

Edition VII. • 2026

Hot end Refractories

Batch plant wear protection
linings

THE ONLY ONE



Take note!

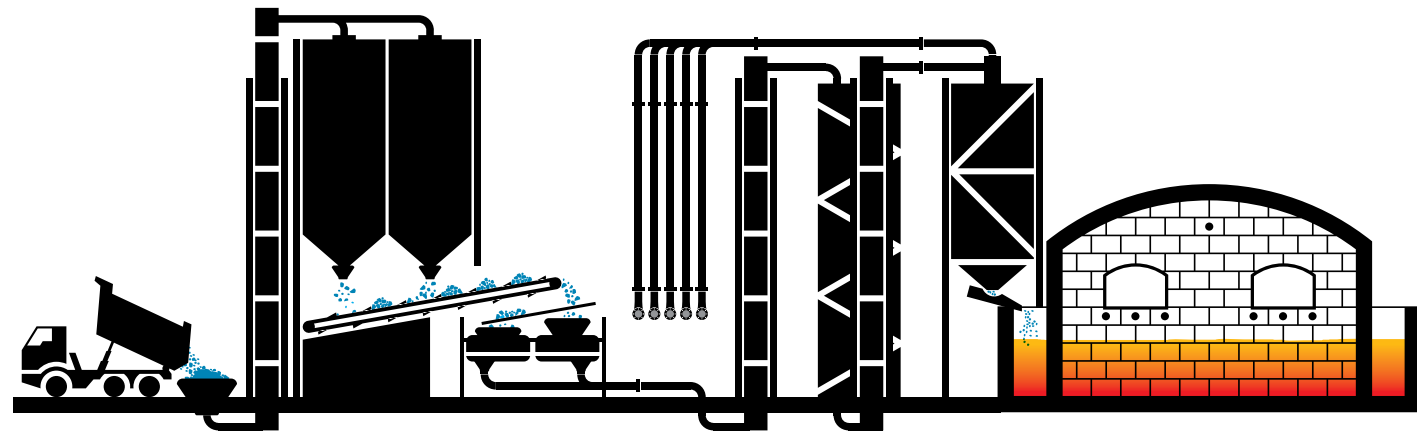
REFRACTORIES CATALOGUE

Refractory parts for the Glassmaking industry





Glass production workflow



1. Batch plant

2. Melting tank

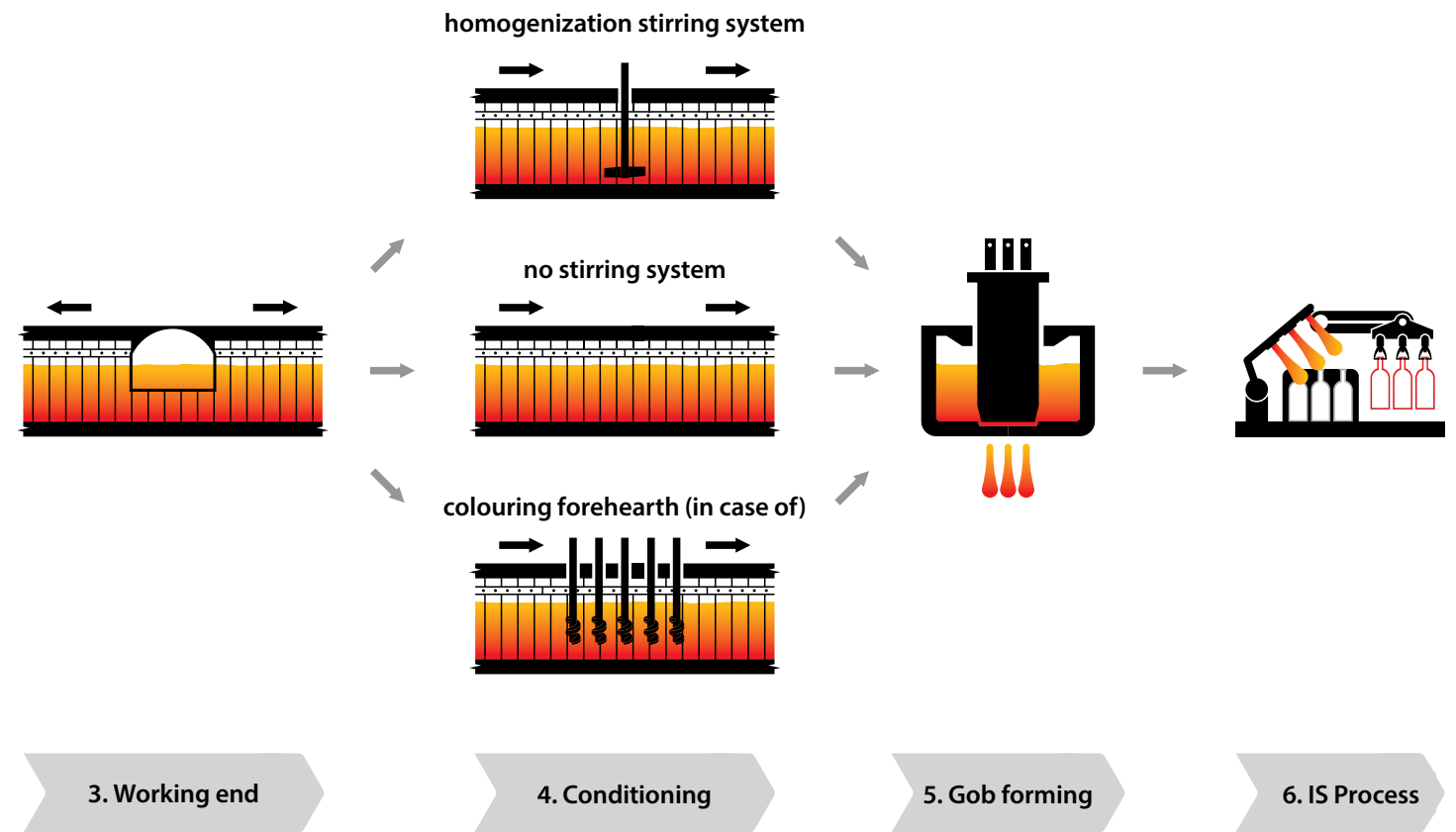
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Glass production workflow



3. Working end

4. Conditioning

5. Gob forming

6. IS Process

Why REFMON?

REFMON Co., Ltd. is a premium bonded-refractory manufacturer strategically located in North-West Hungary, at the heart of the Central European glass industry and close to major international transport routes. As a specialist in glass-industry refractories, REFMON provides high-quality, technically optimized solutions for glass manufacturers worldwide.

Our products are designed to deliver long service life, high wear and thermal-shock resistance, reliable operation and **excellent value for money.**

Our extensive experience with different forming technologies and bonding systems enables us to select and develop the most suitable refractory solutions for each application.

We focus on reducing glass failures, extending campaign life and improving production efficiency.

We are committed to total customer satisfaction through:

- **RELIABLE QUALITY,**
- **COMPETITIVE PRICING,**
- **FAST DELIVERY AND**
- **FLEXIBLE TECHNICAL SUPPORT.**

Stock availability and rapid emergency deliveries help our customers minimize costly production downtime.

Our patented and original solutions, including the PATENTED ROTOR-TUBE, are designed to reduce glass defects and failures while generating significant cost savings.

REFMON serves leading manufacturers in:

- **CONTAINER GLASS,**
- **TABLEWARE,**
- **COSMETIC AND**
- **PHARMACEUTICAL GLASS,**

as well as other segments of the international glass industry.

We believe that high-quality glass production starts with quality raw materials, professional furnace design and high-performance refractories – supported by reliable installation, service and long-term cooperation.

REFMON is a proud member of the German **KALENBORN** and **LIPHARD** companies, having over 100 years of business history on five continents, offering a wide range of wear protection solutions for BATCH plants, conveyor systems, as well as standard and special refractories and SIC biomass applications and more...

Kalenborn
Wear Protection Solutions
www.kalenborn.com

CONRAD LIPHARD & SÖHNE GMBH
www.colisit.de





Glass recycling, Batch Plant & Transportation

Strong Partnership

● **REFMON** is a member of the **KALENBORN** Group, a global leader in wear protection.

Together, we design, manufacture and supply high-performance wear-protection solutions for the glass industry, backed by decades of experience.

Proven Wear Protection

● **KALENBORN** wear-protection solutions are successfully used in batch plants, raw-material handling and glass transportation systems. Our products provide long service life against abrasive wear, corrosion and mechanical stress – even under demanding conditions.

