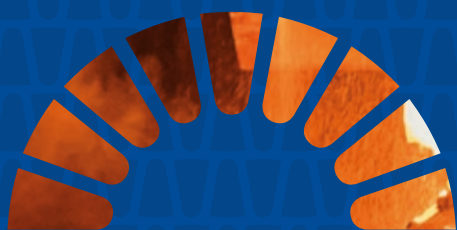


Excellence Made in Italy



REFEL

**FUSED CAST
REFRACTORIES**



The refractory blocks are produced from the purest oxide mixtures which are fused in electric arc furnaces. The melt is refined by direct injection of oxygen, and poured into special moulds constructed individually according to the final block shape as specified by the customer. The entire process is governed by an exclusively designed and highly sophisticated system which is fully computer controlled.







A DYNAMIC COMPANY WITH A WEALTH OF EXPERIENCE



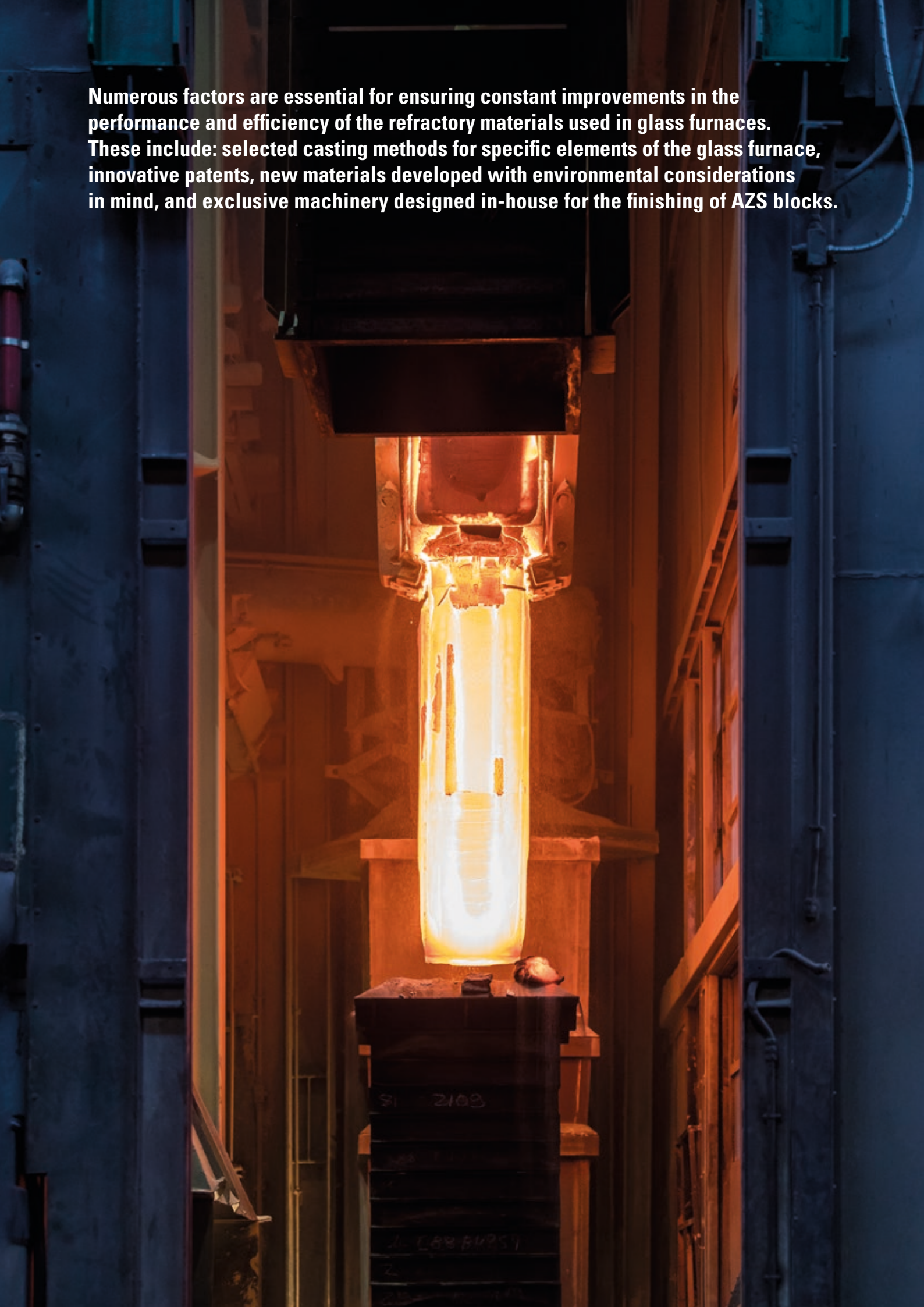
Soon after its foundation in 1986, REFEL S.p.A. was a firmly established presence in the national and international markets for fused cast refractory materials. This immediate success was a direct result of the excellent quality and reliability of its products and of the highly professional technical and commercial support provided to every customer.

In 1993, REFEL became a member of the DIDIER Group which was acquired in 1995 by the predecessor of RHI Group. Since 2017 REFEL is part of LIVIA Group, an independent industrial holding and private investment firm. REFEL's fused cast materials are shipped from San Vito al Tagliamento, in the north of Italy, to major glassworks throughout the world.

REFEL is one of the world's leading producers of fused cast AZS refractory materials thanks largely to a team of highly qualified specialists who have dedicated more than five decades to research, development and production of these materials which are so essential to the glassmaking industry.

This wealth of experience is much sought after by glass manufacturers for whom quality is a prime consideration and who have come to understand that REFEL is not merely a supplier, but a partner with extensive knowledge of their technical requirements that is able to provide technical support of the highest quality.

Numerous factors are essential for ensuring constant improvements in the performance and efficiency of the refractory materials used in glass furnaces. These include: selected casting methods for specific elements of the glass furnace, innovative patents, new materials developed with environmental considerations in mind, and exclusive machinery designed in-house for the finishing of AZS blocks.





THE QUALITY OF REFEL'S TECHNOLOGY

The excellent quality of REFEL's products is not achieved by mere chance: the raw materials are carefully selected and checked; the modern production plant features the most advanced technology; each member of the staff is trained to the highest standards. Together with a high-efficiency production layout, constant monitoring of production and an integrated information system, these factors represent a guarantee of refractory materials which offer the best possible performance.

Constant efforts and considerable investments are dedicated to research and to the perfection of original solutions to meet the needs of an increasingly competitive market.

The surfaces of the blocks are carefully finished using cutting, smoothing, grinding and drilling machines fitted with diamond tools.

Each block is machined within strict tolerances in order to ensure correct installation, best joint accuracy, and rapid assembly of the glass furnace.





REFEL manufactures fused cast AZS refractory materials which offer excellent quality and top performance. This is confirmed by the numerous glass furnaces that the company has supplied to customers throughout the world, and by the tens of thousands of tons of REFEL products used in different applications of the glass and other heavy industries, whose faith in these products is reconfirmed day after day.







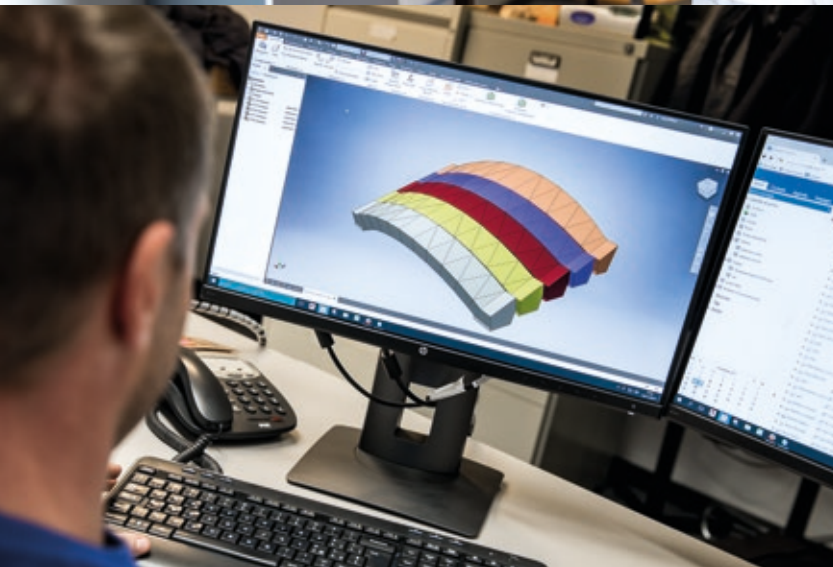
V.25

085 30X5

2129

RESEARCH GUARANTEES THE BEST SOLUTION FOR EVERY REQUIREMENT

REFEL produces fused cast AZS refractory products primarily for the glass industry. The focus on technologically sophisticated materials meets market needs, such as the demand for longer glass furnace service lives, enhanced specific furnace performance, and ever higher glass grades. REFEL has been particularly successful with the production of complex geometries, as employed in the special glass industry.



In order to obtain the best possible product, the annealing times are carefully controlled to guarantee that the internal block structure is homogeneous and without residual mechanical stresses.





1240
1240

125

1240
500
1240

890



REFEL MEANS SAFETY AND RELIABILITY

The REFEL brand has been standing for high-quality, top-notch refractory products and customer-oriented services for the glass industry ever since it was created.

REFEL provides its customers with a complete range of support services. The furnace design is examined together with the customer in order to determine the most suitable solution for the specific installation. When the complete furnace is pre-assembled in San Vito al Tagliamento, the precision of each part and the compliance of the materials with the project specifications are carefully checked. The implemented quality assurance follows the product from the initial design phase right up to final delivery: from the acceptance of incoming raw materials to the parameters for melting, oxidation, casting and annealing, to machining checks, final testing, pre-assembly and shipping of the finished product. In this way REFEL is able to guarantee the safety and reliability of its products. REFEL's after-sales service continues throughout the campaign of the furnace and includes support activities such as laboratory analyses and a continuous information feedback with the customer which helps to develop further improvements for future projects.



TECHNICAL DATA SHEETS



k.507

317

318

REF-1240-FVB
229500

REF-1240
DIS. 22
POS.

TOP

TOP

TOP

630231

809.4

319

RE-1240-FVB
DIS. 229500
POS. 1207

~~RE-1240-FVB
DIS. 229500
POS. 1207~~

320

RE-1240-FVB
DIS. 229500
POS. 1207

321

RE-1240-FVB
DIS. 229500
POS. 1207

322

RE-1240-FVB
DIS. 229500
POS. 1207

323

RE-1240-FVB
DIS. 229500
POS. 1207

324

RE-1240-FVB
DIS. 229500
POS. 1207

325

326

327

328

329

TOP

CHEMICAL ANALYSIS AND PHYSICAL TEST VALUES IN TECHNICAL DATA SHEETS

For all REFEL products technical data sheets are available. These data sheets detail the standard chemical and physical property values of a specific grade. Additional information typical for the grade, such as its classification, application and main raw materials, is also included in a clearly structured overview. Thereby, these data sheets provide the customers with comprehensive basic information regarding the particular product.

