**Designation: C892 – 17**

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

This standard is issued under the fixed designation C892; 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 from ambient up to 3000°F (1649°C).

1.2 When the potential exists that the installation or use of thermal insulation materials, accessories, and systems will 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 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.

1.3 The values stated in inch-pound units are to be regarded as the standard. The values given in parentheses are mathematical conversions to SI units which are provided for information only and are not considered 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]

C71 Terminology Relating to Refractories

C167 Test Methods for Thickness and Density of Blanket or Batt 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

C201 Test Method for Thermal Conductivity of Refractories

C209 Test Methods for Cellulosic Fiber Insulating Board

C356 Test Method for Linear Shrinkage of Preformed High-Temperature Thermal Insulation Subjected to Soaking Heat

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

C665 Specification for Mineral-Fiber Blanket Thermal Insulation for Light Frame Construction and Manufactured Housing

C680 Practice for Estimate of the Heat Gain or Loss and the Surface Temperatures of Insulated Flat, Cylindrical, and Spherical Systems by Use of Computer Programs

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

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

C1101/C1101M Test Methods for Classifying the Flexibility or Rigidity of Mineral Fiber Blanket and Board Insulation

C1104/C1104M Test Method for Determining the Water Vapor Sorption of Unfaced Mineral Fiber Insulation

C1335 Test Method for Measuring Non-Fibrous Content of Man-Made Rock and Slag Mineral Fiber Insulation

## 3. Terminology

3.1 *Definitions*—Terminology C71 and Terminology C168 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.

---

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

Current edition approved Dec. 1, 2017. Published January 2018. Originally approved in 1978. Last previous edition approved in 2010 as C892 – 10. DOI: 10.1520/C0892-17.

[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.

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 (Table 1).

4.3 *Grades*—The product is separated into grades based upon its maximum Apparent Thermal Conductivity values (see Table 2) and minimum Tensile Strength values (see Table 3).

## 5. Ordering Information

5.1 High-temperature fiber blanket thermal insulation is normally purchased on the basis of brand name, type, 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 The purchaser shall be permitted to specify, inspect and sample the material.

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

## 6. Materials and Manufacture

6.1 *Composition*—High temperature fiber thermal insulation shall be composed of fibers, made of metallic oxides of, but not limited to, silicon, aluminum, calcium, and magnesium. The raw materials, processed from the molten state into spun fibers, are then mechanically interlocked through a needling process into insulation blanket felts with out the use of chemical binders.

## 7. Physical and Mechanical, and Chemical Properties Requirements

7.1 *Apparent Thermal Conductivity* shall conform to the requirements of Table 2 when tested in accordance with 11.1.2.

7.2 *Tensile Strength*—shall conform to the requirements of Table 3 when tested in accordance with 11.1.5.

7.3 *Flexibility*—shall be classified as flexible when tested in accordance with 11.1.8.

7.4 *Maximum Use Temperature*—shall conform to the requirements of 4.2 when tested in accordance with 11.1.4.

**TABLE 1 Classification by Type**

| Type | Temperature of use, °F (°C), maximum |
|---|---|
| I | 1350 (732) |
| II | 1600 (871) |
| IIA | 2000 (1093) |
| III | 2300 (1260) |
| IV | 2600 (1427) |
| V | 3000 (1649) |

7.5 *Non-fibrous content (shot)*—shall be limited to a maximum of 30% by weight when testing in accordance with 11.1.3.

7.6 *Linear Shrinkage*—shall be limited to a maximum of 5%, after exposure to the Maximum Use Temperature, in accordance with 11.1.4.

## 8. Dimensions, Mass, and Permissible Variations

8.1 Rolls or flat sheets of blanket are normally furnished in standard dimensions as shown in Table 4,Table 5, and Table 6.

8.2 The standard length, width, and thickness combinations available are a function of the type and grade. Contact the supplier for information on standard or non-standard dimension and combinations.

8.3 The maximum density (determined in accordance with Test Method C167) specified in Table 4 for Grades 3, 4, 6, 8, 10, and 12 are for weight design purposes only.

## 9. Workmanship, Finish, and Appearance

9.1 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.

