INTERNATIONAL STANDARD

ISO 10081-4

First edition
2007-06-01

Classification of dense shaped refractory products —

Part 4: Special products

Classification des produits réfractaires façonnés denses —

Partie 4: Produits spéciaux

Reference number
ISO 10081-4:2007(E)

ISO copyright office
Case postale 56 • CH-1211 Geneva 20
Tel. + 41 22 749 01 11
Fax + 41 22 749 09 47
E-mail copyright@iso.org
Web www.iso.org

Published in Switzerland

Contents

Page

Foreword iv

1 Scope 1

2 Principle 1

3 Classification 2
3.1 Type of product 2
3.2 Group 2
3.3 Nature of raw materials 7
3.4 State of raw materials 8
3.5 Nature of the bond 8
3.6 Post-treatment 8

4 Other refractory products 8

5 Designation of a special product 9

Bibliography 10

Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 10081-4 was prepared by Technical Committee ISO/TC 33, *Refractories*.

ISO 10081 consists of the following parts, under the general title *Classification of dense shaped refractory products*:

— *Part 1: Alumina-silica*

— *Part 2: Basic products containing less than 7 % residual carbon*

— *Part 3: Basic products containing from 7 % to 50 % residual carbon*

— *Part 4: Special products*

Classification of dense shaped refractory products —

Part 4:
Special products

1 Scope

This part of ISO 10081 specifies the classification and designation of dense shaped refractory products of special composition including

a) oxide products,

b) oxide and non-oxide products,

c) non-oxide silicon carbide or carbon-based products, and

d) further special products which are only designated but not classified, for example, non-oxide products, such as boride, nitride or further combinations of the series listed above.

2 Principle

Dense shaped special products shall be classified according to the following six criteria:

a) the type of product;

b) the group determined by the content of its main chemical component(s);

c) the principal raw material(s);

d) the state of the raw materials;

e) the nature of the bond;

f) any post-treatment;

3 Classification

3.1 Type of product

The following types of dense shaped refractory special products shall be classified by chemical analysis as shown in 3.2.

a) alumina-chromia (ACr);

b) chromia (Cr);

c) alumina-chromia-zirconia (ACrZ);

d) alumina-chromia-zirconia-silica (ACrZS);

e) zirconia-silica (ZS);

f) alumina-zirconia-silica (AZS);

g) alumina-carbon (AC);

h) alumina-magnesia-carbon (AMC);

i) alumina-fused silica-carbon (AFC);

j) alumina-silicon carbide-carbon (ASC);

k) zirconia-carbon (ZC);

l) silicon carbide (SiC);

m) carbon (C).

3.2 Group

The groups of dense shaped refractory special products in the above-mentioned series shall be determined by the content of their main chemical component(s) as shown in Tables 1 to 11, and in accordance with the ranges given in the tables.

Table 1 — Alumina-chromia refractory special products — Classification by product type and group

Designation	Group	Contents % (mass fraction)	
		Al_2O_3	Cr_2O_3
Alumina-Chromia	ACr90/5	$90 \leqslant Al_2O_3 < 95$	$5 \leqslant Cr_2O_3 < 10$
	ACr80/10	$80 \leqslant Al_2O_3 < 90$	$10 \leqslant Cr_2O_3 < 20$
	ACr70/20	$70 \leqslant Al_2O_3 < 80$	$20 \leqslant Cr_2O_3 < 30$
	ACr60/30	$60 \leqslant Al_2O_3 < 70$	$30 \leqslant Cr_2O_3 < 40$
	ACr50/40	$50 \leqslant Al_2O_3 < 60$	$40 \leqslant Cr_2O_3 < 50$
Chromia	Cr90		$90 \leqslant Cr_2O_3$
	Cr50		$50 \leqslant Cr_2O_3 < 90$
NOTE The analysis is carried out on calcined products using International Standards such as ISO 12677.			

