



# Standard Specification for Microporous Thermal Insulation<sup>1</sup>

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## 1. Scope

1.1 This specification covers the composition, physical properties, and product forms of microporous thermal insulation for use on surfaces at temperatures from 80°C [176°F] up to 1150°C [2102°F], unless otherwise agreed upon by the manufacturer and purchaser.

1.2 This specification only covers microporous thermal insulation comprising compacted powder, fibers and opacifiers.

1.3 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.

1.4 *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:<sup>2</sup>

- C165 Test Method for Measuring Compressive Properties of 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
- C201 Test Method for Thermal Conductivity of Refractories
- C302 Test Method for Density and Dimensions of Preformed Pipe-Covering-Type Thermal Insulation
- C303 Test Method for Dimensions and Density of Preformed Block and Board-Type Thermal Insulation

<sup>1</sup> This specification is under the jurisdiction of ASTM Committee C16 on Thermal Insulation and is the direct responsibility of Subcommittee C16.20 on Homogeneous Inorganic Thermal Insulations.

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<sup>2</sup> For referenced ASTM standards, visit the ASTM website, [www.astm.org](http://www.astm.org), or contact ASTM Customer Service at [service@astm.org](mailto:service@astm.org). For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

- C335 Test Method for Steady-State Heat Transfer Properties of Pipe Insulation
- C356 Test Method for Linear Shrinkage of Preformed High-Temperature Thermal Insulation Subjected to Soaking Heat
- C390 Practice for Sampling and Acceptance of Thermal Insulation Lots
- C518 Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus
- C585 Practice for Inner and Outer Diameters of Thermal Insulation for Nominal Sizes of Pipe and Tubing
- C665 Specification for Mineral-Fiber Blanket Thermal Insulation for Light Frame Construction and Manufactured Housing
- C795 Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel
- C1045 Practice for Calculating Thermal Transmission Properties Under Steady-State Conditions
- C1104/C1104M Test Method for Determining the Water Vapor Sorption of Unfaced Mineral Fiber Insulation
- E84 Test Method for Surface Burning Characteristics of Building Materials

## 3. Terminology

3.1 *Definitions*—For definitions used in this specification, see Terminology C168.

### 3.2 Definitions of Terms Specific to This Standard:

3.2.1 *flexible microporous insulation, n*—insulation that is capable of conforming to a non planar surface being insulated without damage over a specified temperature range.

3.2.2 *rigid microporous insulation, n*—insulation that will be damaged when forced to conform to a non-planar surface being insulated.

## 4. Classification

4.1 Microporous thermal insulation covered by this specification shall be classified into three types as shown in Table 1. Type classification is based on the physical form in which the insulation is manufactured.

4.2 Microporous thermal insulation covered by this specification shall be classified into four grades as shown in Table 2. Grade classification is based on the maximum recommended use temperature of the insulation.



TABLE 1 Types of Microporous Insulation

| Type                            | Definition   |
|---------------------------------|--|
| Type I – Boards                 | Boards are rigid pieces of microporous insulation of rectangular shape and cross-section in which the thickness is uniform and substantially smaller than the other dimensions. The density of boards is in the range 200 to 450 kg/m <sup>3</sup> [12.5 to 28.1 lb/ft <sup>3</sup> ]. They are supplied either unfaced or faced. Facing materials often have maximum service temperatures lower than that of the insulation and degrade without affecting the insulation properties in service.   |
| Type II – Quilted Panels        | Quilted panels are flexible panels completely encased in woven glass cloth and stitched completely through parallel or crosswise in distances from 25 to 100 mm [1 to 4 in.] in order to give flexibility in one or two dimensions. Thread types used include glass, aramid, or stainless steel. The density of quilted panels is in the range 190 to 300 kg/m <sup>3</sup> [11.9 to 18.7 lb/ft <sup>3</sup> ]. The glass cloth is provided for handling purposes only and embrittles or melts at temperatures below the maximum usage temperature of the insulation without affecting the insulation properties in service. |
| Type III – Molded Pipe Sections | Molded Pipe sections are half-shells or segments of microporous insulation faced with woven glass cloth and high-temperature adhesive for the insulation of cylindrical objects such as pipes. The density of pipe sections is in the range 300 to 400 kg/m <sup>3</sup> [18.7 to 25.0 lb/ft <sup>3</sup> ]. The glass cloth is provided for handling purposes only and embrittles or melts at temperatures below the maximum usage temperature of the insulation without affecting the insulation properties in service.  |

TABLE 2 Grades of Microporous Insulation

| Grade           | Grade Temperature of use, °C [°F], max |
|-----------------|--|
| 1               | 900 [1652]                             |
| 2A              | 1000 [1832]                            |
| 2B <sup>A</sup> | 250 [482]                              |
| 3               | 1150 [2102]                            |

<sup>A</sup>See 4.3 for a definition of the difference between Grades 2A and 2B.