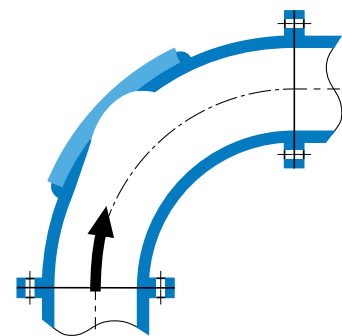
High-Performance Materials

● We offer a broad range of raw materials, including calcium-aluminate, dolomite, sodium-carbonate, calcium-oxide and fining agents. For pipelines and feeding systems, we recommend wear-resistant linings tailored to the specific material and operating conditions.



METALLIC

KALCAST and KALMETALL wear-protection solutions



● It is well known that corrosion mainly affects elbows, and even with over-welding, it does not last long.



CERAMIC

KALOCER, KALCOR, KALCOR-A, KALCOR-S wear-protection solutions

MINERAL MATERIALS

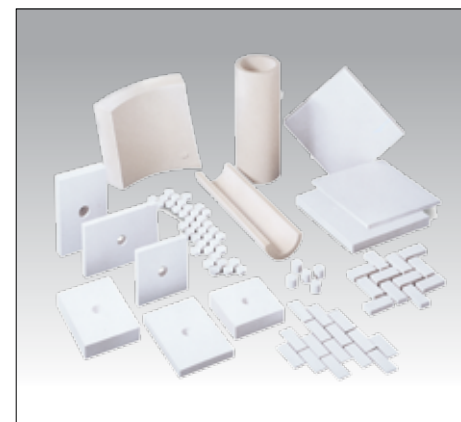


● **ABRESIST** fused-cast basalt

CERAMIC MATERIALS

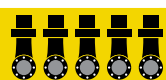


● **KALCOR** zirconium-corundum



● **KALOCER** oxide-ceramic

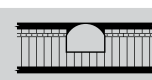
1. Batch plant



2. Melting tank



3. Working end



4. Conditioning



5. Gob forming



6. IS Process



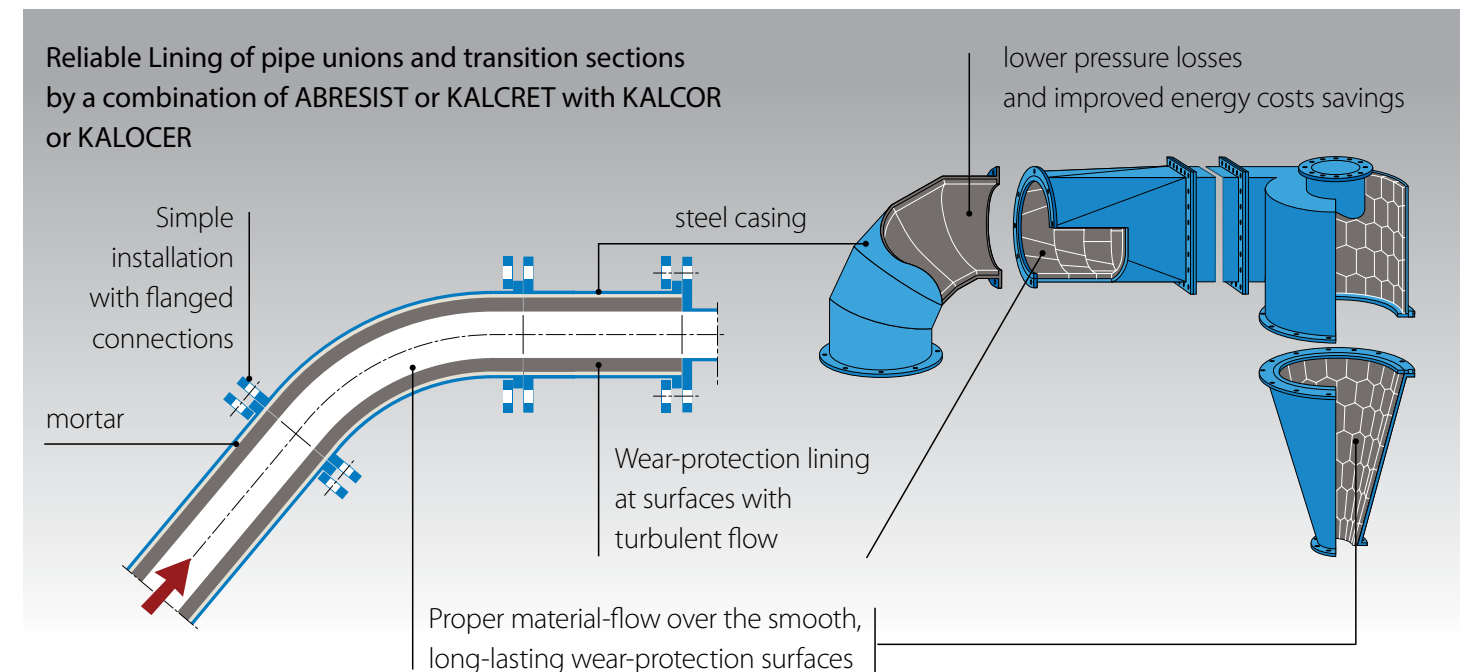
Glass recycling, Batch Plant & Transportation

Efficient Material Handling

● High conveying speeds and abrasive materials can cause severe wear. The right combination of materials and lining systems significantly increases service life and reduces maintenance. Our solutions are proven in demanding applications and transport systems worldwide.

Sustainable and Cost-Effective

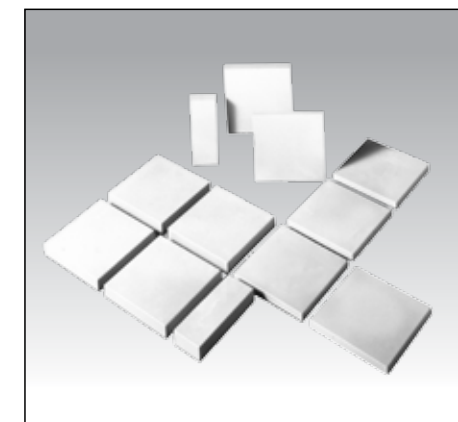
● Based on our long-standing experience, we recommend the most suitable technical solution for each application. High-quality mineral linings, such as **ABRESIST** or **KALCRET** in combination with **KALCOR** or **KALOCER**, help reduce pressure losses, lower energy consumption and deliver excellent value for money.



CERAMIC MATERIALS



● **KALSICA** silicon carbide ceramic



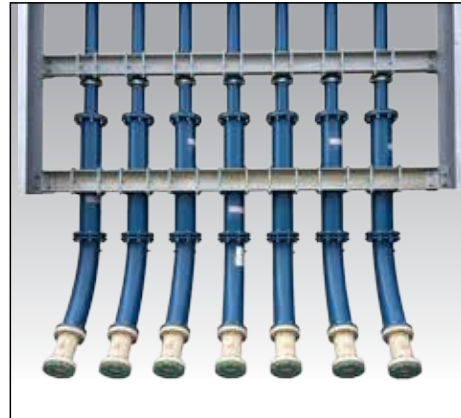
● **KALCERAM** hard ceramic

● In case of specific applications combinations of Kalenborn wear protection materials may be suitable, e.g. **ABRESIST**, **KALCOR**, **KALOCER**, **KALCRET** or **KALMETALL**.



Glass recycling, Batch Plant & Transportation

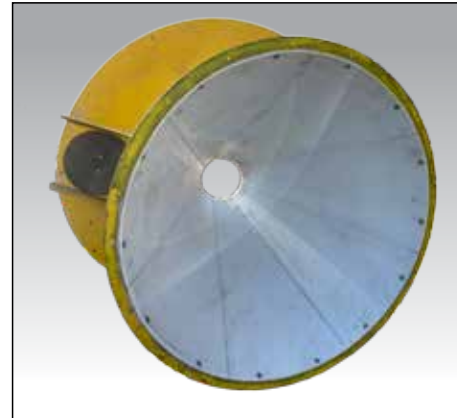
SOME OF OUR REFERENCES



● **ABRESIST Pipe**
raw material pneumatic
transportation



● **ABRESIST KALCOR**
pipe and pipe bends



● **KALEN silo**



● **Kalmetail W100**
dedusting cyclone



● **KALEN-layed**
receiving hopper for sand



● **KALOCER-layed**
cullet hopper



● **ABRESIST**
furnace dedusting cyclones



● **ABRESIST**
glass cullet conveyor



● **KALOCER mixer**



● Diamond-shaped arrangement of
ceramic tiles for very tight bending
radius



● Kalflex used as flexible pipe bend



● Kalflex as part of a diverter valve



● **Kalmetail W**
We produce and supply Kalmetail W
weld overlay customized parts or
standard plates for the glass industry.
Mainly used in bunkers for glass cullets,
vibration chutes or cyclones.