Table 2 — Alumina-chromia-zirconia refractory special products — Classification by product type and group

Designation	Group	Contents % (mass fraction)		
		Al_2O_3	Cr_2O_3	ZrO_2
Alumina-Chromia-Zirconia	ACrZ15/5	$15 < Al_2O_3 \leqslant 70$	$5 \leqslant Cr_2O_3 < 25$	$25 \leqslant ZrO_2 < 50$
	ACrZ5/25	$5 < Al_2O_3 \leqslant 65$	$25 \leqslant Cr_2O_3 < 40$	$10 \leqslant ZrO_2 < 40$
	ACrZ5/40	$5 < Al_2O_3 \leqslant 55$	$40 \leqslant Cr_2O_3 < 80$	$5 \leqslant ZrO_2 < 30$

NOTE 1 $Al_2O_3 + Cr_2O_3 + ZrO_2 \geqslant 85$ % by mass,
$5 < Al_2O_3 \leqslant 70$ % by mass,
$5 \leqslant Cr_2O_3 < 80$ % by mass, and
$5 < ZrO_2 \leqslant 50$ % by mass.

NOTE 2 ZrO_2 content includes HfO_2.

NOTE 3 The analysis is carried out on calcined products using International Standards such as ISO 12677.

Table 3 — Alumina-chromia-zirconia-silica refractory special products — Classification by product type and group

Designation	Group	Contents % (mass fraction)		
		Al_2O_3	Cr_2O_3	ZrO_2+SiO_2
Alumina-Chromia-Zirconia-Silica	ACrZS20/10	$20 < Al_2O_3 \leqslant 55$	$10 \leqslant Cr_2O_3 < 25$	$25 \leqslant ZrO_2+SiO_2 < 50$
	ACrZS15/25	$15 < Al_2O_3 \leqslant 60$	$25 \leqslant Cr_2O_3 < 40$	$10 \leqslant ZrO_2+SiO_2 < 50$
	ACrZS5/40	$5 < Al_2O_3 \leqslant 30$	$40 \leqslant Cr_2O_3 < 80$	$10 \leqslant ZrO_2+SiO_2 < 30$

NOTE 1 ZrO_2 content includes HfO_2.

NOTE 2 The analysis is carried out on calcined products using International Standards such as ISO 12677.

Table 4 — Zirconia-silica refractory special products — Classification by product type and group

Designation	Group	Contents % (mass fraction)	
		ZrO_2	SiO_2
Zirconia	Z95	$95 \leqslant ZrO_2$	
	Z90	$90 \leqslant ZrO_2 < 95$	
	Z70	$70 \leqslant ZrO_2 < 90$	$10 \leqslant SiO_2 < 30$
Zirconia-Silica	ZS60	$60 \leqslant ZrO_2 < 70$	$30 \leqslant SiO_2 < 40$
	ZS50	$50 \leqslant ZrO_2 < 60$	$40 \leqslant SiO_2 < 50$
	ZS35	$35 \leqslant ZrO_2 < 50$	$50 \leqslant SiO_2 < 65$

NOTE 1 The analysis is carried out on calcined products using International Standards such as ISO 12677.

NOTE 2 ZrO_2 content includes HfO_2.

NOTE 3 If necessary, the stabilizer should be specified in “Nature of raw materials” (see 3.3).

Table 5 — Alumina-zirconia-silica refractory special products — Classification by product type and group

Designation	Group	Contents % (mass fraction)		
		Al_2O_3	ZrO_2	SiO_2
Alumina-Zirconia-Silica	AZS70/2	$70 < Al_2O_3 \leqslant 95$	$2 \leqslant ZrO_2 < 15$	$SiO_2 < 28$
	AZS30/15	$30 < Al_2O_3 \leqslant 50$	$15 \leqslant ZrO_2 < 30$	$SiO_2 < 35$
	AZS30/30	$30 < Al_2O_3 \leqslant 55$	$30 \leqslant ZrO_2 < 40$	$SiO_2 < 40$
	AZS30/40	$30 < Al_2O_3 \leqslant 55$	$40 \leqslant ZrO_2 < 50$	$SiO_2 < 30$

NOTE 1 The analysis is carried out on calcined products using International Standards such as ISO 12677.

