Designation: C1373/C1373M – 23

Standard Practice for Determination of Thermal Resistance of Attic Insulation Systems Under Simulated Winter Conditions[1]

This standard is issued under the fixed designation C1373/C1373M; 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 practice presents a laboratory procedure to determine the thermal resistance of attic insulation systems under simulated steady-state winter conditions. The practice applies only to attic insulation systems that face an open attic air space.

1.2 The thermal resistance of the insulation is inferred from calculations based on measurements on a ceiling system consisting of components consistent with the system being studied. For example, such a system might consist of a gypsum board or plywood ceiling, wood ceiling joists, and attic insulation with its top exposed to an open air space. The temperature applied to the gypsum board or plywood shall be in the range of 18 to 24°C [64 to 75°F]. The air temperature above the insulation shall correspond to winter conditions and ranges from –46°C to 10°C [–51 to 50°F]. The gypsum board or plywood ceiling shall be sealed to prevent direct airflow between the warm and cold sides of the system.

1.3 This practice applies to a wide variety of loose-fill or blanket thermal insulation products including fibrous glass, rock/slag wool, or cellulosic fiber materials; granular types including vermiculite and perlite; pelletized products; and any other insulation material that is installed pneumatically or poured in place. The practice considers the effects on heat transfer of structures, specifically the ceiling joists, substrate, for example, gypsum board, air films, and possible facings, films, or other materials that are used in conjunction with the insulation.

1.4 This practice measures the thermal resistance of the attic/ceiling system in which the insulation material has been preconditioned according to the material Specifications C549, C665, C739, and C764.

1.5 The specimen preparation techniques outlined in this standard do not cover the characterization of loose-fill materials intended for enclosed applications.

1.6 This practice is be used to characterize material behavior under controlled steady-state laboratory conditions intended to simulate actual temperature conditions of use. The practice does not simulate forced air flow conditions.

1.7 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.

1.7.1 All values shall be reported in both SI and inch-pound units unless specified otherwise by the client.

1.8 *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.*

1.9 *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]

C167 Test Methods for Thickness and Density of Blanket or Batt Thermal Insulations
C168 Terminology Relating to Thermal Insulation
C177 Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus
C518 Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus
C520 Test Methods for Density of Granular Loose Fill Insulations
C549 Specification for Perlite Loose Fill Insulation

[1] This practice is under the jurisdiction of ASTM Committee C16 on Thermal Insulation and is the direct responsibility of Subcommittee C16.30 on Thermal Measurement.

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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.

C665 Specification for Mineral-Fiber Blanket Thermal Insulation for Light Frame Construction and Manufactured Housing
C687 Practice for Determination of Thermal Resistance of Loose-Fill Building Insulation
C739 Specification for Cellulosic Fiber Loose-Fill Thermal Insulation
C764 Specification for Mineral Fiber Loose-Fill Thermal Insulation
C1045 Practice for Calculating Thermal Transmission Properties Under Steady-State Conditions
C1058 Practice for Selecting Temperatures for Evaluating and Reporting Thermal Properties of Thermal Insulation
C1114 Test Method for Steady-State Thermal Transmission Properties by Means of the Thin-Heater Apparatus
C1363 Test Method for Thermal Performance of Building Materials and Envelope Assemblies by Means of a Hot Box Apparatus

3. Terminology

3.1 *Definitions—* Unless otherwise stated, the definitions listed in Terminology C168 are applicable herein.

