Designation: C 610 – 07

# Standard Specification for Molded Expanded Perlite Block and Pipe Thermal Insulation[1]

This standard is issued under the fixed designation C 610; 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 Department of Defense.*

## 1. Scope

1.1 This specification covers molded expanded perlite block, fittings, and pipe thermal insulation intended for use on surfaces with temperatures between 80 to 1200°F (27 to 649°C).

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 When the installation or use of thermal insulation materials, accessories, and systems may pose safety or health problems, the manufacturer shall provide the user 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 following safety caveat applies only to the test methods portion of 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:* [2]

C 165 Test Method for Measuring Compressive Properties of Thermal Insulations

C 168 Terminology Relating to Thermal Insulation

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

C 203 Test Methods for Breaking Load and Flexural Properties of Block-Type Thermal Insulation

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

C 303 Test Method for Dimensions and Density of Preformed Block and Board–Type Thermal Insulation

C 335 Test Method for Steady-State Heat Transfer Properties of Pipe Insulation

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

C 390 Practice for Sampling and Acceptance of Thermal Insulation Lots

C 411 Test Method for Hot-Surface Performance of High-Temperature Thermal Insulation

C 421 Test Method for Tumbling Friability of Preformed Block-Type Thermal Insulation

C 450 Practice for Fabrication of Thermal Insulating Fitting Covers for NPS Piping, and Vessel Lagging

C 518 Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus

C 585 Practice for Inner and Outer Diameters of Rigid Thermal Insulation for Nominal Sizes of Pipe and Tubing (NPS System)

C 692 Test Method for Evaluating the Influence of Thermal Insulations on External Stress Corrosion Cracking Tendency of Austenitic Stainless Steel

C 795 Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel

C 1045 Practice for Calculating Thermal Transmission Properties Under Steady-State Conditions

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

E 84 Test Method for Surface Burning Characteristics of Building Materials

## 3. Terminology

3.1 *General*—Terminology C 168 shall be considered as applying to the terms used in this specification.

3.2 *Definitions of Terms Specific to This Standard:*

[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.

3.2.1 *composition*—molded expanded perlite block, fitting, and pipe thermal insulation shall be composed principally of expanded perlite and silicate binders. It may also contain reinforcing fibers.

## 4. Standard Shapes, Sizes, and Dimensions

4.1 Molded expanded perlite block, fitting, and pipe thermal insulation shall be as follows:

4.1.1 *Block*—Block shall be furnished in lengths of either 36 or 39.37 in. (914 or 1000 mm), widths of 6 in. (152 mm), 12 in. (305 mm), 18 in. (457 mm), or 24 in. (610 mm), and in thickness from 1½ to 6 in. (38 to 152 mm) in increments of ½ in. (13 mm).

4.1.2 *Pipe Insulation*—Molded expanded perlite 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 lengths of either 36 or 39.37 in. (914 or 1000 mm) to fit standard sizes of pipe and tubing, and in nominal thickness from 1 to 4 in. (25 to 102 mm) in ½-in. (13-mm) increments. Inner and outer diameters of multilayer construction may be specified. Inner and outer diameters shall be in accordance with those standard dimensions specified in Practice C 585. Since outside diameter tolerances may be different under individual manufacturing processes, it may be necessary to have pipe insulation furnished in two or more layers nested by the manufacturer. The purchaser shall consult the manufacturer for specific requirements.

4.1.3 *Fittings*—Molded (expanded insulation fittings shall conform to the inner and outer diameters in accordance with those standard dimensions specified in Practice C 585. Mitered fittings shall be in accordance with Practice C 450.

## 5. Dimensional Tolerances

5.1 *General*—The average tolerances for length, width, and thickness shall comply with the requirements shown in Table 1.

