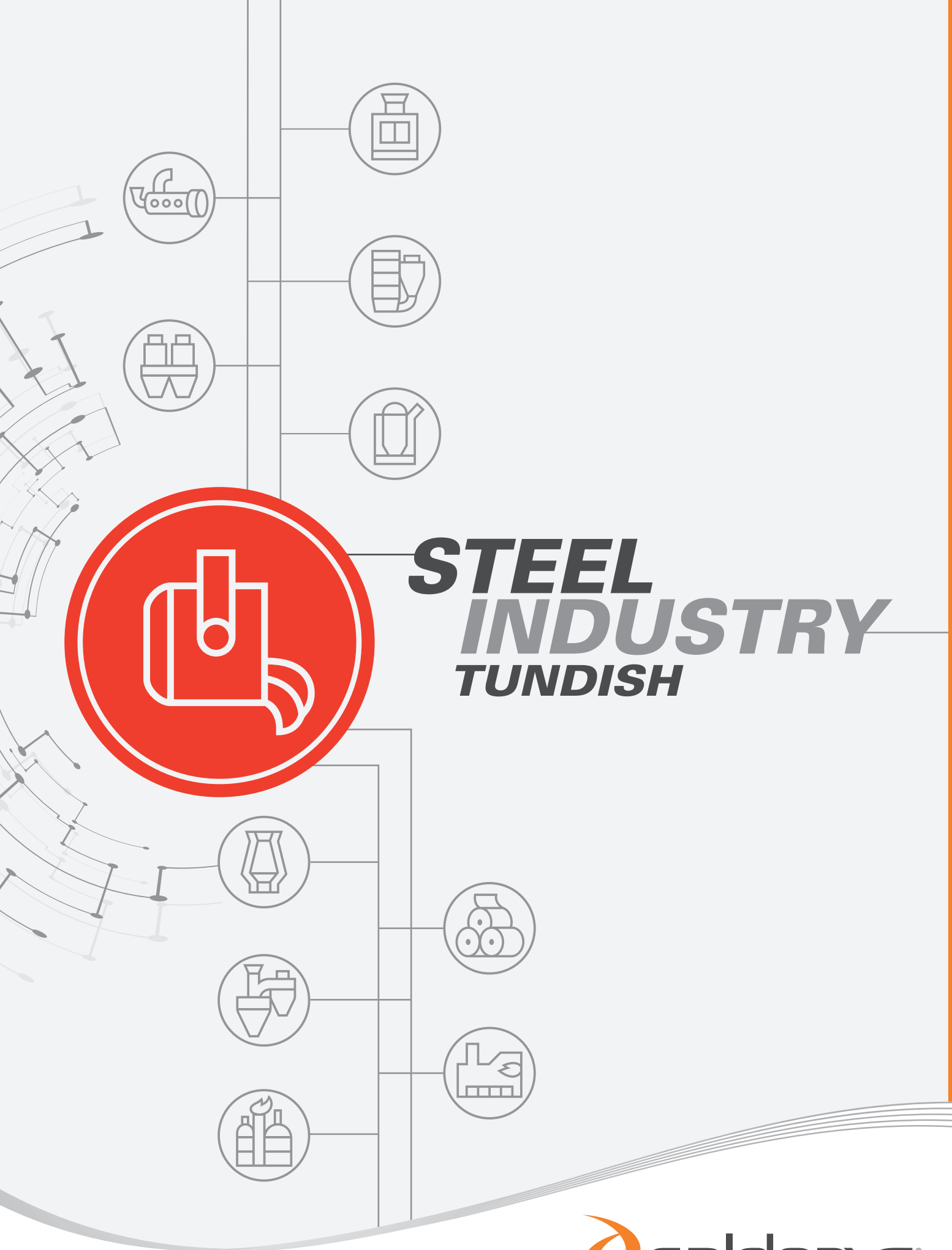


STEEL INDUSTRY
TUNDISH

calderys
a member of Imerys

CALDERYS PERFORMANCE YOU CAN TRUST

For all industries with extreme temperatures and working conditions, Calderys is there for you. Combining a global network with local expertise, we offer customised solutions wherever you are: from monolithic refractory to bricks and precast shapes to a full range of engineering and installation services.

KEY POINTS

- Over 100 years of refractory experience
- Over 2 300 employees across 33 countries
- 19 plants in 16 countries totaling 600 000 tons capacity
- Annual revenue of over € 500 million
- 1 Global Technology Centre and 15 Customisation Labs
- 150 major projects implemented every year
- Wholly-owned subsidiary of Imerys Group

END-TO-END PRODUCTS AND SERVICES

Our end-to-end products and services dedicated to the steel industry encompass:

Product Portfolio

Our comprehensive product portfolio for the steel industry includes both alumina and basic products and covers complete application requirements - Converters, AOD Furnaces, Electric Arc Furnaces, Steel Ladles, RH Degasser Units, Purging plugs, Lances and Tundish Technologies. We also provide installation services for cast-in-situ applications, dry mixes, standard gunning, low-porosity dense gunning, shotcreting and spray solutions.

Design

In addition to product selection considerations, there are considerable benefits to be gained by optimizing the design aspects of the steel vessel. Overall, the selection of products and vessel designs should:

- Meet the metallurgical targets set by the end user, in order to prevent the chosen lining being a potential contaminant in the steelmaking process.
- Provide the best value in use with regards to cost considerations.

