Designation: C 1427 – 99a

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

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 preformed flexible cellular non-crosslinked 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 –40°F to 158°F (–40°C to 70°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 may be governed by building codes that address fire performance.

1.3 This specification covers the physical properties of preformed flexible cellular non-crosslinked 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, may be 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:*

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 Insulating Board[2]

C 335 Test Method for Steady-State Heat Transfer Properties of Horizontal Pipe Insulation[2]

C 390 Criteria for Sampling and Acceptance of Preformed Thermal Insulation Lots[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 (NPS System)[2]

C 1045 Practice for Calculating Thermal Transmission 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 1303 Test Method for Estimating the Long-Term Change in the Thermal Resistance of Unfaced Rigid Closed Cell Plastic Foams by Slicing and Scaling Under Controlled Laboratory Conditions[2]

C 1304 Test Method for Assessing 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]

D 3575 Test Methods for Flexible Cellular Materials Made from Olefin Polymers[4]

E 84 Test Method for Surface Burning Characteristics of Building Materials[5]

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.

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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 08.02.

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

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."

4. Classification

4.1 The preformed flexible cellular non-crosslinked 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 non-crosslinked polyolefin thermal insulation shall be of the following grades:

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

4.2.2 *Grade 2*—Use temperature– 40°F to 158°F (–40°C to 70°C).

5. Material

5.1 These products shall be extruded flexible cellular non-crosslinked polyolefin materials.

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

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

6.1.1 Thermal conductivity, water vapor permeability, and dimensional stability;-physical properties listed in Table 1 are defined as qualification requirements (refer to Criteria C 390, Section 5).

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 Criteria C 390, Sections 5 and 6).

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

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

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

6.2.5 Both Type I and Type II of Grade 1 and Grade 2 insulations shall conform to the 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 are to be tested for the thickness supplied in accordance with Test Method E 84 and the results are to be reported. See Section 1 of Test Method E 84 for information regarding the applicability of this test method for use with cellular plastics.

NOTE 1—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.

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

NOTE 1—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.

Property	Unit	Grade 1	Grade 2
Use temperature, max	°F (°C)	200 (93)	158 (70)
Use temperature, min	°F (°C)	–150 (–101)	–40 (–40)
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)	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)
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
Flexibility (mandrel bend)			
At –120°F (–84°C)		Shall not crack	
At 32°F (0°C)		Shall not crack	
At 75°F (24°C)		Shall not crack	Shall not crack
Dimensional stability, max.	% linear change		
at –150°F (–101°C)		5.0	
at 0°F (–18°C)		5.0	5.0
at 158°F (70°C)		5.0	5.0
at 200°F (93°C)		5.0	

TABLE 2 Dimensional Tolerances, in. (mm)

Type I		
Inside diameter:		
Up to ⅝ (16) incl.	+⅛ (+ 3)	–0 (–0)
¾ (19) to 1-½ (38) incl.	+3⁄16 (+ 5)	–0 (–0)
1-⅝ (41) to 2-⅜ (60) incl.	+¼ (+ 6)	–0 (–0)
Over 2-⅜ (60)	+⅜ (+ 10)	–0 (–0)
Wall thicknesses:		
Up to ¾ (19)	+⅛ (+ 3)	–0 (–0)
¾ and over (19)	+3⁄16 (+ 5)	–0 (–0)
Length:	+3 (+ 75)	–1 (–25)
Type II		
Thickness:		
Up to ½ (13) incl.	+ 1⁄16 (+ 2)	– 1⁄16 (– 2)
Over ½ (13)	+ 3⁄32 (+ 3)	– 3⁄32 (– 3)
Length and width:	+ 3 (+ 75)	–3 (– 75)

6.4.2 Preformed flexible cellular polyolefin 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.

6.4.3 The surface burning characteristics in the vertical orientation may be much different from those in the horizontal orientation.

