Designation: C 417 – 93 (Reapproved 1998)

Standard Test Method for Thermal Conductivity of Unfired Monolithic Refractories[1]

This standard is issued under the fixed designation C 417; 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 test method supplements Test Method C 201, and shall be used in conjunction with that test method for determining the thermal conductivity of unfired monolithic refractories.

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

1.3 *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.*

2. Referenced Documents

2.1 *ASTM Standards:*

C 180 Method of Panel Spalling Testing Fireclay Plastic Refractories[2]

C 182 Test Method for Thermal Conductivity of Insulating Firebrick[3]

C 201 Test Method for Thermal Conductivity of Refractories[3]

C 862 Practice for Preparing Refractory Concrete Specimens by Casting[3]

E 220 Method for Calibration of Thermocouples by Comparison Techniques[4]

3. Significance and Use

3.1 The thermal conductivity of monolithic refractories is a property required for selecting their thermal transmission characteristics. Users select monolithic refractories to provide specified conditions of heat loss and cold face temperature, without exceeding the temperature limitation of the monolithic refractory. This test method establishes placement of thermocouples and positioning of test specimens in the calorimeter.

3.2 This procedure must be used with Test Method C 201 and requires a large thermal gradient and steady state conditions. The results are based upon a mean temperature.

3.3 The data from this test method are suitable for specification acceptance, estimating heat loss and surface temperature, and the design of multi-layer refractory construction.

3.4 The use of these data requires consideration of the actual application environment and conditions.

4. Apparatus

4.1 The apparatus shall be in accordance with Test Method C 201, modified as in 4.2 of this test method, with the addition of thermocouples and refractory fiber paper, as described in Sections 6 and 7.

4.2 The furnace shall be modified by drilling a nominal ⅜-in. (10-mm) diameter hole (Fig. 1) through the insulating firebrick in the furnace wall at each end of the center line of the 18-in. (456-mm) dimension of the furnace cavity. These holes shall be positioned so that the length of the hole will be parallel to the calorimeter surface and the bottom of the hole will coincide with the surface of the calorimeter. Copper tubing shall be placed within each hole so that a compressed-air source can be attached to one side and flexible leads to a flowmeter can be attached to the other.

4.3 A compressed-air supply and flowmeter for air.

5. Test Specimens

5.1 *Castable Refractories*—The test specimens may consist of either a panel 18 by 13½ by 2½ in. (456 by 342 by 64 mm), or an assembly of three straights 9 by 4½ by 2½ in. (228 by 114 by 64 mm) and six soaps 9 by 2¼ by 2½ in. (228 by 57 by 64 mm). These specimens shall be prepared as in one of the following methods and in general accordance with the manufacturer's recommendation for water content and Practice C 862.

5.1.1 *Panel Specimens*—This test specimen shall be a monolithic panel 18 by 13½ by 2½ in. (456 by 342 by 64 mm) in size, and shall be prepared in general accordance with Practice C 862, as outlined in 5.1. The panel shall be cast in a steel mold with two steel rods (Note 1) taped in place at the center line of the 18-in. length of the mold cavity. These steel

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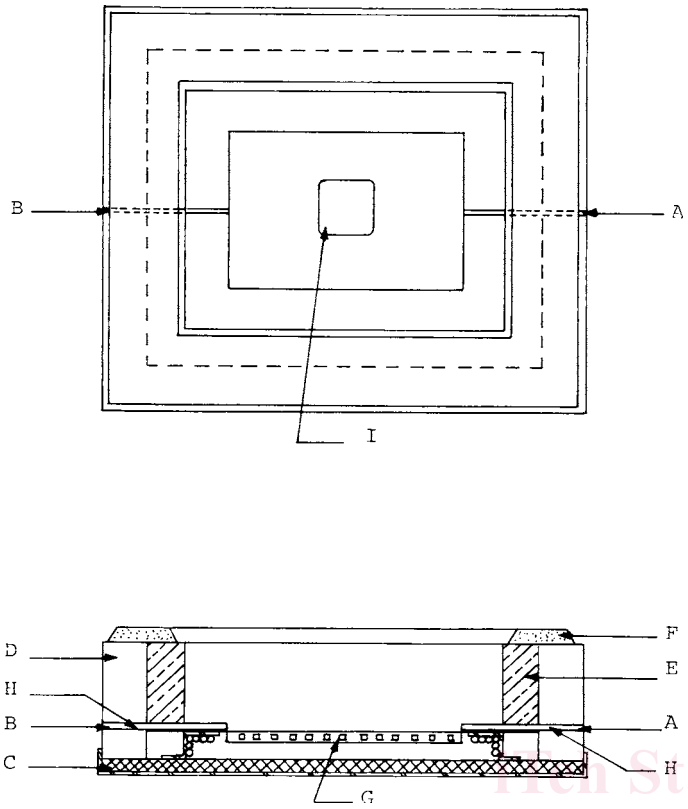
[2] Discontinued, see 1984 *Annual Book of ASTM Standards*, Vol 15.01.

