Designation: C1763 – 16

Standard Test Method for Water Absorption by Immersion of Thermal Insulation Materials[1]

This standard is issued under the fixed designation C1763; 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 determines the amount of water retained (excluding surface water) by flat specimens of thermal insulations after these materials have been fully immersed in liquid water for a prescribed time interval under isothermal conditions. This test method is intended to be used for the characterization of materials in the laboratory. It is not intended to simulate any particular environmental condition potentially encountered in building construction applications.

1.2 This test method does not address all the possible mechanisms of water intake and retention and related phenomena for thermal insulations. It relates only to those conditions outlined in 1.1. Determination of moisture accumulation in thermal insulations due to partial immersion, water vapor transmission, internal condensation, freeze-thaw cycling, or a combination of these effects requires different test procedures.

1.3 This test method does not address or attempt to quantify the drainage characteristics of materials.

1.4 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.

1.5 *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.*

2. Material And Specimen Characteristics that can Influence Results

2.1 The apparent water absorption measured by this test method is dependent on the surface to volume ratio of the sample and time of immersion. As such, comparisons between Procedures A, B, and, C cannot be made. Cracks in the specimens and rough surfaces can increase the apparent water absorption.

2.2 Some materials tend to collect water on surfaces or to trap water in corners and, if not removed, will give incorrect results.

2.3 Materials that change or react with water can have increased (or decreased) apparent water absorption and are not suitable for use with this method. 13.5.1 provides a method for ensuring the specimen has not been physically or chemically altered in a way that would invalidate the measurement. Use this method in cases of dispute.

3. Referenced Documents

3.1 *ASTM Standards:*[2]

C168 Terminology Relating to Thermal Insulation

C303 Test Method for Dimensions and Density of Preformed Block and Board–Type Thermal Insulation

C870 Practice for Conditioning of Thermal Insulating Materials

C1134 Test Method for Water Retention of Rigid Thermal Insulations Following Partial Immersion

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

E691 Practice for Conducting an Interlaboratory Study to Determine the Precision of a Test Method

4. Terminology

4.1 *Definitions*—Terminology C168 applies to terms used in this test method.

5. Summary of Test Method

5.1 Test specimens are conditioned and then immersed in water for a prescribed amount of time. The amount of water absorbed is determined by the weight increase in the specimens.

[1] This test method is under the jurisdiction of ASTM Committee C16 on Thermal Insulation and is the direct responsibility of Subcommittee C16.33 on Insulation Finishes and Moisture.

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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.

6. Significance and Use

6.1 This test method provides a means of measuring the water absorption of flat specimens of thermal insulation materials under isothermal conditions as a result of direct immersion in liquid water. It is intended for quality control and product and material specifications.

6.2 The procedure to be used: A, B, or C as well as any exceptions shall be noted in material specifications citing this test method.

6.3 Repeatability has been established only for one type and size of material at one immersion duration.

NOTE 1—Specifications referring to this test method are encouraged to establish repeatability for specific materials, immersion duration, and dimensions for inclusion in this test method.

7. Apparatus

7.1 *Temperature measuring device*—Such as a thermometer, graduated in Celsius or Fahrenheit degrees with at least 1°C (2°F) sensitivity.

7.2 *Balance,* accurate to 0.1g.

7.3 *Immersion Pan*—A pan or vessel of width and length at least 50 mm (2 in.) larger than the dimensions of the specimen width and length, and of a depth at least 50 mm (2 in.) greater than the specimen thickness.

7.4 *Timing device,* such as stopwatch or timer capable of ±1% of the required immersion duration.

7.4.1 *Specimen Supports and Constraints*—Included in the construction of the immersion pan shall be a means for securing the specimens in a level position, that is, a noncorrosive support for the bottom surface of the specimens and a similar constraining device for the top surface for buoyant materials. The support and constraining devices shall not contact more than 15 % of the specimen surfaces. The space between the support and the bottom of the pan shall be not less than 5 mm (0.2 in.). The pressure exerted on the specimens by the constraining device for the top surface shall be limited to that required to counteract any buoyant force exerted by the specimens at the beginning of the test. Stainless steel is an acceptable support and weight material. An example of a suitable constraining device is a 6.4 mm. (0.25 in.) mesh rigid stainless steel screen.

