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Standard Specification for Calcium Silicate Block and Pipe Thermal Insulation[1]

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1. Scope

1.1 This specification covers calcium silicate block and pipe thermal insulation for use on surfaces with temperatures between 80 and 1700°F (27 to 927°C), unless otherwise agreed upon between the manufacturer and the purchaser.

1.2 The values stated in inch-pound units are to be regarded as the standard. The values given in parentheses are for information only.

1.3 The following safety hazards caveat pertains only to the test method (Section 12) described in 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 165 Test Method for Measuring Compressive Properties of Thermal Insulations[2]

C 168 Terminology Relating to Thermal Insulation 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 203 Test Methods for Breaking Load and Flexural Properties of Block-Type Thermal Insulation[2]

C 302 Test Method for Density and Dimensions of Preformed Pipe-Covering-Type Thermal Insulation[2]

C 303 Test Method for Dimensions and Density of Preformed Block-Type Thermal Insulation[2]

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

C 356 Test Method for Linear Shrinkage of Preformed High-Temperature Thermal Insulation Subjected to Soaking Heat[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 421 Test Method for Tumbling Friability of Preformed Block-Type Thermal Insulation[2]

C 446 Test Method for Breaking Load and Calculated Modulus of Rupture of Preformed Insulation for Pipes[2]

C 450 Practice for Prefabrication and Field Fabrication of Thermal Insulating Fitting Covers for NPS Piping, Vessel Lagging, and Dished Head Segments[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 795 Specification for Thermal Insulation for Use In Contact with Austenitic Stainless Steel[2]

C 870 Practice for Conditioning of Thermal Insulating Materials[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]

E 84 Test Method for Surface Burning Characteristics of Building Materials[3]

3. Terminology

3.1 *Definitions*—For definitions used in this specification, see Terminology C 168.

4. Classification

4.1 Thermal insulation shall be of the following types:

4.1.1 *Type I*—For use on surfaces at temperature to 1200°F (649°C).

4.1.2 *Type II*—For use on surfaces at temperatures up to 1700°F (927°C).

5. Description

5.1 *Composition*—Calcium silicate thermal insulation shall consist principally of hydrous calcium silicate usually with the incorporation of fibrous reinforcement. Asbestos shall not be used as a component in the manufacture of the material.

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

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

TABLE 1 Physical Requirements

NOTE 1—The physical requirements are based on the properties of samples dried or conditioned, or both, as specified in the referenced test methods. Calcium silicate insulation tends to absorb moisture to varying degrees depending on exposure conditions. It can absorb up to 4 times its dry weight if placed in direct contact with water through improper storage or application.

NOTE 2—The user is advised that some applications could require the knowledge of the thermal conductivity of the insulation material at mean temperatures above those shown. Consult the manufacturer for data at mean temperatures exceeding those listed.

	Type I	Type II
Use temperature, max, °F (°C)	1200 (649)	1700 (927)
Density (dry), max, lb/ft^3 (kg/m^3)	15 (240)	22 (352)
Flexural strength, min, psi (kPa)	50 (344)	50 (344)
Compressive strength, min, at 5 % deformation, psi (kPa)	100 (688)	100 (688)
Mass loss by tumbling, max, %		
after first 10 minutes	20	20
after second 10 minutes	40	40
Soaking heat linear shrinkage, max,%	2	2
Hot surface performance:		
warpage, max, in. (mm)	¼ (6)	¼ (6)
cracking	No cracks completely through the insulation thickness. Surface cracks on hot face are acceptable	
Apparent thermal conductivity[A] (see Note 2)		
Btu-in./h-ft^2-°F (W/m-K)max at mean temperature of:		
200°F (93°C)	0.45 (0.065)	0.54 (0.078)
300°F (149°C)	0.50 (0.072)	0.58 (0.084)
400°F (204°C)	0.55 (0.079)	0.61 (0.088)
500°F (260°C)	0.60 (0.087)	0.64 (0.092)
600°F (316°C)	0.66 (0.095)	0.67 (0.097)
700°F (371°C)	0.71 (0.102)	0.70 (0.101)
800°F (427°C)	...	0.73 (0.105)
900°F (482°C)	...	0.75 (0.108)
1000°F (538°C)	...	0.77 (0.111)
Surface burning characteristics:		
Flame spread index, max	0	0
Smoke density index, max	0	0
As shipped moisture content, by weight, max %	20	20

