Designation: C 892 – 93

Standard Specification for High-Temperature Fiber Blanket Thermal Insulation[1]

This standard is issued under the fixed designation C 892; 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 high-temperature fiber blanket thermal insulation for use at various temperatures from 1350°F (732°C) up to 3000°F (1649°C), except when used in high-temperature furnaces.

1.2 *This standard does not purport to address all of the safety problems, 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.*

1.3 When the installation or use of thermal insulation materials, accessories, and systems may pose safety or health problems, the manufacturers shall provide the user with appropriate current information regarding any known problems associated with the recommended use of the company's products, and shall also recommend protective measures to be employed in their safe utilization. The user shall establish appropriate safety and health practices and determine the applicability of regulatory requirements prior to use.

1.4 The values stated in inch-pound units are to be regarded as the standard.

2. Referenced Documents

2.1 *ASTM Standards:*

C 71 Terminology Relating to Refractories[2]

C 167 Test Methods for Thickness and Density of Blanket or Batt Thermal Insulation[3]

C 168 Terminology Relating to Thermal Insulating Materials[3]

C 177 Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded Hot Plate Apparatus[3]

C 201 Test Method for Thermal Conductivity of Refractories[2]

C 209 Test Methods for Cellulosic Fiber Insulating Board[3]

C 356 Test Method for Linear Shrinkage of Preformed High-Temperature Thermal Insulation Subjected to Soaking Heat[3]

C 390 Criteria for Sampling and Acceptance of Preformed Thermal Insulation Lots[3]

C 1058 Practice for Selecting Temperatures for Reporting and Evaluating Thermal Properties of Thermal Insulation[3]

3. Terminology

3.1 *Definitions*—Terminology C 71 and Terminology C 168 shall be considered as applying to the terms used in this standard.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *fibers*—the fibers shall be refractory oxides, processed from a molten state into fibrous form.

3.2.2 *high-temperature fiber thermal insulation*—a thermal insulation, varying in flexibility, composed of refractory inorganic fibers, with or without binder added, and furnished in either flat sheets or rolls.

4. Classification

4.1 The general-type product governed by this specification is blanket or batt composed of inorganic refractory fibers.

4.2 *Types*—The product is separated into types based upon temperatures of use:

Type	Temperature of use, °F (°C), maximum
I	1350 (732)
II	1600 (871)
III	2400 (1316)
IV	2600 (1427)
V	3000 (1649)

4.3 *Grades*—The product is separated into grades based upon its density:

Grade	Density, lb/ft^3(kg/m^3), nominal
3	3 (48)
4	4 (64)
6	6 (96)
8	8 (128)
12	12 (192)

5. Ordering Information

5.1 High-temperature fiber blanket thermal insulation is normally purchased on the basis of brand name, grade, length, width, thickness, and total square footage as specified in the purchase order.

5.2 The type and grade for the intended service shall be as specified by the user with the assistance of the supplier where desirable.

5.3 Inspection and sampling of the material may be specified by the purchaser.

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[1] This specification is under the jurisdiction of ASTM Committee C-16 on Thermal Insulation and is the direct responsibility of Subcommittee C16.23 on Blanket and Loose Fill Insulation.

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[2] *Annual Book of ASTM Standards*, Vol 15.01.

[3] *Annual Book of ASTM Standards*, Vol 04.06.

5.4 When a certification or test report, or both, is required, this shall be specified by the purchaser.

6. Physical and Mechanical Properties

6.1 *Thermal Conductivity* shall conform to the requirements of Table 1 when tested in accordance with 10.1.2.

6.2 *Density* shall conform to the requirements of 4.3 with a tolerance of +30, −15 % of nominal density when tested in accordance with 10.1.1.

6.3 *Temperature of Use* shall conform to the requirements of 4.2 when tested in accordance with 10.1.4.

6.4 Other physical and mechanical properties shall conform to the requirements of Table 2 when tested in accordance with Section 11.

7. Dimensions, Weights, and Permissible Variations

7.1 Rolls or flat sheets of blanket are normally furnished in standard dimensions as shown in Table 3, Table 4, and Table 5.

7.2 Sheets are normally furnished 4 by 8 ft (1219 by 2438 mm) at densities above 8 lb/ft^3 (128 kg/m^3).

7.3 The standard length, width, and thickness combinations available are a function of the type and grade. This information can be obtained by referring to the supplier's literature. Information for non-standard dimensions and combinations can be obtained by contacting the supplier.