It should be highlighted that the values in these technical data sheets are only standard values, which are determined in accordance with the applicable standard tests and, where no standardised methods and procedures are available, by using testing procedures that have been established over a long period of time. Therefore, these standard values do not represent binding specifications and should not be considered express assurance of the exact properties of a product from a specific delivery batch. All values given in the data sheets are determined by using state-of-the-art equipment and in accordance with currently applicable standards and test instructions. In order to ensure the highest quality level of the test values, inter-laboratory studies are conducted on an on-going basis, in particular with independent external laboratories. This assures that the information provided in the technical data sheets is always up to date and accurate, thereby representing valuable basic information for the particular product application.

Chemical analysis

X-ray fluorescence analysis is the classic analytical method to determine the proportion of particular chemical elements contained in a test sample.

The test is conducted exclusively on a fired sample (1025°C) in accordance with DIN EN ISO 12677.

This quantitative standard analytical method is used to examine raw materials and refractory products after vitrification of the powdered sample.

The sample is then tested in the form of fusion beads and the results are expressed in weight percent.

Mineralogical analysis

In order to identify the mineralogical composition, quite independent methods are applied.

A microscope is used to make the microstructure, different minerals and their arrangement visible.

For the investigation of very fine crystalline structures, well-prepared polished sections are made out of the refractory material, which are obtained by using different grinding and polishing grain sizes. These can be etched for better differentiation of the individual crystal phases.

If greater resolution is required, the scanning electron microscope (SEM) is used. For this method, fragments of the material to be examined or ground sections, as for the microscope, can be taken.

If the structure is of prime interest, one works with a gold-vaporised surface. If also the chemical composition is of interest, a carbon-vaporised surface is used.

In the SEM the piece is scanned by an electron beam and displayed on a monitor. A good picture of the refractory texture can be obtained from a broken piece of refractory material.

Due to the large magnification, the special arrangement of the structure components and pores in the material can be seen very well.

In special cases, such as the investigation of impurities, it is easy to qualitatively determine the existing elements. With the assistance of the SEM it is possible to make semiquantitative statements on the chemical composition of the structure components of ground areas.

Another method for examining the crystalline phases is the fine structure X-ray diffraction analysis.

Because crystalline materials have an ordered fine structure, X-rays can be diffracted by the space lattice in such a manner that typical diffraction patterns are obtained for each type of crystal.

In X-ray diffraction diagrams of powdered refractory materials the individual crystalline components can be identified; their quantity can generally be estimated and if standard substances are on hand, they can be analysed quantitatively.

Cold crushing strength

The cold crushing strength of a refractory block is determined at room temperature and is a measure of the mechanical strength of the material.

The cold crushing strength is of importance for the longevity of the furnace because a block with a high crushing strength is more resistant to mechanical load and mechanical stress than a block with a low crushing strength. For comparison: the cold crushing strength of silica bricks is 20-30 N/mm², that of high-alumina bricks is between 30 and 150 N/mm². The highest strength values, i.e. above 640 N/mm², are exhibited by fused cast AZS.

Refractoriness under load

The test for refractoriness under load serves to evaluate the softening behaviour of refractory material at rising temperature and constant load conditions. The softening behaviour under load is not identical to the melting range of pure raw materials, but is influenced by the content and the degree of distribution

of low melting point flux agents. Each type of refractory has a characteristic softening curve. In accordance with DIN EN ISO 1893, samples used to determine the refractoriness under load are cylinders of 50 mm height and 50 mm diameter. These are heated at a constant rate under a load of 0.2 N/mm² and the change in height of the cylinders in relation to the temperature is recorded. The test data result in a softening curve. The temperature T₀₅ (initial temperature of softening) is derived below the culmination point of the curve, corresponding to about 0.5% compression of the sample.

Corrosion resistance

The resistance to thermal and chemical stresses is tested with the dynamic finger test and the static plate corrosion test according to the International Commission on Glass, Technical Committee 11 (the so-called TC11).

In the dynamic finger test, a cylindrical sample is rotated in a platinum crucible together with molten glass. The test is carried out with predefined parameters (temperature, time) and the reduction in diameter at fluxline (three phase contact) is measured. The corrosion rate can also be determined by measuring the decrease in length (forced convection at the rotating cylinder face) as a function of time and at various rotation rates. In the static plate corrosion test, sample platelets are immersed into the glass melt. After the chosen time the fluxline depth of the corroded samples is measured. This test is carried out with four samples under the same test conditions and is, therefore, an appropriate method to compare and evaluate certain refractory grades together. An international round-robin investigation within the Technical Committee 11 of the International Commission on Glass confirmed the good reproducibility of the static plate corrosion test, and the TC11 recommended it as the standard corrosion test.

Stone formation

Due to the interaction of the glass melt with fused cast AZS, solid stones can be generated. The defect potential is evaluated by counting this kind of inclusion inside the remaining glass after each corrosion test.

Blistering

The tendency of fused cast AZS to form bubbles in contact with molten glass is evaluated with an especially developed test procedure in which standard glass is fused in a fused cast AZS crucible.

The number of bubbles contained in the glass samples after test melting is an indication of blistering potential. The tendency to release bubbles is expressed in bubbles/gram glass, following the terminology of glass defects of the International Commission on Glass.

Exudation

In order to evaluate the expulsion of glassy phase, a simulation of the load-free preheating stage, which the refractory blocks in a melting furnace undergo, is performed by heating the test material up to temperatures comparable to real furnace operation conditions. The test procedure follows the recommendations of the Technical Committee 11 of the International Commission on Glass.

The experimental data of REFEL refractories show that for temperatures higher than 1500°C there is only limited exudation which decreases slowly with service time.

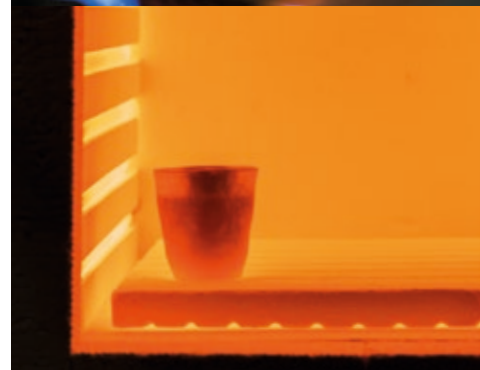
Vapour attack

This test method according to ASTM is performed to evaluate the resistance of refractories in glass melting furnace superstructures to vapour attack. The vapour test method may also be useful for evaluating refractories in other applications where vapour attack occurs.

Density

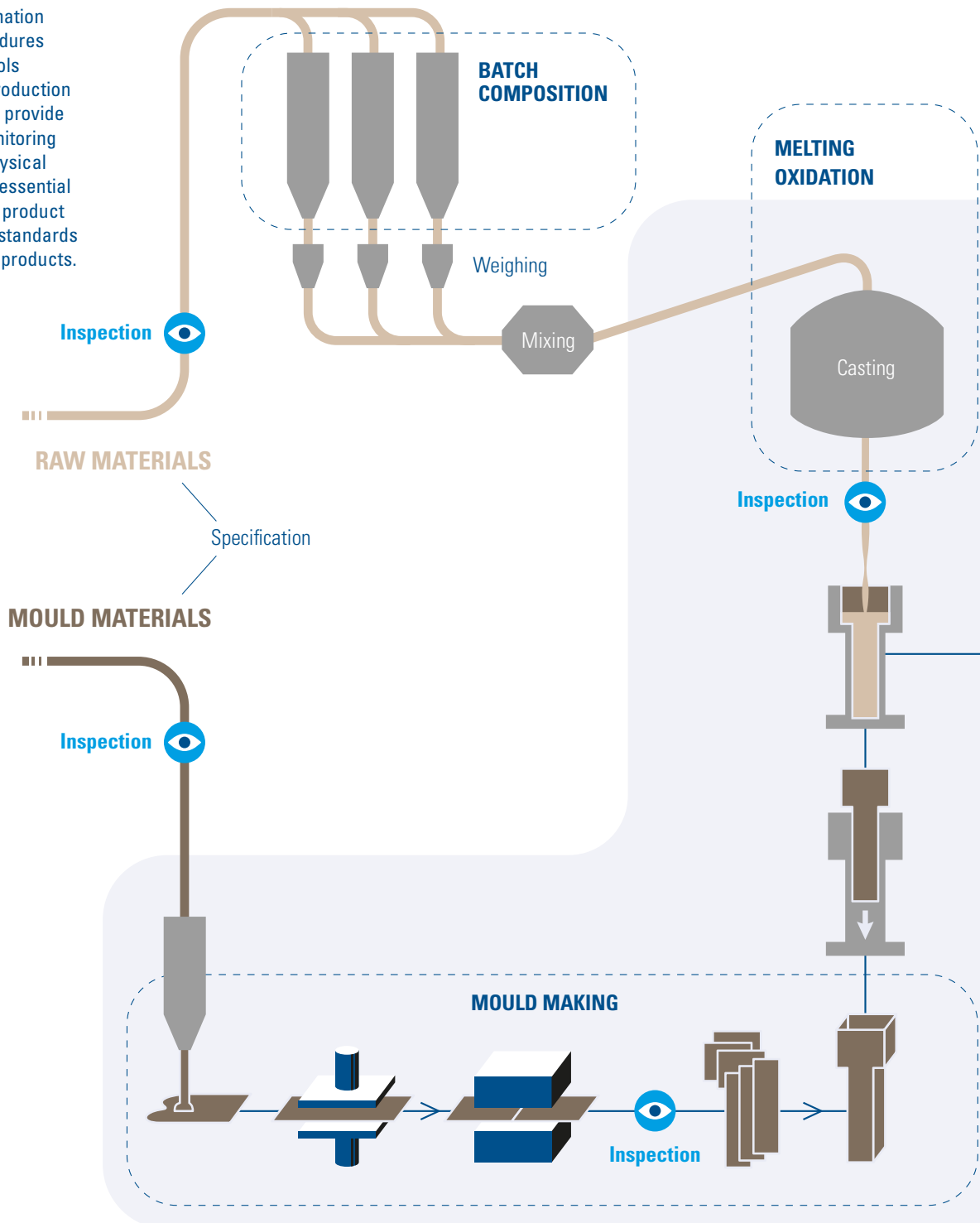
The term bulk density describes the quotient of mass and volume including the pore space. Bulk density is determined by using shaped samples or broken pieces by means of a hydrostatic scale, or by geometric measurement. It is by far one of the most important characteristics of refractories and serves, together with the true density, to calculate the true porosity and, together with the pycnometer method, to calculate the apparent porosity. True density is the quotient of mass and volume excluding pore space and is determined by pycnometer on crushed material.