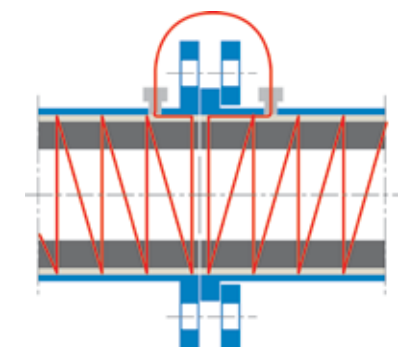
ELECTRICAL SYSTEM



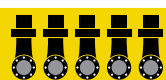
● **KALDETECT**



● **KALDETECT electrical**



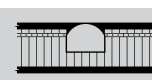
1. Batch plant



2. Melting tank



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REFMON refractories application

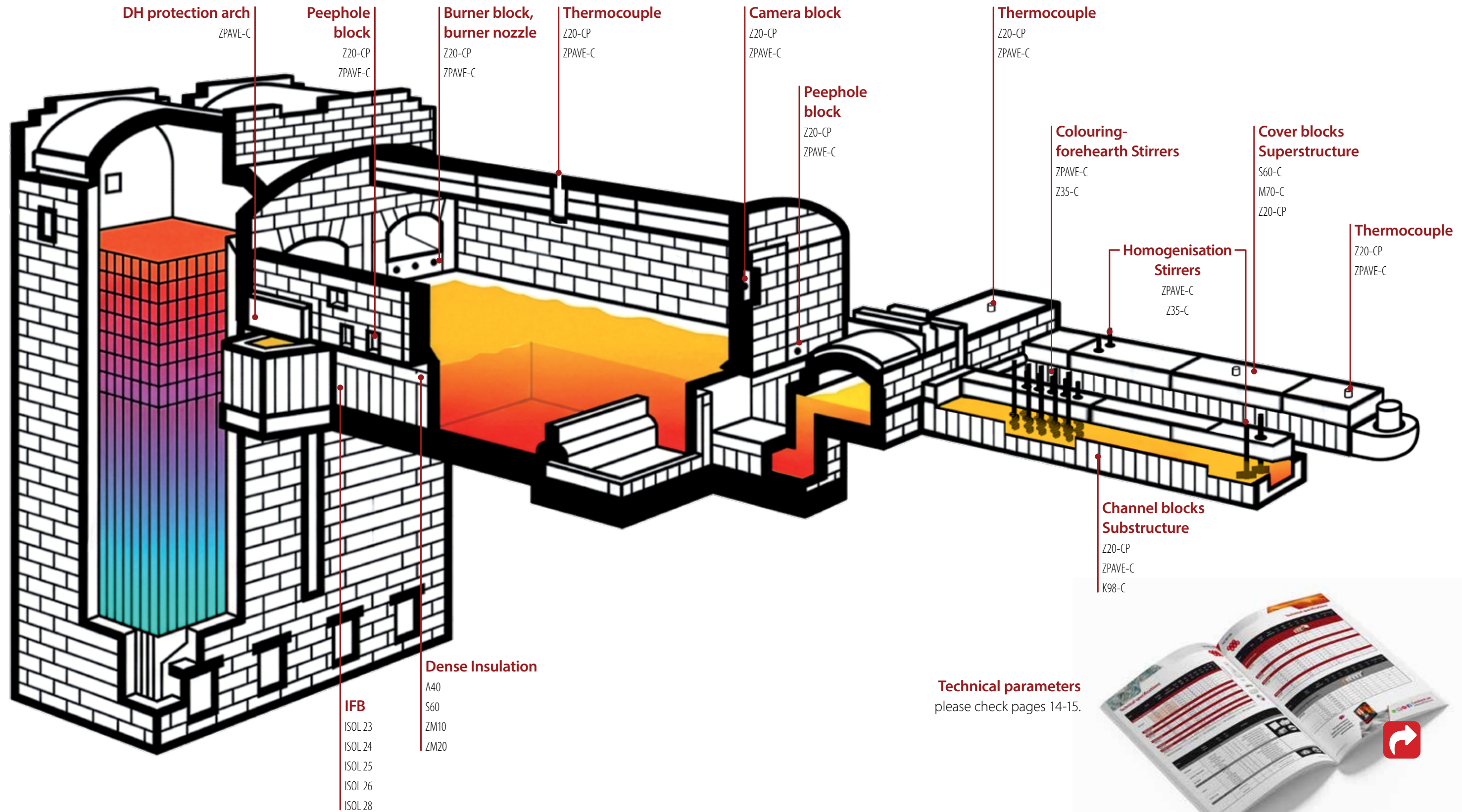
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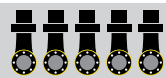
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REFMON refractories application



1. Batch plant



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3. Working end



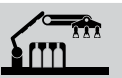
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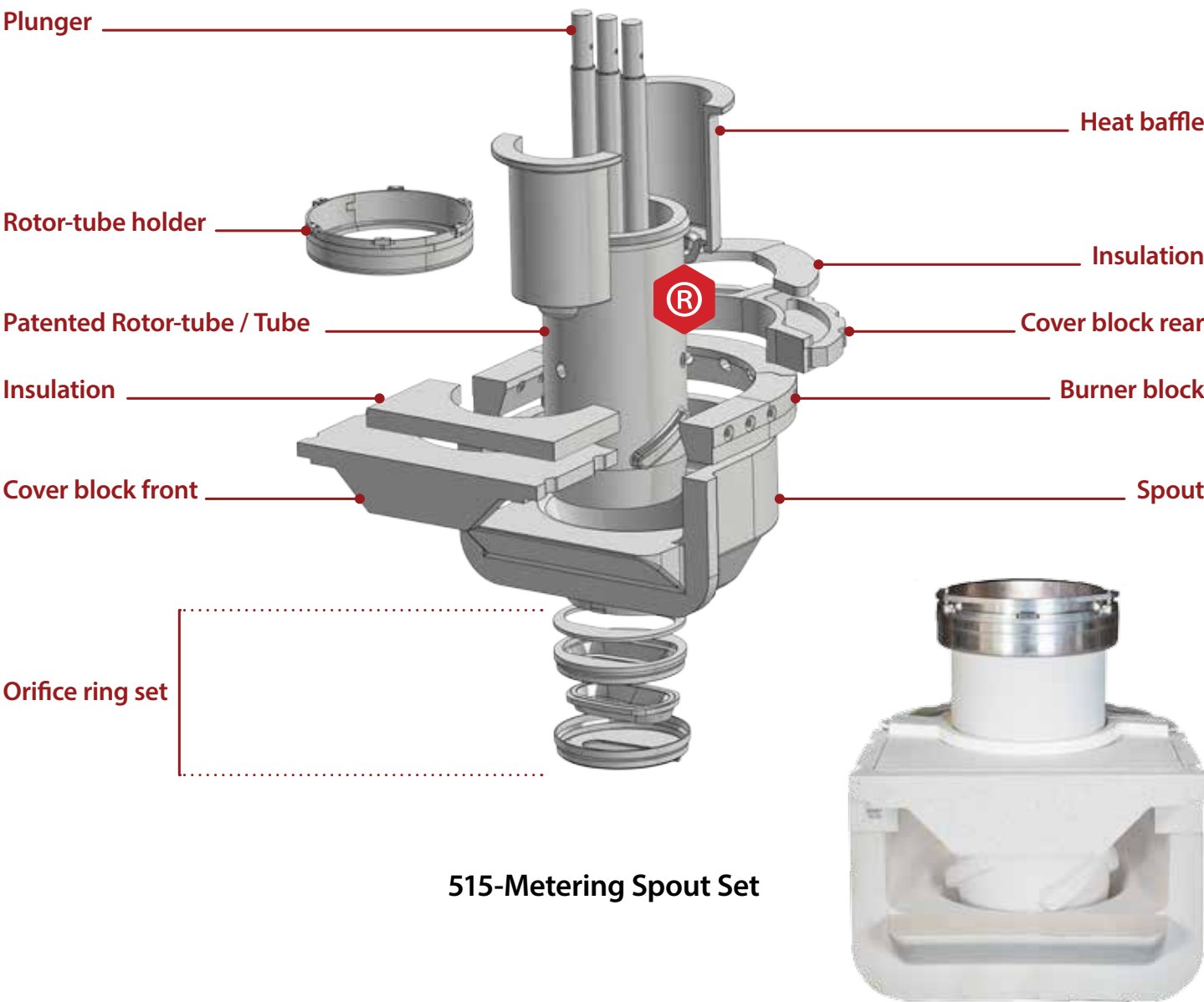




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Gob forming feeder expendables



