



Standard Practice for Air-Oven Aging of Polyolefin Geomembranes¹

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1. Scope

1.1 This practice covers a means for estimating the resistance of polyolefin geomembranes to thermal aging in the presence of air. Only the procedure for heat exposure is specified, not the test method or specimen. The effect of heat on any particular property may be determined by selection of the appropriate test method and specimen.

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

1.4 *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 618 Practice for Conditioning Plastics and Electrical Insulating Materials for Testing²
- D 638 Test Method for Tensile Properties of Plastics²
- D 746 Test Method for Brittleness Temperature of Plastics and Elastomers by Impact²
- D 1238 Test Method for Flow Rates of Thermoplastics by Extrusion Plastometer²
- D 1505 Test Method for Density of Plastics by Density-Gradient Technique²
- D 1525 Test Method for Vicat Softening Temperature of Plastics²
- D 1790 Test Method for Brittleness Temperature of Plastic Film by Impact²
- D 1822 Test Method for Tensile-Impact Energy to Break Plastics and Electrical Insulating Materials²

D 1870 Practice for Elevated Temperature Aging Using a Tubular Oven²

D 3045 Practice for Heat Aging of Plastics Without Load³

D 4439 Terminology for Geotextiles⁴

E 145 Specifications for Gravity—Convection and Forced—Ventilation Ovens⁵

F 412 Terminology Relating to Plastic Piping Systems⁶

F 869 Definitions of Terms Relating to Athletic Shoes and Biomechanics⁷

3. Terminology

3.1 Definitions:

3.1.1 *aging, n*—the process of exposing materials to an environment for an interval of time. (F 869)

3.1.2 *geomembrane, n*—an essentially impermeable geosynthetic composed of one or more synthetic sheets. (D 4439)

3.1.3 *polyolefin, n*—a polymer prepared by the polymerization of an olefin(s) as the sole monomer(s). (F 412)

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. (D 1525)

4. Significance and Use

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

4.2 The elevated temperature for this practice should represent conditions that are sufficiently severe to induce failure of polyolefin geomembranes within an abbreviated period of time.

4.3 The rate of change of a particular property as a function of temperature may be evaluated using the temperatures and times outlined in Practice D 3045.

4.4 Any correlation between this practice and natural life of these materials must be determined for the particular application in which the materials are to be used.

¹ This practice is under the jurisdiction of ASTM Committee D-35 on Geosynthetics and is the direct responsibility of Subcommittee D35.02 on Endurance Properties.

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² Annual Book of ASTM Standards, Vol 08.01.

³ Annual Book of ASTM Standards, Vol 08.02.

⁴ Annual Book of ASTM Standards, Vol 04.09.

⁵ Annual Book of ASTM Standards, Vol 14.02.

⁶ Annual Book of ASTM Standards, Vol 08.04.

⁷ Annual Book of ASTM Standards, Vol 15.07.



4.5 Air-oven aging can be used to evaluate and compare the performance of various heat stabilizer packages.

5. Apparatus

5.1 *Oven*—A controlled, forced-ventilation oven with substantial fresh air intake is recommended. Oven apparatus shall be in accordance with Type 11B in Specifications E 145.

NOTE 1—Cross contamination has been known to occur in rubber products. It is not known if it can occur in semi-crystalline thermoplastics. When it is necessary to avoid contamination among specimens or materials, a tubular oven method such as Practice D 1870 may be desirable.

5.2 *Temperature Measuring Device*—A thermocouple or thermometer adequate to cover the range being tested and accurate to at least $\pm 0.5^\circ\text{C}$.

6. Sampling

6.1 Sampling shall be in accordance with the ASTM test methods for the specific properties to be determined.

7. Conditioning

7.1 Conduct initial tests in the standard laboratory atmosphere as specified in Practice D 618, and with specimens conditioned 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 D 618.

8. Procedure

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

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. Age for the specified time and temperature.

NOTE 2—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 Inspect the specimens weekly to ensure that the specimens have remained properly mounted. Note any visual changes of the specimens.

8.4 Rotate the shelves from top to bottom and from front to back once a week to ensure even exposure.

8.5 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.

9. Potential Tests

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

- 9.1.1 Tensile properties (see Test Method D 638),
- 9.1.2 Melt flow index (see Test Method D 1238),
- 9.1.3 Density (see Test Method D 1505),
- 9.1.4 Tensile impact (see Test Method D 746), and
- 9.1.5 Brittleness temperature (see Test Method D 1790).

10. Calculation

10.1 Express the results of the aging test as a percentage of the change in each physical property, calculated as follows:

$$\text{change, \%} = [(A - O)/O] \times 100 \quad (1)$$

where:

O = original value, and

A = value after aging.

NOTE 3—Since the values of some properties may increase as a function of exposure time, a positive change shows an increase while a negative change shows a decrease in the property value.

10.2 Alternatively, the time to failure can be determined based on a failure criteria such as brittleness, or on a percentage change of a given property.

11. Report

11.1 Report the following information:

- 11.1.1 Geomembrane type, thickness and specimen preparation procedure,
- 11.1.2 Pre-conditioning and post-conditioning procedures followed,
- 11.1.3 Test methods utilized for evaluation of each property,
- 11.1.4 Observations of any visible changes in the test specimens,
- 11.1.5 Type of oven used,
- 11.1.6 Exposure temperature and times used,
- 11.1.7 Mean and standard deviation for results calculated according to 10.1, and
- 11.1.8 Mean time to failure and failure criteria for results generated in 10.2.

12. Keywords

- 12.1 geomembrane; oven aging; polyolefin

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