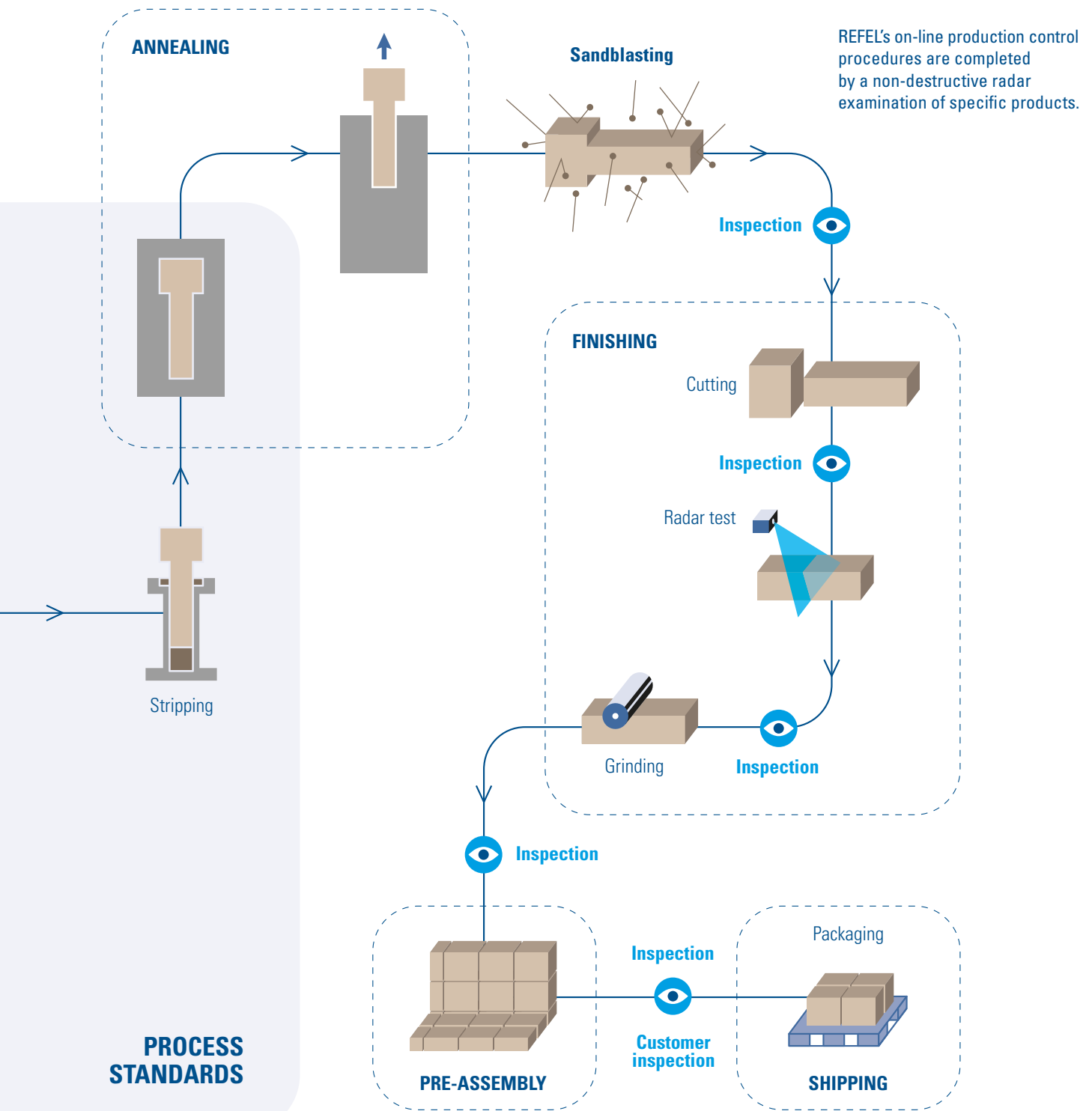
The true porosity of a refractory brick is the ratio of the total pore space (i.e. open and closed pores) of a body to its volume, expressed in volume percent, and is calculated from the true density and the bulk density. Frequently, not the values of the true porosity but those of the apparent or open porosity are quoted as application properties. The apparent porosity includes only those pores which can be infiltrated.



MANUFACTURING CYCLE

A high degree of automation and the strictest procedures for analyses and controls performed along the production line make it possible to provide continuous on-line monitoring of the chemical and physical parameters which are essential to ensure that the final product meets the high quality standards required for refractory products.

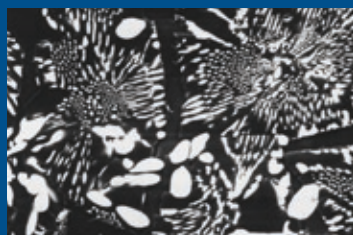




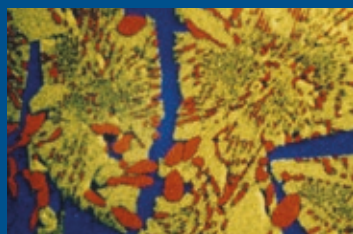
CHEMICAL AND CRYSTALLOGRAPHIC PROPERTIES

REFEL fused cast AZS refractories are characterised by the different percentage of zirconium oxide and glassy phase of the blocks. From the crystallographic standpoint, different coexisting phases can be identified:

- **Baddeleyite:** in the form of bulbous zirconium oxide grains
- **Corundum:** tabular crystals of alpha aluminium oxide
- **Glassy phase:** inter-crystalline matrix acting as a support for the two previous phases



a



b

Image width is 400 μm

REFEL fused cast AZS:

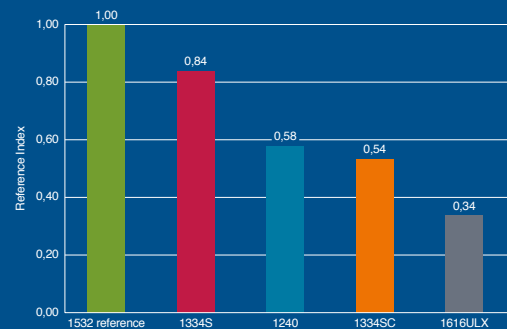
- (a) scanning electron micrograph
- (b) its pseudo-colour image with co-precipitated baddeleyite (red) and corundum (yellow), surrounded by glassy phase (blue)

The homogeneous and well-balanced microstructure ensures:

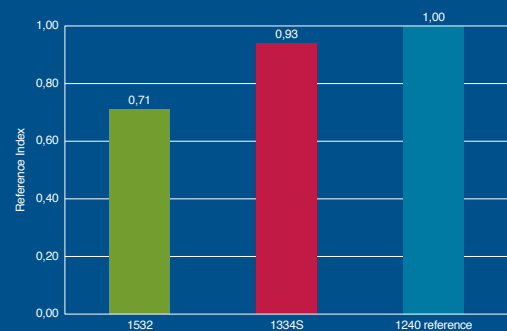
- High compactness
- No liberation of stones
- Limited exudation of glassy phase
- Low or almost no tendency to blistering
- Superior resistance to corrosion at high temperatures

REFRACTORY PROPERTIES

COMPARATIVE EXUDATION PROPERTY

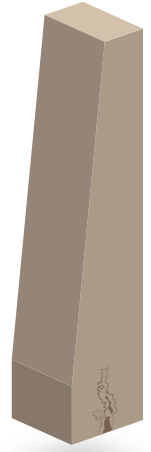
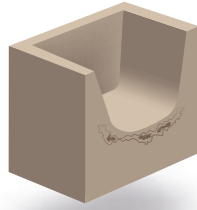


COMPARATIVE CORROSION RESISTANCE



THE RANGE OF REFRACTORIES

		%							Typical mineralogical analysis	
		ZrO ₂	SiO ₂	Na ₂ O	Fe ₂ O ₃	TiO ₂	CaO	MgO		Al ₂ O ₃
STANDARD PRODUCTS	REFEL 1532	32.70	14.90	1.15	<0.25				51.00	Baddeleyite 32.00% Glassy phase 20.00% Corundum 48.00%
	REFEL 1334S	36.50	13.60	1.05	<0.25				48.60	Baddeleyite 36.00% Glassy phase 17.50% Corundum 46.50%
	REFEL 1240	41.00	12.20	1.00	<0.25				45.55	Baddeleyite 40.50% Glassy phase 16.50% Corundum 43.00%
SPECIAL PRODUCTS	REFEL 1334SC	36.50	9.00	0.80	<0.25				53.45	Baddeleyite 36.00% Glassy phase 13.00% Corundum 51.00%
	REFEL 1616ULX	16.90	16.50	2.40	<0.25				64.20	Baddeleyite 14.50% Glassy phase 25.50% Corundum 61.00%
	REFEL 1240 FVMo <small>REFEL FVMo is a composite product of a REFEL 1240 FVB block (matrix) and a molybdenum metal insert</small>	41.00	12.20	1.00	<0.25				45.55	Matrix mineralogical analysis: REFEL 1240



N

Normal cavity

Superstructure, feeder channels,
walls of working end
Subjected to normal stresses
Bulk density: 3.50 g/cm³
Minimum value: 3.40 g/cm³

Superstructure, feeder channels,
walls of working end
Subjected to strong stresses
Bulk density: 3.58 g/cm³
Minimum value: 3.48 g/cm³

Superstructure, feeder channels
Subjected to strong stresses
Bulk density: 3.70 g/cm³
Minimum value: 3.55 g/cm³

Superstructure, crowns
Subjected to strong stresses
Bulk density: 3.72 g/cm³
Minimum value: 3.65 g/cm³

Superstructure
Bulk density: 3.55 g/cm³
Virtually no exudation

NS

Normal cavity Special shape

Superstructure
Subjected to normal stresses
Bulk density: 3.50 g/cm³
Minimum value: 3.40 g/cm³

Superstructure
Subjected to strong stresses
Bulk density: 3.58 g/cm³
Minimum value: 3.48 g/cm³

Superstructure
Subjected to strong stresses
Bulk density: 3.55 g/cm³
Virtually no exudation

CR

Cavity Reduced

Sidewall block tank
Subjected to strong stresses
Bulk density: 3.78 g/cm³
Minimum value: 3.68 g/cm³