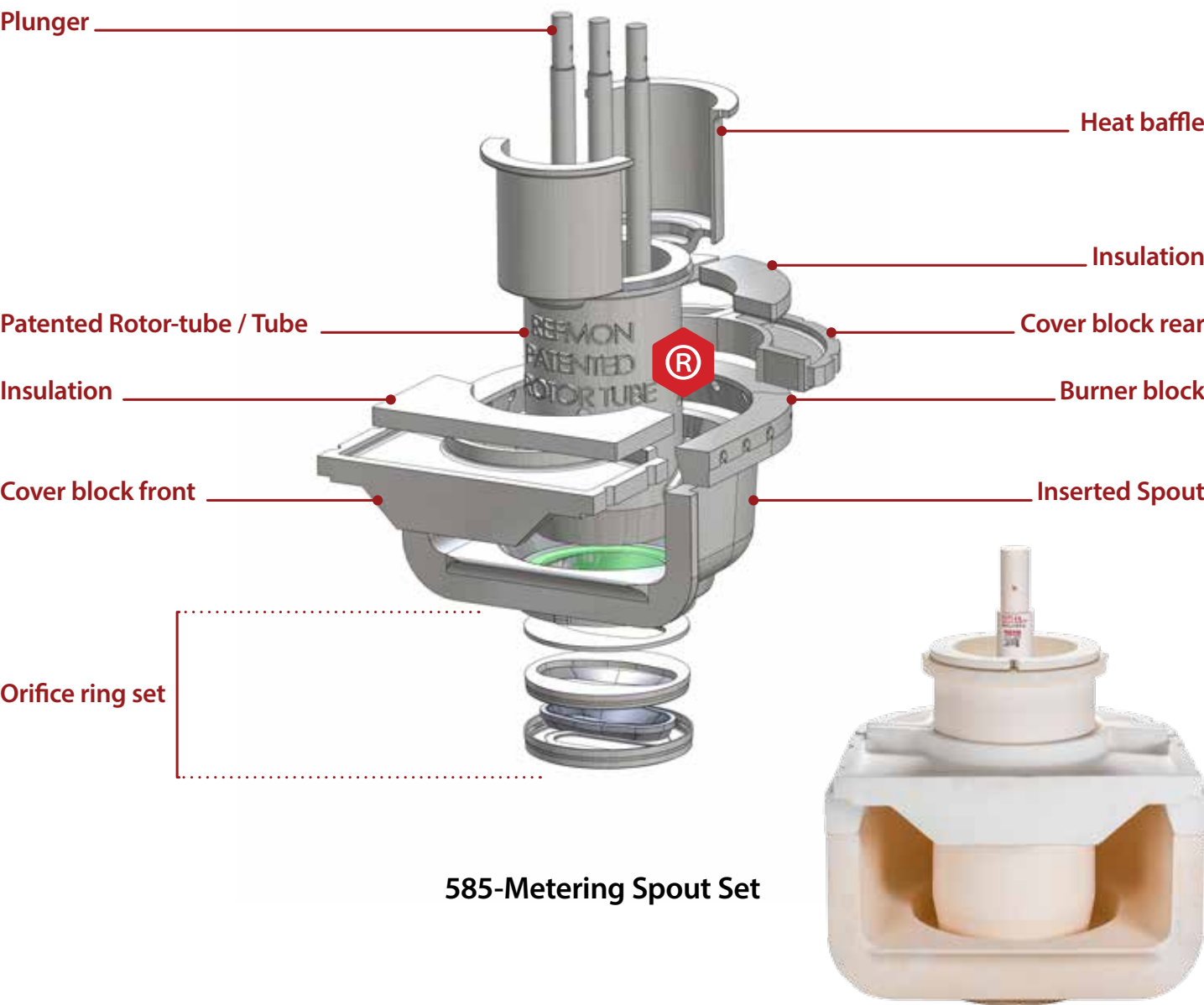
515-Metering Spout Set



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Gob forming feeder expendables



585-Metering Spout Set

Products	Refractory options										Refractory options							Products
	CR90 CR94	CR85 CR96	AZS33 AZS41	Z80	M70-C	Z20-CFP	Z20-CP	ZPAVE-C	Z35-C	FBK	CAST40 CAST50	Muldur	92	95 99,7	Vermiculite	Gasket • Preform CVF	Anti adhesive	
Feeder burner nozzle													●					Feeder burner nozzle
Plunger							●	●	●									Plunger
Heat baffle							●	●										Heat baffle
Tube							●	●	●									Tube
Spout (inserted)	●	●	●	●			●	●	●									Spout (inserted)
Orifice ring (inserted)				●		●		●	●					●			●	Orifice ring (inserted)
Cover block insulation															●	●		Cover block insulation
Cover block				●	●		●	●										Cover block
Spout casing (external insulation)										●	●	●						Spout casing (external insulation)
Patented rotor-tube holder	S 235, S 335																	Patented rotor-tube holder





THE ONLY ONE



Inserted- and non-inserted spout solutions

Longer campaign life, lower cost

● The demand for longer-lasting refractory solutions and lower operating costs makes the right spout design more important than ever. **REFMON** offers reliable solutions for both inserted and non-inserted spouts, using fused-cast AZS (AZS33 and AZS41) and high-chrome refractories (85%-96%).

Bonded-AZS spout bowls

- **REFMON** offers bonded-AZS spout bowls in four standard grades:
- Z20-CP
 - ZPAVE-C
 - Z35-C

Selecting the right Solution

● Spout selection should be based on the:

- glass type,
- product range,
- pulling rate (TPD),
- gob temperature and expected forehearth campaign life.

REFMON provides technical guidance to identify the most suitable refractory solution for each application.

Material and manufacturing matter

● **REFMON** recommends a careful technical comparison of AZS and chrome-alumina refractories from different manufacturers. Differences in chemical composition, manufacturing technology and forming method can have a significant impact on corrosion resistance, blistering, service life and overall performance. Selecting the right material is therefore critical to both technical reliability and cost efficiency.



standard
spouts



standard
metering spouts



AZS-inserted
spouts



chrome-inserted
metering-spouts

THE ONLY ONE



Orifice ring LONG-RUN solutions

Maximum lifetime Minimum downtime Corundum 95% • 99,7% High-zirconia Z80

● **REFMON** developed the inserted orifice ring concept many years ago. Today, market demand continues to grow—not only for flint, but mainly for coloured glass. For more than 17 years, **REFMON** has provided numerous test samples for trial runs, enabling glassmakers to verify the technical and economic benefits: longer service life, reduced corrosion, stable gob weight and significantly less downtime. Actual lifetime can exceed 180 days, sure all depending on gob temperature, gob weight, pulling rate and other operating conditions, this range may vary accordingly.



Technical options for every application

● We offer several technical solutions and cost-efficient alternatives—both for new installations and for retrofitting existing equipment. Based on our long-term experience, **REFMON** has further developed the range with new insert materials, including the NEW **HIGH-ZIRCONIA Z80** (isostatic pressed) and high-alumina technical ceramics with 95% or 99.7% Al₂O₃, which can significantly extend service life compared with conventional solutions. For the most demanding applications, high-density, zero-porosity materials provide excellent corrosion resistance to molten glass. Their potential limitation is lower thermal-shock resistance, that need to be considered while installation and especially heating up recommending longer time for heating up if glass-flow being begun with opening tube vertically.

Experience the difference

● **REFMON** welcomes glassmakers interested in evaluating the performance of our orifice ring solutions. Ask for your orifice ring for a trial run and assess the benefits directly in your own production environment.



LONG-RUN inserted orifice rings

	Spout									Orifice ring					
	Bonded-AZS			AZS-insert		Chrome-insert				Body		Insert			
	Z20-CP	ZPAVE-C	Z35-C	AZS33	AZS41	casted		isostatic-pressed				ISOSTATIC PRESSED			
	Z20-CP	ZPAVE-C	Z35-C	AZS33	AZS41	CR85	CR95	CR90	CR94	Z20-CFP	Z35-C	95	99,7	Z80	
CHEMICAL COMPOSITION %															CHEMICAL COMPOSITION %
Al ₂ O ₃	66	54	45	51,5	45,38	3,0	0,0	-	-	67	45	95	99,7	-	Al ₂ O ₃ [%]
ZrO ₂	21	29	35	32,6	41,00	8,0	-	4-6	-	20	35	-	-	80 ± 1	ZrO ₂ [%]
Cr ₂ O ₃	-	-	-	-	-	84,0	95,0	90 ± 1	94 ± 1	-	-	-	-	-	Cr ₂ O ₃ [%]
SiO ₂	12	16	18	14,8	12,30	-	-	-	-	12	18	2,2	-	0,4	SiO ₂ [%]
Fe ₂ O ₃	0,1	0,1	0,1	Σ<0,30 (Fe ₂ O ₃ , TiO ₂ , CaO, MgO)		0,1	-	-	-	0,1	0,1	< 0,3	-	-	Fe ₂ O ₃ [%]
Na ₂ O	0,2	0,3	0,1			-	-	-	-	0,2	0,1	< 0,2	-	-	Na ₂ O [%]
TiO ₂	0,1	0,1	0,1			3,5	4,0	4,0 ± 0,3	3,8 ± 0,3	0,1	0,1	-	-	-	TiO ₂ [%]
PHYSICAL PARAMETERS															PHYSICAL PARAMETERS
Cold crushing strength [N/mm²]	85	120	120	200	200	900	800	≥ 100	≥ 120	50	100	330	370	≥ 400	Cold crushing strength [N/mm²]
Apparent density [g/cm³]	2,9	2,95	3,17	3,85	4,1	4,1	4,1	≥ 4,2	≥ 4,25	2,8	3,17	3,78	3,90	5,0 - 5,3	Apparent density [g/cm³]
Open porosity [%]	18	19	20	-	-	16	19	≤ 20	≤ 18	19	20	0	0	6 - 8	Open porosity [%]
Thermal expansion at 1000 °C [W/mk]	0,7	0,7	0,7	0,75	0,75	-	-	-	-	0,7	0,7	5,0 - 8,3	5,4 - 8,4	2	Thermal expansion at 1000 °C [W/mk]
Application temperature limit [°C]	1650	1650	1650	1650	1650	-	-	-	-	1650	1650	1500	1650	2200	Application temperature limit °C

