



Standard Specification for Extruded Preformed Flexible Cellular Polyolefin Thermal Insulation in Sheet and Tubular Form¹

This standard is issued under the fixed designation C 1427; 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 two grades of extruded preformed flexible cellular polyolefin thermal insulation. Grade 1 is for operating temperatures from -150°F to 200°F (-101°C to 93°C). Grade 2 is for operating temperatures from -297°F to 250°F (-182°C to 121°C). For specific applications, the actual temperature limit shall be agreed upon between the manufacturer and the purchaser.

1.2 The use of thermal insulation materials covered by this specification are governed by codes and standards that address fire performance. Contact manufacturer for specific performance of product at the intended use thickness.

1.3 This specification covers the physical properties of preformed flexible cellular polyolefin thermal insulation, which have been deemed mandatory for thermal design. Physical properties such as density and coefficient of thermal expansion (CTE) have been deemed nonmandatory for thermal design. Nonmandatory physical properties have been included in **Appendix X1** for information purposes only.

1.4 The values stated in inch-pound units are to be regarded as the standard. The metric unit equivalents of inch-pound units, given in parentheses, are approximate.

1.5 The following safety hazards caveat pertains only to the test methods portion, Section 11, of this specification. *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

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 335 Test Method for Steady-State Heat Transfer Properties of Pipe Insulation

C 390 Practice for Sampling and Acceptance of Thermal Insulation Lots

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 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 1303 Test Method for Predicting Long-Term Thermal Resistance of Closed-Cell Foam Insulation

C 1304 Test Method for Assessing the Odor Emission of Thermal Insulation Materials

D 883 Terminology Relating to Plastics

D 1622 Test Method for Apparent Density of Rigid Cellular Plastics

D 1667 Specification for Flexible Cellular Materials—Poly (Vinyl Chloride) Foam (Closed-Cell)

D 3575 Test Methods for Flexible Cellular Materials Made From Olefin Polymers

E 84 Test Method for Surface Burning Characteristics of Building Materials

E 96/E 96M Test Methods for Water Vapor Transmission of Materials

E 177 Practice for Use of the Terms Precision and Bias in ASTM Test Methods

¹ 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 Nov. 15, 2007. Published December 2007. Originally approved in 1999. Last previous edition approved in 2004 as C 1427 - 04.

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.

E 228 Test Method for Linear Thermal Expansion of Solid Materials With a Push-Rod Dilatometer

E 456 Terminology Relating to Quality and Statistics

E 670 Test Method for Side Force Friction on Paved Surfaces Using the Mu-Meter

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

2.2 Other Standards:

CAN/ULC-S102.2-03 Standard Method of Test for Surface Burning Characteristics of Flooring, Floor Coverings and Miscellaneous Materials and Assemblies.

3. Terminology

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

3.2 Definitions of Terms Specific to This Standard:

3.2.1 *polyolefin*—polymers made by the polymerization of olefins, such as ethylene or propylene or copolymerization of olefins with other monomers.

3.2.2 *cellular polyolefin*—a cellular plastic composed primarily of olefin material, processed to form a flexible foam with a closed cell construction.

3.2.2.1 *Discussion*—These materials are considered foam plastics.

3.2.3 *natural skin*—continuous polymer surface or skin naturally occurring as a result of the extrusion or production process, also referred to as “integral skin.”

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

4. Classification

4.1 The preformed flexible cellular polyolefin thermal insulation shall be of the following types:

4.1.1 *Type I*—tubular.

4.1.2 *Type II*—sheet.

4.2 The preformed flexible cellular polyolefin thermal insulation shall be of the following grades:

4.2.1 *Grade 1 (non-crosslinked)*—Use temperature –150°F to 200°F (–101°C to 93°C).

4.2.2 *Grade 2 (crosslinked)*—Use temperature –297°F to 250°F (–182°C to 121°C).