7. Standard Shapes, Sizes and Dimensions

7.1 *Type I*—Tubular materials are available in 36, 60 or 72-in. (0.91, 1.52 or 1.3-m) standard lengths, as well as, continuous lengths. Tubular insulation is available 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 available in thickness up to 1 in. (25 mm). Sheet insulation is available 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 may be beneficial in determining these actual dimensions.

7.4 The insulation 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 available either without skins, with skin on one side or with skin on two sides. The surface 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.

10. Sampling

10.1 The insulation shall be sampled in accordance with Criteria 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 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 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.

11.2 *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 2—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 may be beneficial 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 sheets for Type I. Use Test Method E 96—desiccant method, with the following conditions:

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

11.3.3 The preferred specimen thickness shall be ½ in. (13 mm) 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.

11.3.5 All specimens shall be run a minimum of three weeks (504 hrs.) and possibly longer to ensure that equilibrium conditions are reached.

11.4 *Water Absorption: Type I and Type II*—Use in accordance with Test Methods C 209. Submersion time shall be 2 h.

11.5 *Flexibility*:

11.5.1 *Scope*—This test method provides a test to determine the flexibility of cellular non-crosslinked polyolefin thermal insulation at temperatures that represent the ambient temperature extremes encountered during installation of these types of materials.

11.5.2 *Significance and Use*—The formulation can sometimes create the potential for cracking, rupture or permanent deformation of cellular non-crosslinked polyolefin thermal insulation. This test method is used to determine the flexibility of the insulation material.

11.5.3 *Apparatus—Mandrel*—shall be ½ ± 1⁄64 in. (13 ± 0.4 mm) in diameter and any suitable length.

11.5.4 *Test Specimens*:

11.5.4.1 *Type I*—The size of the specimen shall be a tube with an inside diameter of 1 to 1-½-in. (25.4 to 38 mm), 6-in. (152-mm) long, with a wall thickness of ½ + ⅛-in. – 0-in. (13 + 3.2 mm – 0 mm). Three specimens shall be tested.

11.5.4.2 *Type II*—The size of the specimen shall be 6 by 3 by ½-in. (150 by 75 by 13 mm), all dimensions ± 1⁄16 in. (± 2 mm). Three specimens shall be tested.

11.5.5 *Procedure*:

11.5.5.1 Condition the specimens at the specified temperature, either –120°F (–84°C), 32°F (0°C) or 75°F (24°C) for 4 h prior to testing. After conditioning, the specimens should be immediately tested as specified in 11.5.5.2.

11.5.5.2 Across the 6-in. (150-mm) dimension, bend the specimen rapidly by hand around the ½-in. (13-mm) mandrel into a "U" shape.

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

11.5.7 *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.

11.6 *Dimensional Stability*:

11.6.1 *Scope*—This test method covers the evaluation of dimensional stability of flexible cellular non-crosslinked polyolefin thermal insulation.

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

11.6.3 *Apparatus*:

11.6.3.1 *Oven*—An air-circulating oven equipped with a temperature control to maintain a temperature of 200± 3°F (93.3 ± 1.7°C) or 158 ± 3°F (70 ± 1.7°C) during the test.

11.6.3.2 *Freezer*—An air-circulating freezer equipped with a temperature control to maintain a temperature of 0 ± 3°F (–18 ± 1.7°C) or –150 ± 3°F (–101 ± 1.7°C) during the test.

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

11.6.4 *Test Specimens*:

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

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

11.6.5 *Procedure*:

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

11.6.5.2 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).

11.6.5.3 Place the specimens in an oven or freezer operating at the specified temperature of 200 ± 3°F (93 ± 2°C), 158 ± 3°F (70 ± 2°C), 0 ± 3°F (–18± 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.

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

11.6.7 *Precision*—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.

11.6.8 *Bias*—The procedure in this test method has no bias because the value of dimensional stability is defined in terms of this test method.

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 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 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/ft^3 (40 kg/m^3) when measured in accordance with Test Method D 1622, Specification D 1667 or Test Method D 3575.

X1.3 *Coefficient of Thermal Expansion (CTE)*—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,* $\times 10^{-6}$ 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)