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Standard Test Method for Determining Changes in Fire-Test-Response Characteristics of Cushioning Materials After Water Leaching[1]

This standard is issued under the fixed designation F1534; 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 fire-test-response test method covers a procedure for leaching cushioning materials with water and determining changes in two specific fire-test-response characteristics: (*1*) the surface flammability, in accordance with Test Method D3675, and (*2*) the specific optical density of smoke generated, in accordance with Test Method E662.

1.2 In view of the wide variation in potential service conditions, it is likely that results of this leaching test will not give a direct correlation with service performance for all applications. However, the test method yields comparative data on which to base judgments as to expected service of cushioning materials and is useful in research and development work.

1.3 The values stated in SI units are to be regarded as the standard. The values given in parentheses are for information only.

1.4 *This standard is used to measure and describe the response of materials, products, or assemblies to heat and flame under controlled conditions, but does not by itself incorporate all factors required for fire hazard or fire risk assessment of the materials, products, or assemblies under actual fire conditions.*

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 and health practices and determine the applicability of regulatory limitations prior to use.* For specific precautionary statements, see Section 7.

1.6 Fire testing is inherently hazardous. Adequate safeguards for personnel and property shall be employed in conducting these tests.

2. Referenced Documents

2.1 *ASTM Standards:*[2]

D3675 Test Method for Surface Flammability of Flexible Cellular Materials Using a Radiant Heat Energy Source

E176 Terminology of Fire Standards

E662 Test Method for Specific Optical Density of Smoke Generated by Solid Materials

3. Terminology

3.1 *Definitions*—For definitions of terms used in this test method and associated with fire issues refer to Terminology E176.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *cushioning, n*—material used to isolate or reduce the effect of externally applied shock or vibration forces, or both.

3.2.2 *fire performance, n*—response of a material, product, or assembly in a specific fire, other than a fire test involving controlled conditions (different from fire-test-response characteristic, q.v.).

3.2.2.1 *Discussion*—The ASTM Policy on Fire Standards distinguishes between the response of materials, products, or assemblies to heat and flame "under controlled conditions," which is fire-test-response characteristic, and "under actual fire conditions," which is fire performance. Fire performance depends on the occasion or environment and may not be measurable. In view of the limited availability of fire-performance data, the response to one or more fire tests, appropriately recognized as representing end-use conditions, is generally used as a predictor of the fire performance of a material, product, or assembly.

3.2.3 *fire-test-response characteristic, n*—response characteristic of a material, product, or assembly, to a prescribed source of heat, or flame, under controlled fire conditions; such

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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.

response characteristics may include but are not limited to ease of ignition, flame spread, heat release, mass loss, smoke generation, fire resistance, and toxic potency of smoke.

3.2.3.1 *Discussion*—A fire-test-response characteristic can be influenced by variable characteristics of the heat source, such as its intensity, or of the burning environment, such as ventilation, geometry of item or enclosure, humidity, or oxygen concentration. It is not an intrinsic property such as specific heat, thermal conductivity, or heat of combustion, where the value is independent of test variables. A fire-test-response characteristic may be described in one of several terms. Smoke generation, for example, may be described as smoke opacity, change of opacity with time, or smoke weight. No quantitative correlation need exist between values of a response characteristic for two or more materials, products, or assemblies, as measured by two or more approaches, or tested under two or more sets of conditions for a given method.

3.2.4 *leaching, n*—removal in solution of the more soluble materials by percolating or moving water.

3.2.5 *softened water, n*—water that has been treated with substances to remove or sequester the calcium or magnesium ions.

3.2.5.1 *Discussion*—Among the substances used for water softening are various sodium phosphates and zeolites (natural hydrated silicate of aluminum and either sodium or potassium or both). Water of specific resistance of 1 MΩ or higher is suitable.

4. Summary of Test Method

4.1 In this test method samples of cushioning materials are subjected to leaching by immersing specimens in flowing softened water for a period of 6 h and then dried. Two fire-test-response characteristics of the cushioning materials, namely the surface flammability, in accordance with Test Method D3675, and the specific optical density of smoke, in accordance with Test Method E662, are measured on specimens of the materials which have undergone the water treatment. The results are then compared with results obtained from untreated specimens of the same materials, to determine the percentage change in each fire-test-response characteristic.

