



Designation: C 534 – 05

## Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form<sup>1</sup>

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 ( $\epsilon$ ) indicates an editorial change since the last revision or reapproval.

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

### 1. Scope

1.1 This specification covers preformed flexible elastomeric cellular thermal insulation in sheet and tubular form. Grade 1 covers materials to be used on commercial or industrial systems with operating temperatures from -183 to 104°C (-297 to 220°F), Grade 2 covers material used on industrial systems with operating temperatures from -183 to 175°C (-297 to 350°F), and Grade 3 covers material used on industrial systems with operating temperatures from -183 to 120°C (-297 to 250°F) where halogens are not permitted.

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, are 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:<sup>2</sup>

- C 168 Terminology Relating to Thermal Insulation
- C 177 Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus
- C 209 Test Methods for Cellulosic Fiber Insulating Board
- C 390 Practice for Sampling and Acceptance of Preformed Thermal Insulation Lots
- C 335 Test Method for Steady-State Heat Transfer Properties of Horizontal Pipe Insulation

- C 411 Test Method for Hot-Surface Performance of High-Temperature Thermal Insulation
- C 447 Practice for Estimating the Maximum Use Temperature of Thermal Insulations
- C 518 Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus
- C 534 Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form
- C 585 Practice for Inner and Outer Diameters of Rigid Thermal Insulation for Nominal Sizes of Pipe and Tubing (NPS System)
- C 692 Test Method for Evaluating the Influence of Thermal Insulations on External Stress Corrosion Cracking Tendency of Austenitic Stainless Steel
- C 795 Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel
- C 871 Test Methods for Chemical Analysis of Thermal Insulation Materials for Leachable Chloride, Fluoride, Silicate, and Sodium Ions
- C 1045 Practice for Calculating Thermal Transmission Properties Under Steady-State Conditions
- C 1058 Practice for Selecting Temperatures for Evaluating and Reporting Thermal Properties of Thermal Insulation
- C 1114 Test Method for Steady-State Thermal Transmission Properties by Means of the Thin-Heater Apparatus
- C 1304 Test Method for Assessing the Odor Emission of Thermal Insulation Materials
- C 1427 Specification for Extruded Preformed Flexible Cellular Polyolefin Thermal Insulation in Sheet and Tubular Form
- D 883 Terminology Relating to Plastics
- D 1622 Test Method for Apparent Density of Rigid Cellular Plastics
- D 1667 Specification for Flexible Cellular Materials-Vinyl Chloride Polymers and Copolymers (Closed-Cell Foam)
- E 84 Test Method for Surface Burning Characteristics of Building Materials
- E 96 Test Methods for Water Vapor Transmission of Materials

<sup>1</sup> This specification is under the jurisdiction of ASTM Committee C16 on Thermal Insulation and is the direct responsibility of Subcommittee C16.22 on Organic and Nonhomogeneous Inorganic Thermal Insulations.

Current edition approved June 1, 2005. Published July 2005. Originally approved in 1964. Last previous edition approved in 2003 as C 534 - 03.

<sup>2</sup> 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.

- E 177** Practice for Use of the Terms Precision and Bias in ASTM Test Methods
- E 456** Terminology for Relating to Quality and Statistics
- E 691** Practice for Conducting an Interlaboratory Study to Determine the Precision of a Test Method
- E 2231** Practice for Specimen Preparation and Mounting of Pipe and Duct Insulation Materials to Assess Surface Burning Characteristics

### 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 is permitted to 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.

3.2.2 *flexible cellular*—a flexible cellular organic polymeric material shall not rupture within 60 s when a specimen 200 by 25 by 25 mm (8 by 1 by 1 in.) is bent around a 25-mm (1-in.) diameter mandrel at a uniform rate of one lap in 5 s in the form of a helix at a temperature between 18 and 29°C (65 and 85°F).

NOTE 1—The flexibility of these materials may decrease at lower temperatures.

### 4. Classification

4.1 The types are designated below:

4.1.1 *Type I*—Tubular.

- Grade 1 Use temperature -183 to 104°C (-297 to 220°F).
- Grade 2 Use temperature -183 to 175°C (-297 to 350°F).
- Grade 3 Use temperature -183 to 120°C (-297 to 250°F).

4.1.2 *Type II*—Sheet.

- Grade 1 Use temperature -183 to 104°C (-297 to 220°F).
- Grade 2 Use temperature -183 to 175°C (-297 to 350°F).
- Grade 3 Use temperature -183 to 104°C (-297 to 220°F).

