



Designation: F1645/F1645M – 22

Standard Test Method for Water Migration in Honeycomb Core Materials¹

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 reappraisal. A superscript epsilon (ϵ) indicates an editorial change since the last revision or reappraisal.

1. Scope

1.1 This test method covers the determination of water migration in honeycomb core materials.

1.2 *Units*—The values stated in either SI units or inch-pound units are to be regarded separately as standard. The values stated in each system are not necessarily exact equivalents; therefore, to ensure conformance with the standard, each system shall be used independently of the other, and values from the two systems shall not be combined.

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, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.4 *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

[D271/C271M Test Method for Density of Sandwich Core Materials](#)

[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](#)

3. Terminology

3.1 *Definitions*—Terminology [D3878](#) defines terms relating to high-modulus fibers and their composites, as 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),

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,

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.

4. Summary of Test Method

4.1 This test method consists of bonding a honeycomb core material to transparent face sheets 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.

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 May 1, 2022. Published May 2022. Originally approved in 1995. Last previous edition approved in 2016 as F1645/F1645M – 16. DOI: 10.1520/F1645_F1645M-22.

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.

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 *Face Sheets*—Results are affected by the permeability of the face sheet material and the flatness of the face sheet 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 face sheets.

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 $\pm 25 \mu\text{m}$ [$\pm 0.001 \text{ in.}$] is desirable for thickness

measurement, whereas an instrument with an accuracy of $\pm 250 \mu\text{m}$ [$\pm 0.010 \text{ in.}$] 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 $\pm 0.5 \%$.

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 $\pm 10 \text{ mm}^3$ [$\pm 0.0005 \text{ in.}^3$].

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 $\pm 1 \text{ mm}$ [$\pm 0.063 \text{ in.}$].

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

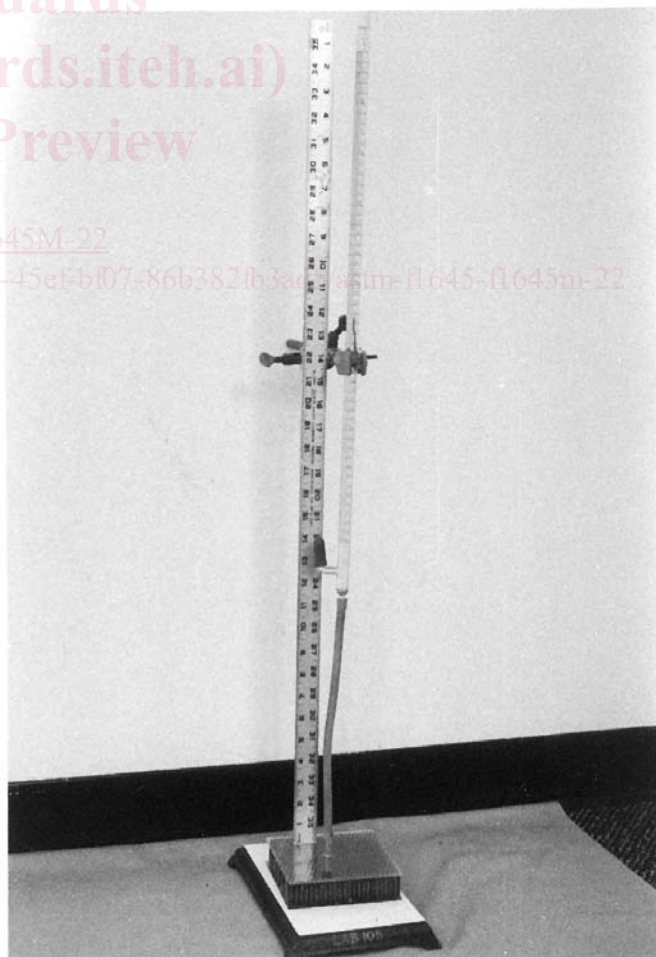


FIG. 1 Water Migration Test Setup

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

8.2.4 *Adhesive*—The honeycomb core material shall be bonded to the face sheets using a water-resistant adhesive. Use of a clear adhesive is recommended. The adhesive shall be applied so that fairly heavy fillets form between the honeycomb core material cell walls and the face sheets, thus assuring a watertight joint between the face sheets and core. After bonding the face sheets to the core, the honeycomb core material specimen shall be inspected for flawed or damaged cells, porous or cracked adhesive, and other defects which can become pathways for water seepage or flow from cell to cell, thus invalidating results.