5. Material

5.1 These products shall be extruded flexible cellular polyolefin materials.

5.2 These products are expanded with hydrochlorofluorocarbon gases, hydrofluorocarbon gases, hydrocarbon gases, chemical blowing agents, atmospheric gases, or combinations thereof. These gases will diffuse from the insulation with time after production.

5.3 Extruded flexible cellular polyolefin materials shall be of uniform density. Even though these materials will 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:

6.1.1 Thermal conductivity, water vapor permeability, and linear shrinkage, physical properties listed in **Table 1** are defined as qualification requirements (refer to Practice **C 390**, Section 5).

6.2 Inspection Requirements:

6.2.1 The requirements for water absorption listed in **Table 1** is defined as inspection requirements (refer to Practice **C 390**, Sections 5 Classification of Requirements and Section 7, Acceptance for Inspection Requirements.)

6.2.2 All dimensional requirements shall be as described in Section 7 and **Table 2**.

6.2.3 All workmanship, finish and appearance requirements shall be as described in Section 8.

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

6.2.5 Both Grade 1 and Grade 2 of Type I and Type II insulations shall conform to the respective physical property requirements listed in **Table 1**.

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

6.4 Surface Burning Characteristics:

6.4.1 Surface burning characteristics shall be tested for the thickness supplied in accordance with Test Method **E 84**. For applications in Canada test to **CAN/ULC-S102.2-03**. The results shall be reported. See Section 1 of Test Method **E 84** for

TABLE 1 Physical Property Requirements (Type I—Tubular and Type II—Sheet)

NOTE 1—The values stated in **Table 1** are not always appropriate as design values. For specific design recommendations using a particular product and for supporting documentation, consult the manufacturer.

Property	Unit	Grade 1 Requirement	Grade 2 Requirement
Use temperature, max	°F (°C)	200 (93)	250 (121)
Use temperature, min	°F (°C)	–150 (–101)	–297 (–182)
Thermal conductivity, max.			
At a mean temperature of:			
–250°F (–157°C)			0.25 (0.036)
–120°F (–84°C)	Btu-in./hr-ft ² -°F	0.29 (0.042)	0.29 (0.042)
0°F (–18°C)	(W/m K)	0.33 (0.048)	0.33 (0.048)
75°F (24°C)		0.35 (0.050)	0.35 (0.050)
120°F (49°C)		0.37 (0.053)	0.37 (0.053)
150°F (66°C)			0.38 (0.055)
200°F (93°C)			0.40 (0.058)
Water-vapor permeability, max.	perm-in (g/Pa s m)	0.05 (7.29 × 10 ^{–9})	0.05 (7.29 × 10 ^{–9})
Water absorption, max.,	% by volume	0.2	0.2
linear shrinkage, at maximum use temperature.	% linear change	7.0	7.0

TABLE 2 Dimensional Tolerances, in. (mm)

<i>Type I</i>		
Inside diameter:		
Up to 5/8 (16) incl.	+1/8 (+ 3)	-0 (-0)
3/4 (19) to 1-1/2 (38) incl.	+3/16 (+ 5)	-0 (-0)
1-5/8 (41) to 2-3/8 (60) incl.	+1/4 (+ 6)	-0 (-0)
Over 2-3/8 (60)	+3/8 (+ 10)	-0 (-0)
Wall thicknesses:		
Up to 3/4 (19)	+1/8 (+ 3)	-0 (-0)
3/4 and over (19)	+3/16 (+ 5)	-0 (-0)
Length:	+3 (+ 75)	-1 (-25)
<i>Type II</i>		
Thickness:		
Up to 1/2 (13) incl.	± 1/16 (2)	
Over 1/2 (13)	± 3/32 (3)	
Length and width:	± 3 %	

information regarding the applicability of this test method for use with cellular plastics and Practice E 2231 for specimen mounting methods. This test does not always define the hazard that may be presented by preformed flexible cellular polyolefin thermal insulation under actual fire conditions. It is retained for reference in this specification as laboratory test data required by some building codes.