## 10. Sampling

10.1 The insulation shall be sampled for the purposes of test in accordance with Practice C390. Specific provision for sampling shall be agreed upon between the supplier and the purchaser.

## 11. Test Methods

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

11.1.1 *Dimensional Measurement and Density*—Test Methods C167. Density is based on nominal thickness.

11.1.2 *Apparent Thermal Conductivity*—Test in accordance with Test Method C177 or C201 (modified by the procedure shown in Annex A1).

11.1.2.1 Practice C1058. shall be used to obtain recommended test temperature combinations for testing purposes.

11.1.2.2 As specified in Practice C1045, the range of test conditions must include at least one test where the hot surface temperature is greater than, or equal to, the hot limit of the temperature range of desired data and at least one test where the cold surface temperature is less than, or equal to, the cold limit of the temperature range desired. The exception to this requirement is given in 11.1.2.2(1) below. At least two additional tests shall be distributed somewhat evenly over the rest of the temperature range.

*(1)* In cases where the maximum temperature of the C177 test device is exceeded by the required hot surface temperature as stipulated in 11.1.2.2, it is acceptable to operate one hot plate at the C177 upper temperature limit and the other hot plate at the lower temperature that gives the target mean temperature.

11.1.2.3 Final analysis of the thermal data shall be conducted in accordance with Practice C1045 to generate a

**TABLE 2 Apparent Thermal Conductivity, maximum Btu in./h·ft²·F (W/m·K) at Mean Temperature, °F (°C)**

| Grade | 75 (24) | 200 (93) | 400 (204) | 800 (427) | 1200 (649) | 1600 (871) | 2000 (1093) |
|---|---|---|---|---|---|---|---|
| 3 | 0.52 (0.075) | 0.56 (0.081) | 0.73 (.105) | 1.32 (.190) | 2.42 (.348) | 4.05 (.583) | 5.94 (.855) |
| 4 | 0.50 (0.072) | 0.54 (0.078) | 0.68 (.098) | 1.13 (.163) | 2.15 (.349) | 3.53 (.508) | 5.47 (.787) |
| 6 | 0.42 (0.060) | 0.47 (0.068) | 0.59 (.086) | 1.03 (.149) | 1.91 (.276) | 3.06 (.440) | 4.75 (.604) |
| 8 | 0.41 (0.059) | 0.46 (0.066) | 0.56 (.081) | 1.01 (.146) | 1.67 (.241) | 2.60 (.374) | 4.18 (.682) |
| 10 | 0.40 (0.058) | 0.45 (0.065) | 0.55 (.079) | 0.98 (.141) | 1.61 (.231) | 2.31 (.333) | 3.63 (.523) |
| 12 | 0.37 (0.053) | 0.43 (0.062) | 0.53 (0.076) | 0.96 (.138) | 1.43 (.206) | 2.11 (.304) | 3.14 (.451) |

**TABLE 3 Tensile Strength, Minimum**

| Grade | Tensile Strength, lb/in.² (KPa) |
|---|---|
| 3 | 1.0 (6.9) |
| 4 | 1.5 (10.3) |
| 6 | 2.0 (13.8) |
| 8 | 3.0 (20.7) |
| 10 | 4.0 (27.6) |
| 12 | 5.0 (34.5) |

**TABLE 4 Density, Maximum and Minimum**

| Grade | Minimum Density , lbs/ft.³ (kg/m³)[A] | Maximum Density , lbs/ft.³ (kg/m³)[B] |
|---|---|---|
| 3 | 2.5 (41) | 4 (64) |
| 4 | 3.4 (54) | 5.5 (88) |
| 6 | 5.1 (82) | 8 (128) |
| 8 | 6.8 (109) | 10.5 (168) |
| 10 | 8.5 (136) | 13 (208) |
| 12 | 10.2 (163) | 16 (256) |

[A] Minimum density limitations is for the purpose of maintaining structural properties.
[B] Maximum density limitations are for the purpose of providing design information for stress analyses of pipe and equipment.