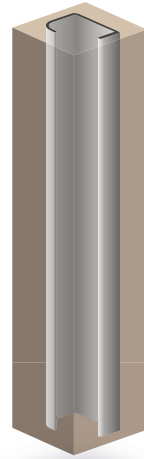
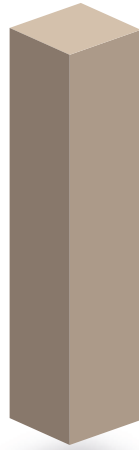
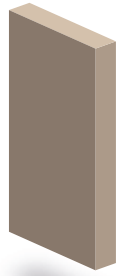
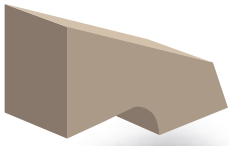
Sidewall block tank
Subjected to strong stresses
Bulk density: 3.85 g/cm³
Minimum value: 3.70 g/cm³

CRS

Cavity Reduced Special shape

Sidewall block tank
Subjected to strong stresses
Bulk density: 3.78 g/cm³
Minimum value: 3.68 g/cm³

Sidewall block tank
Subjected to strong stresses
Bulk density: 3.85 g/cm³
Minimum value: 3.70 g/cm³



FVS
Free Void
Special shape

FVP
Free Void Plate

FVB
Free Void Block

FVMo
Free Void
Molybdenum block

Various installation zones
Subjected to normal stresses
Bulk density: 3.72 g/cm³
Minimum value: 3.60 g/cm³

Tank bottom plates
Subjected to normal stresses
Bulk density: 3.72 g/cm³
Minimum value: 3.60 g/cm³

Various installation zones
Subjected to strong stresses
Bulk density: 3.85 g/cm³
Minimum value: 3.72 g/cm³

Tank bottom plates
Subjected to strong stresses
Bulk density: 3.78 g/cm³
Minimum value: 3.68 g/cm³

Throat, doghouse, corner blocks,
bubbler blocks, sidewall blocks
and electrical furnaces
Subjected to strong stresses
Bulk density: 3.88 g/cm³
Minimum value: 3.78 g/cm³

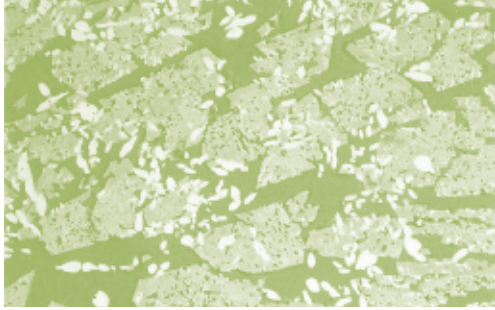
Various installation zones
Subjected to strong stresses
Bulk density: 4.00 g/cm³
Minimum value: 3.90 g/cm³

Tank bottom plates
Subjected to strong stresses
Bulk density: 4.00 g/cm³
Minimum value: 3.90 g/cm³

Throat, doghouse, corner blocks,
bubbler blocks, sidewall blocks
and electrical furnaces
Subjected to strong stresses
Bulk density: 4.00 g/cm³
Minimum value: 3.90 g/cm³

Superstructure, crowns
Subjected to strong stresses
Bulk density: 3.93 g/cm³
Minimum value: 3.85 g/cm³

Throat, submerged bridge-wall
subjected to strong stresses
Bulk density (composed product):
4.10 – 4.60 g/cm³
depending on the block design



REFEL 1532

REFEL 1532, with the lowest zirconium oxide content in the standard product range, is the essential refractory material for glass furnaces. Its chemical and physical properties provide a product which is versatile for applications in various areas of the furnace.

PHYSICAL DATA

Cold crushing strength ¹	> 200 N/mm ²
Refractoriness under load (T ₀₅) ²	1700°C
Corrosion resistance in soda lime glass at 1500°C ³	index 0.71 (referred to 1240 material)
Stone formation in soda lime glass at 1500°C	0
Blistering in soda lime glass at 1150°C ^{4,5}	0
Exudation at 1550°C ⁶	index 1 (reference index)
True density⁷	3.79 g/cm³

¹ DIN EN 993-5

⁴ Crucible test, 96 hours

⁶ ICG TC11, 10 cycles

² DIN EN ISO 1893

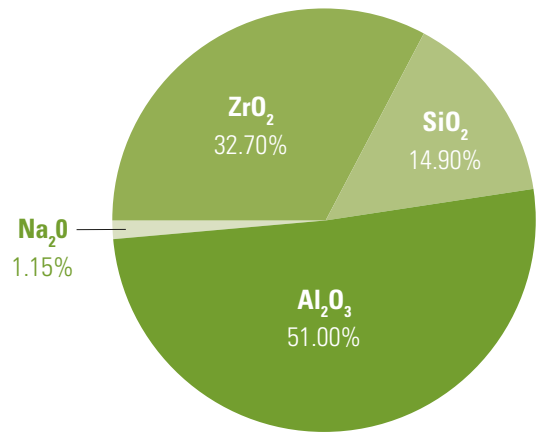
⁵ ICG Subcommittee

⁷ DIN 66137-2

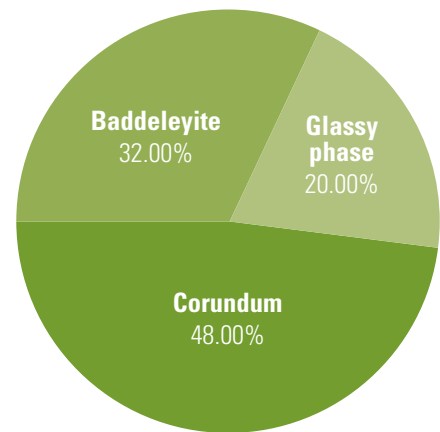
³ ICG TC11, 120 hours

A1 definition

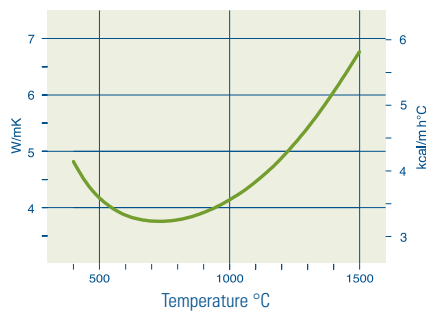
TYPICAL CHEMICAL COMPOSITION



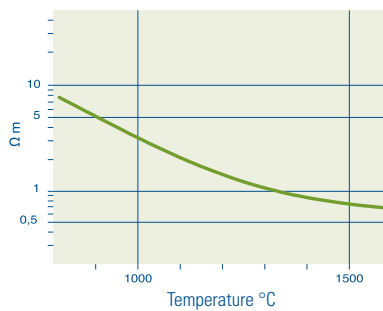
TYPICAL MINERALOGICAL COMPOSITION



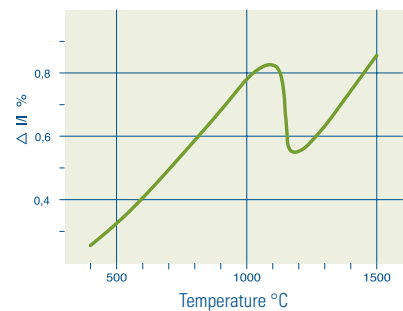
THERMAL CONDUCTIVITY



ELECTRICAL RESISTIVITY

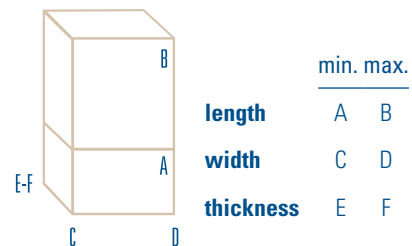
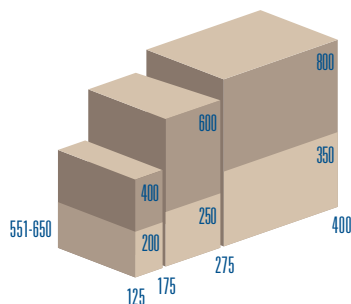
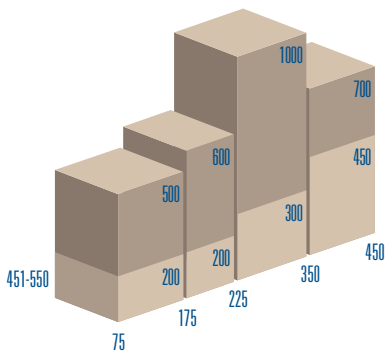
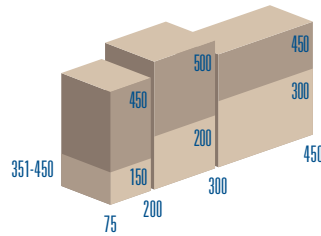
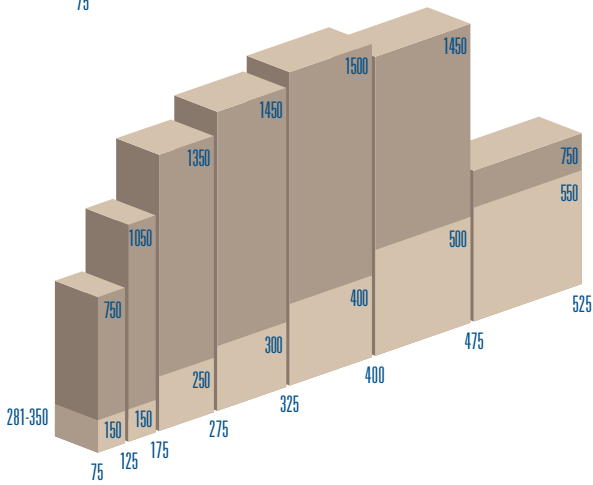
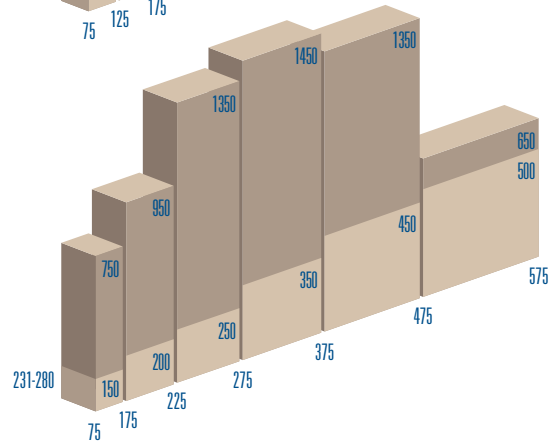
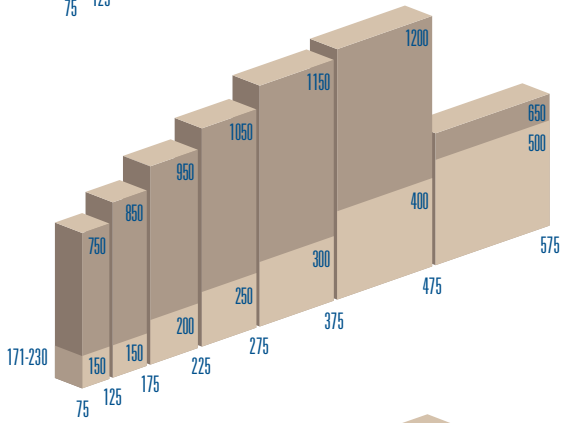
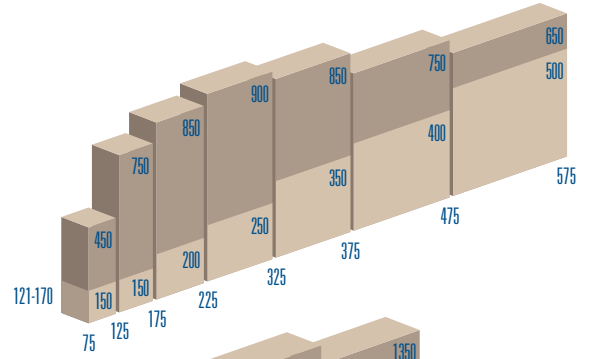
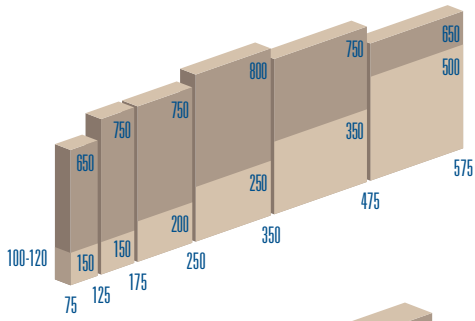