6.4.2 Preformed flexible cellular polyolefin thermal insulation is an organic material and is combustible. Do not expose it to flames or other ignition sources. The fire performance of the material shall be addressed through fire test requirements established by the appropriate governing documents.

6.4.3 It is possible the surface burning characteristics of the materials are different in the vertical orientation from those in the horizontal orientation.

7. Standard Shapes, Sizes and Dimensions

7.1 *Type I*—Tubular materials are manufactured in 36, 60 or 72-in. (0.91, 1.52 or 1.83-m) standard lengths, as well as, continuous lengths. Tubular insulation is manufactured for pipe sizes up to 4-in. (100-mm) nominal pipe size (NPS) with wall thickness up to 1-in. (25.4-mm).

7.2 *Type II*—Sheet and roll material are manufactured in thickness up to 1 in. (25 mm). Sheet insulation is manufactured in the following sizes: 36 by 48 in. (0.91 by 1.22 m) and 48-in. (1.22-m) wide continuous lengths.

7.3 Actual dimensions and tolerances shall be agreed upon between the manufacturer and the purchaser. The Procedure Section and Pipe and Tubing Diameter Section of Practice C 585 is beneficial in some cases in determining the actual dimensions required.

7.4 The insulation dimensions shall conform to Table 2 unless otherwise agreed upon between the supplier and the purchaser.

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 without skins, 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 performance.

10. Sampling

10.1 The insulation shall be sampled in accordance with Practice C 390. Details shall be agreed upon between the purchaser and the supplier.

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 specimen sheets shall be prepared from material having equivalent physical characteristics to Type I (see 11.1.1).

11. Test Methods

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

11.1.1 When standard test specimen sheets are required for tubular material, they shall be prepared from tubular specimen having a minimum inner diameter of 3 in. by longitudinally slitting the tubular specimens along one wall thickness, opening and laying the specimen flat.

11.1.2 These products are manufactured with either skin on one side or skin on both sides. Testing shall be done in the as sold form.

11.2 *Apparent Thermal Conductivity:*

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

11.2.1.1 Test Method C 1114 shall not be used at temperatures or resistance ranges other than those with comparable results to Test Method C 177. In case of dispute, Test Method C 177 is recognized as the final authority.

NOTE 1—Test Method C 335 may be used to determine the apparent thermal conductivity values for Type 1 tubular material operating at or above ambient temperature. Normally, Test Method C 335 is not used to determine the apparent thermal conductivity values for Type 1 tubular material operating at or below ambient temperature.

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

11.2.2.1 Test Method C 1114 shall not be used at temperatures or resistance ranges other than those with comparable results to Test Method C 177. In case of dispute, Test Method C 177 is recognized as the final authority.

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

11.2.4 All materials shall be aged a minimum of 180 days at 73 ± 4°F (23 ± 2°C) and at relative humidity of 50 ± 5 % in

atmospheric air before measuring the thermal conductivity. Test Method C 1303 shall be used in estimating the long-term change in the thermal resistance of unfaced closed cell plastic foams by slicing and scaling under controlled laboratory conditions, providing the material meets the requirements for homogeneity as defined in Test Method C 1303.

11.3 Water Vapor Permeability:

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

11.3.2 Use Test Method E 96, Method A, desiccant method with the environmental conditions set at $50 \pm 2\%$ relative humidity, $73 \pm 2^\circ\text{F}$ ($23 \pm 1^\circ\text{C}$).

11.3.3 The preferred specimen thickness shall be $\frac{1}{2}$ in. (13 mm) with skin on at least one side.

11.3.4 If the material has a skin on one or both surfaces, test with the skin surface toward the high humidity.

11.4 *Water Absorption: Type I and Type II*—Use in accordance with Test Methods C 209. Submersion time shall be 24 h.

11.5 Linear Shrinkage:

11.5.1 *Scope*—This test method covers the evaluation of linear shrinkage of flexible cellular non-crosslinked polyolefin thermal insulation.