**TABLE 5 Thickness Dimensions**

| Thickness, in. (mm) | Tolerance |
|---|---|
| 1/16 (1.6) | + 1/32, −1/64 in. (+0.8, -0.4mm) |
| 1/8 (3.2) | + 1/16, −1/32 in. (+1.6, -0.8mm) |
| 3/16 (4.8) | + 3/32, −3/64 in. (+2.4, -1.2mm) |
| 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 6 Width Dimensions**

| Width, in. (mm) | Tolerance, % |
|---|---|
| 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 |

**TABLE 7 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.

thermal conductivity versus mean temperature relationship for the specimen. Practice C1045 and the specific hot and cold surface temperatures is required to determine the effective thermal conductivity for comparison to the specification requirements.

11.1.2.4 Final step of Practice C1045 analysis would be to calculate the thermal conductivity using the equations generated at a set of mean temperatures for comparison to the specification.

*(1)* While it is recommended that the specification data be presented as conductivity versus temperature, it is possible that several existing specifications will contain mean temperature data from tests conducted at specific hot and cold surface temperatures. In these cases, it is possible that the conductivity will be a as a function of temperature and that the Practice C1045 analysis will provide different results. To ensure that the data is compatible, a Practice C680 analysis, using the conductivity versus temperature relationship from Practice C1045 and the specific hot and cold surface temperatures, is required to determine the effective thermal conductivity for comparison to the specification requirements.

11.1.3 *Non-Fibrous Content (Shot)*—Test Method C1335 Procedure B, with the following exceptions.

11.1.3.1 Use U.S. Standard Sieves No. 30, 50, and 70. The specimen shall first be fired in a furnace at the maximum use temperature for the particular Type for a duration of 5h. After passing all particles and fine fiber through Sieve No. 50, mechanically shake Sieve No. 70 for 30 min.

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

11.1.4 *Linear Shrinkage and Temperature of Use*—Test Method C356, except that dimensions shall be determined by Test Methods C167. The temperature of test shall be the temperature of use, as specified in 4.2.

11.1.5 *Tensile Strength*—Test Methods C209, Section 12 (parallel to surface), except that rate of separation of the jaws shall be 1 to 2 in./min (25 to 50 mm/min).

11.1.6 *Corrosiveness to Steel*—Test in accordance with the corrosiveness method of Specification C665.

11.1.7 *Maximum Use Temperature and Exothermic Temperature Rise*—Test in accordance with Test Method C411and the hot service performance of Practice C447 at the maximum use temperature. All types shall be tested at the insulation's stated maximum thickness, in either single or multiple layer configurations.

11.1.8 *Flexibility*—Test in accordance with Test Method C1101/C1101M (except use 1 in. (25.4 mm) thick material) for classifying the flexibility of the material.

11.1.9 *Water Vapor Sorption*—Test in accordance with Test Method C1104/C1104M for determining the water vapor sorption of the material.

11.1.10 *Stress Corrosion Performance for Use on Austenitic Stainless Steel*—When specified, test in accordance with Specification C795.

## 12. Qualification

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

12.1.1 Apparent Thermal Conductivity.

12.1.2 Tensile Strength.

## 13. Inspection

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

13.1.1 Flexibility.

13.1.2 Non–fibrous content.

13.1.3 Linear shrinkage and temperature of use.

13.1.4 Dimensions.

13.1.5 Workmanship, finish, and appearance.

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

## 14. Rejection and Rehearing

14.1 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.

14.1.1 Upon retest as described in 14.1, failure to conform to this specification shall constitute grounds for rejection.

14.1.2 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.

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

14.2.1 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 7.1.

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

## 15. Certification

15.1 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.

## 16. Packaging and Package Marking

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

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

## 17. Keywords

17.1 alumina-silica, high temperature; fiber; fibrous; nonfibrous content ; refractory fibers; thermal conductivity; thermal insulation; thermal insulation, blanket

# ANNEX

**(Mandatory Information)**

## A1. MODIFIED CALORIMETER (TEST METHOD C201)—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 shall 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 are to 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 produces a good cut.

A1.1.3 After cutting to the 9 by 13½-in. (229 by 343-mm) size, the individual blankets are 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 is 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 shall 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 within 1⁄32 in. (0.79 mm). The leads on a 25 gauge 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 preferred. 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 is 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 is then 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 is then 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." 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 out 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.