NOTE 2 For AZS products, a group is indexed according to the zirconia content (see Table 4).

NOTE 3 ZrO_2 content includes HfO_2.

Table 6 — Alumina-carbon refractory special products — Classification by product type and group

Designation	Group	Contents % (mass fraction)	
		Al_2O_3	C
Alumina-Carbon	AC90/N*	$90 \leqslant Al_2O_3$	N
	AC80/N*	$80 \leqslant Al_2O_3 < 90$	N
	AC70/N*	$70 \leqslant Al_2O_3 < 80$	N
	AC60/N*	$60 \leqslant Al_2O_3 < 70$	N
	AC50/N*	$50 \leqslant Al_2O_3 < 60$	N
	AC40/N*	$40 \leqslant Al_2O_3 < 50$	N
	AC30/N*	$30 \leqslant Al_2O_3 < 40$	N

N*	Carbon contents % (mass fraction)
1	$1 \leqslant C < 5$
5	$5 \leqslant C < 10$
10	$10 \leqslant C < 15$
15	$15 \leqslant C < 20$
20	$20 \leqslant C < 25$
25	$25 \leqslant C < 30$
30	$30 \leqslant C$

NOTE 1 The asterisk indicates the antioxidant additive which is denoted by adding A to the group classification.

NOTE 2 The analysis is carried out on calcined products using International Standards such as ISO 12677.

NOTE 3 Residual carbon content after coking.

NOTE 4 N is equal to the lowest limit of the residual carbon content range.

Table 7 — Alumina-magnesia-carbon refractory special products — Classification by product type and group

Designation	Group	Contents % (mass fraction)		
		Al_2O_3	MgO	C
Alumina-magnesia-carbon	AMC90/N*	$90 \leqslant Al_2O_3$	$5 \leqslant MgO < 10$	N
	AMC80/N*	$80 \leqslant Al_2O_3 < 90$	$10 \leqslant MgO < 20$	N
	AMC70/N*	$70 \leqslant Al_2O_3 < 80$	$10 \leqslant MgO < 30$	N
	AMC60/N*	$60 \leqslant Al_2O_3 < 70$	$30 \leqslant MgO < 40$	N
	AMC50/N*	$50 \leqslant Al_2O_3 < 60$	$40 \leqslant MgO < 50$	N

N*	Carbon contents % (mass fraction)
1	$1 \leqslant C < 5$
5	$5 \leqslant C < 10$
10	$10 \leqslant C < 15$
15	$15 \leqslant C < 20$
20	$20 \leqslant C < 25$
25	$25 \leqslant C < 30$

NOTE 1 The asterisk indicates the antioxidant additive which is denoted by adding A to the group classification.
NOTE 2 The analysis is carried out on calcined products using International Standards such as ISO 12677.
NOTE 3 Residual carbon content after coking.
NOTE 4 N is equal to the lowest limit of residual carbon content range.

Table 8 — Alumina-fused silica-carbon refractory special products — Classification by product type and group

Designation	Group	Contents % (mass fraction)		
		Al_2O_3	Fused Silica (FS)	C
Alumina-fused silica-carbon	AFC80/N*	$80 < Al_2O_3$	$5 \leqslant SiO_2 < 20$	N
	AFC70/N*	$70 < Al_2O_3 < 80$	$15 \leqslant SiO_2 < 30$	N
	AFC60/N*	$60 < Al_2O_3 < 70$	$25 \leqslant SiO_2$	N

N*	Carbon contents % (mass fraction)
1	$1 \leqslant C < 5$
5	$5 \leqslant C < 10$
10	$10 \leqslant C < 15$
15	$15 \leqslant C < 20$
20	$20 \leqslant C < 25$
25	$25 \leqslant C < 30$
30	$30 \leqslant C < 35$

NOTE 1 The asterisk indicates the antioxidant additive which is denoted by adding A to the group classification.
NOTE 2 The analysis is carried out on calcined products using International Standards such as ISO 12677.
NOTE 3 Fused silica content determined in delivered state.
NOTE 4 Residual carbon content after coking.
NOTE 5 N is equal to the lowest limit of residual carbon content range.

