Refractories for Induction Furnaces

Manufacture, Supply and Installation

www.capital-refractories.com

CAPITAL REFRACTORIES

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Capital Refractories

Capital Refractories Limited is one of the largest independent refractory companies in the UK and yet we are a privately owned, family-run business. We have been working with the metallurgical and thermal process industries for some 50 years and have the majority of UK business for induction furnace linings melting steel.

We offer a full manufacture, supply and installation service for both induction furnace and ladle linings which we produce in the UK, USA and China.

Our products are suitable for:

- All steel grades including high temperature alloys (stainless, duplex etc)
- Iron and its alloys (Ni-hard, Ni-resist etc)
- Copper and copper alloys
- Aluminium and aluminium alloys

Hot Face Dry Rammed Lining:
We manufacture and supply an extensive range of linings including spinel and mullite forming products. These have been specifically developed for melting a variety of metals and some allow for a mixed melting programme.

Topping and Spout Material
These are chemically bonded high strength materials that are compatible with our dry linings.

Coil Screed
High grade fine hydraulic cements are available.

Slip Plane Material:
We can offer mica in sheet or roll form.

Repair Materials
Numerous fine grained chemically bonded products are available for lining repairs and joint seals.

Castable Materials for Lids and Bases
Hydraulically bonded multipurpose castables.

All of the above materials have been developed through extensive testing. There are a wide range of products available in order to best meet with the specific application. Our engineers will be able to advise you on which material is appropriate for your application.

Common Products for All Induction Furnaces

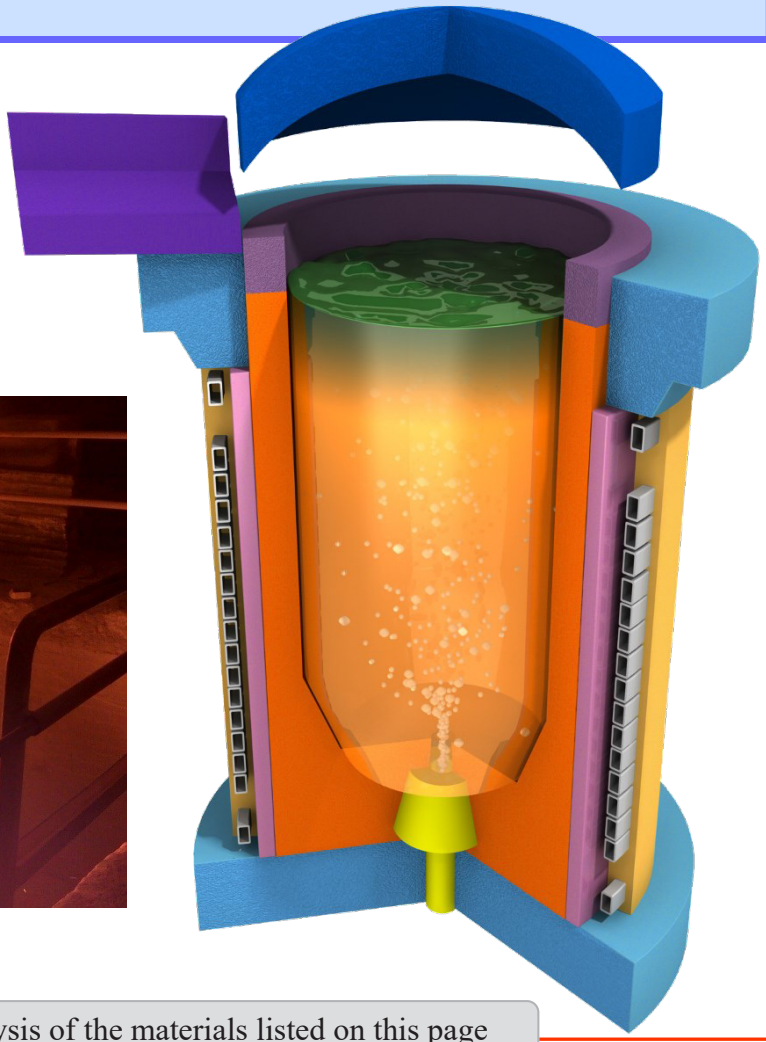
Capital offer specific products for lining, toppings and repair for each alloy type (which are summarised on the following pages), but many products are common to most conditions and some of these are summarised here.