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

[4] *Annual Book of ASTM Standards*, Vol 14.03.



A—Inlet air
B—Exhaust air
C—Transite board
D—Group 16 IFB
E—Group 28 IFB
F—Group 28 grindings
G—Calorimeter assembly
H—Copper tubing, nominal ⅜-in. (10-mm) diameter
I—Center calorimeter

FIG. 1 Furnace Modification

rods form the slot required so that the panel will fit over the tubing used for the entrance and exhaust of air and moisture from the furnace (see Fig. 1).

NOTE 1—Two ½-in. (13-mm) diameter steel rods 2 in. (51 mm) long should have approximately 1/32 in. (0.8 mm) removed longitudinally to provide a flat base.

5.1.2 *Straight Specimens*—This test specimen shall be three 9 by 4½ by 2½-in. (228 by 114 by 64-mm) straight brick and six 9 by 2¼ by 2½-in. (228 by 57 by 64-mm) soap brick and shall be prepared in accordance with Practice C 862, as outlined in 5.1 and 5.1.1, and by cutting as required. The 9 by 4½-in. face of the three straight brick and the 9 by 2¼-in. face of the soap brick shall be flat and parallel, and the thickness shall not vary more than ±0.01 in. (±0.3 mm). No grinding of the finish face is required if care is taken when removing the excess mix with the strikeoff bar and slicking the exposed surface with a minimum amount of troweling. Steel rods (described in Note 1) shall be used in two cavities to provide the required slots for air entry and exit.

5.2 *Plastic Refractories*—The test specimens shall be of the size and number described in 4.1 of Test Method C 201, and shall be prepared in accordance with Method C 180 and 3.2 of Test Method C 201. The soap specimens shall be prepared by cutting dry 9-in. (228-mm) straight specimens with a suitable abrasive cut-off saw. The soap brick adjacent to the 9-in. face of the guard brick shall be slotted with a suitable abrasive cut-off saw at the center line of the 9-in. length to fit over the tubing used for the entrance, and exhaust of the air and moisture.

5.3 *Specimen Curing and Drying*—After the specified curing, the specimens shall be placed in a dryer at 250°F (120°C) for a minimum of 24 h, or until constant mass has been achieved.

6. Installation of Thermocouples in Test Specimen

6.1 *Thermocouples*—Embed calibrated[5] thermocouples in the test specimen at two points for measurement of temperature. Use platinum-10 % rhodium/platinum, Awg Gage 28 (0.320-mm) wire in making the thermocouples.

6.2 *Installation of Thermocouples*:

6.2.1 For castable specimens prepared in accordance with 5.1.1, use the following thermocouple installation procedure. Place the hot junction of the thermocouples in the center of each 18 by 13½-in. (456 by 342-mm) face and just below the surface of the test specimen. Cut grooves to receive the wire in each 18 by 13½-in. face to a depth of 1/32 in. (0.8 mm) by means of an abrasive wheel 0.02 in. (0.5 mm) in thickness. The layout for the grooves allows all of the cold-junction ends of the wires to extend from one end of the specimen. Cut a groove in the center of each 18 by 13½-in. face along the 18-in. dimension and ending 1½ in. (38 mm) from the center point of the specimen. Extend the path of each groove at an angle of 90° to one end of the specimen by cutting grooves parallel to the 13½-in. edges and 1½ in. from the center point of the specimen. Before cementing the thermocouple wires in place, take measurements to obtain, within 0.01 in. (0.3 mm), the eventual distance between the center lines of the thermocouple junctions. Do this by measuring the 2½-in. (64-mm) dimension of the specimens at the location for the hot junctions and deducting the distance between the center line of each junction in its embedded position and the surface of the specimen.

6.2.2 For castable specimens prepared in accordance with 5.1.2 and plastic refractory specimens prepared in accordance with 5.2, use the following thermocouple installation procedure. Place the hot junction of the thermocouples in the center of each 9 by 4½-in. (228 by 114-mm) face, and just below the surface of the test specimen. Cut grooves to receive the wire in each 9 by 4½-in. face of the brick to a depth of 1/32 in. (0.8 mm) by means of an abrasive wheel 0.02 in. (0.5 mm) in thickness. The layout for the grooves allows all of the cold-junction ends of the wires to extend from one end of the brick. Cut a groove in the center of each 9 by 4½-in. face along the 4½-in. dimension, and ending 1 in. (25 mm) from the edge of the specimen. Before cementing the thermocouple wires in place take measurements to obtain within ±0.01 in. (±0.3 mm) the eventual distance between the center lines of the thermocouple junctions. Do this by measuring the 2½-in. (64-mm) dimension of the brick at the location for the hot junctions and deducting

[5] Method E 220 specifies thermocouple calibration procedures for thermocouples.