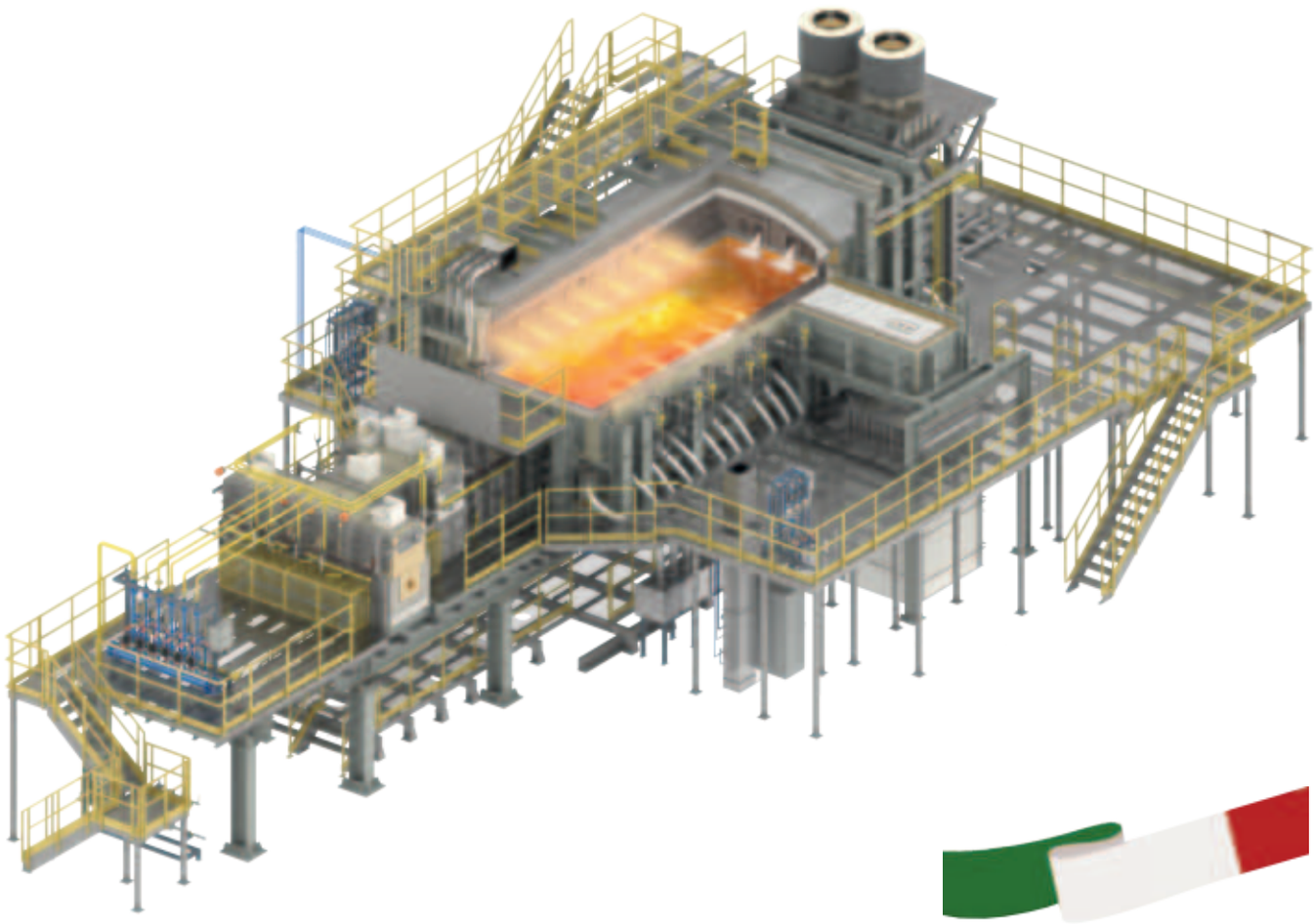
Glass Service

Solutions
for the Glass industry

MAIN PRODUCTS PORTFOLIO

TECHNOLOGY FOR A SUSTAINABLE FUTURE.



DISTRIBUTOR & FOREHEARTH

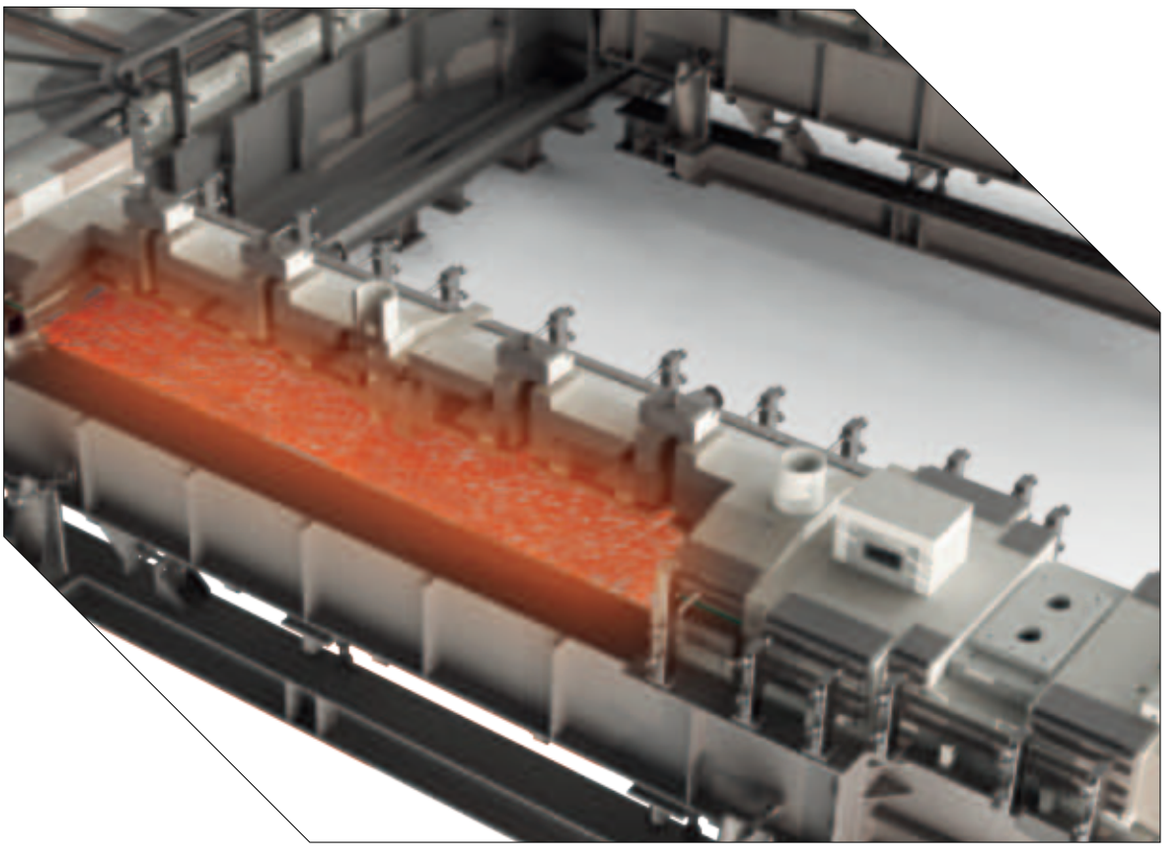
COMBUSTION & TECHNOLGY

ELECTRIC BOOSTERS

BATCH CHARGER

DISTRIBUTOR & FOREHEARTH

Glass Service designs and supplies distributors and forehearths, each to the customers requirements to give the best possible performance and taking into consideration the space available for the installation.

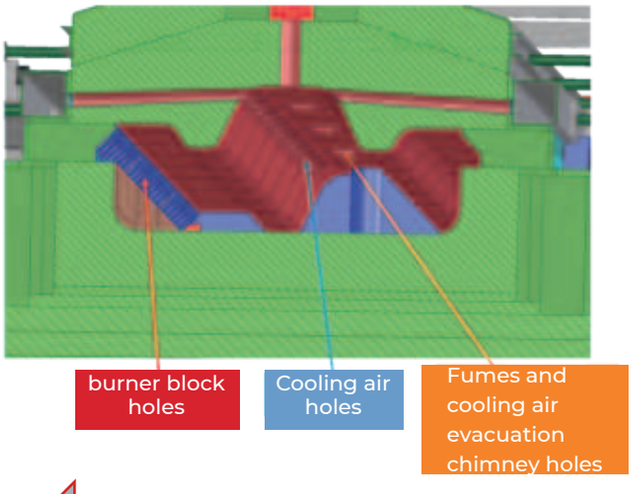


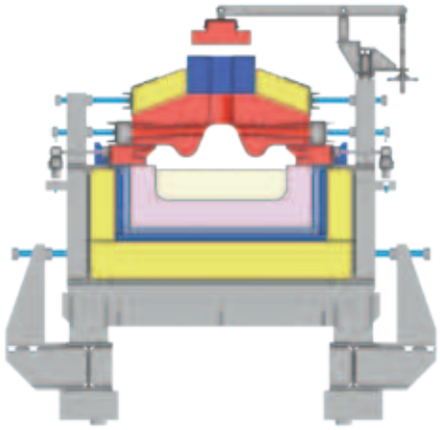
Glass Service has developed a new concept for distributors and forehearths with direct or indirect cooling technology. High thermal insulation combined with high performance central cooling increases the glass thermal homogeneity and reduces energy consumption.
The combination of Glass Service distributor and forehearth design including the Glass Service high performance combustion system reduces the time to change temperature settings for faster job changes.
The distributors available with widths from 400 to 1500 mm and with glass depths from 300 to 600mm depending on the glass colour, types, etc. Profiled longitudinal glass depths are used to ensure the correct velocity and residence time.
The forehearths widths are available from 14" to 54", glass depth from 6" to 9", depending on the glass colour, type, etc.
The distributors and forehearts size are designed to optimize the glass velocity and residence time for the optimum energy performance and thermal homogeneity.
To ensure good thermal homogeneity, all of the combustion systems are designed to allow independent control of left side and right side firing.
Temperature measurement and control can be by either optical pyrometers or platinum thermocouples.

DISTRIBUTOR AND FOREHEARTH FH DC direct cooling

Glass Service has developed a new concept of forehearth for glass container production.
The direct cooling distributor and forehearth type FH-DC combines a high thermal insulation on the sides with a highly efficient central cooling system.
Thanks to this innovation the result is high thermal homogeneity combined with low energy consumption.
A simple refractory construction reduces the number and cost of the refractory parts over the roof blocks. This solution also reduces the installation cost as well as the mechanical bending of the superstructure due the lower weight of the superstructure refractories. The type FH-DC has the following advantages:

- High performance central cooling
- High side thermal insulation
- Low energy consumption
- Simple refractory blocks design and easy installation (reducing installation and refractory cost)
- High resistance to bending
- Constant cooling air distribution along the full zone length
- No over-cooling in the air cooling input area
- Due to the high performance of the centre cooling system the total length can be reduced, thus saving the space for the installation which is especially useful when space is limited.

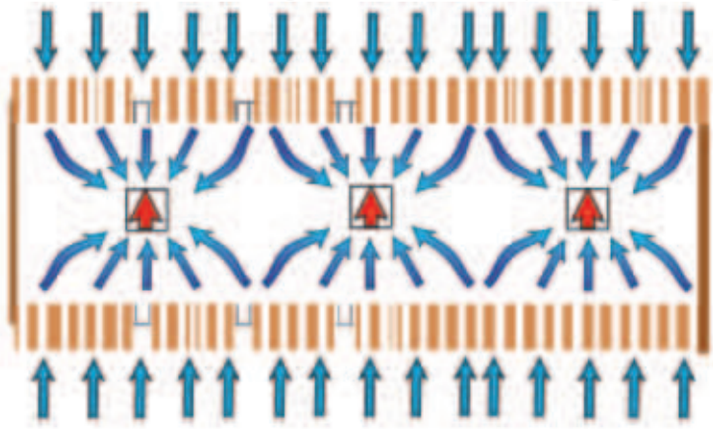




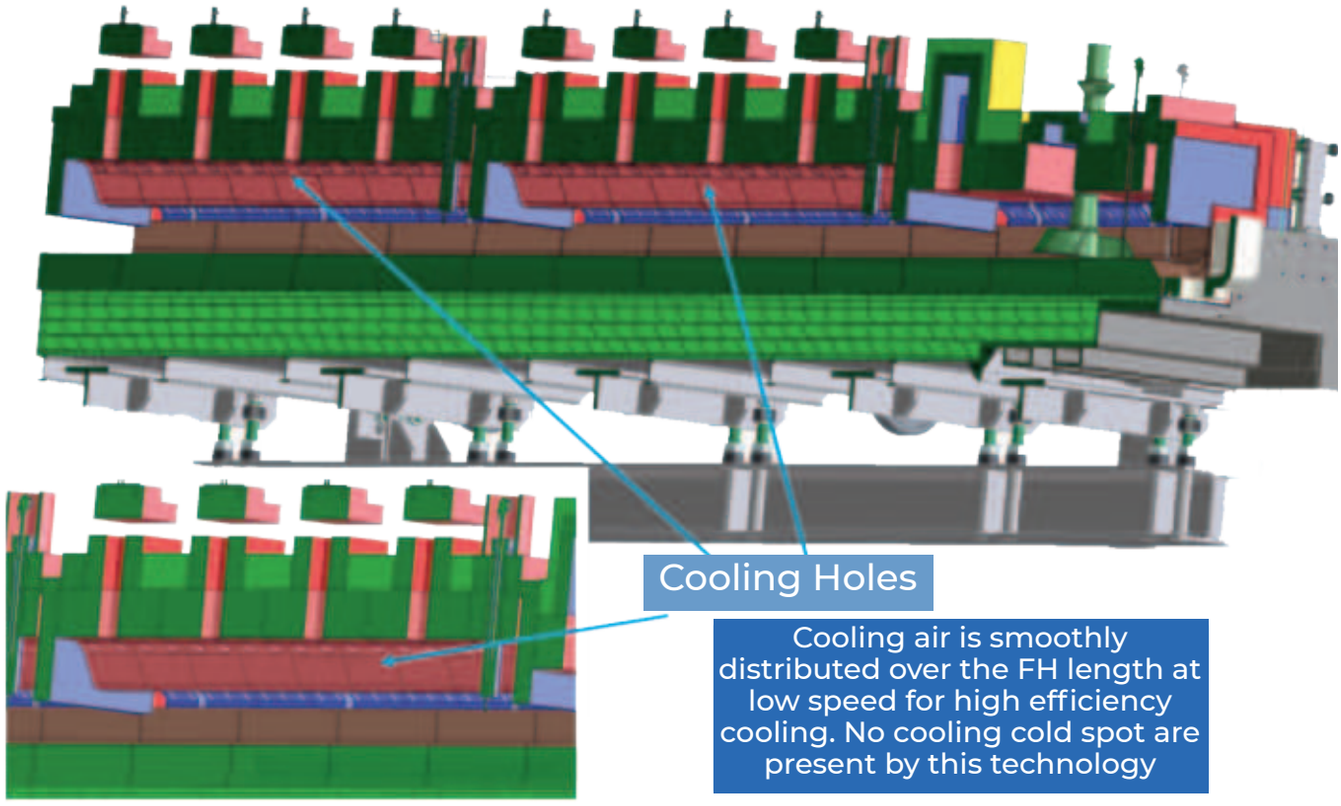
Due to the direct cooling and the special design of the superstructure, the cooling system has the following advantages:

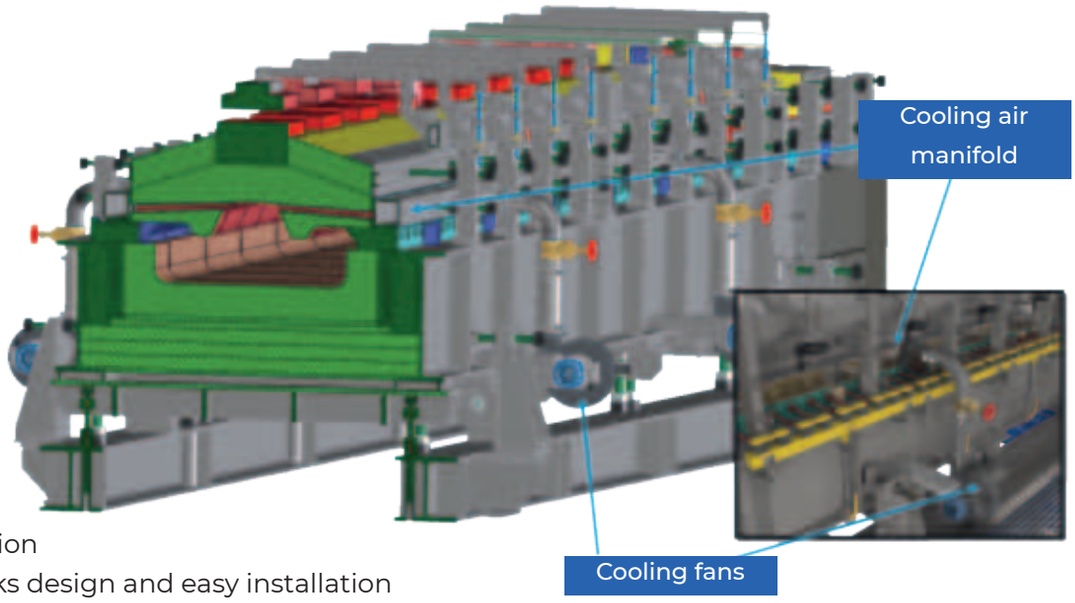
- Cooling effect is developed in a “separated” central channel with minimum «interference» with the heating area
- The flow of the cold cooling air is across the glass flow and distributed on the full zone length, without any over-cooling of the air input zone
- Each cooling zone is “separated” by manifolds and each pair of manifolds (left and right) has its own chimney
- The cooling effect of each zone can be automatically controlled by manual fine tuning of each manifold

By using the “cooling manifolds” concept, using several chimneys, the cooling air is introduced directly into the central cooling zone without impacting on the combustion zones on each side.



This concept avoids the uncontrolled flow of air along the forehearth and gives the operator more confidence about the effects of the local cooling effects, without disturbing the heating effect of the burners.



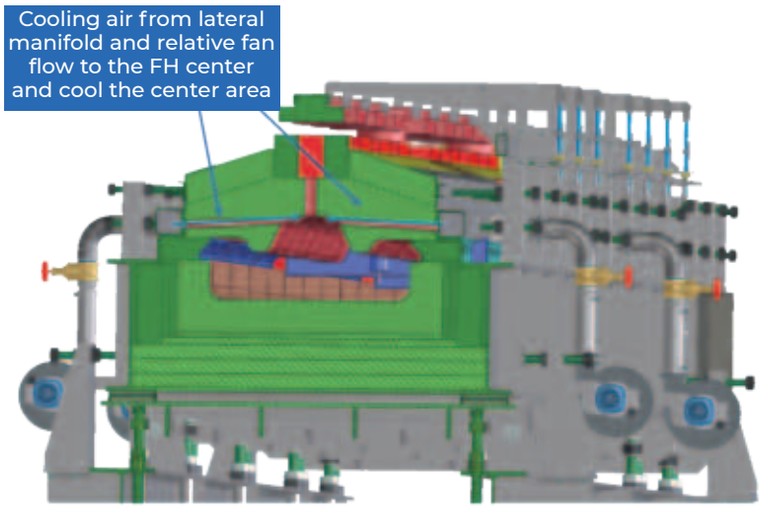


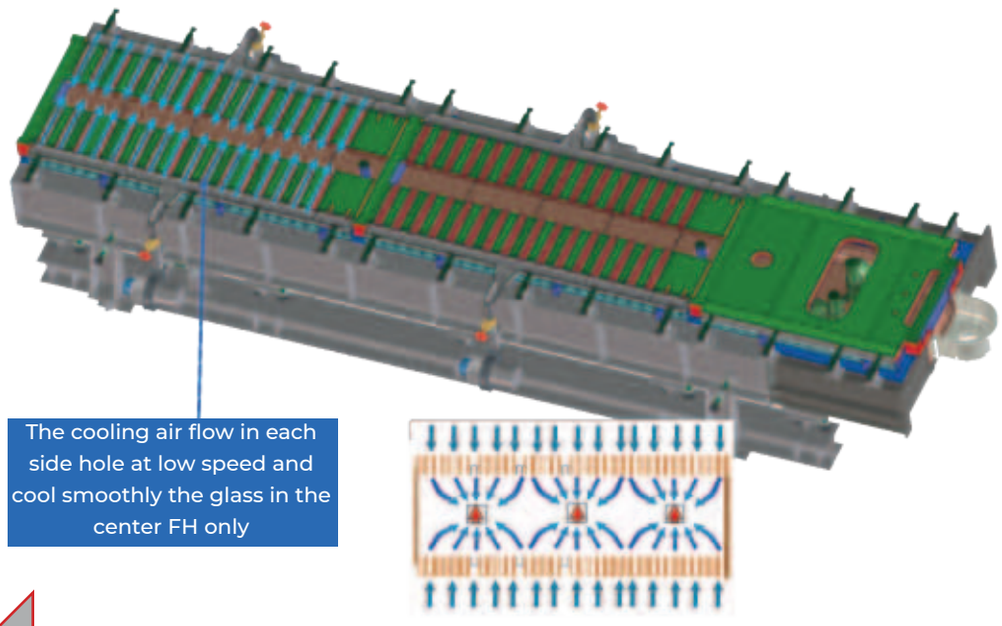
- Low energy consumption
- Simple refractory blocks design and easy installation
- High resistance to mechanical bending
- Constant cooling air distribution over the full zone length
- No over cooling in the air cooling input area
- Due to high performance centre cooling the total length can be reduced, saving the installation space

In forehearths with high pull variations and/or gob temperature differences, especially at opposite conditions (high firing at low pull or high cooling at high pull) the use of separated left and right combustion control is an important tool to help achieve the best homogeneity of the glass flowing to the spout.

The DC (direct cooling) forehearth model gives very high flexibility and cooling effects in a very short length. It can be an ideal solution for forehearth designs when the space available is limited.

For high pull rates and limited space the bottom cooling can be also added.

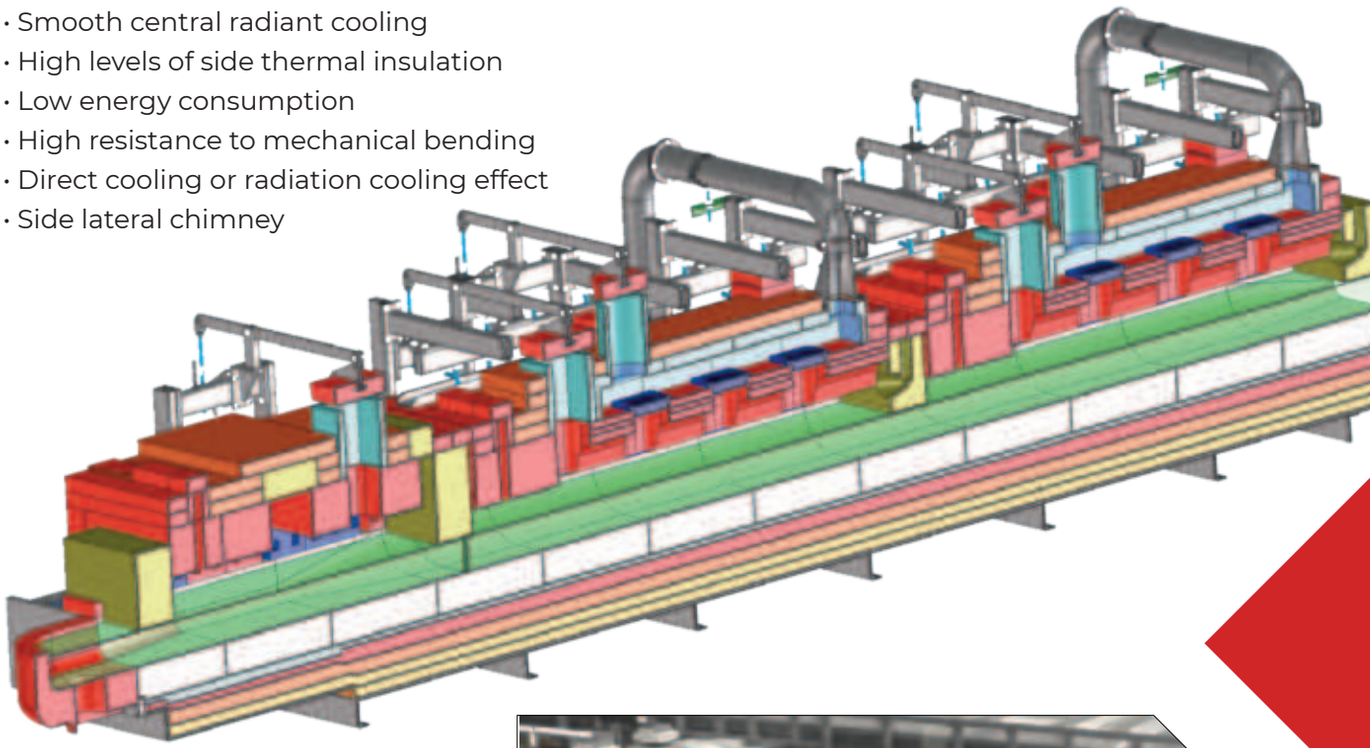


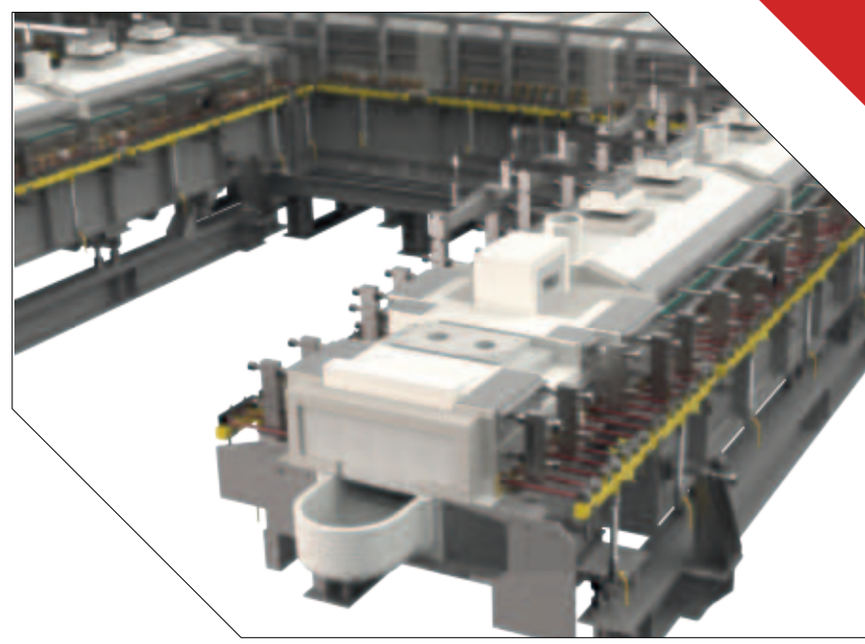


INDIRECT COOLING - FH-DC-IC

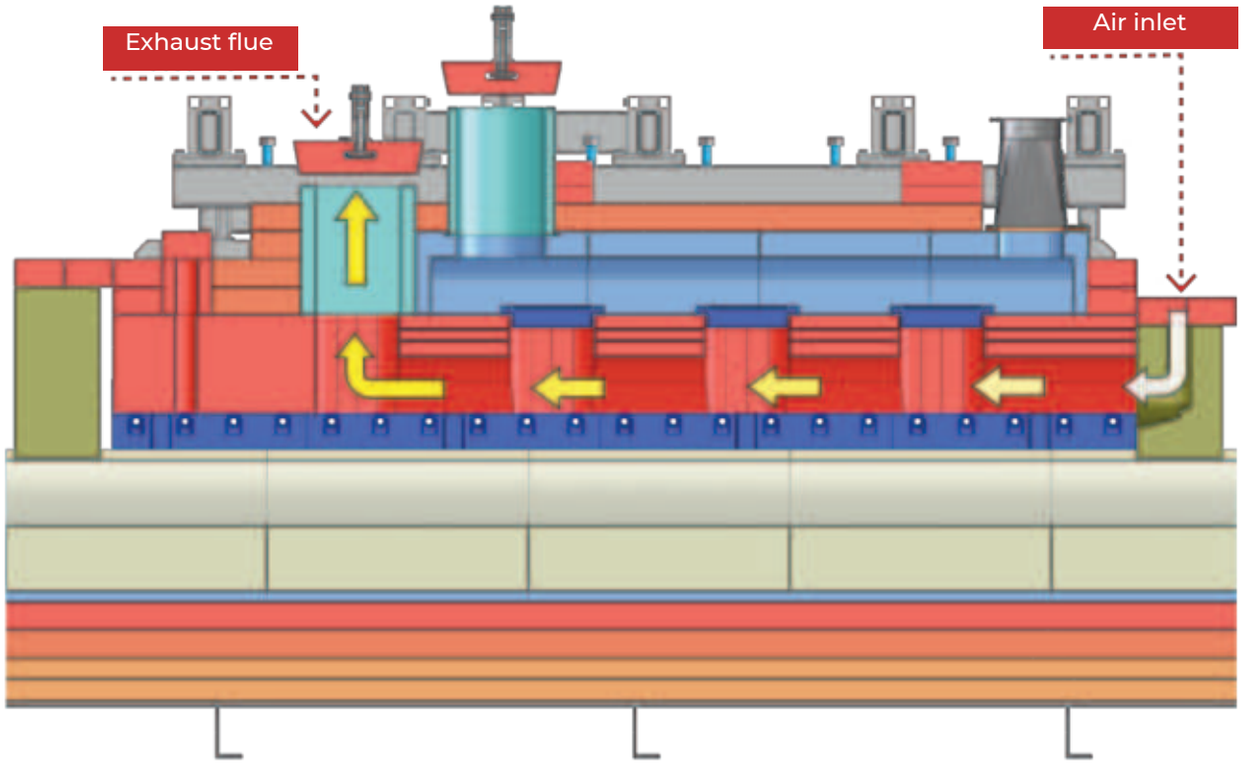
Glass Service has developed the model FH-DC-IC with a combination of radiant central cooling and direct central cooling.
The indirect cooling system has been developed to separate the waste gases from the cooling air.
This solution is recommended for low pulling distributors and forehearths and for special glasses.
The cooling is via radiation plates installed on the centreline of the forehearth, these plates have a sinusoidal, rough surface to improve heat transfer.
For job changes or during periods of high pull, direct cooling can be applied to each zone.
The operator can combine the radiant and the direct cooling effect to obtain the best performance and optimum thermal homogeneity.
For high pull installations, bottom cooling can also be installed.
The refractory design guarantees high mechanical resistance to bending.

The type DC-IC has the following advantages:
- Combination of indirect radiant cooling and direct central cooling
- Smooth central radiant cooling
- High levels of side thermal insulation
- Low energy consumption
- High resistance to mechanical bending
- Direct cooling or radiation cooling effect
- Side lateral chimney



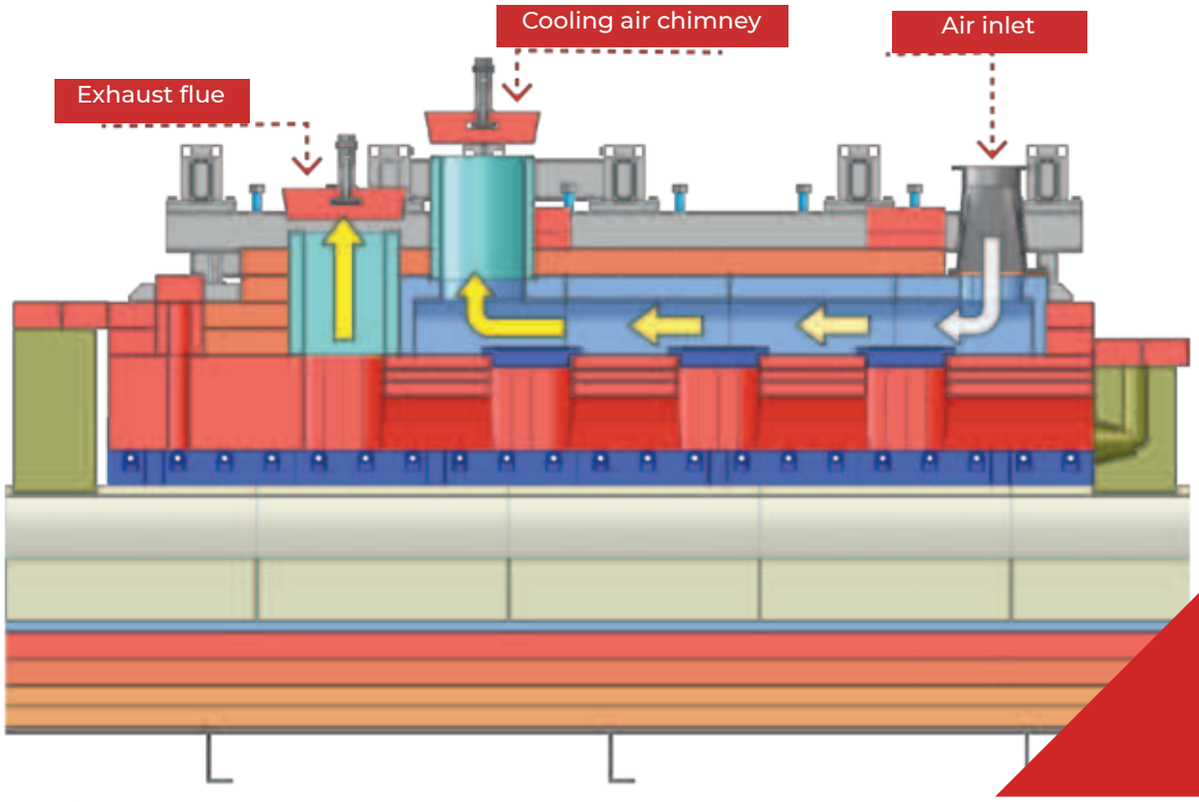


DIRECT COOLING



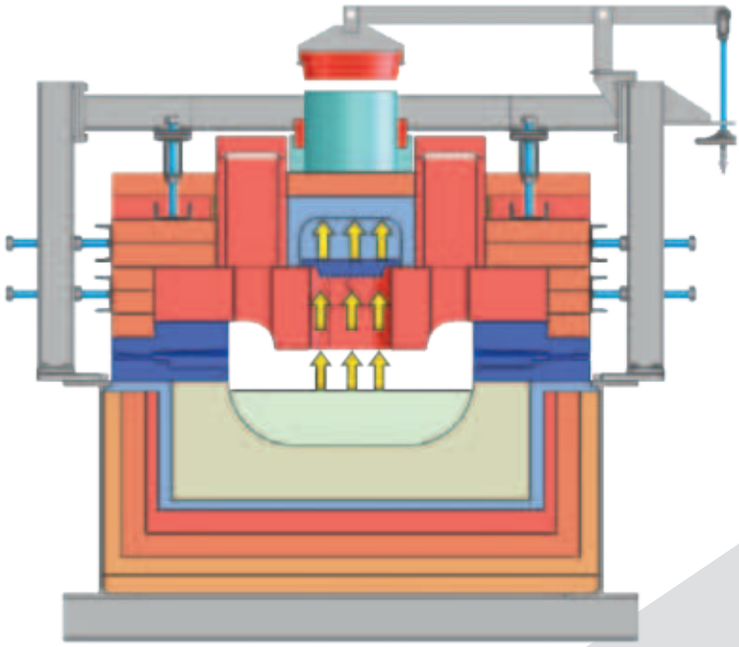
A direct flow of cold air along the forehearth centreline cools the glass along the central area of the forehearth, to improve thermal homogeneity.
The cooling air fan is inverter control.
The cooling air is combined with the waste gases.
The cooling air can be used for fast cooling during job changes or in the case of an extreme increase in temperature of the glass coming from the distributor.

INDIRECT COOLING



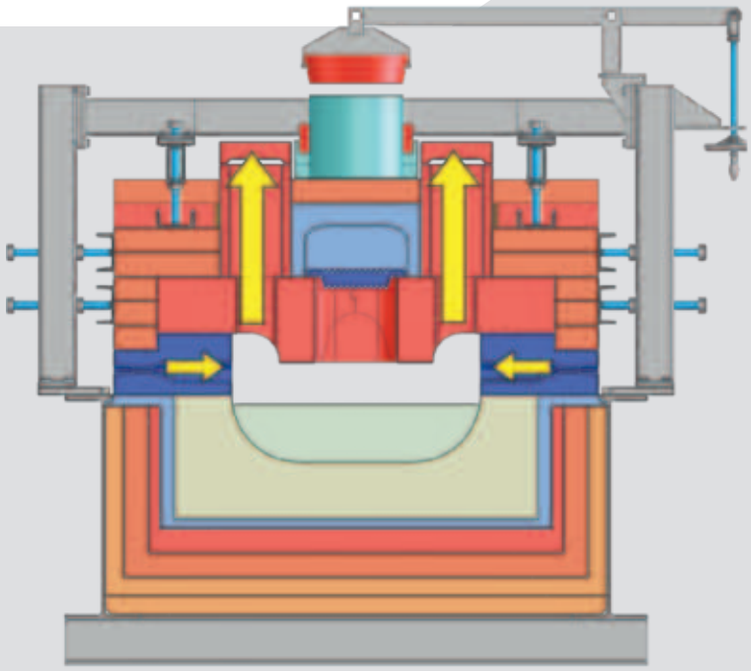
Indirect cooling is based on radiationplate effect. The cooling by radiationplate ensures a smooth cooling effect in the central forehearth section.
The central forehearth glass is cooled by the radiation effect due to the radiating plate.
The special sinusoidal profile of radiating plates ensure a high heat transfer.

- Combination of radiant indirect cooling and direct central cooling
- Smooth central radiant cooling
- High side thermal insulation
- Low energy consumption
- High resistance to mechanical bending
- Direct cooling or radiation cooling effect
- Combination of radiant cooling and direct cooling
- Side lateral chimney



SIDE LATERAL CHIMNEY

The side chimney is used to exhaust the products of combustion to increase the central radiation cooling effect.
The rapid exhaust reduces the energy transfer to the forehearth center.
A combination of independent systems for the right and left firing systems increases the distributor and forehearth efficiency.



TECHNICAL FEATURES

MODEL		FH DC	FC DC-IC
TYPE		DIRCT COOLING	MULTI COOLING
SIZE		K 16 TO K 54	K 26 TO K 54
DEPTH	mm	178 TO 250	
DIRECT COOLING		✓	✓
INDIRECT COOLING		-	✓
SIDE LATERAL COOLING		-	✓
BOTTOM COOLING		-	✓
TEMPERATURE CONTROL		RIGHT & LEFT INDEPENDENT	
COOLING AIR FAN MOTOR POWER	kw	3 Ph 400 VAC 50 Hz - 0,55 Kw	

COLOURING FOREHEARTHS

The colouring forehearth technology was developed to allow the glassmakers to produce short runs of a wide range of colours without the costs of changing colour in the furnace by adding colour in the form of metal oxides in a low melting point boron based frit.
The colour forehearth technology is very flexible allowing the full range of production in a wide range of colours including container, table ware and cosmetic containers.

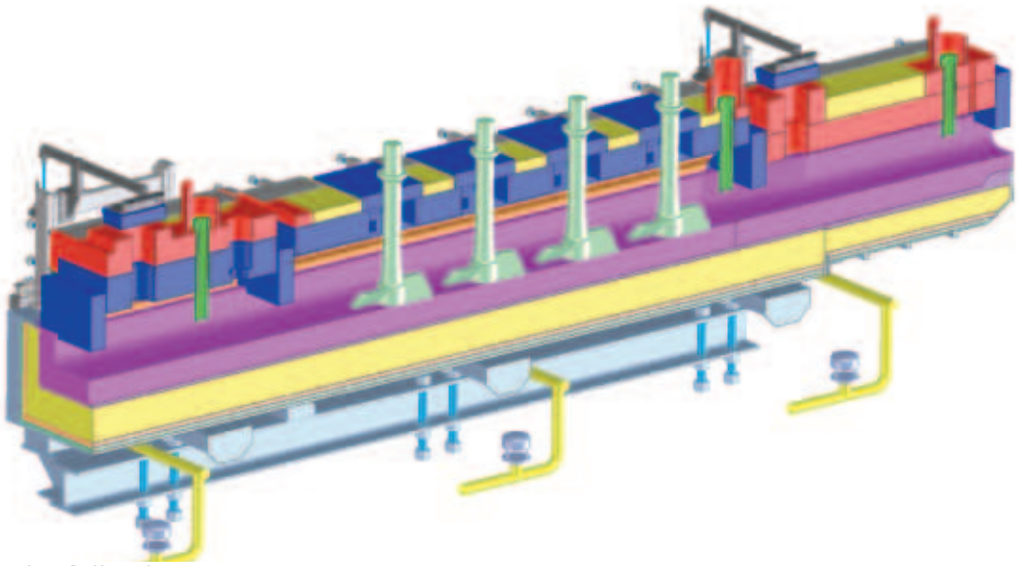
Glass Service has developed colouring forehearths in various sizes and lengths, each designed for the specific pull, colour range and production.

Glass Service designs and supplies the forehearth colouring technology as well as all of the necessary production equipment:

- The automatic frit dosing device
- The stirrer machine
- The control panel

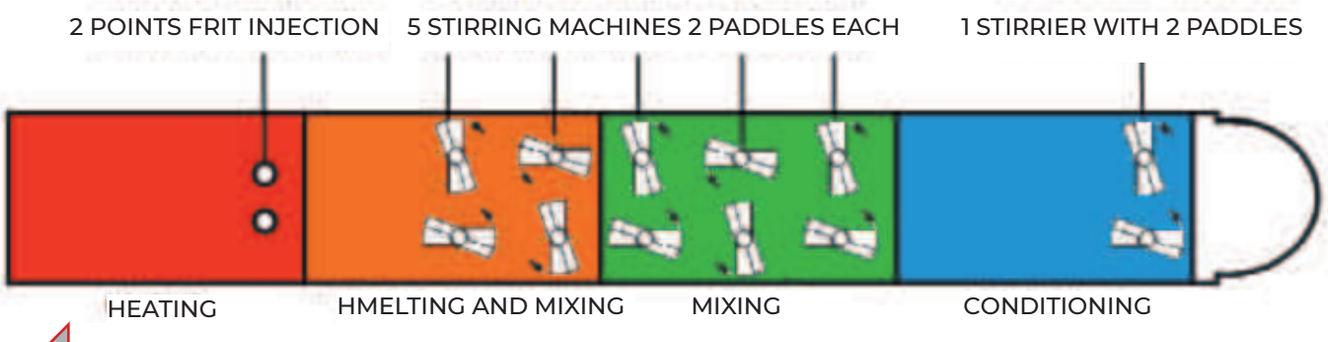
The systems are of strong reliable construction, designed for continuous operation.
The main concepts of our colouring forehearths are: simplicity, flexibility and reliability.
The automatic frit dosing device and the stirrer machine can be easily adapted to a wide range of pull rates and require low maintenance even when operating under heavy working conditions.

Glass Service has designed and provided coloring forehearths to many customers in Italy, France, Turkey, Russia, China, Poland, Morocco and Spain.