Coil Screed

Silkote 90	Hydraulically bonded, low-silica screed that allows for a slightly higher surface temperature than Capscreed. High strength makes it suitable for push out furnaces.
Capscreed	Hydraulically bonded, high alumina induction furnace coil screed. High strength makes it suitable for push out furnaces.

Castable for Lids, Bases & Blocks

Silcast 1600CM	Aluminosilicate multipurpose castable.
Silcast 65	Aluminosilicate high strength castable.



Please see pages 8-11 for detailed analysis of the materials listed on this page

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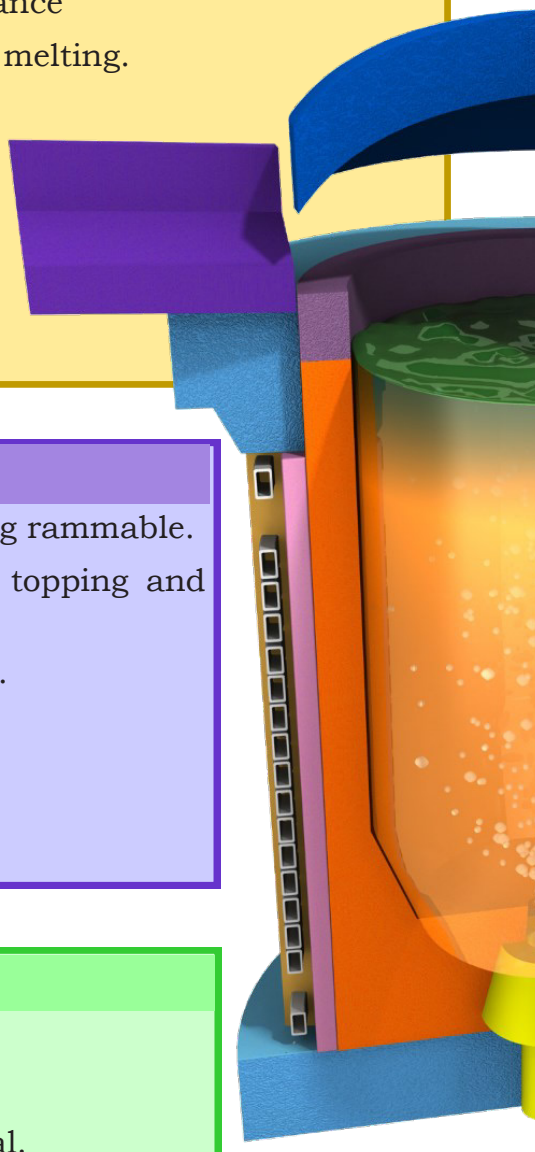
Materials for Steels & Special Alloys

Hot Face Dry Rammed Lining

Coral CXL	General purpose lining with a wide melting temperature range.
Coral HB	High duty, hard wearing lining suitable for most melting applications.
Coral SXL	High duty for elevated temperatures.
Coral Vac	High duty for high temperatures
Coral SMC	Incorporates complex chromes for improved slag resistance.
Coral 85	High performance lining for large furnaces with high temperatures.
Coral GR9	High performance lining for general higher temperature steels.
Coral NGB	High performance lining for erosion resistance
Coral V40	Magnesia rich lining designed for vacuum melting.
Cormag 90	Basic ramming mix for use in continuous melting applications.
CRL 75	Mullite forming material suitable for mixed melting.
WS90 Rammable	High alumina phosphate bonded rammable for special steels



Topping & Spout Material

Almacap	Silicate bonded high alumina hard wearing rammable.
Capram 70	Phosphate bonded high alumina plastic topping and repair mix
Toppatch	Silicate bonded aluminosilicate rammable.
Coral BDT	Dry topping for Coral linings
Coral V40DT	Dry topping for Coral V40.
Mullite BDT	Dry topping for CRL products