8. Workmanship, Finish, and Appearance

8.1 The insulation shall indicate good workmanship in fabrication by a uniform appearance, shall not have visible defects such as tears and holes that will adversely affect the service quality, and shall be free from foreign materials.

9. Sampling

9.1 The insulation shall be sampled for the purposes of test in accordance with Criteria C 390. Specific provision for sampling shall be agreed upon between the supplier and the purchaser.

10. Test Methods

10.1 The properties enumerated in this specification shall be determined in accordance with the following test methods:

TABLE 2 Physical and Mechanical Requirements

Properties	Requirements
Unfiberized shot content, maximum, % (by weight)	30
Linear shrinkage, maximum, % (at maximum use temperature)	5
Tensile strength, minimum, lb/in^2(KPa)	
Grade 3	1.0 (6.9)
Grade 4	1.5 (10.3)
Grade 6	2.0 (13.8)
Grade 8	3.0 (20.7)
Grade 12	5.0 (34.5)

TABLE 3 Thickness Dimensions

Thickness, in. (mm)	Tolerance
1/16 (1.6)	+50, −25 %
1/8 (3.2)	+50, −25 %
3/16 (4.8)	+50, −25 %
1/4 (6.4)	+1/4, −1/8 in. (+6.4, −3.2 mm)
3/8 (9.5)	+3/8, −1/8 in. (+9.5, −3.2 mm)
1/2 (12.7)	+1/2, −1/8 in. (+12.7, −3.2 mm)
3/4 (19.1)	+3/4, −1/8 in. (+19.1, −3.2 mm)
1 (25.4)	+3/4, −1/8 in. (+19.1, −3.2 mm)
1 1/2 (38.1)	+3/4, −1/8 in. (+19.1, −3.2 mm)
2 (51.0)	+3/4, −1/4 in. (+19.6, −6.4 mm)

TABLE 4 Width Dimensions

Width, in. (mm)	Tolerance,[A] %
12 (305)	−2, +10
18 (457)	−2, +10
24 (610)	−2, +10
36 (914)	−2, +10
39 (991)	−2, +10
42 (1067)	−2, +10
48 (1219)	−2, +10
72 (1829)	−2, +10

[A] Excess is permitted.

10.1.1 *Dimensional Measurement and Density*—Test Methods C 167. Density is based on nominal thickness.

10.1.2 *Apparent Thermal Conductivity*—Test Methods C 177 or C 201 (modified by the procedure shown in Annex A1). Temperature of test shall be in accordance with Practice C 1058.

10.1.3 *Unfiberized Shot Content*—See Annex A2.

TABLE 1 Apparent Thermal Conductivity, maximum BTU in./h·ft^2·F (W/m·K)

For Test Method C 177					
Grade	Mean Temperature, °F (°C)				
	400 (204)	800 (427)	1200 (649)	1600 (871)	2000 (1093)
3	0.66 (0.095)	1.13 (0.163)	1.79 (0.258)	2.76 (0.398)	4.20 (0.605)
4	0.62 (0.089)	1.03 (0.148)	1.66 (0.239)	2.58 (0.372)	3.83 (0.552)
6	0.54 (0.078)	0.94 (0.136)	1.47 (0.212)	2.28 (0.329)	3.33 (0.480)
8	0.53 (0.076)	0.92 (0.133)	1.41 (0.203)	2.02 (0.291)	2.72 (0.392)
12	0.53 (0.076)	0.91 (0.131)	1.38 (0.199)	1.80 (0.259)	2.17 (0.313)

For Test Method C 201, Modified[A]						
Grade	Mean Temperature, °F (°C)					
	400 (204)	800 (427)	1200 (649)	1600 (871)	2000 (1093)	2500 (1371)
3	0.54 (0.078)	1.21 (0.175)	2.34 (0.338)	3.87 (0.558)	5.98 (0.862)	9.54 (1.375)
4	0.48 (0.069)	1.02 (0.147)	1.91 (0.275)	3.09 (0.446)	4.69 (0.676)	7.36 (1.061)
6	0.43 (0.062)	0.83 (0.120)	1.46 (0.211)	2.30 (0.332)	3.42 (0.493)	5.27 (0.759)
8	0.40 (0.058)	0.73 (0.105)	1.24 (0.179)	1.89 (0.273)	2.74 (0.395)	4.09 (0.589)
12	0.38 (0.055)	0.64 (0.092)	1.02 (0.147)	1.49 (0.215)	2.08 (0.300)	2.98 (0.429)

[A] Refer to Annex A1 of this specification.