The technology includes the following stage:

- Glass heating zone and colouring frit addition
- The glass is heated to 1250-1300 °C to melt the colouring frit, with a double row of burners installed for high melting energy input
- The frit is added via one or two dosing tubes which are either air or water cooled
- Stirring zone
- The melted frit is mixed into the base glass melt using refractory stirrers, the number of stirrers installed being a function of forehearth dimensions and required pull Two different stirrer design are available, screw and paddle
- One stirrer mechanism is installed before the spout so that during colour changes eliminates any small colour variations and reduce colour change time
- Conditioning
- The glass is conditioned to the correct gob temperature in the final zone



Some examples of coloured bottles

The colouring foreheart technology has a number of critical points for successfull operation the main are:

ISSUE	SOLUTION
Acurate dosing of the frit	Acurate dosing of the frit
Costant chemical composition of the frit	First quality frit
Constant redox atmosphere	High quality combustion system and FH dsign is requires
Homogenous mixing	Good mixing technology
Rapid colour change	The correct FH design is required to minimize the colour change time. The stirrer mechanism installed before the spout eliminates any small colour variations and reduce colour chengfe time
Long life of refractories	The frit contains a high level of boron, during melting the boron vaporus corrode the standard refractory superstructure. A special design of refractory quality increase the FH life.

AUTOMATIC FRIT DOSING DEVICE with air cooling package

Glass Service has developed a new concept of frit dosing with the frit dosing unit installed at low level, the frit being transported to the forehearth pneumatically.

The main hopper contains the frit (see (1) in the sketch below).

To ensure a constant supply of frit, a dedicated sensor located on the base of the hopper generates an alarm when the hopper must be refilled.

The dosing system delivers the dosed amount of frit to the feeding transport system.

The system is controlled from a PLC with colour touch screen, installed in the control panel.

Frit flow from the dosing system (2) is controlled from the PLC which automatically adjusts the spead of the conveyor belt.

The pneumatic transport system uses a high pressure air blower (3) to blow the frit inside a stainless steel pipeline up to a centrifugal dust separator (4).

AUTOMATIC FRIT DOSING DEVICE with air cooling package From the separator the frit falls to the feeding tubes.

The feeding tubes are installed through the forehearth superstructure.

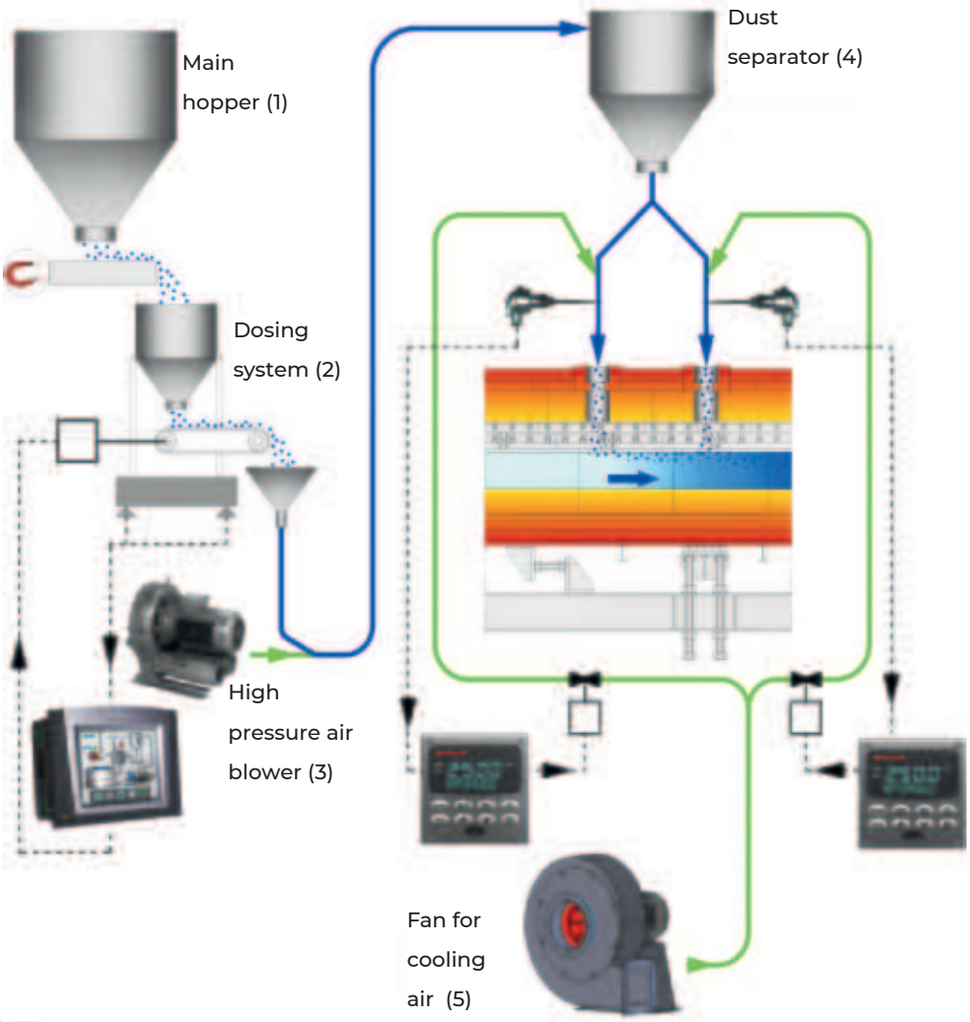
To prevent overheating each tube is equipped with cooling air, and a thermocouple, the cooling air fan (5) being controlled by a single loop controller.

This layout allows the dosing equipment to be located on the ground or in a location where the operating temperature of the electronic devices are kept below 40 / 45°C.

In addition, this allows easy access to the system for the operator, for maintenance and to add the colouring frit into the main feeding hopper.

TECHNICAL FEATURES

Dosing max flow	140 kg/h
Dosing min flow	5 kg/h
Main hopper (A) standard volume	600 litres
Main transfer device	Electromagnetic vibrating channel
Dosing transfer device	Special rubber belt drive by brushless motor
Scale	High precision electronic strain gage
Electronic control	Automatic by touch screen PLC



- The dosing system controlled by a PLC
- The feeding tubes are each provided with 2 thermocouples
- Temperature of the feeding tubes controlled by a UDC
- Easy access to the dosing system for the operator
- Easy maintenance
- Strong steel structure above the forehearth

CONTROL BOARD

The design of Glass Service control board features the following main characteristics:

• A PLC with colour touch screen to manage the operating logic of the frit dosing to the forehearth, with an automatic continuous control of the weight/minute of the quantity of frit dosed into the system. The LOOP action operates by increasing-decreasing the speed of the belt dosing system using special high precision software.

The touch screen interface can manage all of the required information for the colouring technology, managing the dosing, alarms, trends, settings, etc.

• The regulation of each single temperature parameter (internal temperature of each injection tube) is managed by a suitable Honeywell UDC 2500 regulator.

• The external temperature of each injection tube is displayed on a Honeywell DC 1030.

• A series of lights and buttons mirrors exactly the operation status of the system on the front panel.

PLC TOUCH SCREEN

Honeywell
UDC 2500

Honeywell
DC 1030

The default alarms are:

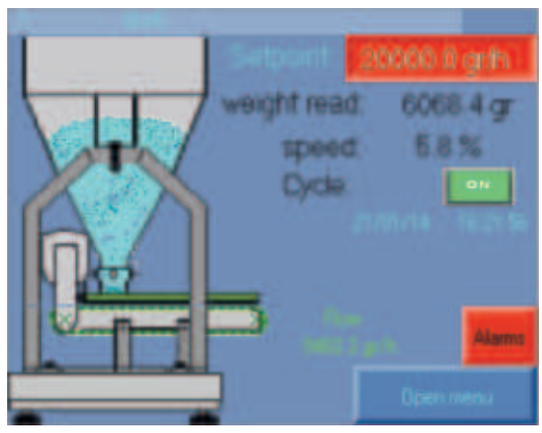
• high temperature into the injection tube
• fan motor
• stirrer motors
• high pressure air blower motor
• frit level in the hopper
• cooling air low pressure
• and other functions on request

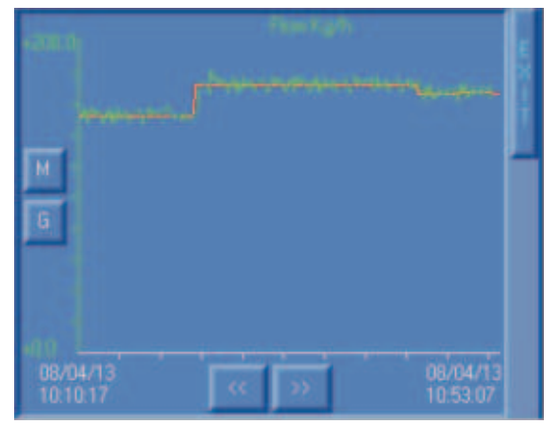
• Stirrer start and stop and speed is controlled via the main cabinet
o small local cabinet is located at feeder level to locally stop the stirrers for security and maintenance

PLC SOFTWARE

The PLC software allows the operator to change the menu language, calibrate the scale, view the history alarms, set the dosing rate, view the flow trend and manage all of the parameters in a single menu.

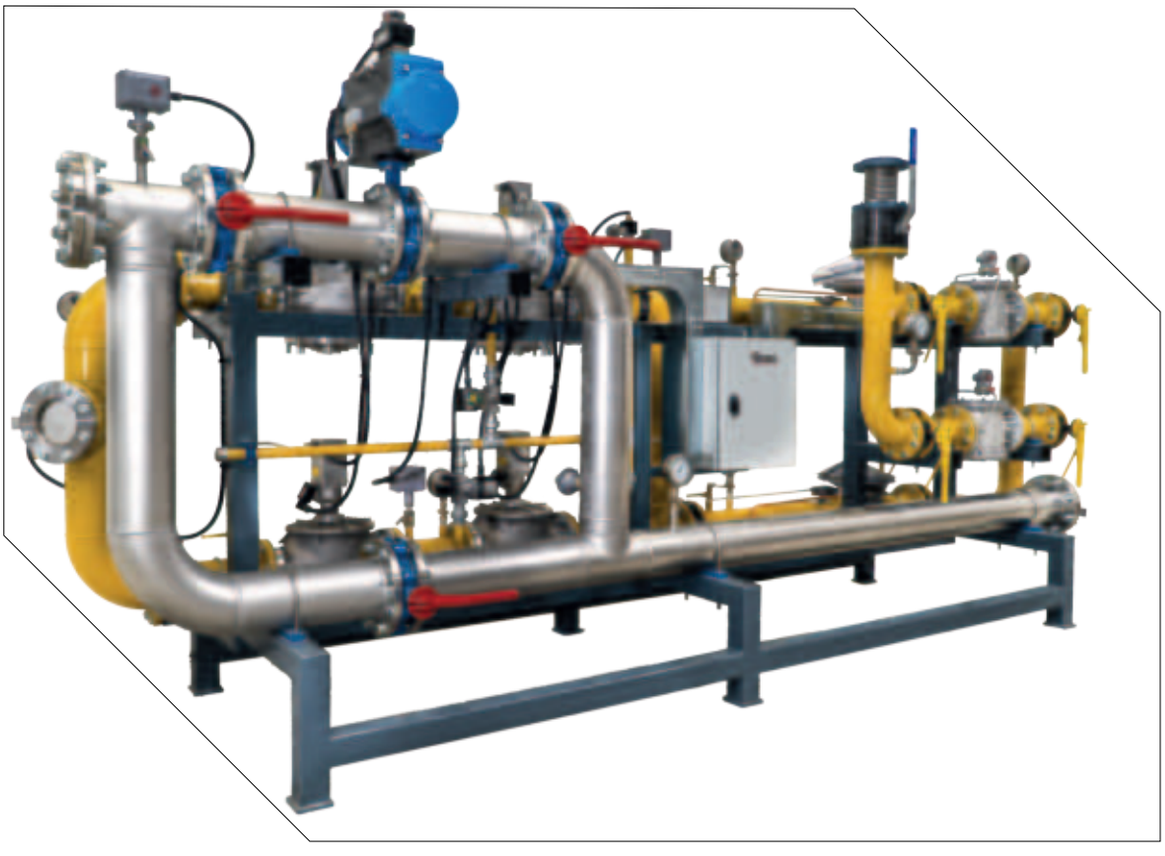
Additional information can be incorporated on request.





OXY-GAS COMBUSTION SYSTEM

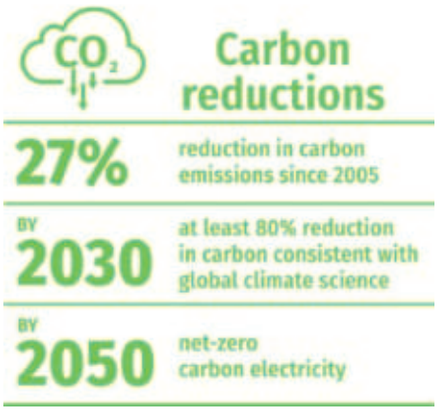
Oxy-fuel combustion systems are now a practical and well tested application for use in glass melting furnaces Glass Service has developed the technology and have supplied a number of complete oxy-fuel combustion systems to glass manufacturers.



COMBUSTION SYSTEM CONFIGURATION

The oxy-fuel combustion technology can be used for special glasses as well as for standard soda lime glass with several advantages:

- Reduced of energy consumption
- Increased glass pull
- Reduction of spares required for the furnace
- Reduced pollution
- Reduced NOx
- Reduction of carryover from the raw materials
- Easy to achieve the high temperatures required for special glasses, such as borosilicate glasses, etc.
- Lower capital investment compared to regenerative or recuperative furnaces as no regenerators or metal recuperators are required
- Lower investment in refractory materials and lower refractory installation cost
- Continuous firing (compared with regenerative furnace)
- Easy control and adjustment of the temperature profile along the furnace longitudinal axis



Glass Service combustion systems can operate with several oxygen sources:

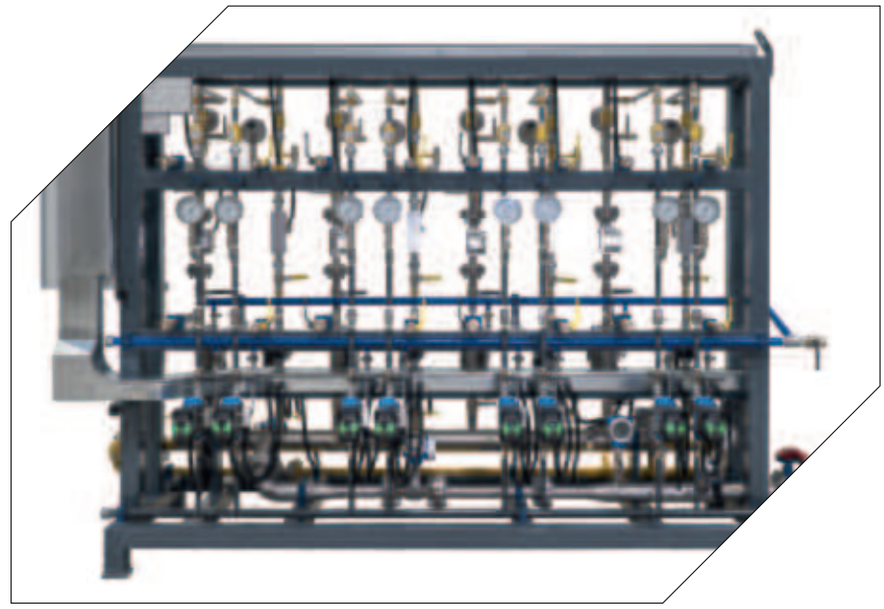
- Cryogenic liquid tank
- VPSA producers
- VSA producers

Glass Service oxygen skid can operate either at high pressure or low pressure input (VPSA and VSA) for instance, 500 mbar.

The combustion system consists of:

- Gas pressure regulator and safety equipment (safety shut off valves, pressure switch, etc.)
- Oxygen pressure regulator and safety equipment (safety shut off valves, pressure switch, etc.)
- Gas and oxygen flow control for each burner
- Compressed air burner cooling
- Burners
- Control system

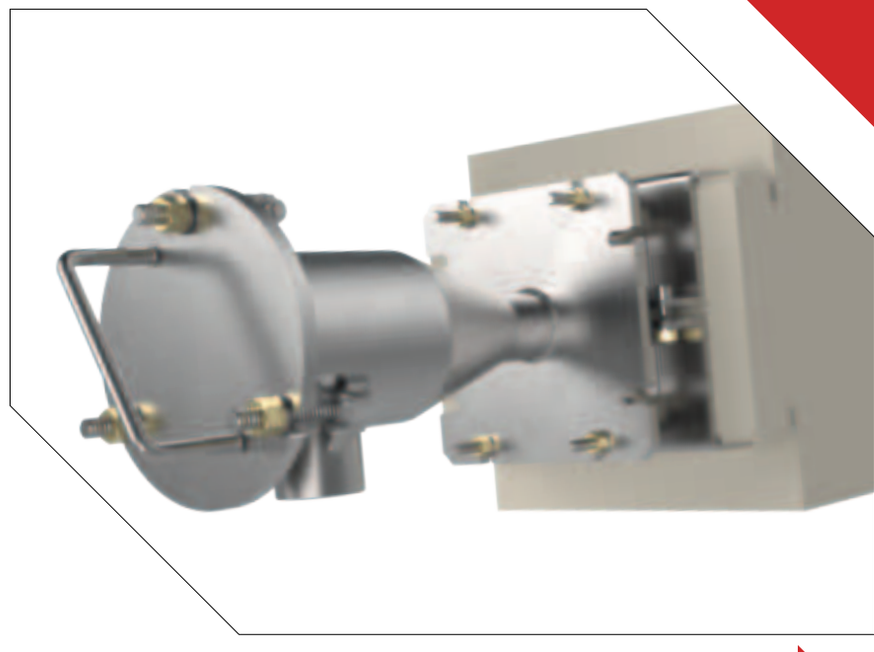
The gas and oxygen flow control must be very accurate and Glass Service have developed a high precision flow control system using Vortex instruments to controls the oxygen and gas flows.
The system takes into consideration variations in the temperature and pressure and compensates for variations at each burner.



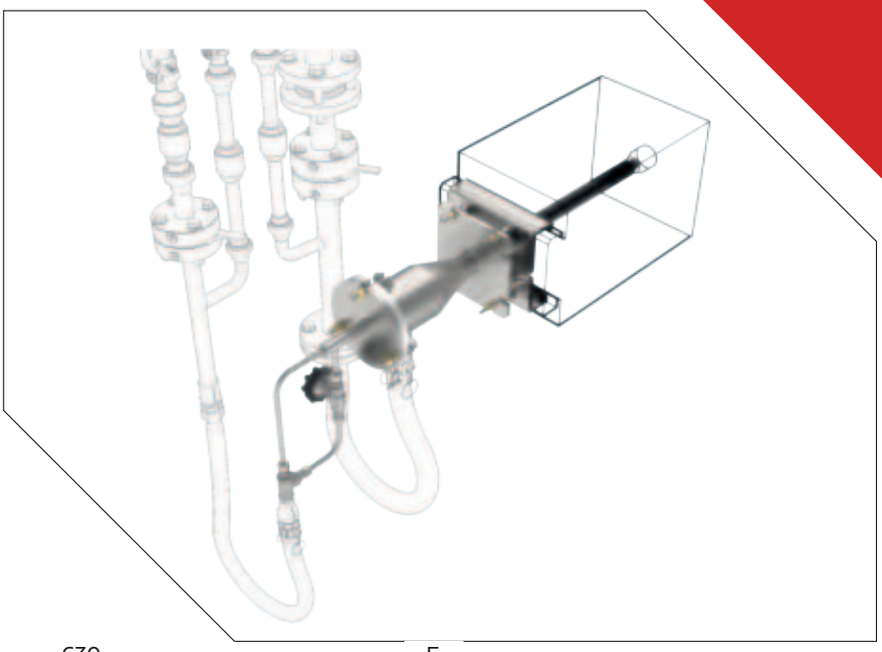
Oxy-fuel combustion systems are now a practical and well tested application for use in glass melting furnaces.
Glass Service has developed the technology and have supplied a number of complete oxy-fuel combustion systems to glass manufacturers.
Glass Service designs and supply oxy-fuel burners for low pressure gas and oxygen and for low and high flow rates.
All Glass Service burner designs have low momentum flames without any peak temperature. This special design feature for glass melting furnaces avoids localised high temperatures on the furnace crown and the potential to create rat holes.
The burner radiation is concentrated in the visible spectrum range improving the radiated energy transmission to the melted glass and the furnace efficiency.

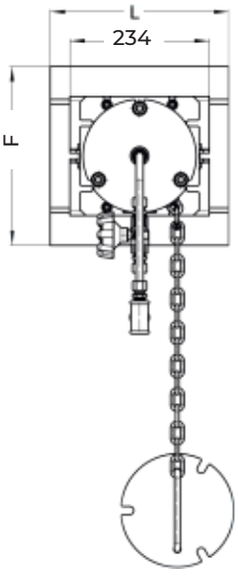
TECHNICAL FEATURES:

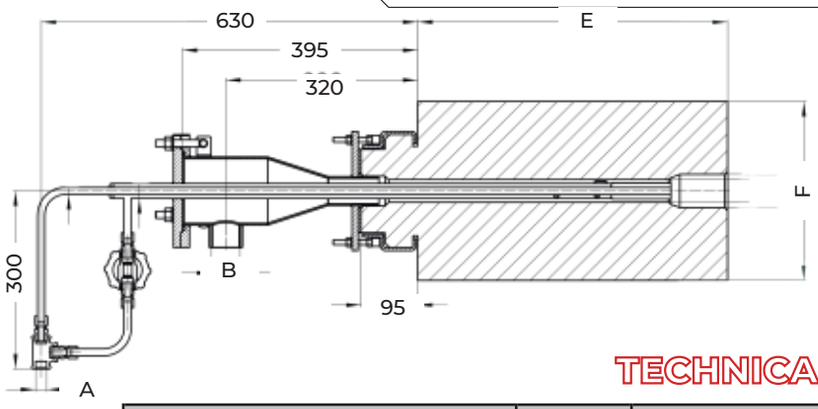
- High temperature operation
- Low momentum burners
- High flame radiation in visible spectrum
- Stepless external regulation of the flame length
- Easy removal of burners for maintenance
- Low flame momentum
- Easy removal for maintenance
- Compressed air cooling for burner shut off
- Burner block material AZS 31 %



For nozzle maintenence a cap in stainless steel can be applied on the burner body

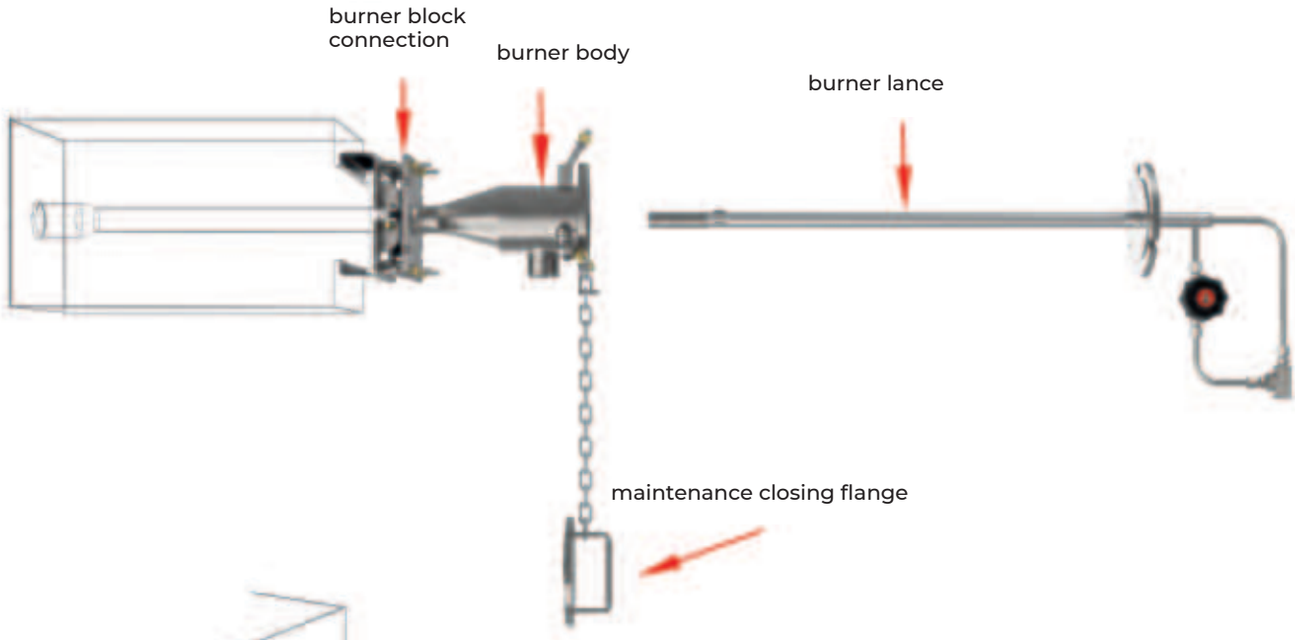


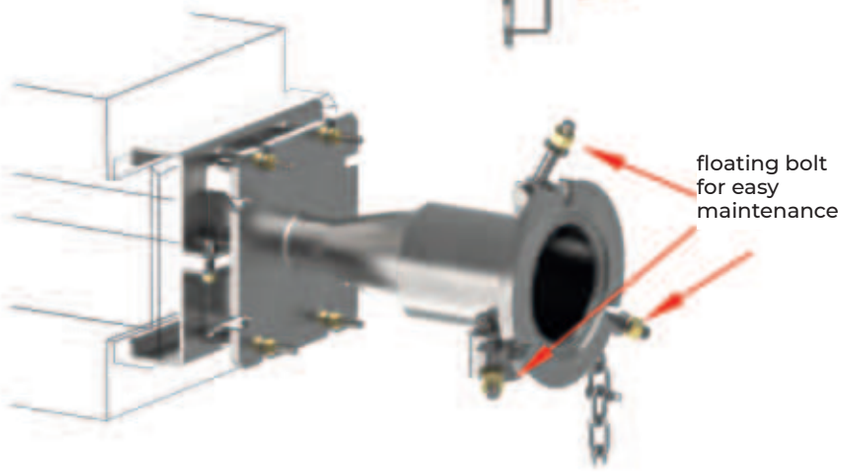




TECHNICAL FEATURES

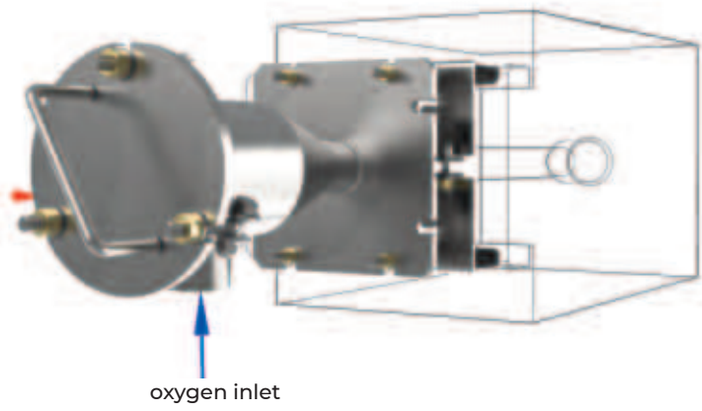
FEATURE	MODEL		BR-OX-200	BR-OX-500
POWER		KW	200	500
RANGE ABILITY			1/3	1/3
OXYGEN RATIO RANGE			2-3	2-3
FLAME LENGHT		M	0,5 ÷ 2	0,5 ÷ 3
FURNACE TEMPERATURE		°C	1300 ÷ 1600	1300 ÷ 1600
NATURAL GAS FLOW	MIN	Nm^3/h	7	15
	MAX		20	50
NATURAL GAS PRESSURE LARGE NOZZLE FLOW 100% LITTLE NOZZLE FLOW 100%		MBAR	20	20
NATURAL GAS PRESSURE LARGE NOZZLE FLOW 0% LITTLE NOZZLE FLOW 100%			60	100
NATURAL GAS LOW CALORIFIC VALUE		$Kcal/Nm^3$	8500	
		Kw/Nm^3	10	
NATURAL GAS DENSITY		Kg/Nm^3	0,71	
OXYGEN PRESSURE INPUT		mbar	20	
OXYGEN DENSITY		Kg/Nm^3	1,43	
A			1/2 BSPP FEMAL	1/2 BSPP FEMAL
B			11/2" BSPP FEMAL	
E	STANDARD	mm	520	
	RANGE		230 ÷ 660	
F	STANDARD		300	
	RANGE		200 ÷ 400	
L			300	





maintenance flange

burner with
installed
maintenance flance
for probe change or
probe maintenance



FOREHEARTHS & DISTRIBUTORS COMBUSTION SYSTEM

FOREHEARTHS & DISTRIBUTORS COMBUSTION SYSTEM

An energy efficient forehearth and distributor combustion system is essential for consistent quality production in the glass industry.
Good control is essential, particularly in the case of special or coloured glasses (e.g. green, amber) where a stable redox condition in the forehearth superstructure is essential for good quality production.
The forehearth and distributor combustion system developed by Glass Service is the result of over 30 years of experience on glass industries.

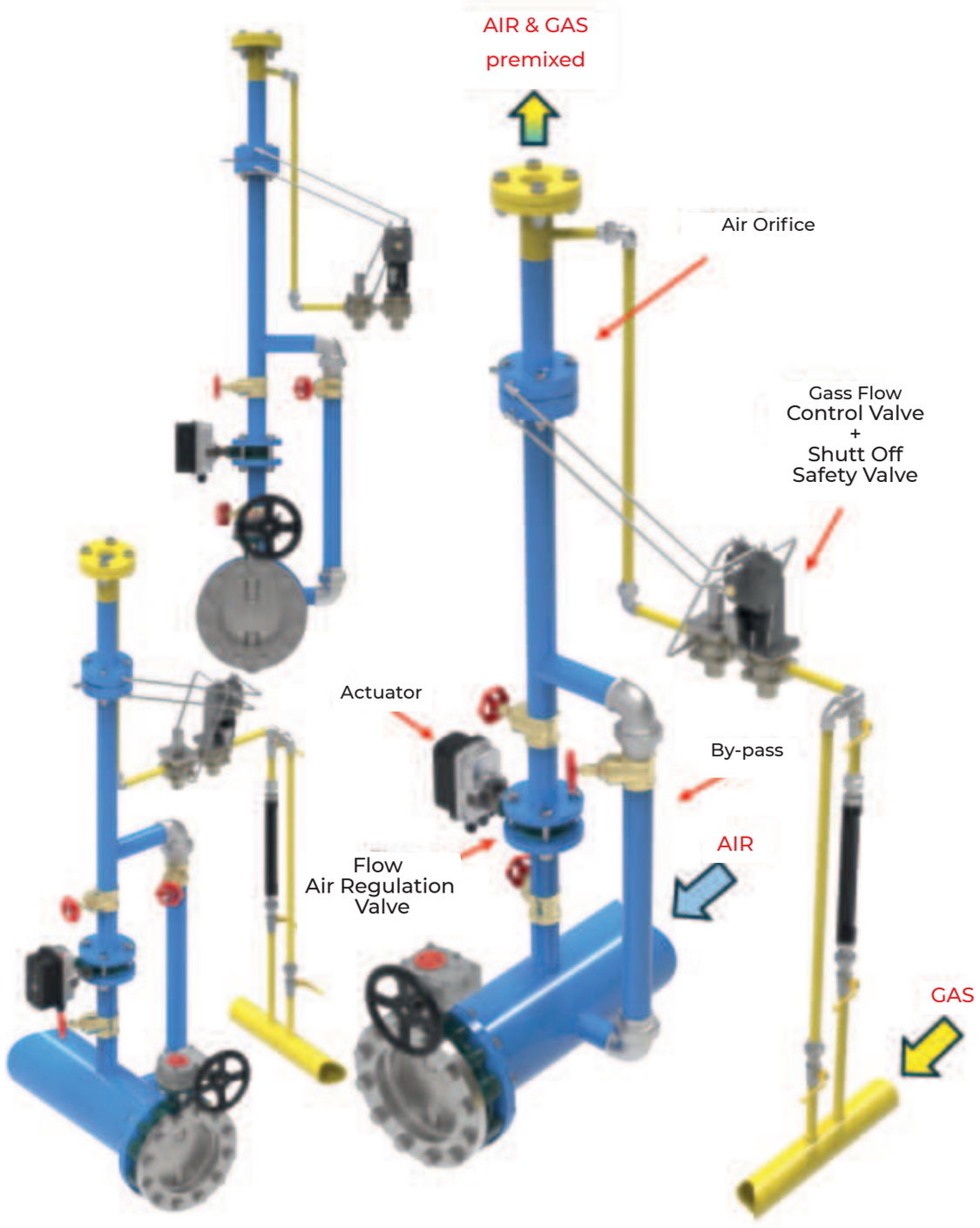
The system used is the premix gas/air type and can be used with natural gas or LPG.

The combustion system match the major request of nowadays glass industries, as:

- Correct combustion ratio in all the full range of flow (3 - 50 mbar manifolds pressure)
- Linear flow valve control characteristic
- Stable ratio condition during burner pressure fluctuations
- Stable ratio conditions after a burner nozzle change or cleaning
- Easy and precise manual setting of the gas/air ratio form each zone
- Wide range of flows and sizes (from DN25 to DN100)

GADP COMBUSTION SYSTEM

The GADP combustion system is based on the constant ratio between the DP (differential pressure) on air orifice plate and gas regulation valve.
The GADP have lower influence on pressure burner fluctuation or burner dirty clogged nozzles.
The GADP technology is recommended for use in medium and high burner flow application, in this case a butterfly air valve can also be used.
The pressure manifold available using GADP are from 6 to 50 mbar and are able to supply burners system and high pressure.



TECHNICAL FEATURES
- Special glass
- Table ware
- Colouring forehearth
- High ratio stability even when burners are dirty or bloked

STANDARD MIXER-ZERO GOVERNOR (ZGT)

The mixer Venturi and zero governor was the common standard in glass industries for many years.

It is used in all the glass type, containers and special glasses.

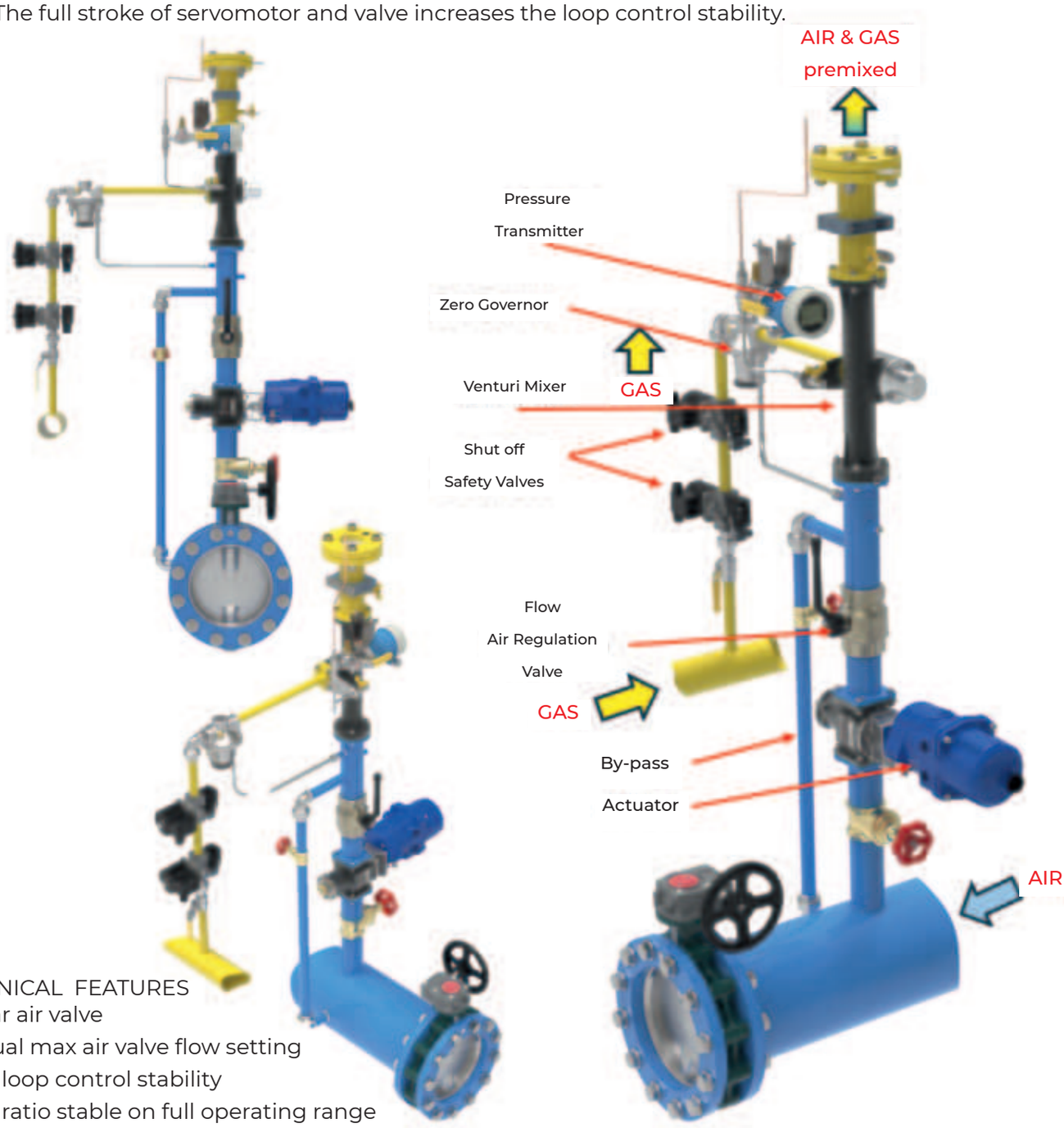
The system is based on the constant ratio of air and gas pressure Glass Service develop several technical detail to improve the quality and performance on ZGT combustion system.

The Glass Service solution increases the system performance and ratio stability.

The air valve used by Glass Service can be adjusted in the max flow by the manual curtain.

The max air flow can be set zone by zone during the installation and can be increase the servomotor valve stroke to the max value (100% opening).

The full stroke of servomotor and valve increases the loop control stability.



TECHNICAL FEATURES

- Linear air valve
- Manual max air valve flow setting
- High loop control stability
- High ratio stable on full operating range
- Pressure tapping upstream the mixer
- Ratio independent control zone
- Recommended for container industries

The zero governor pressure tapping upstream of the Venturi mixer increases the gas/air ratio range and reduces the risk of gas leakage should the zero governor be damaged.
The pressure range using ZGT is from 3 to 50 mbar and Glass Service is able to supply both low and high pressure burner system.
Thanks to the stability across the full range and in particular at low pressure and low flow, this system is highly recommended for use in container industries.

For each zone the required technology is installed (ZGT; GADP; OMN).
Other equipment are also installed for best performance.

- Pressure indicator for each zone
- Pressure transmitter for each zone
- Explosion relief valve for each zone
- Gas flow meter for each FH or Distributor
- Mix test analysis connection for each zone
- Air pressure switch
- Gas pressure switch
- Skid cabling and local junction box

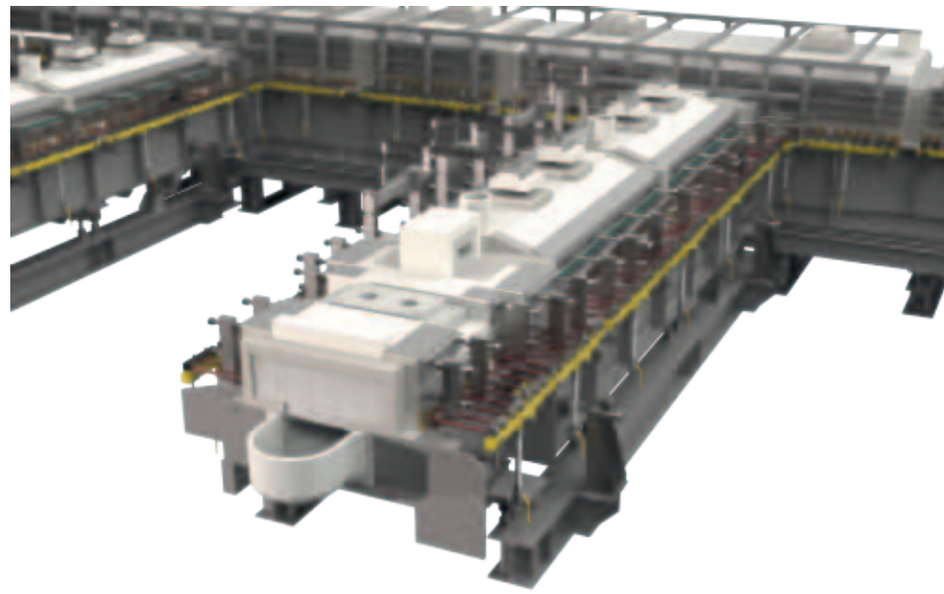
Glass Service can also supply all of the combustion air fans skid mounted, with invertor drive for pressure stability, or direct drive.
Glass Service can also supply the gas governor redundancy skid.

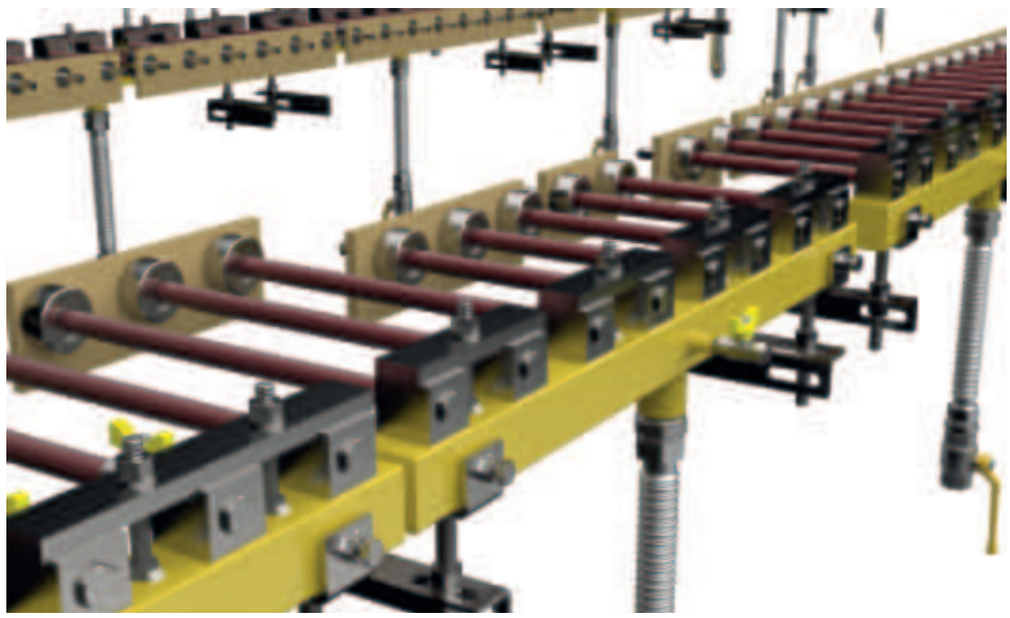
CONSTRUCTION DETAILS

The forehearth & distributor combustion skid designed by Glass Service are compact and easy to install.
The combustion system is preassembled on the skid ready for installation, complete with all up to date equipment necessary for the best performance.

Glass Service developed the foreheart and distributor burner technology as the relative manifolds and foreheart metallic case connection.
The burners are totally sealed to the refractories.
The burner nozzle are available in several sizes as standard production, different nozzle diameters are available on request.

1/4 inches	6,3 mm
3/8 inches	9,5 mm
9/32 inches	7,1 mm
5/16 inches	7,9 mm





The burners are done in special high temperature resistance steel.
The burner are completed with relevant manifolds.
The manifolds include a 3 direction brackets regulation for a better installation and adjustment after heat-up.
Each manifold is integrated with long expansion Joint and shut-off manual valve. The valve is required for burner maintenance.

