Designation: C552 – 22

Standard Specification for Cellular Glass Thermal Insulation[1]

This standard is issued under the fixed designation C552; 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.

This standard has been approved for use by agencies of the U.S. Department of Defense.

1. Scope

1.1 This specification covers the composition, sizes, dimensions, and physical properties of cellular glass thermal insulation intended for use on commercial or industrial systems with operating temperatures between −450 and 800°F (−268 and 427°C). It is possible that special fabrication or techniques for pipe insulation, or both, will be required for application in the temperature range from 250 to 800°F (121 to 427°C). Contact the manufacturer for recommendations regarding fabrication and application procedures for use in this temperature range. For specific applications, the actual temperature limits shall be agreed upon between the manufacturer and the purchaser.

1.2 This specification does not cover cellular glass insulation used for building envelope applications. For cellular glass insulation used in building applications refer to Specification C1902.

1.3 Cellular glass insulation has the potential to exhibit stress cracks if the rate of temperature change exceeds 200°F (112°C) per hour.

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]

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

C203 Test Methods for Breaking Load and Flexural Properties of Block-Type Thermal Insulation

C240 Test Methods for Testing Cellular Glass Insulation Block

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

C303 Test Method for Dimensions and Density of Preformed Block and Board–Type Thermal Insulation

C335/C335M 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

C450 Practice for Fabrication of Thermal Insulating Fitting Covers for NPS Piping, and Vessel Lagging

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

C692 Test Method for Evaluating the Influence of Thermal Insulations on External Stress Corrosion Cracking Tendency of Austenitic Stainless Steel

C795 Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel

C871 Test Methods for Chemical Analysis of Thermal Insulation Materials for Leachable Chloride, Fluoride, Silicate, and Sodium Ions

C1045 Practice for Calculating Thermal Transmission Properties Under Steady-State Conditions

[1] This specification is under the jurisdiction of ASTM Committee C16 on Thermal Insulation and is the direct responsibility of Subcommittee C16.20 on Homogeneous 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.

C1058/C1058M 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
C1617 Practice for Quantitative Accelerated Laboratory Evaluation of Extraction Solutions Containing Ions Leached from Thermal Insulation on Aqueous Corrosion of Metals
C1639 Specification for Fabrication Of Cellular Glass Pipe And Tubing Insulation
C1902 Specification for Cellular Glass Insulation Used in Building and Roof Applications
E84 Test Method for Surface Burning Characteristics of Building Materials
E96/E96M Test Methods for Gravimetric Determination of Water Vapor Transmission Rate of Materials

2.2 *ISO Documents:*[3]

ISO 3951 Sampling Procedure and Charts for Inspection by Variables for Percent Defective
ISO 8497 Determination of steady-state thermal transmission properties of thermal insulation for circular pipes

3. Terminology

3.1 For definitions used in this specification, see Terminology C168.

4. Classification[4]

4.1 Cellular glass insulation covered by this specification shall be classified in the seven grades shown in Table 1. Grades vary in compressive strength, density, thermal conductivity, and flexural strength. Cellular glass insulation is furnished in the following types:

4.1.1 *Type I*—Flat block manufactured,

4.1.2 *Type II*—Pipe and tubing insulation fabricated from Type I, and

4.1.3 *Type III*—Special shapes fabricated from Type I.

NOTE 1—Types not listed here may not be commercially available. These would be considered special order items.

5. Ordering Information

5.1 Purchase orders for cellular glass insulation furnished to this specification shall include the following information:

5.1.1 Type designation (see 4.1),

5.1.2 Dimensions according to type (see Section 9), and

5.1.3 Jacketing when required.

5.2 Any special requirements, such as, type, fabrication combinations not listed in accordance with Section 4, nonstandard dimensions in accordance with Section 9, inspection requirements in accordance with Section 13, or certification requirements in accordance with Section 16 shall be agreed upon between the purchaser and the supplier and stated in the purchase contract.

[3] Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036, http://www.ansi.org.

[4] Type and grade designations are in accordance with *Form and Style for ASTM Standards*, Part B, Section B8, March 2002.

6. Materials and Manufacture

6.1 The block material shall consist of a glass composition that has been foamed or cellulated under molten conditions, annealed, and set to form a rigid noncombustible material with hermetically sealed cells. The material shall be trimmed into blocks of standard dimensions that are rectangular or tapered.

6.2 Special shapes and pipe covering shall be fabricated from blocks in accordance with Practices C450, C585 and Specification C1639.

7. Physical Properties

7.1 The cellular glass insulation shall conform to the physical requirements in Table 1. Contact the manufacturer for specific design recommendations for all material types.

