Designation: ~~C1512 – 10 (Reapproved 2015)~~ C1512 – 10 (Reapproved 2015)$^{\varepsilon1}$

Standard Test Method for Characterizing the Effect of Exposure to Environmental Cycling on Thermal Performance of Insulation Products[1]

This standard is issued under the fixed designation C1512; 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.

ε^1 NOTE—Editorial changes were made throughout in September 2015.

1. Scope

1.1 This test method is applicable to preformed or field manufactured thermal insulation products, such as board stock foams, rigid fibrous and composite materials manufactured with or without protective facings. See Note 1 This test method is not applicable to high temperature, reflective or loose fill insulation.

NOTE 1—If the product is manufactured with a facer, test product with facer in place.

1.2 This test method involves two stages: preconditioning and environmental cycling. During the first stage, 25 mm (1 in.) thick specimens are used to separate two environments. Each of these environments has a constant but different temperature and humidity level. During the environmental cycling stage, specimens also divide two environments namely constant room temperature/humidity on one side and cycling temperature/ambient relative humidity on the other side.

1.3 This test method measures the ability of the product to maintain thermal performance and critical physical attributes after being subjected to standardized exposure conditions. A comparison is made between material properties for reference specimens stored in the laboratory for the test period and specimens subjected to the two-stage test method. To eliminate the effect of moisture from the comparison, the material properties of the latter test specimens are determined after they have been dried to constant weight. The average value determined for each of the two sets of specimens is used for comparison.

1.4 Different properties can be measured to assess the effect of environmental factors on thermal insulation. This test method requires that thermal resistance be determined based upon an average for three specimens measured after completing the test. Secondary elements of this test method include visual observations such as cracking, delamination or other surface defects, as well as the change in moisture content after each of the two stages of exposure prescribed by the test method.

1.5 Characterization of the tested material is an essential element of this test method. Material properties used for characterization will include either compressive resistance or tensile strength values. The compressive resistance or tensile strength is measured on two sets of specimens, one set conditioned as defined in 1.2 and a set of reference test specimens taken from the same material batch and stored in the laboratory for the whole test period. For comparison, an average value is determined for each of the two sets of specimens.

1.6 The values stated in SI units are to be regarded as standard. No other units of measurement are included in this standard.

1.7 *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 requirements prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

C165 Test Method for Measuring Compressive Properties of Thermal Insulations
C168 Terminology Relating to Thermal Insulation

[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.

C177 Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus
C303 Test Method for Dimensions and Density of Preformed Block and Board–Type Thermal Insulation
C518 Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus
C870 Practice for Conditioning of Thermal Insulating Materials
C618 Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete
D1621 Test Method for Compressive Properties of Rigid Cellular Plastics
D1623 Test Method for Tensile and Tensile Adhesion Properties of Rigid Cellular Plastics
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

3. Terminology

3.1 *Definitions*—Terms used in this test method are defined in Terminology C168 with the exceptions included as appropriate.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *compressive resistance*—the compressive load per unit of original area at the specified deformation. See Test Method C165.

3.2.2 *moisture accumulation*—an increase in the average moisture content resulting from a specified exposure to conditions facilitating moisture ingress into the material.

3.2.3 *preconditioning*—a procedure which subjects test specimens to standardized one directional thermal gradient.

3.2.4 *thermal performance*—comparison of thermal resistance of test specimens before and after cycling.

4. Summary of Test Method

4.1 To reduce the testing period, this procedure involves two stages:

4.1.1 *Stage 1*—Preconditioning under constant thermal gradient and relative humidity to accelerate ingress of moisture into the test specimen.

4.1.2 *Stage 2*—Exposure to constant temperature and relative humidity on one side of test specimens with cycling environmental conditions on the other side that include freeze-thaw exposure.

5. Significance and Use

5.1 Exposing a specimen to conditions of one-directional environmental cycling can increase its moisture content until a decrease in material properties occurs (at a specific number of cycles). Such a test could be inappropriate due to the number of cycles required to cause a decrease in material properties since product performance issues often arise only after many years of exposure. The use of a preconditioning procedure is not intended to duplicate expected field performance. Rather the purpose is to increase the moisture content of test materials prior to subjecting to them to environmental cycling.

5.2 The most important aspect of the preconditioning procedure is non-uniform moisture distribution in the specimen. The heat flow is one directional causing moisture flow towards the cold side resulting in zones of dry material on the warm side and high moisture content on the cold side. (Whether the high moisture content zone is located right at the cold surface of the specimen or at some distance from this surface depends upon temperature oscillation and ability of the cold surface to dry outwards). Because the preconditioning procedure involves thermal gradient, this preconditioning procedure results in a distribution of moisture content that may occur under field exposure conditions. However, the resulting moisture content may differ significantly from that which may be demonstrated in typical product applications.

5.3 The preconditioning results in accumulation of moisture in the thermal insulation resulting from the simultaneous exposure to a difference in temperature and water vapor pressure. This test method is not intended to duplicate field exposure. It is intended to provide comparative ratings. As excessive accumulation of moisture in a construction system may adversely affect its performance, the designer should consider the potential for moisture accumulation and the possible effects of this moisture on the system performance.

6. Apparatus

6.1 The room where the apparatus is placed shall be maintained at a temperature and relative humidity of 24 ± 3°C (75 ± 5°F) and 50 ± 10 %.