[A] The thermal transmission properties of calcium silicate block and pipe insulation may vary with temperature, temperature gradient, moisture content, thickness, and shape. Note that the apparent thermal conductivity requirements in the table are based on samples tested under the conditions specified in 12.1.2. These are comparative values for establishing specification compliance. They may not represent the installed performance of the insulation under use conditions differing substantially from the test conditions.

6. Standard Shapes, Sizes, and Dimensions

6.1 Calcium silicate block-type thermal insulation shall be supplied in the form of flat or curved blocks as specified. Standard sizes of the block type insulation shall be as follows:

6.1.1 *Flat Block*—Flat block shall be furnished in lengths of 18 or 36 in. (458 or 914 mm), widths of 6 to 36 in. (152 to 914 mm), and thicknesses from 1 to 6 in. (25 to 152 mm) in ½-in. (13-mm) increments. Thicknesses greater than 3 in. (76 mm) may be furnished in 2 or more layers when specified by the purchaser.

6.1.2 *Curved Block*—Curved block may be furnished in lengths of 36 in. (914 mm), widths of approximately 6 to 12 in. (152 or 305 mm), thicknesses of 1½ to 4 in. (38 to 101 mm) in ½-in. (13-mm) increments, and curved to inside radii of over 16½ in. (419 mm). Individual dimensions shall conform to those specified by the manufacturer.

6.1.3 *Grooved Block*—Grooved block may be furnished in lengths of 36 in. (914 mm), widths of 12 or 18 in. (305 or 458 mm), and thicknesses from 1 to 6 in. (25 to 152 mm) in ½-in. (13-mm) increments. Size and spacing of grooves shall be as specified by the manufacturer. Long edges of grooved block may be furnished beveled as specified by the manufacturer.

6.2 *Calcium Silicate Pipe Insulation*—Calcium silicate pipe insulation shall be supplied either as hollow cylindrical shapes split in half lengthwise (in a plane including the cylindrical axis) or as curved segments. The pipe insulation shall be furnished in sections or segments in a length of 36 in. (914 mm) to fit standard sizes of pipe and tubing, and in nominal wall thicknesses from 1 to 6 in. (25 to 152 mm), in ½ in. (13 mm) increments. Thicknesses greater than 3 in. (76 mm) may be furnished in two or more layers. Inner and outer diameters shall be in accordance with those standard dimensions specified in Practice C 585.

NOTE 1—Molded fitting insulation, which satisfies Practice C 450, may be available for some size/thickness combinations of certain fitting types, as specified by the manufacturer. When multilayer sectional pipe insulation is required, it is necessary to consider the inside and outside diameters of each layer to ensure proper nesting of materials when installed. Necessity of furnishing multilayer pipe insulation nested from the manufacturer shall be based on manufacturer's ability to control outside diameters on inner layers to not greater than inside diameters, at minus tolerances, of nesting outer layer under normal production, as agreed to between purchaser and manufacturer.

7. Dimensional Tolerances

7.1 *General*—The average tolerances for length, width, and thickness shall be as following:

	Block	Pipe
Length	± ⅛ in. (3 mm)	± ⅛ in. (3 mm)
Width	± ⅛ in. (3 mm)	
Thickness	± ⅛ in. (3 mm)	
Inner Diameter		in accordance with Practice C 585
Outer Diameter		in accordance with Practice C 585

7.2 *Pipe Insulation*—The following additional dimensional tolerances apply only to calcium silicate pipe insulation supplied as half sections.