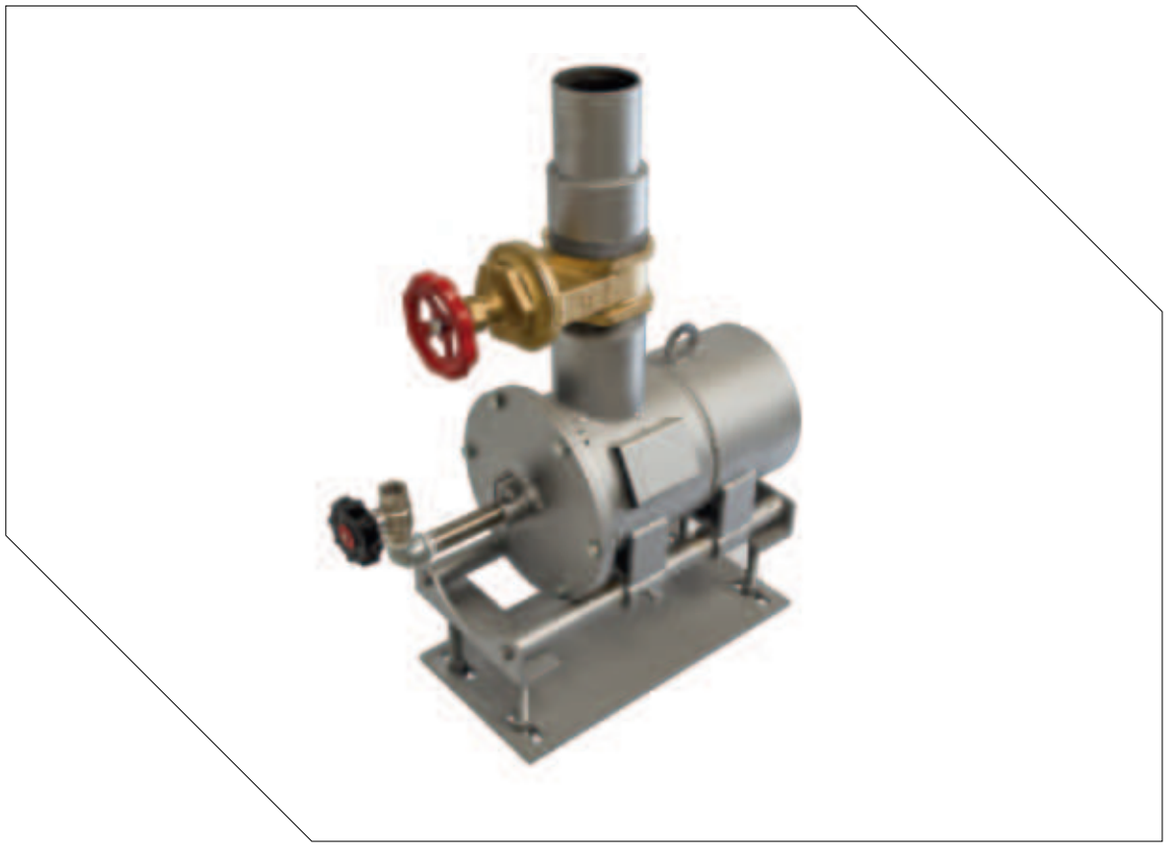
AIR-GAS BURNER

AIR-GAS BURNER

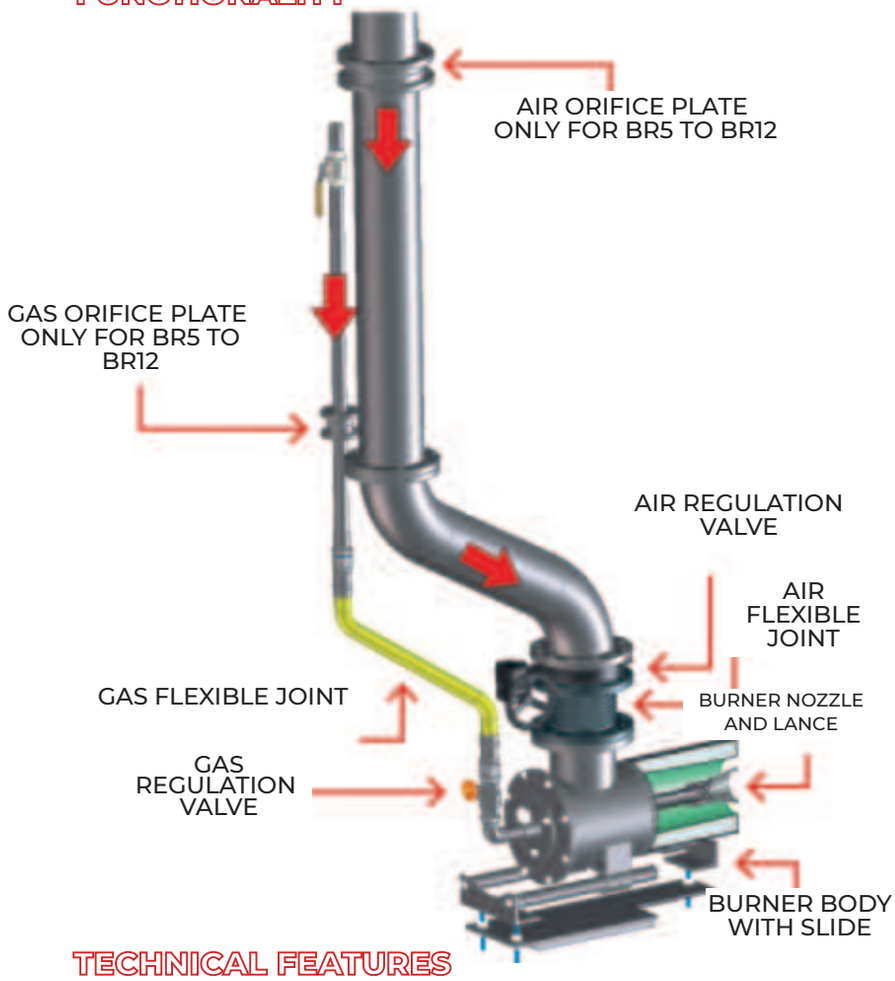
As part of our continuous product development programme, Glass Service has developed a number of burners specifically for the glass industry because this is an important part of the melting technology in terms of control and efficiency.
All of the burners have low momentum flame path without any peak temperature. This special design solution for glass melting furnace avoids the peak temperature on the furnace crown and relative rat holes.
The flame radiation is concentrated in the visible spectrum range improving the energy transmitted by radiation to the melting glass and to the furnace efficiency.

Burners have the following characteristics:

- Low momentum
- High flame radiation in the visible spectrum (500-2000 nanometres)
- Continuous external regulation of flame length for a correct flame path adjustment with dual impulse model
- Available for natural gas or LPG
- Several sizes



FUNCTIONALITY



For each burner Glass Service has developed all of the necessary accessories and can supply to the customer a complete burner solution including:

- Air and gas valves
- Air and gas flexible joints /connections
- Air and gas orifice plates for flow balance and/or flow measurement
- Thermally insulated pipework when required or preheated primary air

A range of burners sizes are available with outputs of from 145 to 1600 kW and with luminous flame pattern for the melting area (LF type) or clear (NF type) for the distributor.

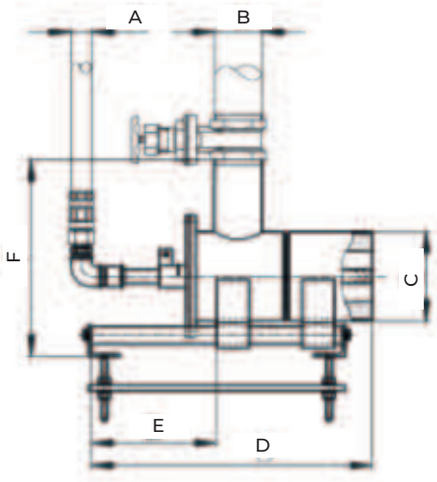
The Glass Service burners are available in different sizes, all of which can be operated in the distributor zone with a clear flame or with a luminous flame in the furnace melting zone.

A typical burner arrangement is represented on the left.

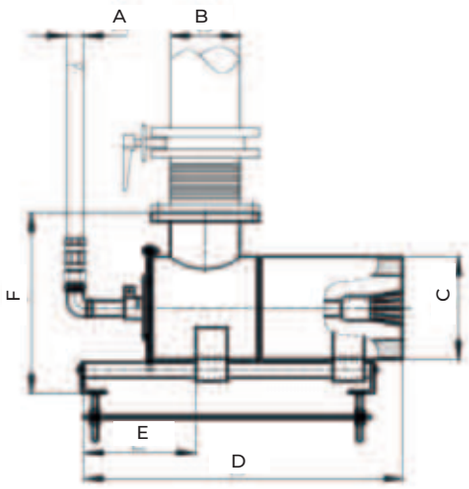
TECHNICAL FEATURES

SIZE	INCH	3	4	5	6	8	12
NOMINAL POWER	KW	145	220	290	365	730	1600
MAX AIR TEMPERATURE	°C	400		600			
AIR PRESSURE	MBAR	30			35		
GAS PRESSURE	MBAR	25			30		
FLAM LENGTH	M	0,3 TO 0,7	0,5 TO 1	0,7 TO 2	1 TO 2,5	1,2 TO 3	1,5 TO 4,5
GAS INLET PIPING -A-	INCH	1"			1" 1/4	1" 1/2	2"
GAS INLET PIPING -B-	INCH	3"	4"	5"	6"	8"	12"
DIMENSION -C-	MM	168	219	244	273	324	457
DIMENSION -D-	MM	540	550	570	920	370	365
DIMENSION -E-	MM	250	250	260	320	370	365
DIMENSION -F-	MM	384	435	455	480	570	700

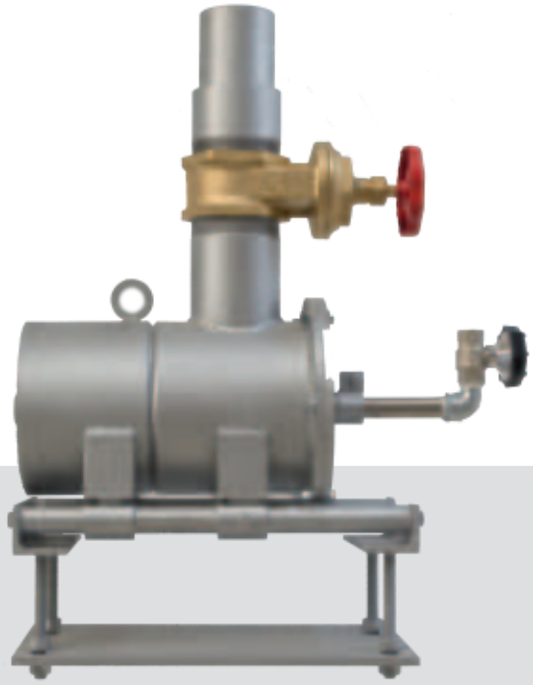
BR size 3" & 4" type

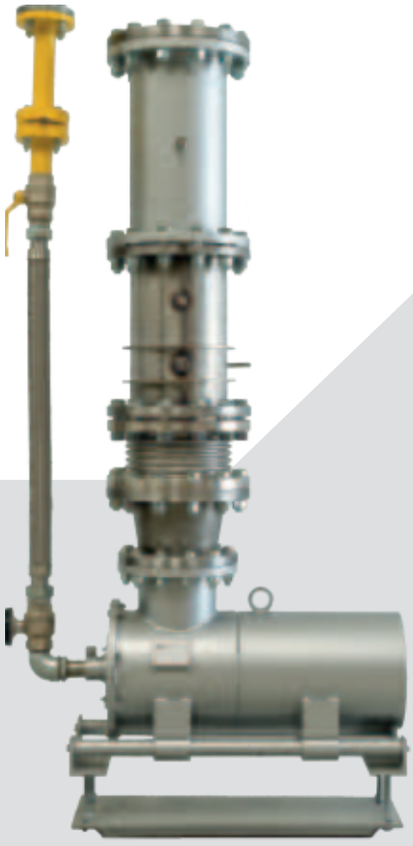


BR size 5" to 12" type



BR size 3" & 4" type





BR size 5" to 12" type

The flame length can be adjusted by changing the nozzle size.
The flame shape (luminous or clear) can be changed by changing the nozzle type.
The burners can be installed with the pipework from above, as illustrated, or from the bottom.
The burner block is an integral part of the burner design and can be supplied by Glass Service or by the customer to Glass Service drawing and specification.
The air and gas orifice plate can be used for the flow control and for the pipe pressure loss balancing.
A special version for temperature upto 800 °C is also available. The model name is BR – HT.

SLF Semi Luminos Flame

RH Radial Hoses

NF Clear Flame

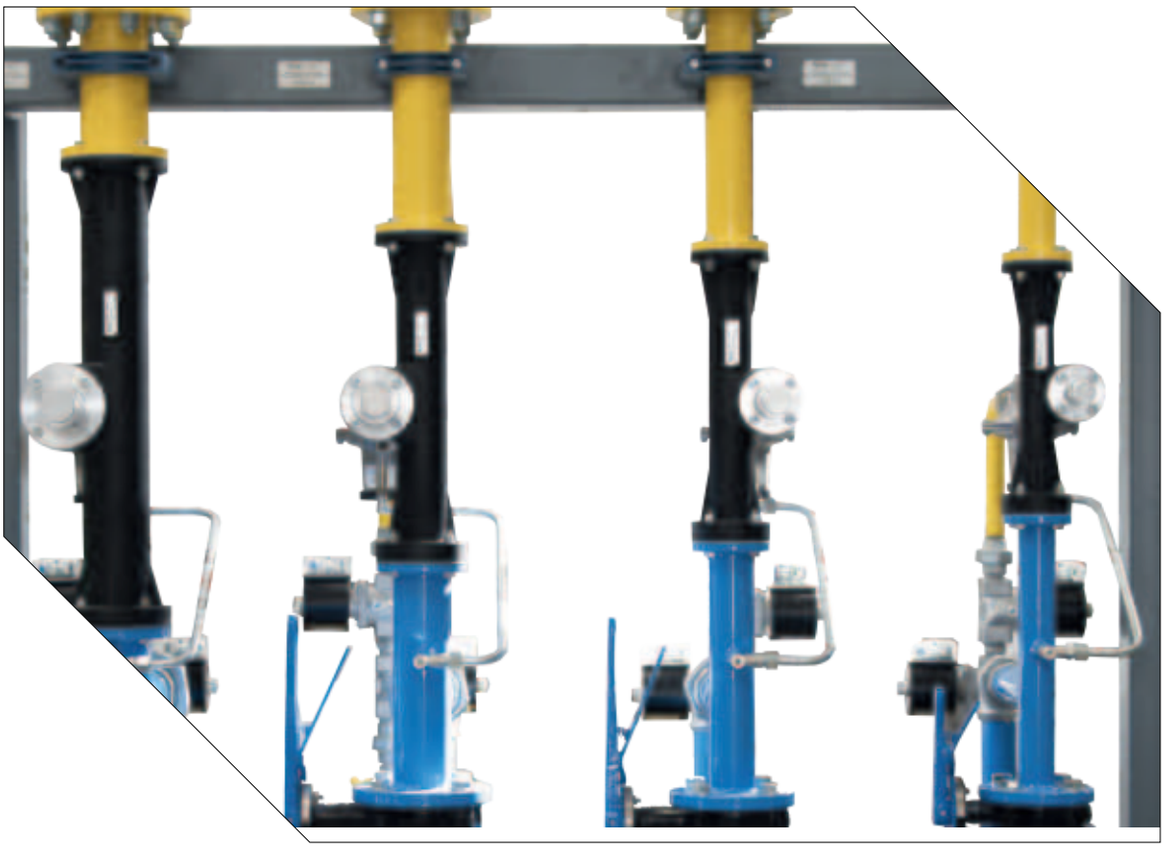
LF Luminos Flame

VENTURI MIXER

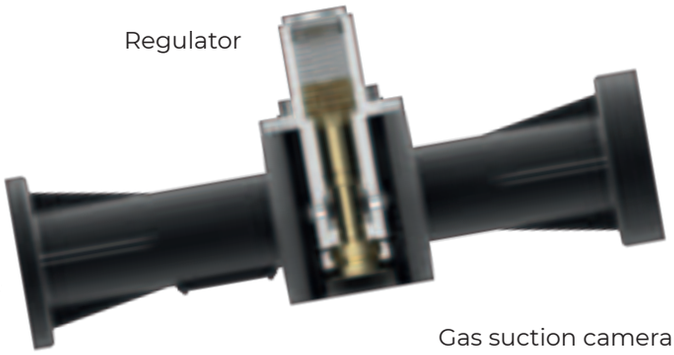
VENTURI MIXER

The main features of the mixer are:

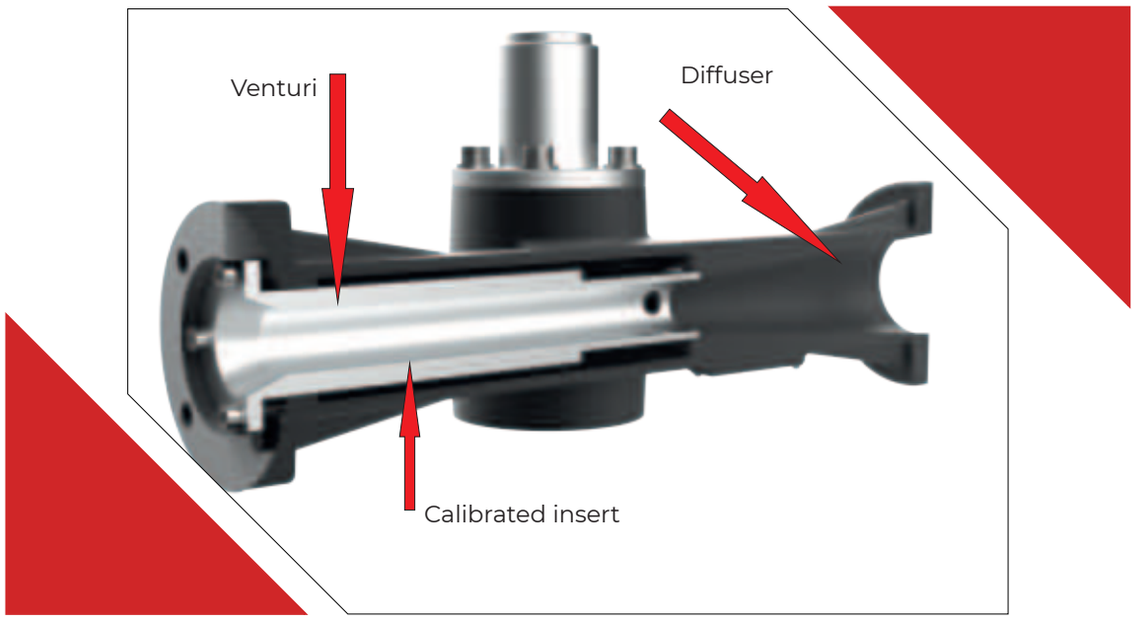
- Low pressure loss
- Multiple size combinations
- Flange connection to facilitate inspection cleaning and regulation of capacity
- Compact and reversible design
- Solid construction
- High reliability due to the cast iron construction
- Orientation-free installation
- Built in gas adjustment valve
- Easy disassembly for fast maintenance and scalability
- Constant combustion ratio

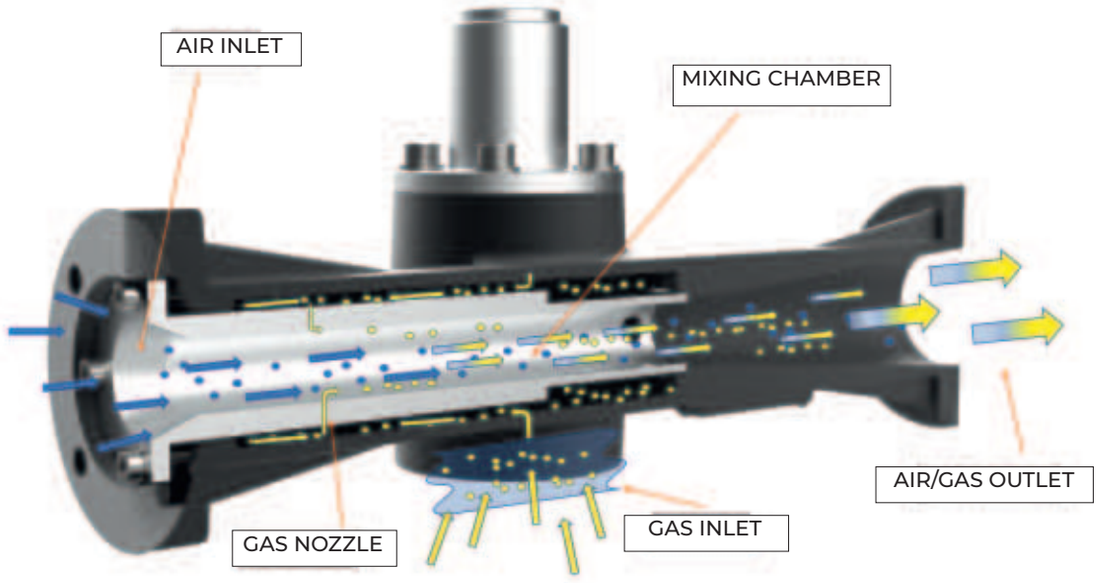


The mixer body and the mixing chamber are machined from a cast piece, the insert is made of Aluminum Anticorodal.
The calibrated nozzle, made in brass and it is customizable.



Gas suction camera





The energy of air passing through the venturi throat generates a depression with a consequential suction effect that forces gas to exit from the gas nozzle. The air/gas mixture then recovers pressure in the mixing chamber at the expense of velocity of the flow. The correct amount of gas is controlled by the pin regulation valve.

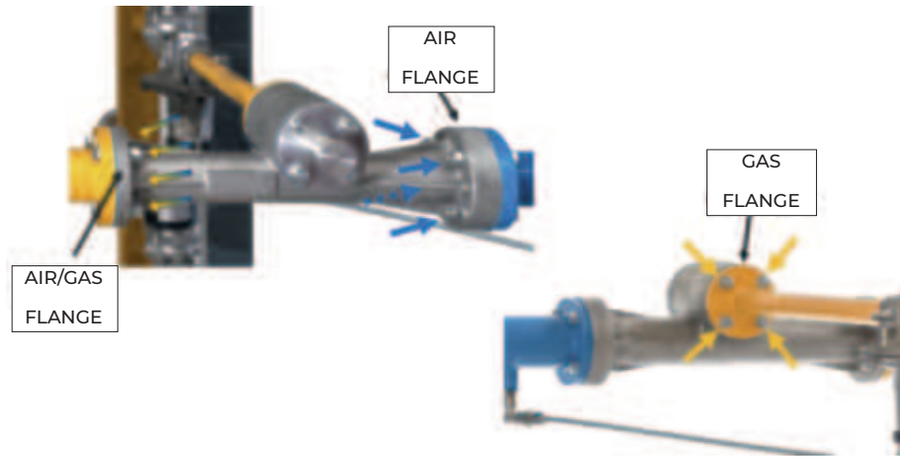
DESIGN CRITERIA

Usually the air inlet pressure should be 3.5 times the mixer pressure. This ratio ensures enough airflow energy to pull the correct amount of gas into the mixer.

Another way to ensure that the system functions correctly is to consider a pressure drop in the venturi mixer of at least 66% of the entire system.

After testing, we have verified that with a ratio between (air inlet pressure)/(mixer pressure) of 3.5:1, the pressure drop in the venturi is 71%, which aligns to the second criteria.

A definitive relationship of about 2.5:1 should also be maintained between mixer air orifice area and burner exit port area.

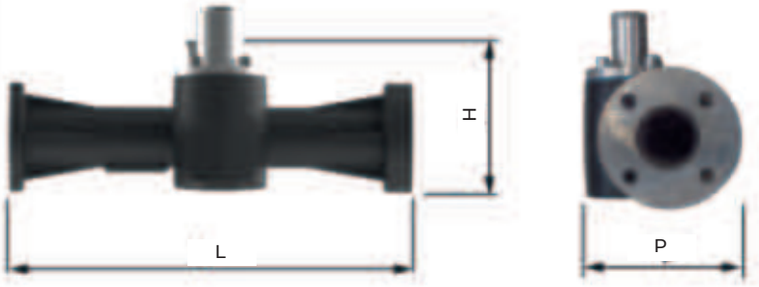


INSTALLATION

Installing the Glass Service venturi mixer is easy and fast: 4 screw for each flange and the mixer is ready to work!

GENERAL DIMENSIONS (mm) AND SIZES AVAILABLE

SIZE	H	L	P
DN40	142	325	124,5
DN50	142	375	143,3
DN65	154,5	425	163,5
DN80	193,5	605	185

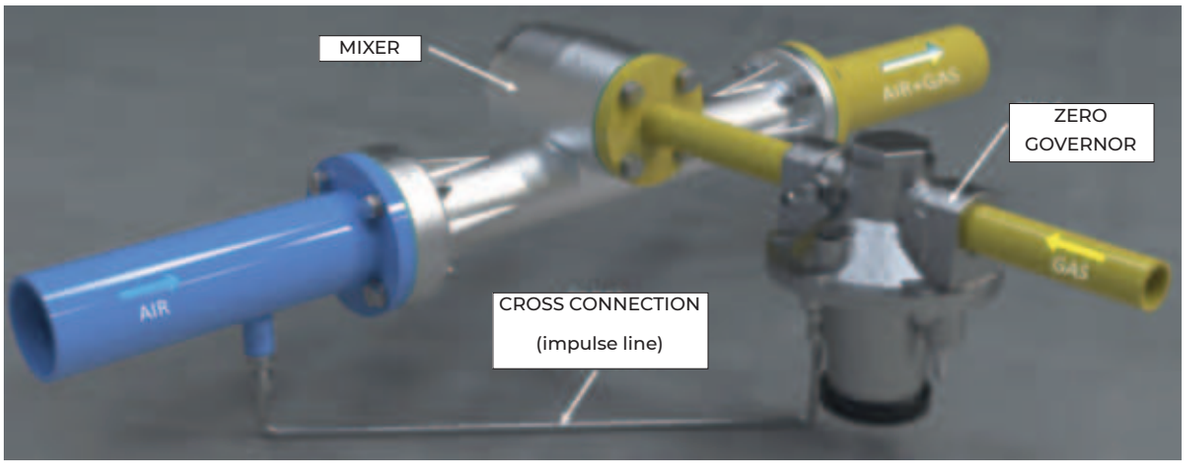


These vaslues considered with a calorific power of 52 Mj/Kg

SIZE	POWER [kw]	MODEL	CODE	INNER INSERT Ø [mm]	SPUD DRILL Ø [mm]
DN40	142	325	124,5	20	8
DN50	142	375	143,3	26	12
DN65	154,5	425	163,5	34	18
DN80	193,5	605	185	40	22

ZERO GOVERNOR ratio regulator

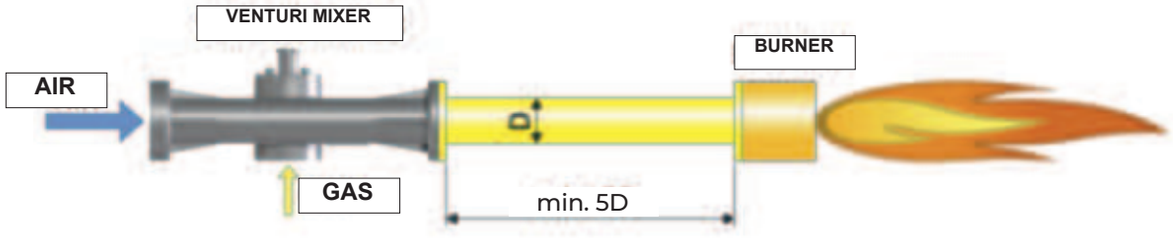
The Glass Service venturi mixer works in combination with the zero governor ratio regulator in order to control the fuel/air ratio in premixed combustion systems. The zero governor works by maintaining atmospheric pressure, known as zero pressure, at the regulator outlet. Increased air flow through the venturi mixer increases suction on the gas line. In order to maintain its zero outlet pressure, the regulator automatically opens its gas valve to increase the amount of gas flowing into the mixer. When the air flow is reduced, suction decreases and the regulator valve closes in order to maintain zero pressure..



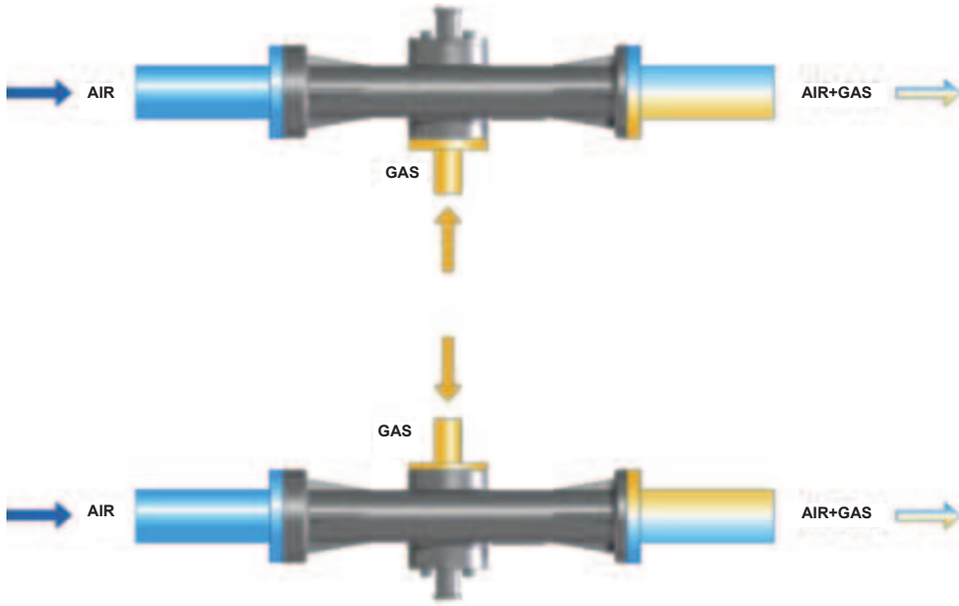
INSTALLATION TIPS

To avoid combustion instability, it is strongly recommended to:

- Not install elbows at the exit of the mixer
- Leave minimum distance of 5 times the tube diameter between the venturi mixer and the burner



As show in the image below the venturi mixer can be installed in symmetrical configuration and, according to the gas arrival line, has interchangeable gas entrance.



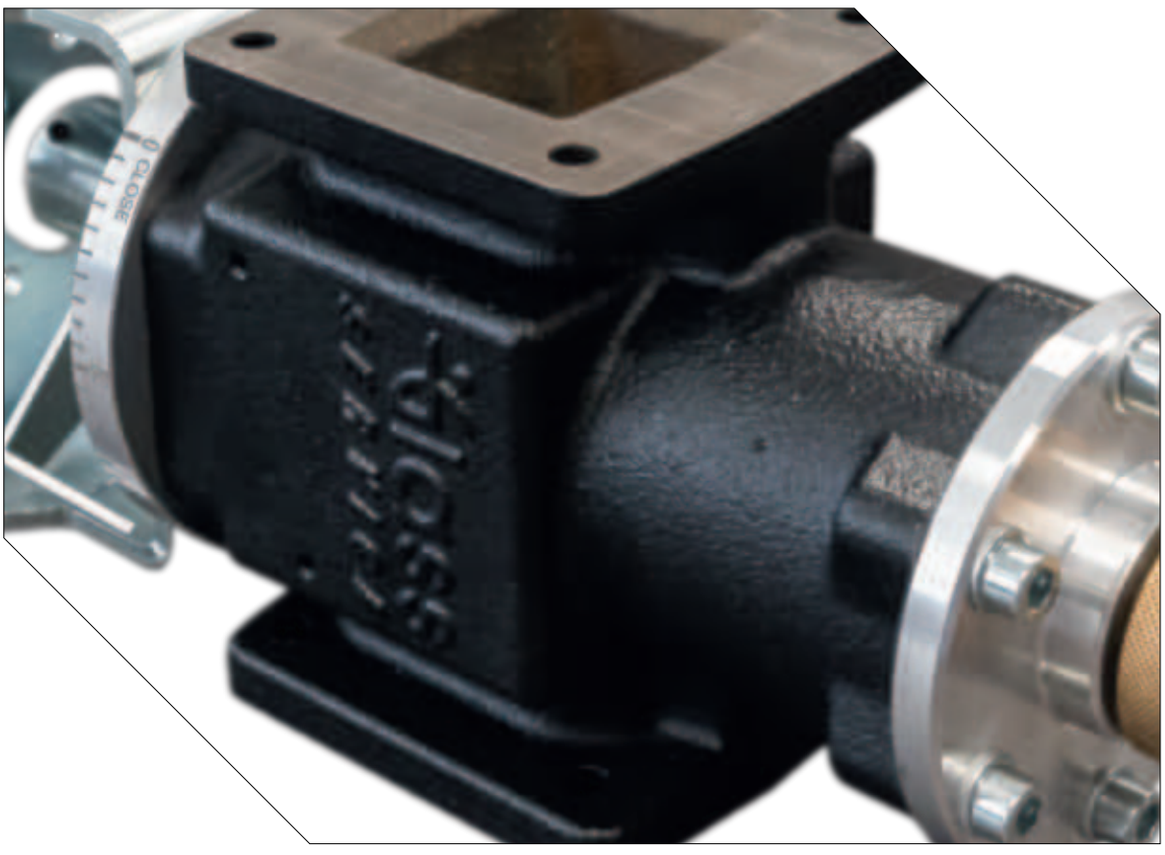
MAINTENANCE:

Designed for easy use, the system meets the needs of those who use it, so the maintenance or the calibration phase is very fast. Remove a few screws and all the relevant parts are available.

ADJUSTABLE PORT AIR VALVE MOD. VV

ADJUSTABLE PORT AIR VALVE MOD. VV

Glass Service designs and manufactures an adjustable port air valve for control purposes.
They are a reliable and accurate means of controlling the air flow at variable pressure for any type of burner or system. The adjustable port feature permits sizing the valve to fit any application after it has been installed. Linkages can be adjusted for full or limited valve travel.
Flow control may be either manual or automatic.
These valves are designed to be used as efficient control systems, installed in any position, but not as shutoff valves.
Internal parts of the valve can be cleaned or replaced without removing the valve from the pipeline.

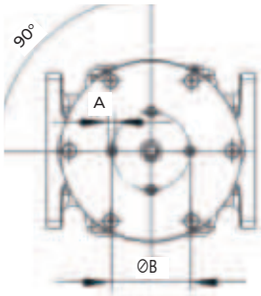


MATERIALS

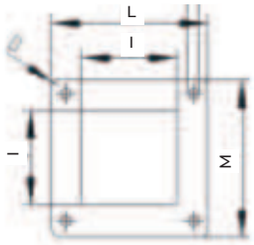
The valve is composed of a cast iron shell with internal components in anticorodal aluminum and self-lubricating bronze bushing.
The design is completed with NBR gaskets.

GENERAL 3D VIEW

VALVE MAIN DIMENSIONS

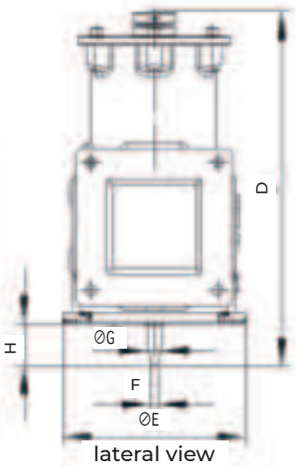


bottom view

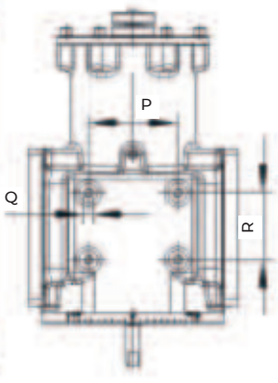


flange view

frontal view

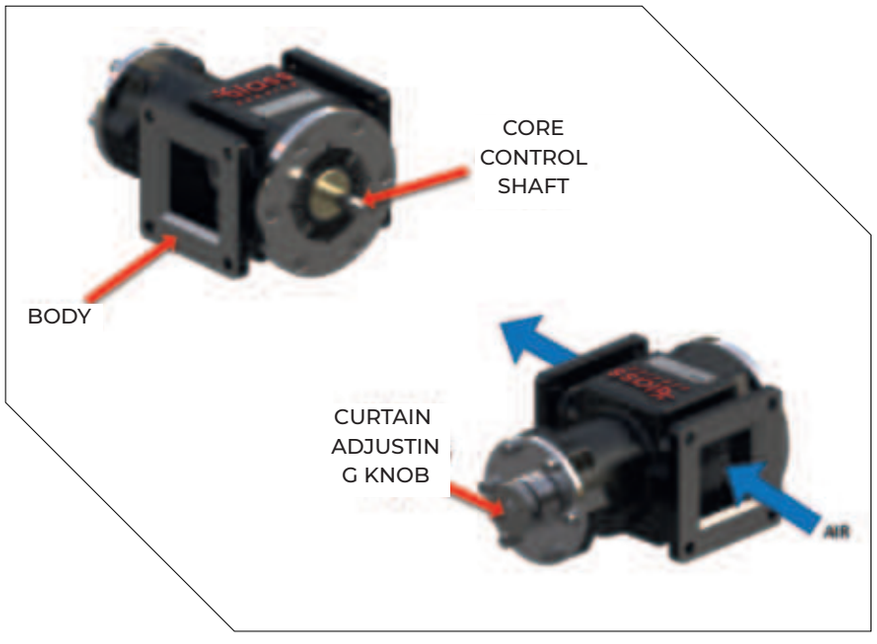


lateral view



black view

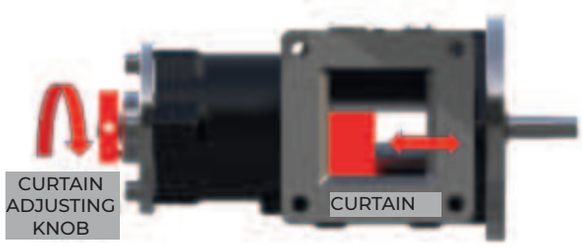
TYPE	A	B	C	D	E	F	G	H	I	L	M	N	O	P	Q	R
BODY B	M6	42	114,4	224	100	8	12	38	49	84	84	7	R6	42	M6	42
BODY C	M6	70	137	254	120	8	12	38,5	62	102	102	9	R6	50	M6	50
BODY D	M6	70	187,5	319	164	8	12	38,5	62	140	140	10,5	R6	50	M6	60

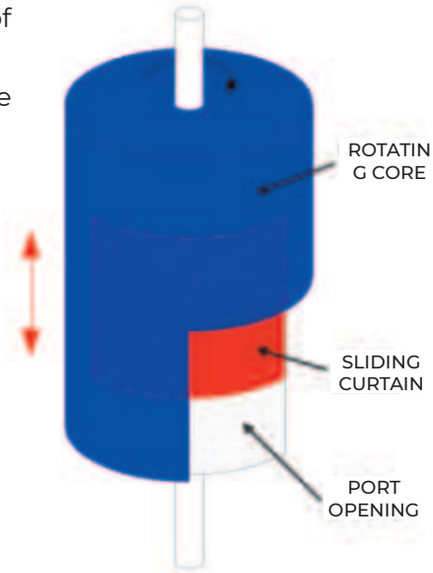


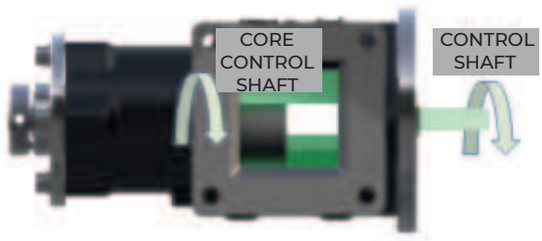
OPERATING PRINCIPLE

Manual or automatic control is accomplished by moving the curtain adjusting knob and the core control shaft as shown in the diagram below.

The capacity of the air flow is determined by the height and width of the valve port opening in relation to the valve outlet.
The height of the port is controlled by the curtain adjusting knob. The width of the port is controlled by the core control shaft.







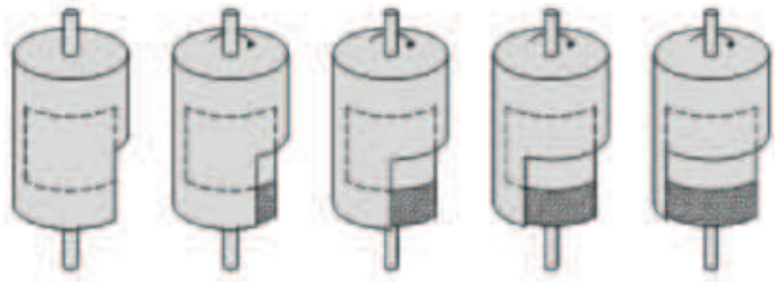
Rotating the curtain adjusting knob, the curtain moves back and forth, opening or closing the port.
Rotating the control shaft, the core rotates accordingly opening or closing the port.

THE MAIN FEATURES

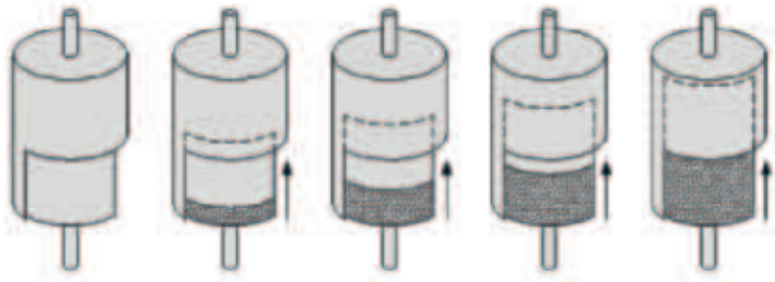
The main features of the adjustable port air valve are:

- Improved flow characteristics over butterfly valve design
- Adjustable port for limiting the maximum flow rate
- Control of the air flow at variable pressure for any type of burner or system
- High reliability due to the cast iron construction
- Orientation-free installation
- Three body sizes for a wide working range
- Easy disassembly for fast maintenance without removal from the pipeline
- Adapts for direct connection or linked connection with actuators

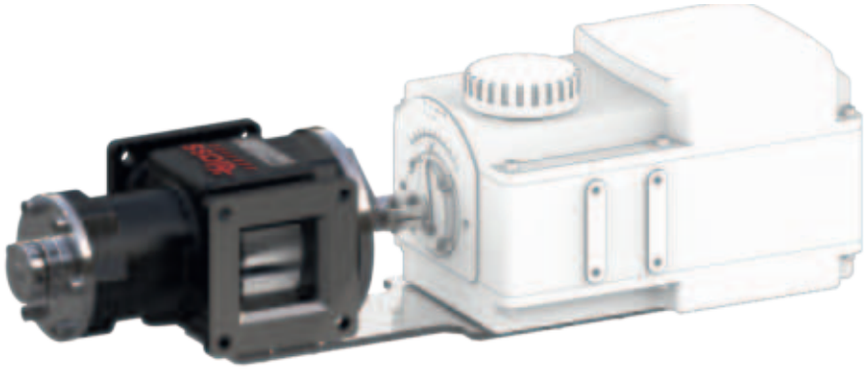
PORT WIDTH ROTATING CORE POSITION (curtain at 50%)

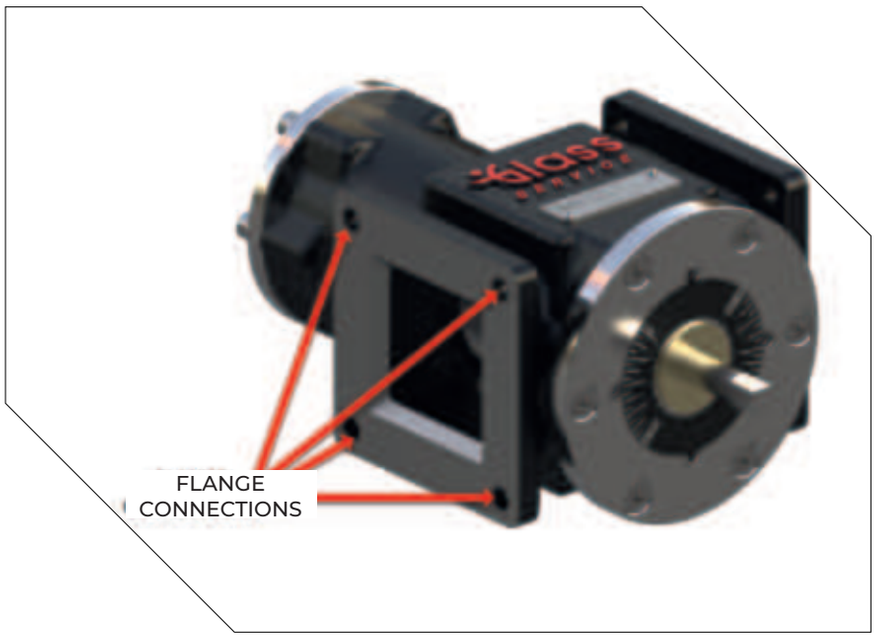


PORT HEIGHT SLIDING CURTAIN POSITION (curtain at 100%)



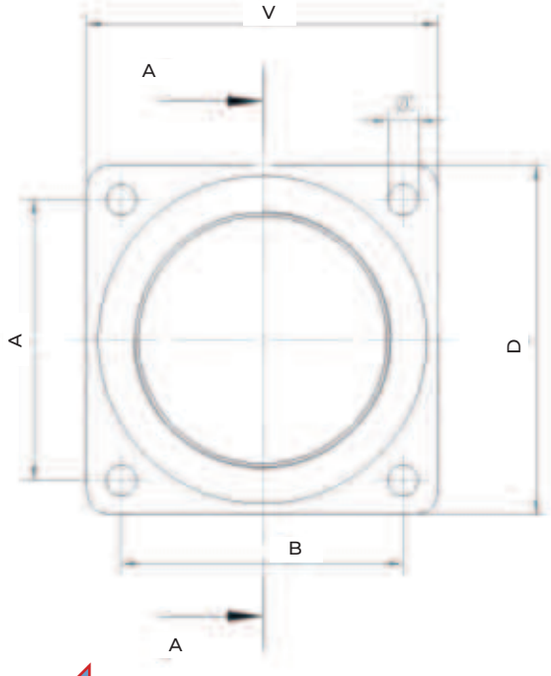
Glass Service adjustable port valve is equipped with tapped mounting pads to facilitate the installation of multiple control motors available in the market.