4. Significance and Use

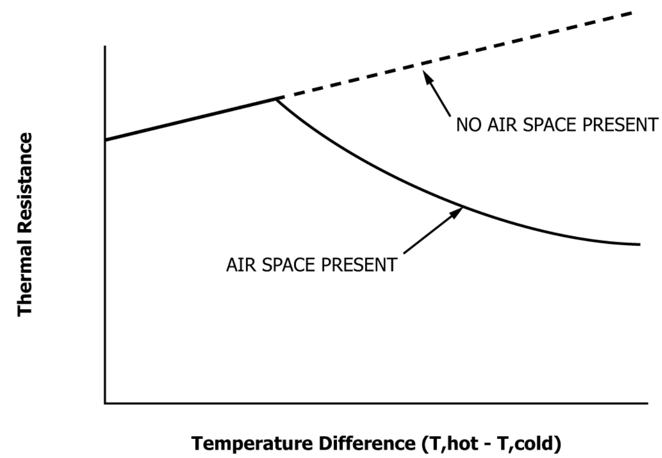
4.1 The thermal resistance of a ceiling system is used to characterize its steady-state thermal performance.

4.2 The thermal resistance of insulation is related to the density and thickness of the insulation. Test data on thermal resistance are obtained at a thickness and density representative of the end use applications. In addition, the thermal resistance of the insulation system will be different from that of the thermal insulation alone because of the system construction and materials.

4.3 This practice is needed because the in-service thermal resistance of some permeable attic insulations under winter conditions is different, lower or higher *R*, than that measured at or close to simulated room temperature conditions utilizing small-scale tests in which the insulation is sandwiched between two isothermal impermeable plates that have a temperature difference (ΔT) of 20 to 30°C [36 to 54°F]. When such insulation is installed in an attic, on top of a ceiling composed of normal building materials such as gypsum board or plywood, with an open top surface exposed to the attic air space, the thermal resistance under winter conditions with heat flow up and large temperature differences is significantly less because of additional heat transfer by natural convection. Fig. 1 illustrates the difference between results from small scale tests and tests under the conditions of this practice. See Ref (**1-12**) for discussions of this phenomenon.[3]

4.4 In normal use, the thickness of insulation products ranges from 75 mm [3 in.] to 500 mm [20 in.]. Installed densities will depend upon the product type, the installed thickness, the installation equipment used, the installation technique, and the geometry of the insulated space.

[3] The boldface numbers in parentheses refer to the list of references at the end of this standard.



NOTE 1—A constant hot-side temperature (*T*, hot) is used for both tests and the temperature difference increases as the cold side temperature (*T*, cold) is decreased. See 5.1.6 for requirements on size of air space.

FIG. 1 Schematic of Thermal Resistance for a Permeable Attic Insulation Under Simulated Winter Conditions (Heat Flow Up)

4.5 The onset of natural convection under winter conditions is a function of specimen thickness for some materials. For purposes of this practice, the tests shall be carried out at thicknesses at which the product is used.

4.6 Since this practice simulates winter conditions, the heat flow direction shall be vertically upwards.

4.7 Specimens shall be prepared in a manner consistent with the intended installation procedure. Products for pneumatic installation shall be pneumatically-applied (blown), and products for pour-in-place installation shall be poured into place. See 5.2.

5. Equipment

5.1 Thermal test apparatus used for this practice shall meet the following requirements:

5.1.1 *Conformance to Standards*—The apparatus shall conform to all requirements of the ASTM thermal test method used, except as required by 5.1.2 – 5.1.6.

5.1.2 *Size*—The apparatus shall be capable of testing specimens at the thickness intended for product use. Length and width of the metering area shall be at least twice the spacing of the wood joists or four times the specimen thickness, whichever is greater (see Fig. 2).

5.1.3 *Temperature*—The apparatus shall be capable of testing with the hot side surface maintained between 18 and 24°C [64 and 75°F], and with the cold side air temperature maintained near the winter condition for the particular climate being simulated, which ranges from –46 to 10°C [–51 to 50°F]. In the absence of specified temperatures, the ambient temperatures listed in Table 2 of C1058 on Temperatures for Thermal Transmittance Evaluations is one source of test temperatures.

NOTE 1—Only those with a hot ambient of 24°C [75°F] are applicable.

5.1.4 *Humidity*—The absolute humidity on both sides of the test apparatus shall be maintained low enough to prevent condensation within the specimen. See 6.9.6 of Test Method C1363 for humidity requirements for the hot box methods, 6.6