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Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form[1]

This standard is issued under the fixed designation C 534; 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 specification covers preformed flexible elastomeric cellular thermal insulation in sheet and tubular form. This specification covers materials to be used on commercial or industrial systems with operating temperatures from −57 to 104°C (−70 to 220°F).

1.2 The values stated in SI units are to be regarded as the standard. The inch-pound equivalents of SI units, given in parentheses, may be approximate.

1.3 *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:*

C 168 Terminology Relating to Thermal Insulating Materials[2]
C 177 Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded Hot Plate Apparatus[2]
C 209 Test Methods for Cellulosic Fiber Insulation Board[2]
C 390 Criteria for Sampling and Acceptance of Preformed Thermal Insulation Lots[2]
C 335 Test Method for Steady-State Heat Transfer Properties of Horizontal Pipe Insulation[2]
C 411 Test Method for Hot-Surface Performance of High-Temperature Thermal Insulation[2]
C 447 Practice for Estimating the Maximum Use Temperature of Thermal Insulations[2]
C 518 Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus[2]
C 585 Practice for Inner and Outer Diameters of Rigid Thermal Insulation for Nominal Sizes of Pipe and Tubing[2]
C 692 Test Method for Evaluating the Influence of Thermal Insulations on the External Stress Corrosion Cracking Tendency of Austenitic Steel[2]
C 795 Specification for Thermal Insulation for use in Contact with Austenitic Stainless Steel[2]
C 871 Test Methods for Chemical Analysis of Thermal Insulation Materials for Leachable Chloride, Fluoride, Silicate, and Sodium Ions[2]
C 1045 Practice for Calculating Thermal Properties from Steady-State Heat Flux Measurements[2]
C 1058 Practice for Selecting Temperatures for Evaluating and Reporting Thermal Properties of Thermal Insulation[2]
C 1114 Test Method for Steady-State Thermal Transmission Properties by Means of the Thin-Heater Apparatus[2]
C 1304 Test Method for Assessing the Odor Emissions of Thermal Insulation Materials[2]
D 883 Terminology Relating to Plastics[3]
D 1622 Test Method for Apparent Density of Rigid Cellular Plastics[3]
D 1667 Specification for Flexible Cellular Materials-Vinyl Chloride Polymers and Copolymers (Closed-Cell Foam)[3]
E 84 Test Method for Surface Burning Characteristics of Building Materials[4]
E 96 Test Methods for Water Vapor Transmission of Materials[2]

3. Terminology

3.1 *Definitions*—Terms used in this specification are defined in Terminology C 168 and in Terminology D 883.

3.2 *Definition of Term Specific to This Standard:*

3.2.1 *cellular elastomeric foam*—a closed-cell foam made of natural or synthetic rubber, or a mixture of the two, and containing other polymers, other chemicals, or both, which may be modified by organic or inorganic additives. These foams have properties similar to those of vulcanized rubber, namely, (*1*) the ability to be converted from a thermoplastic to a thermosetting state by cross-linking (vulcanization) and (*2*) the ability to recover substantially its original shape when strained or elongated.

4. Classification

4.1 The types of preformed flexible elastomeric cellular thermal insulation are designated as follows:

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[1] This specification is under the jurisdiction of ASTM Committee C-16 on Thermal Insulation and is the direct responsibility of Subcommittee C16.22 on Organic and Nonhomogeneous Inorganic Thermal Insulation.

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[2] *Annual Book of ASTM Standards*, Vol 04.06.

[3] *Annual Book of ASTM Standards*, Vol 08.01.

[4] *Annual Book of ASTM Standards*, Vol 04.07.

4.1.1 *Type I*—Tubular, and

4.1.2 *Type II*—Sheet.

4.2 Use temperature for Type I and Type II is −57 to 104°C (−70 to 220°F).

NOTE 1—Continuous long-term exposure at or above the upper use temperature may cause degradation in the form of loss of flexibility (see 11.1.3).

