Designation: ~~F1645/F1645M – 12~~ F1645/F1645M – 16

Standard Test Method for Water Migration in Honeycomb Core Materials[1]

This standard is issued under the fixed designation F1645/F1645M; 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 test method covers the determination of water migration in honeycomb core materials.

1.2 The values stated in either SI units or inch-pound units are to be regarded separately as standard. The values stated in each system may not be exact equivalents; therefore, each system shall be used independently of the other. Combining values from the two systems may result in non-conformance with the standard.

1.2.1 Within the text the inch-pound units are shown in brackets.

1.3 *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:*[2]

C271/C271M Test Method for Density of Sandwich Core Materials

~~C274 Terminology of Structural Sandwich Constructions (Withdrawn 2016)[3]~~

D883 Terminology Relating to Plastics

D3878 Terminology for Composite Materials

D5229/D5229M Test Method for Moisture Absorption Properties and Equilibrium Conditioning of Polymer Matrix Composite Materials

E122 Practice for Calculating Sample Size to Estimate, With Specified Precision, the Average for a Characteristic of a Lot or Process

E177 Practice for Use of the Terms Precision and Bias in ASTM Test Methods

E456 Terminology Relating to Quality and Statistics

~~E1309 Guide for Identification of Fiber-Reinforced Polymer-Matrix Composite Materials in Databases (Withdrawn 2015)[3]~~

~~E1434 Guide for Recording Mechanical Test Data of Fiber-Reinforced Composite Materials in Databases (Withdrawn 2015)[3]~~

3. Terminology

3.1 *Definitions*—Terminology D3878 defines terms relating to high-modulus fibers and their ~~composites. Terminology~~composites, as ~~C274 defines~~well as terms relating to structural sandwich constructions. Terminology D883 defines terms relating to plastics. Terminology E456 and Practice E177 define terms relating to statistics. In the event of a conflict between terms, Terminology D3878 shall have precedence over the other terminologies.

3.2 *Symbols:*

~~*CV* = coefficient of variation statistic of a sample population for a given property (in percent)~~

CV = coefficient of variation statistic of a sample population for a given property (in percent),

S_{n-1} = standard deviation statistic of a sample population for a given property,

x_1 = test result for an individual specimen from the sample population for a given property,

$\bar{x}$ = mean or average (estimate of mean) of a sample population for a given property,

[1] This test method is under the jurisdiction of ASTM Committee D30 on Composite Materials and is the direct responsibility of Subcommittee D30.09 on Sandwich Construction.

Current edition approved ~~April 1, 2012~~April 1, 2016. Published ~~May 2012~~May 2016. Originally approved in 1995. Last previous edition approved in ~~2007~~2012 as ~~F1645 – 07.~~F1645 – 12. DOI: ~~10.1520/F1645_F1645M-12.~~10.1520/F1645_F1645M-16.

[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.

V_c = volume of water necessary to fill one core cell,
V_f = volume of water transfused,
W_c = mass of specimen after filling the primary cell with water,
W_f = mass of specimen after water transfusion, and
W_i = mass of specimen after conditioning, prior to water introduction.

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4. Summary of Test Method

4.1 This test method consists of bonding a honeycomb core material to transparent facings using a water-resistant adhesive, drilling an access hole through one facing to an individual core cell, filling the cell with water, subjecting the filled cell to a constant hydrostatic pressure by maintaining a specified water column height, then measuring the amount of water transferred into the honeycomb core specimen (primarily due to diffusion through the cell walls) within a 24-h period. The amount of water transferred is presented as an approximate number of honeycomb core cells filled with water.

5. Significance and Use

5.1 Water permeability is a fundamental physical property that can be used in conjunction with other properties to characterize honeycomb sandwich core materials. Migration testing can be used to characterize and compare the relative permeability of honeycomb core materials to water.

5.2 This test method provides a standard method of characterizing the rate of water migration within honeycomb sandwich core materials for design properties, material specifications, research and development applications, and quality assurance.

5.3 Factors that influence water migration rate characteristics of honeycomb sandwich core materials and shall therefore be reported include the following: core material, methods of material fabrication, core geometry (cell size), core thickness, core thickness uniformity, cell wall thickness, specimen geometry, specimen preparation, specimen conditioning, facing material, facing permeability, adhesive permeability, adhesive thickness, and methods of mass, volume, and water column height measurement.

6. Interferences

6.1 *Material and Specimen Preparation*—Poor material fabrication practices and damage induced by improper specimen machining are known causes of high data scatter in composites and honeycomb sandwich structures in general. Important aspects of honeycomb sandwich core specimen preparation that contribute to data scatter include the existence of joints, voids or other core discontinuities, out-of-plane curvature, and surface roughness.

6.2 *Core Geometry*—Core-specific geometric factors that affect honeycomb core material water migration rate include core cell size, uniformity of core cell geometry, core cell thickness, core cell thickness uniformity, core thickness, and core thickness uniformity.

6.3 *Facings*—Results are affected by the permeability of the facing material and the flatness of the facing bonding surfaces.

6.4 *Adhesive*—Results are affected by the permeability of the adhesive, the adhesive thickness, and the thickness uniformity of the adhesive. Results are also affected by the presence of voids, cracks, and other defects which compromise the complete bonding of the cell walls to the facings.