Table 9 — Alumina-silicon carbide-carbon refractory special products — Classification by product type and group

Designation	Group	Contents % (mass fraction)		
		Al_2O_3	SiC	C
Alumina-SiC-carbon	ASC80/N*	$80 \leqslant Al_2O_3$	$1 \leqslant SiC < 5$	N
	ASC70/N*	$70 \leqslant Al_2O_3 < 80$	$5 \leqslant SiC < 15$	N
	ASC60/N*	$60 \leqslant Al_2O_3 < 70$	$10 \leqslant SiC$	N
	ASC50/N*	$50 \leqslant Al_2O_3 < 60$	$10 \leqslant SiC$	N

N*	Carbon contents % (mass fraction)
1	$1 \leqslant C < 5$
5	$5 \leqslant C < 10$
10	$10 \leqslant C < 15$
15	$15 \leqslant C < 20$
20	$20 \leqslant C < 25$

NOTE 1 The asterisk indicates the antioxidant additive which is denoted by adding A to the group classification.
NOTE 2 The analysis is carried out on calcined products using International Standards such as ISO 12677.
NOTE 3 SiC content determined on product as received.
NOTE 4 Residual carbon content after coking.
NOTE 5 N is equal to the lowest limit of residual carbon content range.

Table 10 — Zirconia-carbon refractory special products — Classification by product type and group

Designation	Group	Contents % (mass fraction)	
		ZrO_2	C
Zirconia-Carbon	ZC90/N*	$90 \leqslant ZrO_2$	N
	ZC80/N*	$80 \leqslant ZrO_2 < 90$	N
	ZC70/N*	$70 \leqslant ZrO_2 < 80$	N
	ZC50/N*	$50 \leqslant ZrO_2 < 70$	N

N*	Carbon contents % (mass fraction)
1	$1 \leqslant C < 5$
5	$5 \leqslant C < 10$
10	$10 \leqslant C < 20$
20	$20 \leqslant C < 30$
30	$30 \leqslant C < 50$

NOTE 1 The asterisk indicates the antioxidant additive which is denoted by adding A to the group classification.
NOTE 2 The analysis is carried out on calcined products using International Standards such as ISO 12677.
NOTE 3 Residual carbon content after coking.
NOTE 4 N is equal to the lowest limit of residual carbon content range.

Table 11 — Silicon carbide refractory special products — Classification by product type and group

Designation	Group	Contents % (mass fraction)
		SiC
Silicon carbide	SiC99	99 ⩽ SiC
	SiC90	90 ⩽ SiC < 99
	SiC80	80 ⩽ SiC < 90
	SiC70	70 ⩽ SiC < 80
	SiC50	50 ⩽ SiC < 70
	SiC30	30 ⩽ SiC < 50
NOTE The analysis is carried out on the product as received, using the analytical methods in International Standards such as ISO 12677.		

Table 12 — Carbon refractory special products — Classification by product type and group

Designation	Group	Contents % (mass fraction)	
		C	Ash
Carbon	C99,9	99,8 ⩽ C	Ash < 0,2
	C99	99 ⩽ C	Ash < 1
	C95	95 ⩽ C < 99	1 ⩽ Ash < 5
	C90	90 ⩽ C < 95	5 ⩽ Ash < 10
	C80/M	80 ⩽ C < 90	10 ⩽ Ash < 20
	C60/M	60 ⩽ C < 80	10 ⩽ Ash < 40
NOTE 1 M indicates that the higher ash content is caused by non-carbon components (e.g. alumina, silicon carbide, metals, etc.). This leads to micro-pores in the structure.			
NOTE 2 The analysis is carried out on products carbonized in accordance with ISO 10060 using the analytical methods in International Standards, and analytical results are expressed as a dry-basis percentage composition.			

