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Standard Specification for Mineral Fiber Pipe Insulation[1]

This standard is issued under the fixed designation C547; 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.

This standard has been approved for use by agencies of the Department of Defense.

~~ε[1] NOTE—Section 2 and 11.1.5.3 were editorially updated in June 2008.~~

1. Scope

1.1 This specification covers mineral fiber insulation produced to form hollow cylinders for standard pipe and tubing sizes. The mineral fiber pipe insulation may be molded or precision v-grooved, with one or more walls split longitudinally for use on pipe temperatures up to 1400°F (760°C).

1.2 For satisfactory performance, properly installed protective vapor retarders or barriers should be used on sub-ambient temperature applications to reduce movement of moisture through or around the insulation to the colder surface. Failure to use a vapor barrier can lead to insulation and system damage. Refer to Practice C921 to aid material selection.

1.3 Flexible mineral fiber wrap products such as perpendicular-oriented fiber insulation rolls, non-precision or manually scored block or board, or flexible boards or blankets used as pipe insulation, are not covered by this specification.

~~1.4The values stated in inch-pound units are to be regarded as the standard. The values given in parentheses are for information only.~~

1.4 The values stated in inch-pound units are to be regarded as standard. The values given in parentheses are mathematical conversions to SI units that are provided for information only and are not considered standard.

1.5 For Naval Sea Systems Command (NAVSEA) acceptance, materials must also comply with Supplemental Requirements. See Annex A1 of this standard.

1.6 The following safety hazards caveat applies to the test methods portion, Section 11, only: *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:*[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
C302 Test Method for Density and Dimensions of Preformed Pipe-Covering-Type Thermal Insulation
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
C411 Test Method for Hot-Surface Performance of High-Temperature Thermal Insulation
C447 Practice for Estimating the Maximum Use Temperature of Thermal Insulations
C585 Practice for Inner and Outer Diameters of Thermal Insulation for Nominal Sizes of Pipe and Tubing
C612 Specification for Mineral Fiber Block and Board Thermal Insulation
C795 Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel
C921 Practice for Determining the Properties of Jacketing Materials for Thermal Insulation
C1045 Practice for Calculating Thermal Transmission Properties Under Steady-State Conditions

[1] 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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[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.

C1058 Practice for Selecting Temperatures for Evaluating and Reporting Thermal Properties of Thermal Insulation
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
2.2 *Other Standards:*
UL 723 Tests for Surface Burning of Building Materials[3]
NFPA 255 Method of Tests of Surface Burning Characteristics of Building Materials[4]
CAN/ULC-S102 Standard Method of Test for Surface Burning Characteristics of Building Materials and Assemblies [5]

3. Terminology

3.1 The definitions in Terminology C168 shall apply to the terms used in this specification.
3.2 *Definitions of Terms Specific to This Standard:*
3.2.1 *molded*—refers to products preformed via a molding process to yield full-round cylindrical pipe insulation sections.
3.2.2 *precision v-groove*—refers to products fabricated from machined board via a precision cutting process. Machined segments are adhered to a backing to form a full-round cylindrical pipe insulation section. Due to the precision of the process, the product has no gaps when installed.

4. Classification

4.1 Products covered by this specification are classified according to maximum use temperature as follows:
4.1.1 *Type I*—Molded, for use to 850°F (454°C).
Grade A—Requires no heat-up schedule
Grade B—Heat-up schedule is required
4.1.2 *Type II*—Molded, for use to 1200°F (650°C).
Grade A—Requires no heat-up schedule
Grade B—Heat-up schedule is required
4.1.3 *Type III*—Precision v-groove, for use to 1200°F (650°C).
Grade A—Requires no heat-up schedule
Grade B—Heat-up schedule is required
4.1.4 *Type IV*—Molded, for use to 1000°F (538°C).
Grade A—Requires no heat-up schedule
Grade B—Heat-up schedule is required
4.1.5 *Type V*—Molded, for use to 1400°F (760°C)
Grade A—Requires no heat-up schedule
Grade B—Heat-up schedule is required

NOTE 1—**Warning:** Grade B may not be suitable for applications requiring hot installation capability at the maximum temperature indicated. Products having a Grade B designation are designed to be used with a heat-up schedule. Failure to use a heat-up schedule with Grade B products may lead to an exothermic reaction. This is dependent on thickness and temperature. Consult the manufacturer or manufacturer's literature for special heat rate considerations.

4.2 Binder decomposition at elevated temperature may be a limiting factor in certain applications. Consult the manufacturer regarding special heat rate considerations.

5. Materials and Manufacturer

5.1 *Composition*— The mineral fiber insulation for pipes shall be manufactured from mineral substance such as rock, slag, or glass, processed from a molten state into fibrous form with binder. Asbestos shall not be used as an ingredient or component part. Some products may also contain adhesive.
5.2 *Jackets (Facings)*—The user of this specification has the option to specify that the insulation be jacketed.