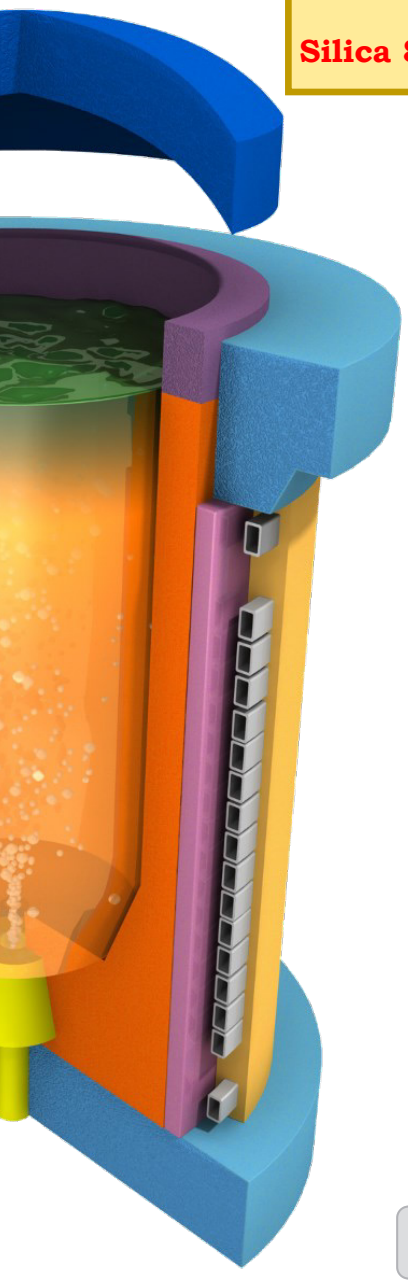
Repair Materials

D10 Plaster	Aluminosilicate patching plaster.
D10F	A finer version of D10 Plaster.
D11	High grade high alumina patching material.
Capram 90F	High grade high alumina patching and topping material.

Materials for Melting Iron and its Alloys

Hot Face Dry Rammed Lining

CRL65	Mullite forming material with excellent resistance to chemical, thermal and mechanical damage. Suitable for mixed melting.
CRL75	Higher performance mullite forming material with excellent resistance to chemical, thermal and mechanical damage. Suitable for mixed melting.
CRL 80B	
Silica 60 grade	Acid lining based on natural quartz with a 0.6% B_2O_3 addition.
Silica 80 grade	Acid lining based on natural quartz with a 0.8% B_2O_3



Topping & Spout Material

Capram 60	Phosphate bonded high alumina zircon enriched plastic repair mix.
Capram 85	Silicate bonded aluminosilicate topping mix.
Mullite BDT	Dry topping for CRL linings.

Repair Materials

D10 Plaster	Aluminosilicate patching plaster.
D10F	A finer version of D10 Plaster.
D11	High grade, high alumina patching material.

Please see pages 8-11 for detailed analysis of the materials listed on this page

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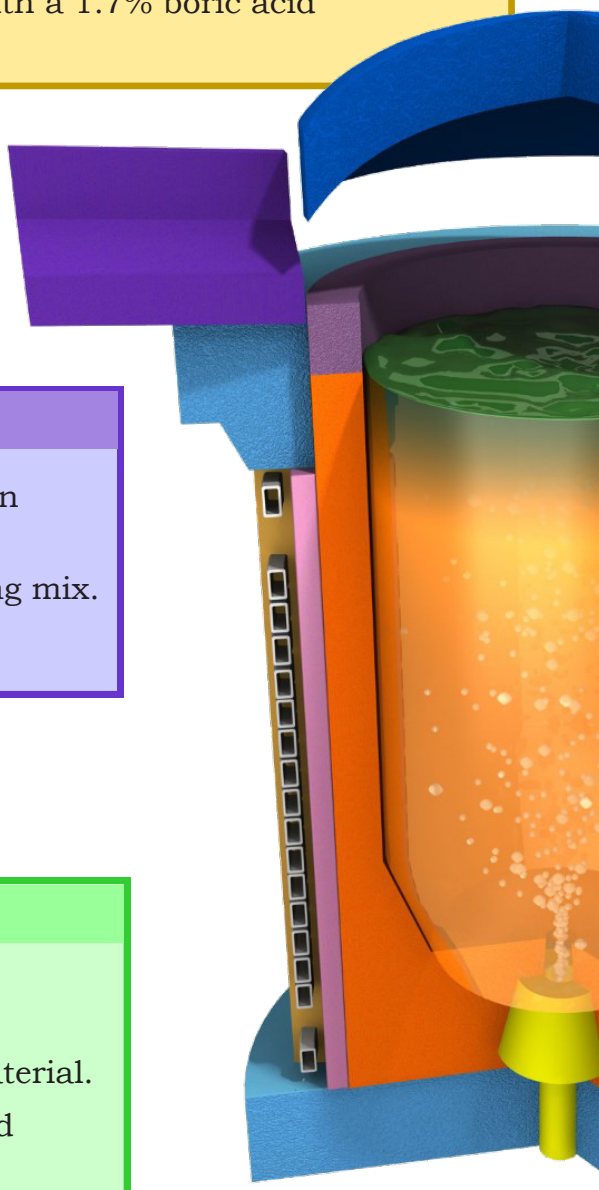
Materials for Melting Copper and its Alloys