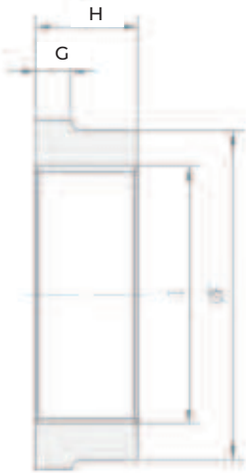




Levering kit is also supplied for connection with servomotors.
Installing the Glass Service adjustable port valve is very easy and fast: just n°4 screws for each flange and the valve is ready to work.

Threading kit is also available to convert the flange connection to standard threaded connection.





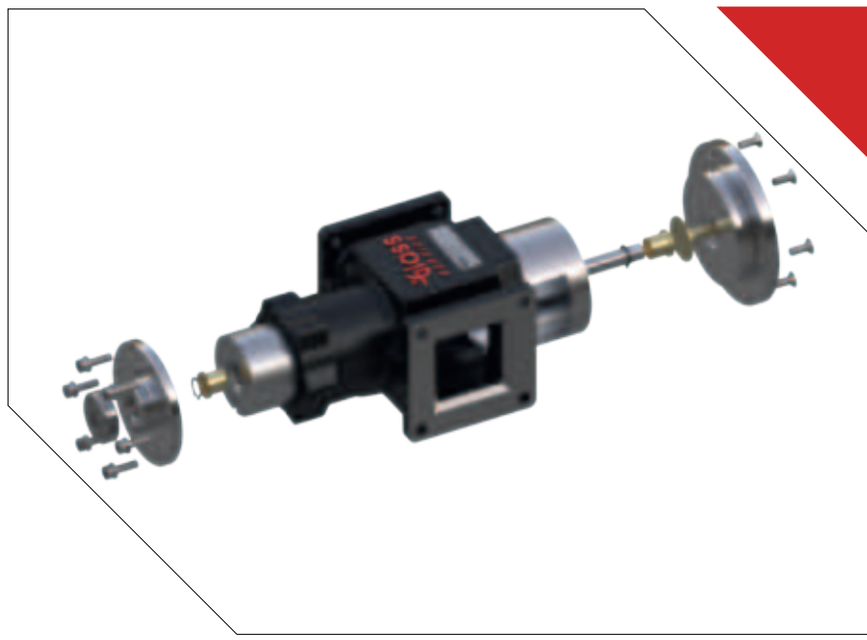
AA

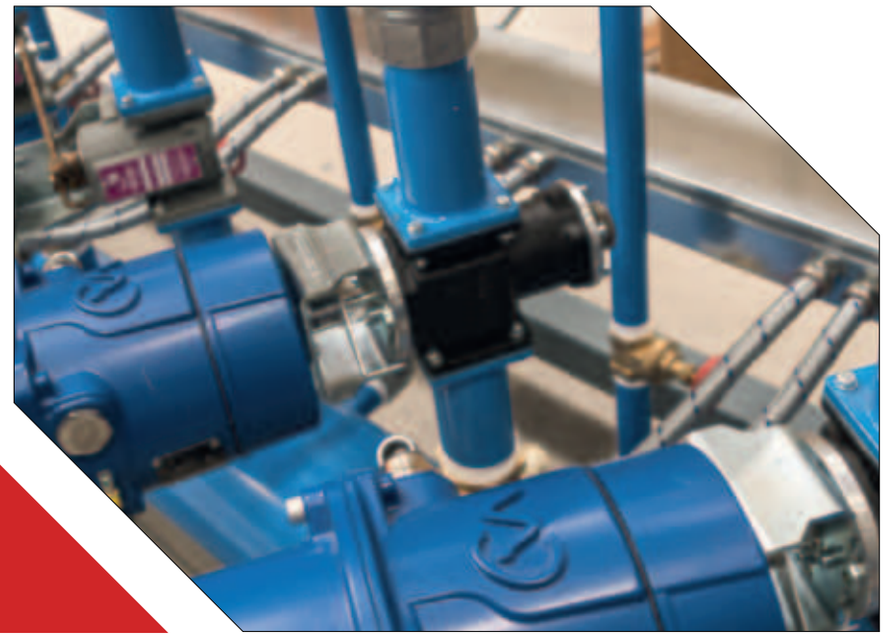
CONNECTION KIT DIMENSIONS

VALVE SIZE	A	B	C	D	E	F	G	H	I
B-DN40	64	64	7	84	84	76	10	27	G1"2/2
B-DN50	64	64	7	84	84	76	10	27	G21"
C-DN50	82	82	9	102	102	96	10	29,5	G2"
C-DN65	82	82	9	102	102	96	10	29,5	G2"1/2
C-DN80	82	82	9	102	102	96	10	40,5	G3"
D-DN80	114,5	114,5	10,5	142	140	136	10	39	G3"
D-DN100	114,5	114,5	10,5	142	140	136	10	39	G3"

MAINTENANCE

Internal parts of the valve can be cleaned or replaced without removing the valve from the pipeline.

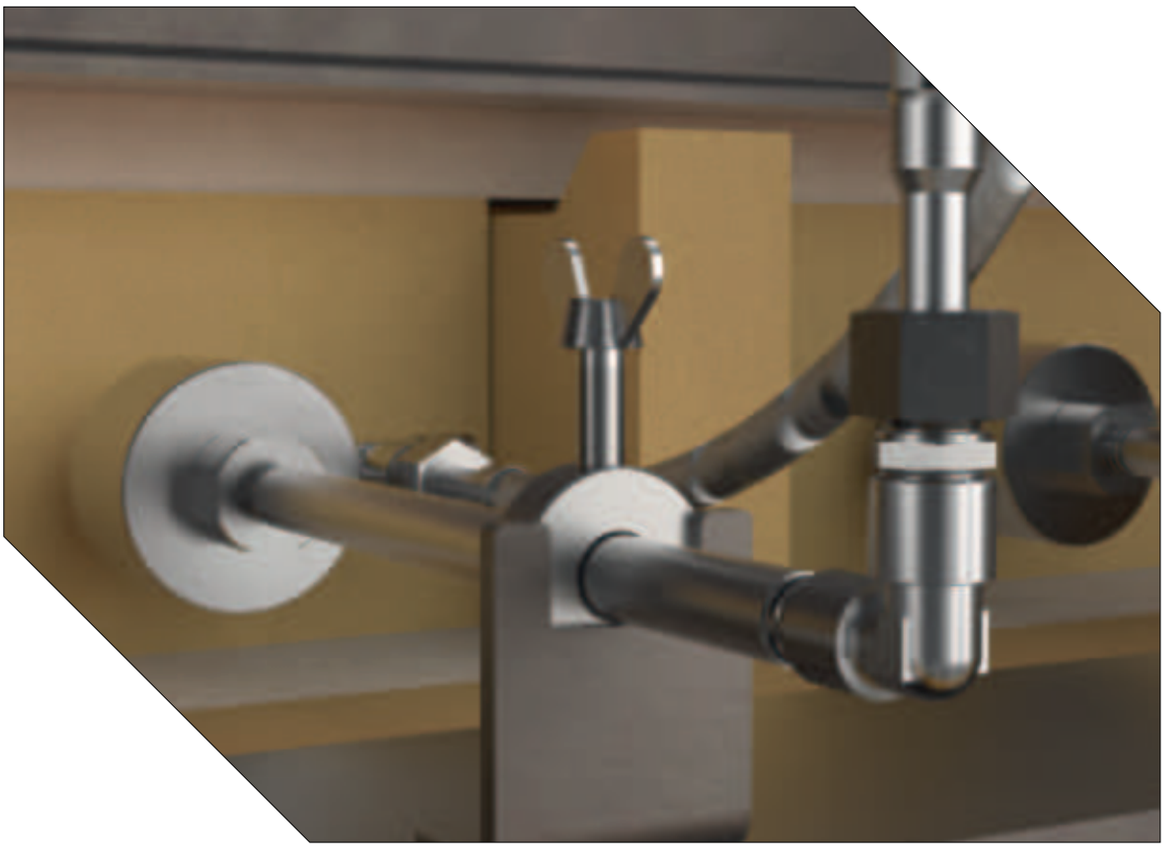




DISTRIBUTOR & FOREHEARTH OXY-GAS TECHNOLOGY

The oxy-gas technology in Distributor and Forehearth reduces the natural gas energy consumption of 60% compared with air-gas technology, as well greenhouse CO2 gas emission.

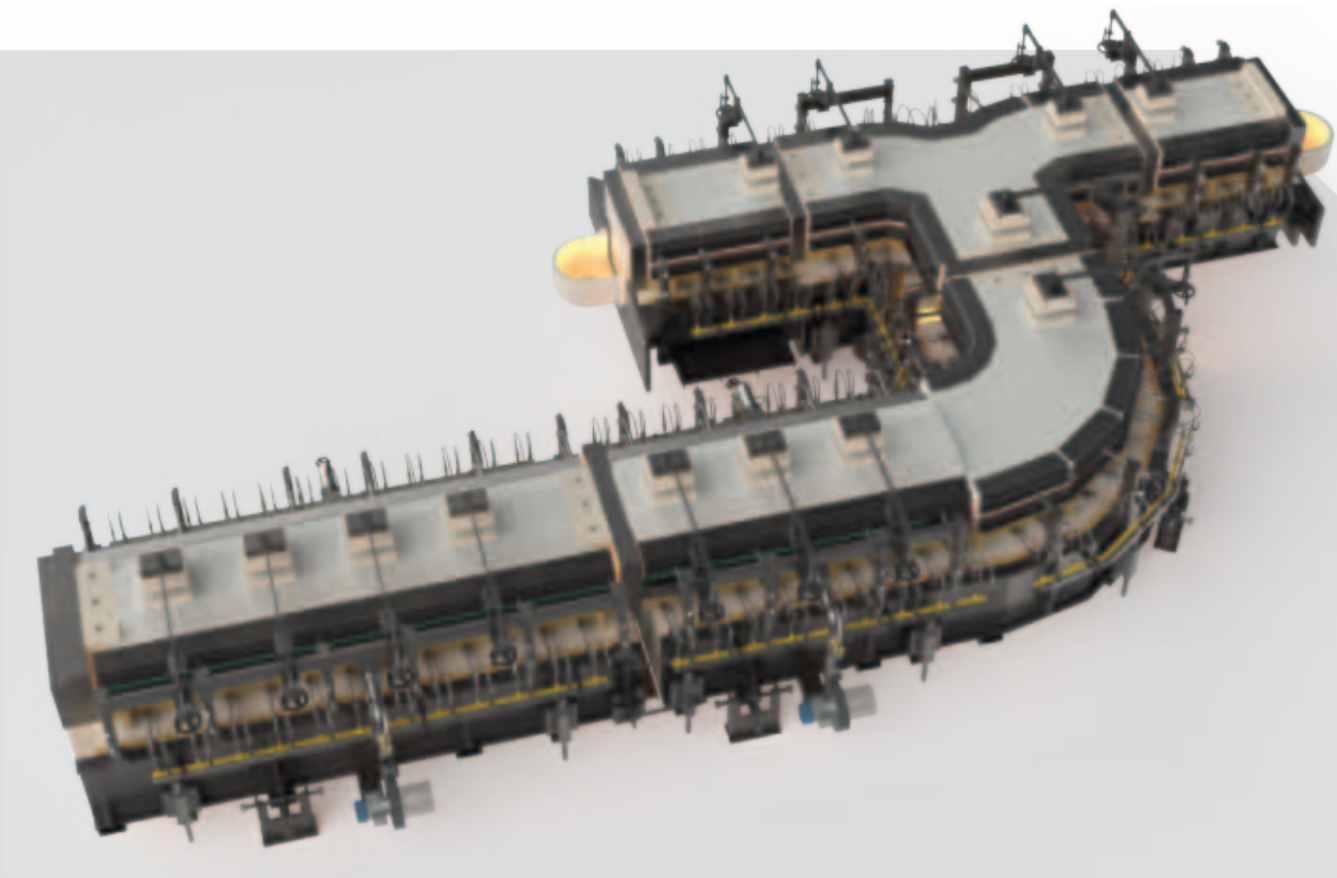
The technology reduces the NOx emission of 80%.



The technology uses separate oxy-gas fluid burners with nozzle mix and eliminates the risk of backfire. The burners, with a special design, are distributed along the distributor and forehearth length and have low power each for a good thermal homogeneity.

Oxy-gas technology approaches the combustion in distributor and forehearth by long experience in combustion technology and solves all the issue. The table resumes the main topics.

PROBLEM	SOLUTION
High thermal glass homogeneity	Large quantity of burners installed low power burners
Carbon deposit on nozzle	Special nozzle design with external nozzle oxy flow cleaning
Bakfire	Separate gas and oxy circuit, oxy-gas mix on nozzle output, use of purge air or Nitrogen flow for burners shut off
Burner nozzle cooling in shut off oxy-gas	Use of purge air or Nitrogen flow
Oxy and gas flow equitable on each single burner	Special burner body design with constant fluid pressure drop
Easy maintenance snf correct burners position in the burner block	Special high precision Burners/refractories connection
Correct ratio oxy/gas	Thermal mass flow control + independent flow control valve for each combution zone
100% reduction of CO2 greenhouse emission	Burners and technology suitable for Hydrogen-Oxygen combustion or Hydrogen + Natural gas blend



Advantages of Oxy-gas technology and Saving energy

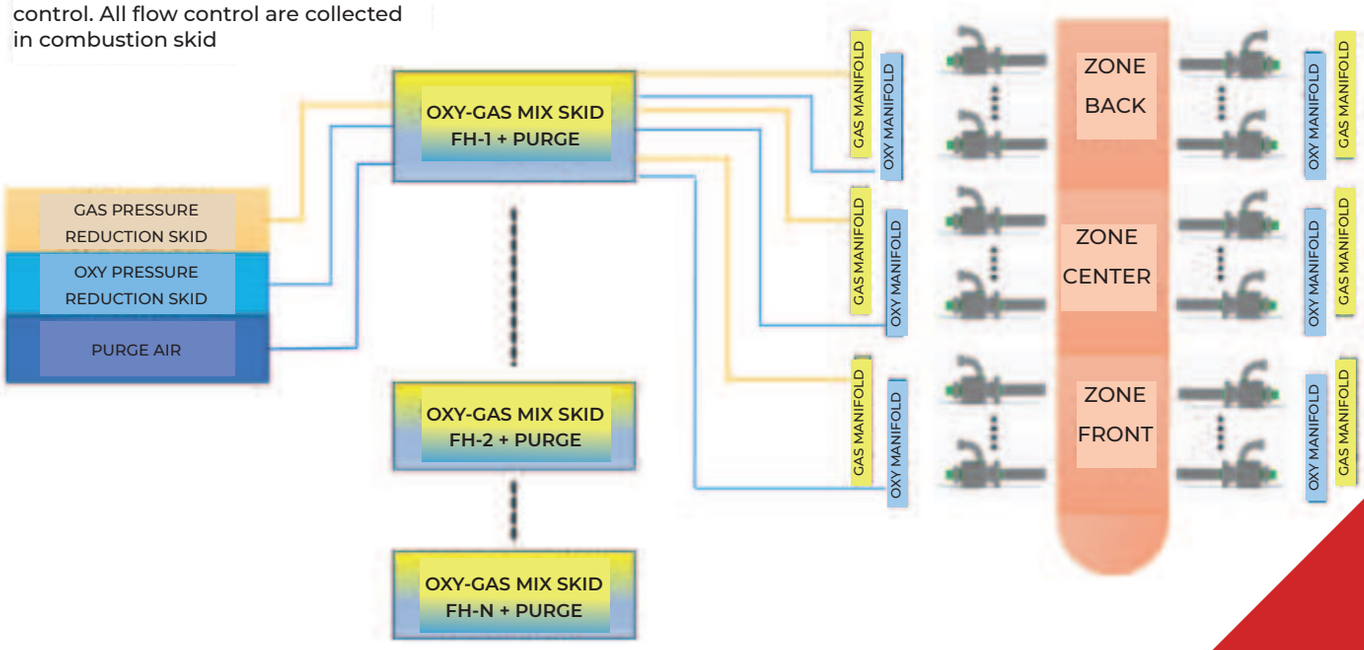
The Oxy-gas technology in Distributor and Forehearth reduces energy consumption till 60% and NOx emission till 80% compare with Air-Gas technology.

NOTE

Comparison data hypothesis: traditional heating premix air/gas zone , 40 burners , 20 each side. Nozzle diameter 6.5 mm, manifold pressure max 20 mbar, natural gas flow for each burner 0.5 Nmc/h. Zone length approx. 2300 mm (skimmer block not included).

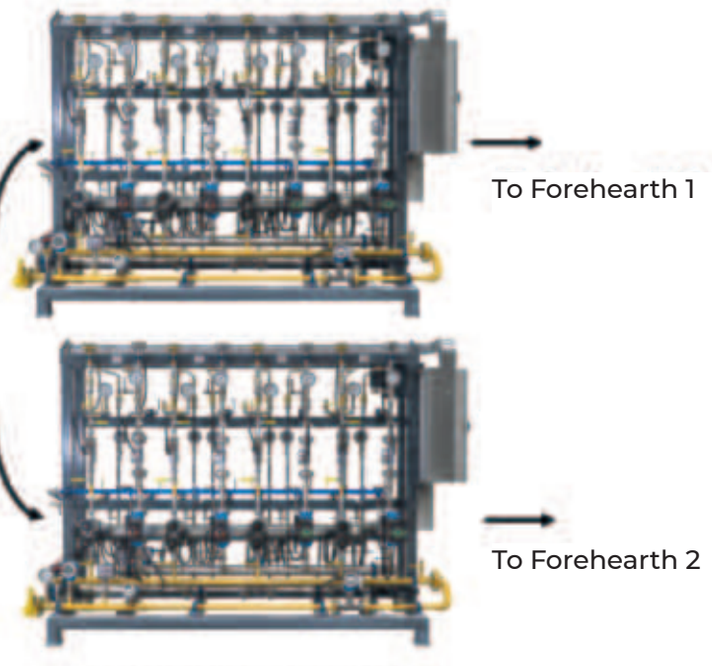
COMBUSTION SKID SKETCH

Each DH&FH have separate flow control. All flow control are collected in combustion skid



The combustion system includes single zone flow control, with single Oxy+Gas flow control

Pressure reduction and safety skid for OXY & GAS



Single zone flow control skids

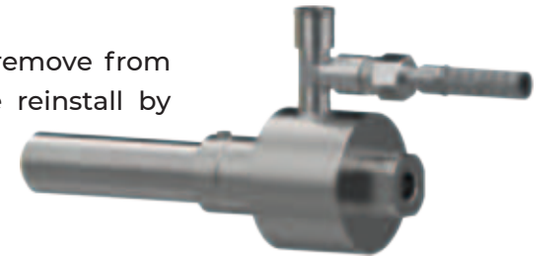
COMBUSTION SKIDS SKETCH

BURNER

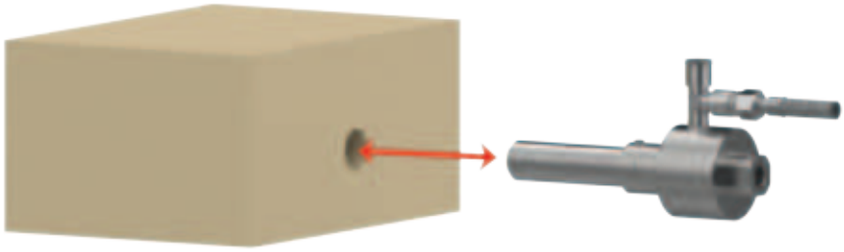
Glass Service Oxy-gas burners are specially designed for distributor and forehearth. The main features are:

- Low power each (power range 1.5-5 Kw)
- Low carbon deposit on nozzle
- Easy removal for maintenance and high precision installation bracket
- Low NOx emission

Burners could be easy remove from operational position are reinstall by the calibrate hole.



The correct alignment from the burner block and the burner nozzle is recommended for the correct functionality.



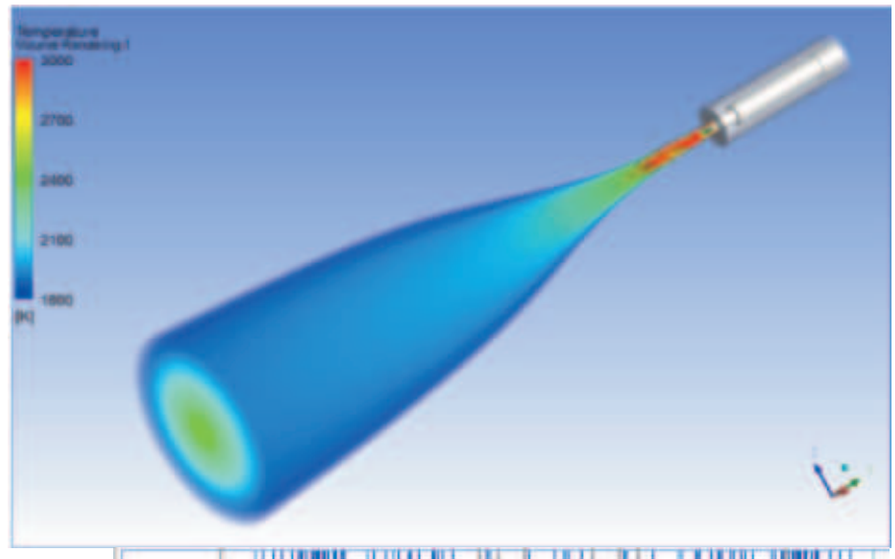
Burners Software Modelling Design

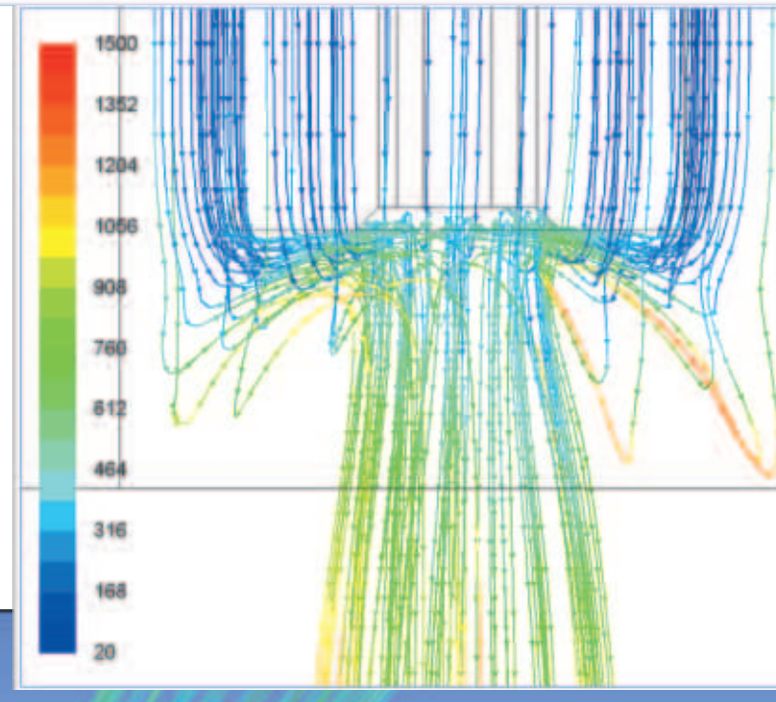
Burners are designed with large use of computational fluid dynamics (CFD) software.

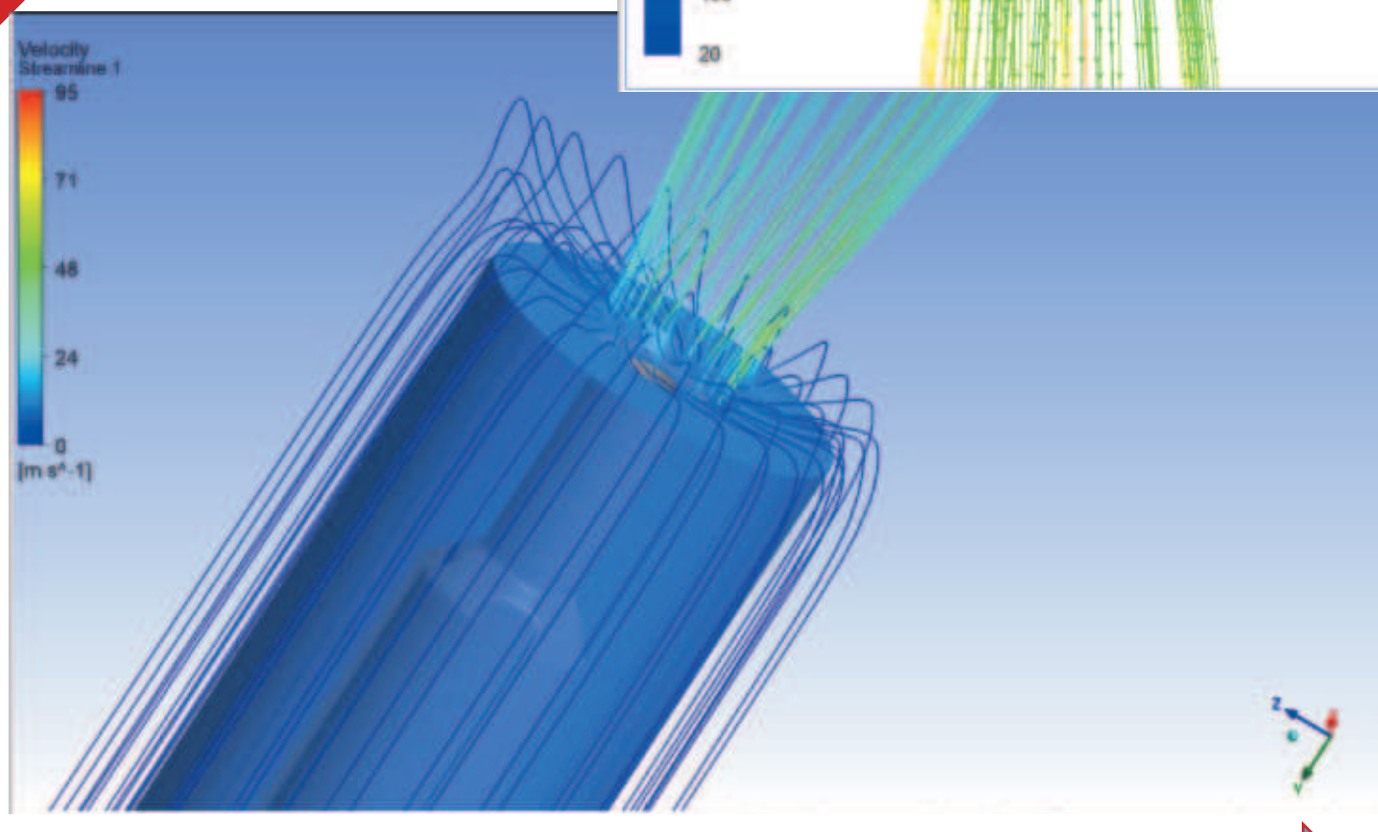
By the Math modelling the flame length and shape as well all the functionality parameter are simulated.

The special burner nozzle design includes the oxy cleaning technology.
Low valve oxy flow surrounds the burner nozzle and doesn't allow contact between the combustion residual and the nozzle steel.

This technology removes the carbon deposit on the nozzle.

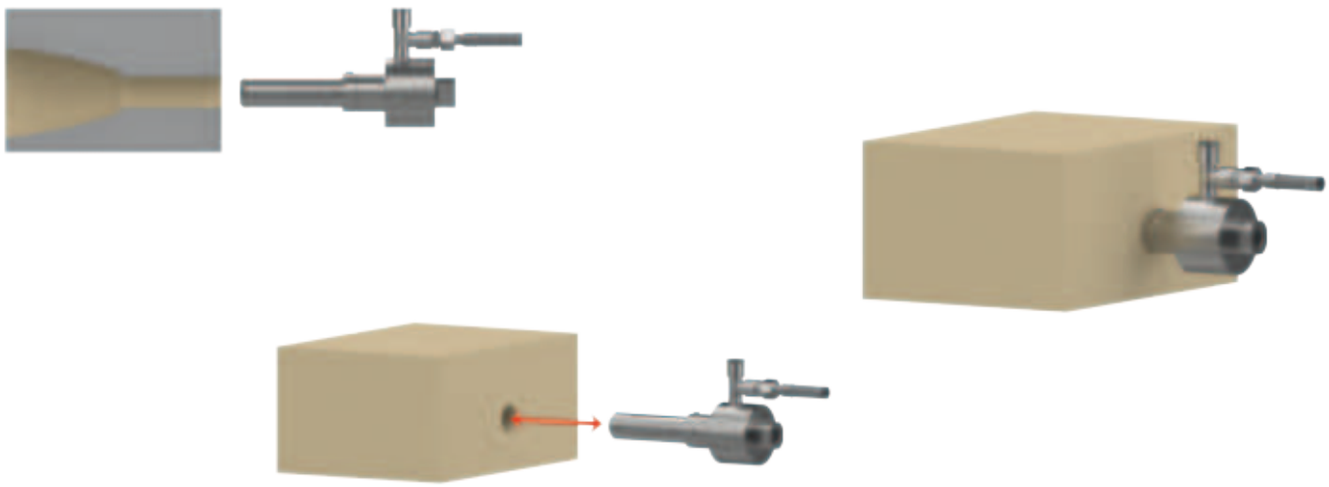






BURNER BLOCK DESIGN

Burner block is an important part of the technology. The burner block designed by Glass Service has a special shape matching correctly with the flame profile.



OXY-HYDROGEN COMBUSTION

The oxy-gas skids can be easily applied to reduce emissions by substituting natural gas with hydrogen. Glass Service has already tested the low-power hydrogen-oxygen burner successfully for distributor and forehearth applications.

The natural gas skid technology, applied with thermal mass flow transmitters and flow control valves, is also suitable for hydrogen use.

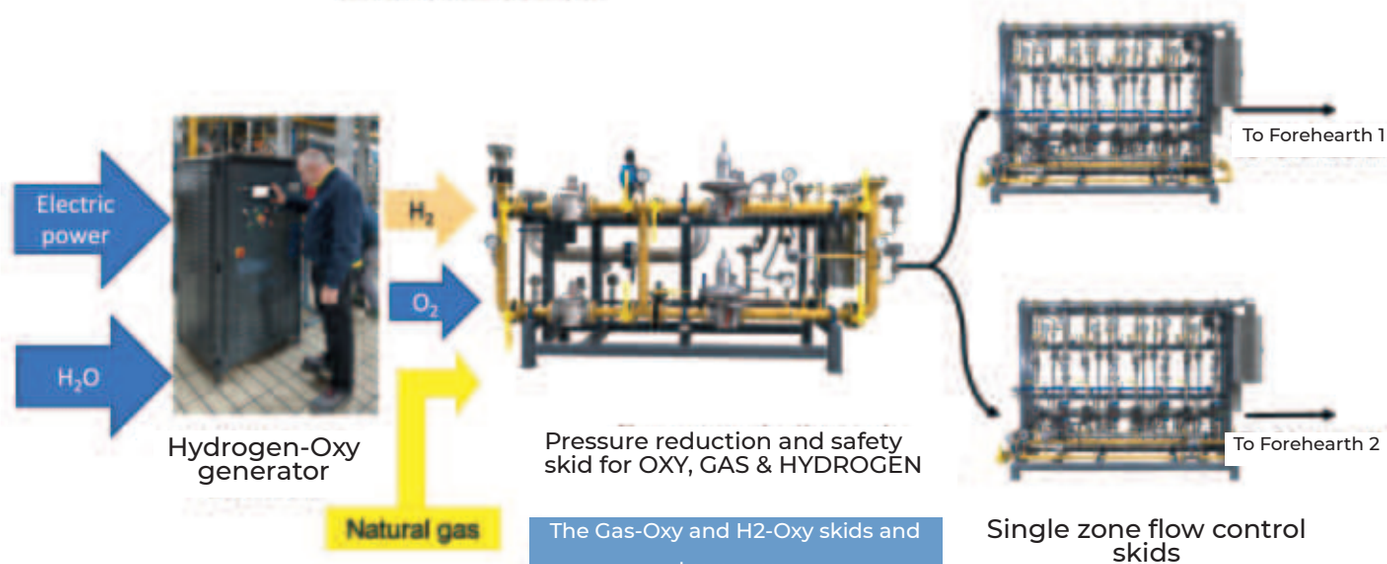
Glass Service has already designed hydrogen combustion technology skids and solved the leakage issues related to materials, fittings, and equipment, making them ready for hydrogen use.

Not just hydrogen can fuel the combustion skids, but in the Green Transition, a blend of natural gas and hydrogen can also be applied.

The oxy-gas combustion technology in distributor and forehearth applications will be the first step towards achieving green hydrogen-oxygen combustion with zero CO2 emissions.

O_2-H_2 + O_2-NG

The Oxy-Gas solution could also introduce the Hydrogen technology as pure Hydrogen or blend



Hydrogen-Oxy generator

Pressure reduction and safety skid for OXY, GAS & HYDROGEN

Single zone flow control skids

COMBUSTION SKIDS SKETCH

The Gas-Oxy and H2-Oxy skids and burner are quite similar, gas+H2 mix or gas/h2 interchange should be apply

FOREHEARTH AND REFRACTORIES

The refractory design for the use of oxy-gas combustion technology in distributor and forehearth applications requires special attention to both the material and the shape of the upper structure.
Glass Service's experience and design are supported by CFD mathematical modeling of the upper structure and burner blocks.
Detailed engineering and CFD mathematical modeling were applied to analyze the interaction between the flame and burner blocks, as well as the interaction between the flame and the refractories of the upper structure.

The design takes into account:

- The limited temperature requirements of the refractories.
- The circulation of waste produced by the burners.
- The thermal homogeneity of the glass.
- The elimination of hot spots on the glass surface.
- The cooling of the central glass stream for high pulling distributor and forehearth applications.

MELTING BOOSTER

MELTING BOOSTER

Electric boosting has been used for many years in the glass industry. Initially most boosters were installed simply to increase furnace output. Today electric boosting can be used to give a number of benefits including:

- Increased furnace output
- Improved and stable glass quality
- Improved efficiency of fossil fuel firing system
- Improved thermal gradients in the melter
- Reduced time for colour changes
- Increased furnace flexibility when changing furnace output (pull changes)

Each booster system is tailor made according to the furnace type and the customers requirements. Glass Service has developed their boosting system technology and can offer systems as follows:

- Melting end booster to increase output
- Thermal barrier booster to stabilize convection currents
- Refining booster
- Throat booster for use during heat up and during low pull conditions

Each booster system supplied by Glass Service can be supplied as a stand alone system or integrated into the furnace control system. Glass Service can supply all of the equipment required for the electric booster including:

- Power transformer(s)
- Control panel
- Electrodes and holders
- Electrode holder water cooling system
- Emergency air cooling
- Cables and connectors

MELTING BOOSTER

- Increasing furnaces output
- Reducing emissions
- Improve glass quality
- Increase furnace output flexibility
- Recommended for coloured glass (green, amber, etc.)
- Retrofit installation possible in operating furnace

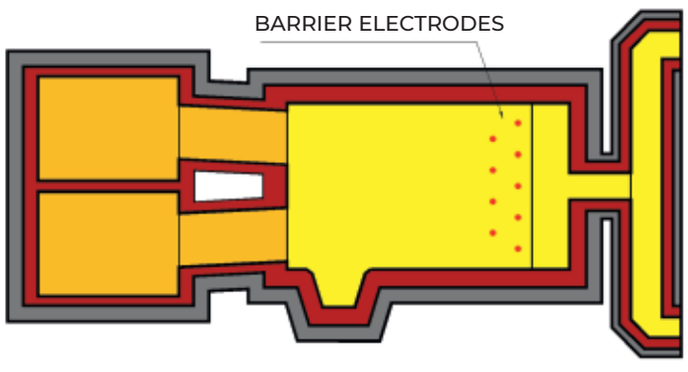
When installed to increase the furnace output, the booster can normally provide an additional 30% over and above the glass melted by the fossil fuel firing. Note that electric boosters are recommended in colour glass furnaces (green, amber, etc.) to maintain bottom temperature.

The melting booster electrodes can be installed in the furnace side walls or in the furnace bottom, however bottom electrodes are preferred to minimise corrosion of the side wall blocks.

Most boosters (depending upon furnace geometry) have an installed power in the range of 400 to 1200 kVA although much larger systems are not uncommon when the cost of electricity is attractive.

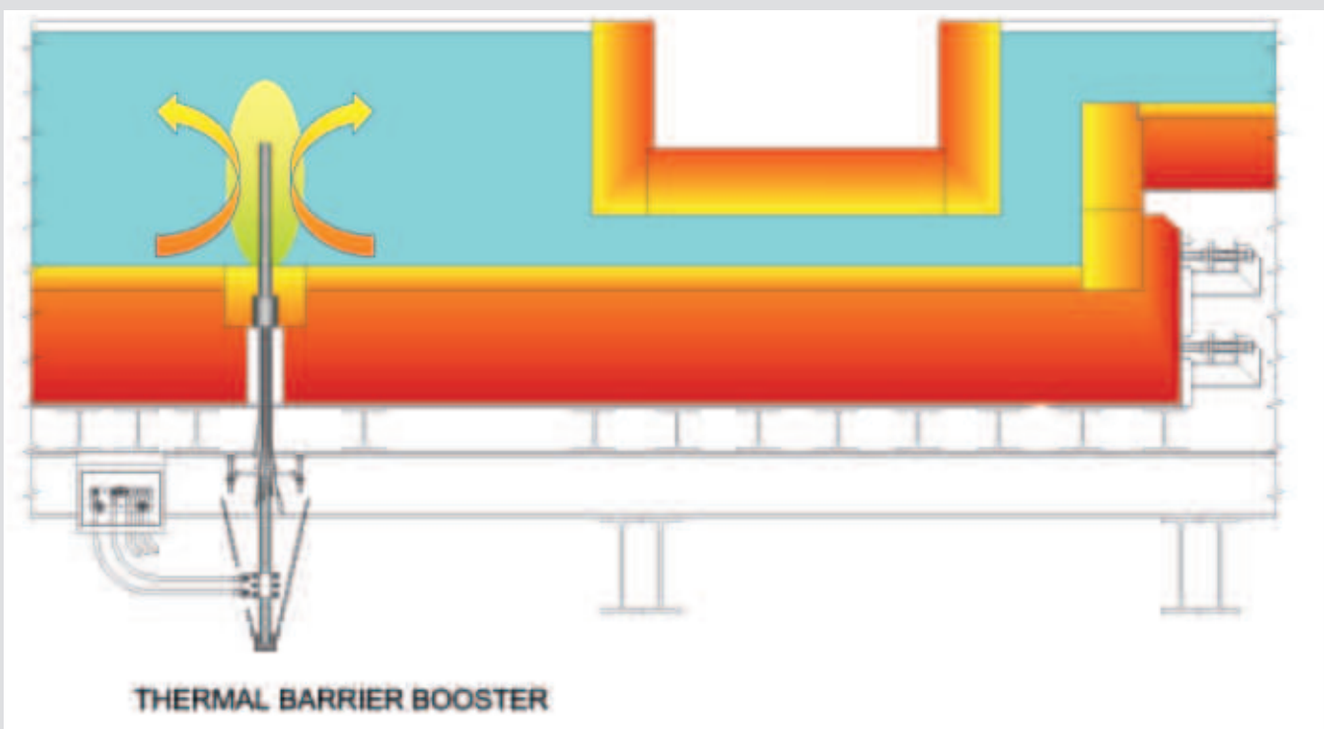
THERMAL BARRIER BOOSTER

- Increasing furnace output
- Reducing emissions
- Improve glass quality
- Increase furnace output flexibility
- Improve the convection current at the hot spot
- Retrofit installation possible in operating furnace



Although the barrier booster provides additional energy which can increase output, the main purpose of this type of booster is to reinforce and to fix the convection current in the furnace at the hot spot and to increase the temperature in the front zone of the furnace.

The improved convection current creates a barrier to the batch resulting in better batch cover and glass quality. It is recommended for soda lime glass and for deeper furnaces. The installed power can vary from 200 to 1000 kVA depending upon furnace size and geometry. The driver technology is usually thyristors & dry-transformer. In some cases, for higher power the tap position changer can also be used. The connection is usually three phase and the electrodes are positioned to give a balanced load on all three phases.
The electrodes are molybdenum rods with water cooled electrode holders. The barrier booster power is limited by the furnace bottom temperature, glass temperature and electrode temperature.



