Designation: C 182 – 88 (Reapproved 2004)

Standard Test Method for Thermal Conductivity of Insulating Firebrick[1]

This standard is issued under the fixed designation C 182; 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 to determine the thermal conductivity of insulating firebrick.

1.2 The values stated in inch-pound units are to be regarded as the standard. The values given 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:* [2]

C 155 Classification of Insulating Firebrick

C 201 Test Method for Thermal Conductivity of Refractories

E 220 Method for Calibration of Thermocouples by Comparison Techniques

3. Significance and Use

3.1 The thermal conductivity of insulating firebrick (IFB) is a property required for the selection of IFB for a specific thermal performance. Users select brick to provide a specified heat-loss and cold-face temperature without exceeding the temperature limitation of the brick. This test method establishes placement of thermocouples and the positioning of test samples in the calorimeter. This test method must be used with Test Method C 201.

4. Apparatus

4.1 The apparatus shall consist of that described in the Apparatus section of Test Method C 201 with the addition of thermocouples, drilling jig, and refractory fiber paper as described in Sections 6 and 7.

5. Test Sample

5.1 The test sample shall be selected and prepared as described in the Test Sample and Preparation section of Test Method C 201.

6. Installation of Thermocouples in Test Specimen

6.1 *Thermocouples*—Calibrated[3] thermocouples shall be embedded in the test specimen at three points for measuring the temperature. Chromel-Alumel thermocouples shall be used for temperatures below 1400°F (760°C), and above that temperature platinum-10 % rhodium/platinum thermocouples shall be used. The platinum thermocouples may also be used at the lower temperatures, but the electromotive force (emf) will not be as high as when using base-metal thermocouples. Wire of AWG 28 (0.320 mm) shall be used for making either type of thermocouple.

6.2 *Installation of Thermocouples*— Holes for the thermocouple wires shall be drilled through the 4½-in. (114-mm) dimension of the test specimen by the use of a drilling jig so as to obtain accurate placement of the thermocouples. The three thermocouples shall be located so that the hot junction of the first couple is 0.20 in. (5.1 mm) below the hot face of the test specimen, the junction of the second at the midpoint, and the junction of the third 0.20 in. above the cold face. The thermocouple wires leading out from the hot junctions shall be located in planes parallel to the calorimeter surface. In order to have the hot junctions over the center of the calorimeter, they shall be located on an axis passing through the center of and at right angles to the 9 by 4½-in. (228 by 114-mm) area of the test specimen.

NOTE 1—Insulating firebrick that cannot be prepared to this precision because of the structure of the product, should be prepared in accordance with the instructions for fireclay dense refractories.

7. Set-Up of Test Sample and Silicon Carbide Slab

7.1 Two strips of refractory fiber paper 13½ by ½ by 0.02 in. (343 by 13 by 0.5 mm) shall be placed along the 13½-in. dimension of the inner guard at the outside edges, as shown in Fig. 1. Twelve strips of refractory fiber paper 2 by ½ by 0.02 in. (51 by 13 by 0.5 mm) shall be placed on the outer guard at intervals in the pattern shown in Fig. 1. These strips serve as

[1] This test method is under the jurisdiction of ASTM Committee C08 on Refractories and is the direct responsibility of Subcommittee C08.02 on Thermal Stress Resistance.

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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] Method E 220 specifies calibration procedures for thermocouples.

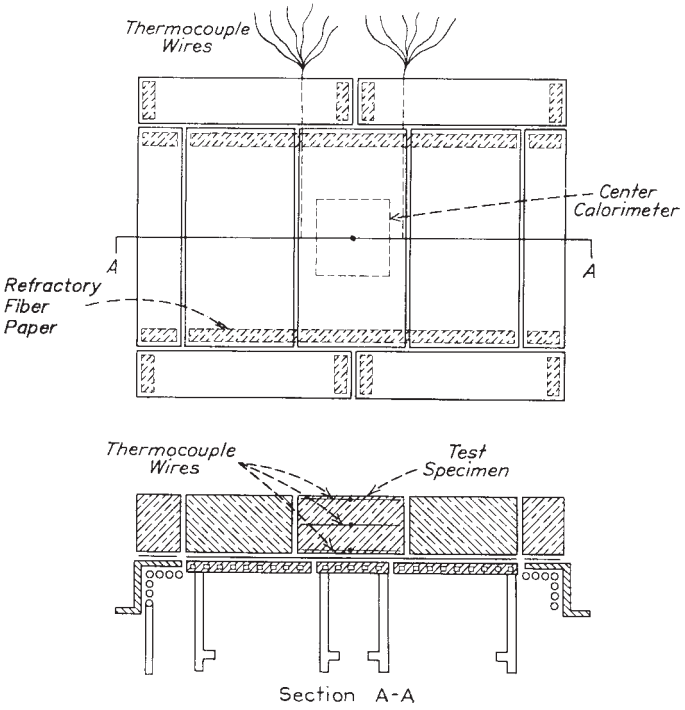

FIG. 1 Arrangement of Refractory Fiber-Paper Strips in Calorimeter Assemblage

spacers to prevent contact between the test material and the calorimeter assembly. The test specimen shall be placed centrally over the center of the calorimeter section on its 9 by 4½-in. (228 by 114-mm) face, the guard brick placed at the sides of the test specimen so as to completely cover the calorimeter and inner guard area, and the soap brick placed around the edge of the three brick so as to completely cover the calorimeter assembly. The small space between the furnace walls and the test brick assembly shall be filled with a granulated insulating firebrick.