NOTE 2—The user is advised that the maximum use temperature of factory-applied facings and adhesives may be lower than the maximum use temperature of the insulation. The specifier shall ensure that sufficient insulation thickness is installed so none of these accessory items (facings and adhesives) are exposed to temperatures above their maximum use temperature. The products covered by this standard are predominantly inorganic in nature. Organic facings, adhesives and binders are also used in the construction of these products. The resulting composite therefore could have increased combustibility.

6. Physical Requirements

6.1 The product shall conform to the following requirements in addition to those specified in Table 1.

[3] Available from Underwriters Laboratories (UL), 333 Pfingsten Rd., Northbrook, IL 60062-2096, http://www.ul.com.
[3] Available from Underwriters Laboratories (UL), 2600 N.W. Lake Rd., Camas, WA 98607-8542, http://www.ul.com.
[4] Available from National Fire Protection Association (NFPA), 1 Batterymarch Park, Quincy, MA 02169-7471, http://www.nfpa.org.
[5] Available from Underwriters Laboratories of Canada, 7 Crouse Road, Scarborough, Ontario MIR3A9.

TABLE 1 Requirements of Mineral Fiber Pipe Insulation (Grades A & B)

Property	Type I (Grades A andB)	Type II (Grades A and B)	Type III (Grades A and B)	Type IV (Grades A and B)	Type V (Grades A and B
Use temperature, max, °F (°C)	850 (454)	1200 (650)	1200 (650)	1000 (538)	1400 (760)
Sag resistance, max, % thickness change	5	5	5	5	5
Linear shrinkage (length), max, % change after change after soaking heat at maximum use temperature	2	2	2	2	2
Water vapor sorption, max, % by weight	5	5	5	5	5
Surface burning characteristics, max					
Flame spread index	25	25	25	25	25
Smoke developed index	50	50	50	50	50
Apparent thermal conductivity, max, Btu.in./h,ft^2, °F(W/m.K)					
Mean temperature[A] °F (°C)					
100 (38)	0.25 (0.036)	0.25 (0.036)	0.25 (0.036)	0.25 (0.036)	0.25 (0.036)
200 (93)	0.31 (0.045)	0.31 (0.045)	0.31 (0.045)	0.31 (0.045)	0.31 (0.045)
300 (149)	0.40 (0.058)	0.37 (0.053)	0.37 (0.053)	0.37 (0.053)	0.37 (0.053)
400 (204)	0.51 (0.074)	0.45 (0.065)	0.45 (0.065)	0.45 (0.065)	0.45 (0.065)
500 (280)	0.64 (0.092)	0.54 (0.078)	0.54 (0.078)	0.54 (0.078)	0.54 (0.078)
600 (316)		0.65 (0.094)	0.65 (0.094)	0.65 (0.094)	0.65 (0.094)
700 (371)		0.77 (0.111)	0.77 (0.111)	0.77 (0.111)	0.77 (0.111)

[A] The user is advised that retrofit applications (where new insulation is being applied over existing) could require knowing the thermal conductivity of the existing layer at mean temperatures above those shown. Consult a manufacturer for data at mean temperatures exceeding those listed.

TABLE 2 Requirements of Mineral Fiber Pipe Insulation (Grade A Only)

Property	Type I (Grade A)	Type II (Grade A)	Type III (Grade A)	Type IV (Grade A)	Type V (Grade A)
Maximum Internal Temp. Rise (Grade A Only), °F (°C)	200 (111)	200 (111)	200 (111)	200 (111)	200 (111)

6.2 *Hot Surface Performance*:

6.2.1 The product shall not crack, warp, flame, or glow during hot surface exposure. No evidence of melting or fiber degradation shall be evident upon post test inspection.

6.2.2 The insulation's internal temperature rise (exotherm) shall not exceed the pipe temperature by more than 200°F (111°C).

6.3 *Non-fibrous (Shot) Content*:

6.3.1 The non-fibrous content of a rock- or slag-based product shall not exceed ~~30%~~25 % by weight.

6.4 For Naval Sea Systems Command (NAVSEA) acceptance, materials must also comply with Supplemental Requirements. See Annex A1 of this standard.

7. Standard Shapes, Sizes, and Dimensions

7.1 The basic shape of mineral fiber pipe insulation forms a right annular cylinder, which is radially slit on at least one side of the cylinder axis. It is furnished in sections or segments designed to fit standard sizes of pipe and tubing.

7.2 Typical available thicknesses range from nominal ½-in. (13 mm) to nominal 6-in. (152 mm), single or double layer, in ½-in. increments for most pipe and tubing sizes.