typical values given



Technical specifications

Group	Brand	Material guide	Type of manufacturing	Al ₂ O ₃ [%]	ZrO ₂ [%]	SiO ₂ [%]	Fe ₂ O ₃ [%]	Na ₂ O [%]	TiO ₂ [%]	CaO [%]	CaO+MgO [%]	Na ₂ O+K ₂ O [%]
BONDED AZS MATERIALS												
RECAST	Z10-CS	standard	chem-cast	78	12	9	0,2	0,3	0,2			
	Z20-CP	premium	chem-cast	66	21	12	0,1	0,2	0,1			
	Z20-CFP	premium	chem-cast	67	20	12	0,1	0,2	0,1			
	ZPAVE-C	extra premium	chem-cast	54	29	16	0,1	0,3	0,1			
	Z35-C	extra premium	chem-cast	45	35	18	0,1	0,1	0,1			
CORUNDUM												
RECAST	K98-C	special	chem-cast	97,7	-	1,9	0,1	0,1		0,2		
MULLITE												
RECAST	M70-C	special	chem-cast	69	-	28	1	0,1	1,5		0,2	
	M75-C	special	chem-cast	75	-	21	1	0,1			0,2	
ANDALUSITE												
RECAST	S60-C	standard	chem-cast	61	-	37	0,8			0,2		0,5
	S65-C	premium	chem-cast	65	-	33	0,7			0,1		0,5
FIRECLAY												
RECAST	Cord 55	standard	chem-cast	43	-	41					11	
FUSED-SILICA												
RECAST	F599	premium	chem-cast	0,2	-	99,5	0,04					
Manufacturing type		C = Casted	CS = Casted Standard	CP = Casted Premium	CFP = Casted Fine Premium							



Technical specifications

Group	Brand	Material guide	Type of manufacturing	Al ₂ O ₃ [%]	ZrO ₂ [%]	SiO ₂ [%]	Fe ₂ O ₃ [%]	Na ₂ O [%]	TiO ₂ [%]	CaO [%]	CaO+MgO [%]	Na ₂ O+K ₂ O [%]
DENSE REFRACTORIES												
REFCOMP	ZM10		pressed	54	10	33	max. 1,00					
	ZM20		pressed	65	22	12						
	ZM30		pressed	50	30	16						
	ZS65		pressed	1,2	65	33						
MULLITE												
REFCOMP	M70		pressed	70		30	1					
	M75		pressed	75		25	0,5					
ANDALUSITE												
REFCOMP	S55		pressed	57		38	1,20					
	S60		pressed	60		35	1,00					
	S63		pressed	60		38	1,00					
	S65		pressed	63		35	1,00					
	S68		pressed	68		28	max. 1,00					
FIRECLAY												
REFCOMP	A40		pressed	40		50	2,00					
	A45		pressed	45		48	1,80					



Group	Brand (ASTM)	Al ₂ O ₃ [%]	SiO ₂ [%]	Description
CERAMIC FIBRE / VACUUM-FORMED INSULATION				
REFMON	Cerfibre 1400	54	45	bulk fibre, paper, felt, blanket, board
	Biocerfibre	0	78	biosoluble ceramic fibre insulation (1200 °C)
GASKET, PREFORM	CVF-Soft (flexible)	48	52	ceramic fibre insulation (1430 °C)
	CVF-Hard	54	45	ceramic fibre insulation (1430 °C)
	AF-1300 (biosoluble)	0	78	biosoluble ceramic fibre insulation (1200 °C)
REFMON	FBK-kitt			microporous insulation for spout
	Slatted 1000			microporous insulation for spout
AUXILIARIES, INSULATION, CEMENTS				
Spout	LC-SP 132011	6,5	90	spout insulation (87)
	Cast-40	40	30	light weight insulation spout, orifice ring
	Cast-50	50	40	light weight insulation spout
	LC-SP (MULDUR)	61	38	insulating dry grog for spout
	LC-SP 138030	5,6	83,7	orifice ring insulation (MN-41)
Orifice ring	LC-OR 132045	48	44	orifice ring luting cement (220)
	LC-OR 132025	48	44	dry, air set cement (353)
	LC-AA 132048	92,6	5,5	anti-adhesive cement (R-298)
AUXILIARIES, METALLIC HOLDERS				
	metallic holder			S 235, S 335 qualities for tube holders
	metallic pan			S 235, S 335 qualities for pans



Group	Brand (ASTM)	Type of manufacturing	Al ₂ O ₃ [%]	ZrO ₂ [%]	SiO ₂ [%]	Fe ₂ O ₃ [%]	Na ₂ O [%]	TiO ₂ [%]	CaO [%]	CaO+MgO [%]	Na ₂ O+K ₂ O [%]
LIGHT-WEIGHT INSULATION (IFB)											
REFMON	ISOL 23	extruding	37		45	0,7			15		1,1
	ISOL 24	extruding	37		56	1,9					
	ISOL 25	extruding	38		55	2,2				0,3	
	ISOL 26	extruding	58		38	0,7					
	ISOL 28	extruding	67		31	0,6					
	ISOL 30	extruding	74		25	0,3					
	ISOL 33	extruding	98		1,5	0,1					
	HKL 1,5 / 180 (ASTM 33)	pressed	90		10	0,1					



For more technical details, please contact customer service or sales representatives.



Contact us
info@refmon.hu



Technical Experiences

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Vibro cast

One of the most common casting technologies is "vibrocasting", but in the case of wear parts, we are talking about a chemically bonded system, provides better resistance and a longer lifespan against glass melt. Its external, visible "skin" structure is somewhat different from that of slip casting, but the real advantage of the manufacturing technology is shown in the internal "under-skin" structure. It is denser, with significantly less internal porosity than other casting methods, making it more resistant to corrosion and therefore expected to last longer.

Key characteristics

- **Chemically bonded system**
Provides better resistance against glass melt.
- **Lower internal porosity**
Denser "under-skin" structure.
- **Higher corrosion resistance**
More resistant to corrosion.
- **Denser glass-contact zone**
Glass-contact is denser than the non-glass-contact area.
- **Longer expected service life**
Improved resistance leads to longer service life.



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Technical Experiences

Freezing cast

Freeze casting provides a denser structure compared to slip casting and can result in higher internal homogeneity and lower porosity in the glass-contact area.

Microstructure

The freezing cast technology produces a fine-grained, dense structure with reduced internal porosity in the glass-contact zone, resulting in improved resistance to glass melt attack and longer service life comparing to slip casting.





Technical Experiences

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Technical Experiences

Slip Cast 1.