8. Qualification Requirements

8.1 The following requirements are generally employed for the purpose of initial material or product qualification for Type I, Block Material:

8.1.1 Compressive strength.
8.1.2 Flexural strength.
8.1.3 Water absorption.
8.1.4 Water vapor permeability.
8.1.5 Thermal conductivity.
8.1.6 Hot-surface performance.
8.1.7 Surface burning characteristics.

8.2 The following requirements are generally employed for qualification of Type II, pipe and tubing insulation:

8.2.1 Thermal Conductivity.

8.2.2 Type II, pipe and tubing insulation shall be fabricated from material having met the qualification requirements of Grade 6 Type I block.

8.3 Type III material shall be fabricated from material having met the qualification requirements of Grade 6 Type I block.

9. Dimensions, Mass, and Permissible Variations

9.1 *Type I, Flat Block*—Blocks shall be nominal rectangular sections. The dimensions shall be as agreed upon by the purchaser and the supplier. Cellular glass thermal insulation block is available in lengths from 24 in. to 36 in. (600 mm to 914 mm) and widths from 18 in. to 24 in. (450 mm to 610 mm). Cellular glass thermal insulation block is available in thicknesses from 1.5 in. to 8 in. (38 mm to 203 mm).

9.2 *Type II, Pipe and Tubing Insulation*—See Specification C1639.

9.3 *Type III, Special Shapes*—Dimensions of special shapes shall be as agreed upon between the supplier and the purchaser.

9.4 *Dimensional Tolerances:*

9.4.1 For Type I, the average measured length, width, and thickness tolerances shall be in accordance with those listed in Table 2.

9.4.2 For Type II, the dimensional tolerances are given in Table 3.

9.4.3 For Type III, dimensional tolerances shall be agreed upon between the purchaser and the supplier.

TABLE 1 Physical Requirements[A,B]

Properties	Grade 6	Grade 8	Grade 10	Grade 12	Grade 14	Grade 16	Grade 24
TYPE I BLOCK							
Compressive strength, capped, min, psi (kPa) (Capped material in accordance with Test Methods C240)	60 (414)	80 (552)	100 (689)	120 (827)	140 (965)	160 (1103)	240 (1655)
Density, lb/ft^3 (kg/m^3) Minimum	6.12 (98)	6.3 (102)	6.9 (110)	7.4 (119)	8.0 (128)	8.5 (136)	10.6 (170)
Compressive resistance, uncapped, min, psi (kPa) (Uncapped at 0.2-in. deformation)	35 (242)	N/A[C]	N/A[C]	N/A[C]	N/A[C]	N/A[C]	N/A[C]
Flexural strength, min, psi (kPa)	41 (283)	45 (310)	51(351)	56 (386)	63 (434)	69 (476)	91 (627)
Water absorption, max, volume %	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Water vapor permeability, max, per·in. or grains·in. of thickness/h·ft^2·in. Hg (ng·Pa^{-1}·s^{-1} ·m^{-1})	0.005 (0.007)	0.005 (0.007)	0.005 (0.007)	0.005 (0.007)	0.005 (0.007)	0.005 (0.007)	0.005 (0.007)
Hot-surface performance warpage, in. (mm), max	0.125 (3)	0.125 (3)	0.125 (3)	0.125 (3)	0.125 (3)	0.125 (3)	0.125 (3)
Cracking per 12.8.1	pass	pass	pass	pass	pass	pass	pass
Behavior of materials in a vertical tube furnace	passed	passed	passed	passed	passed	passed	passed
Surface burning characteristics[D]							
Flame spread index, max	5	5	5	5	5	5	5
Smoke developed index, max	0	0	0	0	0	0	0
Mass Loss Corrosion Rate	≤ DI[E]	≤ DI	≤ DI	≤ DI	≤ DI	≤ DI	≤ DI
Apparent Thermal Conductivity[F,G] : flat block, max							
Btu-in./h·ft^2°F (W/m·K) at mean temperature of:							
°F (°C)							
400 (204)	0.58 (0.084)	0.58 (0.084)	0.58 (0.084)	0.60 (0.086)	0.61 (0.088)	0.61 (0.088)	0.66 (0.095)
300 (149)	0.48 (0.069)	0.50 (0.072)	0.51 (0.074)	0.51 (0.074)	0.52 (0.075)	0.52 (0.075)	0.58 (0.084)
200 (93)	0.40 (0.058)	0.41 (0.059)	0.42 (0.061)	0.43 (0.062)	0.44 (0.063)	0.45 (0.065)	0.50 (0.072)
100(38)	0.33 (0.048)	0.34 (0.049)	0.35 (0.050)	0.36 (0.052)	0.37 (0.053)	0.38 (0.055)	0.43 (0.062)
75 (24)	0.31 (0.045)	0.32 (0.046)	0.33 (0.048)	0.35 (0.050)	0.36 (0.052)	0.36 (0.052)	0.42 (0.060)
50 (10)	0.30 (0.043)	0.31 (0.045)	0.32 (0.046)	0.33 (0.048)	0.34 (0.049)	0.35 (0.050)	0.40 (0.058)
0 (–18)	0.27 (0.039)	0.28 (0.040)	0.29 (0.042)	0.30 (0.043)	0.31 (0.045)	0.32 (0.046)	0.37 (0.053)
–50 (–46)	0.24 (0.035)	0.25 (0.036)	0.26 (0.037)	0.28 (0.040)	0.28 (0.040)	0.29 (0.042)	0.35 (0.050)
–100 (–73)	0.21 (0.030)	0.23 (0.033)	0.24 (0.035)	0.25 (0.036)	0.26 (0.037)	0.27 (0.039)	0.32 (0.046)
–150 (–101)	0.19 (0.027)	0.20 (0.029)	0.22 (0.032)	0.23 (0.033)	0.24 (0.035)	0.25 (0.036)	0.30 (0.043)
–200 (–129)	0.17 (0.025)	0.18 (0.026)	0.20 (0.029)	0.21 (0.030)	0.22 (0.032)	0.23 (0.033)	0.28 (0.040)
–250 (–157)	0.16 (0.023)	0.17 (0.025)	0.18 (0.026)	0.19 (0.027)	0.20 (0.029)	0.21 (0.030)	0.26 (0.037)
TYPE II PIPE AND TUBING							
Apparent thermal conductivity[F,H,I]							
Pipe insulation, max, Btu·in./h·ft^2°F (W/m·K) at mean temperature of:							
°F (°C)							
400 (204)	0.63 (0.091)						
300 (149)	0.52 (0.075)						
200 (93)	0.43 (0.062)						
100 (38)	0.35 (0.050)						
75 (24)	0.34 (0.049)						
50 (10)	0.32 (0.046)						
0 (-18)	0.29 (0.042)						
-50 (-46)	0.26 (0.037)						
-100 (-73)	0.23 (0.033)						
-150 (-101)	0.21 (0.030)						
Hot-surface performance warpage, in. (mm), max	0.125 (3)						
Cracking per 12.8.1	pass						