5. Materials

5.1 These products shall be made of a homogeneous blend of natural or synthetic rubber that may be modified with various thermoplastic or thermosetting resins, plasticizers, modifiers, antioxidants, curatives, blowing agents and other additives. These products are thermoset and not thermoplastic in nature.

5.2 These products are expanded with chemical blowing agents that decompose with the application of heat. The gases produced by these blowing agents are similar to those found in the atmosphere and thus the diffusion rate is not significant. These gases do not change over time and the thermal conductivity of the insulation is stable over time.

5.3 Flexible, elastomeric, cellular thermal insulations shall be of uniform core density and have closed cells. Even though these insulation materials may have a smooth skin surface on one or both sides, they are to be considered homogeneous for the purposes of determining thermal performance.

6. Physical Requirements

6.1 *Qualification Requirements*—Thermal conductivity, water vapor permeability and dimensional stability physical properties listed in Table 1, are defined as qualification requirements (refer to C 390, Section 5, Classification of Requirements and Section 6, Acceptance for Qualification Requirements).

6.2 *Inspection Requirements*:

6.2.1 The requirements for water absorption and flexibility physical properties listed in Table 1 are defined as inspection requirements (refer to C 390, Section 5, Classification of Requirements, and Section 7, Acceptance for Inspection Requirements).

6.2.2 All dimensional requirements are as described in Section 6 and Table 2.

6.2.3 All workmanship, finish and appearance requirements are as described in Section 9.

6.2.4 Compliance with inspection requirements shall be in accordance with Criteria C 390.

6.3 Both Type I and Type II insulations shall conform to the physical property requirements listed in Table 1.

6.4 The material shall be free of objectionable odors at all temperatures within the recommended use range when tested according to Test Method C 1304.

6.5 *Surface Burning Characteristics*—Surface burning characteristics are to be tested for the thickness supplied in accordance with Test Method E 84 and the results are to be reported.

NOTE 2—This test method does not always define the hazard that may be presented by preformed flexible elastomeric cellular thermal insulation under actual fire conditions. It is retained for reference in this standard as lab test data required by some building codes.

NOTE 3—Preformed flexible cellular elastomeric thermal insulation is an organic material and is combustible. It should not be exposed to flames or other ignition sources. The fire performance of the material should be addressed through fire test requirements established by the appropriate governing documents.

7. Standard Shapes, Sizes and Dimensions

7.1 *Type I*—Tubular materials are typically available in 1.52- or 1.83-m (60- or 72-in.) standard lengths, as well as in continuous lengths (see Note 1). Insulation is typically available for diameters up to 200 mm (8 in. nominal pipe size (NPS)) with wall thickness up to 25.4 mm (1 in.).

7.2 *Type II*—Sheet material is available in thicknesses up to 50 mm (2 in.). Sheets are typically available from one or more manufacturers in sizes up to 1.22 m (48 in.) in width and in continuous lengths. Other sizes are available upon request. Individual dimensions shall conform to those specified by the manufacturer.

7.3 Actual dimensions shall be agreed upon between the manufacturer and the purchaser. The procedure section and the pipe and tubing diameter information of Practice C 585 may be beneficial in determining these actual dimensions.

7.4 The insulation tolerances shall conform to Table 2.

8. Surface

8.1 *Type I*—All surfaces (except ends and slits that are mechanically cut) shall have natural skins.