5.2 *Pipe Insulation*—The following additional tolerances apply to perlite pipe insulation supplied as half sections:

5.2.1 *Fit and Closure*—When fitted to the appropriate size pipe, the longitudinal seam of the pipe insulation shall close to within 1⁄16 in. (1.6 mm) along the entire length of the section.

5.2.2 *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. (3.2 mm) or 5 % of the wall thickness, whichever is greater.

5.2.3 *Half-Section Balance*—The plane formed by the split between half sections shall include the cylindrical axis. Deviation of the split plane from the cylinder axis over the 36 or 39.37-in. (914 or 1000-mm) length shall not exceed ⅛ in. (3.2 mm).

**TABLE 1 Dimensional Tolerances**

| | Block | Pipe |
|---|---|---|
| Length | ± ⅛ in. (3.2 mm) | ± ⅛ in. (3.2 mm) |
| Width | ± ⅛ in. (3.2 mm) | ... |
| Thickness | ± ⅛ in. (3.2 mm) | ± ⅛ in. (3.2 mm) |
| Inner Diameter | ... | in accordance with Practice C585 |
| Outer Diameter | ... | in accordance with Practice C585 |

## 6. Workmanship, Finish, and Appearance

6.1 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.

## 7. Physical Requirements

7.1 The insulation shall conform to the physical requirements in Table 2.

## 8. Sampling

8.1 The insulation shall be sampled in accordance with Practice C 390. Specific provision for sampling shall be agreed upon between the purchaser and the supplier.

## 9. Qualification Requirements

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

9.1.1 Flexural strength,
9.1.2 Compressive strength,
9.1.3 Surface burning characteristics,
9.1.4 Linear shrinkage after soaking heat,
9.1.5 Water absorption after heat aging,
9.1.6 Apparent thermal conductivity,
9.1.7 Hot-surface performance,
9.1.8 Stress corrosion cracking of austenitic stainless steel, and
9.1.9 Weight loss by tumbling.

## 10. Acceptance Requirements

10.1 The following requirements are generally employed for purposes of acceptance sampling of lots or shipments of qualified products:

10.1.1 Density,
10.1.2 Dimensional tolerances,
10.1.3 Workmanship, and
10.1.4 Moisture content.

## 11. Test Methods

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

11.1.1 *Density*:
11.1.1.1 *Block Insulation*—Test Method C 303.
11.1.1.2 *Pipe Insulation*—Test Method C 302.
11.1.2 *Apparent Thermal Conductivity*:
11.1.2.1 *Block Insulation*—Test Method C 177 per Practice C 1058 large temperature difference method or Test Method C 518, using 1½ ± ½-in. (38 ± 13-mm) thick specimens.
11.1.2.2 *Pipe Insulation*—Test Method C 335, using 1½ ± ½ in. (38± 13-mm) thick specimens of pipe insulation as supplied for fit to 3-in. nominal iron pipe.
11.1.2.3 *General*—Determinations shall be made at four mean temperatures within the temperature range in accordance with Practice C 1058. The results of these tests shall be used to calculate thermal transmission properties in accordance with Practice C 1045.
11.1.3 *Linear Shrinkage After Heat Soaking*—Refer to Test Method C 356. The test temperature shall be 1200°F (649°C).
11.1.4 *Flexural Strength*:

