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Standard Practice for EVALUATION OF COVER MATERIALS FOR FLAT PLATE SOLAR COLLECTORS[1]

This standard is issued under the fixed designation E 765; 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.

1. Scope

1.1 This practice covers the evaluation of cover materials for flat plate solar collectors.

1.2 This practice includes evaluation procedures for the measurement of primary properties of materials and for the assessment of durability of solar collector covers by comparison of initial primary property values with those obtained after exposure to aging procedures.

1.3 This practice includes both primary property measurement tests and aging procedures. Property test methods are included for measurements of solar transmittance, dimensional stability, impact resistance, tensile strength, and the effect of dirt retention on solar transmittance. Aging procedures are included for exposure to heat, natural weathering, and accelerated weathering.

2. Applicable Documents

2.1 *ASTM Standards*:

D 618 Conditioning Plastics and Electrical Materials for Testing[2]

D 638 Test for Tensile Properties of Plastics[2]

D 794 Recommended Practice for Determining the Permanent Effect of Heat on Plastics[2]

D 882 Tests for Tensile Properties of Thin Plastic Sheeting[2]

D 1042 Test for Linear Dimensional Changes of Plastics Under Accelerated Service Conditions[2]

D 1181 Test for Warpage of Sheet Plastics[2]

D 1204 Test for Linear Dimensional Changes of Nonrigid Thermoplastic Sheeting or Film at Elevated Temperature[2]

D 2565 Recommended Practice for Operating Xenon Arc-Type (Water-Cooled) Light-Exposure Apparatus With and Without Water for Exposure of Plastics[2]

E 424 Test for Solar Energy Transmittance and Reflectance (Terrestrial) of Sheet Materials[3]

E 782 Standard Practice for Exposure of Cover Materials for Solar Collectors to Natural Weathering Under Conditions Simulating Operational Mode[3]

G 23 Recommended Practice for Operating Light- and Water-Exposure Apparatus (Carbon-Arc Type) for Exposure of Nonmetallic Materials[3]

G 53 Recommended Practice for Operating Light- and Water-Exposure Apparatus (Fluorescent UV-Condensating Type) for Exposure of Nonmetallic Materials[3]

2.2 *ANSI Standard*:

Z97.1 – 1975 Safety Performance Specifications and Methods of Test for Safety Glazing Material Used in Buildings[4]

3. Significance and Use

3.1 While this practice is addressed to testing of covers for flat plate collectors, it may be used for testing covers for other solar collectors

[1] This practice is under the jurisdiction of ASTM Committee E-44 on Solar Energy Conversion and is the direct responsibility of Subcommittee E44.04 on Materials Performance.

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[2] *Annual Book of ASTM Standards*, Part 35.

[3] *Annual Book of ASTM Standards*, Part 41.

[4] Available from American National Standards Institute, 1430 Broadway, New York, N. Y. 10018.

where applicable.

3.2 This practice is intended to aid the prediction of in-service performance by short term testing.

3.3 Insufficient data exist to obtain exact correlation between the results of accelerated weathering tests and actual in-service performance.

3.4 Primary properties and their long stability are critical to the performance of a solar collector. Property measurement tests provide for measurement of material properties of solar collector covers. Aging procedures provide for exposure of solar collector covers to environments which may induce changes in material properties as shown in property measurement tests. Property measurement tests performed before and after aging procedures provide a means of determining the effect of the aging procedures on the solar collector cover material and assist in estimating the durability of solar collector covers.

3.5 These tests include only those considered most critical to the performance of the solar collector. Other tests to evaluate materials may also be performed. Appendix X1 contains a listing of supplementary tests.

3.6 This practice is intended for use by material manufacturers, solar collector manufacturers, testing laboratories, and others. The use of this practice will provide material property data and durability data by which a material's suitability for a solar collector cover can be assessed. It will also provide data for comparing the durability of various collector cover materials. However, when using the data for comparison of materials, the user should be aware that the many factors influencing degradation due to weathering vary from location to location as well as time of test. Because of this, outdoor exposure data should be taken as indicative only. For direct comparisons the materials should undergo the identical exposure conditions. Control samples must be used in weathering exposures when identical exposure conditions cannot be used.

4. Test Specimens

4.1 The numbers and types of tests required and the preferred testing sequence are specified in Table 1 and Fig. 1.

4.2 Except for thickness, the geometry of the test specimens used to evaluate the properties of cover materials shall be in accordance with that specified in the specific method. The thickness of the specimens shall be that thickness intended for use in solar collector covers. Warpage specimens will be 15 by 15 cm (6 by 6 in.) (see 6.3).

4.3 Tension test specimens used for evaluating the effects of aging procedures shall be cut from a larger piece of material that was subjected to the aging procedure.

4.4 Separate test specimens shall be used for the physical property tests if the physical property test could change the test specimen prior to measurement of solar transmittance or dirt retention. Optical property tests shall not be performed on test specimens damaged by physical property tests.

