Designation: C 113 – 02

Standard Test Method for Reheat Change of Refractory Brick[1]

This standard is issued under the fixed designation C 113; 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 test method covers the determination of the permanent linear change of refractory brick when heated under prescribed conditions.

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.

NOTE 1—Test methods incorporating additional provisions pertinent to specific refractory materials are given in the following Test Methods: C 179, C 210, and C 605.

1.3 *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 134 Test Methods for Size, Dimensional Measurements, and Bulk Density of Refractory Brick and Insulating Firebrick[2]

C 179 Test Method for Drying and Firing Linear Change of Refractory Plastic and Ramming Mix Specimens[2]

C 210 Test Method for Reheat Change of Insulating Firebrick[2]

C 605 Test Method for Reheat Change of Fireclay Nozzles and Sleeves[2]

E 230 Temperature-Electromotive Force (EMF) Tables for Standardized Thermocouples[3]

3. Significance and Use

3.1 Refractory brick and shapes of different compositions exhibit unique permanent linear changes after heating or reheating. This test method provides a standard procedure for heating various classes of refractories with appropriate heating schedules.

3.2 Linear reheat changes obtained by this test method are suitable for use in research and development, also often used to establish written specifications between producers and consumers.

3.3 Care should be exercised in selecting samples that are representative of the product being tested and that the schedule selected is appropriate to the product.

4. Apparatus

4.1 *Kiln*, of such design that the specified heating schedule and atmosphere can be maintained throughout the heating zone.

4.2 *Linear Measuring Device*, capable of being read to 0.02 in. (0.5 mm) over a span of 10 in. (254 mm). A hook-rule, as specified in Test Methods C 134, a vernier caliper, or a dial gage device may be used.

4.3 *Gas Sampling and Analysis Equipment*, capable of determining the percent free oxygen and total combustibles in the atmosphere of the test chamber.

5. Test Specimens

5.1 For each test use three rectangular specimens measuring 9 by 4½ by 2½ or 3 in. (228 by 114 by 64 or 76 mm) in size, or, if smaller, shapes approaching these dimensions as closely as possible. These may be commercial brick of the specified size or test pieces cut out of larger shapes.

5.2 Using ceramic paint or crayon, label each specimen, and make a reference mark at each end on the center line of a broad face to indicate the exact position where the measurement is made. Measure the length on each of the three test specimens to the nearest 0.02 in. (0.5 mm).

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[1] This test method is under the jurisdiction of ASTM Committee C08 on Refractories and is the direct responsibility of Subcommittee C08.03 on Physical Properties.

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

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

6. Procedure

6.1 *Placing Specimens in Kiln*—Place the test specimens in the kiln so that each rests edgewise, that is, on a 9 by 2½ or 3-in. (228 by 64 or 76-mm) face and set only one course high. Place each specimen upon the corresponding face of a supporting brick that is from the same lot as the test specimen or at least of equal refractoriness. Place between the test specimen and the supporting brick a layer of suitable refractory material, that is non-reactive under the test conditions and passing an ASTM No. 16 (1.18-mm) sieve (equivalent to a 14-mesh Tyler Standard Series) and retained on an ASTM No. 40 (425-µm) sieve (equivalent to a 35-mesh Tyler Standard Series). Place each specimen so that it is not less than 1½ in. (38 mm) from other test specimens or from the furnace wall.

6.2 *Temperature Measurement*—Measure the temperature within the kiln by means of an appropriate calibrated thermocouple. Refer to E 230, Tables 1 and 2, for the tolerances and upper temperature limits for use of various thermocouples. At higher temperatures, the thermocouple may be withdrawn and a calibrated optical or radiation pyrometer can be used. Place the hot junction of the thermocouple or sight the pyrometer so as to register the temperature of the test specimens. Make temperature readings at intervals not greater than 15 min. Check the kiln periodically by thermocouples, pyrometers or pyrometric cones to ensure that temperatures over the hearth do not differ by more than 25°F (14°C) or one-half cone.