Hot Face Dry Rammed Lining

CRL65	Mullite forming material with excellent resistance to chemical, thermal and mechanical damage.
C65 RFL	As CRL 65 but with a low temperature bonding system for fritting with a removable former.
CRL MCR	Mullite based lining with excellent resistance to alkali attack.
Silica 1 Grade	Acid lining based on natural quartz with a 1% boric acid addition.
Silica 17 Grade	Acid lining based on natural quartz with a 1.7% boric acid addition.



Topping & Spout Material

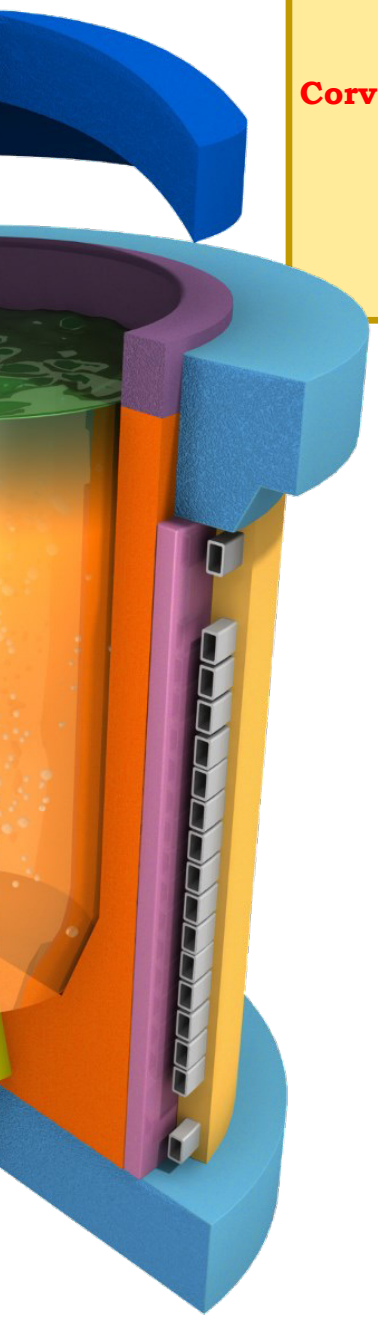
Capram 60	Phosphate bonded high alumina zircon enriched plastic repair mix.
Capram 85	Silicate bonded aluminosilicate topping mix.
Mullite BDT	Dry topping for CRL products

Repair Materials

D10 Plaster	Aluminosilicate patching plaster.
D10F	A finer version of D10 Plaster.
D11	High grade high alumina patching material.
Capram 90F	High grade high alumina patching and topping material.

Please see pages 8-11 for detailed analysis of the materials listed on this page

Materials for Melting Aluminium and its Alloys



Hot Face Dry Rammed Lining:

CRL65	Mullite forming material with excellent resistance to chemical, thermal and mechanical damage. Suitable for high temperature aluminium alloys.
C65 RFL	As CRL 65 but with a low temperature bonding system for fritting with a removable former.
C65 LS	Aluminosilicate mix containing low temperature bonding systems suitable for a removable former sintering. Suitable for standard grades of aluminium.
Corvibe 80	High alumina, silicon carbide enriched mix with low temperature bonding system for removable former sintering. Suitable for standard grade alumina.