TABLE 5 Length Dimensions

Length, in. (mm)	Tolerance[A]
36 (914)	−0
48 (1219)	−0
84 (2134)	−0
96 (2438)	−0
144 (3658)	−0
150 (3810)	−0
180 (4572)	−0
288 (7315)	−0
300 (7620)	−0
312 (7925)	−0
600 (15240)	−0

[A] Not limited—excess is permitted.

10.1.3.1 For the purposes of this specification, the unfiberized particles are those not passing through a U.S. Standard No. 70 sieve (210 µm opening). The unfiberized content is the cumulative weight of unfiberized particles remaining on 30-, 50-, and 70-mesh screens.

10.1.4 *Linear Shrinkage and Temperature of Use*—Test Method C 356, except that dimensions shall be determined by Test Methods C 167. The temperature of test shall be the temperature of use, as specified in 4.2.

10.1.5 *Tensile Strength*—Test Methods C 209, Section 11 (parallel to surface), except that rate of separation of the jaws shall be 1 to 2 in./min (25 to 50 mm/min).

11. Qualification

11.1 Unless otherwise specified, the following requirements shall be employed for the purpose of initial material or product qualification:

11.1.1 Apparent Thermal Conductivity.

11.1.2 Tensile Strength.

12. Inspection

12.1 Unless otherwise specified, the following requirements shall be employed for the purposes of acceptance sampling of lots or shipments of qualified insulation:

12.1.1 Density.

12.1.2 Unfiberized content.

12.1.3 Linear shrinkage and temperature of use.

12.1.4 Dimensions.

12.1.5 Workmanship, finish, and appearance.

12.2 Inspection of the material shall be agreed upon between the purchaser and the supplier as part of the purchase contract.

13. Rejection and Rehearing

13.1 If inspection of the samples shows failure to conform to the requirements of the specification, a second sampling from the same lot shall be tested and the results of this retest averaged with the results of the original test.

13.1.1 Upon retest as described in 13.1, failure to conform to this specification shall constitute grounds for rejection.

13.1.2 In case of rejection, the manufacturer or supplier shall have the right to reinspect the rejected shipment and resubmit the lot after removal of that portion of the shipment not conforming to the specified requirements.

13.2 *Thermal Conductivity*—The need for a test to determine compliance may be as agreed upon between the purchaser and the supplier, but the test shall be made if:

13.2.1 Within the 3-year period preceding the date of purchase the blanket has not been tested by an acceptable testing laboratory and found in compliance with the requirements of 6.1.

13.2.2 The blanket offered for delivery is not the same in all respects as that previously tested by the testing laboratory.

14. Certification

14.1 When specified in the purchase order or contract, the purchaser shall be furnished certification that samples representing each lot have been either tested or inspected as directed in this specification and the requirements have been met. When specified in the purchase order or contract, a report of the test results shall be furnished.

15. Packaging and Package Marking

15.1 *Packaging*—Unless otherwise agreed to or specified between the purchaser and the manufacturer, the product shall be packaged in the manufacturer's standard commercial containers.

15.2 *Marking*—The container shall be marked with the name and brand or trademark of the manufacturer, quantity, length, width, nominal thickness, type, grade, "Store in Dry Place," "Use No Hooks," date of manufacture, and other information as required by the purchaser in the contract or purchase order.

16. Keywords

16.1 alumina-silica high temperature thermal insulation; thermal conductivity; thermal insulating materials-blanket; unfiberized content

ANNEXES

(Mandatory Information)

A1. MODIFIED CALORIMETER (TEST METHOD C 201)—PREPARATION AND PLACEMENT OF FIBROUS INSULATING MATERIAL IN THERMAL CONDUCTIVITY TESTER

A1.1 Selection and Preparation of Sample

A1.1.1 The standard sample of fibrous insulation requires that new material be available to make a pad 13½ by 9 by 2 in. (343 by 229 by 51 mm) thick. The 9 by 13½-in. dimension is usually obtainable in blanket materials. As blankets are available in several thicknesses, it is often necessary to cut several pieces of blanket 9 by 13½-in. that can be placed one upon the other to make the 2-in. thickness. The selection of these individual blankets should be made to provide as uniform a density as possible in each of the individual blanket layers and an individual density as close to the ultimate overall sample density as possible. If the blanket is thin enough or of a low enough density, the layers should be held over a light box to detect any abnormal variation in density.

A1.1.2 The precise cutting of the blanket to size is facilitated by the use of a heavy cardboard or thin sheet steel pattern cut square to 9 by 13½-in. (229 by 343 mm). A butcher knife seems to produce a good cut.