6.2 *Freeze-Thaw Chamber,* capable of maintaining an air temperature of -15 ± 3°C (5 ± 5°F) over an extended period of time. The design of the apparatus should ensure that the temperature of the upper surface of the sheet metal located below the insulation specimen (measured in the center of the pan) be not higher than -4°C (25°F) when the freezer's air temperature reaches its lower limit. This can be achieved by placing thermal insulation between the metal pan and the specimen frame and/or mixing of air in the cold chamber.

6.3 *Sheet Metal Pan,* placed below the specimens. This pan performs two functions: it equalizes temperature and reduces diffusion of water vapor into the freeze-thaw chamber. The distance between the cold surface of the specimen and the sheet metal should be no less than ~~6~~6.35 mm ~~(~~(0.25~~¼~~ in.) and no more than ~~12~~12.7 mm ~~(~~(0.5~~½~~ in). The required space is normally maintained by attaching a support of the required height that is made from ~~6-mm (~~6.35 mm~~¼~~ (0.25 in.) thick Plexiglas or other non-absorbing materials on the inside surface of the specimen frame (see Fig. 2).

6.4 *Frame,* that is placed in the door opening of the freezer (see Figs. 1 and 2) or other means of specimen support. Test frames used are made from ~~6~~6.35 ± 0.5 mm (0.25 ± 0.02 in.) thick Plexiglas or other non-absorbing material. These frames are used to mount individual test specimens. The selection of the test frame (size of the test specimen) may vary based upon the thermal testing apparatus that is used.

6.5 *Warm Chamber,* above the test specimens that is provided with a heater and a temperature controller capable of maintaining a temperature of 24 ± 2°C (75 ± 3°F) and a humidifier capable of maintaining humidity in the warm chamber of 90 ± 5 %RH.

6.6 *Sensors,* for measuring temperature of the freeze-thaw and warm chambers and relative humidity in the warm chamber.

6.7 *Balance,* capable of weighing mass of maximum 1 kg with precision of 0.01 g.

7. Test Specimens

7.1 Test specimens shall be square in cross-section with a minimum area of 645 cm^2 (100 $in.^2$) and a maximum of 3716 cm^2 (576 $in.^2$). The standard specimen thickness shall be 2.54 cm (1 in.). Care should be taken so that the top and bottom surfaces of the specimens exposed to thermal gradient are parallel with one another and perpendicular to the sides.

7.2 All surfaces of the specimens shall be free from visible flaws or imperfections.

7.3 For comparison, two test specimen sets each consisting of a minimum of three specimens are tested. One set of test specimens are tested after preconditioning and after environmental cycling as described in Section 9. A second set of reference test specimens are stored in the laboratory for the duration of preconditioning and environmental cycling test before thermal resistance and compressive resistance or tensile strength testing.

8. Conditioning

8.1 Condition the test specimens before testing at 23 ± 2°C (73 ± 4°F) and 50 ± 5 %RH relative humidity for not less than 40 h prior to test in accordance with Procedure A of Practice C618.

9. Procedure

9.1 Condition specimens to constant mass in accordance with Practice C870 before testing. Measure the dimensions and mass of each specimen in accordance with Test Method C303. Record the initial mass of each specimen prior to subjecting to preconditioning procedure.

9.2 *Testing of Specimens Before and After Environmental Cycling:*

9.2.1 Three specimens shall be tested for thermal resistance value before and after environmental cycling using Test Method C518 or C177.

9.2.2 Where applicable, nine specimens shall be tested for compressive resistance before and after environmental cycling using Test Method C165 or D1621.

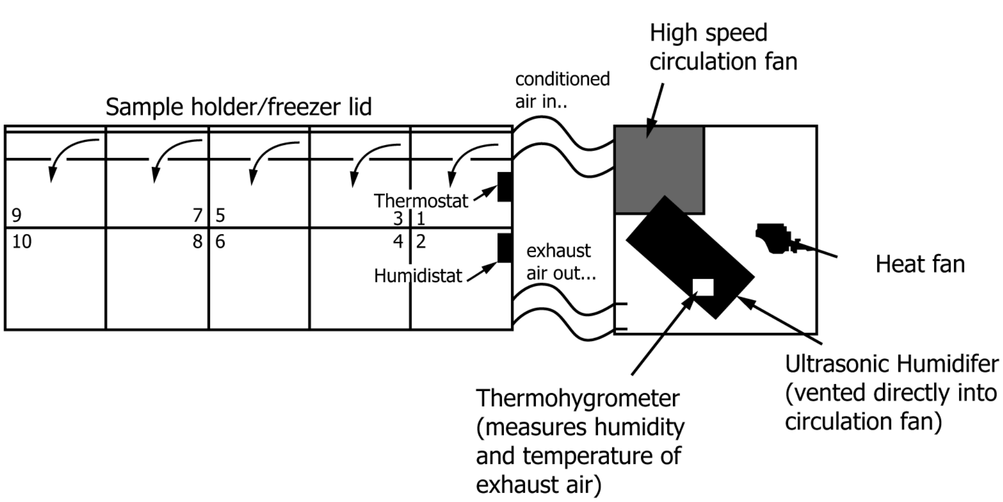

FIG. 1 Plan View of Test Equipment Setup