8. Sampling, Test Specimens, and Test Units

8.1 Number of specimens, dimensions, and dimension tolerance of the test specimen or specimens shall be stated in the material specification to follow one of the following procedures:

8.2 *Procedure A:*

8.2.1 Test specimens shall be 152 ± 3 mm long, 89 ± 3 mm wide, and 51 ± 3 mm thick (6 ± ⅛ in. long, 3½ ± ⅛ in. wide, and 2 ± ⅛ in. thick)

8.2.2 A minimum of two test specimens are required.

8.2.3 Immersion time shall be a minimum of 48 h.

8.2.4 The specimen shall be weighed immediately after the removal of surface water.

8.3 *Procedure B:*

8.3.1 Test specimens shall be 305 ± 3 by 305 ± 3 mm (12 by 12 in.) with all four edges trimmed square and thickness representative of manufactured product.

8.3.2 One specimen from each of three boards shall be tested.

8.3.3 Immersion time shall be 2 h.

8.3.4 The specimen shall be drained by placing on end for 10 min.

8.4 *Procedure C:*

8.4.1 Test specimens shall be 305 ± 3 by 305 ± 3 mm by 25 mm thick. (12 by 12 in. by 1 in. thick.)

8.4.2 Three specimens shall be tested.

8.4.3 Immersion time shall be 24 h.

8.4.4 The specimen shall be shaken vigorously then weighed immediately after the removal of surface water.

NOTE 2—Procedure A is typically used for perlite block insulation.

NOTE 3—Procedure B is typically used for cellulosic fiber insulating board and polyisocyanurate thermal insulation board.

NOTE 4—Procedure C is typically used for polystyrene thermal insulation board.

9. Precision and Bias[3]

9.1 The precision of this test method is based on an interlaboratory study of Test Method C1763 conducted in 2015. Each of ten laboratories tested three different insulating materials. Every "test result" represents an individual determination, and all participants reported triplicate test results. Practice E691 was followed for the design and analysis of the data.

9.1.1 *Repeatability (r)*—The difference between repetitive results obtained by the same operator in a given laboratory applying the same test method with the same apparatus under constant operating conditions on identical test material within short intervals of time would in the long run, in the normal and correct operation of the test method, exceed the following values only in one case in 20.

9.1.1.1 Repeatability can be interpreted as maximum difference between two results, obtained under repeatability conditions, that is accepted as plausible due to random causes under normal and correct operation of the test method.

9.1.1.2 Repeatability limits are listed in Table 1 and Table 2.

9.1.2 *Reproducibility (R)*—The difference between two single and independent results obtained by different operators applying the same test method in different laboratories using different apparatus on identical test material would, in the long run, in the normal and correct operation of the test method, exceed the following values only in one case in 20.

9.1.2.1 Reproducibility can be interpreted as maximum difference between two results, obtained under reproducibility conditions, that is accepted as plausible due to random causes under normal and correct operation of the test method.

9.1.2.2 Reproducibility limits are listed in Table 1 and Table 2.

9.1.3 The above terms (repeatability limit and reproducibility limit) are used as specified in Practice E177.

[3] Supporting data have been filed at ASTM International Headquarters and may be obtained by requesting Research Report RR:C16-1046. Contact ASTM Customer Service at service@astm.org.

TABLE 1 Water Absorbed by Weight (%)

Material	Average[A] $\bar{x}$	Repeatability Standard Deviation s_r	Reproducibility Standard Deviation s_R	Repeatability Limit r	Reproducibility Limit R
Procedure A: Perlite block insulation	43.89	2.93	3.91	8.19	10.96

[A] The average of the laboratories' calculated averages.