Thanks to close working relationship between the steelmakers and Calderys refractory engineers, we are able to meet the design and product selection targets.

Installation

We carry out high-quality installation services by using in-house equipment and through use of optimal installation techniques. This ensures the best installation and dry-out of the refractory so that the customer gets maximum performance.

Maintenance

We offer permanent on-site refractory services including regular and predictive maintenance and repairs. Our comprehensive range of repair products, in co-operation with state of the art measurement techniques, allow for systematic repairs to extend vessel lifetime with minimum vessel downtime.

Project Management

We provide complete project management services including consultation, planning, delivery scheduling, supervision, site management and also direct training for customer personnel.

OUR VALUE TO THE STEELMAKING INDUSTRY

The world leader in monolithic refractory solutions, Calderys has a full product and service portfolio to adapt to the refractory needs of steelmakers. We ensure that we propose products most suitable for your process requirements and deliver to you superior refractory performance and reliable services. We are able to do so by combining our innovative product range and modern installation techniques with end-to-end project management.

Value Optimisation

Offering tailor-made solutions that meet the commercial and technical requirements for optimal performance.

Complete Refractory Solutions

We offer a full range of refractory products to meet the process needs of modern Steelmaking.

Technology Expertise

Ensuring the best possible equipment availability and productivity at the lowest total refractory cost per ton of steel produced, whilst adhering to strict environmental and safety regulations in operations.

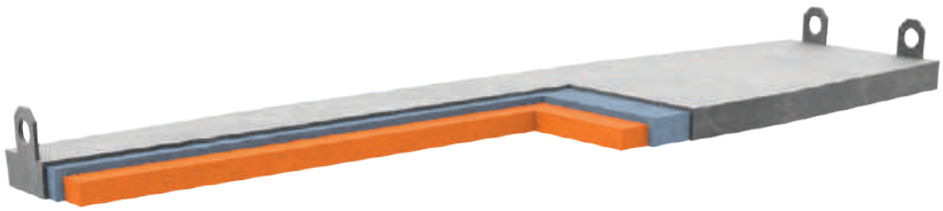
GLOBAL SUPPLY SOLUTIONS

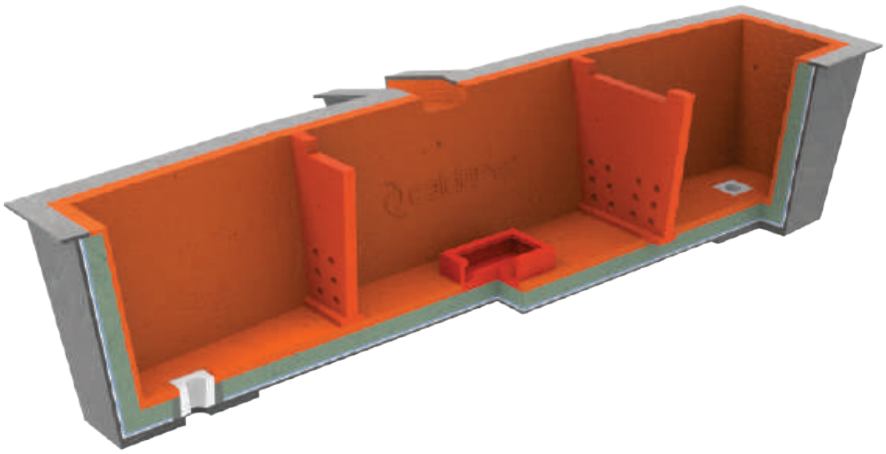
Calderys, An Expert In Tundish Technology

Why choose Calderys?

From the beginning of continuous casting implementation, Calderys has participated in the ongoing development of this technology. Decades of experience enable us to reach the optimal solution in the tundish zone.