8.2 *Type II*—Sheet material is available either without skins, with skin on one side or with skin on two sides. The surface

TABLE 1 Physical Requirements for Type I (Tubular) and Type II (Sheet)[A]

Property	Unit	Type I and Type II
Apparent thermal conductivity, max., at a mean temperature of:	W/m·K (Btu·in./h·ft^2·°F)	
-29°C (-20°F)		0.0395 (0.27)
-18°C (0°F)		0.0403 (0.28)
24°C (75°F)		0.0432 (0.30)
50°C (120°F)		0.0461 (0.32)
66°C (150°F)		0.0478 (0.33)
Water absorption, max.	% by volume	0.2
Water-vapor permeability, max.	g/Pa·s·m (perm-in.)	4.35×10^{-10}(0.30)
Flexibility (mandrel bend):		
at 23°C (73.4°F)		Shall not crack
at 0°C (32°F)		
Dimensional stability, max.	% linear change	7.0

[A]Table 1 describes two types of flexible elastomeric cellular thermal insulation. The values stated in Table 1 may not always be appropriate as design values. For specific design recommendations using a particular product and for supporting documentation, consult the manufacturer.

TABLE 2 Dimensional Tolerances

	Tolerances
Type I—Tubular Material	
Inside diameter, mm (in.):	
Up to 10 (3⁄8), incl.	+2.5 (3⁄32), -0
13 (1⁄2) to 22 (7⁄8), incl.	+3 (1⁄8), -0
25 (1) to 38 (11⁄2), incl.	+5 (3⁄16), -0
41 (1-5⁄8) to 60 (2-3⁄8), incl.	+6 (1⁄4), -0
Over 60 (2-3⁄8)	+10 (3⁄8), -0
Wall thicknesses, mm (in.):	
Up to 19 (3⁄4), incl.	+3 (1⁄8), -0
19 and over (3⁄4)	+5 (3⁄16), -0
Length, mm (in.)	+75 (3), -25 (1)
Type II—Sheet Material	
Thickness, mm (in.):	
Up to 13 (1⁄2), incl.	± 2 (± 1⁄16)
Over 13 (1⁄2)	± 3 (± 3⁄32)
Length and width, mm (in.):	
Up to 150 (6), incl.	± 6 (± 1⁄4)
Over 150 (6) to 300 (12), incl.	± 10 (± 3⁄8)
Over 300 (12)	± 3%

will be at the manufacturer's option, unless otherwise specified.

9. Workmanship, Finish and Appearance

9.1 The insulation shall be free of visual defects that will adversely affect the service quality. For example, blisters, blow holes and tears when occurring to an excessive degree shall be judged to adversely affect the service quality of the material.

10. Sampling

10.1 The insulation shall be sampled in accordance with Criteria C 390. Details shall be agreed upon between the buyer and seller.

10.2 When possible, the insulation shall be tested in the form supplied. However, when Type I does not lend itself to testing or to making of test specimens because of its shape, standard test sheets shall be prepared from tubular material having equivalent physical characteristics to Type I (see 10.1).

10.2.1 When standard test sheets are required for tubular material, they shall be prepared by longitudinally slitting the tubular specimens along one wall thickness, opening and laying the sample flat.

11. Test Methods

11.1 *Test Conditions*—The physical requirements enumerated in this specification shall be determined in accordance with the following test methods:

11.1.1 *Apparent Thermal Conductivity*:

11.1.1.1 *Type I*—Choose from Test Methods C 177, C 518, C 1114 or C 335 in conjunction with Practice C 1045. Use standard test sheet for C 177, C 518 or C 1114.

NOTE 4—Test Method C 335 may be used to determine the apparent thermal conductivity for Type I tubular material operating at or above ambient conditions. Normally, Test Method C 335 is not used to determine the apparent thermal conductivity values for Type I tubular material operating at or below ambient temperature.

11.1.1.2 *Type II*—Choose from Test Methods C 177, C 518 or C 1114 in conjunction with Practice C 1045.

11.1.1.3 Tests shall be conducted with a temperature differential of 25 ± 5°C (50 ± 10°F) between the hot and cold plates of the testing apparatus in accordance with Table 3 of Practice C 1058.