TABLE 2 Water Absorbed by Volume (%) – Individual Readings

Material	Average[A] $\bar{x}$	Repeatability Standard Deviation s_r	Reproducibility Standard Deviation s_R	Repeatability Limit r	Reproducibility Limit R
Procedure B: Polyiso rigid foam board	1.18	0.06	0.10	0.16	0.29
Procedure C: XPS foam board	0.18	0.03	0.08	0.08	0.22

[A] The average of the laboratories' calculated averages.

9.1.4 Any judgment in accordance with statements 9.1.1 and 9.1.2 would have an approximate 95 % probability of being correct.

9.2 *Bias*—At the time of the study, there was no accepted reference material suitable for determining the bias for this test method, therefore no statement on bias is being made.

9.3 The precision statement was determined through statistical examination of all reported results, from ten laboratories, three insulating materials.

9.4 To judge the equivalency of two test results, it is recommended to choose the material closest in characteristics to the test material.

10. Preparation of Apparatus

10.1 Fill the immersion pan with distilled, deionized water sufficient to maintain a 25 mm (1 in.) head of water over the sample surface at all times during the test.

10.2 Allow the water to reach a steady temperature of 23 ± 1°C (73 ± 2°F).

11. Calibration and Standardization

11.1 All measuring equipment shall have calibration certificates that are current at the time of use of the equipment.

12. Conditioning

12.1 Pre-condition per Test Method C870. Additional conditioning, such as heat-soaking, shall be performed as required by the material specification.

13. Procedure

13.1 Measure test specimen dimensions and calculate density per Test Method C303. Weigh each specimen to the nearest 0.1 g. This weight is the pre-immersion weight, W_1.

13.2 The selection of Procedure A, B, or C, including their proscribed sample size and duration of immersion, shall be stated in the material or product specification.

13.3 Submerge each specimen horizontally in the pan under 25 ± 2 mm (1 ± 0.1 in.) of distilled, deionized water. Specimens shall be placed on the sample supports described in 7.4.1. For buoyant materials, the specimen constraints described in 7.4.1 shall be used. If necessary, add distilled, deionized water at 23 ± 1°C (73 ± 2°F) to ensure that the specimens are immersed to the required depth.

13.4 During the test, the immersion pan shall remain in an environment with a temperature of 23 ± 2°C (73 ± 4°F).

13.5 Remove the specimens from the water, drain as required in procedure B or C, then remove any excess surface water by light blotting with a paper towel not to exceed two seconds per surface. Non-rigid materials shall be supported for draining in a rack such as described in Test Method C1134, Fig. 2 and 3, with solid contact between the rack and specimen less than 15% in surface area. After draining and removal of surface water, immediately weigh each specimen to the nearest 0.1 g. This weight is the weight after immersion, W_2.

13.5.1 Some insulation materials are either friable or reactive with water or both as described in 2.3. In cases of dispute, the following procedure shall be performed. After water absorption testing, the specimens shall be dried in a drying oven at 50 ± 2°C (120 ± 5°F). The specimens shall be conditioned until constant mass is achieved. Constant mass is reached when consecutive weighings of the test specimens, taken at a minimum of 2 h apart, result in a weight change of not more than 0.2 %. The final specimen weight must not differ from the initial specimen weight by more than 5%. The purpose of this final requirement is to ensure the specimen has not undergone physical changes (such as breakage) or chemical changes that would invalidate the measurement.

14. Calculation or Interpretation of Results

14.1 *Definitions of Symbols:*

t = specimen height, cm (in.)
l = specimen length, cm (in.)

w = specimen width, cm (in.)
V = specimen volume, cm^3 ($in.^3$)
W_1 = pre-immersion weight of the specimen, g.
W_2 = specimen weight after immersion, draining & blotting, g.
ρ = density of water in g/cm^3 (g/in^3)

14.2 Calculate the percent water absorbed by weight as:

$$100 \times (W_2 - W_1)/W_1 \quad (1)$$

14.3 Calculate the specimen volume as:

$$V = l \times w \times t \quad (2)$$

14.4 Calculate the percent water absorbed by volume by multiplying the water absorption as:

$$(\text{Percent by Volume}) = (\text{Percent by Weight}) \times (\text{Material Density})/(\text{Water Density}) \quad (3)$$