7.2.1 *Fit and Closure*—When fitted to the appropriate size pipe by banding on 9-in. (229-mm) centers, the longitudinal seams on both sides of the pipe insulation shall close to within 1/16 in. (2 mm) along the entire length of the section.

7.2.2 *Concentricity*—The inner bore of the pipe insulation shall be concentric with the outer cylindrical surface. The deviation from concentricity shall not exceed ⅛ in. (3 mm) or 5 % of the wall thickness, whichever is greater.

7.2.3 *Half-Section Balance*—The plane formed by the slit between half sections shall include the cylindrical axis. Deviation of the slit plane from the cylindrical axis over a 36-in. (914-mm) length shall not exceed ⅛ in. (3 mm).

7.3 *Grooved Block*—The following additional requirements apply only to calcium silicate block insulation containing grooves and intended for installation over curved surfaces, 20 in. (508 mm) in diameter of larger.

7.3.1 *Fit and Closure*—When fitted to the curved surface, the grooves shall close to ⅛ in. (3 mm) or less through the depth of the groove. The exposed surface crack shall not open more than ⅛ in. (3 mm).

8. Workmanship

8.1 Since some requirements for this material are not easily defined by a numerical value, the insulation shall not have visible defects that will adversely affect its service qualities.

9. Physical Requirements

9.1 The insulation shall conform to the physical requirements of Table 1.

10. Sampling

10.1 The insulation shall be sampled in accordance with Criteria C 390. Specific provision for sampling shall be agreed upon between the purchaser and the supplier as part of the purchase contract.

11. Qualification Requirements

11.1 The following requirements are generally employed for purpose of initial material or product qualification:

11.1.1 Flexural strength.
11.1.2 Compression strength.
11.1.3 Mass loss by tumbling.
11.1.4 Linear shrinkage after soaking heat.
11.1.5 Hot surface performance.
11.1.6 Apparent thermal conductivity.
11.1.7 Surface burning characteristics.
11.1.8 Moisture content.

12. Test Methods

12.1 The properties enumerated in this specification shall be determined in accordance with the following test methods. Samples shall be preconditioned in accordance with Practice C 870.

12.1.1 *Density and Dimensions*:

12.1.1.1 *Block Insulation*—Test Method C 303.

12.1.1.2 *Pipe Insulation*—Test Method C 302.

12.1.2 *Apparent Thermal Conductivity*:

12.1.2.1 *General*—Apparent thermal conductivity versus mean temperature shall be calculated in accordance with Practice C 1045. Determinations shall be made at four or more mean temperatures. Two of the test mean temperatures shall be within 25°F (14°C) of the highest and lowest mean temperature specified in Table 1 for the appropriate material type. The other two determinations shall be made at mean temperatures spaced equally within the specified range. All test temperatures shall be selected in accordance with Practice C 1058 and reported in the test results.

12.1.2.2 The results of these tests shall be interpolated through reasonable curve fitting or numerical techniques, to establish the apparent thermal conductivity at the specified mean temperature.

12.1.2.3 *Block Insulation*—Test Methods C 177, C 518, or C 1114 using 1½ ± ½ in. (38 ± 13 mm) thick specimens of block insulation.

12.1.2.4 *Pipe Insulation*—Test Method C 335 using 1½ ± ½ in. (38± 13 mm) thick specimens of pipe insulation as supplied for a fit to 3 in. nominal iron pipe.

12.1.3 *Linear Shrinkage After Heat Soaking*—Test Method C 356. The test temperature shall be as specified in 4.1.

12.1.4 *Flexural Strength*:

12.1.4.1 *Block Insulation*—Test Methods C 203.

12.1.4.2 *Pipe Insulation*—Test Method C 446.

12.1.5 *Compressive Strength (Block Insulation Only)*—Test Method C 165, Procedure A.