4.3 Grade 2B microporous insulation is hydrophobic and has been chemically treated to make the material water-repellant.

4.3.1 Grade 2B, hydrophobic insulation, will retain its water repellency up to 250 °C [482 °F]. At higher temperatures, the treatment will degrade at a rate which depends on the temperature applied. The user shall contact the manufacturer for specific information on the lifetime of the treatment at higher temperatures than 250 °C [482 °F].

4.3.2 Grade 2B, hydrophobic insulation, which has been heated to the point where the hydrophobic treatment is destroyed, performs as Grade 2 insulation with a use temperature of 1000 °C [1832 °F].

## 5. Ordering Information

5.1 The type, grade and dimensions shall be specified by the purchaser.

5.2 The purchaser shall specify inspection of the material, where required.

5.3 When a certification, test report, or both, are required, it shall be specified by the purchaser.

5.4 The purchaser and supplier shall agree whether the insulation shall be supplied plain or with facings to facilitate ease of handling, to minimize dust generation, or to resist the ingress of water. If faced, the purchaser and supplier shall agree on the type and requirements. (**Warning**—The purchaser is advised that the maximum use temperature of facings, adhesives, and thread is usually lower than the maximum use temperature of the insulation. The purchaser and supplier shall agree whether the facings need to maintain their integrity on heating or whether they are sacrificial ).

## 6. Materials and Manufacture

6.1 *Composition*—Microporous insulation shall be comprised of compacted inorganic metal oxide powders of surface area greater than 90 m<sup>2</sup>/g [3,052 sq yd/oz], powdered inorganic infra-red opacifiers and man-made or natural fibers or filaments. Asbestos shall not be used as an ingredient or component of the product.

6.2 Typical facings are as follows:

6.2.1 Glass cloth, wrapped around or adhered to the surface of the microporous insulation with an alkali silicate based adhesive;

6.2.2 For other facings, if available, contact the manufacturer.

## 7. Physical Properties

7.1 The microporous insulation shall conform to the physical requirements described in Tables 3-5, other than for maximum density which is provided for information only. Consult the manufacturer for specific design recommendations for all material types, grades, and classes.

7.2 The user is advised that some applications require knowledge of the thermal conductivity of the insulation material at mean temperatures above those shown. Consult the manufacturer for data at mean temperatures exceeding those listed.

7.3 The physical requirements are based on the properties of samples dried and conditioned, or both, as specified in the referenced test methods. Microporous insulation, other than grade 2 hydrophobic, tends to absorb moisture to varying degrees depending on exposure conditions. It can absorb up to 4 times its dry weight if placed in direct contact with water through improper storage or application. Proper packaging and storage is required as defined in 15.1.

## 8. Dimensions and Tolerances

8.1 Type I boards are supplied in standard lengths up to 1000 ± 3 mm [40 ± 0.12 in], widths up to 550 ± 3 mm [22 ± 0.12 in], and thicknesses from 10 ± 0.5 mm [0.4 ± 0.02 in] to 70 ± 0.8 mm [2.8 ± 0.02 in]. Refer to the manufacturer for specific dimensional requirements.



TABLE 3 Type I Boards

| Properties   | Grade 1       | Grade 2       | Grade 2 hydrophobic | Grade 3       |
|--|---------------|---------------|---------------------|---------------|
| Maximum usage temperature °C [°F] <sup>A</sup>   | 900 [1652]    | 1000 [1832]   | 1000 [1832]         | 1150 [2102]   |
| Apparent thermal conductivity W/m-K [Btu-in./h·ft <sup>2</sup> °F], max<br>At mean temperature °C [°F] |               |               |                     |               |
| 100 [212]  | 0.027 [0.187] | 0.027 [0.187] | 0.027 [0.187]       | 0.033 [0.229] |
| 200 [392]  | 0.029 [0.201] | 0.029 [0.201] | 0.029 [0.201]       | 0.035 [0.236] |
| 300 [572]  | 0.031 [0.215] | 0.031 [0.215] | 0.031 [0.215]       | 0.037 [0.257] |
| 400 [752]  | 0.034 [0.236] | 0.034 [0.236] | 0.034 [0.236]       | 0.040 [0.270] |
| 500 [932]  | 0.038 [0.263] | 0.038 [0.263] | 0.038 [0.263]       | 0.044 [0.284] |
| 600 [1112]   | 0.042 [0.294] | 0.042 [0.294] | 0.042 [0.294]       | 0.047 [0.326] |
| 800 [1472]   | 0.054 [0.371] | 0.054 [0.371] | 0.054 [0.371]       | 0.053 [0.367] |
| Linear shrinkage, %, in the length and width dimensions at<br>maximum usage temperature, max           | 2             | 2             | 2                   | 2             |
| Linear shrinkage, %, in the thickness dimension at maximum usage<br>temperature, max                   | 10            | 10            | 10                  | 10            |
| Water vapor sorption, max, % by weight   | 17            | 17            | 5                   | 10            |
| Compressive strength, min at 10% deformation kPa, [psi]  | 140 [20.3]    | 140 [20.3]    | 100 [14.5]          | 100 [14.5]    |
| Surface Burning Characteristics:   |               |               |                     |               |
| Flame spread index, max  | 0             | 0             | 0                   | 0             |
| Smoke developed index, max   | 10            | 10            | 10                  | 10            |
| Corrosiveness  | Passed        | Passed        | Passed              | Passed        |