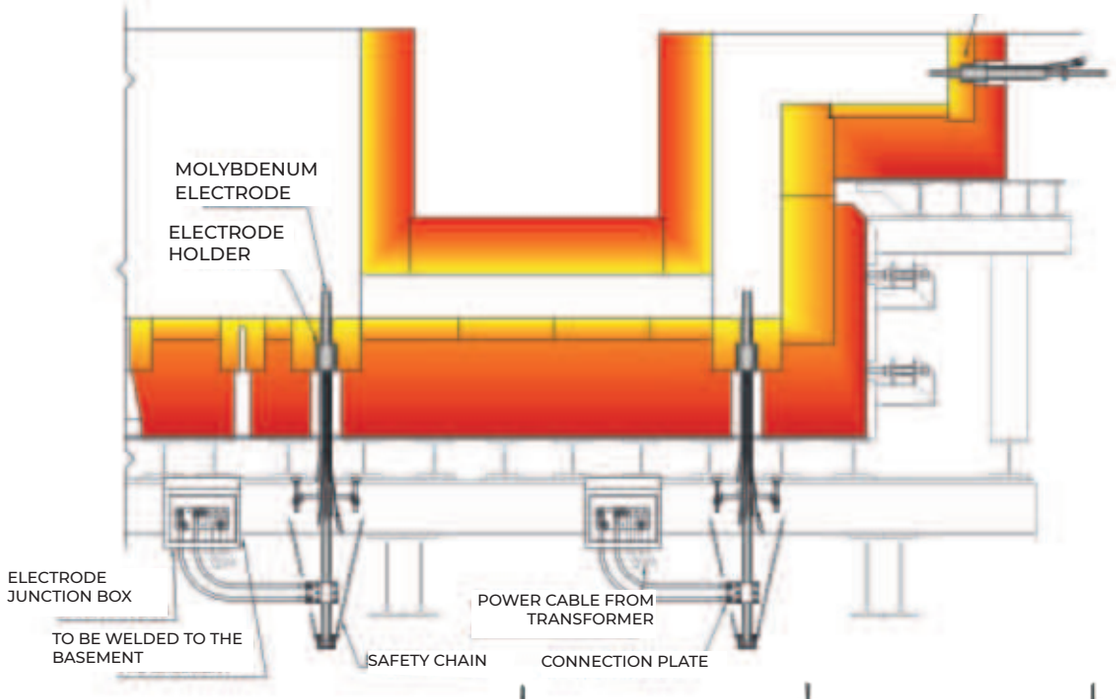
THERMAL BARRIER BOOSTER

THROAT BOOSTER

The throat booster is used for the heating up of the furnace's throat or temperature maintenance. It is recommended for deep refiner furnace, coloured and special glasses.
The power installed is usually in the range 30-70 kVA.

The driver technology is thyristor and dry-transformer low voltage drive single phase (e.g. 400 Vac).
The electrodes are made of molybdenum with water cooled electrode holders.

MOLYBDENUM EARTH ELECTRODE & HOLDER



TRANSFORMER TECHNOLOGY

The power transformer technology used depends on the size of the installation.
For smaller installations:
• Thyristor technology with dry transformer

For larger installations:
• High voltage, oil filled transformer with tap change switch

With the exception of throat boosters which are usually single phase, the majority of installations are three phase and are designed to give a balanced load on the three phases. Each system is individually designed to suit the customers requirements, the installed power of the booster being calculated to provide the required increase in output (or other parameter), taking into consideration the furnace design, glass composition / colour, furnace bottom temperatures, electrode current density, etc.

CIRCUIT TYPE ON LOAD TAP POSITION CHANGER TRANSFORMER

- Clean sinusoidal wave output
- Long transformer life over 40 years
- High energy efficiency
- No obsolescence

The use on load tap changer transformer technology OLTC has been developed by Glass Service and is a very powerful and reliable transformer technology.

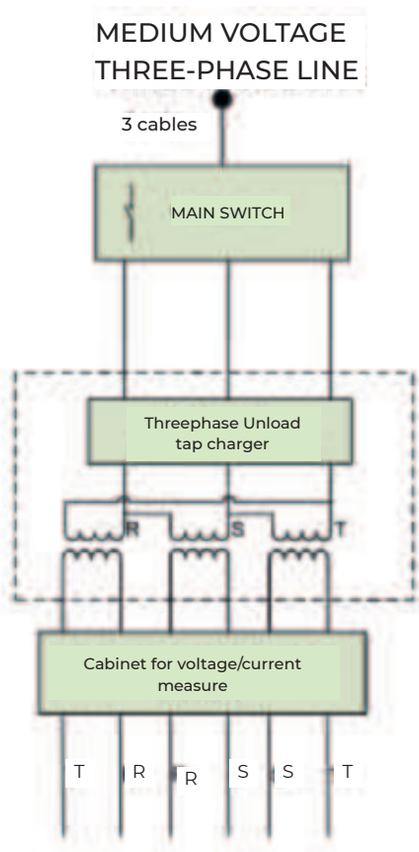
The OLTC is the most used technology in all the electrical power stations for voltage adjustment.
The voltage is regulated by step with no energy disconnection.

The OLTC transformers used by Glass Service have the following features:

- Voltage input, medium voltage, range from 4000 to 20000 Volt
- Power range 400-1200 kVA
- Three phase or mono phase available
- Voltage output regulator from 21 to 29 step
- Voltage output range from 80 to 300 Volt
- Transformer primary connection, delta, zigzag (interconnected star) for special unit
- Transformer secondary connection, open delta, close delta
- Special transformer SCOTT-TYPE also available
- Transformer cooling ONAN (oil-natural; air-natural) or ONWF (oil-natural; water-forced)
- Bucholz safety relay, oil temperature control, water temperature control

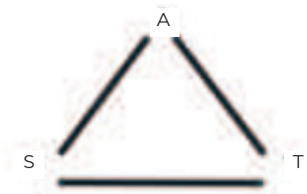
The OLTC transformer has several advantages:

- Clean sinusoidal wave on the output
- Strong construction
- On load tap position changer operating life over 40 years (1,2 million operation maintenance free)
- High energy efficiency (low losses)
- Reduced field cabling
- Long life and zero obsolescence, can be reused for several campaign



MEDIUM VOLTAGE
TRAFO OIL + AIR
COOLED

FURNACE
ELECTRODES



OPEN DELTA
ELECTRODE
CIRCUIT

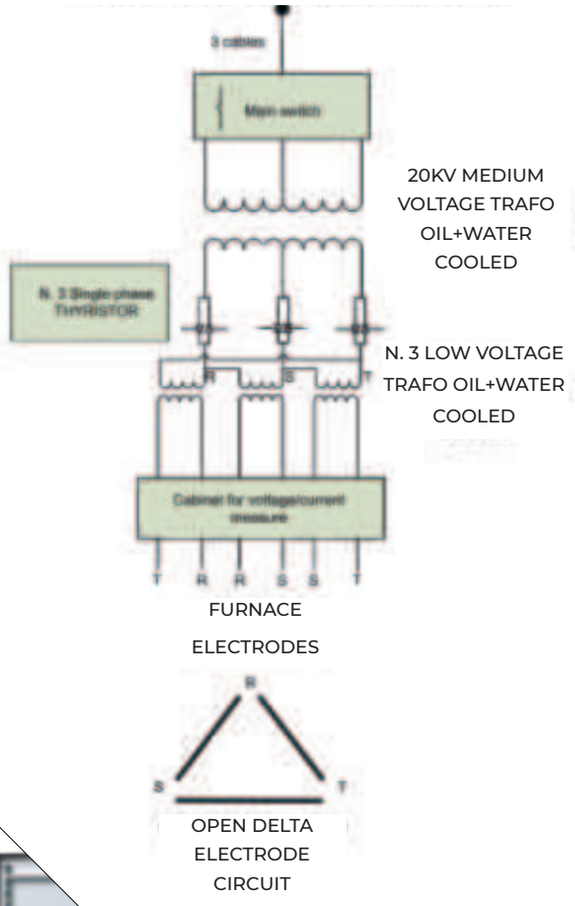
CIRCUIT TYPE THYRISTOR UNIT

The thyristor unit TU is used for low power boosters in the range of 30-400 kVA, this system is considerabily cheaper to instal than OLTC. The thyristor drive technology developed by Glass Service has increased energy savings and safety levels. The TU comprises a Thyristor unit control cabinet and one or more dry transformers. The power is regulated by phase angle control.

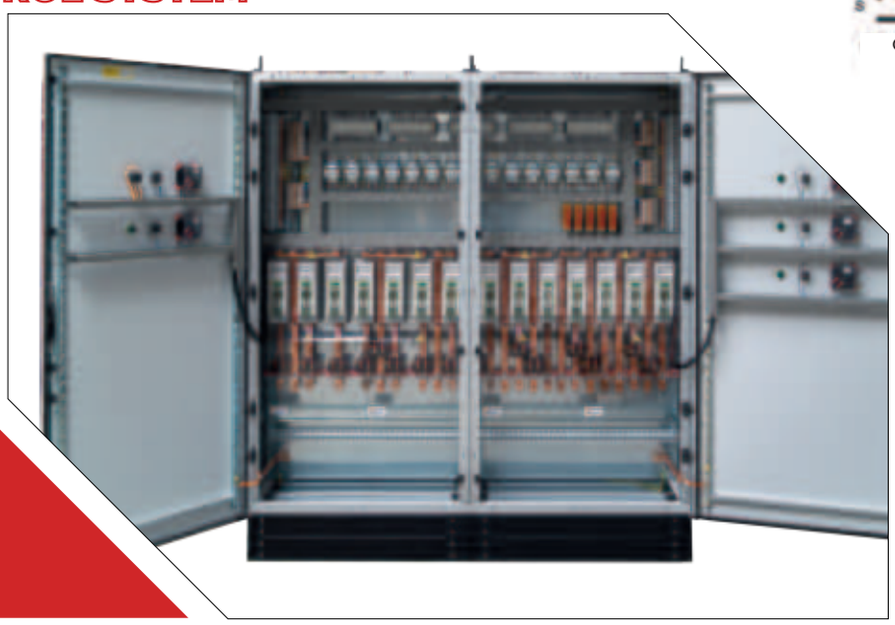
The TU develop from Glass Service has the following features:

- Voltage input range from 220 to 600 Vac
- Voltage output 80-300 Vac
- Power range from 20 to 600 kVA for each transformer
- Dry transformer with multi voltage selection on the secondary circuit are fitted with a temperature sensor connected to the safety control system in the control panel
- Continuous power regulation
- Connection open or closed delta or special connection

20KV MEDIUM VOLTAGE THREE FASE LINE



CONTROL SYSTEM



The HMI could dedicate by local touch screen panel or central PC SCADA. Al the process parameters and variables are controlled and recorded in the control system for process analysis.

Glass Service has developed a special control system dedicated to booster technology. The system is based on DCS Honeywell HC900 and is able to manage the Tap position changer booster OLTC or the thyristor TU booster. Control system is able to manage:

- Power booster PID or current booster PID
- Voltage input
- Voltage output
- Current value for each electrodes
- Temperature value for each electrode
- Earth current and voltage
- Water cooling for each electrode
- Transformer alarms
- Thyristor alarm

Emergency condition strategy manage

WATER COOLING

- Easy maintenance
- Visual flow water control
- High reliability
- Strong construction
- Easy water flow regulation and control

Each booster has a dedicated water cooling circuit to provide cooling water to the electrode holders using a special flow control and monitoring system designed by Glass Service.

The water flow is manually controlled and in the event of low water flow any increase in temperature is detected by a temperature sensor. In addition any pressure drop is detected by a pressure switch. The water flow switch is highly reliable and very simple to maintain.

ELECTRODE HOLDER

- Strong mechanical construction, one piece head
- Double cooling circuit water + air
- Air cooling circuit for easy hot installation
- Horizontal or vertical installation
- Full accessories including supports, connectors, etc

Glass Service has developed a new high reliable electrode holder for use with molybdenum electrodes. The holder has a dual cooling circuit, the main circuit being for water and the secondary circuit for emergency air to be used in the event of a water cooling fault and also during the initial electrode installation.
The electrode holder is manufactured from a special alloy with resistance to high temperatures. The head is produced from a single piece, machined and welded using laser technology.

Holders are supplied for use with a range of electrode diameters including 1.50, 2.0, 3.0 and 4.0 inch.

Main electrode holder features:

- Dual cooling circuit, water primary and emergency air
- Thermocouple K type for temperature head detection
- One block machined head
- Laser welding tube cooling connection
- Max head temperature 1000°C
- Operation head temperature max 800°C
- Cooling water consumption 5 l/min
- Max water temperature 35°C
- Cooling water pressure 2-4 bar
- Installation vertical or horizontal

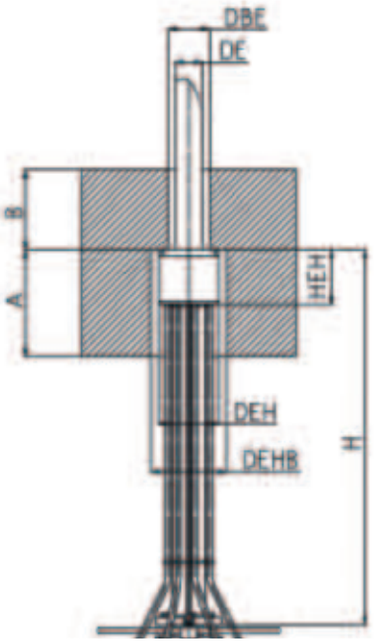
The electrode holder can be equipped with several installation accessories:

- Cooling water special tube with high electrical resistance
- Electrode holder with mechanical support and electrical insulation
- Emergency support for bottom installation
- Water and air valve and fittings

Glass Service has developed a new high reliability electrode holder for molybdenum rods.
Its most innovative feature it's a **double cooling system** with a main circuit for water and a secondary/ emergency one for compressed air. This is to be used in the event of cooling water fault and also during initial and later electrode installation/positioning.
The holder has a dual cooling circuit, the main circuit being for water and the secondary circuit for emergency air to be used in the event of a water cooling fault and also during the initial electrode installation..

A WIDE RANGE OF ANCILLARIES COMPLETES THE SUPPLY.

- Cooling water special tube with high electrical resistance.
- Electrode holder with mechanical support and electrical insulation.
- Emergency support for bottom installation.
- Water and air valve and fittings.
- Strong mechanical construction, one piece head
- Double cooling circuit water + air.
- Air cooling circuit for easy hot installation
- Horizontal or vertical installation.

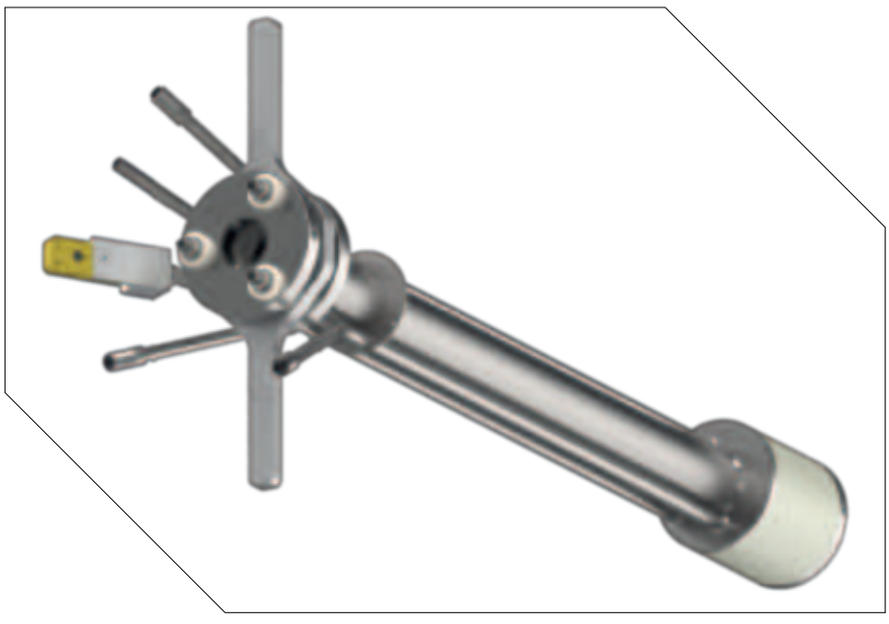


CHARACTERISTIC DIMENSIONS

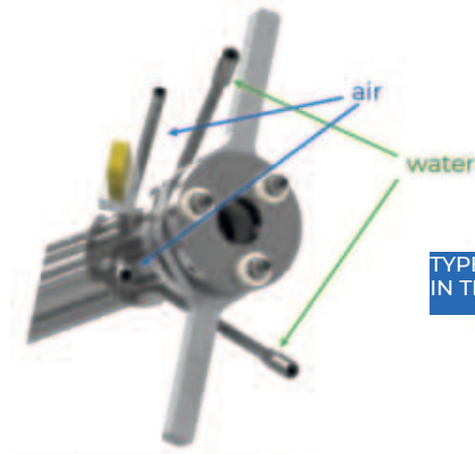
DIAMETER OF REFERENCES	GLASS SERVICE DESCRIPTIVE CODE HELECTRODEHOLDER	ELECTRODE DIAMETER	ELECTRODE HOLE	ELECTRODE HOLDER DIAMETER	ELECTRODE HOLDER HOLE	ELECTRODE HOLDER HEADHIGH		
		DE [mm]	DBE [mm]	DEH [mm]	DEHE [mm]	HEH [mm]	A [mm]	B [mm]
1-1/2"	PE-C-31.75-AA	31,75	50 (+0,5/-0,0)	95	98 (+0,5/-0,0)	102	Minimum: 102	150
2"	PE-C-50.8-AA	50,8	67 (+05/-0,0)	114	117 (+0,5/-0,0)	102	Minimum: 102	150
2-1/2"	PE-C-60.3-AA	63,5	78 (+0,5/-0,0)	127	130 (+0,5/-0,0)	102	Minimum: 102	150
3"	PE-C-76.2-AA	76,2	94 (+0,5/-0,0)	139	142 (+0,5/-0,0)	102	Minimum: 102	150

FEATURES

Max head temperature 1000 °C
Operation head temperature max 800 °C
Cooling water consumption 5 l/min
Max water temperature 35° C
Cooling water pressure 2-4 bar



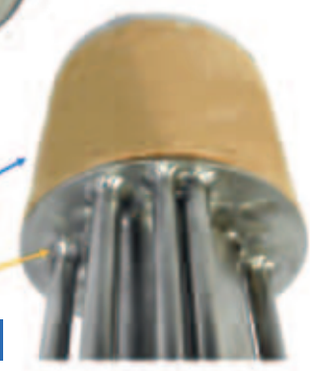
MAIN ELECTRODE FEATURES



DOUBLE COOLING WATER AND AIR FOR EMERGENCY AND ELECTRODE INSERT

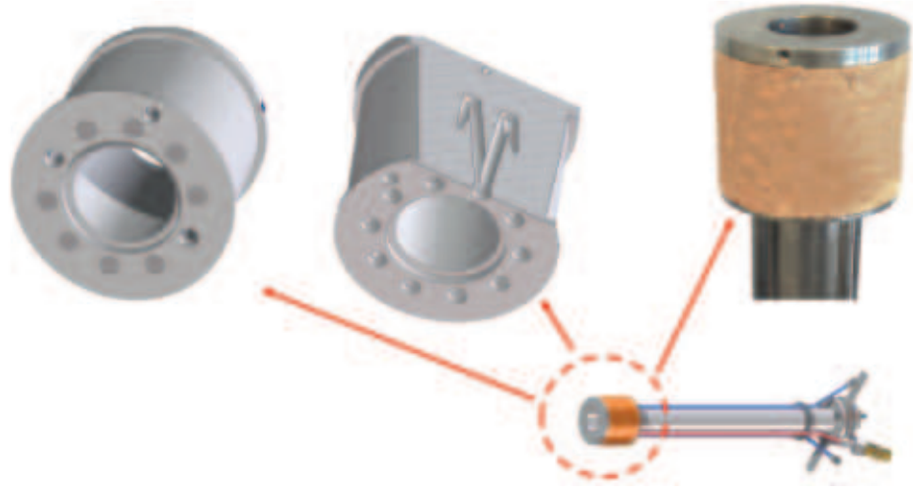
TYPE K THERMOCOUPLE INSERTED IN THE ELECTRODE HEAD

ONE BLOCK MACHINED HEAD



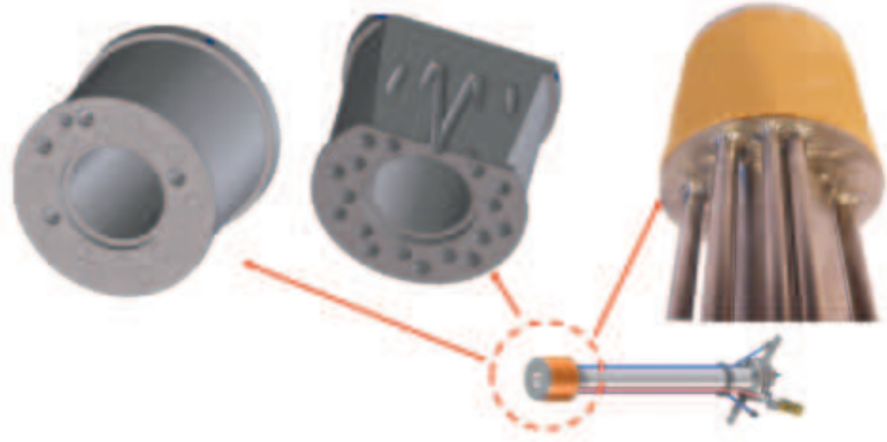
LASER WELDING TUBE COOLING CONNECTION

ELECTRODE HOLDER SINGLE COOLING CIRCUIT



The electrode holder is manufactured from a special alloy with resistance to high temperatures. The head is produced from a single piece, machined

ELECTRODE HOLDER DOUBLE COOLING CIRCUIT



ELECTRIC MOLYBDENUM DISTRIBUTOR AND FOREHEARTH HEATING

ELECTRIC MOLYBDENUM DISTRIBUTOR AND FOREHEARTH HEATING

Technology description

• For the heating of the distributor and forehearth, Glass Service has developed the technology of glass heating using dry electrodes installed on the side-walls of every section.

• The electrodes are directly immersed in the molten glass and heat it through a direct passage of electric current.

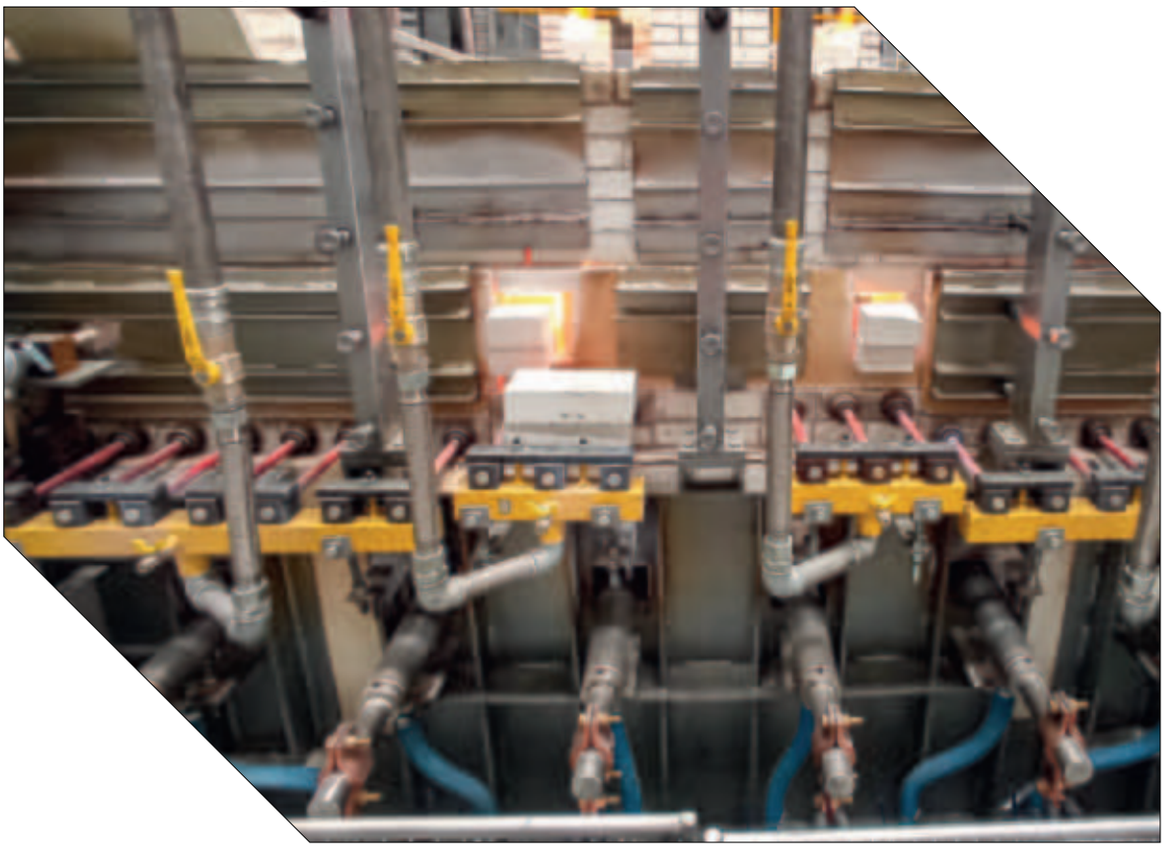
• The electrodes are cooled by ventilated air produced by a centrifugal fan without the use of water, simplifying field installation, reducing piping, and eliminating the management of the heated water.

• For start up, Glass Service has developed a special preheating technique that facilitates the hot insertion of the electrodes.

• The power emitted by each electrode is limited to ensure good thermal homogeneity of the glass and a long lifespan of the molybdenum.

• The power of each section is relatively low; typically, powers in the range of 20-50 kW are installed to deliver much less than the installed value, i.e., 7-16 kW per zone.

• For operator safety reasons, the voltage of the electrodes is also kept very low, typically around 50-100 VAC maximum.



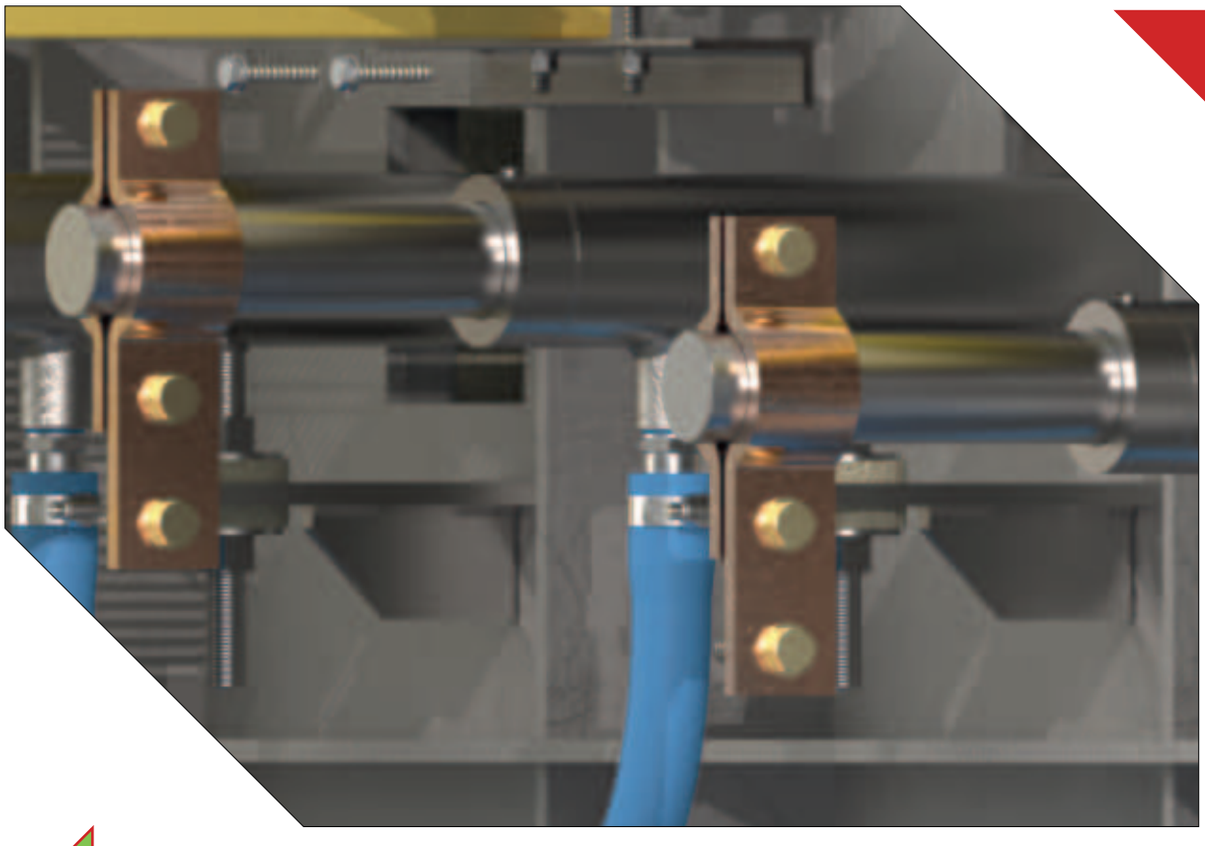
PROBLEM	SOLUTION
ELECTRODES WATER COOLING MANAGE	DRY AIR-COOLED ELECTRODE
HIGH COST OF AIR COOLING BY COMPRESS AIR	• ELECTRODE HOLDER DESIGN SUITABLE FOR LOW PRESSURE COOLING AIR PRODUCED BY CENTRIFUGAL FAN • HIGH COOLING EFFICIENCY ELECTRODES HOLDRE
GLASS THERMAL HOMOGENEITY	INSTALLING OF LARGE QUANTITY OF ELECTRODES WITH LOW ELECTRIC POWER EACH ONE
OXYGEN BUBBLER FORMATION	• INSTALLING OF LARGE QUANTITY OF ELECTRODES WITH LOW ELECTRIC POWER EACH ONE • VDC CURRENT/VOLTAGE COMPENSATOR AVAILABLE
SAFETY OF MAINTENANCE AND PRODUCTION OPERATOR	USE OF LOW VOLTAGE POWER IN EACH SECTION
ELIMINATION OF RESIDUAL VOLTAGE IN THE GOB	INSTALLATIONOF GROUND ELECTRODE CLOSE TO THE SPOUT
SHORT CIRCUIT PROTECTION	FUSES BOARD TECHNOLOGY
FAULT OF ELECTRICAL INSULATION	GROUND ELECTRODE CURRENT CONTROL AND ALARM TRIG

ELECTRODE TECHNOLOGY DRY

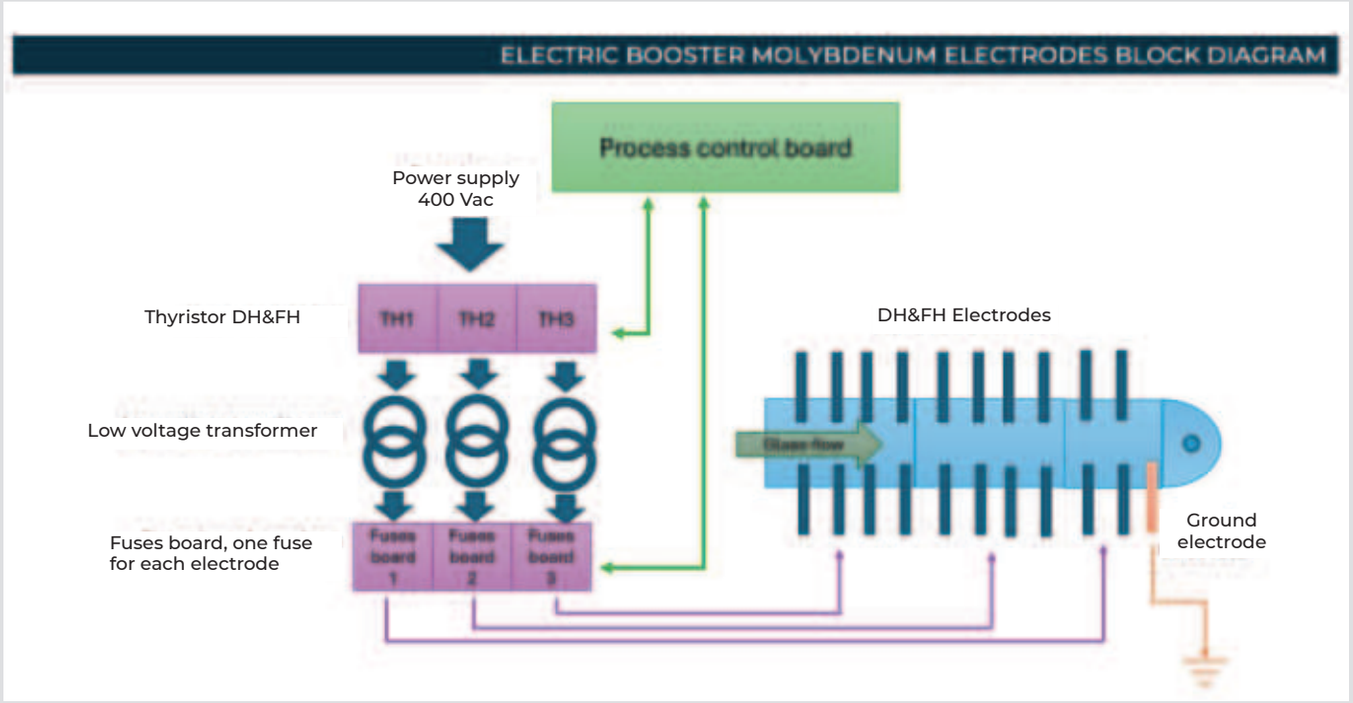
Heating with immersed electrodes reduces energy emitted through the combustion of Natural Gas by up to 60% compared to air/gas heating technology. Consequently, it also reduces 60% CO2 emissions into the atmosphere.

The technology can be applied to all types of glass, including flint, amber, and green. For extra flint glass or crystal glass lead, the molybdenum electrodes can be replaced with tin oxide ones, to avoid a slight grey shades, caused by chemical reaction between glass and molybdenum.

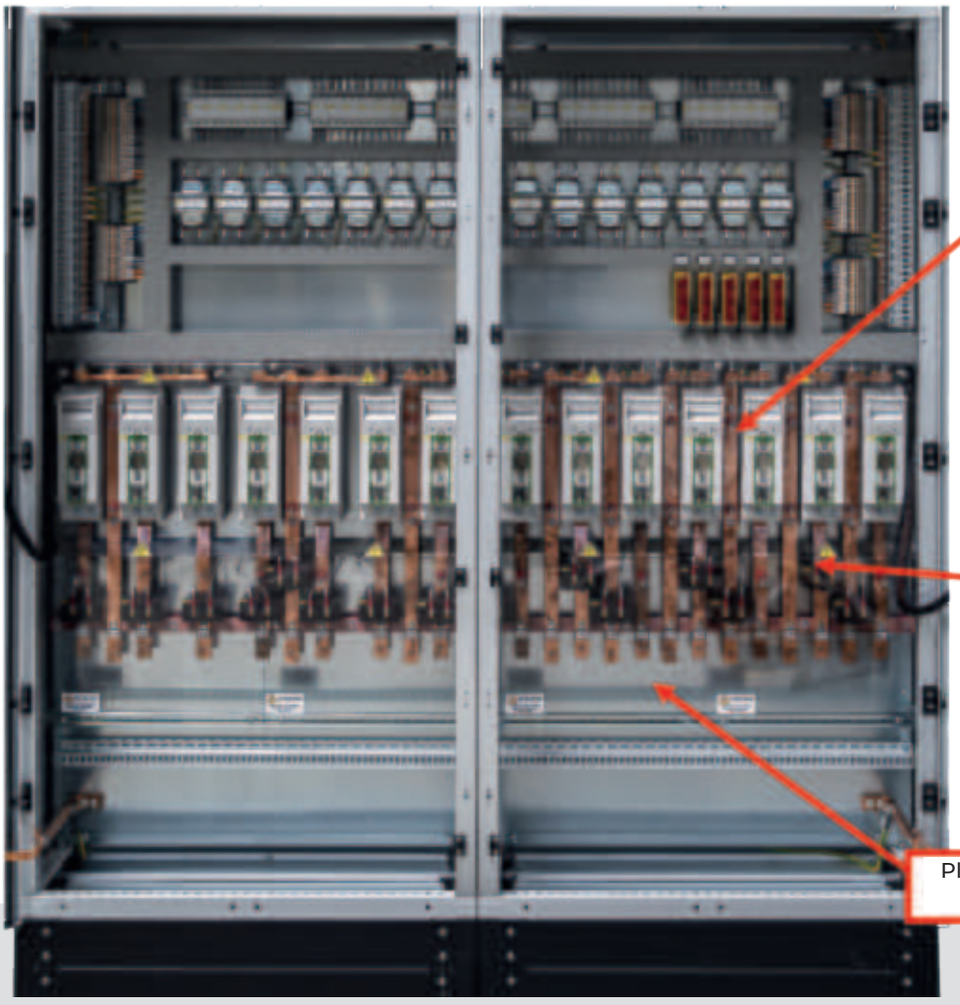
The technology used for electric power panels involves the use of thyristors coupled with low-power dry-type transformers. This technology is suitable for low electrical powers to be supplied and allows a perfect control.



ELECTRIC BOOSTER MOLYBDENUM ELECTRODES BLOCK DIAGRAM



Output fuse open, one for each electrode



Fuses board section distributor and forehearth

The Glass service technology includes in the electrical power circuit a fuse panel with a dedicated fuse for each installed electrode.

With this solution, short circuit protection is ensured, and perfect electrical isolation is achieved in case of maintenance in a single channel zone.

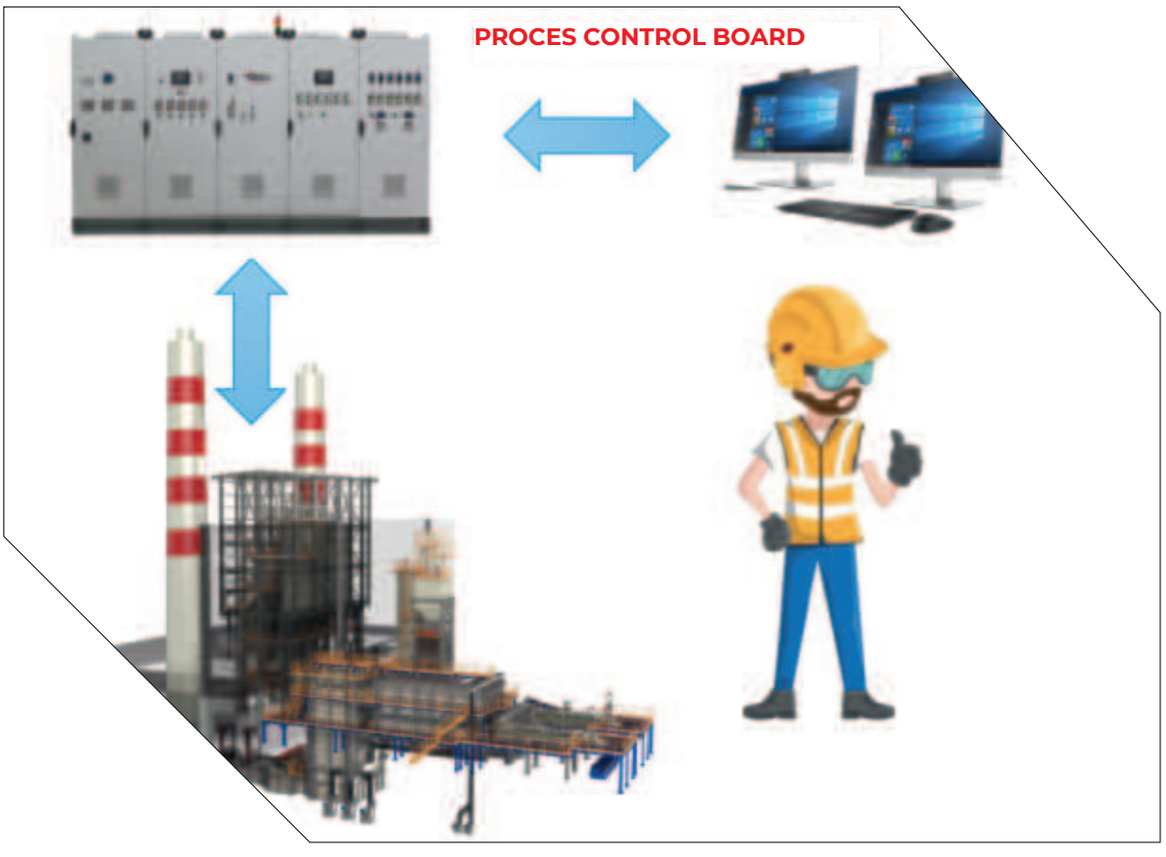
EDISTRIBUTOR AND FOREHEARTHS AIR-COOLED ELECTRODES

PROCESS CONTROL BOARD

PROCESS CONTROL BOARD

The Glass Service process control board should manage the glass production process and relative equipment as well batch plant, melting furnace, Distributor and Forehearth.

The control process board developed by Glass Service places particular emphasis on the safety of the managed devices in accordance with current regulations, as well as providing an easy interface for the operator.

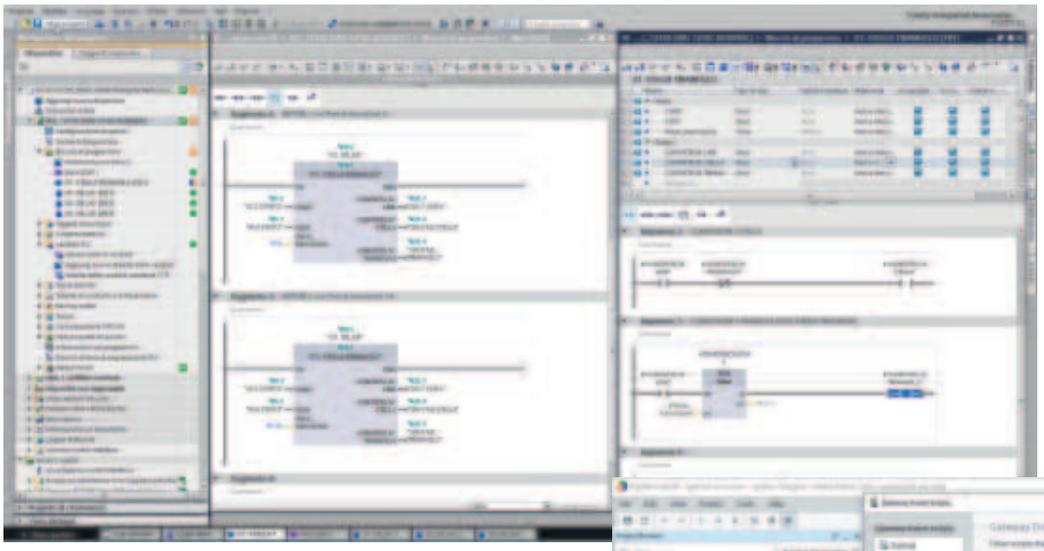


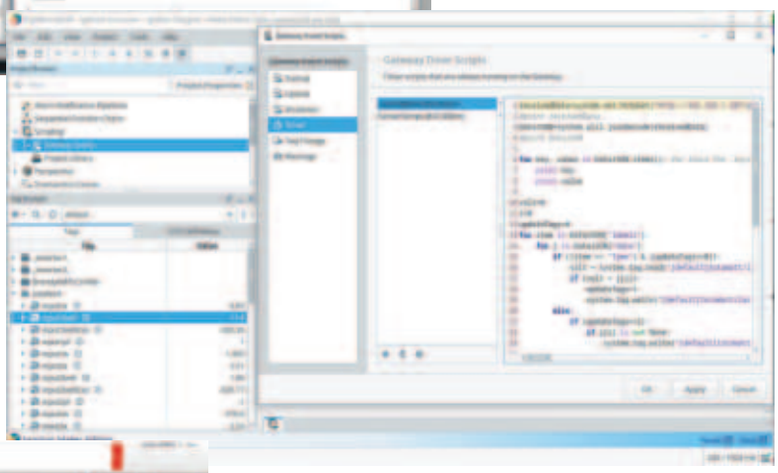
DESIGN

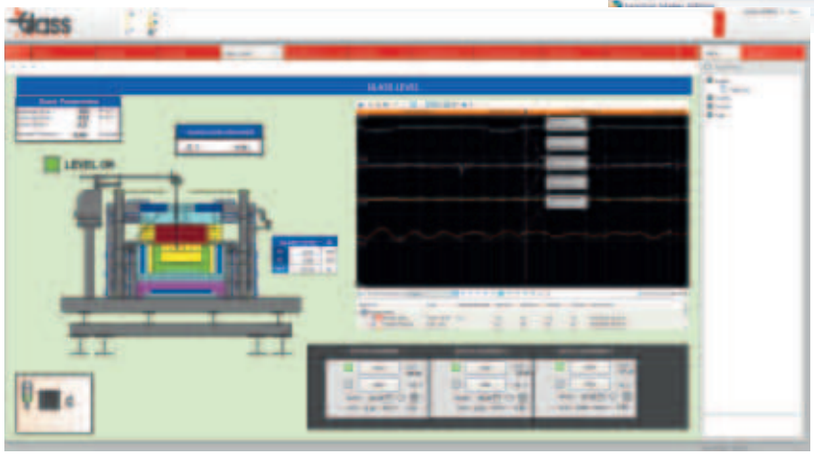
Glass Service process control board design uses the best advanced technologies and software. Expert designers are involved, in the first-class component selection (Siemens, Schneider, ABB) and sizing. The process control procedures and software analysis as well the risk analysis are evaluated in Glass Service team involving software engineer, electrical engineer, combustion engineer, process production expert.