[A] Physical property requirements shown are for the materials in the as-manufactured condition. They do not necessarily represent the values of these properties under certain in-service conditions, depending on the type of installation and the ultimate temperature exposure.
[B] Types II and III are fabricated from Type 1, Grade 6 block.
[C] N/A = Not Applicable.
[D] For Types II and III, smoke developed index and flame spread index will remain constant with some fabrication techniques and will change with other fabrication techniques. For applications requiring a flame spread index of 25 and a smoke developed index of 50, contact fabricator or manufacturer.
[E] DI = deionized water.
[F] Thermal transmission properties of insulation will vary with temperature, temperature gradient, thickness, and shape. Note the apparent thermal conductivity values in the table are based on samples tested under conditions specified in 12.3 These are comparative values for establishing specification compliance. They do not necessarily represent the installed performance for the insulation under use conditions differing substantially from the test conditions.
[G] Evaluated at a small temperature difference in accordance with Practice C1058/C1058M.
[H] Evaluated at a large temperature difference in accordance with Practice C1058/C1058M.
[I] Single layer or inner layer on a multilayer system piping insulation fabricated in half sections has the potential to exhibit stress cracks above 250°F (122°C). The thermal performance in this range is characterized with cracks present.

TABLE 2 Manufacturers Dimensional Tolerances

Dimensions, in. (mm)	Block (Type I)
Length	±1/16 (1.6)
Width	±1/16 (1.6)
Thickness	±1/16 (1.6)

TABLE 3 Fabrication Tolerances

Dimensions, in. (mm)	(Type III)	Pipe (Type II)
Length	±1/8 (3.2)	In accordance with Practice C1639
Width	±1/8 (3.2)	In accordance with Practice C1639
Thickness	±1/8 (3.2)	In accordance with Practice C1639
Inner diameter	. . .	In accordance with Practice C1639
Outer diameter	. . .	In accordance with Practice C1639

9.4.4 For Types I and II, special dimensional tolerances shall be agreed upon between the purchaser and the supplier as stated in the purchase contract.