7.2 When testing Group 28, 30, 32, or 33 insulating firebrick, it may be desirable to obtain test results at higher mean temperatures than is possible with the sample set-up described in 7.1. This can be accomplished by placing a 0.5-in. (13-mm) thick layer of ceramic fiber-block insulation or 0.5 in. of Group 20 insulating firebrick between the calorimeter area and the test sample. Sufficient material is required to cover an area 18 by 13½ in. (456 by 342 mm). The solid sheet of back-up insulation shall be ground so as to provide surfaces that are plane and do not vary from parallel by more than ±0.01 in. (0.3 mm). This shall be placed on the refractory fiber strips described in 7.1. Additional refractory fiber strips, in an identical pattern, shall be placed on top of the ceramic fiber board. The test specimen and guard brick shall then be placed as described in 7.1.

7.3 The silicon carbide slab shall be placed over the 9 by 13½-in. (228 by 342-mm) area of the three 9-in. sample brick, and it shall be spaced 1 in. (25 mm) above the sample by placing under each corner of the slab rectangular pieces of Group 30 or 32 (see Classification C 155) insulating firebrick cut to measure ⅜ in. (10 mm) square and 1.00 in. (25.4 mm) in length.

8. Procedure

8.1 Place the heating chamber in position, start the water flowing through the calorimeter assembly, and supply the current to the heating unit. Above a temperature of 1470°F (800°C), the furnace atmosphere shall contain a minimum of 0.5 % oxygen with zero % combustibles. Take the atmosphere sample from the furnace chamber proper, preferably as near the test specimen as possible. Maintain the rate of water flow through the calorimeter between 120 and 200 g/min, and determine by weighing the quantity of water collected during a measured time period. The mass of water collected shall be not less than 200 g and shall be weighed to an accuracy of ±0.5 g. The rate of flow shall be constant within± 1 % during the test period.

8.2 Allow the furnace to reach a condition of steady state of heat flow (test period), which shall be that condition when the measured flow of heat into the calorimeter varies less than 2 % over a 2-h period, during which time the temperature difference between the calorimeter and inner guard has not been more than 0.05°F (0.03°C), the hot face of the test specimen has not varied more than ±5°F (±3°C), and the temperature of the water entering the calorimeter has not varied at a rate of more than 1°F (0.5°C)/h (Note 2). Usually, 12 h or more are needed to obtain a balance with the apparatus after a definite change is made in the hot-face temperature.

NOTE 2—Significant errors will result if the tolerances specified are exceeded.

8.3 After the steady state of heat flow has been reached, measure the temperature of the test specimen, the rate of water flow through the calorimeter, and the temperature rise of the water flowing through the calorimeter. Take at least four sets of readings (Note 3) at approximately 30-min intervals during the 2-h holding period, and average these for the final values for that particular heating chamber temperature. Obtain such data when the heating chamber is maintained at the temperatures recommended in Table 1. Temperatures other than those given in the table may be used to obtain additional information.

NOTE 3—From these data a preliminary thermal conductivity calculation may be made, using estimated distances between thermocouple junctions in the test specimen.

8.4 At the conclusion of the test, remove the specimen and cut it in two, close to the thermocouple junctions. Then grind the specimen to expose the hot junctions, and measure the distance between their center lines to the nearest 0.01 in. (0.3 mm). If upon being cut in two the test specimen shows abnormal internal voids or cracks, state this fact in the report, as the results will not be representative of the material.

9. Record of Test Data, Calculations, and Report

9.1 The record of test data, the calculations, and the report shall be made in accordance with the Record of Test Data, Calculation, and Report sections of Test Method C 201.

10. Precision and Bias

10.1 Refer to Test Method C 201 for a statement of precision and bias.

TABLE 1 Heating Chamber Temperature

Group Number	Bulk Density Not Greater Than,		Recommended Temperatures for Control Points, °F (°C)		
	lb/ft^3	g/cm^3	Low	Medium	High
16	34	0.54	900 (480)	. . .	1600 (870)
20	40	0.64	900 (480)	1400 (760)	2000 (1095)
24	48	0.77	900 (480)	1500 (815)	2300 (1260)
26	54	0.86	900 (480)	1650 (900)	2600 (1425)
28	60	0.96	900 (480)	1750 (955)	2800 (1540)
30	68	1.09	900 (480)	1750 (955)	2800 (1540)
32	95	1.52	900 (480)	1750 (955)	2800 (1540)
33	95	1.52	900 (480)	1750 (955)	2800 (1540)

11. Keywords

11.1 calorimeter; insulating firebrick; refractories; thermal conductivity