- Cost optimisation
- Product optimisation
- Design optimisation



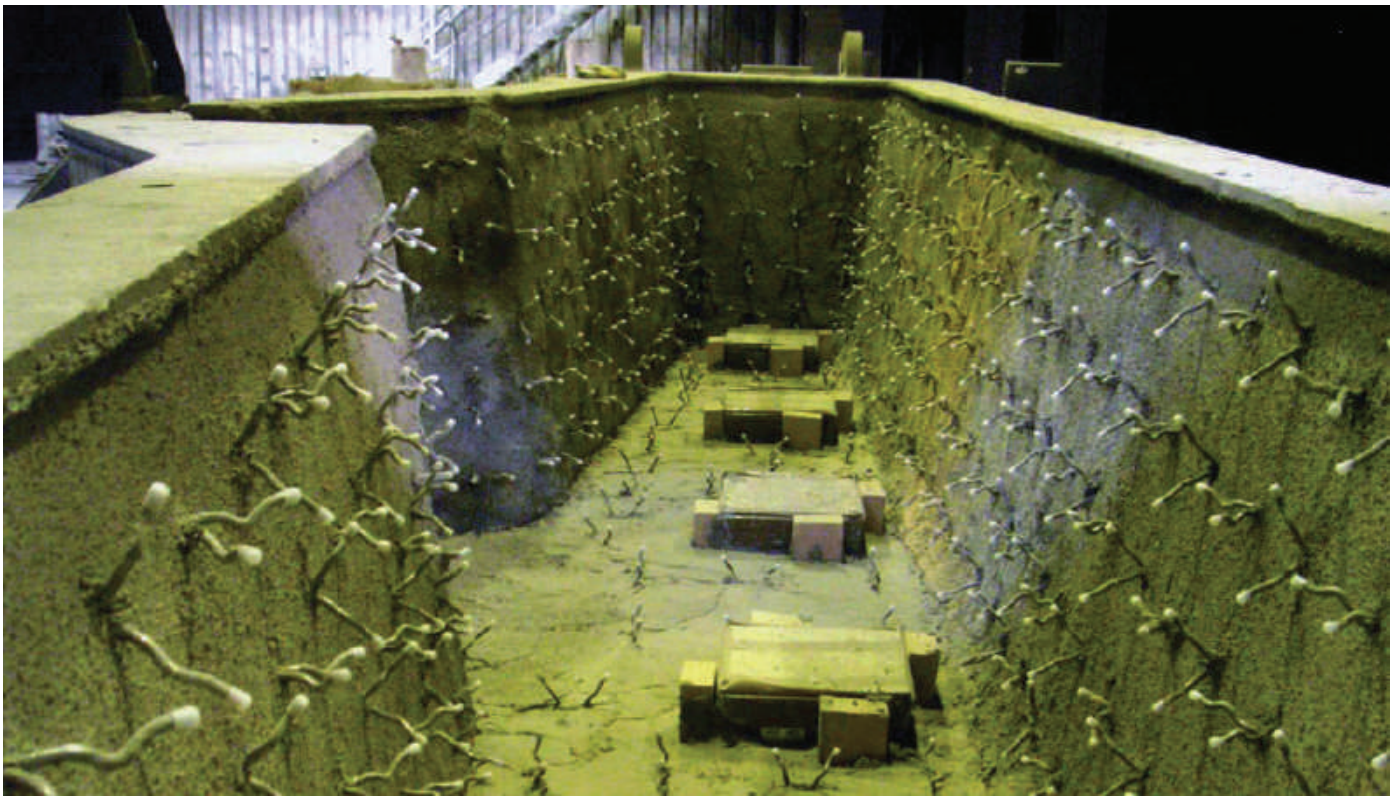


Calderys offers a full range of solutions based on monolithic refractories that result in an improved and efficient tundish lining life. Castable refractories are increasingly used to line the safety layer of tundishes and to optimise the safety and thermal profile aspects for the tundish lining.

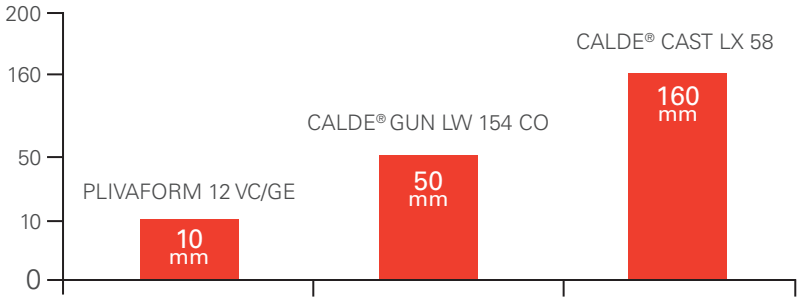
For working linings, dry vibratable magnesia based DVM have emerged as an alternative to sprayed magnesia wear linings, in order to tackle the risk of hydrogen pick up during the critical continuous casting process. Calderys is able to deliver cold or hot setting DVM that are adapted to all types of steel quality or process requirements. Discover what we can do for your process.

CALDERYS PERMANENT LINING

The permanent lining is exposed to different challenges: chemical corrosion (resulting from the penetration of steel and slag), mechanical wear, thermal stress (due to thermal cycling). To tackle those challenges, our range of permanent lining is designed to withstand such demands to allow for the optimal thermal profile to reduce heat loss, strong durability for longer life and overall cost balance. Our Permanent Lining Technology can be installed by vibration or free flowing techniques.



Calderys Permanent Lining Concepts:



- 10mm PLIVAFORM 12 VC/GE
- 50mm CALDE® GUN LW 154 CO
- 160mm CALDE® CAST LX 58
- Average shell temperature 150°C (max 200°C)

CALDERYS PERMANENT LINING

Calderys Permanent Lining concepts are designed to optimise the wear resistance required for long life usage as well as a strong consideration for the thermal profile and the risks associated with heat loss within the tundish. By using Calderys multi layer designs, it is proven to improve both the robust requirements for permanent lining while providing increased insulation properties.