14.4.1 For the level of accuracy desired, the density of water shall be taken as 1 gm/cm^3 (62.4 lb/ft^3).

15. Report

15.1 Report the following information:
15.1.1 Procedure used: A, B, or C.
15.1.2 Description and nominal dimensions of the material tested.
15.1.3 Individual specimen weight, before immersion.
15.1.4 Duration of immersion.
15.1.5 Preconditioning and conditioning, if any.
15.1.6 Draining time, if any.
15.1.7 Individual specimen water absorption amount in grams.
15.1.8 Individual specimen percent water absorption by weight as described in 14.2 if required by the material specification.
15.1.9 Individual specimen percent water absorption by volume as described in 14.4 if required by the material specification.

16. Precision and Bias[4]

16.1 The precision of this test method is based on an interlaboratory study of Test Method C1763 conducted in 2013. A single laboratory tested a total of three materials. Every "test result" represents an individual determination. The laboratory reported triplicate test results for the Procedure B analysis. Except for the use of just a single laboratory, Practice E691 was followed for the design and analysis of the data.

16.1.1 *Repeatability limit (r)*—Two test results obtained within one laboratory shall be judged not equivalent if they differ by more than the "*r*" value for that material; "*r*" is the interval representing the critical difference between two test results for the same material, obtained by the same operator using the same equipment on the same day in the same laboratory.

16.1.2 Repeatability limits are listed in Tables 3-5.

TABLE 3 Board PCF

Material	Average	Repeatability Standard Deviation	Repeatability Limit
	$\bar{x}$	s_r	r
Specimen 1	1.9258	0.0131	0.0367
Specimen 2	1.9082	0.0081	0.0227
Specimen 3	1.9725	0.0184	0.0515

TABLE 4 Weight Gain (%)

Material	Average	Repeatability Standard Deviation	Repeatability Limit
	$\bar{x}$	s_r	r
Specimen 1	4.1327	1.2356	3.4598
Specimen 2	2.8888	0.4255	1.1915
Specimen 3	3.8539	0.8547	2.3931

TABLE 5 Water Absorption by Volume (%)

Material	Average	Repeatability Standard Deviation	Repeatability Limit
	$\bar{x}$	s_r	r
Specimen 1	0.1274	0.0382	0.1070
Specimen 2	0.0882	0.0126	0.0354
Specimen 3	0.1216	0.0258	0.0721

16.1.3 *Reproducibility limit (R)*—Two test results shall be judged not equivalent if they differ by more than the "*R*" value for that material; "*R*" is the interval representing the critical difference between two test results for the same material, obtained by different operators using different equipment in different laboratories.

16.1.4 Reproducibility limits cannot be calculated from a single laboratory's results.

16.1.5 The above terms (repeatability limit and reproducibility limit) are used as specified in Practice E177.

16.1.6 Any judgment in accordance with statements 16.1.1 and 16.1.2 would normally have an approximate 95 % probability of being correct, however the precision statistics obtained in this ILS must not be treated as exact mathematical quantities which are applicable to all circumstances and uses. The limited number of laboratories reporting replicate results guarantees that there will be times when differences greater than predicted by the ILS results will arise, sometimes with considerably greater or smaller frequency than the 95 % probability limit would imply. Consider the repeatability limit as a general guide, and the associated probability of 95 % as only a rough indicator of what can be expected.

16.2 The precision statement was determined through statistical examination of 27 results; three (3) measurements each on three (3) specimens for density, weight gain, and water absorption, from a single laboratory, on 2 in. thick polyisocyanurate foam insulation boards of dimensions 6 by 6 in. with an average density of 2.2 pcf (pounds per cubic foot). Immersion time was 2 h.

16.3 *Bias*—No information can be presented on the bias of the Procedure B for measuring weight gain and water absorption because no material having an accepted reference value is available.

[4] Supporting data have been filed at ASTM International Headquarters and may be obtained by requesting Research Report RR:C16-1042. Contact ASTM Customer Service at service@astm.org.

17. Keywords

17.1 immersion; rigid thermal insulation; thermal insulation; water absorption; water retention