5. Recommended Conditioning for Physical Property Tests

5.1 *Conditioning*—Unless otherwise specified, the test specimens for physical property tests shall be conditioned at 23 ± 2°C (73 ± 4°F) and 50 ± 5 % relative humidity for not less than 40 h prior to test in accordance with Procedure A of Method D 618.

5.2 *Test Conditions*—Conduct tests in the standard laboratory atmosphere of 23 ± 2°C 73 ± 4°F) and 50 ± 5 % relative humidity, unless otherwise specified in the methods.

NOTE 1—In actual practice, collector cover materials must have acceptable physical properties over a wide range of temperature and humidity conditions. However performing physical property tests above or below ambient conditions is difficult to implement.

TEST METHODS

6. Property Measurement Tests

6.1 *Solar Transmittance*:

6.1.1 Transmittance is an important factor in the admittance of energy through the solar collector cover.

6.1.2 Determine solar energy transmittance by the appropriate method described in Method E 424. The same method shall be used for the initial and final measurements. Four measurements shall be made, rotating the test specimen 90° after each measurement. The average of the four values shall be considered the solar transmittance of the material. If Method A is used, a representative sample of the material must be supplied for transmittance

measurements to establish initial properties.

NOTE 2—Method A of Method E 424 uses a spectrophotometer with an integrating sphere, and is especially useful for precise determinations of minor changes in clear or uniformly diffusing cover materials. Method B of Method E 424, using a pyranometer, is especially useful for nonuniformly diffusing thick cover materials.

6.1.3 These methods provide a means for measuring solar transmittance under fixed conditions of incidence and viewing and have been found practical for both transparent and translucent materials.

6.2 *Effect of Dirt Retention of Solar Transmittance*:

6.2.1 Dirt on a solar collector cover will block the passage of solar energy and reduce solar energy transmittance.

6.2.2 The effect of dirt retention on the solar transmittance of a solar collector cover material may be determined on a test specimen exposed to natural weathering (7.2). Measure solar transmittance as described in 6.1.2. Then using a very soft brush, clean both sides of the sample with a 0.1 % solution of nonionic detergent[5] in distilled water. Rinse with distilled water, blot remaining water, and air dry. Take care to avoid scratching or stretching plastic materials. Remeasure the total solar transmittance. The difference in solar transmittance before and after cleaning is an indication of the amount of dirt retained during natural weathering.

NOTE 3—Since dirt retention in natural outdoor weathering is dependent on when the last rainfall took place, it is difficult to compare dirt retention on materials that have not undergone identical, simultaneous weathering.

6.3 *Dimensional Stability*:

6.3.1 Changes in the shape of a solar collector cover may result from exposure to service conditions. A material may sag, shrink, or warp.

6.3.2 Determine changes in linear dimensions for rigid and semirigid materials as described in Method D 1042, and for nonrigid materials as described in Method D 1204.

6.3.3 Determine warpage of rigid and semirigid plastic materials using the apparatus described in Method D 1181, or an equivalent apparatus. During heat aging, suspend the test specimens vertically from a single point at the center of the top edge. Measure at the location having the greatest deviation from flatness. Specimens for this test shall be 15 by 15 cm (6 by 6 in.). Specimens must be cut to size prior to heat aging.

6.4 *Tensile Properties*:

6.4.1 Tensile properties are an indication of the mechanical properties of a material. During environmental exposure a material may soften or become more brittle. Tensile properties include tensile strength, percent elongation at yield and at break, and modulus of elasticity.

6.4.2 Since tensile properties are influenced by temperature and humidity, carefully condition the test specimens in accordance with 5.1 and 5.2 prior to each test.

6.4.3 Determine tensile properties of rigid and semirigid plastic materials as described in Method D 638 using Speed B with a Type IV specimen. For flexible membrane materials, use Method D 882.

6.5 *Impact Resistance*:

6.5.1 Impact resistance is the ability of a material to resist fracture under shock force.

6.5.2 Determine hail impact resistance of solar collector cover materials using ASTM Proposed Practice for Determining Resistance of Cover Plates for Solar Energy Collectors to Hail Impact.[6]

6.5.3 Collector covers are also subject to impact by thrown and wind-blown solid objects. The evaluation of impact resistance to these objects will require different standard practices than that for hail impact resistance.

7. Aging Procedures

7.1 *Heat Stability*:

7.1.1 The elevated temperatures reached by solar collector covers may cause changes in properties of the material. The design of the solar collector will influence the temperatures attained by the collector covers. This heat stability test is intended to be an early screening device to discriminate between materials that are probably not suitable for solar collector covers and those that may have value in this application.

[5] Suitable nonionic detergents include Alconox, available from Alconox, Inc., 217 Park Ave. S., New York, N. Y. 10003; or Triton DF16 and Triton X100, available from Rohm and Haas, Industrial Chemical Dept., Philadelphia, Pa. 19105; or equivalent.

[6] This proposed practice is a draft under development. A copy of the latest draft is available from ASTM Information Center, 1916 Race St., Philadelphia, Pa. 19103.