Alternative Configurations for Reducing Thermal Losses

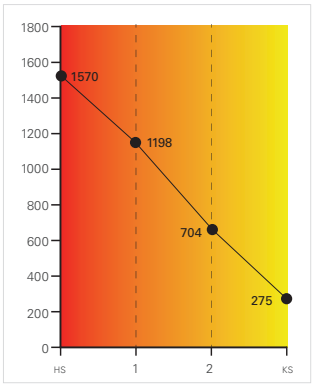
Plant A	Material	S (mm)	TC (W/m.K)	T interface (°C)	Heat Loss (kW/m²)
WEAR	CALDE® MAG SPRAY G 89	40	0.55	1570	6.95
PERMANENT	CALDE® CAST LX 58	120	1.695	1198	
INSULATION	CALDE® GUN MW STRONG LITE	30	0.496	704	
	Steel Shell			275	

Plant B	Material	S (mm)	TC (W/m.K)	T interface (°C)	Heat Loss (kW/m²)
WEAR	CALDE® MAG SPRAY G 89	40	0.55	1570	5.75
PERMANENT	CALDE® CAST LX 58	120	1.748	1261	
INSULATION	DURABOARD CT	10	0.15	856	
	Steel Shell			247	

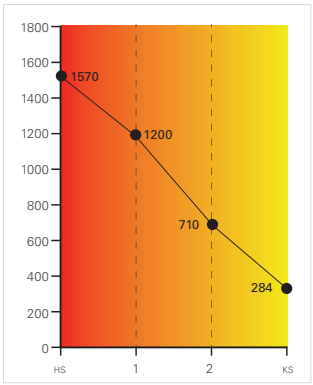
Plant C	Material	S (mm)	TC (W/m.K)	T interface (°C)	Heat Loss (kW/m²)
WEAR	CALDE® MAG SPRAY G 89	40	0.55	1570	4.50
PERMANENT	CALDE® CAST LX 58	120	1.771	1326	
INSULATION	CALDE® GUN MW STRONG LITE	30	0.3	1010	
	DURABOARD CT	10	0.15	747	
	Steel Shell			215	

-51%

Standard Insulation



WALL



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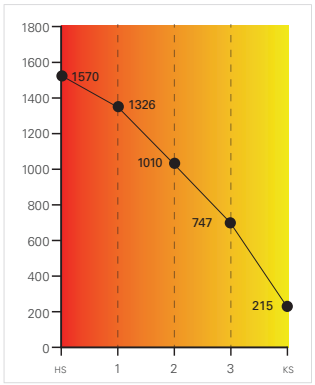
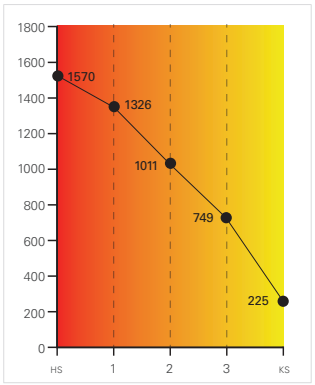
Best Insulation



WALL



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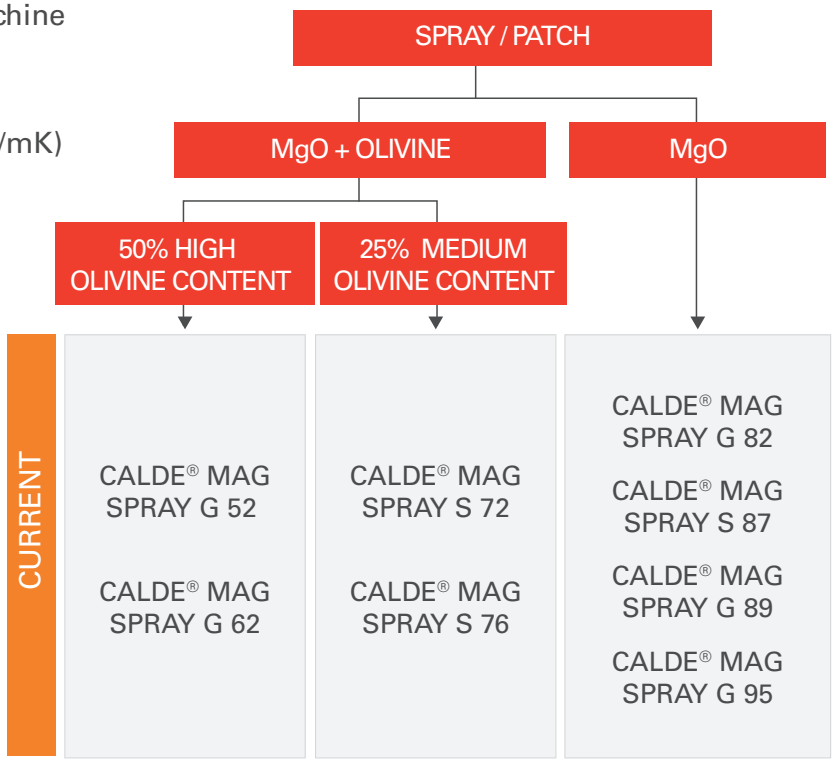
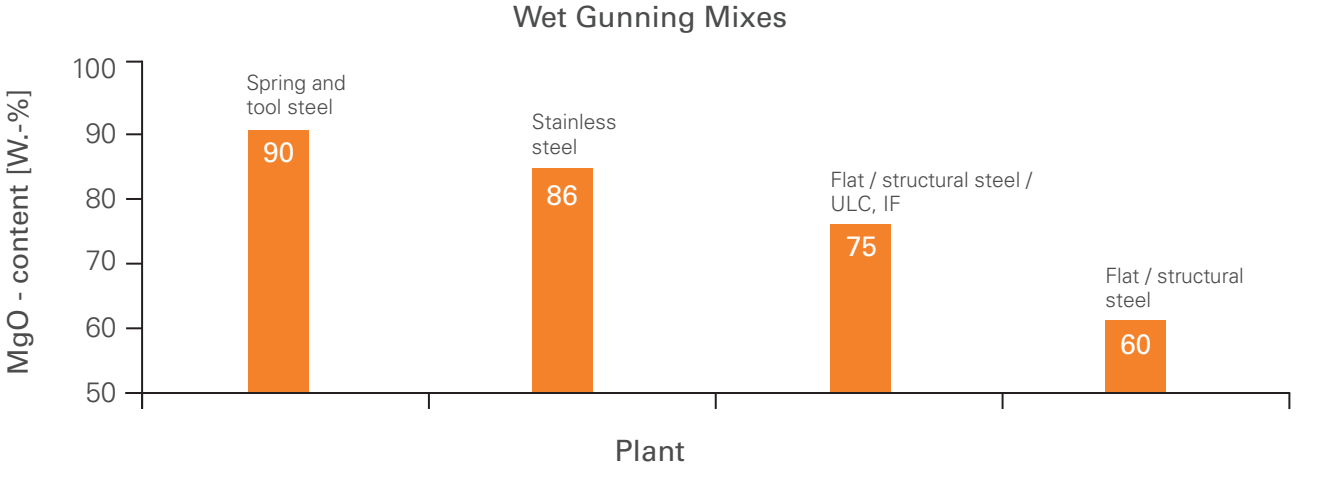
WORKING LINING SPRAY / GUNNING WITH MACHINES

