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Standard Practice for Outdoor Exposure Testing of Photodegradable Plastics¹

This standard is issued under the fixed designation D 5272; 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 defines test conditions applicable when Practices D 1435 ~~and G 7~~ and G 7 are employed for the outdoor exposure testing of photodegradable plastics.

1.2 *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.*

NOTE 1—There is no ISO standard that is equivalent to this standard.

2. Referenced Documents

2.1 ASTM Standards:²

D 882 Test ~~Methods~~ Method for Tensile Properties of Thin Plastic Sheet

D 883 Terminology Relating to Plastics

~~D 1435 Practice for Outdoor Weathering of Plastics²~~

~~D 1898 Practice for Sampling of Plastics²~~ Practice for Outdoor Weathering of Plastics

D 3593 Test Method for Molecular Weight Averages and Molecular Weight Distribution of Certain Polymers by Liquid Size-Exclusion Chromatography (Gel Permeation Chromatography GPC) Using Universal Calibration³

D 3826 Practice for Determining Degradation End Point in Degradable ~~Polyolefins~~ Polyethylene and Polypropylene Using a Tensile Test

E 772 Terminology Relating to Solar Energy Conversion

G 7 Practice for Atmospheric Environmental Exposure Testing of Nonmetallic Materials

G 169 Guide for Application of Basic Statistical Methods to Weathering Tests

G 183 Practice for Field Use of Pyranometers, Pyrhemimeters and UV Radiometers

3. Terminology

3.1 The terminology given in Terminology E 772 and Terminology D 883 is applicable to this practice.

4. Significance and Use

4.1 When discarded as litter, articles made using photodegradable plastics are subject to attack by daylight (particularly solar-ultraviolet radiation), oxygen, heat, and water. The 5° exposure angle used in this practice represents typical conditions for degradation experienced by litter.

4.2 This practice requires characterization of the duration of exposure in terms of solar-ultraviolet radiation. Solar-ultraviolet radiation varies considerably as a function of location and time of year. This can cause dramatic differences in the time required to produce a specified level of degradation in a polymer. Daro⁴ has shown that when the same lot of polyethylene containing an iron-salt prodegradant is exposed at various times of the year in a single location, the time required to produce an average of two

¹ This practice is under the jurisdiction of ASTM Committee D-20 on Plastics and is the direct responsibility of Subcommittee D20.96 on Environmentally Degradable Plastics.

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² This practice is under the jurisdiction of ASTM Committee D20 on Plastics and is the direct responsibility of Subcommittee D20.96 on Environmentally Degradable Plastics and Biobased Products.

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³ 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*, Vol 08.01, volume information, refer to the standard's Document Summary page on the ASTM website.

⁴ Withdrawn

⁵ Annual Book of ASTM Standards, Vol 12.02.

⁶ Daro, A., et al. "Degradation of Polymer Blends IV, Natural Weathering of Low Density and Linear Low Density Polyethylene," *European Polymer Journal*, Vol 26, No. 1, 1990, pp. 47-52.

chain scissions per molecule varied by over 130 %. Daro, and Zerlaut and Anderson⁵ have shown that this variability can be significantly reduced when total solar or solar-ultraviolet radiation, or both, is used to characterize the exposure increments.

4.3 In addition to variations in level of daylight and solar-ultraviolet radiation, there are significant differences in temperature, and moisture stresses between different locations, and between different years, or periods within a single year, at a single location. Because of this variability, results from this test cannot be used to predict the absolute rate at which photodegradable plastics degrade. Results from this test can be used to compare relative rates of degradation for materials exposed at the same time in the same location. Results from multiple exposures of a common lot of material (during different seasons over several years) at different sites can be used to compare the relative rates at which a particular photodegradable plastic will degrade in each location.

NOTE 2—An inherent limitation in solar-radiation measurements is that they do not reflect the effects of variations in temperature and moisture exposure, which often can be as important as solar radiation. The same solar-ultraviolet radiation increment will not necessarily give the same changes in properties of the test specimen in different exposure sites. Results from this practice must be regarded as giving only a general indication of the degree of degradability and should always be considered in terms of characteristics of the exposure site as well.