<sup>A</sup>See **Warning** statement in 5.4.

TABLE 4 Type II Quilted Panels

| Properties   | Grade 1       | Grade 2       | Grade 2 hydrophobic |
|--|---------------|---------------|---------------------|
| Maximum usage temperature °C [°F] <sup>A</sup>   | 900 [1652]    | 1000 [1832]   | 1000 [1832]         |
| Apparent thermal conductivity W/m-K [Btu-in./h·ft <sup>2</sup> °F], max<br>At mean temperature °C [°F] |               |               |                     |
| 100 [212]  | 0.031 [0.215] | 0.031 [0.215] | 0.031 [0.215]       |
| 200 [392]  | 0.035 [0.242] | 0.035 [0.242] | 0.035 [0.242]       |
| 300 [572]  | 0.039 [0.250] | 0.039 [0.250] | 0.039 [0.250]       |
| 400 [752]  | 0.044 [0.306] | 0.044 [0.306] | 0.044 [0.306]       |
| 500 [932]  | 0.050 [0.345] | 0.050 [0.345] | 0.050 [0.345]       |
| 600 [1112]   | 0.056 [0.387] | 0.056 [0.387] | 0.056 [0.387]       |
| 800 [1472]   | 0.070 [0.482] | 0.070 [0.482] | 0.070 [0.482]       |
| Linear shrinkage, %, in the length and width dimensions at maximum<br>usage temperature, max           | 2             | 2             | 2                   |
| Linear shrinkage, %, in the thickness dimension at maximum usage<br>temperature, max                   | 10            | 10            | 10                  |
| Water vapor sorption, max, % by weight   | 12            | 12            | 5                   |
| Compressive strength, min at 10% deformation kPa, [psi]  | 50 [7.3]      | 50 [7.3]      | 25 [3.6]            |
| Surface Burning Characteristics:   |               |               |                     |
| Flame spread index, max  | 0             | 0             | 0                   |
| Smoke developed index, max   | 10            | 10            | 10                  |
| Corrosiveness  | Passed        | Passed        | Passed              |

<sup>A</sup>See **Warning** statement in 5.4.

8.2 Type II quilted panels are supplied in standard lengths of 1200 ± 3 mm [48 ± 0.12 in], widths of 600 ± 3 mm [36 ± 0.12 in], and thicknesses from 3 ± 0.5 mm [0.25 ± 0.02 in] up to 12.5 ± 0.8 mm [0.5 ± 0.03 in]. Refer to the manufacturer for specific dimensional requirements.

8.3 Type III molded pipe sections are supplied as either half shells or segments. Type III molded pipe sections are available for nominal pipe sizes per the C585. Contact the manufacturer for thickness availability and specific tolerances.

## 9. Workmanship, Finish and Appearance

9.1 The microporous insulation shall indicate good workmanship in fabrication by a uniform appearance. The insulation shall not have visible defects such as tears, holes, crushed areas or major cracks and shall be free from foreign materials.

## 10. Qualification Requirements

10.1 Unless otherwise specified, the following requirements shall be employed for the purpose of initial material or product qualification:

- 10.1.1 Apparent thermal conductivity,
- 10.1.2 Linear shrinkage at maximum temperature of use,
- 10.1.3 Water vapor sorption,
- 10.1.4 Corrosiveness, and
- 10.1.5 Minimum compressive strength.

## 11. Sampling

11.1 Unless otherwise specified, sampling for qualification and inspection tests, if required, shall be in accordance with Practice C390.