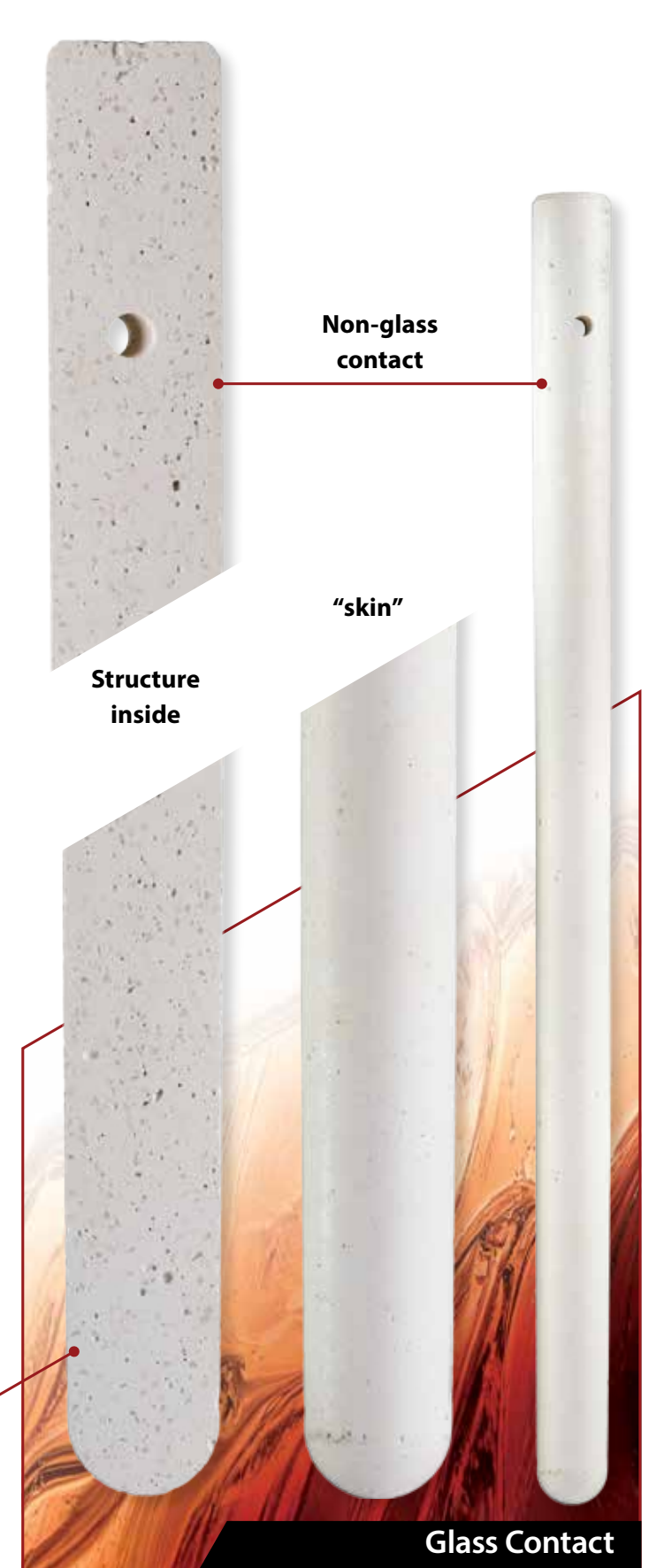
Several competitors manufacture special-shaped glass-contact refractories using slip casting technology. Slip casting can produce a visually smooth and homogeneous external surface ("skin"), which gives the impression that the product is completely dense and free of porosity. However, the external appearance does not necessarily represent the internal structure. Depending on the raw materials, slurry formulation, casting parameters and drying conditions, significant porosity and connected pores can be present beneath the surface. These may facilitate glass penetration and lead to faster corrosion in glass-contact applications.

Key characteristics

- **Smooth external surface**
Visually homogeneous "skin".
- **Higher internal porosity**
Connected pores can be present below the surface.
- **Technology-dependent structure**
Influenced by slurry and drying conditions.
- **Risk of glass penetration**
Internal porosity can provide pathways for molten glass.

Slip Cast 2.

Not all slip-cast refractories perform in the same way. Even when products are manufactured using the same basic casting technology, differences in raw material selection, particle-size distribution, slurry formulation and processing conditions can result in significantly different internal structures. The two examples shown here demonstrate that the quality difference is not necessarily visible from the external surface.





Manufacturing and structural differences

Bonded-Materials

● Manufacturing processes vary between producers depending on the technology applied, the quality of the raw materials used – premium, standard or recycled – and the bonding system. These factors can significantly influence the structure, properties and final performance of a refractory material. From West to East, numerous producers continue to manufacture and supply refractories for the container glass industry. However, glassmakers are aware of significant differences in service life and, in particular, of typical problems such as blisters, cords, seeds, severe corrosion, cracking and breakage. These issues can result in unplanned production changes, reduced production efficiency and, consequently, increased production costs and lower competitiveness.

● Physical and chemical testing is therefore essential, either in-house or in cooperation with independent laboratories. In addition, comparative studies and practical evaluations can provide valuable evidence of the performance of refractory materials under real operating conditions.

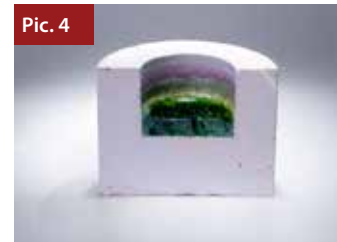
● For REFMON, corrosion testing with both flint and coloured glass is particularly important. Static corrosion tests (**Pics. 1–6**) and dynamic corrosion tests (**Pic. 7**) are regularly carried out either in our own laboratory or by external independent laboratories. The tests are conducted in accordance with international standards, while in some cases we also perform extended tests at higher temperatures and/or with a greater number of cycles.

Structure of the Bonded-Materials

● Regarding our zircon-mullite and zircon-silicate product lines, REFMON can offer refractory materials containing 20%, 29%, 35%, 65% and 80% ZrO_2 , depending on the customer's or designer's specifications. Where specifications are not available, REFMON can recommend the most suitable refractory grade based on the aggressiveness of the glass, the application and the actual operating conditions.



K-98 1450°C, 72 h



Z35-C 1450°C



Z10-CS 1450°C, 72 h



Z20-CP 1450°C, 72 h



Zpave-C 1450°C, 72 h



Z20-CP 6% BaO-Na glass 1450°C, 72 h



S60-C M70-C K98-C Z20-CP Zpave-C ZA35



Z20-CP



Zpave-C



Z35-C



ZS65



Z80

Corundum, High-Chrome

● REFMON's product range includes special high- Al_2O_3 isostatic-pressed corundum refractory materials with zero porosity, developed primarily for **LONG RUN ORIFICE RINGS**. These materials are extremely wear-resistant and depending on the gob-temperature, TPD value and type of glass, their service life can reach 100–150 days and, in extreme cases, up to 200 days. At the same time, they are eco-friendly and recyclable and not harmful to humans, unlike chromium-containing materials where there are potential risks. (**Pics. 8–9**)

Chrome-containing refractory materials

● Chrome-based refractories are selected for demanding glass-contact applications where corrosion resistance, high-temperature stability and long service life are critical. The microstructure and processing route strongly influence their resistance to wear and chemical attack. Plenty of high-chrome existing on the market, but vary based on the manufacturing technology either with vibrocast or pressed (hydraulic or isostatic), consequently qualities and pricing show clear differences as well as applicability for certain glass qualities and lifespan. Microstructure differences are obviously visible as well as performances in glass contact.



Casted chrome 1. (84% Cr_2O_3)



Casted chrome 2. (85% Cr_2O_3)



Isostatic pressed chrome (94% Cr_2O_3)



AZS 33 producer 1.



AZS 41 producer 1.

Structure of the AZS-Materials

● AZS (Alumina-Zirconia-Silica) materials are known as furnace strategical materials, but applied as alternative for inserting e.g. spouts presenting more economical solution compared to high-chrome.

High corrosion resistance with good thermal stability and mechanical strength. Their performance depends strongly on composition, phase distribution and microstructure. Microstructural comparison helps identify differences in density, porosity, crystal phases and glass penetration between manufacturers. (**Pics. 10–13**) Refmon pays attention a lot sourcing of the best fused-cast quality on the market.



AZS 33 producer 2.



AZS41 producer 2.



Glass Defects Analysis

Refractory Analysis

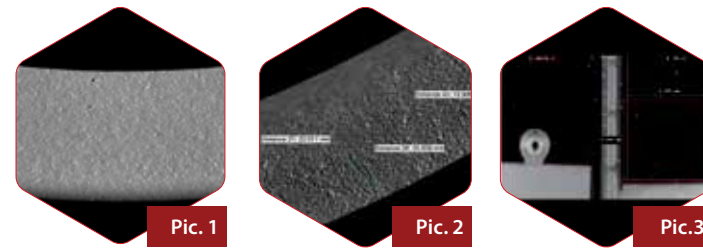
• This led REFMON to explore one of the most advanced 21st-century technologies: X-ray Computed Tomography (CT). CT scanning enables non-destructive investigation of the internal condition of refractory components.

- internal cracks (**Pics 1-2.**)
- internal structure and porosity (**Pic 4.**)
- Grain size and structural features, supporting the selection of suitable refractories and the identification of unsuitable materials.

• Blistering potential analysis (**Pic 3.**)

• Beyond sales, **REFMON** aims to build technological cooperation with glassmakers, developing a clearer understanding of their processes and the challenges they face under extreme hot-end conditions.

HIGHER EFFICIENCY, IMPROVING COMPETENCE.



