Designation: C1427 – 21

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

This standard is issued under the fixed designation C1427; 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 extruded preformed flexible cellular polyolefin thermal insulation operating temperatures from –150°F to 200°F (–101°C to 93°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 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 *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, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.6 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

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
C335 Test Method for Steady-State Heat Transfer Properties of Pipe Insulation
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
C518 Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus
C534 Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form
C585 Practice for Inner and Outer Diameters of Thermal Insulation for Nominal Sizes of Pipe and Tubing
C670 Practice for Preparing Precision and Bias Statements for Test Methods for Construction Materials
C1045 Practice for Calculating Thermal Transmission Properties Under Steady-State Conditions
C1058 Practice for Selecting Temperatures for Evaluating and Reporting Thermal Properties of Thermal Insulation
C1114 Test Method for Steady-State Thermal Transmission Properties by Means of the Thin-Heater Apparatus
C1303 Test Method for Predicting Long-Term Thermal Resistance of Closed-Cell Foam Insulation
C1304 Test Method for Assessing the Odor Emission of Thermal Insulation Materials
C1763 Test Method for Water Absorption by Immersion of Thermal Insulation Materials
D883 Terminology Relating to Plastics
D1622 Test Method for Apparent Density of Rigid Cellular Plastics

[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.

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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.

D1667 Specification for Flexible Cellular Materials—Poly (Vinyl Chloride) Foam (Closed-Cell)
D3575 Test Methods for Flexible Cellular Materials Made from Olefin Polymers
E84 Test Method for Surface Burning Characteristics of Building Materials
E96/E96M Test Methods for Water Vapor Transmission of Materials
E177 Practice for Use of the Terms Precision and Bias in ASTM Test Methods
E228 Test Method for Linear Thermal Expansion of Solid Materials With a Push-Rod Dilatometer
E456 Terminology Relating to Quality and Statistics
E691 Practice for Conducting an Interlaboratory Study to Determine the Precision of a Test Method
E2231 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 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 C168 and in Terminology D883.

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.

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 C390, 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 C390, 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 C390.

6.2.5 Both 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 Test Method C1304.

6.4 *Surface Burning Characteristics:*

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

TABLE 2 Dimensional Tolerances, in. (mm)

Type 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)
Type II		
Thickness:		
Up to 1/2 (13) incl.	± 1/16 (2)	
Over 1/2 (13)	± 3/32 (3)	
Length and width:	± 3 %	

6.4.1 Surface burning characteristics shall be tested for the thickness supplied in accordance with Test Method E84. For applications in Canada test to CAN/ULC-S102.2. 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. The results shall be reported. See Section 1 of Test Method E84 for information regarding the applicability of this test method for use with cellular plastics and Practice E2231 for specimen mounting methods. This test does not always define the hazard potentially resulting from burning of preformed flexible cellular polyolefin thermal insulation under actual fire conditions. It is retained for reference in this specification as laboratory test data required by applicable codes and regulations.

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 C585 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 C390. 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 C177, C518, C1114 or C335 in conjunction with Practice C1045. Use standard test sheet for Test Methods C177, C518, or C1114.

11.2.1.1 Test Method C1114 shall not be used at temperatures or resistance ranges other than those with comparable results to Test Method C177. In case of dispute, Test Method C177 is recognized as the final authority.

NOTE 1—Test Method C335 may be used to determine the apparent thermal conductivity values for Type 1 tubular material operating at or above ambient temperature. Normally, Test Method C335 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 C177, C518 or C1114 in conjunction with Practice C1045.

11.2.2.1 Test Method C1114 shall not be used at temperatures or resistance ranges other than those with comparable results to Test Method C177. In case of dispute, Test Method C177 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 C1058, 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 C1303 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 C1303.

11.3 *Water Vapor Permeability:*

11.3.1 *Type I and Type II*—Use standard test specimen sheets for Type I. Use Test Method E96/E96M—desiccant method, with the following conditions:

11.3.2 Use Test Method E96/E96M, Method A, desiccant method with the environmental conditions set at 50 ± 2 % relative humidity, 73 ± 2°F (23 ± 1°C).

11.3.3 The preferred specimen thickness shall be ½ 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:*

11.4.1 *Type I*—Test Method C1763, Procedure B: Cylindrical Specimen. Immersion time shall be 24 h. For compliance testing, use ⅞ in. (22 mm) ID by 1 in. (25 mm) wall cylindrical specimen. It is possible that other dimensions will have different performance values. Check with the manufacturer.

11.4.2 *Type II*—Test Method C1763, Procedure B: Flat specimen. Immersion time shall be 24 h. For compliance testing, use 1 in. (25 mm) thickness. It is possible that other dimensions will have different performance values. Check with the manufacturer.

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 (–101°C) ± 1 % and the upper temperature limit of 200°F (93°C) ± 1 % of the material.

11.5.4 *Apparatus:*

11.5.4.1 *Oven*—An oven equipped with a temperature control to maintain a temperature of 200 ± 3°F (93 ± 2°C) during the test.

11.5.4.2 *Freezer*—A freezer equipped with a temperature control to maintain a temperature of –150 ± 3°F (–101 ± 2°C) during the test.

11.5.4.3 *Steel Rule*—Graduated in inches (milimetres) 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 ± 3.6°F (23 ± 2°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 ± 3°F (93 ± 2°C), or –150 ± 3°F (–101 ± 2°C). After 7 days remove the specimens from the oven, or freezer, condition for at least 2 h at 73.4 ± 3.6°F (23 ± 2°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:*

(1) For precise definitions of statistical terms, refer to Terminology E456, Relating to Statistics.

(2) For more information on calculation methods relating to the use of statistical procedures, refer to Practices E177, C670 and E691.

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

11.6.2.3 *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.

11.6.2.4 *Statement of Repeatability*—Repeatability is the closeness between test values within the same lab.

11.6.2.5 *Statement of Reproducibility*—Reproducibility is the closeness between test values between different labs.

11.6.2.6 *General Considerations:*

(1) Summary of Experiments—Specifications C534 and C1427 have identical linear shrinkage tests. This study included the three material types called out in C534 and the one type called out in C1427. 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]

(2) Repeatability Statement—The repeatability standard deviation has been determined to be 0.41 with a mean value of

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