TABLE 5 Type III Molded Pipe Sections

| Properties  | Grade 2       |
|---|---------------|
| Maximum usage temperature °C [°F] <sup>A</sup>  |               |
| Apparent thermal conductivity <sup>B</sup> W/m-K [Btu-in./h·ft <sup>2</sup> °F], max      |               |
| At mean temperature °C [°F] <sup>C</sup>  |               |
| 100 [212]   | 0.030 [0.208] |
| 150 [302]   | 0.031 [0.215] |
| 200 [392]   | 0.032 [0.222] |
| 250 [482]   | 0.033 [0.229] |
| 300 [572]   | 0.035 [0.242] |
| 400 [752]   | 0.039 [0.270] |
| 600 [1112]  | 0.047 [0.333] |
| 800 [1472]  | 0.060 [0.416] |
| Linear shrinkage, %, in the length and width dimensions at maximum usage temperature, max | 2             |
| Linear shrinkage, %, in the thickness dimension at maximum usage temperature, max         | 10            |
| Water vapor sorption, max, % by weight  | 10            |
| Compressive strength, min at 10% deformation kPa, [psi]                                   | 140 [20.3]    |
| Surface Burning Characteristics:  |               |
| Flame spread index, max   | 0             |
| Smoke developed index, max  | 10            |
| Corrosiveness   | Passed        |

<sup>A</sup>See **Warning** statement in 5.4.

<sup>B</sup>Tested with a least 2 bands installed per 500 mm length.

<sup>C</sup>See 12.4.4 regarding mean temperatures above the capability of Test Method's **C335** equipment.

## 12. Test Methods

12.1 The properties enumerated in this standard shall be determined in accordance with the following test methods:

12.2 *Compressive Strength*—Test Method **C165**

12.3 *Density and Dimensions*:

12.3.1 *Types I and II*—Test Method **C303**.

12.3.2 *Type III*—Test Method **C302**.

12.4 *Linear Shrinkage*—All grades of microporous insulation shall be tested according to Test Method **C356**, using the maximum usage temperature of the grade of insulation as the temperature of soaking heat for 24 h. Test samples shall not be faced or coated.

12.5 *Apparent Thermal Conductivity*:

12.5.1 *General*—Apparent thermal conductivity versus mean temperature shall be calculated in accordance with Practice **C1045**. Determinations shall be made at four or more mean temperatures. So far as is possible within the limitations of the apparatus, the mean temperatures chosen shall be equally spaced throughout the range of temperatures and shall cover the full temperature usage range of the insulation.

12.5.2 Types I and II shall be tested in accordance with Test Method **C177** guarded hot plate methods, **C518** heat flow meter, or Test Methods **C201** test method for refractories.

NOTE 1—Some products, such as Type II Quilted, are defined by the presence of a facing or stitching. These products will be tested with the facing and stitching in place.

12.5.3 Type III shall be tested in accordance with Test Method **C335** horizontal pipe method, using  $25 \pm 3$  mm [ $1 \pm 0.12$  in.] thick specimens pipe insulation as supplied to fit a 88.9-mm diameter pipe (standard nominal 80-mm [3-in.] pipe size). Where test data cannot be obtained at temperatures above the limitation of the Test Method **C335** equipment, Test Methods **C201** or Test Method **C177** shall be used on a flat sample of equivalent grade and density.

12.6 *Surface Burning Characteristics*—Test Method **E84**.

12.7 *Stress Corrosion Performance*—Compliance with Specification **C795** is necessary only when requested to assess corrosivity when the insulation is applied to austenitic stainless steel pipe.

12.8 *Water Vapor Sorption*—Test Method **C1104/C1104M**.

12.9 *Corrosiveness*—Test in accordance with Specification **C665** 13.8, Corrosiveness

## 13. Inspection

13.1 The following requirements are generally employed for the purpose of acceptance sampling of lots or shipments of qualified insulation:

13.1.1 Dimensional tolerance, and

13.1.2 Workmanship.

## 14. Rejection

14.1 Failure to conform to the requirements in this specification shall constitute cause for rejection. Rejection shall be reported to the manufacturer or the seller promptly and in writing. The manufacturer and supplier have the right to verify the rejected products.

## 15. Packaging and Package Marking

15.1 *Packaging*—Unless otherwise specified, insulation shall be packaged in the manufacturer's standard commercial containers. Special packaging shall be provided when agreed to in writing between purchaser and seller. Microporous insulation shall always be stored and applied in dry conditions protected from exposure to rain or standing water.

15.2 *Marking*—Unless otherwise specified, each container shall be clearly marked with the following information: the name and address of the manufacturer, product identification, quantity and nominal dimensions.

## 16. Certification

16.1 When specified in the purchaser order or contract, a producer's or supplier's certification shall be furnished to the

purchaser that the material was manufactured, sampled, tested, or inspected in accordance with this specification and has been found to meet the requirements. When specified in the purchase order or contract, a report of the test results shall be furnished.

## **17. Keywords**

17.1 board; hydrophobic; microporous insulation; molded pipe section; panel; quilt; thermal conductivity; thermal insulation

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