11.1.2 *Water Vapor Permeability*—Use standard test sheets for Type I. For Type II, use the desiccant method of Test Methods E 96 with the following conditions:

11.1.2.1 The desiccant method shall be performed against a 50 ± 5 % relative humidity at 23 ± 2°C (73 ± 4°F),

11.1.2.2 The preferred specimen thickness shall be approximately 13 mm (1⁄2 in.) with skin on at least one side,

11.1.2.3 The specimen shall be tested so that the skin surface is toward the high humidity, and

11.1.2.4 All samples shall be run a minimum of three weeks (504 h) and possibly longer to ensure that equilibrium conditions have been reached.

11.1.3 *Flexibility*:

11.1.3.1 *Scope*—This test method determines the flexibility of cellular elastomeric materials at temperatures that represent the ambient temperature extremes encountered during installation of these types of materials.

11.1.3.2 *Significance and Use*—The formulation and the state of cure can sometimes create the potential for cracking, rupture or permanent deformation of cellular elastomeric materials. This test method is used to determine the flexibility of the insulation material.

11.1.3.3 *Apparatus*—A mandrel that shall be 13 ± 0.4 mm (1⁄2± 1⁄64in.) in diameter and any suitable length.

11.1.3.4 *Test Specimens*—For Type I, the size of the specimen shall be a tube with an inside diameter of 25.4 to 38 mm (1 to 11⁄2 in.), 152 mm (6 in.) long, with a wall thickness of 13 + 3.2 mm, −0 (1⁄2 + 1⁄8 in. −0 in.). Three specimens shall be tested. For Type II, the size of the specimen shall be 150 by 75 by 13 mm (6 by 3 by 1⁄2in.), all dimensions ± 2 mm (1⁄16in.). Three specimens shall be tested.

11.1.3.5 *Procedure*—Condition the samples at the specified temperature, either 23°C (73.4°F) or 0°C (32°F) for 4 h prior to testing. After conditioning, the samples should be immediately tested as follows: across the 150-mm (6-in.) dimension, bend the specimen rapidly by hand around the 13-mm (1⁄2-in.) mandrel into a U shape.

11.1.3.6 *Interpretation of Results:* Test specimens that crack, rupture or have permanent deformation shall be considered to have failed.

11.1.3.7 *Precision and Bias*—No information is presented about either the precision or bias of this flexibility test method since the test result is non-quantitative.

11.1.4 *Dimensional Stability*:

11.1.4.1 *Scope*—This test method covers the evaluation of dimensional stability of flexible cellular elastomeric materials.

11.1.4.2 *Significance and Use*—This test method provides a relatively simple and short-term evaluation of in-use performance with regard to dimensional stability.

11.1.4.3 *Apparatus*—Needed are an air-circulating oven equipped with a control to maintain a temperature of 93.3 ± 1.7°C (200 ± 3°F) during the test and having an expanded metal shelf, and a steel rule, graduated in mm (in.), capable of measuring to increments of 1.0 mm (0.05 in.).

11.1.4.4 *Test Specimens*—For Type I, use three 300-mm (12-in.) long specimens from each of the test samples. For Type II, use three specimens 300 by 75-mm (12 by 3 in.) cut from each of the test samples.

11.1.4.5 *Procedure*—At each of two points approximately 250 mm (10 in.) apart on the centerline of each specimen, place a benchmark. Condition the specimen 24 h at a temperature of 23 ± 2°C (73.4 ± 3.6°F) and measure the distance between the benchmarks to the nearest 1.0 mm (0.05 in.). Place the specimens on an expanded metal shelf in an oven operating at a temperature of 93 ± 2°C(200 ± 3°F). After 7 days, remove the specimens from the oven, condition for at least 2 h at 23 ± 2°C (73.4 ± 3.6°F) and remeasure.

11.1.4.6 *Report*—Report the dimensional stability as the change in length between the two bench marks expressed as a percentage of the length measured originally.

11.1.4.7 *Precision and Bias*—The precision of this dimensional stability test method is not known because interlaboratory data are not available. This test method may not be suitable for use in case of disputed results as long as these data are not available. Work is proceeding in the development of a precision statement. The procedure in this test method has no bias because the value of dimensional stability is defined in terms of this test method.