Overview

Calderys Tundish Spray mixes are specially formulated to give the optimum cost / performance criteria: From lower cost products for optimum commercial considerations, to the highest grade products for long sequence lengths and higher steel grade manufacturing.

- Easy installation with wet spray machine
- Dry out of approx. 25% water
- Low thermal conductivity (0.5-0.9 W/mK)
- High Insulation
- Low density material (1.0-1.3 g/ccm)
- Hot start of casting (>1000°C)
- Lining thickness variation from 20-150mm
- Cold start of casting after pre-dry-out (4-5h at 450°C) possible
- Casting hours of < 100h





DRY-COLD SETTINGS WITH MACHINES

With cold setting, semi dry tundish DVM technologies, the main advantage is the availability of the tundish; the formwork can be removed on a cold tundish in as little as 20 minutes, and on a ready heated tundish below 10 minutes.

There is no need of any pre-heater and depending on the processing the tundish can be used as well for cold or hot start. Through fast turnarounds, the optimal tundish availability is reached.

The product is installed using a custom made continuous mixer for adding the small water amount to activate the special binder components.

Main comparison of 3 Cold Setting DVM

	Binder Type	Resin	Silicate	Organo Ceramic
Machinery	Mould	Yes	Yes	Yes
	Vibration	Vibration / Rodding	Vibration / Rodding	Preferred
	Continuous	Yes input for 2 fluids	Yes input for 2 fluids	Yes input for 1 fluid
Health & Safety	Classification	Fumes with some BaP and phenols, odour	Irritant	Not Classified
Installation time		Similar: for small tundish until 25t less than 45 min For big tundish like in long products: less than 90 min		
Setting time	Residual T: 20°C	45 min	45 min	30 min
	Residual T>70°C	20 min	20 min	10 min
Deskulling		Middle	Easy	Easy
Price	Index	100	100	110

DRY-HOT SETTINGS
TUNDISH

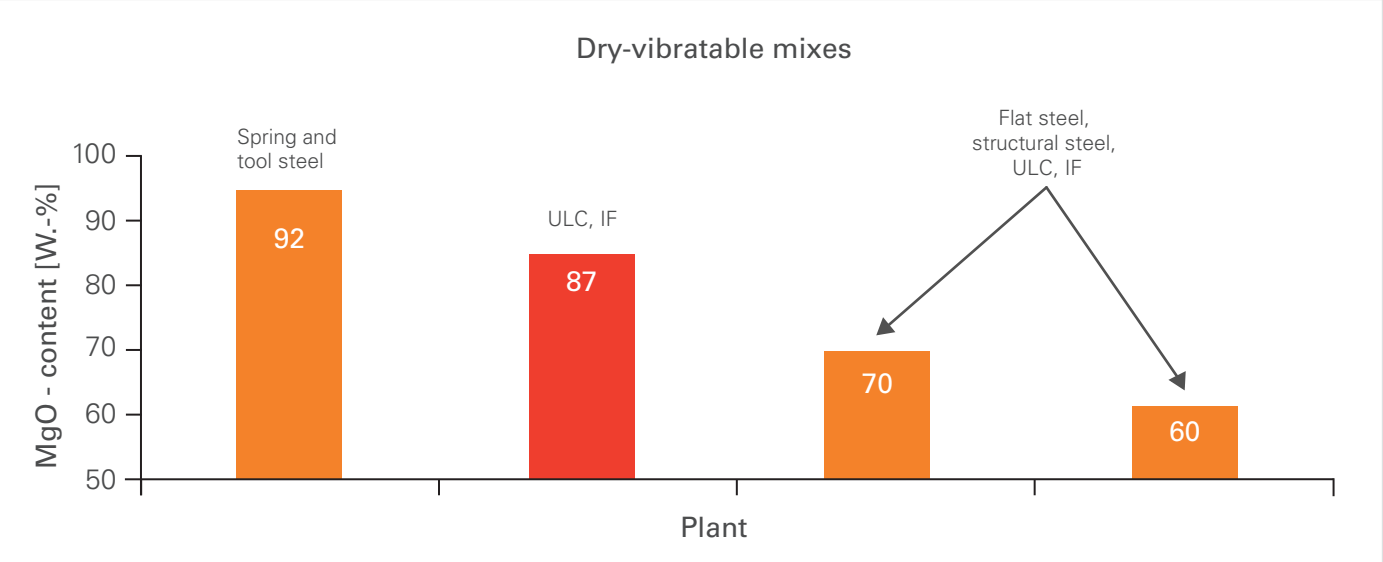
Calderys offers you two solutions, depending on your requirements.

