Designation: C1482 – 23

Standard Specification for Polyimide Flexible Cellular Thermal and Sound Absorbing Insulation[1]

This standard is issued under the fixed designation C1482; 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 the composition and physical properties of lightweight, flexible open-cell polyimide foam insulation intended for use as thermal and sound-absorbing insulation for temperatures from –328°F up to +572°F (–200°C and +300°C) in commercial and industrial environments.

1.1.1 Annex A1 includes faced polyimide foam as specified by the U.S. Navy for marine applications.

1.1.2 This standard is designed as a material specification and not a design document. Physical property requirements vary by application and temperature. No single test is adequate for estimating either the minimum or maximum use temperature of polyimide foam under all possible conditions. Consult the manufacturer for specific recommendations and physical properties for specific applications.

1.1.3 The use of an appropriate vapor retarder is required in all applications where condensation could occur and cause a decrease in thermal performance or affect other system properties.

1.2 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.

1.3 This standard is used to measure and describe the response of materials, products, or assemblies to heat and flame under controlled conditions, but does not by itself incorporate all factors required for fire-hazard or fire-risk assessment of the materials, products, or assemblies under actual fire conditions.

NOTE 1—The subject matter of this material specification is not covered by any other ASTM specification. There is no known ISO standard covering the subject of this standard.

1.4 *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.*

1.5 *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]

C165 Test Method for Measuring Compressive Properties of Thermal Insulations

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

C302 Test Method for Density and Dimensions of Preformed Pipe-Covering-Type Thermal Insulation

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

C421 Test Method for Tumbling Friability of Preformed Block-Type and Preformed Pipe-Covering-Type Thermal Insulation

C423 Test Method for Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method

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

C585 Practice for Inner and Outer Diameters of Thermal Insulation for Nominal Sizes of Pipe and Tubing

C634 Terminology Relating to Building and Environmental Acoustics

[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.

C665 Specification for Mineral-Fiber Blanket Thermal Insulation for Light Frame Construction and Manufactured Housing
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
C1304 Test Method for Assessing the Odor Emission of Thermal Insulation Materials
C1338 Test Method for Determining Fungi Resistance of Insulation Materials and Facings
C1559 Test Method for Determining Wicking of Fibrous Glass Blanket Insulation (Aircraft Type)
D395 Test Methods for Rubber Property—Compression Set
D543 Practices for Evaluating the Resistance of Plastics to Chemical Reagents
D638 Test Method for Tensile Properties of Plastics
D2126 Test Method for Response of Rigid Cellular Plastics to Thermal and Humid Aging
D3574 Test Methods for Flexible Cellular Materials—Slab, Bonded, and Molded Urethane Foams
D3675 Test Method for Surface Flammability of Flexible Cellular Materials Using a Radiant Heat Energy Source
E84 Test Method for Surface Burning Characteristics of Building Materials
E96/E96M Test Methods for Gravimetric Determination of Water Vapor Transmission Rate of Materials
E176 Terminology of Fire Standards
E662 Test Method for Specific Optical Density of Smoke Generated by Solid Materials
E795 Practices for Mounting Test Specimens During Sound Absorption Tests
E800 Guide for Measurement of Gases Present or Generated During Fires
E1354 Test Method for Heat and Visible Smoke Release Rates for Materials and Products Using an Oxygen Consumption Calorimeter
E2231 Practice for Specimen Preparation and Mounting of Pipe and Duct Insulation Materials to Assess Surface Burning Characteristics

2.2 *U.S. Federal Standards:*

FAR 25.853(a), Appendix F, Part 1, (a) (1) (i) Test Criteria and Procedures for Showing Compliance with Sec. 25.853, or 25.855[3]
FAR 25.856(a), Appendix F, Part VI, Test Method to Determine the Flammability and Flame Propagation Characteristics of Thermal/Acoustic Insulation Materials
MIL-C-20079 Cloth, Glass; Tape, Textile Glass; and Thread, Glass[4]
MIL-A-3316 Adhesive, Fire-Resistant, Thermal Insulation[4]
DOD-E-24607 Enamel, Interior, Nonflaming (Dry), Chlorinated Alkyd Resin, Semigloss (Metric)[4]