THERMAL EXPANSION



DIMENSIONS OF MANUFACTURABLE PARALLELEPIPED BLOCKS

REFEL 1532 — N



Standard formats

length	width	thickness
600	x 300	x 200
600	x 300	x 300
600	x 400	
600	x 500	

The first two figures refer to the casting face; the third indicates the thickness.



REFEL 1532 — NS

The first two figures refer to the casting face; the third indicates the thickness.

Standard formats

length		width		thickness
300	x	300	x	200
300	x	300	x	250
600	x	300	x	200
600	x	300	x	250



REFEL 1532 — FVP

The first two figures refer to the casting face; the third indicates the length.

Standard formats

width		thickness	length	
500	x	75		x 600
500	x	100		
500	x	120		
400	x	150	x	500

532-N
229802
2333

RE-1532-N
DIS.229802
POS.2333

23 38 ^{K57005}
205

⁶³¹⁹¹³
^{P.40}
POS.2340

²⁰⁶
206

^{K66} OS.2339

¹⁷⁵
175

RE-1532-N
DIS.229802
POS.2328

K106

K127

¹⁷⁴
174

RE-1532-N
DIS.229802
POS.2326

¹⁶²
162

K127

RE-1532-N
DIS.229802
POS.2326

¹⁶³
163

K125

RE-
DIS.
POS

¹³⁷
137

^{K158}
RE-1532-N
DIS.229802
POS.2317

^{K159}
RE-1532-N
DIS.229802
POS.2317

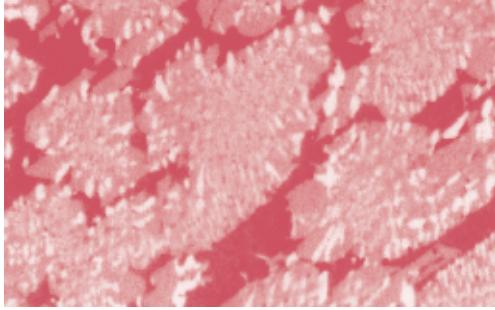
¹²⁴
124

K174

RE-1532-N
DIS.229802
POS.2307

¹²⁵
125

532-N
229802
2307



REFEL 1334S

REFEL 1334S, with a medium zirconium oxide content and a highly compact structure, is designed to provide higher resistance to glass corrosion than REFEL 1532.

PHYSICAL DATA

Cold crushing strength ¹	> 200 N/mm ²
Refractoriness under load (T ₀₅) ²	1700°C
Corrosion resistance in soda lime glass at 1500°C ³	index 0.93 (referred to 1240 material)
Stone formation in soda lime glass at 1500°C	0
Blistering in soda lime glass at 1150°C ^{4,5}	0
Exudation at 1550°C ⁶	index 0.84 (referred to 1532 material)
True density⁷	3.87 g/cm³

¹ DIN EN 993-5

² DIN EN ISO 1893

³ ICG TC11, 120 hours

⁴ Crucible test, 96 hours

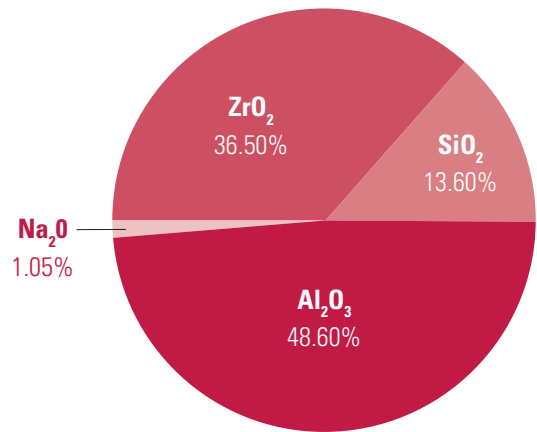
⁵ ICG Subcommittee

A1 definition

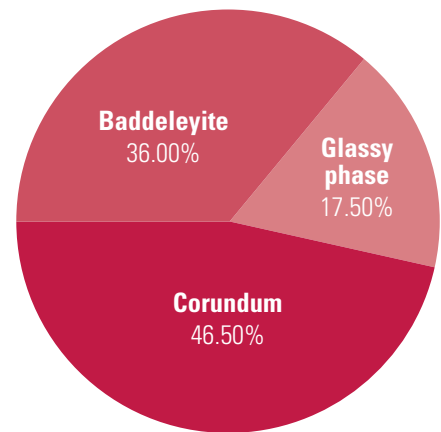
⁶ ICG TC11, 10 cycles

⁷ DIN 66137-2

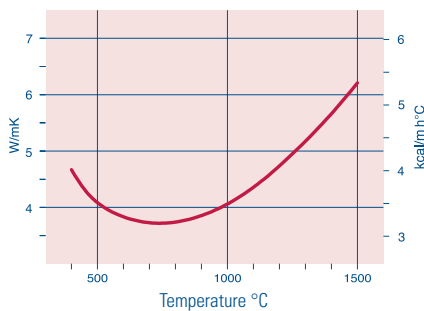
TYPICAL CHEMICAL COMPOSITION



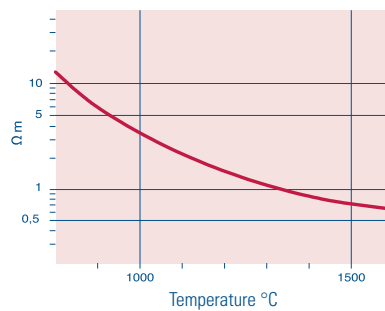
TYPICAL MINERALOGICAL COMPOSITION



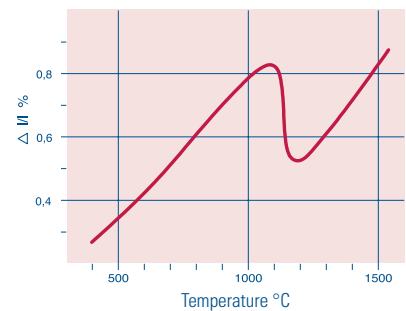
THERMAL CONDUCTIVITY



ELECTRICAL RESISTIVITY

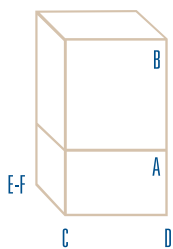
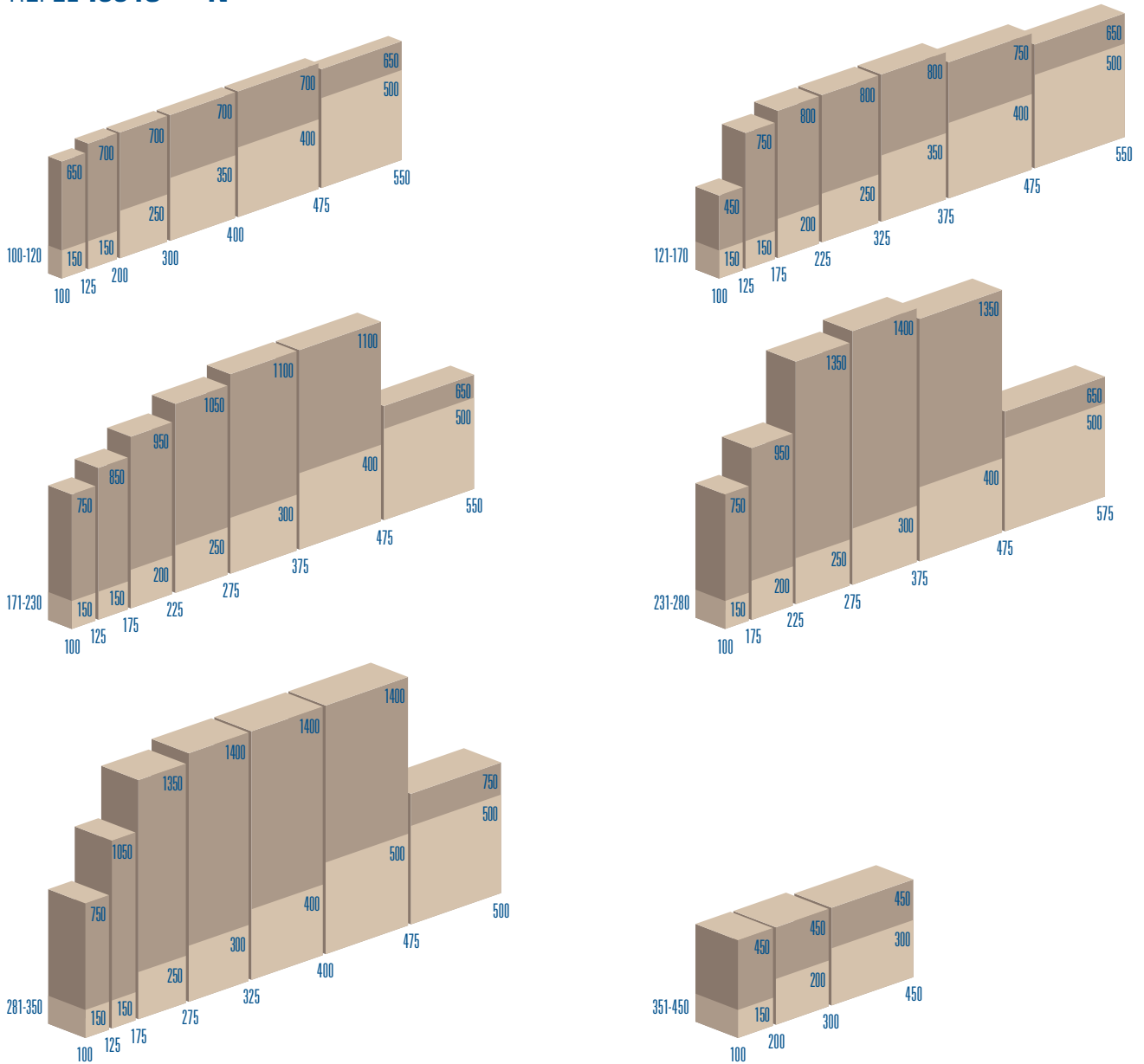


THERMAL EXPANSION



DIMENSIONS OF MANUFACTURABLE PARALLELEPIPED BLOCKS

REFEL 1334S — N



	min.	max.
length	A	B
width	C	D
thickness	E	F

Standard formats

length	width	thickness
600	x 300	x 200
600	x 300	x 300
600	x 400	
600	x 500	

The first two figures refer to the casting face; the third indicates the thickness.