5. Significance and Use

5.1 The fire performance of a material or product is affected by a combination of its fire-test-response characteristics. Two of the most commonly determined fire-test-response characteristics of cushioning materials are the surface flammability, in accordance with Test Method D3675, and the specific optical density of smoke, in accordance with Test Method E662.

5.2 Cushioning materials used in upholstery applications are potentially exposed to leaching of the active ingredients due to (*1*) water solubility of the treating agents or (*2*) exposure to high humidity.

5.3 In view of the importance that the fire performance of the cushioning materials used in upholstery applications remain constant throughout their intended service life, this test method provides a means to test for the potential change in two fire-test-response characteristics due to leaching.

6. Apparatus

6.1 *Water Tank*—Use a water container or tank of a shape and size sufficient for the specimens to be fully submersible therein, to ensure full water contact with all surfaces. Determine the volume of the water container in litres by filling it with water and measuring the volume of the water. Confirm that the container is large enough that the ratio of the specimen(s) to water shall be no less than 1 to 20 by volume, by comparison with the volume of the specimens to be used, as determined in 8.4.

NOTE 1—The maximum volume of each specimen to be tested in Test Method D3675 is 1.73 L. The maximum volume of each specimen to be tested in Test Method E662 is 0.30 L.

6.2 *Softened Water:*

6.2.1 Use an established water softening procedure that ensures the presence of negligible amounts of alkaline or alkaline earth ions (principally sodium, potassium, calcium, and magnesium).

NOTE 2—It is advisable to have the facility running water tested before acquiring a new water softening system. The use of a water indicator system in which a light turns on when the water contains excessive ions is recommended. A system consisting of one carbon tank and two mixed bed tanks in series, with a quality light in between the mixed beds, to maintain a water quality of 2 MΩ/cm or greater, is suitable for this application. The concept of the "quality light" is that, when the light goes out, the first mixed bed is removed and replaced by the second mixed bed, and a new second mixed bed is installed in its place. The carbon tank is a requirement, but it prolongs the life of the mixed beds.

NOTE 3—The presence of alkaline or alkaline earth metal ions has been shown to possibly affect the flammability performance.

6.2.2 Provide a means of supplying a continuous flow of softened water to the bottom of the container at a rate of at least between two and three water changes per hour. Set the temperature of the flowing softened water to 20 ± 5°C (68 ± 9°F).

6.3 Provide a means at the top of the water container for disposing of the overflow.

6.4 Ensure that the apparatus has a means of suspending the specimens in such a manner that they are not in contact with each other during the leaching process. Ensure too that contact of the specimens with the container is minimized.

6.5 There are two alternative methods for specimen placement during leaching:

6.5.1 Place specimens in tank within a wire mesh cage, or

6.5.2 Suspend specimens from a rod within the tank by means of small clips and weigh them at the bottom.

7. Safety Precautions

7.1 The test methods associated with assessing the fire-test-response characteristics of the cushioning materials are fire test methods, which are inherently hazardous.

7.2 In each of the fire test methods, the test procedures involve high temperatures and combustion processes. Hazards therefore exist for burns, ignition of extraneous objects or clothing, and inhalation of combustion products. The operator must take appropriate precautions during the insertion and removal of the test specimens, for example by using protective gloves. The operator must ensure not to touch either the

ignition source, or the radiant heating source or any associated fixtures while hot, except with the use of appropriate protective gear.

8. Test Specimens

8.1 Ensure that a sufficient number of test specimens is available to determine the fire-test-response characteristics of the cushioning materials in accordance with Test Methods D3675 and E662 both before and after leaching.

8.2 Provide test specimens of the size required by Test Methods D3675 and E662.

8.3 Provide the appropriate number of test specimens as required by Test Methods D3675 and E662.

8.4 Determine the volume in litres of each test specimen used for Test Methods D3675 and E662.

9. Calibration

9.1 Follow the directions in Test Methods D3675 and E662 for calibration of the corresponding equipment.

9.2 The only parts of the leaching test equipment that require calibration are the temperature control devices. Use commonly accepted procedures for ensuring that the temperature remains within the required range.