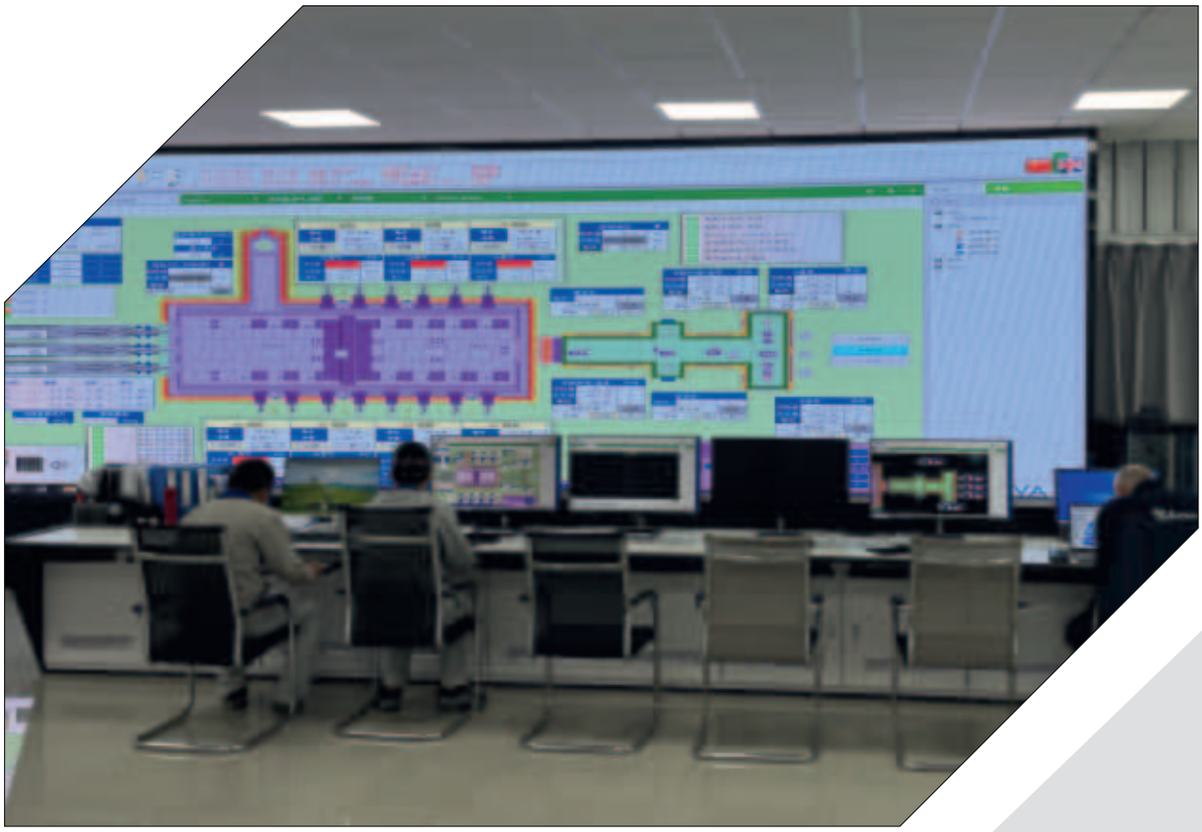
Glass Service design of process control board includes:

- Process control analysis
- Electrical diagram and electrical sizing
- DCS-PLC sizing
- DCS-PLC software design
- HMI/SCADA software design
- Process control board cold test inside and on field, start up









MAIN PERFORMANCES

The main performances of Glass Service process control board are:
- High reliability
- Safety according the current regulation
- Full automatic process control
- Easy interface with the operator and easy manage
- Full process information and variable available in real time or historical data base and time trend
- Alarm manage and alarm historical data base
- Automatic troubleshooting
- Remote control

Loops

The loops controlled by the board are:
- Temperature (input from thermocouple or pyrometer)
- Gas/air ratio
- Oil/air ratio
- Gas/oxy ratio
- Furnace pressure
- Combustion air temperature

Alarms

The alarms are displayed on the touch screen and recorded in the memory, the main allarm groups are:
- High/low temperature
- Device fault (fans – motor)
- Incorrect ratio Gas/air, Oil/air, Gas/oxy
- Water cooling fault (es. For the batch charger)

Trends

The trends are reported on the HMI SCADA PC and on touch screen displays.

The trends are recorded in internal memory.

DCS AND PLC CONTROLLER

Glass Service installs the Honeywell DCS HC900 or the Siemens PLC series 1500 and S7-400 as the standard controller.
All controllers can be configured with single or dual CPUs and various redundancy strategies, in safety or standard configuration.

DCS HC900 EDGE Honeywell

The ControlEdge HC900, belonging to the ControlEdge 900 Platform, is an advanced process and logic controller with a modular, scalable design that is built to work with a wide range of process equipment in a cost-effective way. It comes with a touchscreen operator interface that makes it very easy to operate.

The process and safety controller possesses a flexible architecture that can accommodate the most demanding application.

With its advanced features and versatile connectivity, it is capable of customized pinpoint control. The ControlEdge HC900 also simplifies the documentation process and eliminates filing errors.

HC900 most important performance

- Hot Software upgrade, software can be modified with furnace in operation with continuity of control supervision
- Hot swap, I/O board can be changed in hot condition with furnace in operation with continuity of control supervision
- SIL2 version available
- Remote control I/O connected by Ethernet TPC/IP standard
- Touch screen directly connected to the CPU by Modbus RS485 communication
- CPU redundancy available, single CPU or double CPU rack
- Power supply redundancy available for CPU and/or I/O rack
- I/O health monitor for Thermosensors

PLC Simatic S7-1500 Siemens

Using the SIMATIC S7-1500 controller gives you top performance and built-in viability into the future.

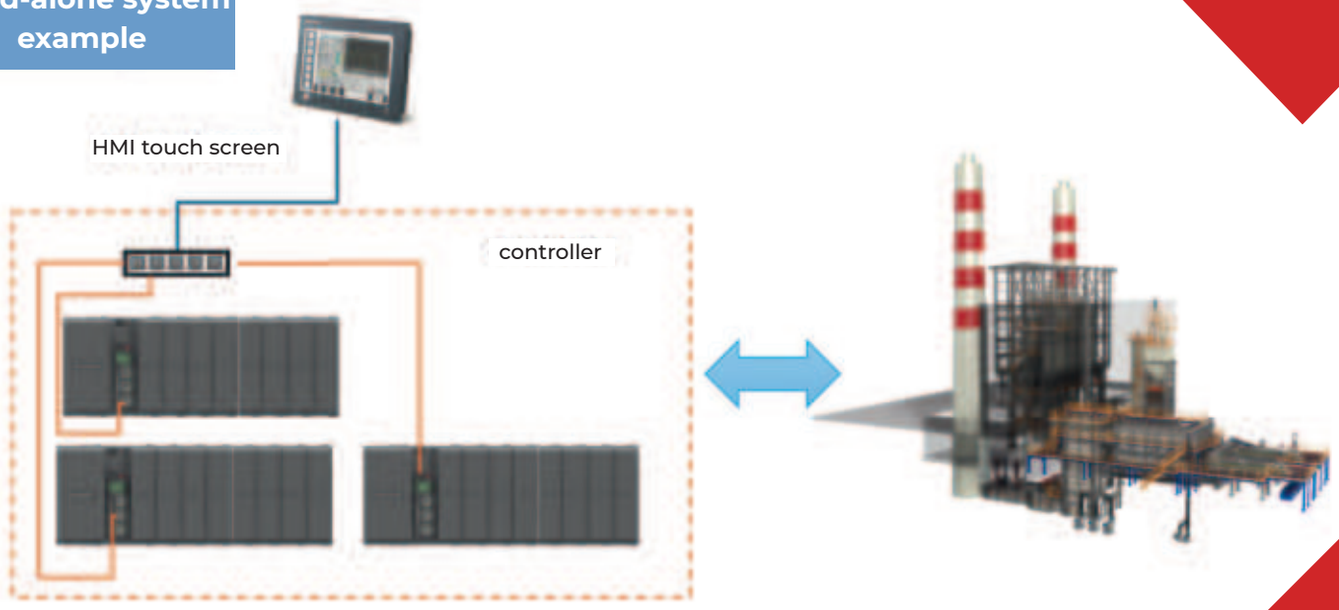
You can turn the most sophisticated machine designs into reality thanks to the modular structure of the controller, which provides reliable assistance as you work your way through the digital transformation.

Siemens S7-1500 most important performance

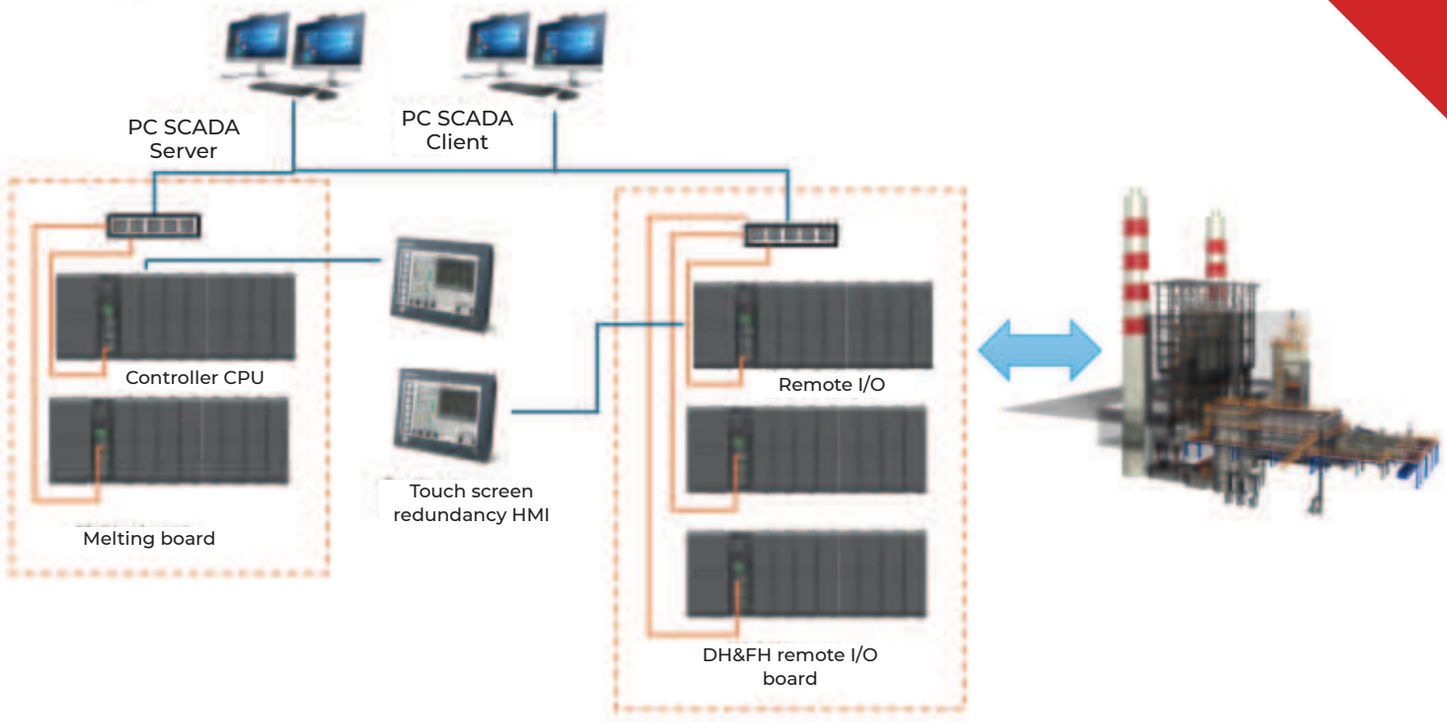
- SIL2-SIL3 version available
- Remote control I/O connected by Profinet standard
- Touch screen directly connected to the CPU by independent communication
- CPU redundancy available, single CPU or double CPU rack
- Power supply redundancy available for CPU and/or I/O rack

The simplest control architecture proposed as standard by Glass Service includes a system based on a PLC/DCS with one CPU + various I/O boards and an HMI touch screen user interface.
With the same controls, more complex control architectures can be designed using remote I/O units.

Base solution for stand-alone system example



Pro solutionfor more integrated distributed system example

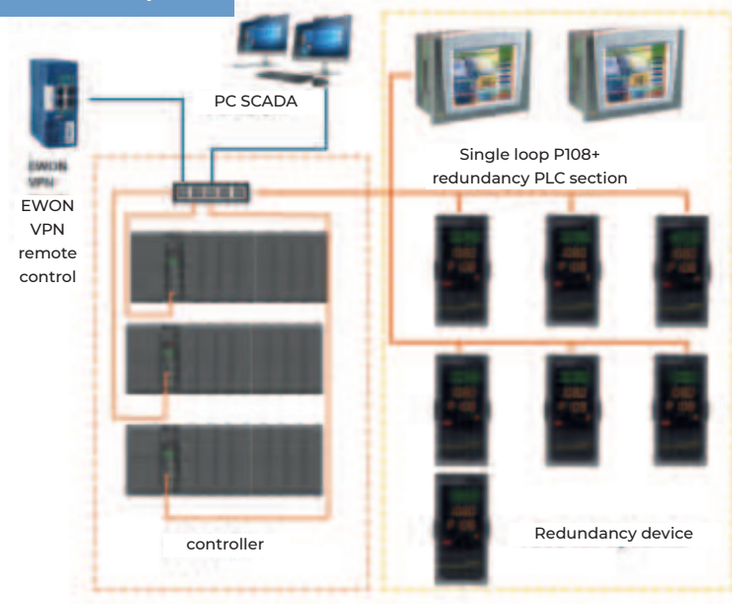


On the 24h/7d equipment redundancy strategy is very important for control continuity. The redundancy strategy should be managed with several solution.

Glass Service developed several redundancy strategy, some sample are reported in the table. Some customized strategy can be applied.

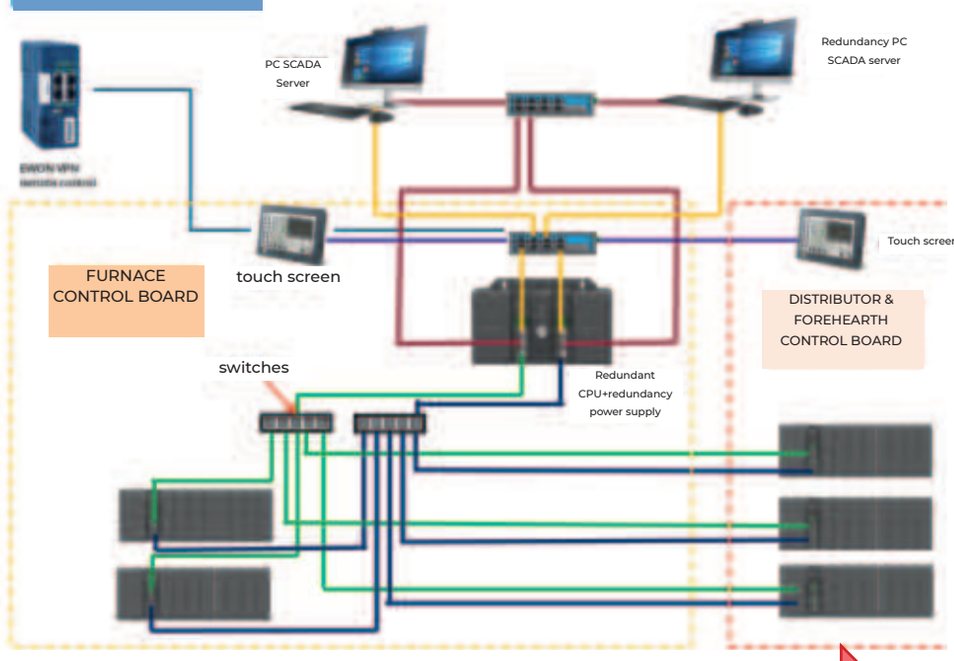
solution 1 example	single loop controller + redundancy PLC	• one single loop controller manages each control PID loop • electromechanical redundancy manages the ON/OFF of the electrical device (fans, Shutt off valves etc.) • simple PLC manages the complex equipment (batch charger, oxy-gas combustion skids, glass level controller)
solution 2 example	redundancy CPU + redundancy HMI	• The PLC install a redundancy CPU + redundancy CPU power supplier • HMI SCADA PC has a touch screen (one more) as redundancy • Network comunication from CPU and I/O is double and redundant • redundancy PC SCADA Server

Redundancy solution nr. 1 Example



By the design of a redundant control system, Glass Service is able to ensure complete service continuity both in the event of failures of individual units and during routine maintenance, such as software controller modifications.

Redundancy solution nr. 2 Example



SAFETY INTEGRATION LEVEL PROCESS CONTROL BOARD SIL2-SIL3 AND PLC CONTROLLER

According current regulation EN746/2 (EU) and ANSI/ NFPA86 (USA) the combustion process controller must be in compliance with the correct safety integrity level.
Glass Service approached the SIL methodology by the LOPA risk management technique.

Glass Service can certify the process control board SIL2-SIL3 capable.

SIL2-SIL3 capability is requested in European Community as well in USA for:

- Melting combustion
- Distributor and Forehearth combustion
- Electrical power booster safety
- Dangerous device

ACTIVITY	DESCRIPTION LOPA METHODOLOGY	IN CHARGE TO	SOLUTION
1 - PROCESS DESIGN	GOOD PREOCESS DESIGN PROVIDES A SYSTEM THAT IS ROBUST AND CAN PREVENT OR TOLLERATE DEVIATIONS IN OPERATING CONDITION	GS DESIGN OFFICE	GS PROVEN DDSIGN KNOWLEDGE
2 -BASICPROCESS CONTROL SYSTEM (SOMETIMES DENOTED AS THE PROCESS CONTROL SYSTEM PCS)	BPCS IS THE CONTROL SYSTEM USED DURING NORMAL OPERATION. INPUT SIGNALS FROM THE PROCESS AND/OR FROM THE OPERATOR ARE GENERATED INTO OUTPUT WHICH MAKE THE PROCESS OPERATE IN A DESIRED MANNER. IF THE SYSTEM DISCOVERS THAT THE PROCESS IS OUT OF CONTROL (E.G.HIGH PRESSURE) IT MAY INITIATE ACTIONS TO STABILIZE THE PROCESS	• GS PROCESS CONTROL BOARD • GS SOFTWARE DESIGN • GS RISK ANALYSIS	• GS SIL PROCESS CONTROL DESIGN • SIL CERTIFIED DCS/PLC • GS SIL CETIFIED PROCESS CONTROL BOARD • GS SIL CERTIFIED SOFTWARE
3 - ALARMS AND OPERATOR INTERVENTION	ALARMS MONITORING CERTAIN PARAMETERS (E.G. PRESSURE AND TEMPERATURE) ARE CONSIDERED ANOTHER PROTECTION LAYER. WHEN THE ALARM IS TRIPPED, THE OPERATOR MAY INTERVENE TO STOP THE HAZARDOUS EVENT.	GS PROCESS CONTROL BOARD	
4 - SAFETY INSTRUMENTED SYSTEM SIS	IMPLEMENTS THE WANTED SAFETY FUCTION SIF (SAFETY INSTRUMENTED FUNCTION) TO BRING THE PROCESS TO A SAFE STATE. IN LOPA, SIFS ARE CONSIDERED AS CRITICAL PROTECTION LAYERS.	GS PROCESS CONTROL BOARD	
5 - PHYSICAL PROTECTION (RELIEF DEVICES)	PHYSICAL PROTECTION INCLUDES EQUIPMENT LIKE PRESSURE RELIEF DEVICE. E.G. IN A SEPARATOR THIS MAY BE A BLOW OFF VALVE WHICH BLOWS-OFF IF THE PRESSURE IS TOO HIGH PROTECTING THE UNDRELYING EQUIPMENT	GS COMBUSTION SKIDS	GS SKID SIL DESIGN
6 - PHISYCAL CONTAINMENT (BUNDS)	POST RELEASE PROTECTION IS PHYSICAL CONTAINMENT SUCH AS DIKES, BLAST WALLS ETC. THESE HAVE THEIR FUCTION AFTER THE RELEASE OR EXPLOSION HAS OCCURED TO PREVENT SPREAD OF DAMAGE	CUSTOMER	
7 - EMERGENCY RESPONSE LAYER	PLANT AND COMMUNITY EMERGENCY RESPONSE, ARE CONSIDERED THE FINAL PROTECTION LAYER. IF AN ACCIDENT OCCURS, PROCEDURES, EVACUATION PLANS, EQUIPMENT AND MEDICAL TREATMENT HELP THE EXPOSED PERSONNEL TO ESCAPE, OR TO MITIGATE DAMAGE / INJURY.	CUSTOMER	

HUMAN MACHINE INTERFACE

HMI is an important section of the process control board. In Glass Service design approach HMI must have the main features:

- Easy to manage and to understand by operator
- Stable and reliable
- Collect all data for historical analysis
- Able to manage alarm and historical data alarm
- HMI/SCADA software design

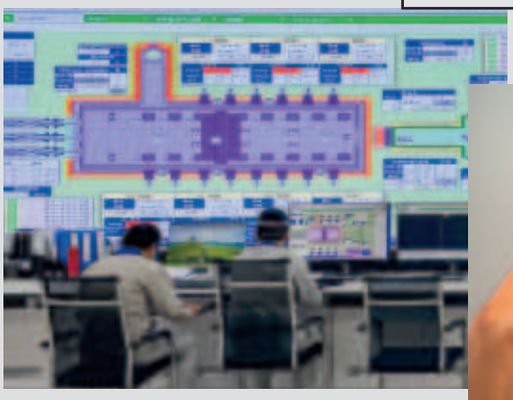
GLASS SERVICE DEVELOPED THE HMI IN 2 MAIN FAMILY:

PC SCADA

PC SCADA HMI is mainly based on WIN software and PC based hardware.

The SCADA software application running on WIN used by Glass Service could be according the customer request, main software used are WIN-CC Simens; CITEC Schneider, IGNITION.

PROBLEM	SOLUTION
HIGH RELIABILITY OF PC HARDWARE	• DIRECTLY CONNECTION TO CONTROLLER CPU • PROPERTY COMUNICATION PROTOCOL
CLEAR HMI INTERFACE	• LARGE SCREEN USED STANDARD FROM 10,4 TO 22" COLOUR DISPLAY • CLEAR AND SIMPLE GRAPHIC SOFTWARE
24H/7D CONTINUITY SERVICE	• FIRST QUALITY HARDWARE
DATA ANALYSIS	• DATA BASE STORAGE OF ALL FURNACE VARIABLE • DATA ANALYSIS SOFTWARE TOOLS, AS WELL TREND VIEW OF HISTORICAL DATA
SOFTWARE ASSISTANCE	• REMOTE CONTROL BY GS SOFTWARE ELECTRONIC OFFICE
DATA PRTOTECTION	• INDIPENDENT ETHERNET WETWORK FOR SCADA PC • FIRE WALL SOFTWARE INSTALLED • VPN USE ONLY FOR REMOTE CONTROL CONNECTION



TOUCH SCREEN HMI

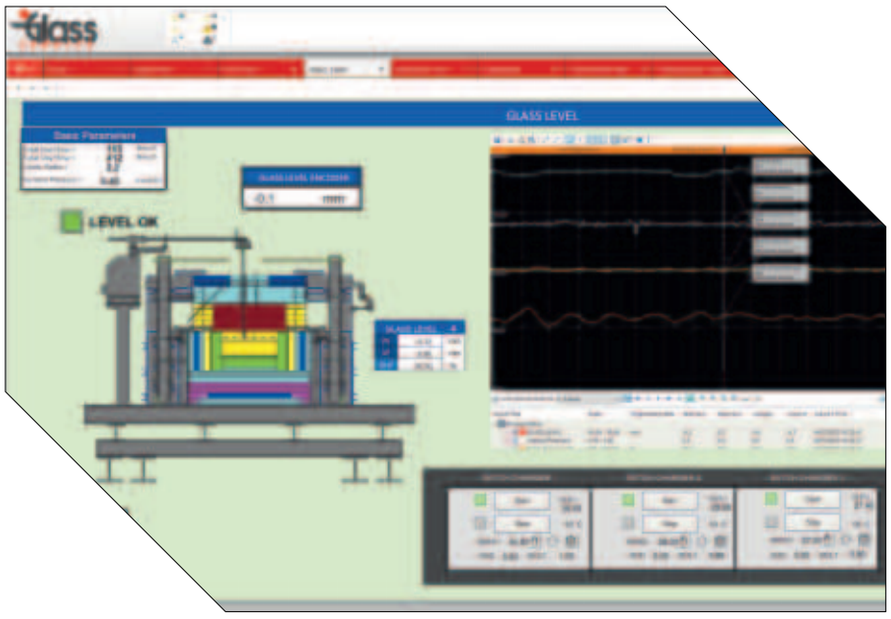
Touch screen can be used as redundancy HMI or as main HMI for low cost process control board. The main touch screen used by Glass Service are:

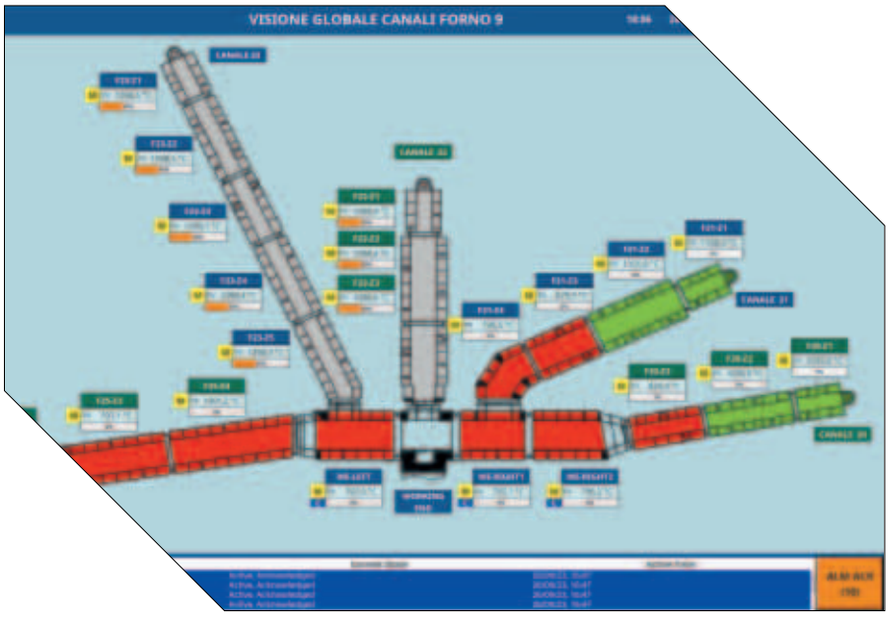
- Siemens HMI panel machine size 12.1” to 21.5“
- Honeywell Control station size 10.4” to 15”
- ASEM size 12” to 24”

Standard software used on Touch screen is:

- Siemens WinCC
- Honeywell station designer
- ASEM

PROBLEM	SOLUTION
HIGH RELIABILITY OF HARDWARE/ SOFTWARE COMUNICATION	• DIRECTLY CONNECTION TO CONTROLLER CPU • CONNECTION PROPERTY COMUNICATION PROTOCOL
CLEAR HMI INTERFACE	• LARGE SCREEN USED STANDARD FROM 10,4 TO 22" COLOUR DISPLAY • CLEAR AND SIMPLE GRAPHIC SOFTWARE
24H/7D CONTINUITY SERVICE	• FIRST QUALITY HARDWARE
SOFTWARE ASSISTANCE	• REMOTE CONTROL BY GS SOFTWARE ELECTRONIC OFFICE
DATA PRTOTECTION	• DIRECTLY CONNECTION TO CONTROLLER CPU • CONNECTION PROPERTY COMUNICATION PROTOCOL • NO WINDOW-BASED SOFTWARE USED • VPN USE ONLY FOR REMOTE CONTROL CONNECTION


GLASS LEVEL
LEVEL OK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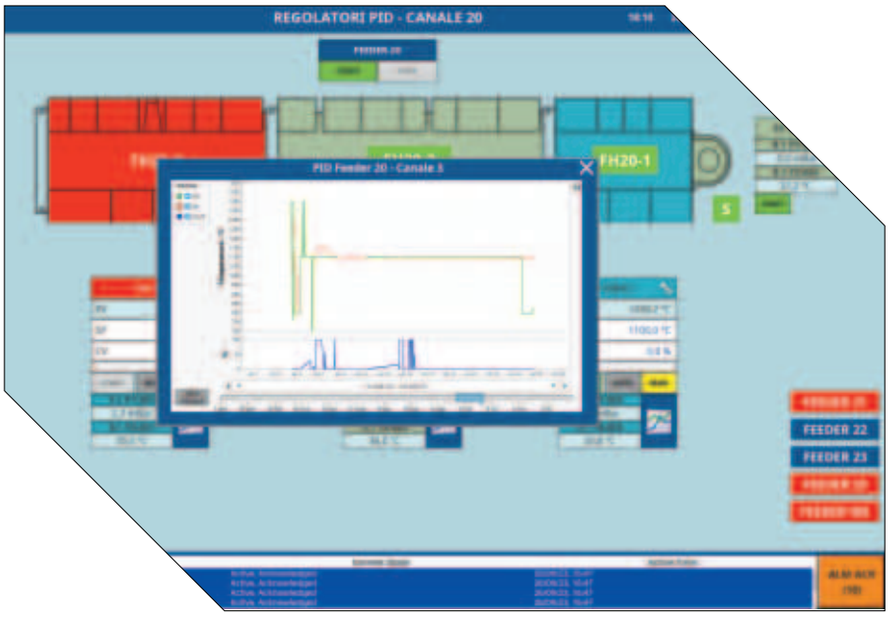
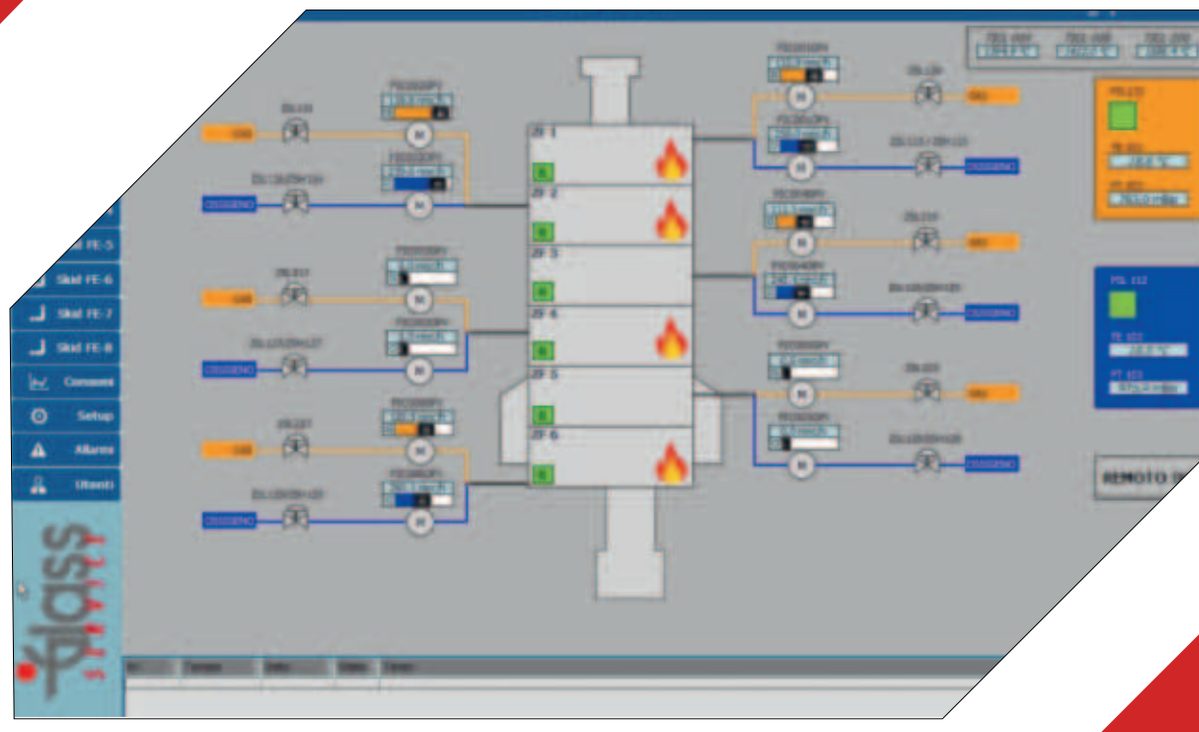

REGOLATORI PID - CANALE 20
PID Feeder 20 - Canale 3
FH20-1
FEEDER 22
FEEDER 23



REMOTE CONTROL

Glass Service remote control design developed the features of:

- Remote software assistance and upgrade
- Trouble shooting of furnace or DH&FH manage
- Data safety and intrusion protection by the use of EWON VPN Talk2m industrial cloud connection
- High data speed connection worldwide by cloud connection

FIXED AND OSCILLATING SCOOP BATCH CHARGER

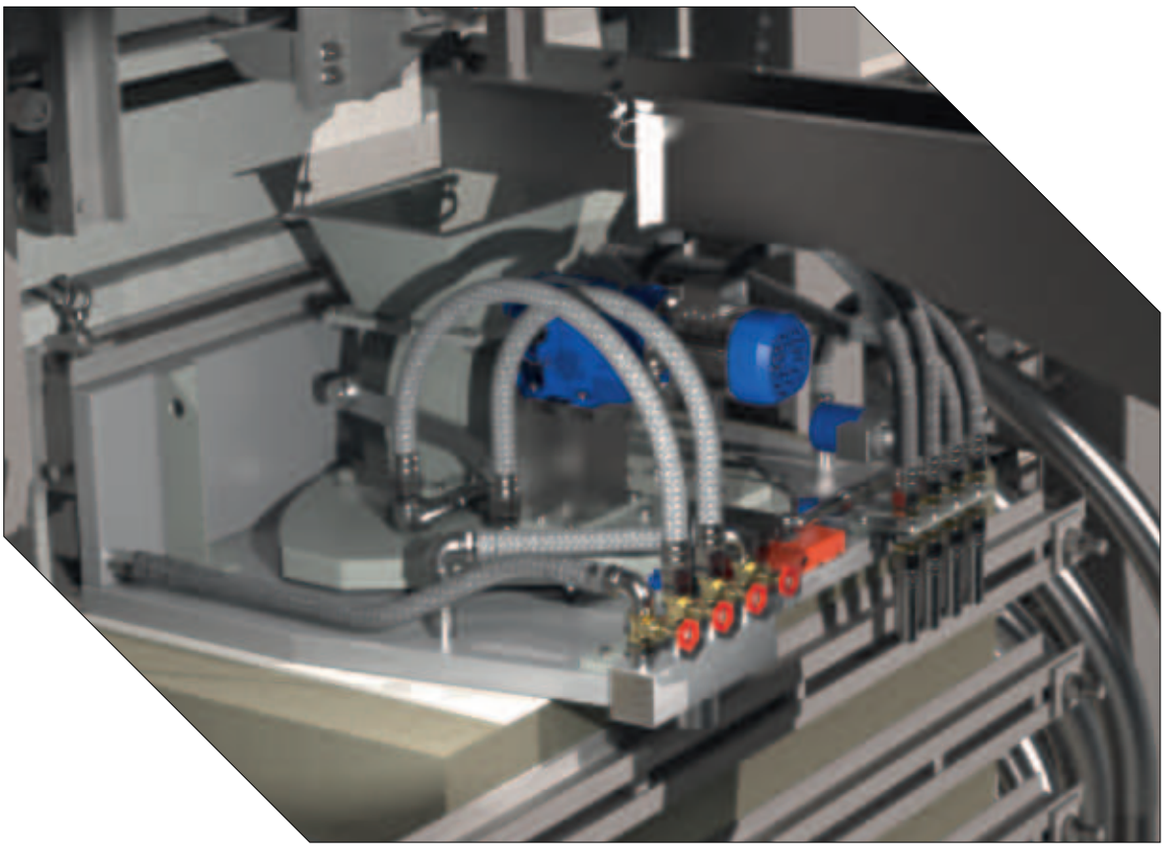
FIXED AND OSCILLATING SCOOP BATCH CHARGER

The batch charging in furnace technology has a large influence on the furnace performances.

Glass Service develops the batch chargers machine in several model and size for a better setting on specific glass production and furnace size.

For each furnace and glass type the batch charging methods and the batch charger machine size have several advantages:

- Increase the furnace pull/rate performance
- Decrease the energy consumption
- Reduce the furnace pollution dust carry over
- Reduce the glass level oscillation
- Reduce the NOx formation



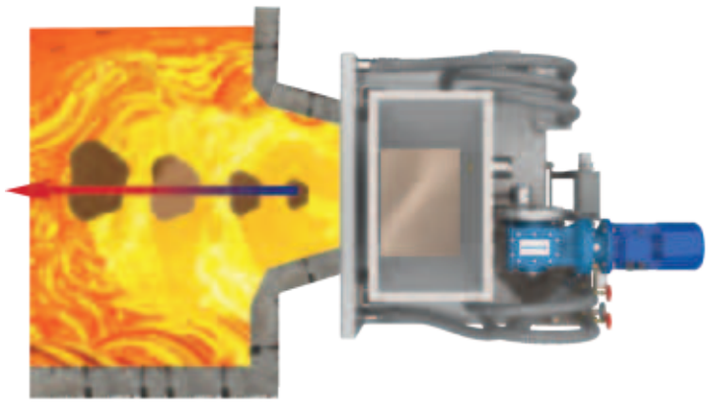
The Glass Service batch chargers machines are designed for the 24h/7days continuous use and are optimized with very strong reliable construction.
For the 24h/7days use the design is optimized for an easy and quick maintenance. The use of quick dismantling group and simple mechanism eases the maintenance activity. The correct batch charger machine sizing reduces the glass level oscillation and increases the glass level loop control precision.
The correct and constant glass level increases the production in all the forming process.
The Glass Service batch chargers have a complete dog-house sealing and reduce the NOx formation by external air furnace input.
The main concepts that led the project of our batch chargers are: simplicity, flexibility and reliability.
These machines can be easily adapted to a wide range of pull rates and require low maintenance even when operating under heavy working conditions.
Our batch charging machine is directly installed and sealed on top of the dog house sidewall blocks, with the following advantages:

- Low NOx formation
- Low energy losses
- Low dusting (reduced carryover)
- Better furnace pressure control
- The supporting structure is basically a double electro-welded water-cooled stainless steel shield.
- Scoop machine is available in two versions:
  - Fixed type, n° 2 sizes available
  - Oscillating type (n° 2 sizes available pressure)

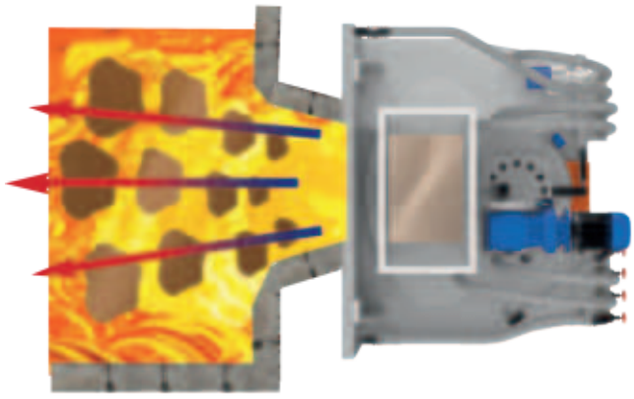
The batch charger includes the following main components:

- Main horizontal basement (water cooled)
- Vertical shield (water cooled)
- Small sized hopper to prevent batch compacting
- Water cooled scoop
- Drive system for oscillating scoop with AC servo-ventilated electric motor (driven by inverter) and coupled with gearbox;
- Capacitive sensor to detect minimum batch level in the hopper;
- Set of flexible hoses for water cooling (suitable for high temperature and pressure)
- Independent cooling water manifolds, equipped with flow-sensors and thermometers

fixed scoop type



Oscillanting scoop type

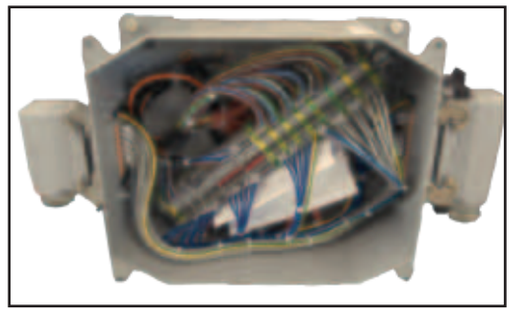


The oscillating version has the following additional features:
• Water cooled oscillating basement with ± 22° max rotation angle and five positions selectors (manually settable)
• Drive system for the oscillating base via an electric motor and linear actuator.