Understanding the root cause of glass defects

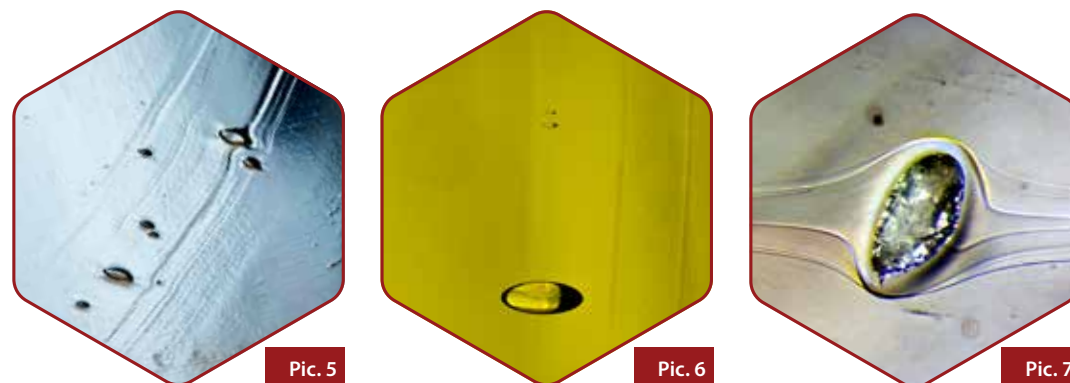
Glass quality problems

• Glass quality main problems like cords, blisters, seeds, (**Pics 5-7**) are common across the glass industry. Their causes can be diverse, making root-cause identification challenging. Potential sources include unsuitable refractories, batch and raw-material issues, and operational conditions. A systematic analysis helps distinguish refractory-related defects from problems originating elsewhere in the process.

From melt to inspection

• Any of these factors can generate defects that become visible during gob forming, IS forming (PPC system), and later through increasingly accurate inspection machines. One of the most common glass-quality defects is the “cat-scratch”. One tool for improving production-line efficiency is REFMON’s original, patented rotor-tube (see study pages 24–25).

Examples of glass defects



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Some of the References



• Rotor-tube, lifespan with a range of 4–15 months.



• Rotor-segment, lifespan with a range of 6–9 months.

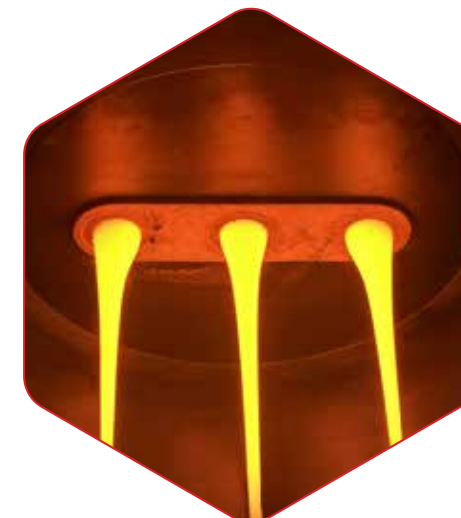


• Standard tube, lifespan with a range of 6–12 months.



After
17 months
of operation
Hungary

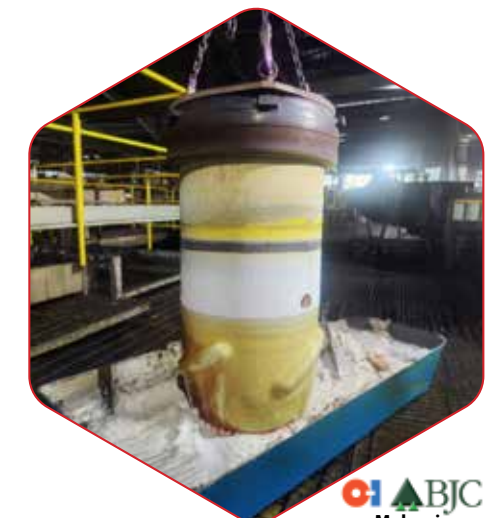
• Depending on gob-temperature, glass colour and production capacity of the line and rotation speed.



• Inserted orifice ring



• Stirrer, 6 months



• Rotor-tube, 13 months



Trouble shooting solutions

Improving glass quality for Container Glass: PATENTED ROTOR-TUBE

- Having been proceed a study related to the correlation between physical study, mathematical simulation and industrial experiences on the PATENTED ROTOR-TUBE design, which as helped improve glass quality within the feeder solving many unexpected glass-defects on the lines improving efficiency, consequently saving money.
- We cannot design a PATENTED ROTOR-TUBE for each feeder, which would be the best solution for a glassmaker adapting parameters to real flow and glass properties.
- We will introduce two of them and explain the influence on glass quality. The first is rotation speed. The second, which is also a way to describe our philosophy when developing the rotor-tube, is the number of helixes.
- Study is about 1:2 scale feeder with, under real conditions the parameters: 30 TPD, 1140 Celsius, 218 Pas, glass level 196 mm.
- When we talk about tube rotation, we know that almost all lines work with a speed value between 1 and 6 RPM. Our study is based on three cases: 2, 4 and 6 RPM and only clockwise rotation considered.

Number of helix and glass quality

Introducing helixes on a tube is easy to understand based on the stirrer effect point-of-view. There is a risk to badly influence the gob weight stability and then to generate more issue than we get initially especially on the NNPB process.

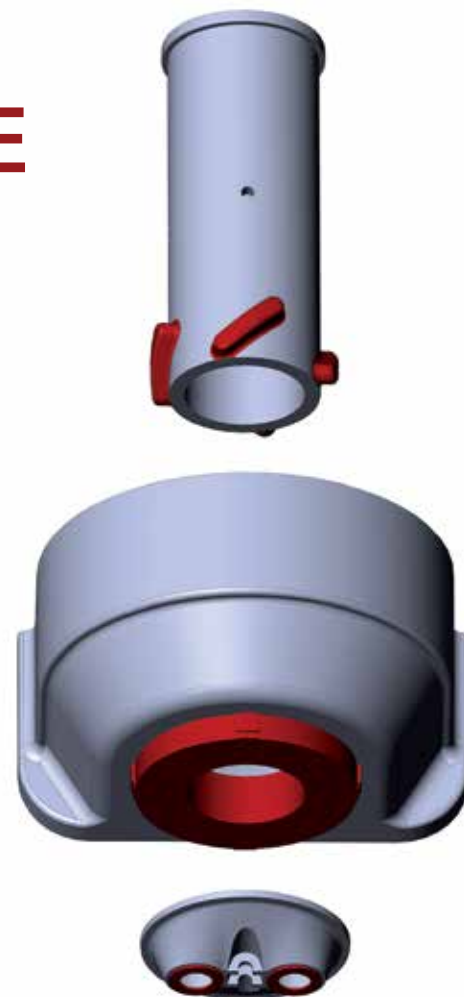
Defects

The transversal section of the feeder is divided into 15 areas, with three vertical positions (top, middle and low) and five horizontal positions (right, midright, middle, mid-left and left). For each area, we can introduce a coloured tracer representing a glass defect as a 'heterogeneity in the glass structure'. High resolution cameras record the behaviour of the tracer.

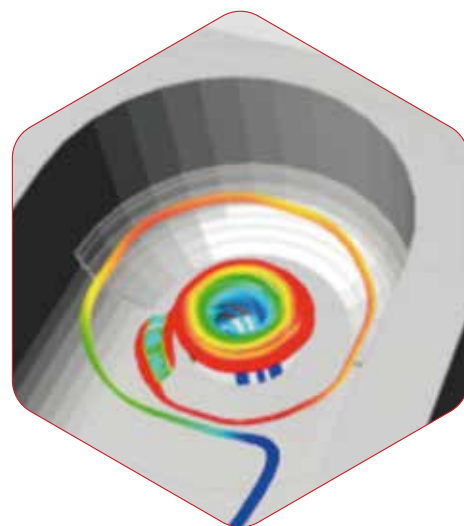
Results

More than 150 trials were made covering all the above cases. To evaluate the performance of the PATENTED ROTOR-TUBE we established a ranking from one to five as:

1. Sharp cord in the spout
 2. Nearly sharp cord in the spout
 3. Part of the tracer is mixed, part is nearly invisible cord in the spout
 4. Tracer is mixed, mixed tracer is visible in the spout
 5. Tracer is mixed, no colouration in the spout.
- One being the lowest rank when the defect isn't mixed and fully rejected in the spout, five is the highest rank when the defect is fully mixed before going through the spout.
 - From 2 to 4 RPM, the performance increases by an average 17% in our cases. From 4 to 6 RPM, the performance increases by an average 9% in our cases. In details, it appears that the efficiency is increased for the upper part of the glass, for the left side



● Patented Rotor-tube helix, part of the innovative Expendables set



● Visual representation of defect speed and trajectory

of the glass and also for the right part of the glass.

- Let's start saying that moving from 0 to 4 helixes greatly increases the glass quality, about 31%, especially on the top and lateral parts. For the lower middle part of the glass, we haven't any significant improvement for these cases, again.
- But, except within the 6-RPM case, moving from 0 to 2 helixes doesn't show an improved dilution of the defect since it's even slightly worse. After introducing the first design of two helixes rotor-tube, we worked in various parameters such as helixes position, size, angle and so on. The next step was to offer this solution with higher number of helixes, four being our internal consensus. Following the above results, we advise people facing glass defects to earnestly consider a trial with a four-helixes rotor-tube, which is an additional tool to RPM changes.