6.5 *Environment*—Results are affected by the environmental conditions under which specimens are conditioned, as well as the conditions under which the tests are conducted. Specimens tested in various environments can exhibit differences in water migration rate.

7. Apparatus

7.1 *Micrometers and Calipers*—A micrometer having a flat anvil interface, or a caliper of suitable size, shall be used. The accuracy of the instrument(s) shall be suitable for reading to within 1.0 % of the sample length, width and thickness. For typical specimen geometries, an instrument with an accuracy of ±25 μm [±0.001 in.] is desirable for thickness measurement, whereas an instrument with an accuracy of ±250 μm [±0.010 in.] is acceptable for length and width measurement.

7.2 *Balance or Weighing Scale*—If the amount of water transferred into the honeycomb core material specimen is to be measured by mass, an analytical balance or weighing scale is required that is capable of measuring the initial mass of the honeycomb core material specimen accurately to ±0.5 %.

7.3 *Syringe*—If the amount of water transferred into the honeycomb core material specimen is to be measured volumetrically, a graduated syringe is required that is capable of measuring accurately to ±10 mm^3 [±0.0005 $in.^3$].

7.4 *Water Migration Setup*—The water migration test setup, shown in Fig. 1, shall consist of a buret, a scale to measure height such as a meter stick [yardstick], a support stand, clamps to secure the buret to the support stand, and a flexible hose or tube. The scale to measure water column height shall be capable of measuring accurately to ±1 mm [±0.063 in.].

8. Sampling and Test Specimens

8.1 *Sampling*—Test at least five specimens per test condition unless valid results can be gained through the use of fewer specimens, as in the case of a designed experiment. For statistically significant data, consult the procedures outlined in Practice E122. Report the method of sampling.

8.2 *Test Specimens:*

8.2.1 *Core Geometry*—Honeycomb core material test specimens shall have a square or rectangular cross-section. The recommended minimum specimen size is 75 mm [3.0 in.] in length by 75 mm [3.0 in.] in width by 13 mm [0.5 in.] thick.

NOTE 1—The honeycomb core specimen's cross-section is defined to be in the facing plane, in regard to the orientation that the core would be placed in a structural sandwich construction. For a honeycomb core the cross-section is in the plane of the cells, which is perpendicular to the orientation of the cell walls.

8.2.2 *Core Preparation and Machining*—Prepare the honeycomb core material samples so that the facing plane surfaces are parallel to each other and perpendicular to the sides of the core. Take precautions when cutting specimens from large sheets of core material to avoid notches, undercuts, rough or uneven surfaces due to inappropriate machining methods. Obtain final dimensions by lubricated precision sawing, milling, or grinding. The use of diamond tooling has been found to be extremely effective for many material systems. Record and report the honeycomb core material specimen cutting preparation method.

8.2.3 *Facings*—The honeycomb core material shall be bonded to impermeable, transparent facings which permit visual observation into the honeycomb core cells by illumination. Clear plastic facings are recommended, for ease of locating a hole over a single cell as well as observation of water migration (see Fig. 2).

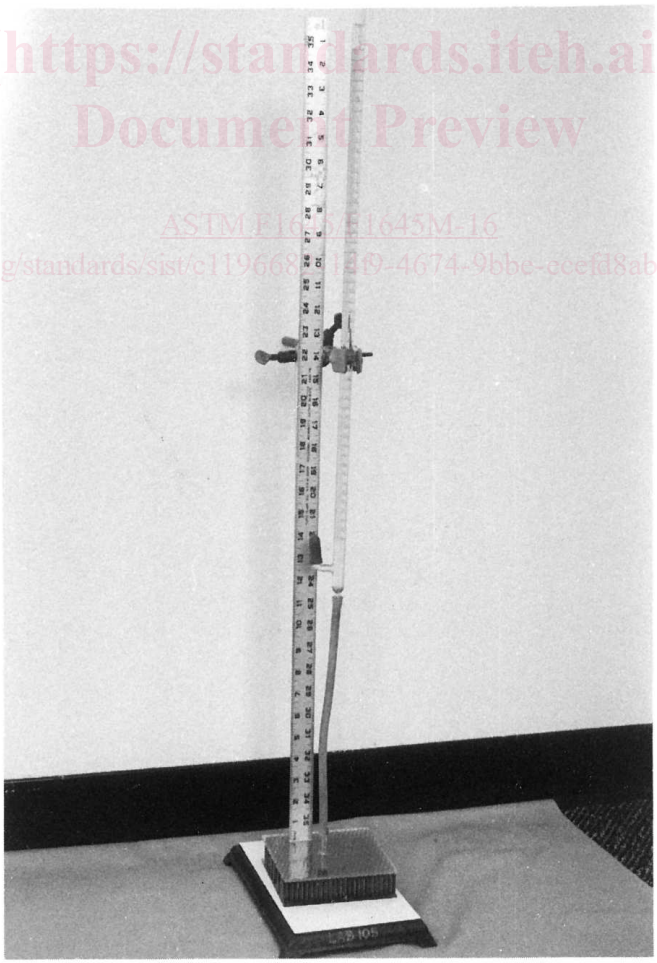

FIG. 1 Water Migration Test Setup