Topping & Spout Material:

Capram 60	Phosphate bonded high alumina, zircon enriched plastic repair mix.
Capram 85	Silicate bonded aluminosilicate topping mix.
Mullite BDT	Dry topping for CRL linings.

Repair Materials

D10 Plaster	Aluminosilicate patching plaster.
D10F	A finer version of the D10 Plaster
D11	High grade, high alumina patching material.
P12	High grade, high alumina patching material with non-wetting additives.

Washcoat:

D10 Zircon Washcoat	Zircon based paint.

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Dry Vibration Linings

Product Name	Principle Raw Materials	Bonding	Chemical Analysis / %						
			Al_2O_3	SiO_2	MgO	CaO	Fe_2O_3	Other	
Coral CXL	White fused alumina	Ceramic	85	0.2	14	0.3	0.1		-
Coral HB	White fused alumina	Ceramic	85	0.5	13	0.1	0.4		-
Coral SXL	White fused alumina	Ceramic	86	0.2	13	0.3	0.1		-
Coral Vac	White fused alumina	Ceramic	86	0.2	14	0.2	0.1		-
Coral SMC	White fused alumina	Ceramic	89	0.2	8	0.5	1.1	Cr_2O_3	1.5
Coral FG	Brown fused alumina	Ceramic	82	0.9	14	0.5	0.2		-
Coral 85	White fused alumina	Ceramic	86	0.1	13	0.2	0.1		-
Coral GR8	White fused alumina	Ceramic	89	0.1	10	0.1	0.1		-
Coral NGB	White fused alumina	Ceramic	85	0.1	15	0.2	0.1		-
Coral V40	Fused Magnesia	Ceramic	38	2.2	58	1.0	0.1		-
Cormag 90	Dead Burnt Magnesia	Ceramic	10	1.5	86	1.9	0.5		-
CRL65	Andalusite	Ceramic	68	29	<0.5	<0.5	1.0		-
CRL75	Andalusite	Ceramic	74	23	<0.5	<0.5	0.6		-
C65 RFL	Andalusite	Chemical	68	29	<0.5	<0.5	0.8		-
C65 LS	Andalusite	Chemical	59	36	<0.5	<0.5	0.8		-
Corvibe 80	Brown fused alumina	Chemical	81	2.5	<0.5	<0.5	0.4	SiC	10
Silica 60 grade	Quartzite	Ceramic	0.6	99	-	<0.5	0.2	B_2O_3	0.6
Silica 80 grade	Quartzite	Ceramic	0.6	99	-	<0.5	0.2	B_2O_3	0.8
Silica 1 Grade	Quartzite	Ceramic	0.6	99	-	<0.5	0.2	H_3BO_3	1.0
Silica 17 Grade	Quartzite	Ceramic		99	-	<0.5	0.2	H_3BO_3	1.7

	Max. Grain Size / mm	Bulk Density / kg m^{-3}	Max. Service Temp / °C		Comments	Suitable for Alloys of:			
			Sust-ained	Short-term		Steel	Iron	Copper	Aluminium
	5	2870	1700	1750	General purpose lining with a wide melting temp range	☑		☑	
	5	2850	1680	1720	High duty, hard wearing lining suitable for most melting applications	☑			
	5	2850	1700	1750	High duty for elevated temperatures	☑			
	5	2900	1720	1800	High duty for high temperatures	☑			
	5	2800	1700	1750	Contains complex chromes for slag resistance	☑			
	5	2850	1680	1720	Lower temp lining for manganese & stainless steels	☑			
	5	2900	1700	1750	High performance lining for large furnaces & high temps	☑			
	5	2870	1700	1760	High duty lining for elevated temperatures	☑			
	5	2880	1720	1780	High performance lining for erosion resistance	☑			
	8	2750	1700	1750	Magnesia rich lining for vacuum melting	☑			
	4	2700	1700	1750	Basic ramming mix for continuous melting	☑			
	5	2600	1650	1700	Mullite forming, excellent chemical, thermal and impact resistance.		☑		
	5	2600	1650	1720	Mullite forming, for mixed melting	☑	☑	☑	
	5	2600	1400	1600	Mullite-forming for removable former practice			☑	
	5	2600	1300	1400	Mullite forming with aluminium non-wetting additives.				☑
	5	2800	1500	1550	For removable former practice				☑
	4	2100	1620		Acid lining based on natural quartzite		☑		
	4	2100	1580		Acid lining based on natural quartzite		☑		
	4	2100	1620		Acid lining based on natural quartzite			☑	
	4	2100	1580		Acid lining based on natural quartzite			☑	