2.3 *Private Sector Standards:*

Boeing BSS 7239 Test Method for Toxic Gas Generation by Materials on Combustion[5]
TAPPI T 803 Puncture and Stiffness Test of Container Board[6]
TM-232 Vertical Pipe-Chase Test to Determine Flame-Propagation Characteristics of Pipe Covering[7]

3. Terminology

3.1 *Definitions*—Terms used in this specification are defined in Terminology C168, Terminology C634, and Terminology E176. In the case of a conflict, Terminology C168 shall be the dominant authority.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *flexible cellular product*—a cellular organic polymeric material that will not rupture 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 at a temperature between 64 and 85°F (18 and 29°C), in accordance with the description of a flexible cellular product (currently Subsection 3.1.3) in Test Methods D3574.

3.2.2 *slab*—a rectangular section, piece, or sheet of foam that is cut from a bun, or block of foam.

3.2.3 *polyimide foam*—a flexible cellular product in which the bonds formed between monomers during polymerization are imide or amide bonds. The theoretical mole fraction of imide bonds must be greater than the theoretical mole fraction of amide bonds.

4. Classification

4.1 The flexible polyimide cellular insulations of this specification are classified into Types I through VII as listed in Tables 1 and 2 (Note 2). Type I is further subdivided into two grades based on maximum allowable thermal conductivity at 75°F (24°C). The Types II and III are subdivided into classes (Note 3).

NOTE 2—Although all types find application in a wide variety of markets, the current primary market for each type is as follows:
Type I—marine and industrial applications.
Type II—Type II is Type I foam faced and used in specific marine applications, as specified for the U.S. Navy in Annex A1.
Type III—Type III is Type I foam pipe shaped and used in specific marine applications, as specified for the U.S. Navy in Annex A1.
Types IV, V, and VII—aerospace applications depending on density.
Type VI—applications requiring improved high temperature and fire performance.

NOTE 3—The Type II and Type III designations as well as the subdivision of Types into Classes is to maintain uniformity with existing U.S. Navy nomenclature (Annex A1).

[3] Federal Aviation Regulations Part 25 (Airworthiness Standards, Transport Category Aircraft, and Section 25.853. Procedure in appendix F, Part I, (a) (1) (i) and (ii). Available from Superintendent of Documents, U.S. Government Printing Office P.O. Box 371954, Pittsburgh, PA 15250-7954.

[4] Available from Standardization Documents Order Desk, DODSSP, Bldg. 4, Section D, 700 Robbins Ave., Philadelphia, PA 19111-5098, http://www.dodssp.daps.mil.

[5] Available from Boeing Commercial Airplane Group, Material Division, P.O. Box 3707, Seattle, WA 98124-2207.

[6] Available from Technical Association of the Pulp and Paper Industry (TAPPI), 15 Technology Parkway South, Norcross, GA 30092, http://www.tappi.org.

[7] Available from Armstrong World Industries, Inc., Research and Development, P.O. Box 3511, Lancaster, PA 17604.

TABLE 1 Polyimide Foam Classification (inch-pound)

