Designation: C 401 – 91 (Reapproved 2000)

# Standard Classification of Alumina and Alumina-Silicate Castable Refractories[1]

This standard is issued under the fixed designation C 401; 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 classification pertains to alumina and alumina-silicate castable refractories that, when tempered with water, will develop structural strength by chemical action.

1.2 The values 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 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 113 Test Method for Reheat Change of Refractory Brick[2]

C 133 Test Methods for Cold Crushing Strength and Modulus of Rupture of Refractories[2]

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

C 862 Practice for Preparing Refractory Concrete Specimens by Casting[2]

C 865 Practice for Firing Refractory Concrete Specimens[2]

## 3. Significance and Use

3.1 Alumina and alumina-silicate castable refractories are produced to yield property characteristics commensurate with different end use properties. Volume stability, modulus of rupture, bulk density, and lime content have become useful measures to distinguish various alumina and alumina-silicate castable formulations for initial fitness for service. This classification is considered useful for purchase specifications and for quality control.

## 4. Basis of Classification

4.1 *Regular Castable Refractories*—This class includes alumina and alumino-silicate castable refractories which contain hydraulic-setting cement and which have a total lime (CaO) content greater than 2.5 % on a calcined basis. Under this class, castables having a modulus of rupture after drying of at least 300 psi (2.07 MPa) are normal-strength, and those having at least 600 psi (4.14 MPa) modulus of rupture are high-strength types. They are further classified on the basis of volume stability of cast test brick when fired at the temperatures prescribed in Table 1.

4.2 *Low-Cement Castable Refractories*—This class includes alumina and alumino-silicate castable refractories which contain hydraulic-setting cement and which have a total lime (CaO) content of greater than 1.0 to 2.5 % on a calcined basis.

4.3 *Ultra-Low Cement Castable Refractories*—This class includes alumina and alumino-silicate castable refractories which contain hydraulic-setting cement and which have a total lime (CaO) content of greater than 0.2 to 1.0 % on a calcined basis.

4.4 *No-Cement Castable Refractories*—This class includes alumina and alumino-silicate castable refractories which do not contain hydraulic-setting cement and in which the bonding agent(s) contribute no significant amount of lime (CaO). The product might contain up to 0.2 % total lime (CaO) on a calcined basis as contributed by the aggregate.

4.5 *Insulating Castable Refractories*—This class includes insulating castable refractories which are classified on the basis of bulk density of dried cast test brick and volume stability of such test brick when fired at the temperatures prescribed in Table 2.

## 5. Test Methods

5.1 The properties enumerated in this classification shall be determined in accordance with the following ASTM methods:

5.1.1 *Modulus of Rupture*—Test Methods C 133 on test brick with Practice C 862, and after oven-drying in accordance with the Curing of Test Specimens section of Practice C 862. Specimens should be fired as given in heating schedule of Practice C 865.

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[1] This classification is under the jurisdiction of ASTM Committee C08 on Refractories and is the direct responsibility of Subcommittee C08.92 on The Joseph E. Kopanda Subcommittee for Editorial, Terminology and Classification.

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

**TABLE 1 Regular Castable Refractories**

| Test Requirements | Classes of Alumina-Silica Base Castable Refractories | | | | | | |
|---|---|---|---|---|---|---|---|
| | Class A | Class B | Class C | Class D | Class E | Class F | Class G |
| Permanent linear shrinkage, not more than 1.5 % when fired for 5 h at | 2000°F (1095°C) | 2300°F (1260°C) | 2500°F (1370°C) | 2700°F (1480°C) | 2900°F (1595°C) | 3100°F (1705°C) | 3200°F (1760°C) |

**TABLE 2 Insulating Castable Refractories (Refer to 4.5)**

| Test Requirements | Classes of Insulating Castable Refractories | | | | |
|---|---|---|---|---|---|
| | Class N | Class O | Class P | Class Q | Class R |
| Permanent linear shrinkage, not more than 1.5 % when fired for 5 h at | 1700°F (925°C) | 1900°F (1040°C) | 2100°F (1150°C) | 2300°F (1260°C) | 2500°F (1370°C) |
| Maximum bulk density, lb/ft$^3$(g/cm$^3$) after drying at 220 to 230°F (105 to 110°C) | 55 (0.88) | 65 (1.04) | 75 (1.20) | 90 (1.44) | 95 (1.52) |
| | Class S | Class T | Class U | Class V | |
| Permanent linear shrinkage, not more than 1.5 % when fired for 5 h at | 2700°F (1480°C) | 2900°F (1595°C) | 3000°F (1650°C) | 3200°F (1760°C) | |
| Maximum bulk density, lb/ft$^3$(g/cm$^3$) after drying at 220 to 230°F (105 to 110°C) | 95 (1.52) | 100 (1.60) | 105 (1.68) | 105 (1.68) | |

5.1.2 *Permanent Linear Shrinkage*—Test Method C 113 on specimens prepared in accordance with Practice C 862 and fired as given in heating schedule of Practice C 865.

5.1.3 *Bulk Density*—Test Methods C 134 on test brick prepared and oven-dried in accordance with Practice C 862 and fired as given in heating schedule of Practice C 865.

## 6. Retests

6.1 Because of variables resulting from sampling and the lack of satisfactory reproducibility in tests conducted by different laboratories, the material may be resampled and retested when requested by either the manufacturer or the purchaser. This may apply in instances when the first test results do not conform to the requirements prescribed in this classification. The final results to be used shall be the average of at least two sets of results, each of which has been obtained by following in detail the specified testing procedures.

## 7. Keywords

7.1 alumina; alumina-silicate; castable refractories; insulating castable refractories; low-cement castable refractories; no-cement castable refractories; regular castable refractories; ultra-low cement castable refractories