as the lamp reflector. It shall have a vertical adjustment to control specimen-to-lamp distance. The table shall accommodate two specimen trays, each having an area of approximately 0.13 m^2 (630 by 210 mm) separated by a median containing a center port for the cosine receptor (light sensor) of the radiometer.

5.3 To assure uniform test conditions, it is important that all lamps shall be in accordance with 5.1.1 and 5.1.2. All 1500-mA lamps shall be cool white. Both 430-mA lamps shall be fluorescent F40T12UVB sunlamps.

5.4 The apparatus shall be used only in an environment which meets ASHRAE recommendations of 20 to 25.5°C ambient temperature and 40 to 50 % relative humidity.

5.4.1 The lamps and ballasts shall be forced-air cooled to maintain the air temperature in the test chamber between 30 and 40°C.

5.4.2 The apparatus shall be equipped with a thermostatic sensor that will cause the lamps to be turned off should the upper temperature limit in the specimen area be exceeded.

5.5 The apparatus shall be equipped with timing devices and time meters to control on-time for the 1500-mA lamps, to control on/off cycling for the 430-mA lamps, and to record total time of operation for each type of lamp.

5.6 The apparatus shall include a properly calibrated radiometer to measure irradiance in the exposure chamber. The light detector shall be located centrally in the exposure table; it shall have a bandpass from 250 to 400 nm and be a cosine response receptor.

[6] A 1500-mA lamp is a cool white (CW) fluorescent lamp with a tubular bulb approximately 38 mm in diameter and 1220 mm in length, rated at 110 W and designated F48T12 CW/VHO, or its equivalent. F48T12CW/VHO Fluorescent Cool White Lamps, available from North American Philips Lighting Corp., Bloomfield, NJ 07003, have been found satisfactory.

[7] A 430-mA lamp is a fluorescent sunlamp (FS) of similar dimension to the cool white lamp described in Footnote 5, rated at 40 W and designated as F40T12UVB, or its equivalent. F40T12UVB Fluorescent UV Sunlamps are also available from North American Philips Lighting Corp.

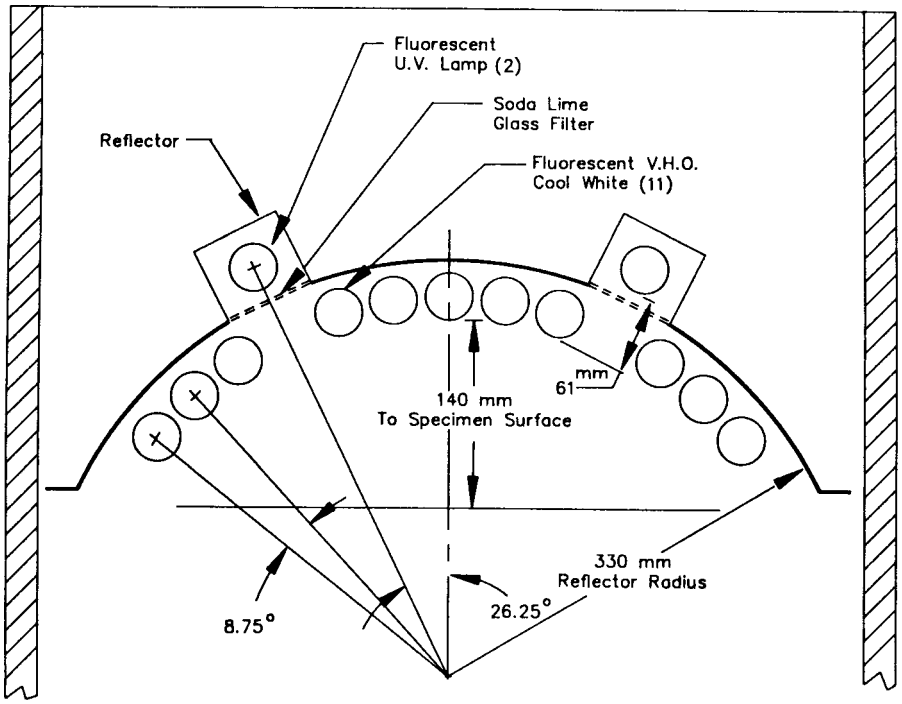


FIG. 2 Apparatus, Schematic Cross Section

6. Safety Precautions

6.1 Never look directly at the operating sunlamps unless wearing UV protective eyewear. The apparatus specified in Section 5 shall be constructed so that the operator will not be exposed to hazardous levels of UV radiation. Access to the lamp area shall be protected by safety switches that turn thelamps off prior to gaining access. The apparatus shall have a circuit breaker switch controlling electric power to the apparatus.

6.2 Sunlamps should be discarded when they are no longer suitable for this apparatus; they should not be used for any other purpose.

7. Test Specimens

7.1 The recommended specimen size is a rectangular flat piece 50 by 80 by 4 mm (maximum thickness). This size is adequate for visual or instrumental evaluation. Other specimen dimensions may be used by mutual agreement among the parties concerned but exposed surfaces should be coplanar.

7.2 It is recommended that one half of each test specimen be masked with aluminum foil, tightly wrapped to prevent exposure of the covered side. The entire specimen may be exposed if an unexposed control is used to judge color shift, or if the color of the test specimen is measured instrumentally and recorded prior to exposure.

7.2.1 Use of aluminum foil-masked specimens may result in a higher irradiance level due to increased reflectivity of the specimen area.

8. Preparation of Apparatus

8.1 Verify proper lamp function before starting any test.

8.2 Verify the UV irradiance level of each type of lamp before starting a test. Carry out verification of irradiance with samples in place; otherwise reflectance of the bare aluminum tray will give erroneous results. Radiometer readings at the start of the test shall not be less than 8.0 W/m^2 for the 1500-mA lamps and 1.0 W/m^2 for the 430-mA lamps.

9. Conditioning

9.1 Specimen conditioning is unnecessary for this test beyond a visual inspection for uniformity of color and the absence of surface irregularities which could adversely affect color measurement.

9.2 Pre-age the lamps by leaving them on for a minimum of 48 h prior to initial test. Replace all of the lamps when the irradiance falls below the limits specified in 8.2.

10. Procedure

10.1 Make an initial color determination prior to loading specimens.

10.2 Open specimen drawer and load specimen trays. Arrange the specimens in rows beginning in the middle and leaving a minimum 25-mm empty border around the edge of the trays. Each tray will accommodate 21 to 22 samples of the 50 by 80-mm size recommended in 7.1.

10.2.1 Adjust the specimens or specimen table so that the surfaces of all test specimens are within 3 mm of being coplanar with the cosine receptor.

10.3 Close the specimen drawer and verify lamp irradiance level in accordance with 8.2.

10.3.1 Turn on both sets of lamps. After 20 min, turn off FS lamps and record the CW irradiance (radiometer reading) in W/m^2. Calculate the exposure time for the desired cool white UV Actinic Exposure (UVAE) as follows:

$$\text{CW Exposure, h} = \text{CW UVAE/CW Irradiance} \quad (1)$$

(*Example*: CW Exposure, h = 3240/10.8 = 300 h)