11.5.2 *Significance and Use*—This test method provides a relatively simple and short term evaluation of in-use performance with regard to linear shrinkage. This standard does not address ID or Wall dimensional changes.

11.5.3 Test at the lower temperature limit of -150°F or -297°F (-101°C or -182°C) $\pm 1\%$ and the upper temperature limit of 200°F or 250°F (93°C or 121°C) $\pm 1\%$ of the material as defined in the Scope (Section 1) for Grade 1 and Grade 2, respectively.

11.5.4 Apparatus:

11.5.4.1 *Oven*—An oven equipped with a temperature control to maintain a temperature of $200 \pm 3^\circ\text{F}$ ($93.3 \pm 1.7^\circ\text{C}$) or $250 \pm 3^\circ\text{F}$ ($121 \pm 1.7^\circ\text{C}$) during the test.

11.5.4.2 *Freezer*—A freezer equipped with a temperature control to maintain a temperature of $-297 \pm 3^\circ\text{F}$ ($-182 \pm 1.7^\circ\text{C}$) or $-150 \pm 3^\circ\text{F}$ ($-101 \pm 1.7^\circ\text{C}$) during the test.

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

11.5.5 Test Specimens:

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

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

11.5.6 Procedure:

11.5.6.1 At each of two points approximately 10-in. (250-mm) apart on the centerline of each specimen, place a benchmark.

11.5.6.2 Condition the specimen 24 h at a temperature of $73.4 \pm 3.6^\circ\text{F}$ ($23 \pm 2^\circ\text{C}$) and measure the distance between the benchmarks to the nearest 0.05 in. (1.0 mm).

11.5.6.3 Place the specimens in an oven or freezer operating at the specified temperature of $200 \pm 3^\circ\text{F}$ ($93 \pm 2^\circ\text{C}$), $250 \pm 3^\circ\text{F}$ ($121 \pm 2^\circ\text{C}$), $-297 \pm 3^\circ\text{F}$ ($-182 \pm 2^\circ\text{C}$) or $-150 \pm 3^\circ\text{F}$ ($-101 \pm 2^\circ\text{C}$). After 7 days remove the specimens from the

oven, or freezer, condition for at least 2 h at $73.4 \pm 3.6^\circ\text{F}$ ($23 \pm 2^\circ\text{C}$) and remeasure.

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

11.6 Precision and Bias :

11.6.1 The precision and bias statements for all test methods listed in this specification with the exception of linear shrinkage are found in the referenced standards.

11.6.2 Precision and Bias Statement for Linear Shrinkage:

11.6.2.1 Definitions and Additional Information:

11.6.2.2 For precise definitions of statistical terms, refer to Terminology E 456, Relating to Statistics.

11.6.2.3 For more information on calculation methods relating to the use of statistical procedures, refer to Practices E 177, E 670 and E 691.

11.6.2.4 *Statement of Precision:* Precision is the closeness of agreement between test results obtained under prescribed conditions.

11.6.2.5 *Statement of Bias:* Bias is a systematic error that contributes to the difference between the mean of a large number of test results and an accepted reference value.

11.6.2.6 *Statement of Repeatability:* Repeatability is the closeness between test values within the same lab.

11.6.2.7 *Statement of Reproducibility:* Reproducibility is the closeness between test values between different labs.

11.6.2.8 General Considerations:

11.6.2.9 *Summary of Experiments:* Specifications C 534 and C 1427 have identical linear shrinkage tests. This study included the three material types called out in C 534 and the one type called out in C 1427. Samples consisted of 7 different specimens (varying by size and manufacturer) for each of the 4 types called out. The specimens were tested according to their classified grade maximum temperature use. The testing was conducted at 6 laboratories. The results from all samples were used to develop the repeatability and reproducibility values. This was a very broad study considering the range of specimens used. It was felt that the data could be improved by working with the laboratories in their test procedures and data reporting.³

11.6.2.10 *Repeatability Statement:* The repeatability standard deviation has been determined to be 0.41 with a mean value of 4.23%. for all materials tested. This corresponds to a 95% repeatability value of $\pm 26.9\%$

11.6.2.11 *Reproducibility Statement:* The reproducibility standard deviation has been determined to be 0.79 with a mean value of 4.23% for all materials tested. This corresponds to a 95% reproducibility value of $\pm 52.2\%$.