A1.1.3 After cutting to the 9 by 13½-in. (229 by 343-mm) size, the individual blankets should be weighed and the density determined. Since the thicknesses of the blankets vary, it may be necessary to compress the assembled layers before installation in the tester so that the assembly is 2 in. (51 mm) thick. This can be done by placing a steel plate on top of the sample and loading it to compress the sample to 2 in. The maximum compression allowed is 15 %.

A1.2 Preparation of Tester

A1.2.1 In order to accurately measure the surface temperature of the calorimeter, a thin-foil thermocouple is applied to the center of the calorimeter surface. The foil thermocouple shall be 0.0005 in. (0.0127 mm) or less and may be Type J, K, T, or E. The thermocouple shall be bonded to an electrically insulating matrix 0.003 in. (0.0762 mm) thick or less. The leads shall be electrically insulated and of sufficient length to exit the apparatus without an internal junction. The thermocouple shall be held on the surface by a thin layer of adhesive, such as double-back tape. After the thermocouple is in place, the surface shall be painted with a high-emittance coating with an emittance of 0.9 or higher.

A1.2.2 The 9 by 13½-in. (229 by 343-mm) silicon carbide slab, approximately ¾ in. (19.1 mm) thick, which forms the top surface of the sample, is cleaned and shall be flat and smooth with 1/32 in. (0.79 mm). The leads on a 25 gage Type S thermocouple shall be insulated with fine alumina tubing. The bead shall be covered with a small amount of alumina cement so that it does not come in contact with the silicon carbide plate. The thermocouple shall then be placed in slots cut in the silicon carbide plate and cemented in place so that the thermocouple is in the center of the plate's bottom surface.

A1.2.3 The sample chamber is prepared by placing ceramic fiber insulation of the same type being tested around the perimeter on the outer guard section so that the test chamber that is formed is 9 by 13½-in. (229 by 343 mm) in area. This insulation shall stand 2½-in. (63.7 mm) from the calorimeter surface. The insulation immediately to the rear of the sample under which the leads on the foil thermocouple pass through to the ice junction will need to be cut into strips to allow the passage of other thermocouple leads through this outer insulation.

A1.2.4 The thickness of the sample is held at some predetermined thickness (usually 2-in. (51 mm)) using four pieces of alumina tubing ⅜-in. (13 mm) in diameter by 2-in. (51 mm) long placed in the four corners of the calorimeter chamber. These support the silicon carbide slab that acts as the sample hot face. These four supports shall be cut with great care to ensure equal length as their thickness contributes directly to the precision of the thermocouple spacing.

A1.3 Sample Installation

A1.3.1 To determine the thermocouple separation or sample thickness to use in the calculation, it has been found that any micrometer measurement may be used. The following method is referred. A piece of stiff modeling clay is shaped to approximately 1 in. (25 mm) in diameter, and 2 1/16 in. (52 mm) long. This piece of clay is placed over the lower thermocouple bead on the calorimeter, and the top silicon carbide slab containing the hot face thermocouple is lowered into the sample chamber until it is seated firmly upon the four supporting corners. The silicon carbide slab is then removed and the clay column lifted carefully from the lower thermocouple. The length of this clay column is determined with either a micrometer or a vernier height gage. Generally, three determinations made in this manner will yield a uniform thickness measurement for the space between the calorimeter surface and the silicon carbide slab.

A1.3.2 The sample previously prepared in the form of a pad 9 by 13½ in. (229 by 343 mm) and approximately 2 in. (51 mm) thick should be weighed to determine the sample density, ⅜-in. (9.5-mm) diameter corners are then cut out of this sample to provide room for the ⅜-in. diameter supports in the corners. The sample can then be lowered into the test chamber and will fit, although some care shall be taken to see that the sample is not so large as to permit curling up of the bottom edges as they slide past the outer insulation. Care shall also be taken to see that the fibrous insulation sample does not protrude above the supports on the corners. The silicon carbide slab is then lowered on top of the sample until it is firmly seated on the four support corners. If the top slab does not seat firmly upon the supports, one or perhaps two more silicon carbide slabs may be placed upon the top slab to provide additional weight. The test may then be started.

A1.4 Procedure

A1.4.1 Make the measurements in the manner described in the booklet entitled "Recommended Operating Instructions for Use with the ASTM Thermal Conductivity Tester."[4] As the thermal conductivity of the fibrous insulating materials is lower than insulating firebrick, the flow settings will be slightly different than those encountered in the measurements of insulating firebrick. Carry tests to hot-face temperatures equal to the use limit of the material.