Industrial feedback

- With more than 100 feeders around the world using the concept of rotor-tube (mainly the two-helixes version of our innovative design but we are currently implementing everywhere the four helixes version) we have built a strong empiric experience of its performance. From 6 to 14" inner diameter, from 20 to 130tpd feeder, from extra flint to various colour and glass chemistries, from cosmetic to pot through pharmaceutical and tableware products, we collected plenty of data and we came to a tricky conclusion: it is impossible to fully predict the performance of our rotor-tube in detail. At least, we can 'feel' that this defect will be corrected, this one will be not

be cleared and so on. But feeling isn't enough when it comes to decision time. The already very-subjective notion of defect will change drastically from one line to another and from one factory to another, driven by glass products application.

- We have to start with the very rare cases where the rotor-tube doesn't give full satisfaction. The first case was a container-line producing bottles for alcoholic beverages but not luxuryoriented. Half of the products were affected by cords and subject to rejection. The use of the rotor-tube didn't help with such a critical situation and only the refurbishment of conditioning area gave back a proper quality for the glass. The second case was a line producing bottles for wine in a famous French wine region. One line gave tremendous cords and a second one gave slight cords but still acceptable. The installation of a rotor-tube on both improved the line with tremendous cords, but on the second line, it appears that defect level was worse with the rotor-tube.

● The third case was similar to the first one, with an old furnace giving many cords. The rotor-tube brought improvements but only the stirrer system, until a recent refurbishment of the furnace was able to clear the defects.

- Many people know about the rotor-tube and its success, so the following positive results may sound familiar. For the cords, the rotor-tube is able to reduce the intensity level and/or duration by 40 to 60%. Nonetheless, in case of old furnace and conditioning area giving high amounts of cords, the rotor-tube may not be efficient enough to reach an acceptable level.

- For the cat scratches, the rotor-tube gives positive results but not over 100% of the running period.

● **For the glass suffering light streaks or coloured streaks, the rotor-tube showed a significant improvement, especially in the case of bigger machines, from 10" to 14" tubes.**

- So, connecting industrial feedback, mathematical simulation and physical simulation, we have seen that for lateral part and upper parts, moving from 0 to four helixes step-by-step increases glass quality.

- As a general conclusion, I would recommend first to use the right quality refractories when building a new furnace because most of these painful defects come from refractories, and then, when the furnace starts to age or already gives unexpected glass defects, to use the rotor-tube with four helixes, working on the RPM to get optimal efficiency but knowing that after a certain level, it is worthless to increase it. In certain cases, the rotor-tube will not give the expected results, especially for old furnaces or young furnaces made of low quality refractories, especially fused-cast AZS.



Partnership



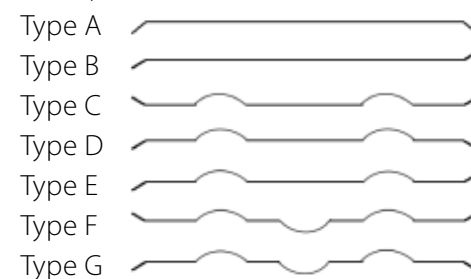
● Taking into account the advantages provided by the win-win situation, refmon has entered into a partnership with the following companies, which also provide glass manufacturers with products and services indispensable for the glass industry.



Leaf Springs

● Redfoot manufactures leaf springs to meet the highest performance standards needed for necking arms in glass container manufacturing. The stainless steel coils are imported from top European steel mills, the coils specially selected from mill stock to ensure exceptional characteristics with high temperature resistance and low plastic deformation, resulting in a long lifetime on the I.S. machine. Material selection ensures tensile strengths of +2000MPa thus assuring that the leaf spring does not permanently deform when inserted in the necking arm. The material is heat treated above 400°C to ensure that necking temperatures of 300°C does not cause leaf spring softening during manufacturing of glass containers.

● Shape specifications



● CONTACT INFORMATION

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Solutions for Glass Industry

● Repair and refurbishment of PPC systems servomotors used in IS machines.
 ● Warehousing solutions – manufacturing and supply of parts and components for glassware handling and transfer systems.
 ● Spare parts for IS machines – supply and manufacturing of mechanical, pneumatic, electrical and process components.
 ● Refurbishment and modernization of machine components
 ● Technical support for glass manufacturing plants.
 ● Software solutions for the glass industry – development and implementation of software for machine control, process monitoring, diagnostics and production optimization.

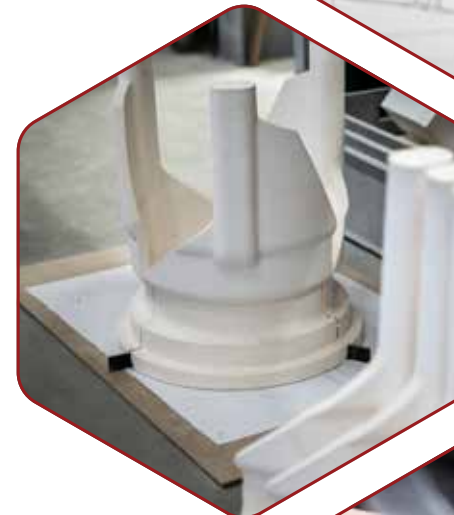
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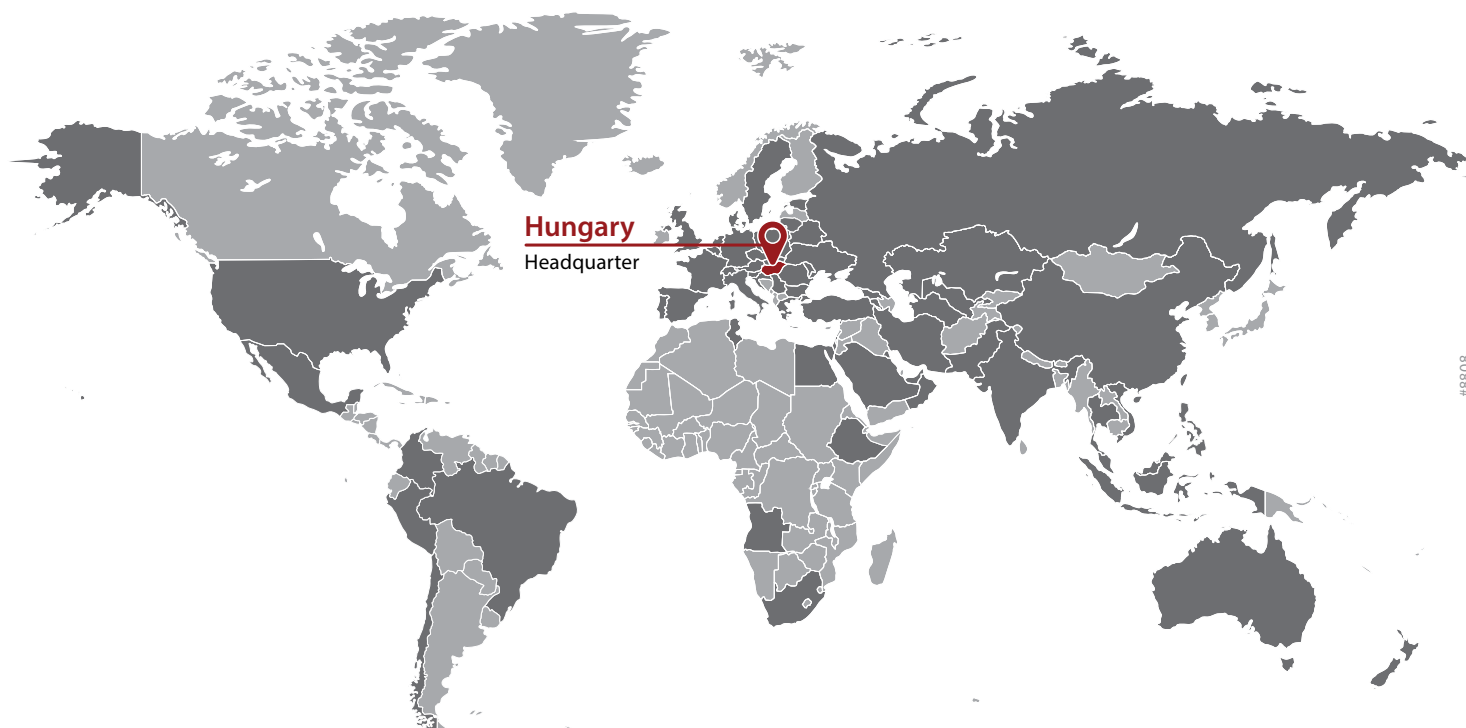
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- Long-term partnership



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