To alleviate the issues of smell / odour typically associated with the heating phase of dry vibratable mixes, only hex free resins are used within Calderys **Resin bonded systems**. For **Resin free systems**, specially selected binders are chosen that result in nearly odour free during drying. Such binder technology allows the product to harden below 200 degrees to ensure sufficient strength development to allow for speedy mould removal, with no significant residual build up of product to the inner mould's surfaces. After the inner mould has been removed, a tundish lined with dry setting technology can be used in both cold (no preheating) and hot states.

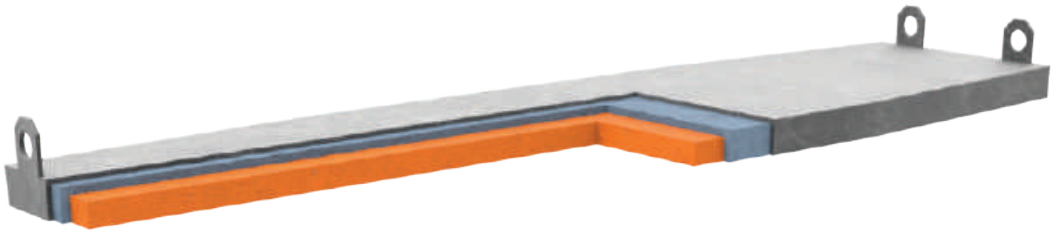
The inner mould can be a simple design, that can be heated using standard air heating. A more complicated device, using a closed inner mould cavity that allows for hot gas to be passed through the inner chambers from either gas or electrical air heating, will mean a higher initial investment cost but in the longer term, the lower energy consumption and shorter heating time can mean both lower energy costs and improved tundish availability.

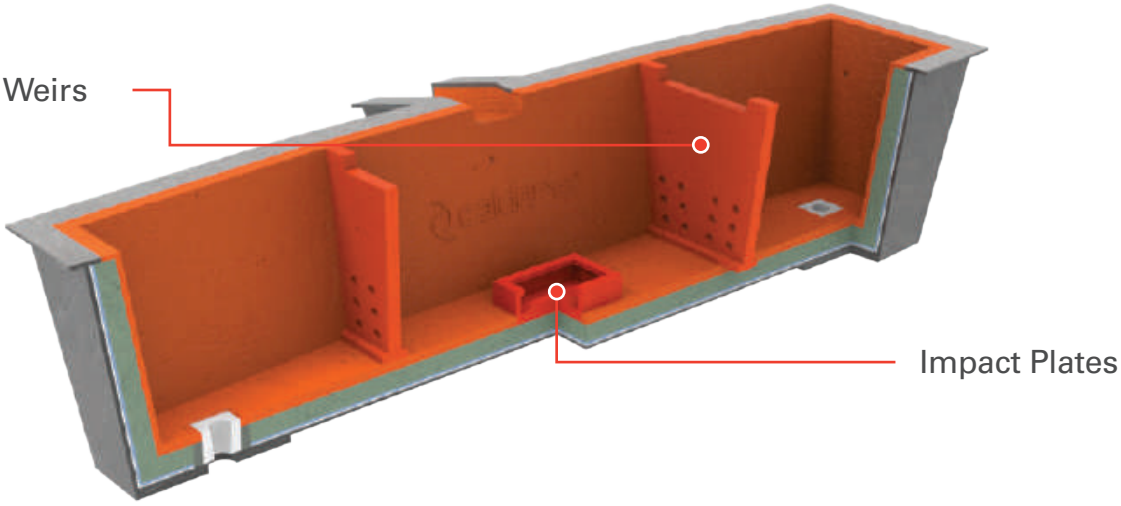
Dry-vibratable technology - metallurgy:

- Low hydrogen pick-up (0.9-1.4 ppm)
- Use of olivine down to 60% MgO
- Standard binder (resin) Silica-free
- Pick-up of Carbon possible through phenolic resin



ACCESSORIES





Dams and Weirs

The location of these components must be gauged to the geometric profile of the tundish. With the right design and placement, increased residence times can be gained which can allow for improved steel reactions to improve overall steel cleanliness.

Standard Offer:

- CALDE® FLOW LA 70 : Andalusite
- CALDE® CAST UB 85 : Bauxite

Impact Plates

Because the plates stay in the tundish for several sequences, the refractory material chosen must be highly resistant to wear. Usually, two plates are inserted in the permanent lining so that the upper plate becomes partially worn and is the only one that has to be changed.