A1.4.2 After testing, reweigh the sample to determine the loss of any lubricants, resins, or adhesives that might be present in the sample. Because of the variation in density for this type of sample, it is advisable to determine the density over the small area of the test calorimeter, approximately 3 in. (76 mm) square. For this purpose, it has been found that a "cookie cutter" sample can be taken using a suitable tin can 3 to 4 in. (76 to 102 mm) in diameter. Remove one rim of the can to make a sharp circular edge. Use this tin can cookie cutter to core a sample from the sample pad over the test calorimeter. Weigh this sample and, knowing the diameter of the can and sample test thickness, determine the true sample density.

[4] This booklet was originally drafted by the Refractories Division of Babcock and Wilcox Co. ASTM has been advised that this booklet is no longer available. Subcommittee C16.23 is taking this issue under advisement.

A2. UNFIBERIZED SHOT CONTENT OF INORGANIC FIBROUS BLANKETS

A2.1 Scope

A2.1.1 This practice covers a method of determining the shot content of inorganic fibrous blanket thermal insulations.

A2.2 Significance and Use

A2.2.1 High temperature fibrous thermal insulation may contain various amounts of non-fibrous material (shot) which can affect the thermal performance of the insulation. Shot content is used as an indirect measure of thermal performance for lot inspection purposes, because of its timeliness and relative ease of use, as compared against thermal conductivity test methods that are used for qualification purposes.

A2.3 Apparatus

A2.3.1 *Electric Furnace*, capable of maintaining a temperature of 2300°F (1260°C).

A2.3.2 *Evaporating Dish*, size 00A.

A2.3.3 *Analytical Balance*, capable of weighing to an accuracy of 0.0001 g.

A2.3.4 *Sieves*, three 8-in. diameter U.S. Standard Sieves (No. 30, 50, and 70) (210-µm opening) nested in order with top cover and bottom receiver.

A2.3.5 *Stoppers*, rubber, No. 12 and 13.

A2.3.6 *Mechanical Sieve Shaker.<usb>* [5]

A2.3.7 *Sieve Shaker Timer*.

A2.3.8 *Bristle Brush*, 1 in. (25 mm).

A2.3.9 *Weighing Dish*, tared.

A2.4 Specimen

A2.4.1 *Unbonded Fibers*—A 10-g specimen taken from a representative area shall be used for the test. The sample shall be fired in a furnace at 2300°F (1260°C) for 5 h.

A2.4.2 *Bonded Fibers*—A 10-g specimen shall be cut from the sample with a knife or cork borer, with care taken that no particles are lost. The sample shall be fired in a furnace at 2300°F (1260°C) for 5 h.

[5] The W. S. Tyler Ro-Tap, or its equivalent, has been found suitable for this purpose.

A2.5 Procedure

A2.5.1 Weigh the fired fiber sample on the analytical balance to the nearest 0.0001 g.

A2.5.2 Place the sample on the top No. 30 screen of the nested set and break up the surface of the specimen shape by pressing it against the sieve surface using the flat face of the rubber stopper. Continue this operation until all the fine fibers have passed through this screen.

A2.5.3 Transfer the remaining particles from the screen to a weighing dish using the bristle brush and weigh on an analytical balance to the nearest 0.0001 g.

NOTE A2.1—Steps described in A2.5.3, A2.5.4, and A2.5.5 may be combined for weighing as one lot.

A2.5.4 Continue breaking up the specimen on the No. 50 screen with the flat face of the rubber stopper until all the fine fibers have passed through the screen. Transfer the remaining particles to a weighing dish and weigh on an analytical balance to the nearest 0.0001 g.

A2.5.5 Place the cover on the remaining sieve and shake for 30 min using a mechanical sieve shaker.

A2.5.6 Remove the cover, brush the fine fibers from the sides of the sieve to the center of the screen, and use the flat face of the rubber stopper to force the fine fibers through the No. 70 screen. Transfer the remaining particles from this screen to a weighing dish and reweigh on an analytical balance to the nearest 0.0001 g.

A2.6 Calculation

A2.6.1 Calculate the percentage of shot as follows:

$$W_C = \frac{W_p\,(100)}{W_T}$$

where:

W_C = % weight of the cumulative shot,
W_p = weight of particles retained on the three specified sieves, and
W_T = total weight of the specimen.

A2.7 Precision and Bias

A2.7.1 Precision and bias are being determined.