6.3 *Test Atmosphere*—At all temperatures above 1470°F (800°C) the furnace atmosphere shall contain a minimum of 0.5 % oxygen and 0 % combustibles. Take gas-analysis samples from the furnace chamber proper.

6.4 *Test Temperature Schedule*—Operate the kiln so as to conform to the appropriate heating schedule for the class of refractory being tested as shown in Table 1. Adjust the firing during the hold period so that the temperatures will average the specified temperature within 5°F (3°C). After completion of the heating schedule, cool the specimens in the closed kiln to below 800°F (425°C) before removing.

6.5 *Measuring Fired Specimens*—Remeasure the test specimens at room temperature in accordance with 4.2 after rubbing the ends with an abrasive block to remove small blisters, if necessary.

7. Calculation and Report

7.1 Calculate the percentage linear change based upon the original length of each specimen. Report the average of the three individual values as the reheat change in the test.

8. Precision and Bias

8.1 *Interlaboratory Test Data*—An interlaboratory round-robin test was conducted between eight laboratories at three different reheat temperatures.

8.1.1 In the interlaboratory study, four types of brick were tested, three samples each, a total of seven sets at each laboratory.

8.1.2 Heating schedules, brick types tested, averages of all determinations, and precisions are given in Table 2.

8.2 *Precision*—For the components of variation given in Table 2, a test result composed of three samples should be considered significantly different at a confidence level of 95 %, if the repeatability or reproducibility exceeds the precision data given in Table 2.

8.3 *Bias*—No justifiable statement on bias is possible since the true physical properties of refractories cannot be established by an acceptable reference material.

9. Keywords

9.1 heating schedule; refractory brick; reheat change; temperature measurements; test atmosphere

TABLE 1 Heating Schedule for Reheat of Various Types of Refractories

Elapsed Time from Start of Heating, h	Allowable Deviation from Schedule, ±°F (±°C)	Temperature of Test Specimen, °F (°C) (The highest temperature in each schedule shall be maintained for 5 h)							
		Schedule A	Schedule B	Schedule C	Schedule D	Schedule E	Schedule F	Schedule G	Schedule H
1	50 (28)	1380 (750)	1740 (950)	1740 (950)	1605 (875)	1500 (815)	1740 (950)	1740 (950)	1740 (950)
2	25 (14)	2010 (1100)	2370 (1300)	2370 (1300)	2280 (1250)	2230 (1220)	2370 (1300)	2370 (1300)	2370 (1300)
3	15 (8.5)	2190 (1200)	2550 (1400)	2685 (1475)	2460 (1350)	2350 (1290)	2640 (1450)	2685 (1475)	2685 (1475)
4	15 (8.5)	...	...	2845 (1565)	...	...	2730 (1500)	2845 (1565)	2845 (1565)
5	15 (8.5)	...	...	2910 (1600)	...	...	...	2910 (1600)	2910 (1600)
6	15 (8.5)	...	...	...	...	...	...	2970 (1630)	2970 (1630)
6½	15 (8.5)	...	...	...	...	...	...	3000 (1650)	3000 (1650)
7	15 (8.5)	...	...	...	...	...	...	...	3025 (1665)
8	15 (8.5)	...	...	...	...	...	...	...	3070 (1690)
8½	15 (8.5)	...	...	...	...	...	...	...	3090 (1700)

TABLE 2 Precision of Interlaboratory Test Results Relative precision does not apply since values pass through the point of zero.

NOTE—Relative precision does not apply since values pass through the point of zero.

	Schedule B 2550°F		Schedule C 2910°F			Schedule H 3090°F		Pooled Precision
	Hi-Duty Fireclay	70 % Alumina	S. Duty Fireclay	70 % Alumina	90 % Alumina	70 % Alumina	90 % Alumina	
Linear change average %	−0.11	+0.79	−0.49	+2.89	+0.16	+2.43	+0.83	...
Precision								
Repeatability I_I	0.32	0.34	0.35	0.36	0.18	0.53	0.41	0.36
Reproducibility I_R	0.34	0.72	0.81	0.56	0.25	0.79	0.49	0.60