4.2 Grade 1 is flexible elastomeric material for use on typical commercial systems.

4.3 Grade 2 is a high temperature flexible elastomeric material.

4.4 Grade 3 is an elastomeric material that does not contain any leachable chlorides, fluorides or polyvinyl chloride.

NOTE 2—Continuous long-term exposure at or above the upper use temperature may cause degradation in the form of loss of flexibility

### 5. Materials

5.1 These products shall be made of a homogeneous blend of natural or synthetic rubber that is permitted to be modified with various thermoplastic or thermosetting resins, plasticizers, modifiers, antioxidants, curatives, blowing agents and other additives. These products are thermoset and are 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 are permitted to 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 Practice **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 listed in **Table 1** is defined as an inspection requirement (refer to Practice **C 390**, Section 5, Classification of Requirements, and Section 7, Acceptance for Inspection Requirements).

6.2.2 All dimensional requirements shall be as described in Section 6 and **Table 2**.

**TABLE 1 Physical Requirements for Type I (Tubular) and Type II (Sheet)<sup>A</sup>**

Property	Unit	Grade 1	Grade 2 (higher temperature)	Grade 3 (non-chloride/non-fluoride containing)
Apparent thermal conductivity, max., at a mean temperature of:	W/m-K (Btu-in./h-ft <sup>2</sup> -°F)			
-150°C (-238°F)		0.023 (0.16)	0.023 (0.16)	0.023 (0.16)
-100°C (-148°F)		0.028 (0.18)	0.028 (0.18)	0.028 (0.18)
-29°C (-20°F)		0.036 (0.25)	0.036 (0.25)	0.036 (0.25)
-18°C (0°F)		0.038 (0.26)	0.038 (0.26)	0.038 (0.26)
24°C (75°F)		0.040 (0.28)	0.043 (0.30)	0.040 (0.28)
50°C (120°F)		0.043 (0.30)	0.047 (0.32)	0.043 (0.30)
86°C (150°F)		0.045 (0.31)	0.049 (0.34)	0.045 (0.31)
150°C (300°F)		NA	0.061 (0.42)	NA
Water absorption, max.	% by volume	0.20	0.20	0.20
Water-vapor permeability, max.	g/Pa-s-m (perm-in.)	1.44 × 10 <sup>-10</sup> (0.10)	1.44 × 10 <sup>-10</sup> (0.10)	1.44 × 10 <sup>-10</sup> (0.10)
Linear shrinkage, max after soak at maximum use temperature	% linear change	7.0 %	7.0 %	7.0 %

<sup>A</sup> **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, mm (in.)**

	Tolerances
<b>Type I—Tubular Material</b>	
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 (1 1/2), 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)
<b>Type II—Sheet Material</b>	
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%

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

6.2.4 Compliance with inspection requirements shall be in accordance with Practice 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 shall be tested for the thickness supplied in accordance with Test Method E 84 with mounting according to Practice E 2231 and the results shall be reported.

NOTE 3—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 4—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.

6.6 *Leachable Chloride/Fluoride Content*—Grade 3 shall be below the detectable limit of the test procedure used for leachable chlorides or fluorides when tested according to Test Method C 871.

## 7. Standard Shapes, Sizes and Dimensions

7.1 *Type I*—Tubular materials are manufactured in 1.52- or 1.83-m (60- or 72-in.) standard lengths, as well as in continuous lengths. Insulation is manufactured 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 manufactured in thicknesses up to 50 mm (2 in.). Sheets are manufactured 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 is 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 manufactured either with skin on one side or with skin on two sides. The surface shall 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 Practice 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 and 11.1.2).

## 11. Test Methods

### 11.1 Test Conditions:

11.1.1 The physical requirements enumerated in this specification shall be determined in accordance with the following test methods:

11.1.2 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.

11.1.3 These products are produced with either skin on one side or skin on both sides. Testing shall be done in the final end use form.

### 11.2 Apparent Thermal Conductivity:

11.2.1 *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 5—Test Method C 335 may be used for below ambient conditions. The authors of this reference state, “the regression curves for sheet and pipe insulation agree with 1.5% and 2.5% at mean temperatures of 25° and 10°C, respectively. The measured apparent thermal conductivities of both types of materials are well below the maxima allowed by C 534.”<sup>3</sup>

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

<sup>3</sup> Wiles, K.E., Desjarlais, A.O., Stovall, T.K., McElroy, D.L., Childes, K.W., and Miller, W.A., A Pipe Insulation Test Apparatus for Use Below Room Temperature, *Insulation Materials: Testing and Applications, 4th Volume, ASTM STP 1426*, A.O. Desjarlais and R.R. Zarr, Eds. ASTM International, West Conshohocken, PA, 2002.