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Dense Refractory Castables

Product Name	Principle Raw Materials	Max. Service Temp / °C	Max. Grain Size / mm	Chemical Analysis / %					
				Al_2O_3	SiO_2	Fe_2O_3	CaO	Other	
Silcast 1600CM	Chamotte	1600	10	62	32	0.9	3.0	-	
Silcast 65	Mullite	1700	8	65	29	1.0	2.9	-	
Capscreed	Brown fused alumina	1700	1	91	3.1	0.3	3.6	-	
Silkote 90	White fused alumina	1700	1	92	0.3	0.1	7.0	-	

A more comprehensive brochure for monolithics is available upon request

Wet Rammables, Patching & Miscellaneous

Product Name	Principle Raw Materials	Max. Service Temp / °C	Max. Grain Size / mm	Chemical Analysis / %						Bulk Density (dried 110°C) / kg m^{-3}	Type of Set
				Al_2O_3	SiO_2	Fe_2O_3	ZrO_2	Na_2O	P_2O_5		
Capram 60	Mullite	1650	5	51	33	0.9	9.4	-	3.8	2500	Chemical
Capram 66	Mullite	1650	5	64	30	0.9	-	-	3.6	2500	Chemical
Capram 70	Mullite	1700	5	68	25	0.9	-	-	3.3	2700	Chemical
Capram 90F	WFA	1800	3	89	6.6	0.3	-	-	5.0	2900	Chemical
Capram 85	Bauxite	1650	5	76	18	1.0	-	1.3	-	2550	Air
Toppatch	Bauxite	1650	5	73	17	1.5	-	2.1	-	2500	Air
Almacap	Bauxite	1700	5	74	17	1.5	-	2.0	-	2550	Air
WS 90 Rammable	WFA	1800	5	92	1.7	0.2	-	-	5.0	3350	Chemical
WS 90ZP Rammable	WFA	1750	5	85	13	0.7	-	2.0	-	3250	Air
D10	Bauxite	1700	3	77	13	1.5	-	-	5.0	2550	Chemical
D10f	Bauxite	1700	1	77	13	1.5	-	-	5.0	2550	Chemical
D11	WFA	1800	1	94	2.0	0.1	-	-	4.3	2750	Chemical
Zircon Washcoat	Zircon	1700	0.1	23	29	0.4	43	1.4	2.1	3200	Chemical

	Permanent Linear Change / %		Cold Crushing Strength / MPa			Bulk Density / kg m^{-3}			Thermal Conductivity, mean 800°C / W m^{-1} K^{-1}	Approx Water Addition litres /25 kg
	Fired 1000 °C	Fired at Service Temp	Dried 110°C	Fired 1000°C	Fired at Service Temp	Dried 110°C	Fired 1000°C	Fired at Service Temp.		
	-0.1	-0.3	25	20	55	2350	2300	2300	1.3	2.5
	-0.1	+1.1*	109	102	91*	2530	2480	2440*	1.8	1.75
	-0.1	-1.5*	69	75	90*	2690	2600	2700		3.2
	-0.3	-0.5*	69	63	26*	2510	2370	2390		3.2