**TABLE 2 Physical Requirements[A]**

| | | Pipe | Block |
|---|---|---|---|
| Density, lb/ft$^3$(kg/m$^3$) | min | 10 (160) | 10 (160) |
| | max | 14 (224) | 14 (224) |
| Flexural Strength, Lb/in. (kPa) | min | 45 (310) | 45 (310) |
| Stress corrosion Cracking of Austentic Stainless Steel | pass | ... | ... |
| Compressive Strength at 5% Deformation, lb/in.$^2$(kPa) | min | 70 (483) | 70 (483) |
| Weight Loss by Tumbling, % loss in Weight after 10 minutes | max | 70 | 70 |
| Moisture content,[B]% by weight | max | 10 | 10 |
| Linear Shrinkage,% at 1200°F (649°C) for 24 h max | length | 2 | 2 |
| | width | 2 | 2 |
| | thickness | 8 | 8 |
| Apparent Thermal Conductivity[C] Btu-in./h-ft$^2$—°F (W/m/K), max | Mean Temperature | App. Thermal Conductivity by Test Method C 335 | App. Thermal Conductivity by Test Method C 177 or C518 |
| | 100°F (38°C) | 0.48 (0.069) | 0.48 (0.069) |
| | 200°F (93°C) | 0.53 (0.076) | 0.53 (0.076) |
| | 300°F (149°C) | 0.59 (0.085) | 0.59 (0.085) |
| | 400°F (204°C) | 0.64 (0.092) | 0.64 (0.092) |
| | 500°F (260°C) | 0.69 (0.099) | 0.69 (0.099) |
| | 600°F (316°C) | 0.75 (0.108) | 0.75 (0.108) |
| | 700°F (371°C) | 0.80 (0.115) | 0.80 (0.115) |
| Water Absorption of Thermal Insulation after heat aging and 48 h Water Immersion, moisture gain , % by weight | 600 °F (316°C) | 50 | 50 |
| Surface Burning Characteristics | | | |
| Flame spread, max | | 0 | 0 |
| Smoke Developed, max | | 5 | 5 |
| Hot-surface Performance | | | |
| Warpage, in. (mm), max | | ¼ (6) | ¼ (6) |
| Cracking | | No cracks completely through the insulation thickness. Surface cracks on hot face are acceptable. | |

[A] Physical property requirements shown are for the materials in the as-manufactured condition. They may or may not represent the values of these properties under certain in-service conditions, depending on the type of installation and the ultimate temperature exposure.

[B] Water absorption values shown are for insulation in the as-manufactured condition. Those portions of the insulation exposed to elevated temperatures may not retain their water absorption characteristics.

[C] The thermal transmission properties of perlite block and pipe insulation may vary with temperature, temperature gradient, thickness, and shape. Note that the apparent thermal conductivity requirements in the table are based on samples tested under the conditions specified in Test Methods C 177 or C 335. These are comparative values for establishing specification compliance. They may not represent the installed performance of the insulation under use conditions differing substantially from test conditions.

11.1.4.1 *Block Insulation*—Test Methods C 203, test 2-in. (50-mm) thick specimens.

11.1.4.2 *Pipe Insulation*—

11.1.5 *Compressive Strength (Block Insulation Only)*—Test Method C 165. Test 2-in. (50-mm) thick specimens.

11.1.6 *Weight Loss by Tumbling*—Test Method C 421.

11.1.7 *Moisture Content*—Four specimens, each 6 by 6 in. (150 by 150 mm) by 2 in. (50 mm) thick shall be tested. Each of the four specimens shall then be placed in a controlled environment of 73 ± 4°F (23 ± 2°C) and a relative humidity of 50 ± 5 % for a minimum of 24 h. The specimens should then be weighed to the nearest 0.1 g. These weights should be recorded as the as-received weights. The specimens should then be placed in an air-circulating oven at a temperature of 250 ± 5°F (121 ± 3°C) for a minimum of 2 h. 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 these weights as the moisture-free weight. The moisture content can then be calculated as follows:

$$\text{moisture content} = 100 \times (W_{AR} - W_{MF})/W_{MF} \quad (1)$$

where:

$W_{AR}$ = as-received specimen weight, and

$W_{MF}$ = moisture-free specimen weight.

The value reported should be the numerical average of the calculated moisture content of the four specimens rounded to the nearest 1 %.

11.1.8 *Water Absorption After Heat Aging*:

11.1.8.1 *Scope*—This test method covers a laboratory procedure for evaluating the moisture resistance of molded expanded perlite block thermal insulation when exposed to three specific operating temperatures.

