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Standard Practice for Air-Oven Aging of Polyolefin Geomembranes¹

This standard is issued under the fixed designation D5721; 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 means for estimating the resistance of polyolefin geomembranes to thermal aging in the presence of air.

1.2 This practice should be used as a guide to compare thermal aging characteristics of materials as measured by the change in some property of interest. This practice does not predict thermal aging characteristics where interactions between stress, environment, temperature, and time control failure.

1.3 This practice is useful for the development of formulations of polyolefin geomembranes.

1.4 The values stated in SI units are to be regarded as standard. No other units of measurement are included in this 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

D618 Practice for Conditioning Plastics for Testing

D638 Test Method for Tensile Properties of Plastics

D746 Test Method for Brittleness Temperature of Plastics and Elastomers by Impact

D792 Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement

D1238 Test Method for Melt Flow Rates of Thermoplastics by Extrusion Plastometer

D1505 Test Method for Density of Plastics by the Density-Gradient Technique

D1525 Test Method for Vicat Softening Temperature of Plastics

D1790 Test Method for Brittleness Temperature of Plastic Sheeting by Impact

D3045 Practice for Heat Aging of Plastics Without Load

D4439 Terminology for Geosynthetics

D5885/D5885M Test Method for Oxidative Induction Time of Polyolefin Geosynthetics by High-Pressure Differential Scanning Calorimetry

D6693/D6693M Test Method for Determining Tensile Properties of Nonreinforced Polyethylene and Nonreinforced Flexible Polypropylene Geomembranes

D8117 Test Method for Oxidative Induction Time of Polyolefin Geosynthetics by Differential Scanning Calorimetry

E145 Specification for Gravity-Convection and Forced-Ventilation Ovens

F412 Terminology Relating to Plastic Piping Systems

3. Terminology

3.1 *Definitions:*

3.1.1 For definitions of general terms used in this standard, refer to Terminology D4439.

3.1.2 *aging, n*—the process of exposing materials to an environment for an interval of time.

3.1.3 *polyolefin, n*—a polymer prepared by the polymerization of an olefin(s) as the sole monomer(s). (F412)

3.1.4 *Vicat softening point*—the temperature at which a flat-ended needle of 1 mm² circular cross section will penetrate a thermoplastic specimen to a depth of 1 mm under a specified load using a selected uniform rate of temperature rise. (D1525)

4. Significance and Use

4.1 Under the conditions of this test, the specimens undergo degradation at a rate that is a function of the thermal endurance of the polyolefin geomembrane under examination.

4.2 The rate of change of a particular property as a function of temperature may be evaluated using the temperatures and times outlined in Practice D3045.

¹ This practice is under the jurisdiction of ASTM Committee D35 on Geosynthetics and is the direct responsibility of Subcommittee D35.02 on Endurance Properties.

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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.

4.3 Any correlation between this practice and service life of polyolefin geomembranes must be determined for the particular application in which they are to be used.

4.4 Air-oven aging can be used to evaluate and compare the performance of various heat stabilizer packages exposed to air oxidation.

5. Apparatus

5.1 *Oven*—A controlled, forced-ventilation oven with substantial fresh air intake. Oven apparatus shall be in accordance with Type 11B in Specification E145, that is, with a precision of ± 1.5 °C for an aging temperature of 85 °C, and 50 to 200 air changes per hour. The calibration of the oven must be performed as indicated in Specification E145.

5.2 *Temperature Measuring Device*—The temperature around the specimens shall be measured in several locations in the oven and recorded at least once per day, for instance, with the aid of suitable calibrated thermocouples with an accuracy of at least ± 0.5 °C.

5.3 The shape of the coupons and their location in the oven may affect the flow of air, and thus their temperature during the test. When several specimens are hung in the same oven, the temperature should be verified individually for each sample, or, the temperature measured in a sufficient number of locations throughout the volume of the oven occupied by exposed coupons to ensure that the temperature of each coupon is within the tolerance specified in 5.1.

NOTE 1—The use of nine thermocouples, that is, one in each corner and one in the center of the chamber, has been found satisfactory. Alternate strategies may be applied.

5.4 The specimens shall be suspended from glass or other chemically inert fixtures in the center of the oven, spaced and not touching.

6. Sampling

6.1 The size and shape of the coupon(s) exposed in the oven must be selected to permit preparation of the number of test specimens required for each test selected for evaluation after aging (see Section 9).

6.2 The size and shape of the coupon(s) exposed in the oven must be selected to ensure proper ventilation and uniformity of the temperature within the enclosure of the oven during the test (see 8.1 and Note 2).

6.3 The size and shape of the coupon(s) exposed in the oven must be chosen to permit discarding at least 12.5 mm around the perimeter of the specimen to avoid side effects. This width may have to be increased for multicomponent or reinforced geomembranes.

6.4 The location of the coupon(s) exposed in the oven on the laboratory sample should be selected in such a way that the test specimens evaluated after aging will be aligned in the machine direction and as close as possible to the test specimens evaluated before aging.

NOTE 2—The sampling requirement in 6.4 aims to minimize the influence of the normal variation of the properties of a product across its length and width on the test result, to better focus on the property change

caused by air-oven aging of the polymer.

7. Conditioning

7.1 Conduct initial tests in accordance with the requirements of the ASTM test method for determining the specific property or properties required.

7.2 When required, conditioning of specimens following exposure at elevated temperature and prior to testing, unless otherwise specified, shall be in accordance with Practice D618.

8. Procedure

8.1 Allow the oven to equilibrate at the test temperature. The test temperature should be below the Vicat softening point of the material.

8.1.1 The default test temperature is 85 °C. Other temperatures may be used when agreed between parties.

8.1.2 Verify that the temperature is within the tolerance at least once per day.

8.2 Suspend the specimens for exposure below an oven shelf in a way to maintain a distance of at least 20 mm between specimens and to allow for the entire shelf with specimens to be removed.

NOTE 3—Certain metals are known to affect the thermal endurance of some polyolefins. Therefore, direct contact of the specimens with metal shall be minimized.

8.3 Age the coupon for the specified time and temperature.

8.3.1 The aging duration should be 90 days unless otherwise specified. Additional durations may be selected when agreed between parties.

8.3.2 Inspect the specimens weekly to ensure that the specimens have remained properly mounted. Note any visual changes of the specimens.

8.4 At the end of an aging interval, remove a set of specimens and allow them to cool. Test the specimens for the selected property in accordance with the appropriate test method, including provisions for conditioning.

8.5 At least 12.5 mm must be discarded around the perimeter of the specimen to avoid side effects. The quantity of material discarded may have to be increased for multicomponent or reinforced geomembranes.

9. Potential Tests

9.1 The following properties may be appropriate for evaluating the effects of oven exposure:

9.1.1 OIT (see Test Method D8117),

9.1.2 HP-OIT (see Test Method D5885/D5885M),

9.1.3 Tensile properties (see Test Method D638 or D6693/D6693M),

9.1.4 Melt flow index (see Test Method D1238),

9.1.5 Density (see Test Method D1505 or D792),

9.1.6 Tensile impact (see Test Method D746), and

9.1.7 Brittleness temperature (see Test Method D1790).

9.1.8 Other properties may be useful to assess the effect of heat aging on a polyolefin geomembrane.