Standard Offer:

- CALDE® CAST UB 85 : Bauxite

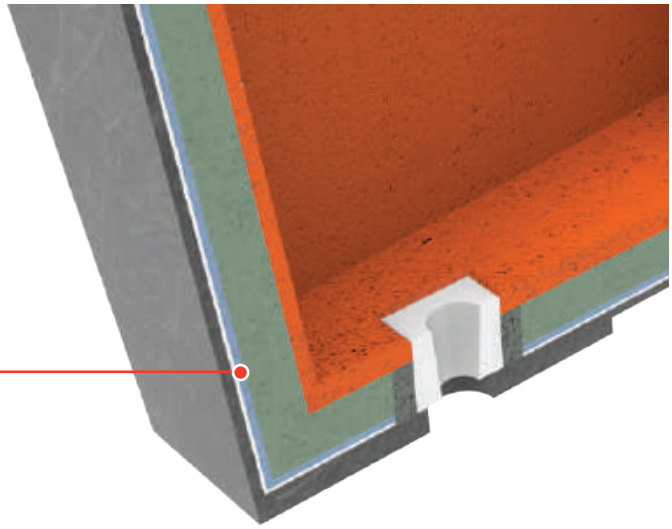
Insulation

Light:

- CALDE® CAST LW 132 C/G

Dense:

- CALDE® CAST AF 470 : Andalusite



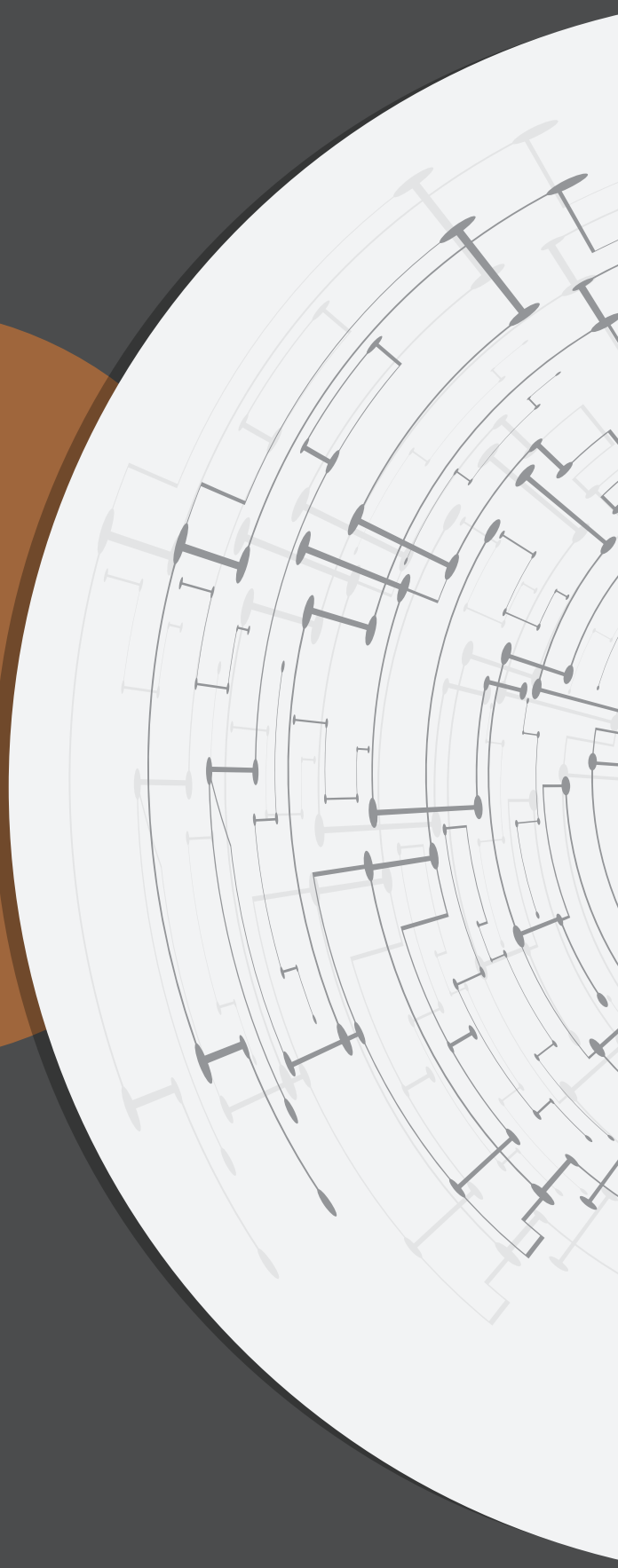
Multi Component Dam and Baffle

Transfer Box

CALDERYS PRODUCTS

A solution wherever you need us

Product name	Main component	Binding system	Max. recomm. temp. (°C)	Max. grain size (mm)	Chemical analysis (wt %)				Material required (t/m³)	Water required for mixing on site (liters/100 kg)	Permanent linear change (%)		CCS (N/mm²)	
					Al_2O_3	MgO	SiO_2	CaO						
CALDE® CAST 41	Tabular Alumina	Hydraulic	1750	6	96	-	0.1	3.6	2.82	7.2 to 8	-0.1 (1200 °C)	0.2 (1600 °C)	60 (1200 °C)	65 (1600 °C)
CALDE® CAST LT 94 SP	Tabular Alumina Spinel	Hydraulic	1850	7	92.5	5.3 -	-	1.5	3.15	4 to 5	0 (1200 °C)	0.2 (1600 °C)	90 (1200 °C)	n.a
CALDE® CAST LW 132 C/G	Perlite	Hydraulic	1320	5	40.5		33	18	0.97 (cast)	40 to 50 (cast)	-0.4 (1200 °C)	-0.6 (1200 °C)	3.5 (800 °C)	1.5 (1200 °C)
CALDE® CAST LX 50	Chamotte	Hydraulic	1520	6	52	-	43	2.3	2.40	6.0 to 7.2	-0.2 (1200 °C)	0.15 (1400 °C)	110 (1200 °C)	110 (1400 °C)
CALDE® CAST LX 58	Andalusite	Hydraulic	1650	6	57	-	38	2.3	2.5	5.6 to 6	0.04 (1200 °C)	1 (1600 °C)	85 (1200 °C)	90 (1600 °C)
CALDE® CAST LX 85	Bauxite	Hydraulic	1600	6	83	-	11	2.2	2.83	5.2 to 6	-0.2 (1200 °C)	1.45 (1400 °C)	95 (1200 °C)	50 (1400 °C)
CALDE® CAST UB	Bauxite	Hydraulic	1680	5	84.3	-	11.5	0.5	3	4.5 to 6	-0.2 (1200 °C)	1.8 (1600 °C)	100 (1200 °C)	120 (1600 °C)
CALDE® CAST UB 85	Bauxite	Hydraulic	1680	6	83.5	-	11.6	0.6	2.85	5 to 6.3	-0.2 (1200 °C)	1.1 (1600 °C)	140 (1200 °C)	120 (1600 °C)
CALDE® FLOW AZ	Andalusite Zircon	Hydraulic	1650	6	59	-	28.4	1.5	2.75	4.5 to 6	-0.2 (1200 °C)	0.3 (1600 °C)	130 (1200 °C)	140 (1600 °C)
CALDE® FLOW LA 70	Andalusite	Hydraulic	1650	6	70	-	26.5	1.5	2.70	5.8 to 6.8	-0.1 (1200 °C)	1.3 (1600 °C)	140 (1200 °C)	110 (1500 °C)
CALDE® GUN LW 154 CO	Light Weight Aggregates	Hydraulic	1540	5	88	-	0.25	0.25	1.25	added at the nozzle	0 (1200 °C)	-0.85 (1400 °C)	4 (1200 °C)	5 (1400 °C)
CALDE® GUN M32	Bauxite	Hydraulic	1650	3	79.5	-	13.4	2.4	2.75	added at the nozzle	-0.2 (1200 °C)	-1.5 (1600 °C)	25 (1200 °C)	90 (1600 °C)
CALDE® GUN MW STRONG LITE	Insulating Chamotte	Hydraulic	1320	4	39	-	41	12	1.60	added at the nozzle	-0.35 (1200 °C)	-0.7 (1200 °C)	9 (1000 °C)	9 (1200 °C)
CALDE® MAG DRY R 80	Magnesia Olivine	Chemical	1700	2	-	79	12.6	2.5	1.91	-	n.a	n.a	0.5 (1000 °C)	n.a
CALDE® MAG DRY R 90	Magnesia	Chemical	1700	2	-	90	3.5	1.8	1.95	-	n.a	n.a	n.a	n.a
CALDE® MAG RAM S 75	Magnesia	Chemical	1700	1	-	75	18	2	1.30		n.a	n.a	1.6 (1000 °C)	n.a
CALDE® MAG RAM S 88	Magnesia	Chemical	1700	1	-	88	5.8	1.6	1.80	-	n.a	n.a	-0.3 (1000 °C)	n.a
CALDE® MAG SPRAY G 72	Magnesia	Chemical	1650	1.2	-	71	21.5	3.1	2.02	17 to 21	n.a	n.a	n.a	n.a
CALDE® MAG SPRAY G 82	Magnesia	Chemical	1650	1.2	-	82	12	4	2.02	17 to 21	n.a	n.a	n.a	n.a
CALDE® MAG SPRAY G 89	Magnesia	Chemical	1650	1.2	-	88.7	6.7	2	-	17 to 21	n.a	n.a	n.a	n.a
CALDE® MAG SPRAY S 76	Magnesia Olivine	Chemical	1700	1.6	-	72	20	1.7	1.6	23 to 28	n.a	n.a	n.a	n.a
CALDE® MAG SPRAY S 87	Magnesia	Chemical	1700	1.5	-	87	5.2	3.1	1.73	22 to 28	n.a	n.a	n.a	n.a
CALDE® RAM B 80	Bauxite	Ceramic	1630	3	80	-	15	-	2.8	-	-0.10 (1200 °C)	1 (1600 °C)	60 (1200 °C)	n.a
CALDE® STIX 151	High Alumina Raw Materials	Hydraulic	1550	6	55	-	32	6.7	2.1 (trowelled)	12 to 14 (trowelled)	-0.45 (trowelled 1200 °C)	-0.75 (trowelled 1400 °C)	18 (trowelled 1200 °C)	25 (trowelled 1400 °C)



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