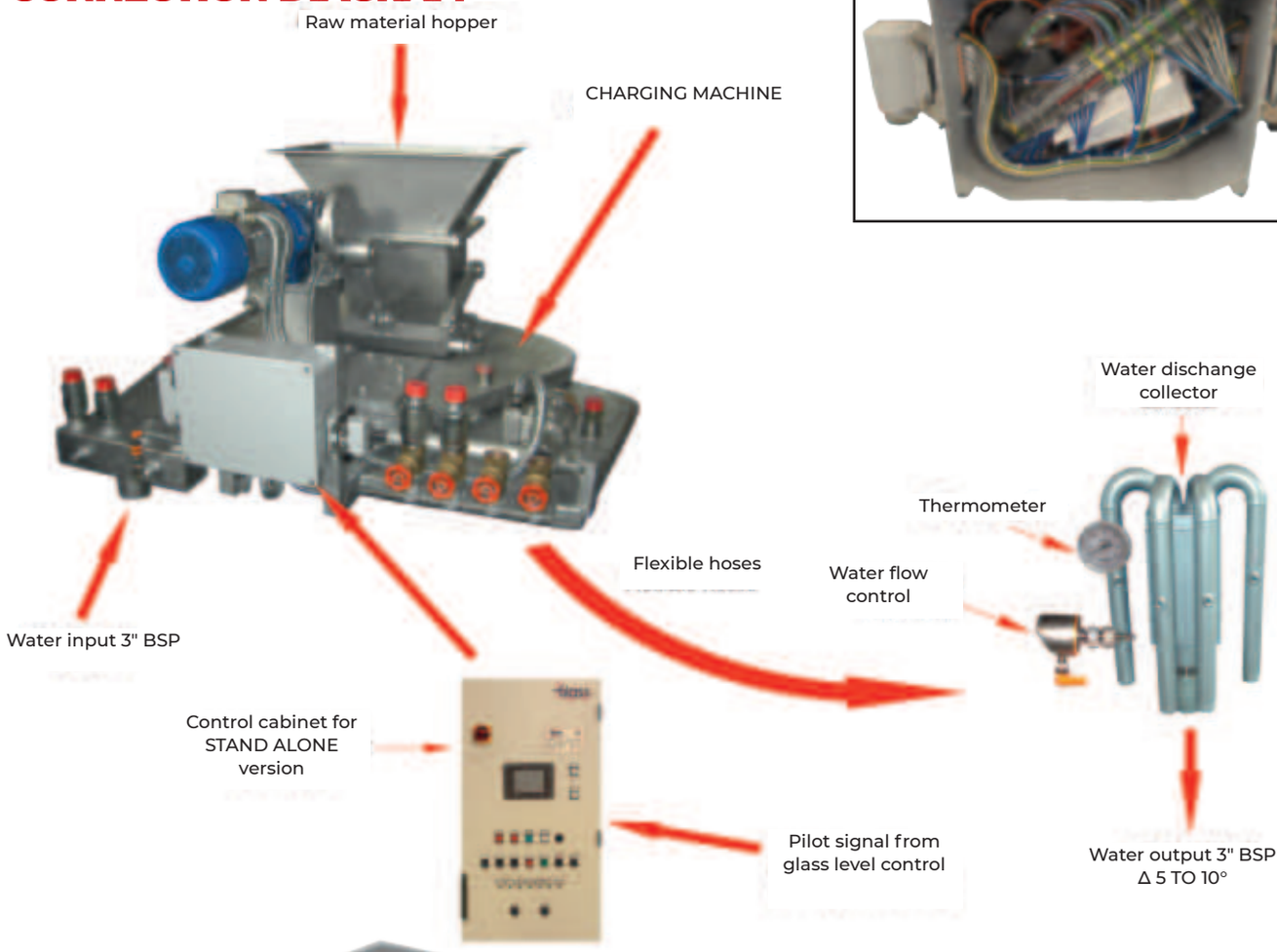
A cranrod mechanism is used to operate the scoop mechanism which is manualy adjustable for good control of the raw materials flow rate.

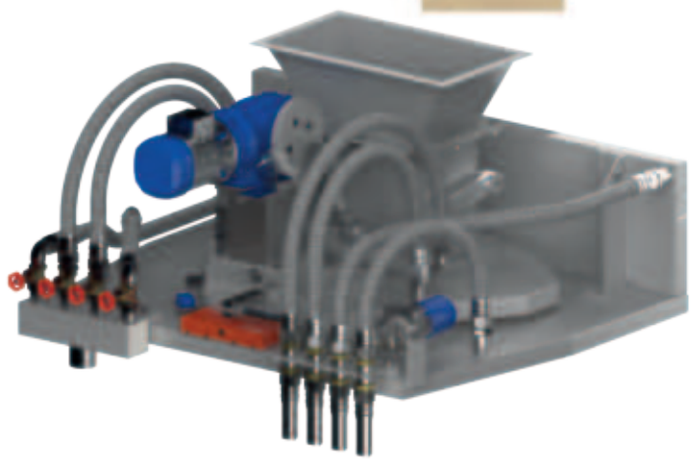
All machines are fully tested and wired with high temperature cables, components and junction box.

To cope with the high temperature environment, the scoop is driven by a class F, self braking motor with inverter which is also fitted with separate air cooling.

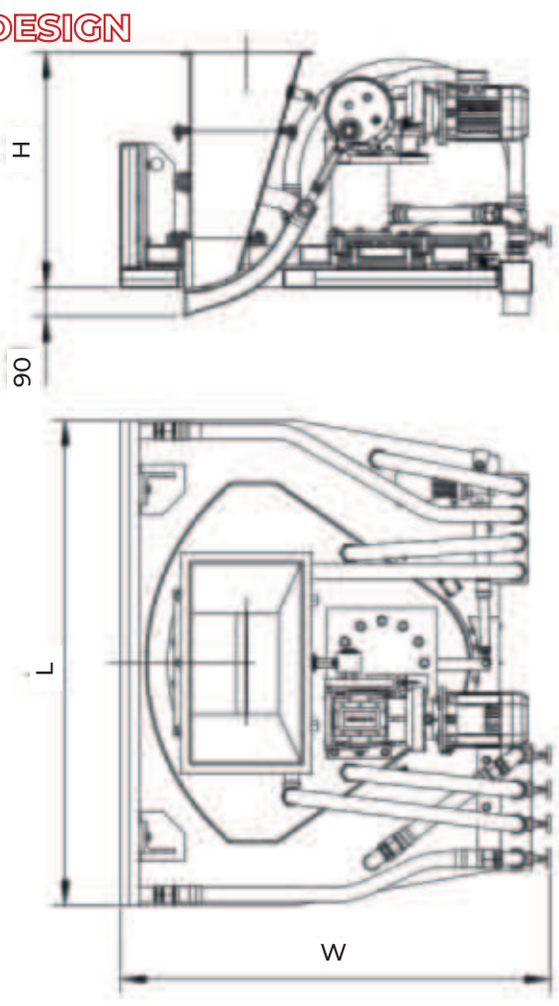


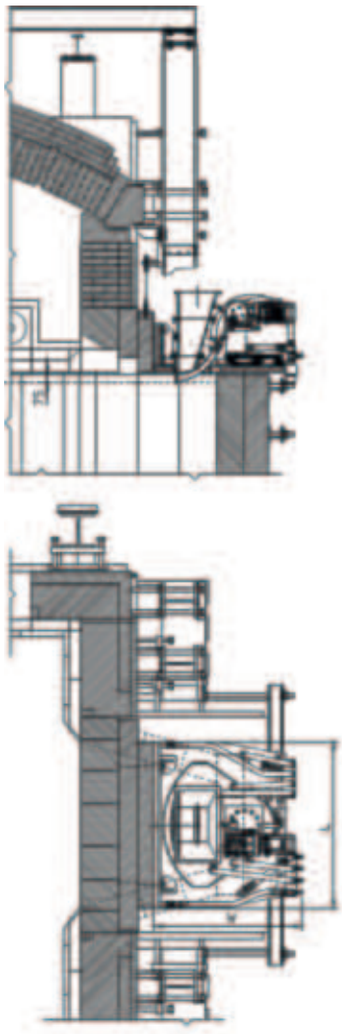
CONNECTION DIAGRAM





DESIGN





TECHNICAL FEATURES

MODEL		INFO PO 250-100-AA	INFO PO 400-180-AA	INF PG 400-180-AA	INF PG 600-280-AA
TYPE		FIXED			
SCOOP WIDTH	mm	250	400	400	600
SCOOP MAX DEPTH		70			
SCOOP SPEED RANGE	STROKES/MIN	6 TO 30			
CRANK GEAR POSITIONS		4			
FLOW RATE @ 50 Hz.	kG/MIN	43 TO 98	76 TO 177		122 TO 281
OSCILLATING ANGLE		-	-	44° (± 22°)	
NUMBER OF OSCILLATING POSITION		-	-	2,3 OR 5	
MATERIAL BEING HANDLED		GLASS BATCH - CULLET ONLY - GLASS BATCH & CULLET			
MAX CULLET SIZE	mm	25			
MOISTURE CONTENT		0,5 TO 3%			
MAIN MOTOR POWER	KW	1,5			
OSCILLATING MOTOR POWER		-	-	0,13	
ELECTRIC POWER CONNECTION		3Ph + E 400 VAC 50 Hz			
WATER COOLING REQUIREMENTS	LITERS/MIN	120			160
WATER COOLING INLET PRESSURE	BAR	2 TO 4			
WATER INLET SPECIFICATIONS		TREATED INDUSTRIAL WATER (4 FRENCH DEGREES) 40 PPM CALCIUM CONTENT - @ 20 TO 35 °C			
WATER FLOW CONTROL		1 WATER INPUT THERMOMETER 3 WATER OUTPUT THRMOMETER 1 WATER INPUT PRESSURE SWITCH 3 WATER OUTPUT FLOW SWITCH		1 WATER INPUT THERMOMETER 4 WATER OUTPUT THRMOMETER 1 WATER INPUT PRESSURE SWITCH 4 WATER OUTPUT FLOW SWITCH	
DIMENSIONS (LxHxW)	MM	900 X 635 X 1230	1050 X 750 X 1230	1550 X 750 X 1360	1850 X 750 X 1360
WEIGHT	KG	325	400	550	600

CONTROL BOARD

The batch charger can be controlled and actuated through a local control board or it may be connected to the main control room by a suitable 4-20mA signal.

The control board is of rugged steel construction and is delivered completely wired and tested ready to be connected with special connectors to the batch charger junction box.

Two different operating modes are available:
a) Continuous cycle
b) ON-OFF cycle

a) In Continuous cycle mode, the machine works continuously and the charging speed is controlled either automatically or manually.

In “Automatic mode” by a remote 4-20mA signal (from the glass level control) continuously adjusting the quantity of raw batch charged according to the production needs.

In “Manual mode” the charger speed is set manually (1 to 100%) from the AUTO/MAN station located on
the front of the control board.

b) In ON-OFF cycle an adjustable timer is set by the operator to stop and start the batch charger.

In “Automatic mode” the ON-OFF signal0 comes from the glass level control. The machine works at the selected speed during the time when the “ON” signal is active and stops during the “OFF” time range.

In “Manual mode” the operator can directly set the start and stop timing cycle and the relevant charging speed.

TECHNICAL FEATURES

MODEL	INF PO 400-180-AA	INF PG 400-180-AA
CHARGING MACHINE TYPE	FIXED	OSCILLATING
MENAGEMENT AND CONTROL	ELECTROMECHANICAL	PLC
RS 485 MODBUS	-	✓
ALARMS MANAGEMENT	WITH LED	ON PLC PANEL
MANUAL MODE (0 TO 100)	✓	✓
REMOTE CONTROL SIGNAL (4 TO 20 mA)	✓	✓
ALARMS TRANSMISSION	FREE CONTACT	WITH RS 485
SPEED CONTROLLER	ELECTRONIC FREQUENCY INVERTER	
MANAGEMENT OF OSCILLATING POSITION	-	TIME FOR EACH POSITION
NUMBER OF MACHINES CONTROLLED	1	MAX 2
ELECTRIC POWER CONNETION	3ph + E 400 VAC 50 Hz	
DIMENSION (LxHxW)	600 X 1900 X 600	600 X 1900 X 600

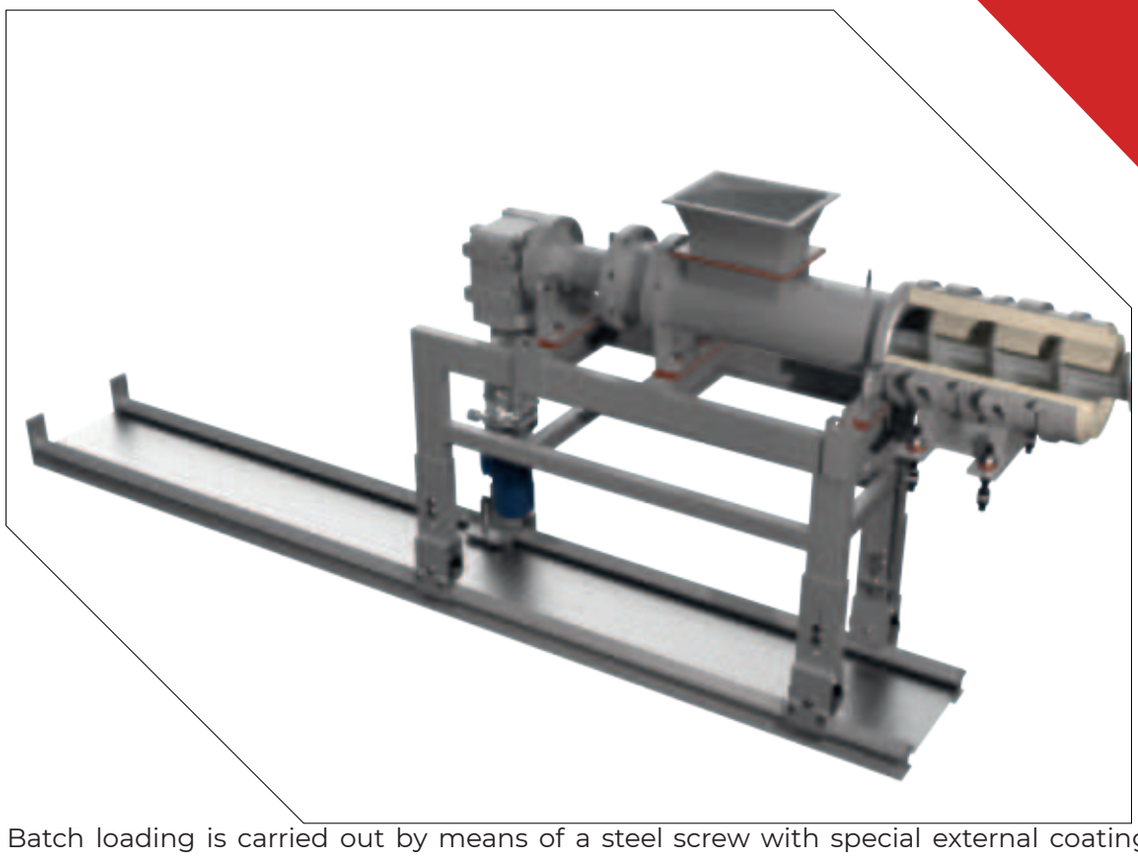
SCREW BATCH CHARGER

SCREW BATCH CHARGER

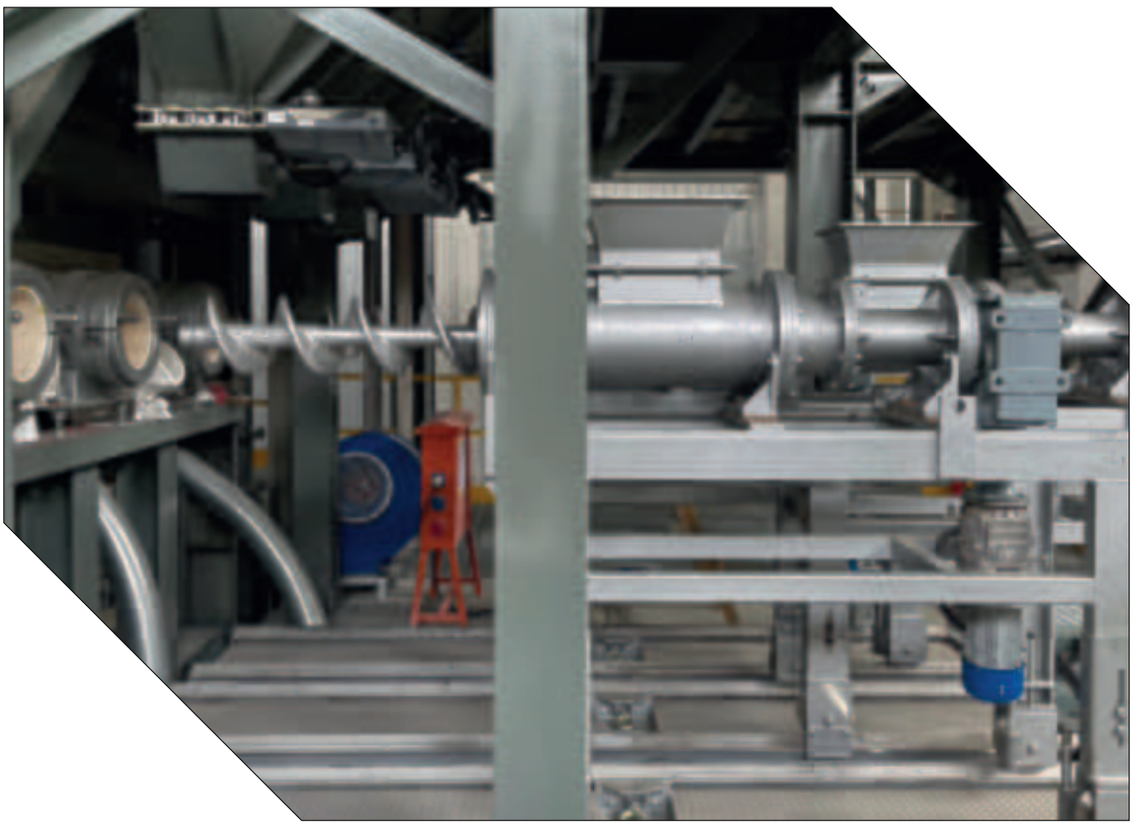
The batch charger is one of the most important pieces of equipment installed in a glass furnace as it has an important influence on the performance of the furnace.
Glass Service has developed a range of batch chargers including a screw batch charger. Screw batch chargers are normally installed in the back wall of the furnace through a refractory block.
The mechanism is installed on a welded steel frame with four wheels which travel on rails for easy positioning and removal.

The batch charger includes the following main components:

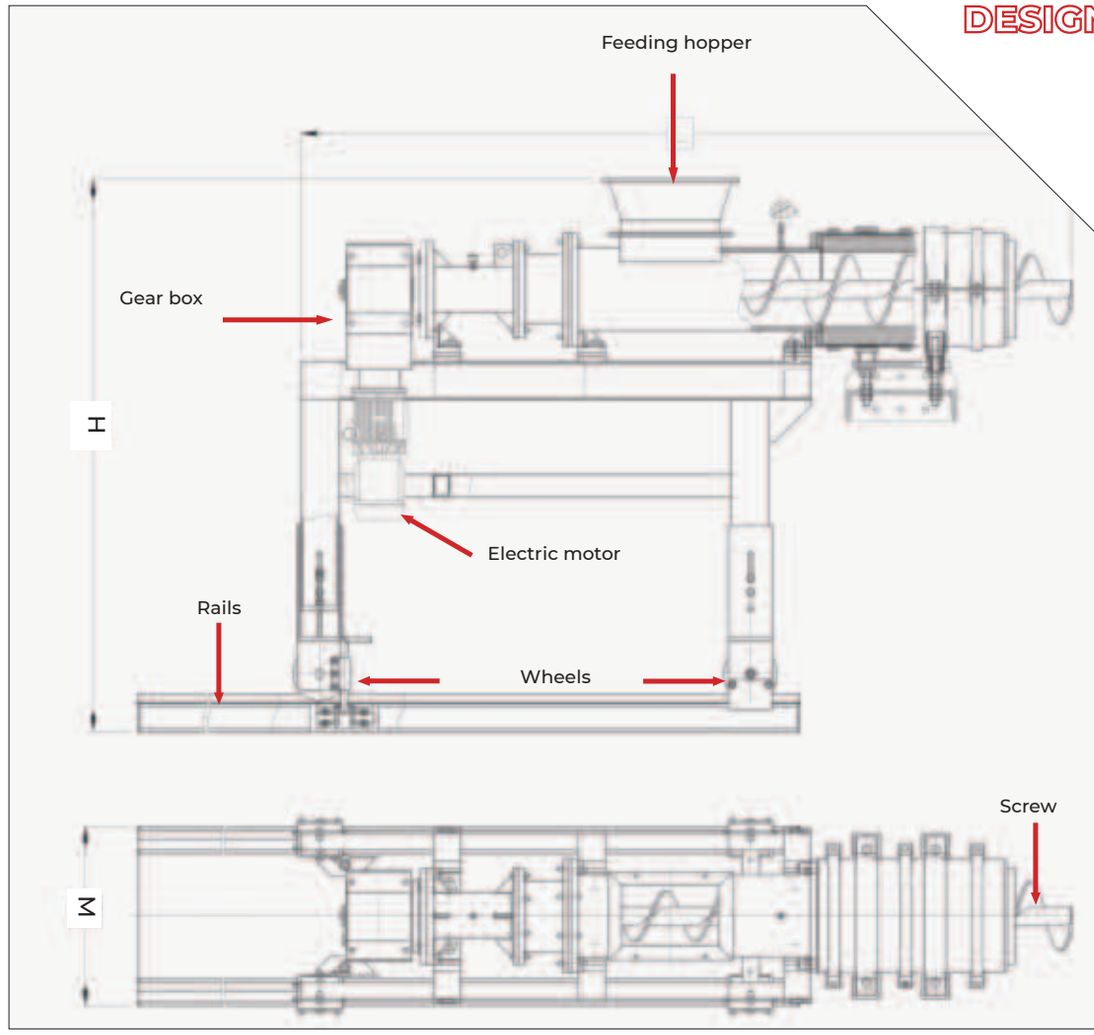
- Rails
- Supporting frame realized with steel profiles
- Feeding hopper
- Screw with special external coating
- Feed tube
- Refractory protection for the screw nose
- Drive system with AC servo-ventilated motor and gearbox



Batch loading is carried out by means of a steel screw with special external coating to prevent wear. Batch is loaded via the feed hopper and is fed by gravity into the feed tube onto the feed screw (manufactured of steel with a special coating to minimise wear) which in turn charges the batch into the furnace. The screw is actuated by a three-phase asynchronous electric motor coupled to a speed reducing gear unit. The motor is controlled by an inverter located in the main control board, driven by a 4-20mA signal from the glass level control, thus ensuring a continuous and smooth regulation of the charging rate. The drive includes large diameter conical roller bearings and a system to prevent batch damaging the bearings, etc.

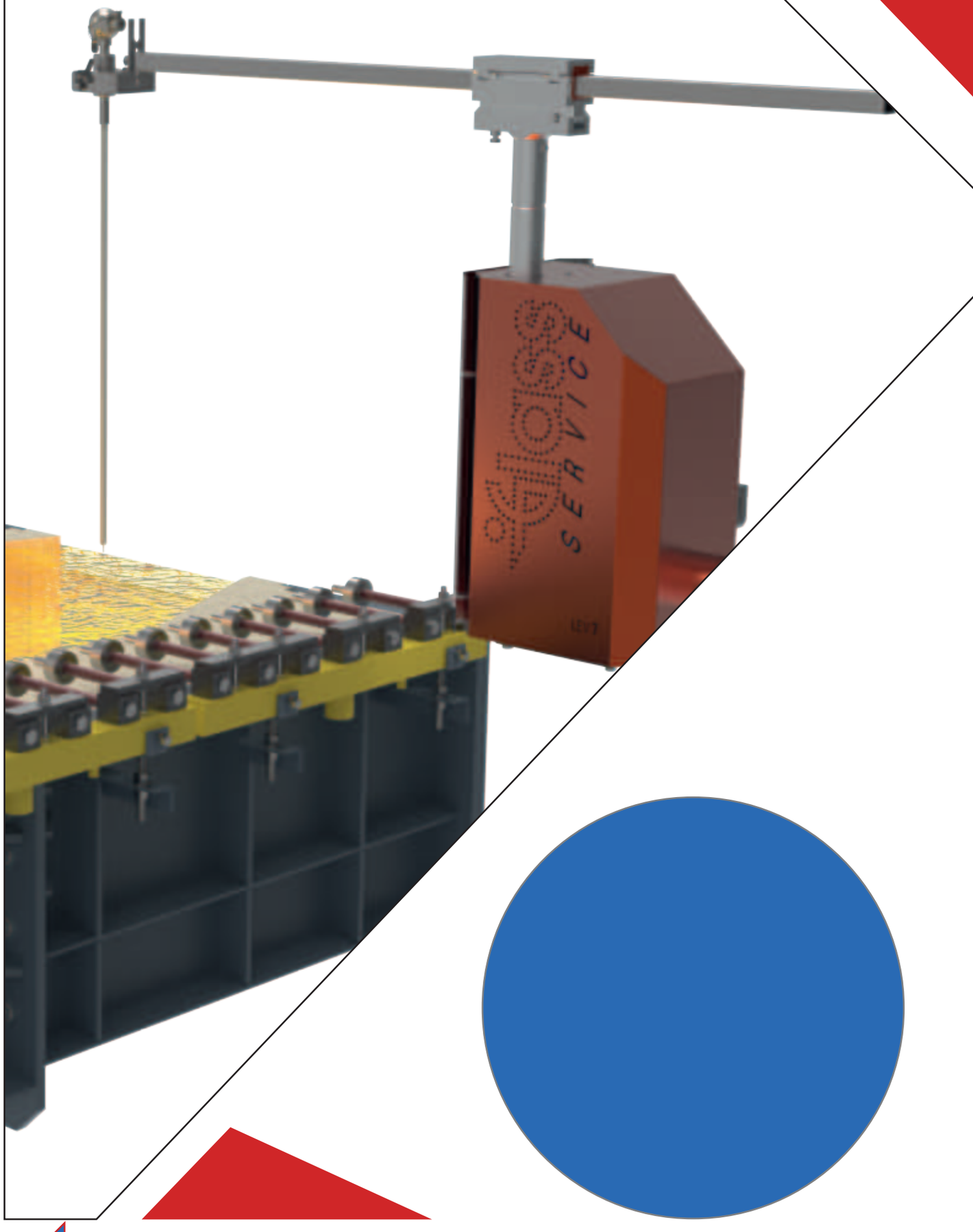


DESIGN



TECHINAL FEATURES

MODEL		INF CR R 270/1250 040 AA
TYPE		REFRACTORY HEAD
FEEDING TUBE INNER DIAMETER	mm	270
SCREW DIAMETER	mm	250
SCREW PITCH	mm	150
GEAR BOX RATIO		1 TO 171,5
MOTOR SPEED	rpm	1430
SCREW SPEED	rpm	8,3
FLOW RATE	Kg/min	7,5 TO 37
MATERIAL BEING HANDLED		GLASS BATCH - CULLET ONLY - GLASS BATCH &CULLET
MAX CULLET SIZE	mm	25
MOISTURE CONTENT		0,5 TO 3%
MAIN MOTOR POWER	KW	1,5
ELECTRIC POWER CONNECTION		3Ph + E/400 VAC 50 Hz
DIMENSION (LxHxW)	mm	2800 x 2000 x 650
WEIGHT	Kg	


SERVICE

GLASS LEVEL CONTROL MACHINE MODEL LEV 7

The glass level is one of the most important parameter to control in a glass furnace.
Glass level fluctuations have a large influence on the production quality and on the furnace efficiency.
An accurate glass level control:

- Reduces fluctuations in the batch charger speed
- Reduces carryover
- Stabilizes the gas/fuel flow
- Stabilizes the furnace temperature pattern
- Reduces the energy consumption
- Increases the glass quality
- Increases the production efficiency

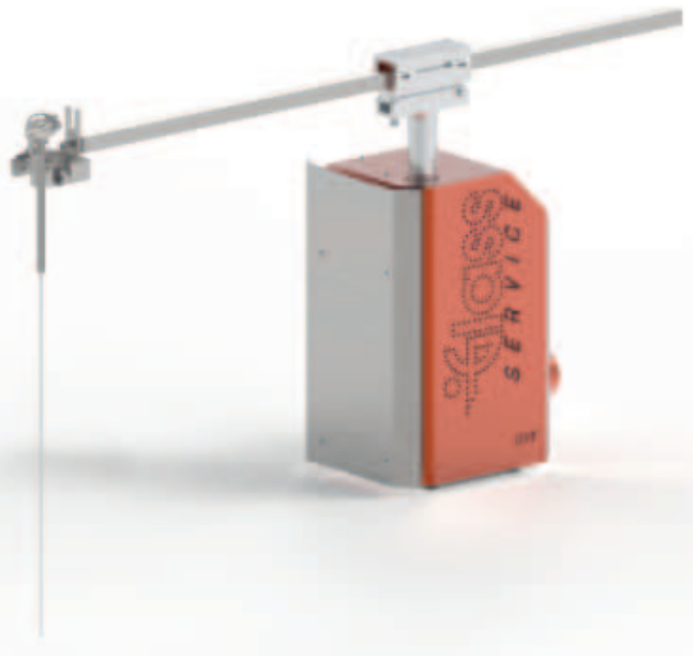
The Glass Service level control unit is a very precise machine using very simple principles and a robust mechanical mechanism to give precise measurement of the glass level in the furnace.

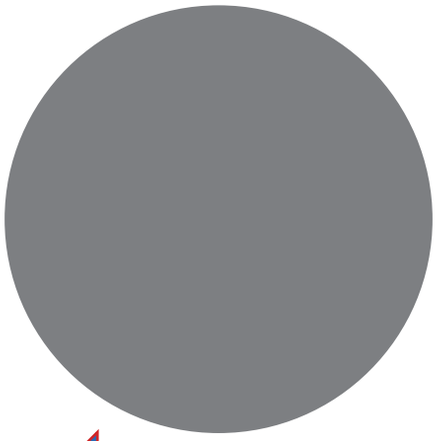
LEVEL CONTROL UNIT

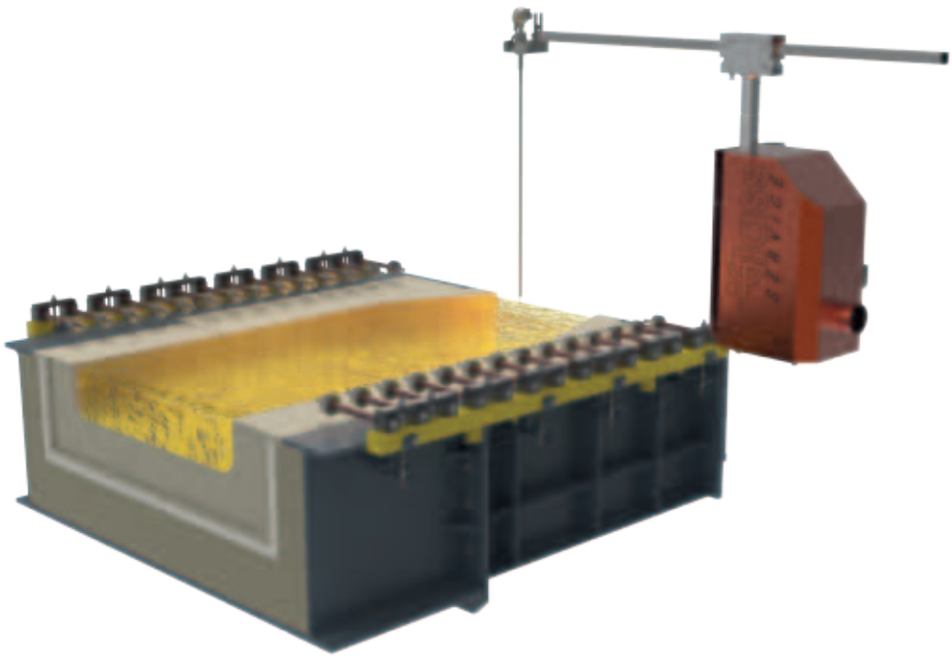
The glass level is detected by a platinum tip touch the surface of the molten glass, to ensure a clean measurement, it utilises an electrical current to break any tail produced by contact with the glass.
All of the parameters detected, (touch speed, touch frequency, recession speed, etc.) can be programmed from the dedicated touch screen PLC with optimal settings for the specific furnace and glass type.

The glass level is detected by a high precision optical encoder directly connected to the platinum tip by a mechanical play free mechanism.

Glass level controls have to operate in very arduous conditions, the Glass Service level control is very reliable and is designed for 24h/7d operation in high temperature environments, to be user friendly and for easy maintenance.





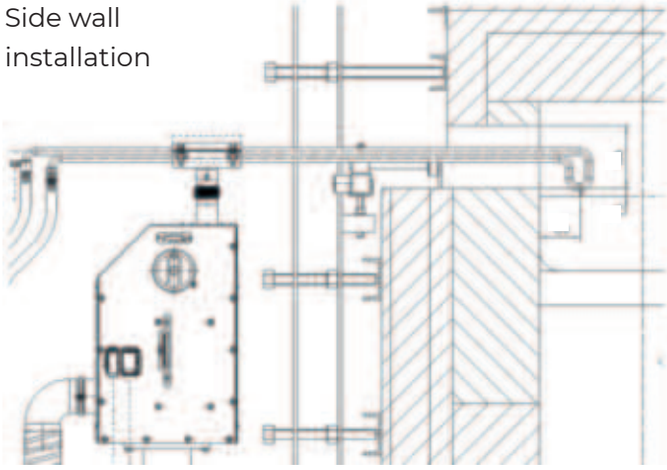


GLASS LEVEL CONTROL MACHINE MODEL LEVEL 7

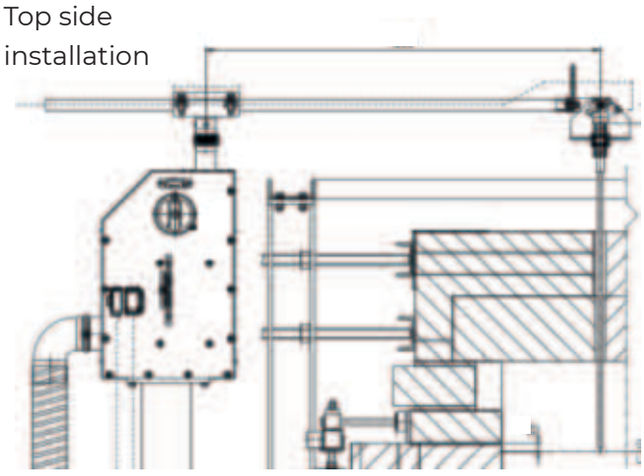
The machine is composed of:
- Glass level machine
- Probe
- Control board
- Connecting cables (option)
- Cooling fan

Cooling water flow and temperature control system (only for water-cooled probe configuration)

Side wall installation



Top side installation



LEV7 supports two probe configurations:

1) **Side Wall installation** – water cooled metal probe with platinum tip

2) **Top installation** – vertical alumina probe type with platinum tip

Glass level measurement is achieved through a platinum/rhodium sensor that, by touching the glass surface closes the detection circuit. The probe assembly is moved up and down by means of a sturdy crank-rod mechanism with two different speeds, starting with a higher speed, as the probe approaches the glass, the speed is reduced for accurate glass level detection. The crank position is controlled by a high precision encoder and the resulting vertical stroke is calculated by the control PLC. When glass is detected the machine reacts simultaneously by:
- Raising the probe at high speed
- Using a high voltage transformer to generate a high current electrical impulse that will avoid any glass particles from adhering to the probe tip.

As a result of this process the PLC will then update two analog or digital output signals, proportional to the measured glass level and the glass level set point. The output signals can be used to:
- Directly drive a batch charger machine (the LEV7 model, through a PID loop or ON/OFF control, is ready for direct control of a batch charger).
- Displaying/processing through another management system (PLC, DCS, etc.).

The system is designed for easy handling of all working parameters such as: frequency of the measuring cycle ON/OFF electrical impulse approach speed; measuring speed; etc...

All parameters are easily set on the touch-screen display.

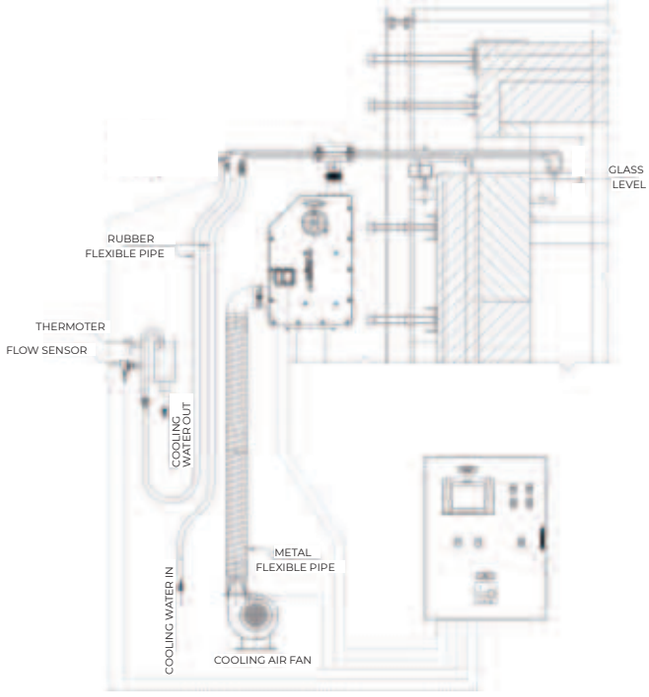
Lev 7 main features (others available on request)

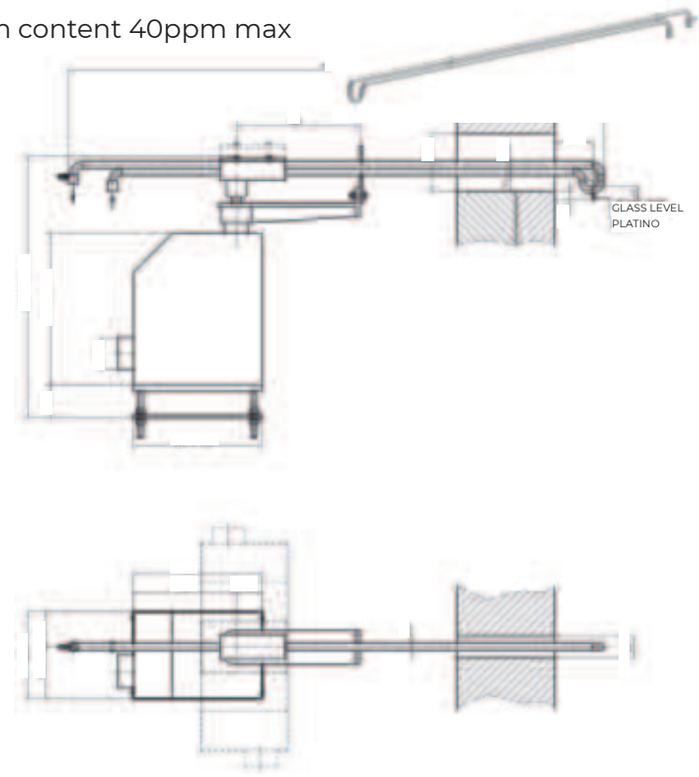
- Vertical probe position regulation by mechanical handle: maximum stroke 100 mm and position indicator
- Quick change mechanism to facilitate easy probe remova
- Cabling through suitable connectors for easy machine connection
- Auto zero detection
- Glass level auto calibration
- Level Set Point programmed from touch-screen, with process overview
- Touch screen LCD
- Movement by asynchronous servo-cooled motor driven by vectorial inverter, directly coupled on gear-box (without belts or chains)
- Vertical movement by sturdy crank-rod mechanism with ball bearings
- Resolution: ± 0.1 mm
- Repeatability: ± 0.1 mm
- Max vertical stroke: 40 mm
- Encoder can be excluded in case of fault
- Dedicated transformer for electric impulse to avoid glass sticking
- Programmable electric shock timing
- Programmable probe speeds
- Programmable measure-cycle timing
- Alarm messages on touch screen display
- Programmable High and Low level alarms
- Alarm contact output by electro-mechanical relay
- RED-GREEN-YELLOW lights for immediate indication of machine status
- Alarm horn
- 2 programmable 4 to 20 mA outputs
- ON/OFF output contact to drive ON/OFF batch charger
- Batch charger direct drive PID loop feature
- Ethernet Modbus optionally available
- Installed power: 0,34 kW, 220 VAC, 50 Hz.

Side wall configuration

Water cooled side installation. Single pipe probe in stainless steel with platinum/rhodium tip Ø3 mm x 15 mm, total length 1600 mm. For this installation a side slot will be required in the forehearth or the distributor.

- Cooling water flow: 20 litres/min
- Max temperature cooling water Input: 35°C
- Max temperature cooling water Output: 45°C
- Water cooling pressure range: 2 to 4 bars
- Water request: chloride 50ppm, ph 8 to 8.5 calcium content 40ppm max

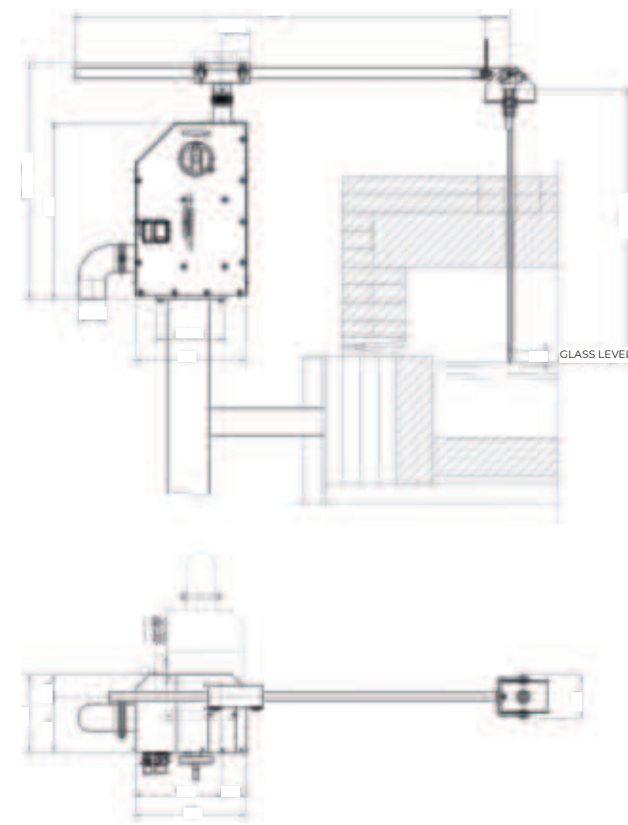


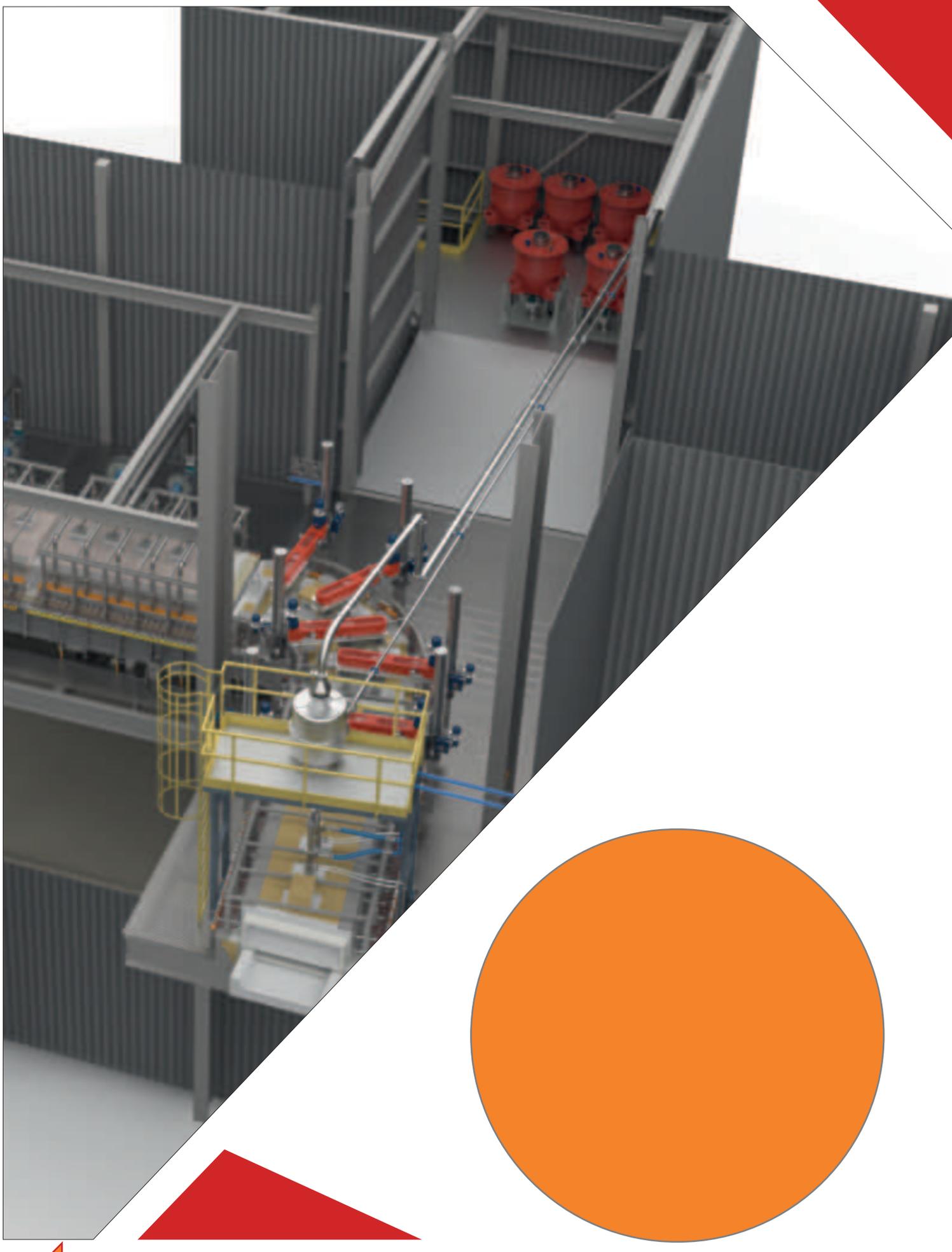


Installation from the top

Vertical probe in alumina 799 with platinum/rhodium tip Pt Ø2 mm x 15 mm.