REFEL 1334S — NS

The first two figures refer to the casting face; the third indicates the thickness.

Standard formats

length	width	thickness
300 x 300	x 200	
300 x 300	x 250	
600 x 300	x 200	
600 x 300	x 250	



REFEL 1334S — FVP

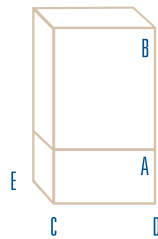
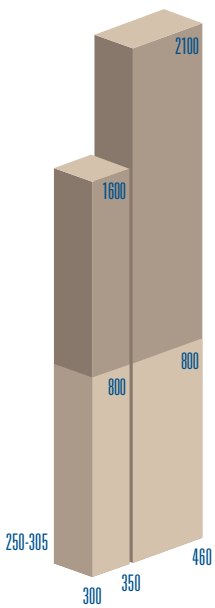
The first two figures refer to the casting face; the third indicates the length.

Standard formats

width	thickness	length
500 x 75		x 600
500 x 100		
500 x 120		
400 x 150		x 500



REFEL 1334S — CR

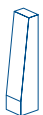


	min.	max.
length	A	B
width	C	D
thickness	E	

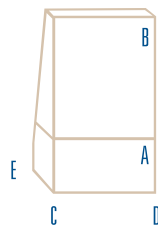
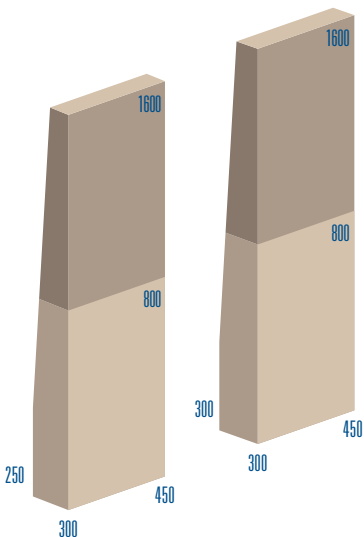
Standard formats

width	thickness	length
		900
		1000
		1100
400 x 250	x	1200
400 x 300	x	1300
		1400
		1500
		1600

The first two figures refer to the casting face; the third indicates the length.



REFEL 1334S — CRS



	min.	max.
length	A	B
width	C	D
thickness	E	

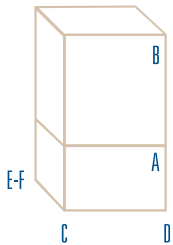
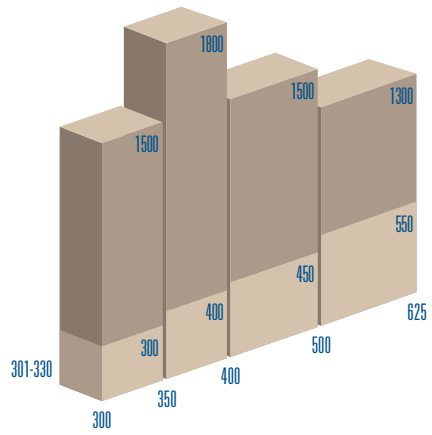
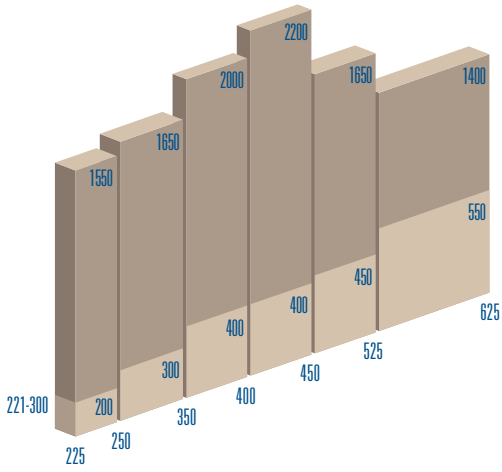
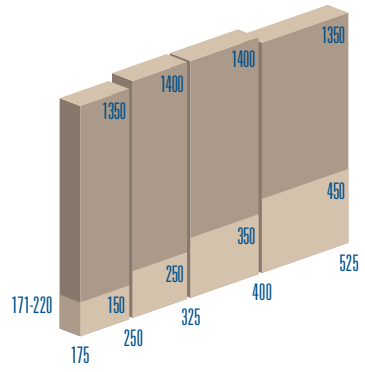
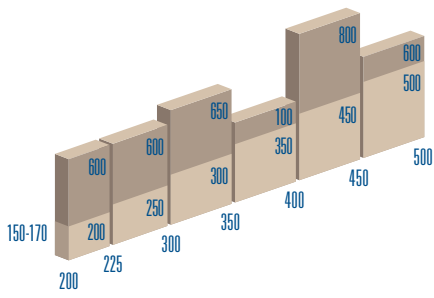
Standard formats

width	thickness	length
		1000
		1100
		1200
400 x 250	x	1300
400 x 300	x	1400
		1500
		1600

The first two figures refer to the casting face; the third indicates the length.



REFEL 1334S — FVB

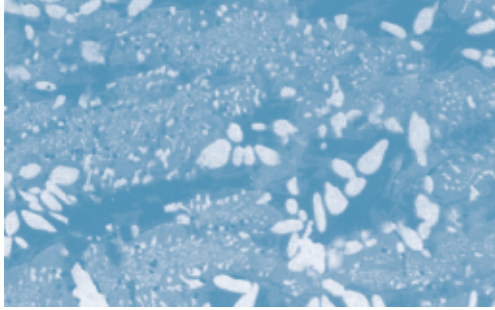


	min.	max.
length	A	B
width	C	D
thickness	E	F

Standard formats

width	thickness	length
		900
		1000
		1100
400	x 250	1200
400	x 300	1300
		1400
		1500
		1600

The first two figures refer to the casting face; the third indicates the length.



REFEL 1240

REFEL 1240, with the highest zirconium oxide content in the standard product range, offers the greatest resistance to glass corrosion. Its special chemical and physical properties make REFEL 1240 the ideal solution for those areas of the furnace which are subject to particular stress.

PHYSICAL DATA

Cold crushing strength ¹	> 200 N/mm ²
Refractoriness under load (T ₀₅) ²	1700°C
Corrosion resistance in soda lime glass at 1500°C ³	index 1 (reference index)
Stone formation in soda lime glass at 1500°C	0
Blistering in soda lime glass at 1150°C ^{4,5}	0
Exudation at 1550°C ⁶	index 0.58 (referred to 1532 material)
True density⁷	3.98 g/cm³