	TYPE I Grade 1	TYPE I Grade 2	TYPE IV	TYPE V	TYPE VI	TYPE VII
Density, range, lb/ft^3	0.36–0.53	0.36–0.53	0.28–0.37	0.50–0.58	0.35–0.55	0.42–0.52
Maximum Apparent Thermal Conductivity Btu-in./h ft^2–°F						
–238°F	0.14	0.14	0.14	0.14	0.14	0.14
–58°F	0.23	0.22	0.23	0.23	0.23	0.23
75°F	0.32	0.29	0.34	0.30	0.34	0.34
212°F	0.51	0.47	0.54	0.47	0.50	0.50
356°F	0.74	0.70	0.81	0.70	0.74	0.74
572°F	NA[A]	NA[A]	NA[A]	NA[A]	1.15	NA[A]
Upper Temperature Limit – test temperature for C411, °F	400	400	400	400	572	400
High Temperature Stability – % of initial tensile strength retained after 336 h in air oven at 400° F, min, %	60	60	NA[A]	NA[A]	NA[A]	NA[A]
High Temperature Stability – % of initial tensile strength retained after 336 h in air oven at 572° F, min, %	NA[A]	NA[A]	NA[A]	NA[A]	70	NA[A]
Compressive Strength, min, lb/in.^{2} at 25% deflection	0.5	0.5	NA[A]	NA[A]	0.5	NA[A]
50% Compression Deflection, min, lb/in^2	1.2	1.2	NA[A]	NA[A]	NA[A]	NA[A]
Compression Set, max, %	NA[A]	NA[A]	45	40	NA[A]	40
Steam Aging						
Change in Tensile Strength, max, %	25	25	NA[A]	NA[A]	25	NA[A]
Dimensional and weight changes, max, %	10	10	NA[A]	NA[A]	10	NA[A]
Corrosiveness	pass	pass	pass	pass	pass	pass
Chemical Resistance	pass	pass	pass	pass	pass	pass
Surface Burning Characteristics, 2 in. thickness						
Flame Spread Index, max	10	10	15	15	10	15
Smoke Developed Index, max	15	15	20	20	15	20
Radiant Panel Surface Flammability, Radiant Panel Index, max	5	5	5	5	2	NA[A]
Vertical Burn[B]						
Burn Length, max, in.	NA[A]	NA[A]	2	2.4	NA[A]	2.4
After Flame Time, max, s	NA[A]	NA[A]	1	1	NA[A]	1
Total heat release (2 min), max, Btu/ft^2	79	79	NA[A]	NA[A]	NA[A]	NA[A]
Flammability and Flame Propagation						
After Flame Time, max., s	NA[A]	NA[A]	3.0	3.0	NA[A]	3.0
Flame Propagation, max., in.	NA[A]	NA[A]	2.0	2.0	NA[A]	2.0
Maximum heat release rate, max, Btu/min-ft^2	106	106	NA[A]	NA[A]	NA[A]	NA[A]
Specific Optical Smoke Density, D_m, max						
non-flaming mode	5	5	5	5	5	5
flaming mode	10	10	10	10	5	10
Total Hydrogen Halide (HCl, HBr, and HF) Gases in Smoke, Flaming Exposure, max, ppm (Above background for empty chamber)	10	10	NA[A]	NA[A]	10	NA[A]
Toxic Gas Generation: max, ppm						
CO	300	300	300	300	300	300
HCN	5	5	5	5	5	5
HF	5	5	5	5	5	5
HCl	10	10	10	10	10	10
HBr	5	5	5	5	5	5
SO2	5	5	5	5	5	5
NOx	10	10	10	10	10	10
Acoustical Absorption Coefficient 2 in. thickness, min Noise Reduction Coefficient (NRC)	0.75	0.70	0.75	0.85	0.70	0.85
Tumbling Friability						
600 Revolutions, mass loss, Max %	3.0	3.0	3.0	3.0	3.0	3.0
1200 Revolutions, mass loss Max, %	5.0	5.0	5.0	5.0	5.0	5.0
Odor Emission	Pass	Pass	Pass	Pass	Pass	Pass
Fungi Resistance	Pass	Pass	Pass	Pass	Pass	Pass
Wicking, 48h, distance above water line, max at 72°F, in.	0.5	0.5	0.5	0.5	0.5	0.5

[A] NA = not applicable
[B] The material shall not melt, drip, or flow when tested as required.

5. Materials and Manufacture

5.1 Polyimide foam shall be manufactured from the appropriate monomers, and necessary compounding ingredients to conform to 3.2.3. This is not intended to imply that foam products made using different materials are equivalent with respect to all physical properties.

6. Physical Properties

6.1 The insulation shall conform to the requirements in Tables 1 and 2 for each type, unless specifically stated otherwise by agreement between the supplier and the purchaser. Tests shall be made in accordance with the methods specified in 11.1 – 11.20.