Designation: C 534 – 03

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

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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 -57 to 104°C (-70 to 220°F), Grade 2 covers material used on industrial systems with operating temperatures from -40 to 175°C (-40 to 350°F), and Grade 3 covers material used on industrial systems with operating temperatures from -40 to 120°C (-40 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:*

C 168 Terminology Relating to Thermal Insulation[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 Insulating Board[2]

C 356 Test Method for Linear Shrinkage of Preformed High-Temperature Insulation Subjected to Soaking Heat[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 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 (NPS System)[2]

C 692 Test Method for Evaluating the Influence of Thermal Insulations on External Stress Corrosion Cracking Tendency of Austenitic Stainless 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 Transmission Properties Under Steady-State Conditions[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 Emission 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 is permitted to be modified by organic or inorganic additives. These foams have properties similar to those of vulcanized

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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.

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 -57 to 104°C (-70 to 220°F).
Grade 2 Use temperature -40 to 175°C (-40 to 350°F).
Grade 3 Use temperature -40 to 120°C (-40 to 250°F).

4.1.2 *Type II*—Sheet.

Grade 1 Use temperature -57 to 104°C (-70 to 220°F).
Grade 2 Use temperature -40 to 175°C (-40 to 350°F).
Grade 3 Use temperature -40 to 105°C (-40 to 220°F).

4.2 Grade I 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 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 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.

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 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 shall be tested for the thickness supplied in accordance with Test Method E 84 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

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

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·ft²·°F)			
-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^{-10}(0.10)	1.44×10^{-10}(0.10)	1.44×10^{-10}(0.10)
Linear shrinkage, max after soak at maximum use temperature	% linear change	5.0 %	7.0 %	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, mm (in.)

	Tolerances
Type I—Tubular Material	
Inside diameter, mm (in.):	
Up to 10 (⅜), incl.	+2.5 (3⁄32), -0
13 (½) to 22 (⅞), incl.	+3 (⅛), -0
25 (1) to 38 (1½), incl.	+5 (3⁄16), -0
41 (1-⅝) to 60 (2-⅜), incl.	+6 (¼), -0
Over 60 (2-⅜)	+10 (⅜), -0
Wall thicknesses, mm (in.):	
Up to 19 (¾), incl.	+3 (⅛), -0
19 and over (¾)	+5 (3⁄16), -0
Length, mm (in.)	+75 (3), -25 (1)
Type II—Sheet Material	
Thickness, mm (in.):	
Up to 13 (½), incl.	± 2 (± 1⁄16)
Over 13 (½)	± 3 (± 3⁄32)
Length and width, mm (in.):	
Up to 150 (6), incl.	± 6 (± ¼)
Over 150 (6) to 300 (12), incl.	± 10 (± ⅜)
Over 300 (12)	± 3%

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 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 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 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 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 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.

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

11.2.3 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.

11.2.4 The mean apparent thermal conductivity for four samples of the material tested shall not be greater than the value stated in Table 1. The apparent thermal conductivity of an individual specimen shall not greater than 105% of the value stated in Table 1.

11.3 *Water Vapor Permeability*:

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

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

11.3.3 The preferred specimen thickness shall be 13 mm (½ in.) with skin on at least one side,

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

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

11.4 *Linear Shrinkage*:

11.4.1 *Type I and Type II*—Use Test Method C 356. Use provisions for Linear shrinkage-length only with a specimen size of 300 × 75mm (12 × 3in.)

11.4.2 Test at the upper temperature limit of the Grade being evaluated ± 1 %. See 4.1.1 and 4.1.2 for the upper temperature limits.

11.4.3 *Apparatus*:

11.4.3.1 *Oven*—An air-circulating oven equipped with a temperature control to maintain a temperature of 175°C ± 1.7°C (350 ± 3°F) during the test and having an expanded metal shelf.

11.4.3.2 *Steel Rule*—Graduated in mm (in.) capable of measuring to increments of 1.0 mm (0.05-in.).

11.4.4 *Test Specimens*:

11.4.4.1 *Type I*—Three 300-mm (12-in.) long specimens from each of the test samples.

11.4.4.2 *Type II*—Three specimens 300 by 75 mm (12 by 3-in.) cut from each of the test samples.

11.4.5 *Procedure*:

11.4.5.1 At each of two points 250 ± 25 mm (10 ± 1 in.) apart on the centerline of each specimen, place a benchmark.

11.4.5.2 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.).

11.4.5.3 Place the specimens on an expanded metal shelf in an oven operating at the upper temperature limit of the Grade being evaluated ± 1.7°C (± 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. See Section 4.1 and 4.2 for the upper temperature limits.

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

11.4.7 *Precision and Bias*—The precision of this dimensional stability test method is not known because interlaboratory data are not available. This test method shall not be used 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.

11.5 *Water Absorption*:

11.5.1 *Type I and Type II*—Test Methods C 209. Submersion time shall be 2 h.

11.5.2 The specimens shall have a skin on at least one surface.

11.6 *Maximum Use Temperature*:

11.6.1 When tested in accordance with 11.6.2, the insulation shall not soften, collapse, melt or drip during hot surface exposure. No cracking, delamination, or warping, shall be evident upon post-test inspection.

11.6.2 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.

11.7 *Leachable Chloride / Fluoride Content*:

11.7.1 *Type I and Type II*—Test Method C 871.

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 is subject to 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; elastomeric; flexibility; linear shrinkage; preformed thermal insulation; sheet material; 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]

X1.5 *Flexibility*—Flexibility at the time and temperature of installation is a key parameter for these materials. Flexibility at temperatures outside of normal installation temperatures change for a variety of reasons

X1.5.1 Flexibility at lower temperatures may decrease but is reversible as the temperature increases. Continuous long-term exposure at or above the upper use temperature may cause non-reversible loss of flexibility due to continued crosslinking of these materials.

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