3.3 Nature of raw materials

Dense shaped refractory special products shall be classified in accordance with 3.1 by the chemical component contents which have been calculated from the chemical composition of their principal raw materials.

Table 13 — Examples of raw materials

Corundum
Bauxite
Mullite
Sillimanite, andalusite, kyanite
Silica, fused silica
Magnesia
Chrome oxide (chromia)
Zirconia, zircon, zirconia-lime, alumina-zirconia
Silicon carbide
Carbon, including metallurgical coke, anthracite, graphite

3.4 State of raw materials

The raw materials shall be classified by using one of four designations as follows:

— naturally occurring (raw, calcined or sintered);

— synthetic (calcined or sintered);

— fused;

— stabilized zirconia (stabilized with none, lime, magnesite or yttria).

NOTE A distinction is made between calcined raw materials heat-treated at medium temperature, and sintered raw materials treated at high temperature.

3.5 Nature of the bond

The bonding system shall be classified by using one of four designations as follows:

— oxide ceramic bond, formed during firing at temperatures above 800 °C;

— non-oxide ceramic bond, formed during firing at temperatures above 800 °C;

— inorganic chemical bond, formed by chemical bonding at ambient temperatures or at temperatures below 800 °C;

— organic chemical bond, formed at ambient or higher temperatures:

1) with or without impregnation after firing;

2) with carbon, silicon nitride, sialon, boride;

3) with or without tempering at temperatures below 800 °C.

3.6 Post-treatment

Any post-treatment shall be classified by using one, or both, of the following designations:

— tempering (at a temperature up to 800 °C);

— impregnation.

4 Other refractory products

Some special refractories, for which a classification is not possible, shall be described according to five criteria:

a) the type of product;

b) the principal raw material(s);

c) the state of the raw material(s);

d) the nature of the bond;

e) any post-treatment.

However, the minimum content limit for the principal component in these products shall be more than 50 % by mass:

1) nitrides;

2) borides;

3) carbides (except silicon carbide);

4) spinels (other than chromite and magnesia spinel);

5) alumina-magnesia-carbon;

6) oxide and non-oxide ceramics: special oxide or non-oxide based products in which the purity of one or several of the components is higher than 99,5 %.

5 Designation of a special product

The six classification criteria given in Clause 3, i.e. type, group, state and nature of raw materials, nature of bond, and post-treatment, shall be used for the designation of dense shaped refractory products of the mentioned series.

EXAMPLES Some examples of designations are as follows:

— alumina-chromia products in the group ACr70/5, based on synthetic sintered corundum and chromia with an oxide ceramic bond;

— alumina-zirconia-silica products of the group AZS15, based on synthetic sintered corundum and naturally occurring zircon with an oxide ceramic bond;

— alumina-carbon products with antioxidant additives of the group AC80/5A, based on naturally occurring sintered bauxite with an organic chemical bond, with tempering;

— silicon carbide products of the group SiC70, based on synthetic silicon carbide with silicon nitride bond;

— carbon product of the group C60, based on synthetic graphite with an organic chemical bond formed at higher temperatures.

Bibliography

[1] ISO 10081-1, *Classification of dense shaped refractory products — Part 1: Alumina-silica*

[2] ISO 10081-2, *Classification of dense shaped refractory products — Part 2: Basic products containing less than 7 % residual carbon*

[3] ISO 10081-3, *Classification of dense shaped refractory products — Part 3: Basic products containing from 7 % to 50 % residual carbon*

[4] ISO 836, *Terminology for refractories*

[5] ISO 10060, *Dense, shaped refractory products — Test methods for products containing carbon*

[6] ISO 12677, *Chemical analysis of refractory products by XRF — Fused cast bead method*

[7] EN 12475-4, *Classification of dense shaped refractory products — Part 4: Special products*

ICS 81.080

Price based on 10 pages