10. Workmanship, Finish, and Appearance

10.1 Since some requirements for this material are not easily specified by numerical value, the insulation shall have no visible defects that will adversely affect its service qualities.

11. Sampling

11.1 The insulation shall be sampled for the purpose of testing in accordance with Practice C390 or ISO 3951[5]. Any specific provisions for sampling shall be agreed upon between the purchaser and the supplier.

12. Test Methods

12.1 All cellular glass is produced initially in block form. When special shapes are required, cellular glass is fabricated into pipe, curved or segmental insulation, or precision V-grooved (material specifically cut to fit around the exterior surface of piping or equipment with no gaps). All initial qualification testing shall be made on block specimens. All tests shall be conducted on specimens with no surface moisture. The properties referenced in this specification shall be determined in accordance with the following test methods:

12.2 *Density:*

12.2.1 *Type I*—Block insulation: Test Method C303.

12.2.2 *Type II*—Pipe insulation: Test Method C302.

12.3 *Thermal Conductivity*—Make determinations at four mean temperatures in accordance with Practice C1058/C1058M. Use the results of these tests to calculate thermal transmission properties in accordance with Practice C1045.

NOTE 2—At the time of developing the thermal conductivity values in the Type II Cellular Glass Pipe and Tubing Insulation table, ISO 8497 was used to develop below ambient values for mean temperatures from -150°F (-101°C) to 75°F (24°C) since no known commercial C335/C335M apparatus had the capability of performing such testing.

12.3.1 *Type I: Block Insulation*—Use either Test Method C177, C518, or C1114 in conjunction with Practice C1045, using the specimen preparation described in Test Methods C240. Test Method C518 shall not be used at temperatures or thermal resistances other than those in the range of calibration. Test Method C1114 shall not be used at temperatures or thermal resistance ranges other than those with comparable/verifiable results to Test Method C177. In case of dispute, Test Method C177 is recognized as the final authority.

12.3.2 The number of specimens to be tested and the sampling plan shall be in accordance with Practice C390 where applicable. For the purpose of inspection by the user's representative or independent third party, the number of specimens shall conform to ISO 3951 Inspection Level S-3, 10.0 % AQL using the S Method.

12.3.3 *Type II, Pipe and Tubing Insulation*—Test Method C335/C335M in conjunction with Practices C1058/C1058M and C1045 for above ambient mean temperatures. For below ambient mean temperatures use test method ISO 8497 in conjunction with Practices C1058/C1058M and C1045.

12.3.4 Samples shall be fabricated into 1½ + ½ , – 0-in. (38 + 13, – 0-mm) thick specimens of pipe insulation.

12.4 *Compressive Properties—(Type I-Block)*—Determine the compressive strength in accordance with Test Method C165, Procedure A, with the test parameters and specimen preparation techniques described in Test Methods C240. This process indicates a failure point in compressive loading.

12.4.1 Due to the sample preparation, with the inclusion of felts and asphalt, the test method described in Test Method C165 to determine compressive modulus of elasticity does not apply for cellular glass as a material by itself.

12.4.2 For compressive resistance of uncapped material, use Test Method C165, Procedure A, preferably test a half block, or quadrant, 2-in. (50-mm) thickness to a deformation of 0.2 in. (5 mm). This process does not indicate a failure point in compressive loading.

NOTE 3—For ultimate yield strength with no deformation, capping in accordance with Test Methods C240 is required.

12.5 *Flexural Strength (Type I Block)*—Test Methods C203, using Procedure A, Method I or II.

12.6 *Water Absorption (Type I-Block)*—Test Methods C240.

12.7 *Water Vapor Permeability (Type I-Block)*—Test Methods E96/E96M. Use water method at a temperature in the range from 73.4 to 90°F (23 to 32.2°C).

12.8 *Hot Surface Performance (Type I-Block)*—Test Method C411 tested at 4-in. (102-mm) thickness (double layer of 2-in. or 51-mm blocks with staggered joints). (*Type II-Pipe*—tested at 3-in. (76-mm) thickness (double layer of 1.5-in. or 38-mm layers with joints staggered). The test temperature shall not exceed the manufacturer's maximum use temperature. A heating rate not exceeding 200°F/h (112 K/h) shall be employed. Test specimens shall be unfaced.

[5] ISO 3951 Sampling procedures for inspection by variables — Part 1: Specification for single sampling plans indexed by acceptance quality limit (AQL) for lotby- lot inspection for a single quality characteristic and a single AQL, ISO copyright office Case postale 56 • CH-1211 Geneva 20 Tel. + 41 22 749 01 11 Fax + 41 22 749 09 47 E-mail copyright@iso.org Web http://www.iso.org/iso/home.html