11.1.5 *Water Absorption*—For Type I and Type II, use Test Methods C 209. Submersion time shall be 2 h.

11.1.6 *Maximum Use Temperature*:

11.1.6.1 When tested in accordance with 11.1.6.2, the insulation shall not soften, collapse, melt or drip during hot surface exposure. No softening, collapsing, melting, or dripping shall be evident upon post-test inspection.

11.1.6.2 Type I and Type II shall be tested in accordance with Test Method C 411 and the hot surface performance of Practice C 447 at the insulation's maximum use temperature and at the manufacturer's maximum recommended thickness. The surface shall be at the intended temperature when testing begins. No special requirements for heat-up shall be specified by the manufacturer.

12. Inspection

12.1 Inspection of the material shall be made at the point of shipment or at the point of delivery, as agreed upon between the purchaser and the supplier.

13. Rejection

13.1 Material that fails to conform to the requirements of this specification may be rejected. Rejection shall be reported to the manufacturer or supplier promptly and in writing.

14. Packaging and Marking

14.1 Unless otherwise agreed or specified between the purchaser and the supplier, material under this specification shall be packaged in the manufacturer's standard commercial containers.

14.2 Unless otherwise specified, shipping containers shall be marked with the name and designation of the manufacturer, grade of material, type, size, thickness and quantity of the material in the container.

15. Keywords

15.1 cellular elastomeric; cellular materials; dimensional stability; flexibility; preformed thermal insulation; sheet material; shrinkage; thermal insulating materials—pipe

APPENDIX

(Nonmandatory Information)

X1. SUPPLEMENTARY INFORMATION

X1.1 *Water-Soluble Chlorides and Use on Austenitic Stainless Steel:*

X1.1.1 Water-soluble or leachable chlorides and other halides are normally present in trace quantities in most commercial elastomeric thermal insulation materials. In the presence of moisture and oxygen, as well as under certain service conditions, these ions are capable of initiating stress corrosion cracking in susceptible metal alloys such as austenitic stainless steels. There are not sufficient leachable inhibitors present in the elastomeric insulation to prevent the effects by stress corrosion on austenitic stainless steel.

X1.1.2 It is not practical to indicate a safe upper limit for the chloride content since water may leach out soluble chlorides from a substantial volume of insulation material or the environment and allow these chlorides to be concentrated at the metal-insulation interface.

X1.1.3 Austenitic stainless steel may be used in a variety of operating systems. Extra care should be taken if these insulation materials are to be used on austenitic stainless steel systems that operate above 54°C (130°F). Consult the manufacturer for specific recommendations.

X1.1.4 Consult the manufacturer for specific test results of leachable chlorides if this material is to be used in a containment area of a nuclear power facility.

X1.1.5 For more information, refer to Specification C 795 and Test Methods C 692 and C 871.

X1.2 *Water Absorption/Water Vapor Infiltration*—Due to the closed-cell structure of these materials, they do not absorb significant amounts of liquid water. They may, however, be affected by water vapor permeability. Great care should be taken during installation of any system operating below ambient temperature to ensure that all seams and joints are properly sealed. Particular attention should be paid to water vapor permeability during the material selection process as this will have an impact on the long-term performance of the insulation system.

X1.3 *Density*—The density of this type of insulation material is not a performance property. For reference purposes only, densities of these types of products typically range from 48 to 136 kg/m^3(3.0 to 8.5 lb/ft^3) when measured in accordance with Test Method D 1622 or Specification D 1667.

X1.4 *Preventing Corrosion of Copper Lines*—Useful information for preventing corrosion of insulated copper lines may be found ASTM STP 1320.[5]

[5] Hough, P. A., and Lenox, R. S., "Preventing Environmentally-Caused Corrosion of Insulated Copper Lines," *Insulation Materials: Testing and Applications: Third Volume, ASTM STP 1320*, ASTM, 1997, pp. 473–484.

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