Designation: C 1547 – 02 (Reapproved 2007)

Standard Classification for Fusion-Cast Refractory Blocks and Shapes[1]

This standard is issued under the fixed designation C 1547; 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 classification covers commercial fusion-cast refractory blocks and shapes. Its purpose is to set forth the various types and classes of these materials according to their mineralogical compositions. These compositions are important to determining their suitability for use in specified applications. This standard is not intended to cover commercial fused grains or beads.

1.2 *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 requirements prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:* [2]

C 1118 Guide for Selecting Components for Wavelength-Dispersive X-Ray Fluorescence (XRF) Systems

E 1479 Practice for Describing and Specifying Inductively-Coupled Plasma Atomic Emission Spectrometers

2.2 *Other Document:*

"A Practical Guide for the Preparation of Specimens for X-Ray Fluorescence and X-Ray Diffraction Analysis," Victor E. Buhrke, Ron Jenkins and Deane K. Smith, eds., John Wiley & Sons, Inc., New York, 1998

NOTE 1—Chemical analysis of refractory products are determined by a combination of x-ray fluorescence (XRF) and inductively coupled plasma (ICP) analyses using standard reference materials (SRM), including various types of minerals and refractory materials which are available from the National Institute of Standards and Technology and other appropriate sources.

3. Terminology

3.1 For definitions of terms used in this classification, see Terminology C 71.

4. Significance and Use

4.1 This classification categorizes the defined types of fused-cast refractory blocks and shapes into distinct classes based on mineralogical composition. Such classes have historically been useful for relating the defined types and classes with specific industrial applications and for developing product or purchasing specifications.

5. Basis of Classification

5.1 Fused alumina refractories are classified by the content of soda, Na_2O, as determined by chemical analysis and the resulting beta- (β-) alumina ($NaAl_{11}O_{17}$) or beta″- (β″-) alumina ($NaMg_2Al_{15}O_{25}$) content as determined by quantitative x-ray diffraction (XRD) or by quantitative image analysis of representative polished sections.

NOTE 2—Differential rates of solidification at the surface and the interior of fusion cast shapes, result in different grain sizes. Likewise, the segregation of one or more components may occur during solidification. Therefore the most representative specimens are small, rapidly cooled ladles or shapes (no dimension >3 in. (>75 mm)) obtained by casting into metallic or graphite molds directly from the pouring stream of the fusion furnace.

5.2 Fused alumina-zirconia-silica (AZS) and high zirconia refractory types are classified by the content of monoclinic zirconia (ZrO_2) as determined by chemical analysis or quantitative image analysis on representative polished sections.

5.3 Fused aluminosilicate refractories are classified by their alumina to silica (Al_2O_3:SiO_2) ratios as determined by chemical analysis and by the amount of monoclinic zirconia present as determined by x-ray diffraction (XRD) or quantitative image analysis.

5.4 Fused chromium-containing refractories are classified by the amount of chromia present by chemical analysis and by its mineralogical form as determined by x-ray diffraction (XRD) or by quantitative image analysis.

[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] 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.

5.5 Magnesia-containing fused refractories are classified by the amount and type of MgO (periclase) and spinel phases ($R^{2+}R^{3+}{}_2O_4$, where R^{2+} represents the relevant divalent cations and R^{3+} represents the relevant trivalent cations) as determined by x-ray diffraction (XRD) or by quantitative image analysis.

6. Test Methods

6.1 The determination of Al_2O_3, Cr_2O_3, MgO, Na_2O, SiO_2, and ZrO_2 compositions, where required by this classification, shall be determined by x-ray fluorescence (XRF) and/or inductively coupled plasma (ICP) spectrometry using standard reference materials which are available from the National Institute of Standards and Technology (NIST) or other appropriate sources.

6.2 The determination of the relative amounts of α-(corundum) and β-alumina is accomplished by measuring and comparing relative peak intensities by x-ray diffraction (XRD). Where possible, a calibration curve should be prepared within the appropriate composition ranges from standard reference materials.

6.3 Chromium may be present as solid solutions of Al_2O_3-Cr_2O_3, or as chromite spinel solid solutions. These phases may be identified by characteristic x-ray diffraction peaks, however, because of their variable compositions, it is usually preferable to utilize quantitative image analysis for phase identification.

6.4 Quantitative image analysis is best performed on polished sections (using reflected light) by manual point counting or, where possible, by computerized image analysis. Many phases are separable by differences in their reflectivity and/or morphology.

NOTE 3—Image analysis of certain compositions can be complicated by a eutectic solidification microstructures within certain grains. For example, it is common for the secondary zirconia in AZS compositions to occur as extremely fine, dispersed grains within larger α-Al_2O_3 (corundum) grains. Extreme care is required to obtain reliable results.

7. Retests

7.1 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 no 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.

TABLE 1 Classification of Fused Alumina Refractories by Soda (Na_2O) and Beta-Alumina Content

Class	Soda Content (wt%)	β-Alumina Content (vol%)
Fused α-Alumina	<1.1	<10
Fused α-β Alumina	3.5-4.7	50-65
Fused β-Alumina	5.2-7.7	>95
Fused β″-Alumina	4.5 (~8 MgO)	>95 as β″ ($NaMg_2Al_{15}O_{25}$)

TABLE 2 Classification of Fused Alumina-Zirconia-Silica (AZS) and Fused Zirconia Refractories by Zirconia Content

Class	Zirconia Content (wt%)	Zirconia Content (vol%)
AZS 21	19-23	18.5-22.5
AZS 33	31-34	30.5-33.5
AZS 36	34.5-37.5	34-37
AZS 40	38-41	37.5-41
Zirconia	>90	>90

TABLE 3 Classification of Fused Aluminosilicate Refractories by Alumina and Zirconia Content

Class	Alumina Content (wt%)	Alumina:Silica Ratio
Mullite-Corundum	>67	>3.6
Mullite-Corundum-ZrO_2	>67 (>3 Zirconia)	>3.6

TABLE 4 Classification of Fused Chrome-Containing Refractories by Chromia (Cr_2O_3) Content and Mineral Form

Class	Chromia Content	Mineral Form
Chrome 25	25-29	
-Alumina-Chrome		Chromite spinel and Al_2O_3-Cr_2O_3 solid solutions (ss.)
-AZS-Chromia (AZSC)		Al_2O_3-Cr_2O_3 ss.
Chrome 70	70-77	Cr_2O_3-Al_2O_3 ss. and Chromite spinel
Chrome 80	80-85	Cr_2O_3-Al_2O_3 ss. and Chromite spinel

TABLE 5 Classification of Magnesia-Containing Refractories by Types and Content of MgO and Spinel

Class	Spinel Content (vol%)	MgO Content (vol%)
Magnesia-Spinel (46-50 wt% MgO)	65-75 (as $MgAl_2O_4$)	25-35 (as MgO)
Magnesia-Chromite (18-22 wt% Cr_2O_3)	37-43 (as chromite spinel)	48-56 (as $Mg1\text{-}_xFe_xO$)

8. Keywords

8.1 alumina; aluminosilicate; AZS; brick; chrome; classification; fusion cast; magnesia-chrome; refractories; zirconia