¹ DIN EN 993-5

² DIN EN ISO 1893

³ ICG TC11, 120 hours

⁴ Crucible test, 96 hours

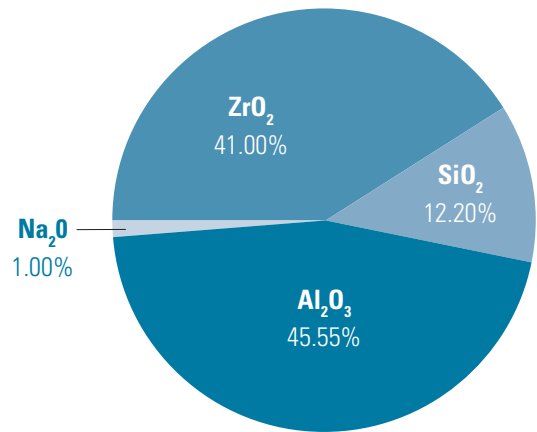
⁵ ICG Subcommittee

A1 definition

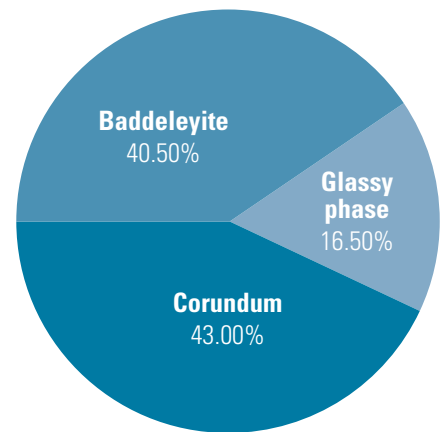
⁶ ICG TC11, 10 cycles

⁷ DIN 66137-2

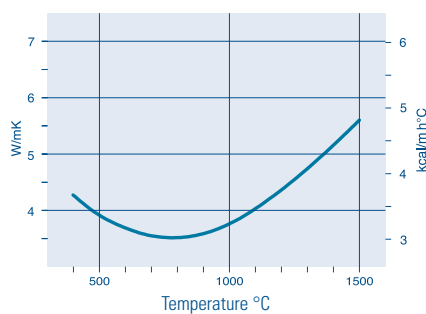
TYPICAL CHEMICAL COMPOSITION



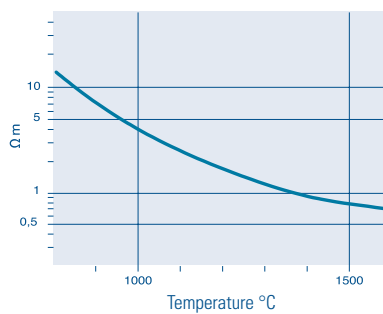
TYPICAL MINERALOGICAL COMPOSITION



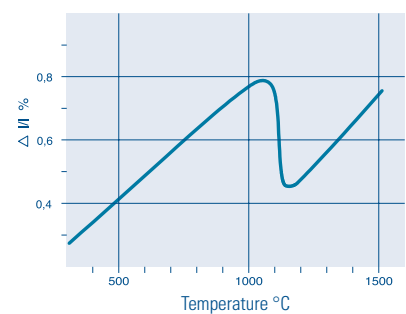
THERMAL CONDUCTIVITY



ELECTRICAL RESISTIVITY



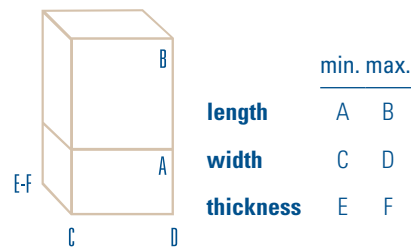
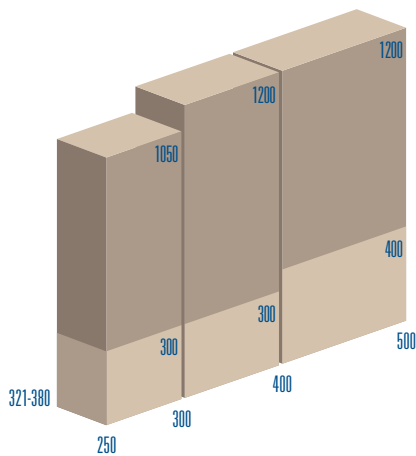
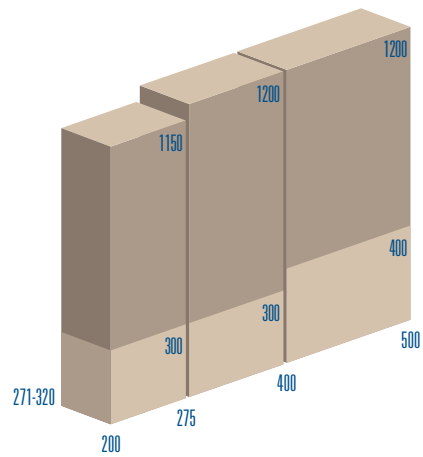
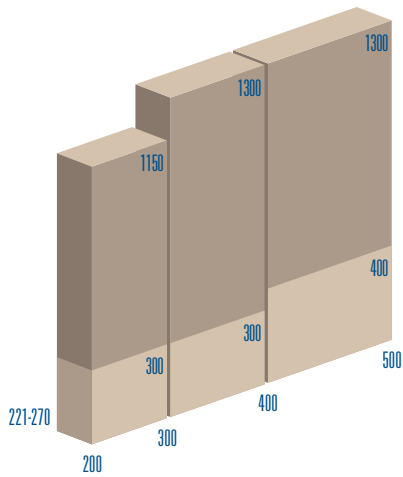
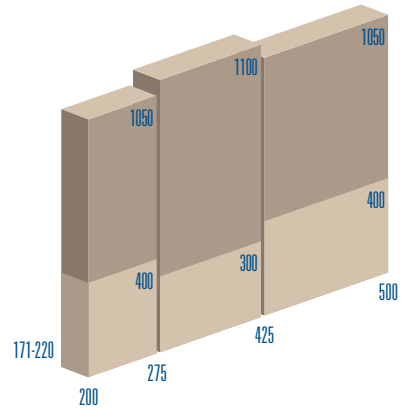
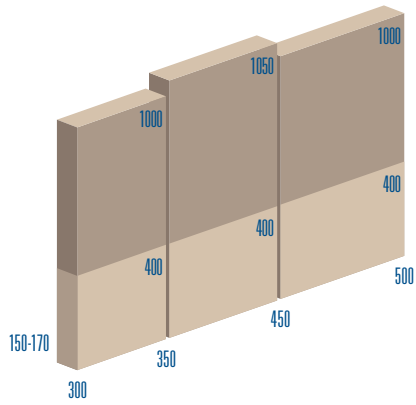
THERMAL EXPANSION



DIMENSIONS OF MANUFACTURABLE PARALLELEPIPED BLOCKS

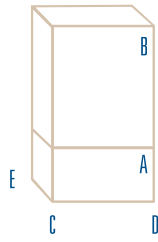
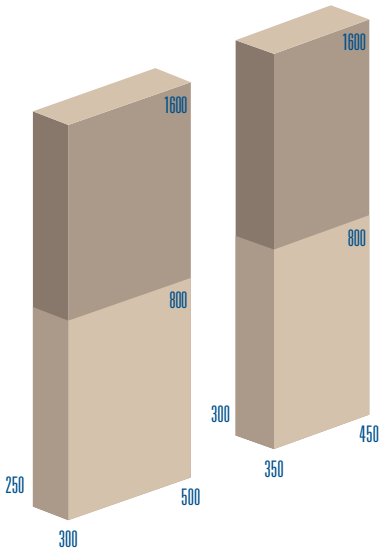


REFEL **1240** — **N**





REFEL 1240 — CR



	min.	max.
length	A	B
width	C	D
thickness	E	

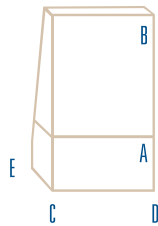
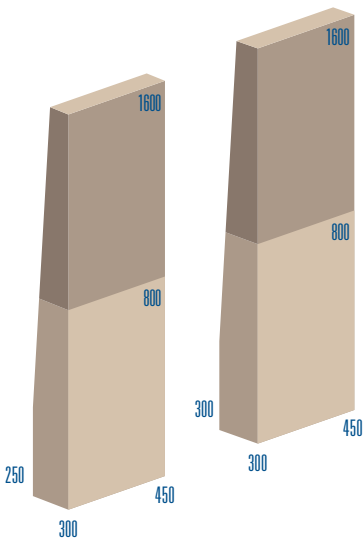
Standard formats

width	thickness	length
		900
		1000
		1100
400	x 250	1200
400	x 300	1300
		1400
		1500
		1600

The first two figures refer to the casting face; the third indicates the length.



REFEL 1240 — CRS



	min.	max.
length	A	B
width	C	D
thickness	E	

Standard formats

width	thickness	length
		1000
		1100
		1200
400	x 250	1300
400	x 300	1400
		1500
		1600

The first two figures refer to the casting face; the third indicates the length.



REFEL 1240 — FVP

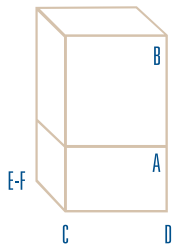
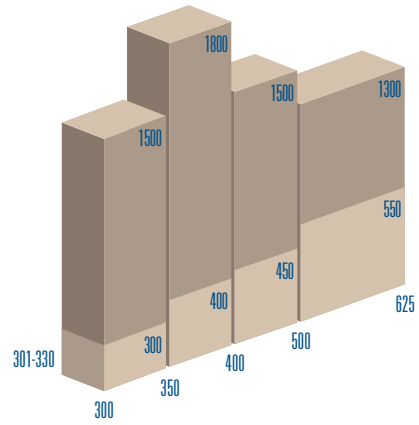
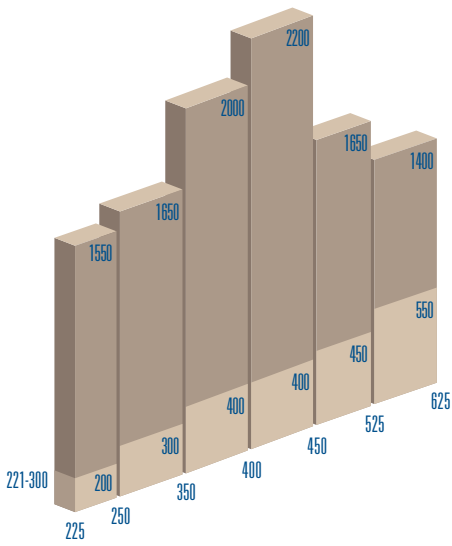
The first two figures refer to the casting face; the third indicates the length.

Standard formats

width	thickness	length
400	x 150	x 500



REFEL 1240 — FVB

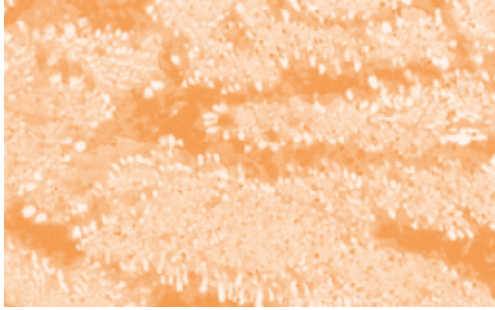


	min.	max.
length	A	B
width	C	D
thickness	E	F

Standard formats

width	thickness	length
		900
		1000
		1100
400	x 250	1200
400	x 300	1300
		1400
		1500
		1600

The first two figures refer to the casting face; the third indicates the length.



REFEL 1334SC

SPECIAL PRODUCTS

REFEL 1334SC, with medium zirconium oxide content, high-creep resistant and limited in glassy phase percentage, combines long life with a minimized exudation, thus enabling superior service performance in air and oxy-fuel furnace crowns and superstructures.

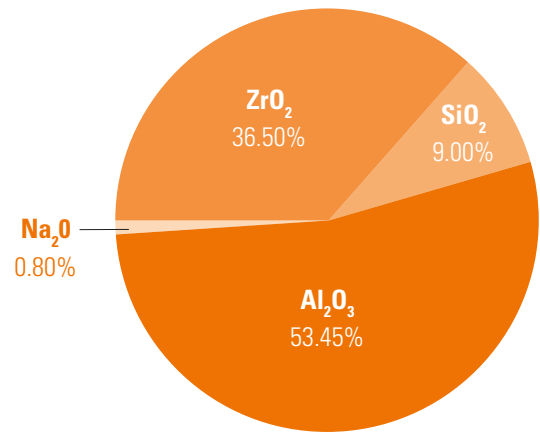
PHYSICAL DATA

Cold crushing strength ¹	> 200 N/mm ²
Refractoriness under load (T ₀₅) ²	1745°C
Exudation at 1550°C ³	index 0.54 (referred to 1532 material)
True density⁴	4.02 g/cm³

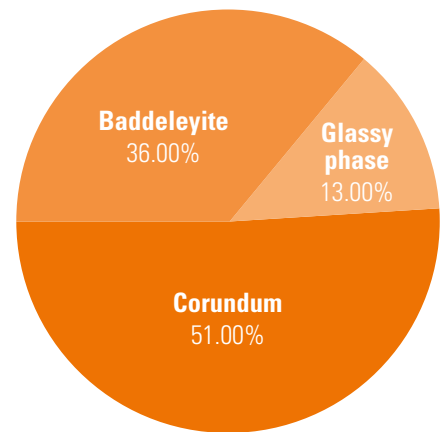
¹ DIN EN 993-5
² DIN EN ISO 1893
³ ICG TC11, 10 cycles
⁴ DIN 66137-2

REFEL 1334SC blocks are generally used in air and oxy-fuel furnace crowns which are subject to the greatest stresses. The shapes and sizes of these blocks vary widely. For this reason, REFEL will examine the feasibility of each block individually.

