Designation: E744 – 07 (Reapproved 2022)

Standard Practice for Evaluating Solar Absorptive Materials for Thermal Applications[1]

This standard is issued under the fixed designation E744; 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 practice covers a testing methodology for evaluating absorptive materials used in flat plate or concentrating collectors, with concentrating ratios not to exceed five, for solar thermal applications. This practice is not intended to be used for the evaluation of absorptive surfaces that are (*1*) used in direct contact with, or suspended in, a heat-transfer liquid, (that is, trickle collectors, direct absorption fluids, etc.); (*2*) used in evacuated collectors; or (*3*) used in collectors without cover plate(s).

1.2 Test methods included in this practice are property measurement tests and aging tests. Property measurement tests provide for the determination of various properties of absorptive materials, for example, absorptance, emittance, and appearance. Aging tests provide for exposure of absorptive materials to environments that may induce changes in the properties of test specimens. Measuring properties before and after an aging test provides a means of determining the effect of the exposure.

1.3 The assumption is made that solar radiation, elevated temperature, temperature cycles, and moisture are the primary factors that cause degradation of absorptive materials. Aging tests are described for exposure of specimens to these factors.

NOTE 1—For some geographic locations, other factors, such as salt spray and dust erosion, may be important. They are not evaluated by this practice.

1.4 The values stated in SI units are to be regarded as the standard.

1.5 *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.*

1.6 *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:*[2]

B537 Practice for Rating of Electroplated Panels Subjected to Atmospheric Exposure

E408 Test Methods for Total Normal Emittance of Surfaces Using Inspection-Meter Techniques

E434 Test Method for Calorimetric Determination of Hemispherical Emittance and the Ratio of Solar Absorptance to Hemispherical Emittance Using Solar Simulation

E772 Terminology of Solar Energy Conversion

E781 Practice for Evaluating Absorptive Solar Receiver Materials When Exposed to Conditions Simulating Stagnation in Solar Collectors with Cover Plates

E903 Test Method for Solar Absorptance, Reflectance, and Transmittance of Materials Using Integrating Spheres

G26 Practice for Operating Light-Exposure Apparatus (Xenon-Arc Type) With and Without Water for Exposure of Nonmetallic Materials (Discontinued 2001) (Withdrawn 2000)[3]

G90 Practice for Performing Accelerated Outdoor Weathering of Materials Using Concentrated Natural Sunlight

G151 Practice for Exposing Nonmetallic Materials in Accelerated Test Devices that Use Laboratory Light Sources

G155 Practice for Operating Xenon Arc Lamp Apparatus for Exposure of Materials

NOTE 2—In previous editions, Practice G26 was referenced for xenon arc exposure. It has been replaced with Practices G151 and G155, the performance-based standards, which cover the same apparatus used in Practice G26. The latter had described very specific designs used for xenon arc exposure.

[1] This practice is under the jurisdiction of ASTM Committee E44 on Solar, Geothermal and Other Alternative Energy Sources and is the direct responsibility of Subcommittee E44.20 on Optical Materials for Solar Applications.

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[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] The last approved version of this historical standard is referenced on www.astm.org.

3. Terminology

3.1 Refer to Teminology E772 for terminology relating to solar energy conversion.

4. Significance and Use

4.1 The methods in this practice are intended to aid in the assessment of long-term performance by comparative testing of absorptive materials. The results of the methods, however, have not been shown to correlate to actual in-service performance.

4.2 The testing methodology in this practice provides two testing methods, in accordance with Fig. 1.

4.2.1 Method A, which aims at decreasing the time required for evaluation, uses a series of individual tests to simulate various exposure conditions.

4.2.2 Method B utilizes a single test of actual outdoor exposure under conditions simulating thermal stagnation.

4.2.3 Equivalency of the two methods has not yet been established.

5. Test Specimens

5.1 Test specimens shall consist of the complete absorber material including coatings or layers and specific substrates where applicable.

5.2 The specimens shall be prepared in accordance with procedures and conditions used (or expected to be used) in commercial practice or in accordance with the recommendations of the coatings or material supplier.