12.1.6 *Mass Loss by Tumbling*—Test Method C 421.

12.1.7 *Hot Surface Performance*—Test Method C 411. The test temperature shall be that specified in 4.1 or the manufacturer's recommended temperature limit, whichever is higher. The thickness of the specimen shall be the manufacturer's recommended thickness for the test temperature.

12.1.8 *Surface Burning Characteristics*—Test Method E 84.

12.1.9 *Stress Corrosion Performance*—If requested by the purchaser, test according to the test method in Specification C 795.

12.1.10 *As Shipped Moisture Content By Weight*:

12.1.10.1 *Scope*—This test method covers determination of moisture content by weight of calcium silicate insulation as shipped from the manufacturer's warehouse.

12.1.10.2 *Significance and Use*—Calcium silicate insulation is manufactured from a wet slurry mixture; the moisture content after drying or curing will affect the thermal performance and density of the product in the as shipped state.

12.1.10.3 *Test Specimen*—The test specimen shall be of a size that can be conveniently tested in a drying oven not less than 6 by 6 by 2 in. thick (150 by 150 by 51 mm).

12.1.10.4 *Apparatus*—Drying oven and scale (accurate to within ½ oz (7 g).

12.1.10.5 *Procedure*—The specimen shall be weighed. This mass should be recorded as the initial weight. The specimen shall then be placed in a drying oven at a temperature above 215°F (102°C) and not to exceed 300°F (149°C) (Dry for approximately 24 h for materials 2 in. (51 mm) thick and less, and 48 h for materials over 2 in. thick (51 mm)). Cool the specimen to room temperature in a desiccator and reweigh. Repeat the process until successive weighings agree to within 0.2 % of the specimen weight obtained in the latest weighing. Record this weight as the moisture-free weight.

12.1.10.6 *Calculations*—Calculate as shipped moisture content as follows:

$$M = 100\ [(I - W_{MF})/W_{MF}] \quad (1)$$

where:

M = moisture content, weight, percent,
W_{MF} = moisture-free specimen weight, and
I = initial specimen weight.

12.1.10.7 *Precision and Bias*—The precision of this test method is not known because inter-laboratory data are not available. Inter-laboratory data are being obtained and a precision statement will be added with the next revision.

13. Inspection

13.1 The following requirements are generally employed for purposes of acceptance sampling of lots or shipments of qualified calcium silicate insulation:

13.1.1 Density,
13.1.2 Dimensional tolerances, and
13.1.3 Workmanship.

14. Rejection and Rehearing

14.1 Material that fails to conform to the requirements of the agreed-upon specification may be rejected. Rejection should be reported to the producer or supplier promptly and in writing. In case of dissatisfaction with the results of the test, the producer or supplier may make claim for a rehearing.

14.2 Upon the request of the purchaser in the contract or order, the certification of an independent third party indicating conformance to the requirements of this specification may be accepted instead of the manufacturer's certification.

15. Certification

15.1 When specified in the purchaser order or contract, a producer's or supplier's certification shall be furnished to the purchaser that the material was manufactured, sampled, tested, or inspected in accordance with this specification and has been found to meet the requirements. When specified in the purchase order or contract, a report of the test results shall be furnished.

16. Packaging and Marking

16.1 *Packaging*—Material shall be packaged to afford protection against deterioration and damage during shipment from the manufacturer to the initial destination. Unless otherwise agreed upon or specified between the purchaser and manufacturer or supplier, material shall be packaged in containers supplied by the manufacturer and commonly used for this purpose. Shipping containers shall comply with the regulations applicable to the mode of transportation.

16.2 *Marking*—Unless otherwise specified, each container shall be plainly marked with the manufacturer's name, address, telephone number, product name, type, quantity of insulation, nominal dimensions, and jacket type and accessories, if any, of the material in the container.

17. Keywords

17.1 block and pipe thermal insulation; calcium silicate; thermal conductivity; thermal insulation