10. Conditioning

10.1 Condition the specimens as required by Test Methods D3675 and E662.

11. Leaching Procedure

11.1 Conduct leaching on only one cushioning material at a time.

11.2 Submerge specimens in water tank for a period of 6 h.

11.2.1 Squeeze the specimens upon immersion to remove any entrapped air.

11.2.2 Submerge the specimens by one of the alternative methods indicated in 6.5.

11.2.3 Start water flow and continue for a total of 6 h (with a tolerance of ±5 min).

11.3 After the immersion period, squeeze the wet specimens to remove excess water and then dry them in an air circulating oven at 70 ± 3°C (158 ± 5°F) until a constant weight is achieved (at least 3 h are required).

11.4 Optionally, weigh the specimens before and after the leaching process to determine whether any significant weight losses occur.

NOTE 4—A weight loss larger than 3 % is likely to be significant.

12. Testing of the Unleached Samples

12.1 Determine the radiant panel index (I_s) of the original unleached samples by testing specimens in accordance with Test Method D3675.

12.2 Determine the specific optical density of smoke generated by the original unleached samples by testing specimens in accordance with Test Method E662. Use a specimen thickness of 25 mm (1 in.).

12.3 Test specimens of the unleached and leached samples on the same day. Alternatively, test the unleached samples earlier, but not more than 96 h before testing the leached samples.

13. Testing of the Leached Samples

13.1 Condition and test the leached specimens as required by both Test Methods D3675 and E662.

13.2 Determine the radiant panel index (I_s) of specimens of the leached samples in accordance with Test Method D3675.

13.3 Determine the specific optical density of smoke generated by specimens of the leached samples in accordance with Test Method E662. Use a sample thickness of 25 mm (1 in.).

14. Calculation

14.1 Express the results of the leaching test as a percentage of the change in the fire-test-response characteristic, calculated by Eq 1.

$$P = \frac{(L - O)}{O} \times 100 \quad (1)$$

where:

P = percentage change,
O = original value of fire-test-response characteristic, and
L = value of fire-test-response characteristic after leaching.

15. Report

15.1 Report the following information:

15.1.1 Identification of the sample,

15.1.2 Identification of the fire-test-response characteristic measured,

15.1.3 Dates when the leaching test was carried out and when the fire-test-response characteristics of leached and unleached specimens were determined,

15.1.4 Volume of the water container, as determined in 6.1,

15.1.5 Volume of each of the specimens to be used for Test Methods D3675 and E662.

15.1.6 The ratio of water volume to specimen volume for both Test Methods D3675 and E662.

15.1.7 Any observations made during leaching,

15.1.8 All data required by Test Methods D3675 and E662 for the original and the final determination of the corresponding fire-test-response characteristics,

15.1.9 The percentage change, for each fire-test-response characteristic, as calculated by Eq 1 in accordance with Section 14, and

15.1.10 (Optionally) the weight of the specimens before and after leaching.

16. Precision and Bias

16.1 The precision of the procedure for leaching is being determined.

16.2 The precision and bias of the procedures for flame-spread index (I_s) and optical density of smoke generation are as specified in Test Methods D3675 and E662, respectively.

17. Keywords

17.1 cushioning; fire; fire performance; fire-test-response characteristic; leaching; optical density; smoke obscuration; softened water

APPENDIX

(Nonmandatory Information)

X1. COMMENTARY

X1.1 Fire hazard involves a series of three processes, namely: (*1*) generation of heat and smoke (combustion products) from a burning product; (*2*) transport of heat and smoke from their source (origin of the fire) to their target (people or products) and (*3*) effect of the fire products (heat or smoke) on the target.

X1.2 The fire performance of cushioning materials is often enhanced by incorporation of additives, some of which may be water soluble. It is conceivable, therefore, that the fire performance of the cushioning materials may change after exposure to water.

X1.3 This standard does not address the fire hazard resulting from burning the cushioning materials tested. However, specifications often require materials to achieve certain levels of performance when tested in accordance with a fire-test-response standard. This standard offers a method for checking the extent of the original values of two fire-test-response characteristics retained after leaching.