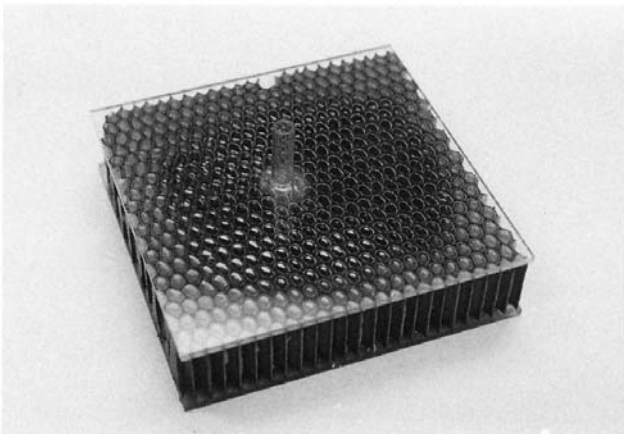


FIG. 2 Water Migration Specimen

8.2.5 *Specimen Preparation for Water Introduction*—A hole shall be drilled through the upper facing over one centrally located honeycomb core material cell. The hole shall permit access of water into only one cell. A suitable connection, such as a tube bonded over or into the hole, shall be provided for the application of hydrostatic pressure (see Fig. 2). If the amount of water transferred is monitored by mass, an appropriate seal shall be used to cover the hole, to prevent water loss during weighings.

8.2.6 If honeycomb core material density is to be reported, then obtain these samples from the same sheet of honeycomb core material being tested. Density may be evaluated in accordance with Test Method C271/C271M.

8.3 *Labeling*—Label the test specimens so that they will be distinct from each other and traceable back to the sheet of origin, and will neither influence the test nor be affected by it.

9. Calibration

9.1 The accuracy of all measuring equipment shall have certified calibrations that are current at the time of use of the equipment.

10. Conditioning

10.1 The recommended pre-test condition is effective moisture equilibrium at a specific relative humidity as established by Test Method D5229/D5229M; however, if the test requestor does not explicitly specify a pre-test conditioning environment, no conditioning is required and the test specimens may be tested as prepared.

10.2 The pre-test specimen conditioning process, to include specified environmental exposure levels and resulting moisture content, shall be reported with the test data.

NOTE 2—The term moisture, as used in Test Method D5229/D5229M, includes not only the vapor of a liquid and its condensate, but the liquid itself in large quantities, as for immersion.

10.3 If no explicit conditioning process is performed the specimen conditioning process shall be reported as “unconditioned” and the moisture content as “unknown”.

11. Procedure

11.1 *Parameters to Be Specified Before Test:*

11.1.1 The specimen sampling method, specimen geometry, and conditioning travelers (if required).

11.1.2 The properties and data reporting format desired.

NOTE 3—Determine specific material property, accuracy, and data reporting requirements prior to test for proper selection of apparatus.

11.1.3 The environmental conditioning test parameters.

11.1.4 The buret measurement accuracy.

11.2 *General Instructions:*

11.2.1 Report any deviations from this test method, whether intentional or inadvertent.

11.2.2 Following final honeycomb core material specimen machining, but before conditioning and testing, measure the specimen length and width (including the facings) at three places. The thickness of the specimen (including the facings) shall be measured at four locations surrounding the primary honeycomb core cell, and recorded as the average of the four