11.1.8.2 *Significance and Use*:

(*1*) Molded perlite insulation products are formulated to be resistant to water absorption. It is important that the materials

retain a large proportion of their water resistance even after exposure to elevated temperatures.

(2) This test method is used to determine the water resistance after submersion of perlite insulation materials after exposure to soaking heat.

11.1.8.3 *Test Specimens*—Specimens are to be 6 ± ⅛ by 3½ ± ⅛-in. (152 ± 3 by 89 ± 3-mm) by 2 ± ⅛-in. (51 ± 3-mm) thick perlite block. Four specimens are required. Mark each specimen for identification. The density of each specimen can be no greater than 14.0 lb/ft$^3$ (224 kg/m$^3$).

11.1.8.4 *Apparatus*:

(*1*) *Steel Rule*, graduation in 1⁄16 in.

(*2*) *Electric Oven*, capable of maintaining temperatures as high as 700°F (371°C) with a ±10 % to 5 % accuracy.

11.1.8.5 *Procedure*:

(*1*) Place three specimens in the electric oven. The fourth block will be retained as a control specimen.

(*2*) Operate the oven at 300°F (149°C) for a minimum of 24 h. Remove one of the specimens and allow it to cool in a controlled environment of 73.4 ± 1.8°F (23 ± 1°C) and 50 ± 5 % relative humidity before testing.

(*3*) Operate the oven at 500°F (260°C) for a minimum of 24 h. Remove one of the specimens and allow it to cool in a controlled environment of 73.4 ± 1.8°F (23 ± 1°C) and 50 ± 5 % relative humidity before testing.

(*4*) Operate the oven at 700°F (371°C) for a minimum of 24 h. Remove one of the specimens and allow it to cool in a controlled environment of 73.4 ± 1.8°F (23° ± 1°C) and 50 ± 5 % relative humidity before testing.

NOTE 1—**Precaution:** In addition to other precautions, wear appropriate hand protection to avoid injury when removing hot specimens from the oven.

(*5*) After all of the specimens have cooled for at least 12 h in a desiccator, weigh each of the three heat-treated specimens and the control specimen to the nearest 0.1 g.

(*6*) Completely immerse each specimen so that a head of 1 in. of distilled water at ambient temperature is maintained for a minimum of 48 h. Withdraw each specimen and quickly wipe off excess surface moisture with a damp cloth. Immediately weigh each specimen to the nearest 0.1 g.

11.1.8.6 *Calculation*—Calculate the percent of water absorption by weight, using the weights obtained after heat soaking as the dry weight. The calculation should be as follows:

$$\text{water absorption} = 100 \times (W_{AI} - W_{AHS})/W_{AHS} \quad (2)$$

where:

$W_{AI}$ = after immersion specimen weight, and

$W_{AHS}$ = after heat soak specimen weight.

11.1.8.7 *Report*—The report shall include the density of the specimens and the water absorption after immersion.

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

11.1.10 *Hot-Surface Performance*—Test Method C 411 at 1200°F (649°C).

11.1.11 *Stress Corrosion Cracking of Austenitic Stainless Steel*—Test Method C 692 for preproduction qualification.

11.1.12 *Precision and Bias*—Precision and bias have not yet been determined but are being investigated. A precision and bias statement will be included when the proper data have been obtained and analyzed.

## 12. Inspection

12.1 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 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.

13.2 In case of rejection, the manufacturer or supplier will 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. Certification

14.1 When specified in the purchase 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.

14.2 Certification to the stress corrosion requirements of Specification C 795 can be supplied for a given production lot if requested in the purchase order.

## 15. Packaging and Marking

15.1 *Packaging*—Unless otherwise agreed upon or specified between the purchaser and manufacturer or supplier, block and pipe insulation shall be packed in the manufacturer's standard commercial containers.

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

## 16. Keywords

16.1 block; expanded perlite; fittings; molded; pipe; thermal insulation