11.7 Maximum Use Temperature:

11.7.1 When tested in accordance with 11.7.2, the insulation shall not collapse, melt or drip during hot surface exposure. No softening, collapsing, melting, or dripping shall be evident upon post-test inspection.

11.7.2 Type I and Type II shall be tested in accordance with Test Method C 411 and the hot surface performance of Practice

³ Supporting data have been filed at ASTM International Headquarters and may be obtained by requesting Research Report RR: C16-1029.

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 will be rejected. Rejection shall be reported to the manufacturer or supplier promptly and in writing.

14. Packaging and Marking

14.1 Unless otherwise agreed upon 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, type, size, thickness, and quantity of the material in the container.

15. Keywords

15.1 flexible thermal insulation; polyethylene foam; polyolefin foam; polyolefin thermal insulation; preformed thermal insulation; thermal insulating materials - pipe; thermal insulating materials - sheet

APPENDIX

(Nonmandatory Information)

X1. SUPPLEMENTARY INFORMATION

X1.1 Water Absorption/Water Vapor Infiltration—Due to the closed-cell structure of these materials, they do not absorb significant amounts of liquid water. However, they may accumulate liquid water internally by the process of diffusion and condensation of water vapor due to 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 permeability during the material selection process as this will have an impact on the long-term performance of the insulation system.

X1.2 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 are less than 2.5 lb/ft³ (40 kg/m³) when measured in accordance with Test Method **D 1622**, Specification **D 1667** or Test Method **D 3575**.

X1.3 Coefficient of Thermal Expansion (CTE)—Test Method **E 228**. The coefficient of thermal expansion may be

helpful during the design stage of jobs in the upper and lower operating temperature extremes. These values may vary with density and composition and should be obtained from the manufacturer. The following are approximate values:

Operating Temperature, °F (°C)	Coefficient of Thermal Expansion, mean, × 10 ⁻⁶ in./in./°F (mm/mm/°C)
-150 (-101)	30.9 (55.6)
-100 (-73)	36.4 (65.5)
-50 (-46)	42.0 (75.6)
0 (-18)	45.6 (82.1)
50 (10)	53.6 (96.5)
100 (38)	61.3 (110.3)
150 (66)	73.3 (131.9)
200 (93)	82.8 (149.0)

X1.4 Installation Temperature Limit—This product has an application temperature range of -150 to 200°F (-101 to 93°C) but should be installed at temperatures above 0°F (-18°C) as it will lose flexibility as the temperature drops below this temperature.

ASTM International takes no position respecting the validity of any patent rights asserted in connection with any item mentioned in this standard. Users of this standard are expressly advised that determination of the validity of any such patent rights, and the risk of infringement of such rights, are entirely their own responsibility.

This standard is subject to revision at any time by the responsible technical committee and must be reviewed every five years and if not revised, either reapproved or withdrawn. Your comments are invited either for revision of this standard or for additional standards and should be addressed to ASTM International Headquarters. Your comments will receive careful consideration at a meeting of the responsible technical committee, which you may attend. If you feel that your comments have not received a fair hearing you should make your views known to the ASTM Committee on Standards, at the address shown below.

This standard is copyrighted by ASTM International, 100 Barr Harbor Drive, PO Box C700, West Conshohocken, PA 19428-2959, United States. Individual reprints (single or multiple copies) of this standard may be obtained by contacting ASTM at the above address or at 610-832-9585 (phone), 610-832-9555 (fax), or service@astm.org (e-mail); or through the ASTM website (www.astm.org).