NOTE 3—Results may vary due to coating substrate interactions.

NOTE 4—Some absorbers may not have discreet coatings or layers, for example, pigmented materials.

6. Conditioning

6.1 Specimens shall be measured and tested as received without additional processing or preconditioning.

7. Test Methods

7.1 *Property Measurement Tests*—Perform all property measurement tests at room temperature unless otherwise specified.

7.1.1 *Solar Absorptance*—Test in accordance with Test Method E903, unless otherwise specified.

NOTE 5—The spectral reflectance curves from which solar absorptance is calculated are often a more sensitive indicator of the onset of absorber material's degradation than integrated solar absorptance values. This is especially true for changes occurring in spectral regions where there is a limited amount of energy in the solar spectrum, for example, in the near infrared region.

7.1.2 *Emittance*—Test in accordance with Test Methods E434 or E408, unless otherwise specified.

7.1.3 *Appearance*—Test in accordance with Practice B537, unless otherwise specified.

7.2 *Environmental Exposure:*

7.2.1 *Outdoor Exposure Under Simulated Stagnation Conditions*—Expose test specimens for a minimum period of twelve months (Note 6) using Practice E781.

NOTE 6—It may be desirable to continue exposures of test specimens beyond the time period recommended to obtain additional rate data or to obtain data on mechanisms of degradation.

7.2.2 *Outdoor Exposure Using Fresnel Concentration*—Expose test specimens to direct sunlight reflected from the Fresnel concentrators described in Practice G90. Test specimens shall be mounted in a manner similar to that shown in Fig. 2. The cooling of the test specimens shall be adjusted to maintain the absorber specimens at stagnation temperatures. Refer to Cycle 3 of Practice G90 for details of the water spray operating procedure.

NOTE 7—The spectral transmission characteristics of the cover(s) used in a solar collector will control the amount and spectral distribution of the solar radiation reaching the absorber surface. For this reason, testing should be performed with the glazings to be used in the actual collector

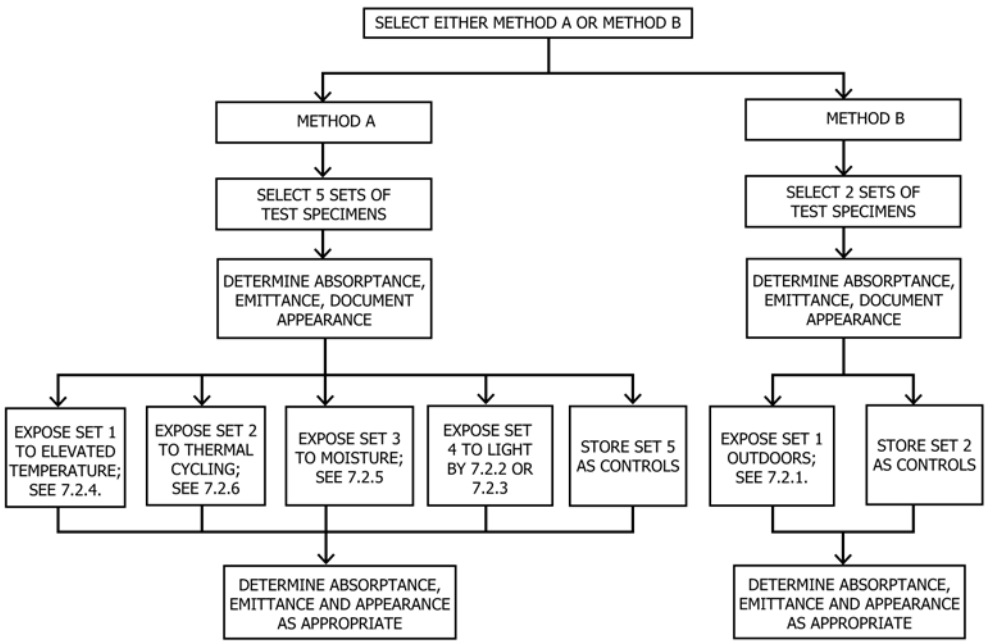

FIG. 1 Outline of Test Method Options