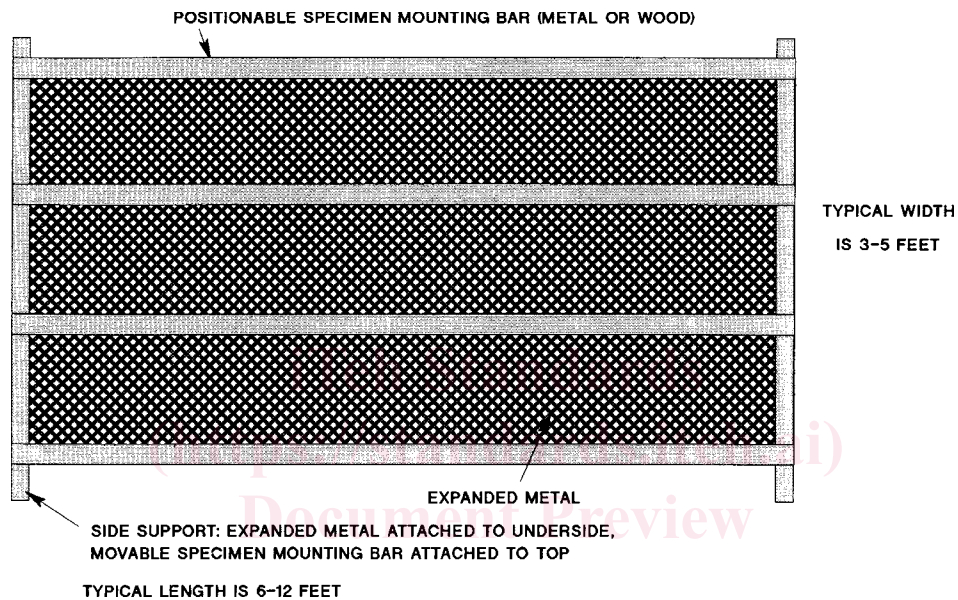


FIG. 1 Typical Rack Construction for Exterior Exposures of Photodegradable Plastics

4.4 Where measurement of total solar-ultraviolet radiation is not possible, exposure duration can be determined by the number of days, weeks, or months exposed. When this practice is used, a reference material whose degradation properties have been well established must be exposed at the same time as the other materials being tested. The reference material used must be agreed upon by all interested parties. The time to produce a specified level of degradation for each material in this simultaneous exposure is then compared. It is also a good practice to use reference materials when exposure length is determined by total solar or solar UV radiant exposure.

NOTE 3—A reference material can be a single lot of material which has shown consistent results after a number of exposures. It is not necessary that the composition or properties of the reference material be characterized and certified by a recognized standards agency or group.

5. Apparatus

5.1 Use exposure racks constructed in accordance with the requirements of Practice G 7. Unless otherwise specified, position the exposure racks so that specimens face the equator and so that the exposed surfaces are 5° from the horizontal. If other exposure rack orientations are used, they must be reported.

5.2 Use one of the following rack constructions for exposing photodegradable plastic specimens:

5.2.1 *Exposure Rack A*—Positionable mounting bars used for attaching specimens shall be arrayed over a regular mesh expanded-metal (aluminum or stainless steel) sheet backing. Use 16–18 gage metal with approximately 0.5-in. openings. It is recommended that the surface area of the expanded metal be 60 to 70 % open. Use a noncorroding material for the mounting bars. 6061T6 aluminum or untreated wood are typical materials used for the mounting bars. Fig. 1 is a top view showing typical rack construction.

⁴ Annual Book of ASTM Standards, Vol 14.02.

⁵ Zerlaut, G. L., and Anderson, T. A., "Ultraviolet Radiation as a Timing Technique for Outdoor Weathering of Materials," Society of Automotive Engineers, *SAE Technical Paper Number 850348*, 1985.