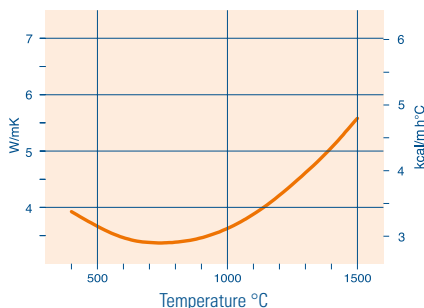
TYPICAL CHEMICAL COMPOSITION



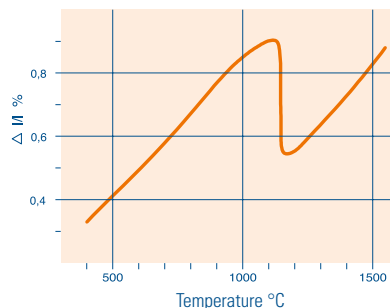
TYPICAL MINERALOGICAL COMPOSITION

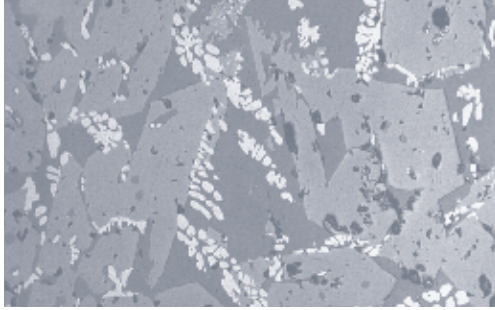


THERMAL CONDUCTIVITY



THERMAL EXPANSION





REFEL 1616ULX

SPECIAL PRODUCTS

REFEL 1616ULX is a fused cast AZS product with an exclusive composition of the glassy phase and ultra-low exudation behaviour. In comparison to all available products on the market, REFEL 1616ULX shows almost no glassy phase exudation, even after several heat-up and cool-down cycles.

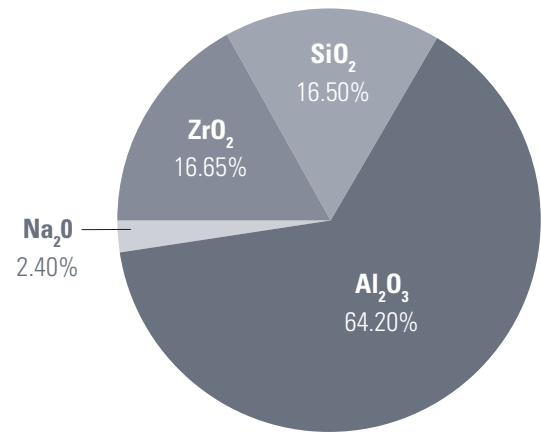
PHYSICAL DATA

Cold crushing strength ¹	> 200 N/mm ²
Refractoriness under load (T ₀₅) ²	1650°C
Exudation at 1550°C ³	index 0.34 (referred to 1532 material)
True density⁴	3.52 g/cm³

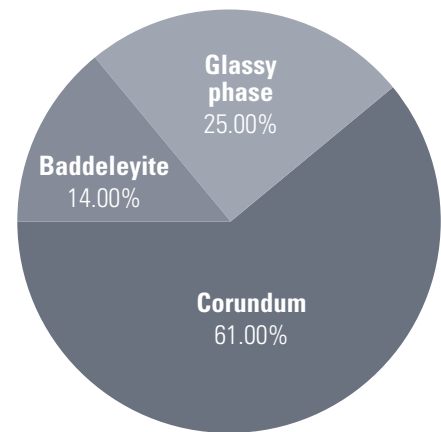
- ¹ DIN EN 993-5
- ² DIN EN ISO 1893
- ³ ICG TC11, 10 cycles
- ⁴ DIN 66137-2

REFEL 1616ULX blocks are used for superstructure. The shapes and sizes of these blocks vary widely. For this reason, REFEL will examine the feasibility of each block individually.

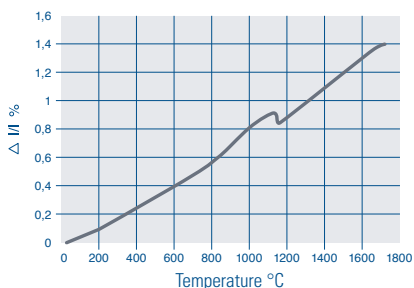
TYPICAL CHEMICAL COMPOSITION



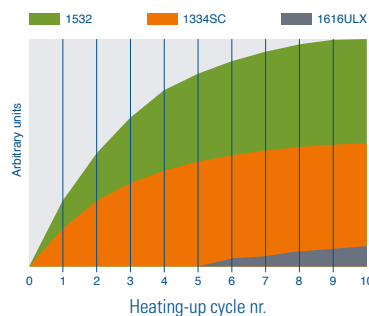
TYPICAL MINERALOGICAL COMPOSITION



THERMAL EXPANSION



EXUDATION ACCORDING TO TC11





REFEL 1240 FVMo

SPECIAL PRODUCTS

REFEL 1240 FVMo is a special product, patented by REFEL, composed of fused cast 41% ZrO₂ material, reinforced with a molybdenum insert, and is particularly suitable for those areas of the glass tank that are submerged and subjected to strong attack, such as the throat.

PHYSICAL DATA

REFEL 1240 matrix

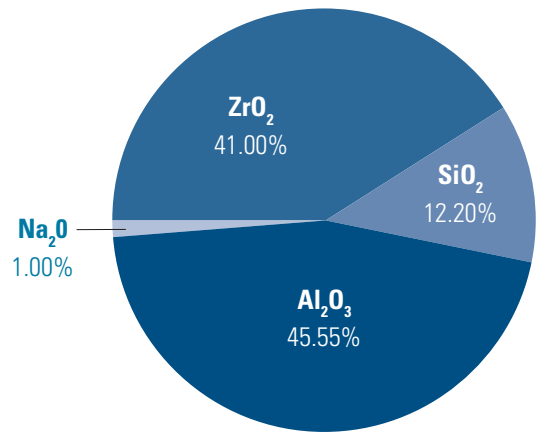
Cold crushing strength	> 200 N/mm ²
Refractoriness under load (T ₀₅)	1700°C

Molybdenum insert in glass melts

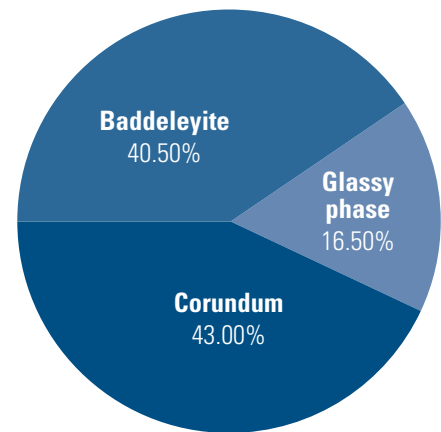
Corrosion	0
Blistering	0
Stone formation	0
Exudation	0
Bulk density	4.10 - 4.60 g/cm³

REFEL 1240 FVMo combines a 1240 FVB block (bulk density 4.00 g/cm³) with a molybdenum metal insert (density 10.20 g/cm³). The bulk density of a REFEL 1240 FVMo block correlates with the size and shape of the insert which varies depending on the application of the block.

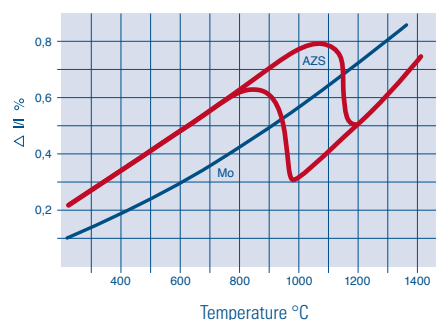
TYPICAL CHEMICAL COMPOSITION



TYPICAL MINERALOGICAL COMPOSITION

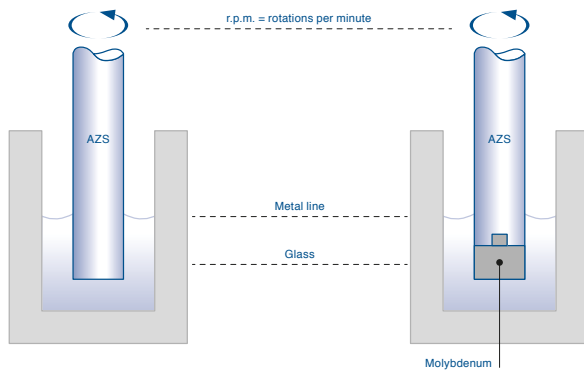


THERMAL EXPANSION

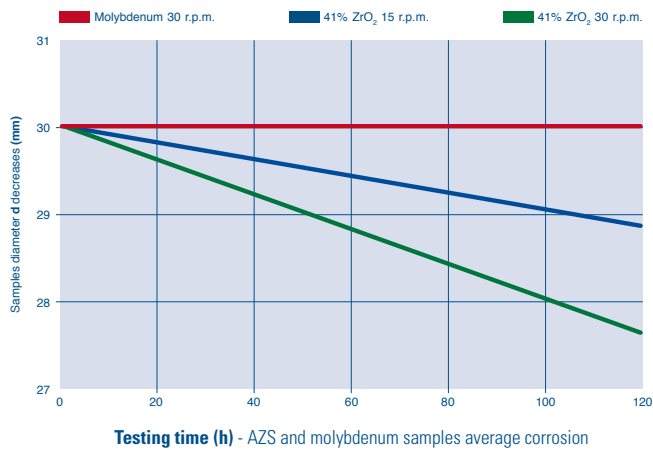
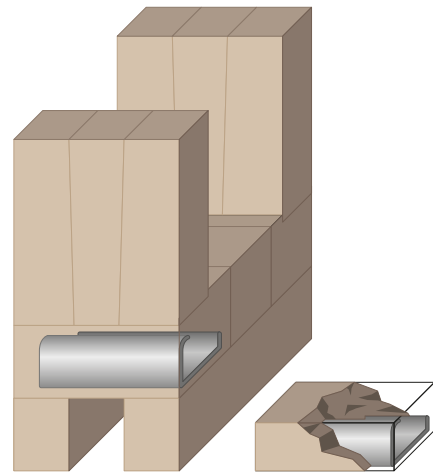


DYNAMIC CORROSION

Fused AZS 41% ZrO₂ and molybdenum at 1550 °C in Na-Ca glass with SO₃= 0.27%.



APPLICATION EXAMPLES





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