* Fired to 1600°C

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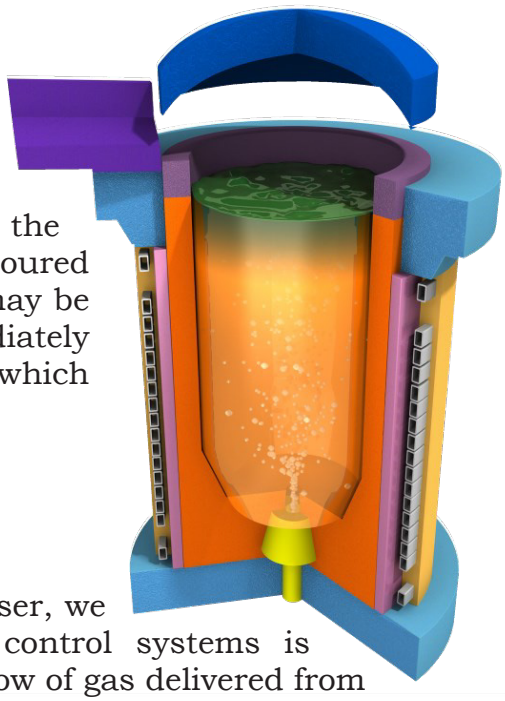
Gas Diffusers

For many years our area of specialisation has been the development, manufacture and supply of induction furnace linings. We have used this knowledge to develop additional materials, and have established gas diffusers suitable for integration into one of our furnace linings.

Benefits of gas diffusers:

- Reduction of inclusions and improved quality.
- Reduction in volume of rejects.
- Improved recovery of additions.
- Improved melt homogeneity.
- Cost-effective over time compared with drip-feed systems.
- Low maintenance.
- Improved melt rate.



The gas diffuser is fitted to the bottom and under the lining - the gas diffuses through the lining (coloured yellow in the illustration). In some applications it may be necessary to use a more permeable lining immediately above the diffuser. For this we supply Coral GDR which is coloured to facilitate installation.

For the safe and effective operation of any gas diffuser, we ***thoroughly recommend*** that one of our flow control systems is installed to regulate and control the pressure and flow of gas delivered from the source to the diffuser.

This system should be installed and operated in line with our written instructions, and the first installation should be supervised by our experts using one of our linings.

Guidance on Sintering an Induction Furnace Lining

We recommend that an individual sintering schedule is developed for each furnace - we can advise you on this. The type and size of furnace, metals melted and practices at each foundry vary greatly and so the information within this brochure should be used as a guide only.

Spinel forming linings
Steel-melting furnaces should be filled with a dense charge and should be typically heated at 200-300°C per hour. The height of the bath should be raised to slightly above the lining/joint line and kept at about 1680°C for 1 hour.

Liquid Sinter
In many cases a sintering can be carried out by pouring hot metal into the induction furnace rather than slowly bringing the temperature up. This is only possible where there is a convenient nearby supply of hot metal. For non-ferrous melting the former can be removed, however for ferrous melting the former should be left in place.

The furnace should be loaded with dense flat scrap up to 20% of the total furnace capacity. This helps to reduce the chance of erosion in the base of the furnace during metal pouring. The former temperature should be raised to 700-800°C (cherry red colour) over a 1-2 hour period. This reduces the thermal shock on the former when the metal is poured in. The temperature should not be raised any higher as this could increase the risk of deforming the former or splitting its weld.

Metal should be poured in steadily and as quickly as possible without creating too much turbulence. Typically this would be of the order of 1 tonne per minute. The minimum temperature of the metal from the donor furnace should be about 1650°C for steel or normal fritting temperature for other alloys. The remaining schedule would be identical to that of a melt-out former.

Basic linings
The fritting of basic linings (generally >50% MgO) is broadly similar to spinel forming linings but the sinter temperature is generally approximately 1650-1670°C.

Acid linings
Acid linings should be ramped at 200-400°C per hour to a temperature 50°C above the normal maximum operating temperature and held for a minimum of 30 minutes.

Aluminosilicate (mullite-forming) linings
Aluminosilicate linings with a melt-out former should be filled with a dense iron or copper alloy charge and ramped at 200-400°C per hour to a temperature 100°C above the normal maximum operating temperature and held for a minimum of 60 minutes.

When using a removable former the initial heat up should be performed either inductively with a removable susceptor or a thicker former, or by a gas burner to heat the former at 80-100°C per hour up to 700-800°C. Temperatures above this can lead to deformation of the former. The furnace should then be cooled to allow the former to be safely removed and then the furnace should be gently filled with dense scrap before ramping at 200-300°C per hour to the operating temperature. Covering the surface of the former with mica or cardboard will facilitate the removal of formers with a shallow taper.

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