7.3 Individual dimensions for inner diameter and wall thickness shall conform to Practice C585.

7.4 Standard section or segment length shall be 3 ft (0.91m) or as agreed upon between the buyer and seller.

8. Dimensional Tolerances

8.1 Length equals ±⅛-in. (3 mm).

8.2 When installed on a nominal pipe or tubing size as defined in Practice C585, the insulation shall fit snugly and have tight longitudinal and circumferential joints.

8.3 The inner and outer bore of the insulation shall be concentric to the outer surface. The deviation from concentricity shall not exceed 3⁄16 in. (5 mm).

9. Workmanship

9.1 The insulation shall not have defects that will adversely affect installation or service quality.

10. Sampling

10.1 When specified in the purchase order or contract, sampling and acceptance shall be in accordance with Practice C390.

11. Test Methods

11.1 The properties in this specification shall be determined in accordance with the following test methods, with jacketing excluded unless stated otherwise.

11.1.1 *Density and Dimensions*—Test Method C302.

11.1.2 *Linear Shrinkage*— Test Method C356.

11.1.3 *Thermal Conductivity*—Test Method C335.

11.1.3.1 Thermal performance shall be characterized on a 3-in. NPS × 2-in. pipe insulation size. Thermal performance must be assessed on actual pipe insulation sections. Data obtained on flat samples, using Test Method C177, shall not be used to state compliance with this specification.

11.1.3.2 Practice C1058 may be used to obtain recommended test temperature combinations for testing purposes.

11.1.3.3 As specified in C1045, the range of test conditions must include at least one test where the hot surface temperature is greater than, or equal to, the hot limit of the temperature range of desired data and at least one test where the cold surface temperature is less than, or equal to, the cold limit of the temperature range desired. At least two additional tests shall be distributed somewhat evenly over the rest of the temperature range.

11.1.3.4 Final analysis of the thermal data shall be conducted in accordance with C1045 to generate a thermal conductivity versus temperature relationship for the specimen.

11.1.3.5 The final step of C1045 analysis is to calculate the thermal conductivity using the equations generated at a set of mean temperatures for comparison to the specification.**Warning—** While it is recommended that the specification data be presented as thermal conductivity versus temperature, several existing specifications may contain mean temperature data from tests conducted at specific hot and cold surface temperatures. In these cases, the conductivity as a function of temperature from the C1045 analysis may provide different results. To insure that the data is compatible, a C680 analysis, using the thermal conductivity versus temperature relationship from C1045 and the specific hot and cold surface temperatures, is required to determine the effective thermal conductivity for comparison to the specification requirements.

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

11.1.5 *Surface Burning Characteristics* —Test Method E84.

11.1.5.1 Flat specimens otherwise identical in composition to pipe insulation shall be used. This applies to plain and factory-jacketed products, with and without self-sealing longitudinal lap closure systems.

11.1.5.2 Test Methods UL 723 or NFPA 255 may be substituted for Test Method E84. These methods are largely considered synonymous by most building officials.

~~11.1.5.3For~~11.1.5.3 For Canada, test in accordance with Test Method CAN/ULC-S102. When the referenced Canadian document in this specification is referred to in applicable Canadian building codes, the editions, referenced by those building codes, shall govern.

11.1.6 *Hot Surface Performance*—Test Method C411 and Standard Practice C447.

11.1.6.1 A 3-in. (75-mm) nominal pipe size or larger shall be used. A test specimen shall be at least 36-in. (914-mm) in length. All types shall be tested at 6-in. (150-mm) nominal thickness, in either single or multiple layer configurations.

11.1.6.2 All products shall be tested without jacketing, with the exception of products where the jacket is an integral part necessary to hold the insulation together such as precision v-groove. The test pipe shall be at the Type I, Type II, Type III, or Type IV temperature specified in 4.1, when the insulation is applied. For Class B material any special requirement for heat-up shall be specified by the manufacturer shall be used.

11.1.6.3 Immediately upon application to the pipe, the internal temperature rise shall be measured as prescribed in the Hot Surface Performance section of Standard Practice C447.

11.1.7 *Sag Resistance*:

11.1.7.1 *Scope*—This procedure is used to determine thickness loss as a result of exposure to maximum service during the hot surface performance test.

11.1.7.2 *Significance and Use*—Products having excessive thickness loss at elevated temperature could yield less than expected in-service performance.

11.1.7.3 *Definition*—Sag is defined as the extent of thickness loss due to material fatigue or decomposition due to elevated temperature.

11.1.7.4 *Procedure*—For the sag determination, measure the thickness of the test length before and after 96-h hot surface exposure. A pin gage suitable for this is described by Test Methods C167. The measurement shall be taken at the top longitudinal center of the horizontally mounted test specimen. The pin gage shall be vertically inserted through the insulation to obtain tip contact with the hot pipe surface. The pin gage shall be read with a steel rule to the nearest 1/32-in. (1 mm). Calculate the thickness sag as follows:

$$\% \text{ change} = ((t1 - t2)/t1) \times 100 \quad (1)$$