The probe total length is 1000 mm plus the DIN type connector head.





STIRRER MECHANISM

STIRRER MECHANISM

The purpose of the Stirring Mechanisms is to homogenize the glass in the forehearth.

The main applications are:

- Removal of cat scratches
- Removal of cords
- Glass blending in colouring forehearths

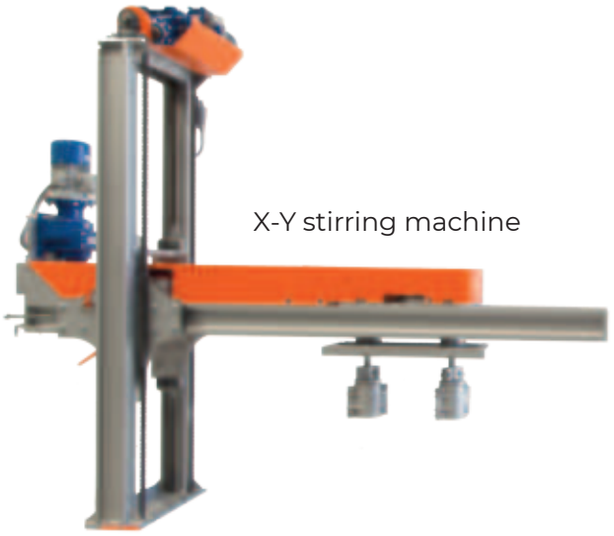
Taking into account the severe working conditions due to the high working temperatures, special attention has been paid to select the appropriate materials, both for the steel supporting frame and for the moving parts which are subject to wear, in order to improve their reliability and to reduce as much as possible the maintenance operations.

Generally a stirrer mechanism comprises the following:

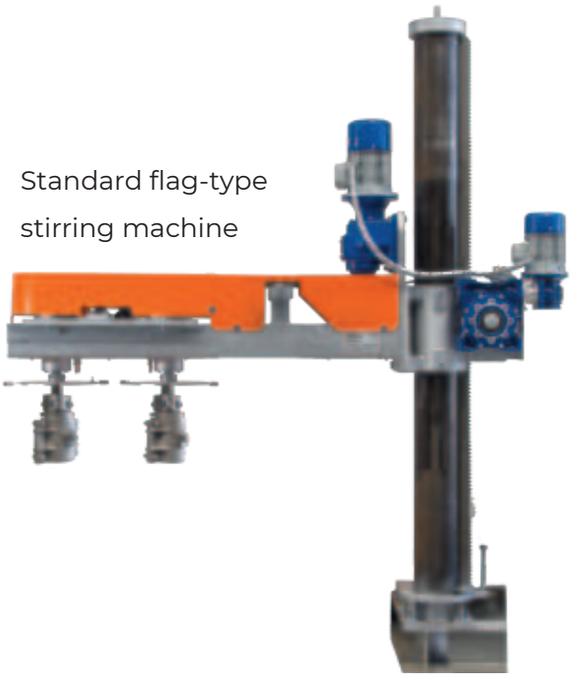
- A steel support frame
- A manual or automatic lifting system to remove the stirring unit
- Stirrers (paddle type or screw type)
- Control system (either a central control cabinet or a local control panel)

Glass Service produces the following stirrer systems:

- Standard flag-type stirring machine
- X-Y stirring machine



X-Y stirring machine



Standard flag-type stirring machine

FLAG-TYPE STIRRER MECHANISM

The stirring machine consist of:

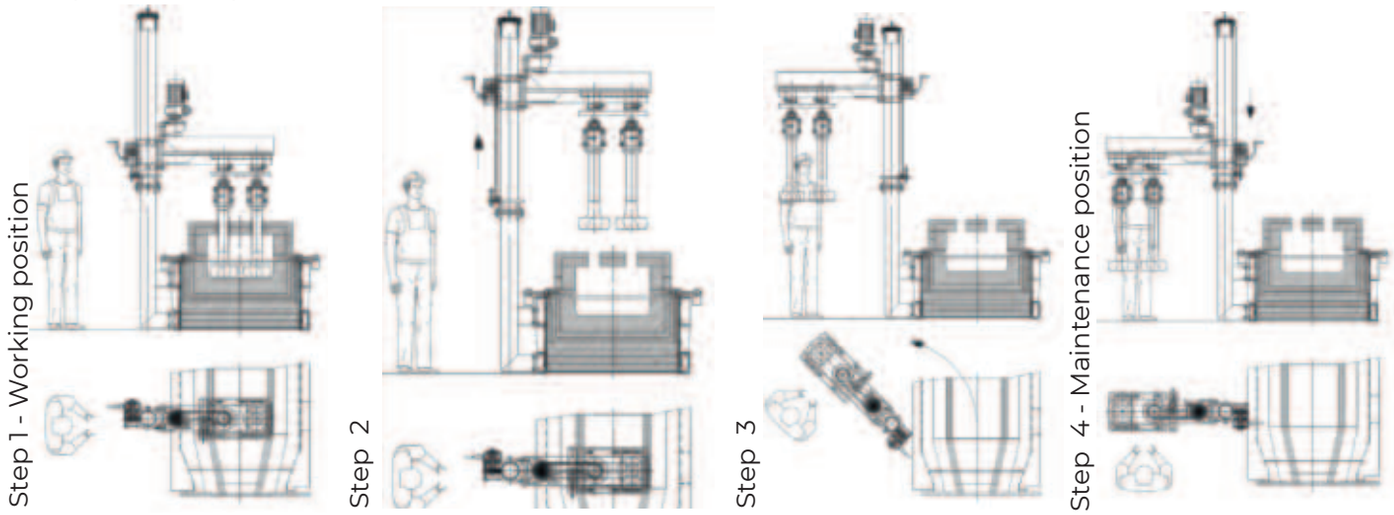
- Strong steel structure
- Quick release coupling for the refractory screws or paddles
- Bearing lubrication and cooling system
- Up to 5 rotors can be installed
- Easy changing of the paddles/screws
- Easy maintenance
- Steel vertical support column manufactured from large diameter steel tube
- Stirring mechanism that can be moved vertically on the above column by means of a manually operated rack and pinion system (optionally a motor can be installed)
- Drive system comprising an electric motor and gearbox with manual speed control
- Drive system with chain, tensioner and pinion
- Screw spindles provided with special high temperature graphite bearings
- Quick type coupling system for refractory screws or paddles
- Compressed air system with filter, pressure governor and accessories for bearing cooling and lubrication
- Heat shield
- Control box with drive inverter, emergency stop button and start/stop

TECHNICAL CHARACTERISTICS

VERTICAL HEIGHT	APPROX. 2.275 MM - CUSTOMIZABLE
VERTICAL STROKE OF STIRRING MECHANISM	APPROX. 950 MM - CUSTOMIZABLE
DISTANCE FROM CENTER FOREHEARTH TO SUPPORT COLUMN	CUSTOMIZED
N° OF ROTORS	1 TO 5
MAX. WEIGHT STIRRERS	120 KG EACH
STIRRER REVOLUTION SPEED (MANUAL ADJUSTMENT) SCREEW TYPE	4,8 - 26 RPM
STIRRER REVOLUTION SPEED (MANUAL ADJUSTMENT) PADDLE TYPE	1,3 - 12,6 RPM
INSTALLED POWER	0,75 KW
POWER SUPPLY	380 V 3 PH - 50 HZ/440 V 60 HZ

MAINTENANCE AND REPLACEMENT OF STIRRERS

The maintenance and the replacement of the paddles/screws is easily carried out.
The operation sequence for this is as follows:



X-Y STIRRER MECHANISM

Main features:

- Minimal installation spaces
- Maintenance operation simplified
- Quick type coupling system for refractory screws or paddles
- Bearing cooled and lubricated
- Up to 5 rotors installable
- Minimum space required for stirrer replacement

X-Y STIRRER MOVEMENTS

Glass Service has developed a stirring mechanism with two movements on both the X and Y axes that greatly reduces the space required for the installation and simplifies any maintenance operation. This machine is a vertical structure attached to the forehearth steel frame. An electric motor drives the chuck support arm up and down the structure.

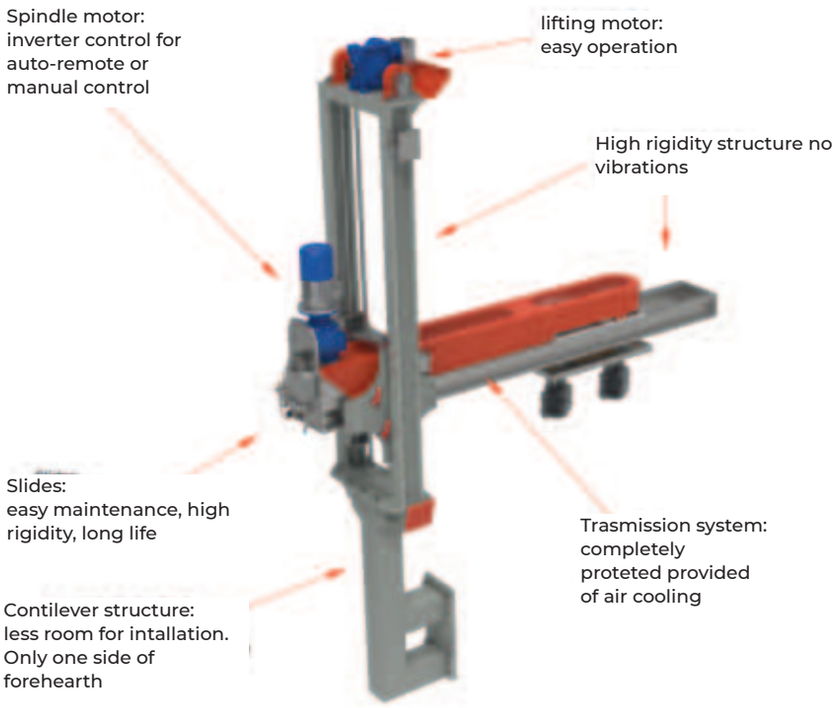
This Y movement is achieved by moving the supporting arm on two parallel reinforced rails with special bearings and reinforced wheels. The motor and gearbox are located on top of the structure with a chain directly coupled to the chuck holder arm. In the unlikely event of chain breakage the arm cannot fall down due to the special design of the rails. The chuck support arm can easily slide towards the side of the forehearth on a horizontal arm. This movement is again operated on two parallel and reinforced rails with special bearings and reinforced wheels whilst power transmission is achieved through a rack and pinion. Each spindle turns on large graphite ball bearings. Thanks to this innovation the following features can be achieved:

- Minimum installation space
- Any maintenance operation, both on paddles or motor, is simpler and performed away from the hottest area of the forehearth
- The re-positioning of the spindles over the forehearth is very simple and precise.

TECHNICAL CHARACTERISTICS

GENERAL DIMENSION	ACCORDINGFOREHEARTH DIMENSIONS
N° OF ROTORS	1 TO 5
ROTORS INTERXIS	TAILORED
MAX. WEIGHT OF EACH STIRRERS	60 KG
STIRRER REVOLUTION SPEED (MANUAL ADJUSTMENT) SCREEW TYPE	4,8 - 26 RPM
STIRRER REVOLUTION SPEED (MANUAL ADJUSTMENT) PADDLE TYPE	1,3 - 12,6 RPM
INSTALLED POWER	0,75 KW
INSTALLED POWER FOR SPINDLE ARM RAISING MECHANISM	0,18 KW
POWER SUPPLY	380 V 3 PH - 50 HZ/440 V 60 HZ

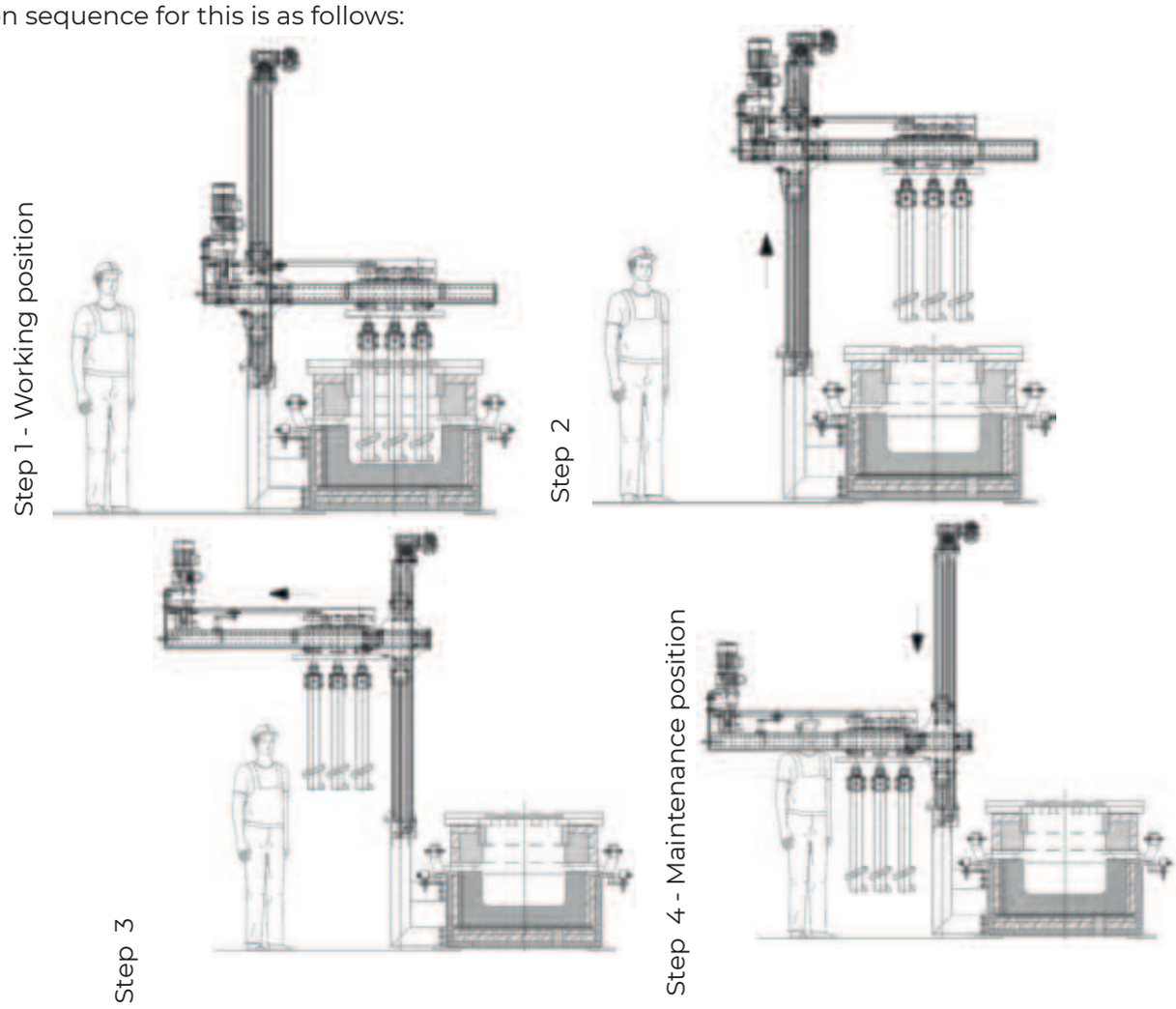
On the top of the chuck holder arm the rotors power transmission group is located. Rotors are driven by a motor plus its gearbox, allowing a perfect control of the rotation speed.
This group is designed to allow, for each rotor, the possibility to rotate in two directions, so that, according to the installation the system can be configured as following:
• All rotors with the same rotation sense
• Each rotor rotating in opposite rotation
Optionally an inverter can be used to control the rotation speed. Each moving part of the machine is fitted with steel guards for safety purposes as well as to protect the mechanisms from dust. The drive assembly is also cooled and lubricated by means of compressed air.
The machine can support any type of rotor currently available on the market.
The chuck and rotor coupling system is a quick release model.



MAINTENANCE AND REPLACEMENT OF STIRRERS

The maintenance and replacement of the paddles/screws is easily carried out and requires very little space at the side of the forehearth.

The operation sequence for this is as follows:



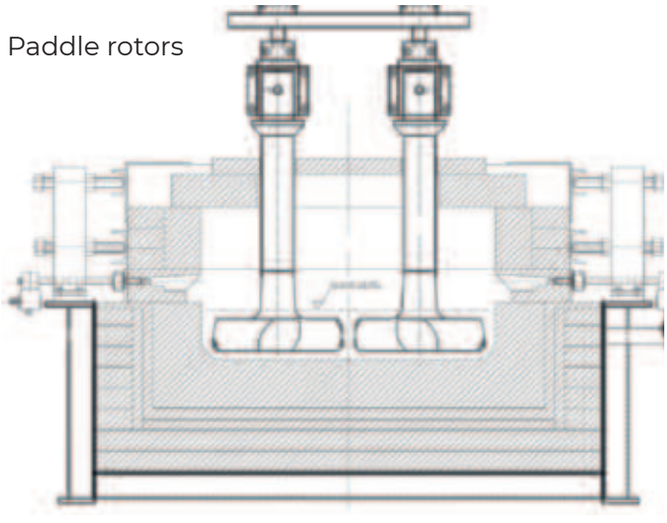
ROTORS TYPE

Two types of rotors can be used, these are:

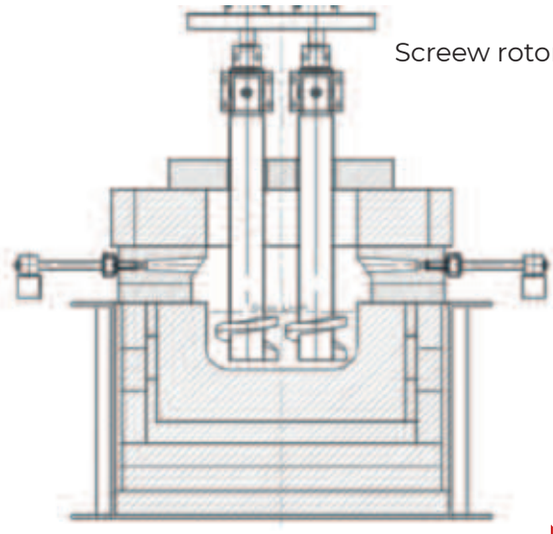
- Paddle type
- Screw type

Glass Service will suggest the correct type of rotor according to the customer requirements.

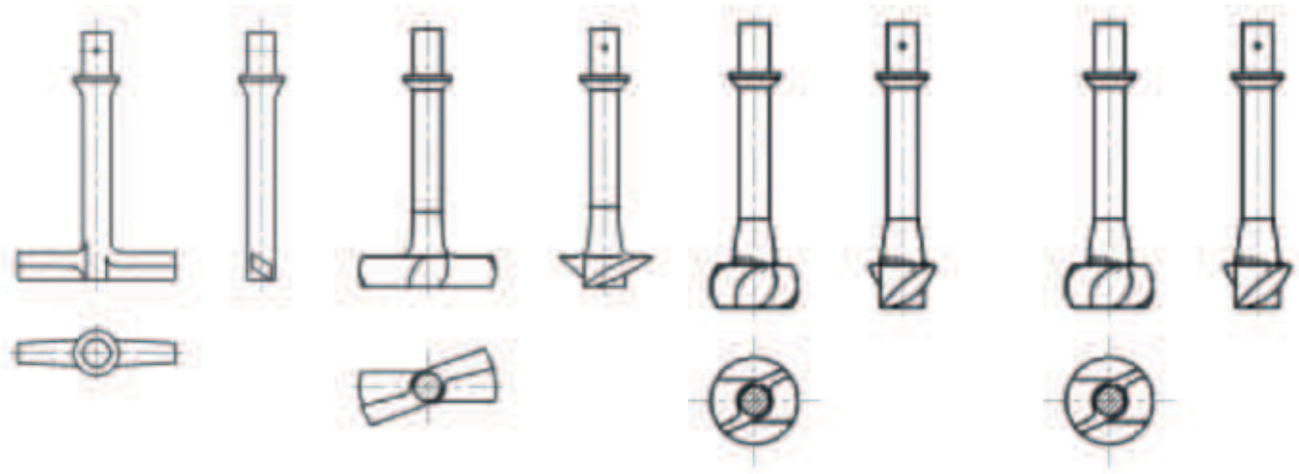
Paddle rotors



Screew rotors

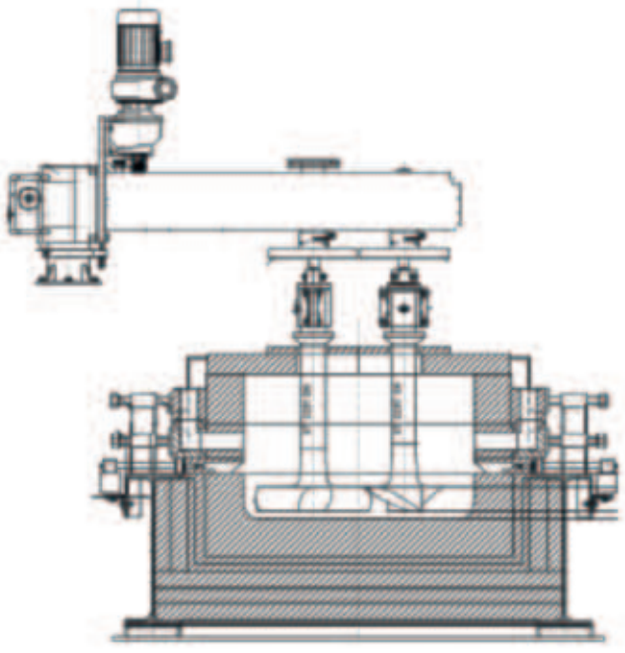


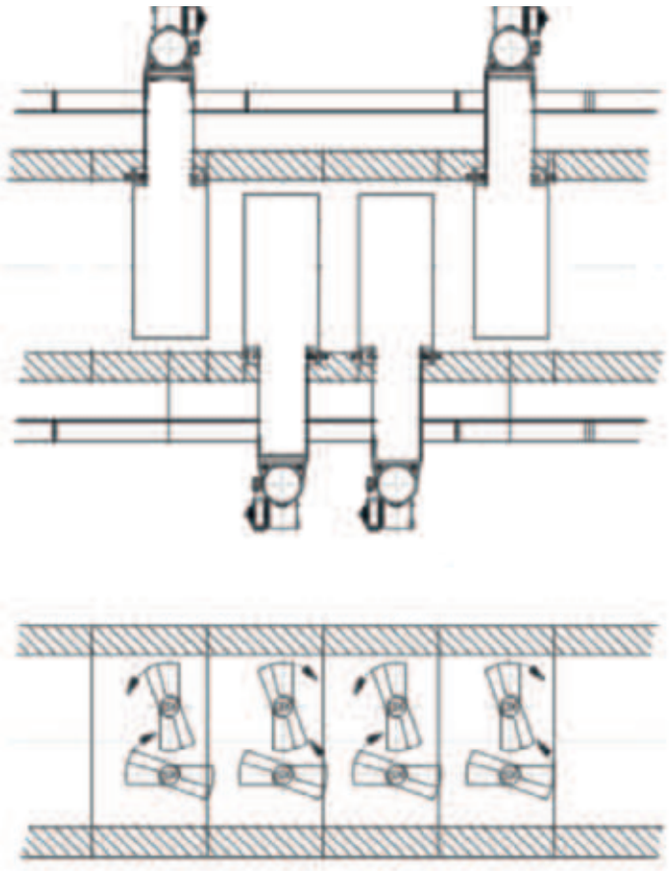
Below are some types of rotors that Glass Service can supply according to the requirements of the customer :



ROTORS POSITIONING

Depending on the forehearth width, type of glass, type of colouring, the available space at the sides of the forehearth etc., we will offer the best solution for the installation of the stirring unit.
Below are simple sketches of a possible installation:





CONTROL CABINET

Glass Service can provide a compact control cabinet including:

- Main power on/off
- Motor protection control
- Start / stop push buttons for spindle rotation
- Emergency stop button
- Red flashing light for alarms

As an option we can provide remote control cabinet with:

- Inverter control for spindles rotation.
- Speed control device for chucks rotation (AUTO/MAN, INC/DEC speed, integrated display). A spindle speed control using an inverter integrated into the control cabinet will allow the system speed to be controlled remotely in the optimal range (i.e. 1.4 to 13 rpm for paddles) both from a remote DCS (with a 4-20 mA signal) as well as directly from the stirrer cabinet, setting a value between 0 and 100%.

OPTIONS

There are some options that we can provide:

- motorized vertical lifting: if required, the vertical lifting can be supported by an electric motor driven by up-down pushbuttons.
- pneumatic clutch: to avoid that rotors can be broken by any extra torque on the same The pneumatic clutch is very useful in case of colouring foreheart installations or in case of installations with several sets of propeller type stirrers.

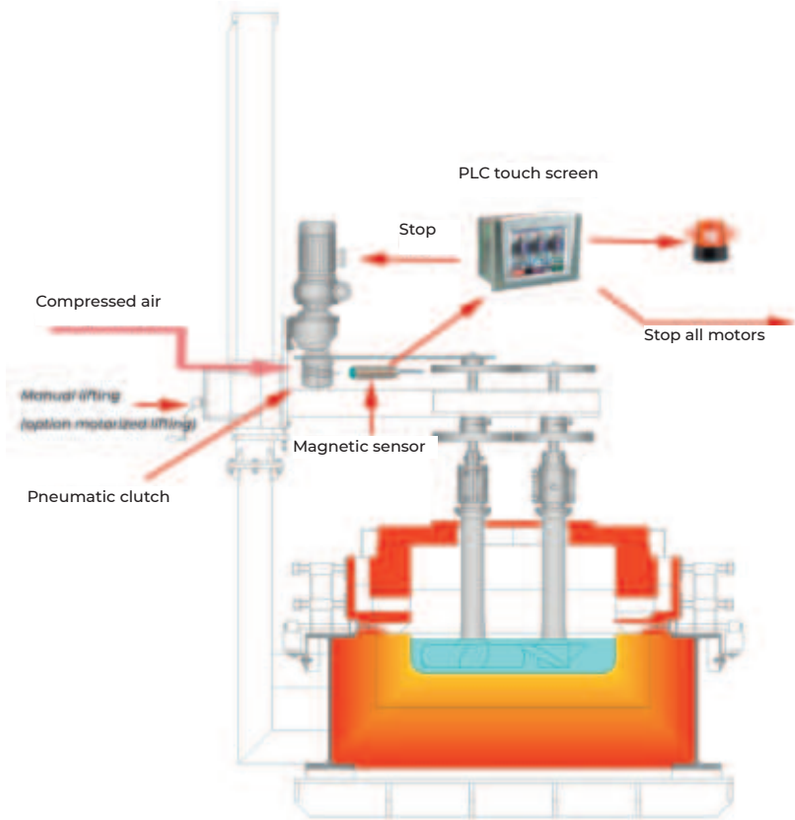
In the case of one refractory stirrers breaking, it can also break the neighbouring stirrer.

The risk of several stirrers being damaged is real when many stirrers are installed.

The pneumatic clutch can solve this problem.

The clutch max torque is set by the operator during the start up. If a rotor suddenly requires extra torque the pneumatic clutch

opens and stops the mechanical transmission, the opening is detected and the PLC stops all stirrer machine motors and sounds an alarm.



√ **Pneumatic clutch available**

√ **Motorized vertical lifting**

BOTTOM DRAIN

BOTTOM DRAIN

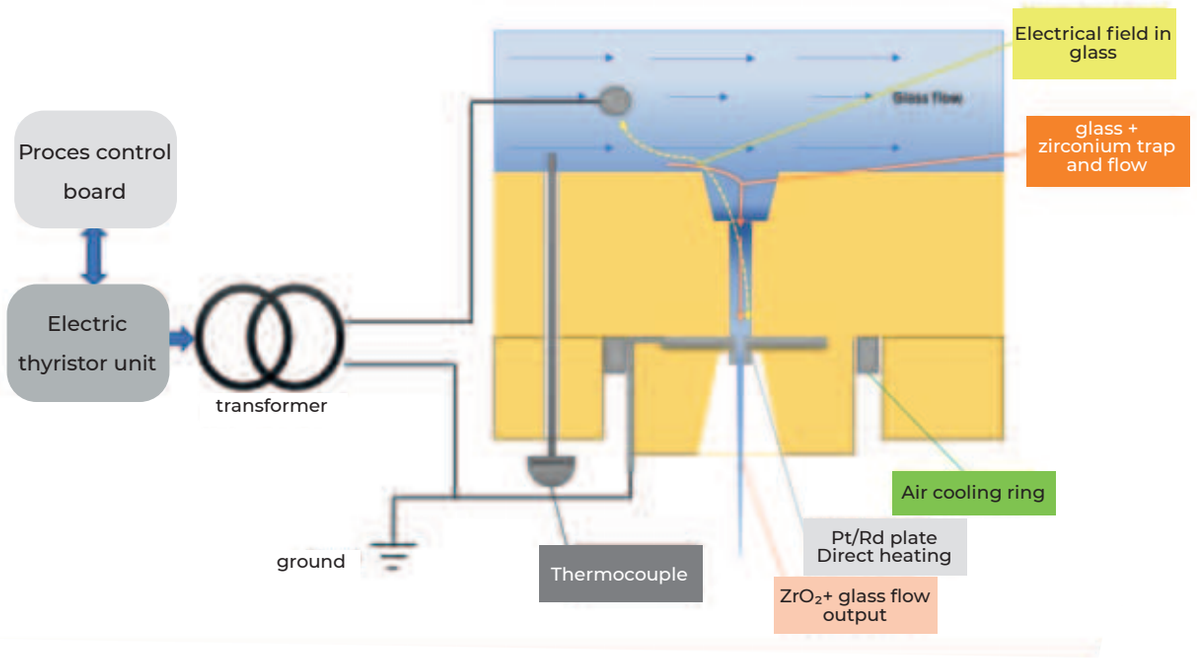
Zircon cords, also known as "cat scratches", pose a growing concern for glass manufacturers worldwide.
In the glass industry, especially for products like tableware, pharmaceutical tubes, molded borosilicate glass, and TFT glass for screens, the absence of cords is a fundamental and critical requirement.
Although there's no evidence suggesting cords affect the physical properties of containers, the glass container market is increasingly emphasizing cord-free glass. Zircon cords are inherent to the glass manufacturing process, stemming from the presence of ZrO2 in furnace and forehearth construction materials. Physical and chemical erosion leads to the formation of zircon-rich glass, which tends to separate from the base glass, resulting in the well-known zircon cords.

Glass Service has designed and developed an effective Bottom Drain system that ensures maximum removal of zircon-enriched glass, guaranteeing compliance with the most strict requirements for cord-free glass either independently or in conjunction with stirrers.

BOTTOM DRAIN TECHNOLOGY USES THE FOLLOWING MAIN FEATURES:

- Refractory design bottom Zirconium trap special block
- Pt/Rd plate with calibrate hole direct heated DHT (Direct Heating Technology) by electrical current
- Air cooling Molybdenum electrode
- Electric power circuit including thyristor unit and power transformer
- Air cooling ring (fans) to prevent glass leak
- Platinum immersed thermocouple for glass temperature reading

The trap block is specially designed to ensure effective separation between high-quality glass and zircon-enriched glass to be drained out. Constructed from fused cast AZS material, the block features a shaped and calibrated drain hole at the bottom



For the Bottom Drain System under normal operating conditions, an electrical power consumption of approximately 2 to 10 kW is typical. The quantity of glass removed depends on various factors, but Glass Service's experience suggests a drainage rate between 300 and 1500 kg/day is adequate. Typically, the Bottom Drain system operates continuously, although intermittent operation is possible for higher product quality.

Glass drainage is primarily influenced by the outlet nozzle's size. An electrical heating system maintains a constant temperature at the outlet nozzle, ensuring a consistent glass pull rate. Power adjustment, synchronized with temperature, stabilizes the pull over time, enabling control of the drained glass flow by increasing or decreasing power.

PROBLEM	SOLUTION
BOTTOM ZIRCONIUM STREAM CAPTURE	• SPECIAL BOTTOM REFRACTORY DESIGN WITH A TRAP • INSTALLATION OF TRASP IN MAIN GLASS STREAM, USUALLY DISTRIBUTOR OF FOREHEARTH (NOT IN MELTING AREA)
GLASS DRAIN FLOW CONTROL	• ELECTRICAL HEATING PT/RD PLATE WITH HIGH PRECISION REGULATION THYRISTOR • THERMOCOUPLE IN DRAIN AREA FOR GLASS TEMPERATURE READING
GLASS DRAIN FLOW MAXIMUM VALUE	CORRECT SIZING OF PLATE HOLE
WATER COOLING MANAGE	• NO WATER USED • COOLING RING BY AIR GENERATED BY FANS AIR COOLING DRY ELECTRODE (AIR BY FANS)
GLASS VOLTAGE RESIDUAL IN GLASS OUTPUT DRAIN	ELECTRICAL GROUNDING OF OUTPUT PT/RD PLATE
LONG LIFE AND STABLE FLOW IN DRAIN	USE OF PT/RD PLATE AND DRAIN HOLE NOZZLE

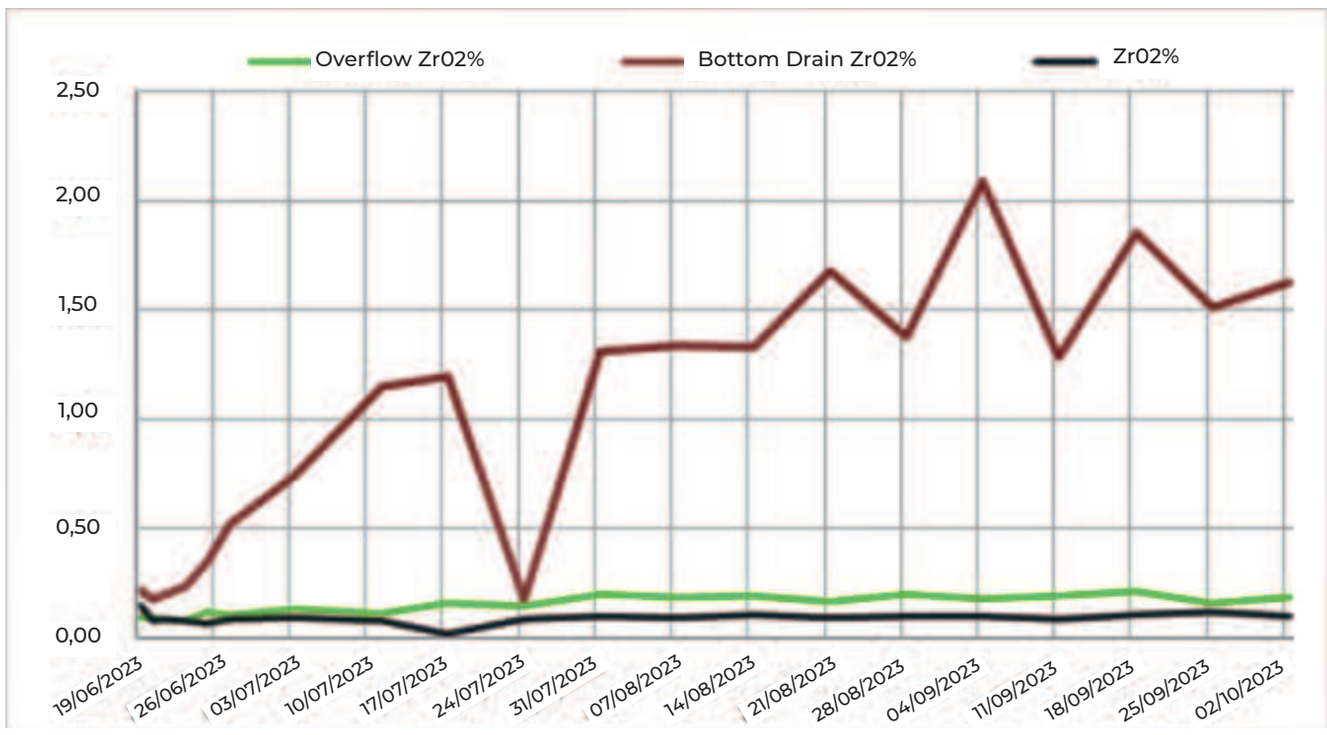
IMPROVED PRODUCT QUALITY

The Bottom Drain System effectively eliminates visible zircon cords in production, confirmed through chemical analysis of drained glass, specifically ZrO2% content.

This capability ensures enhanced product quality and consistency, addressing a common issue in glass manufacturing.

The image depicts a real-life scenario of a specialized borosilicate glass application, specifically designed to withstand high levels of corrosion on refractories. This bottom drain system is installed within the distributor main stream, showcasing its adaptability and effectiveness in challenging environments.

In red the glass drain out, ZrO2 increase from glass basic 0,1% to 2% , drain flow 40 Kg/h continuous operation.

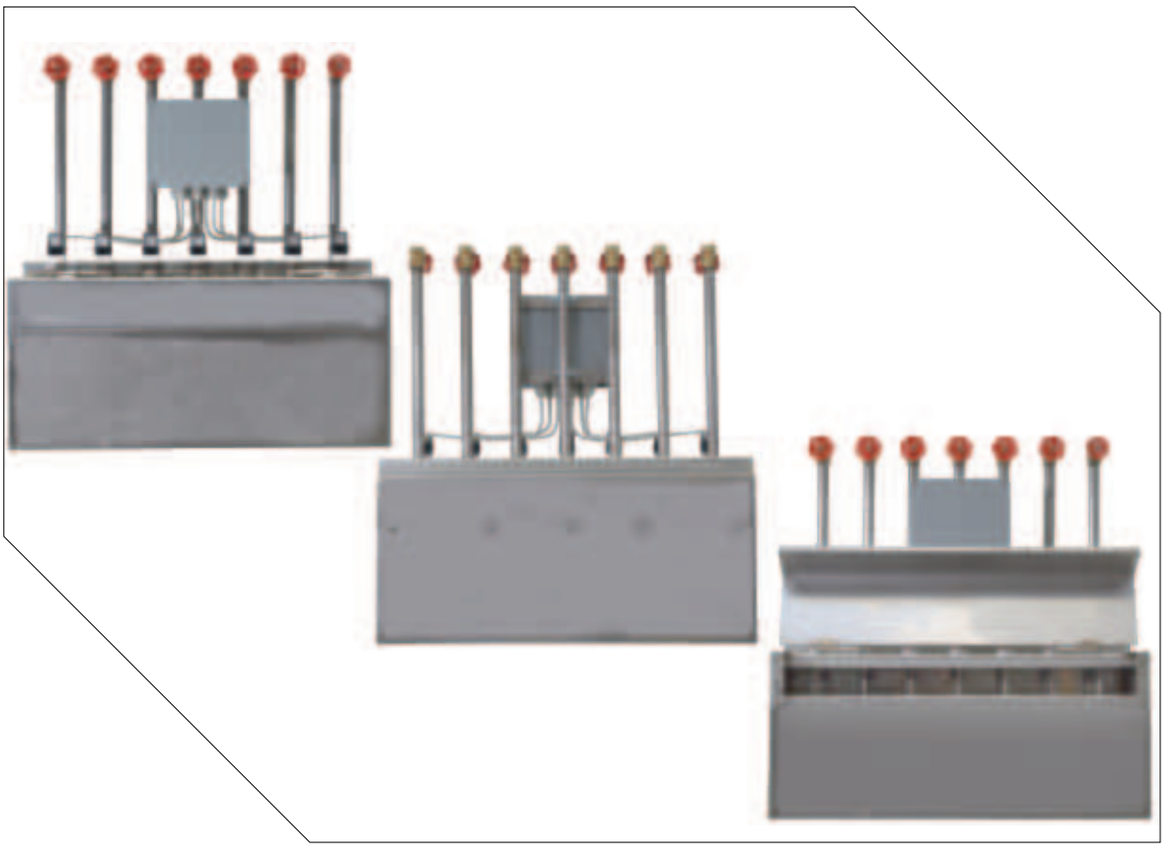


WATER-COOLED BUBBLING SYSTEM

WATER-COOLED BUBBLING SYSTEM

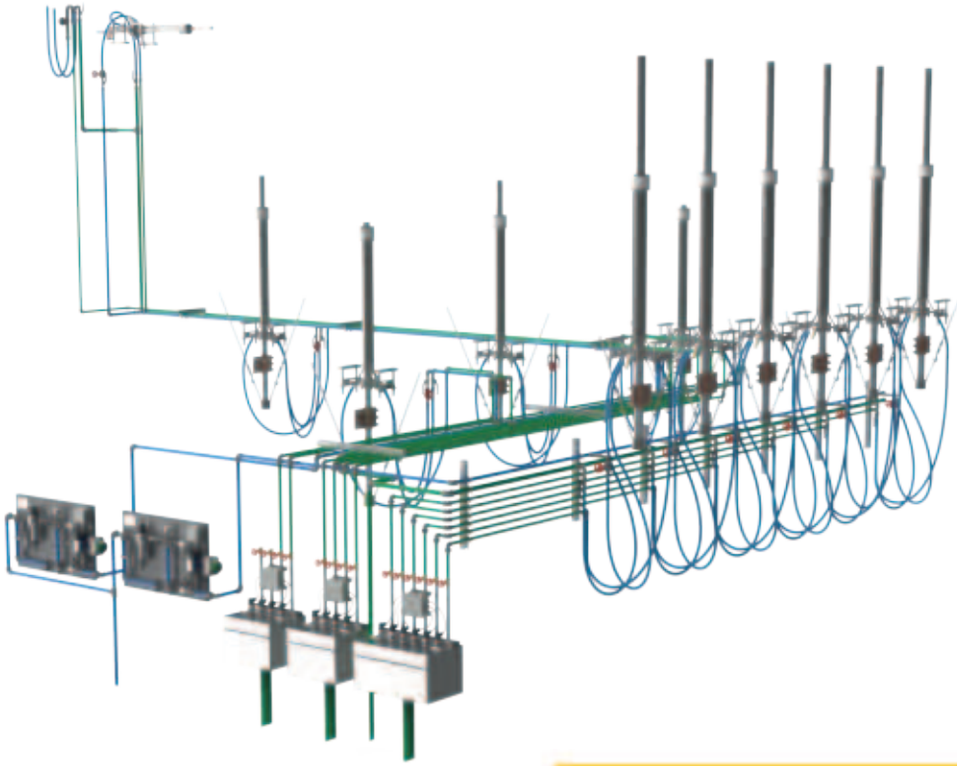
Bubbler systems are installed for a number of reasons:

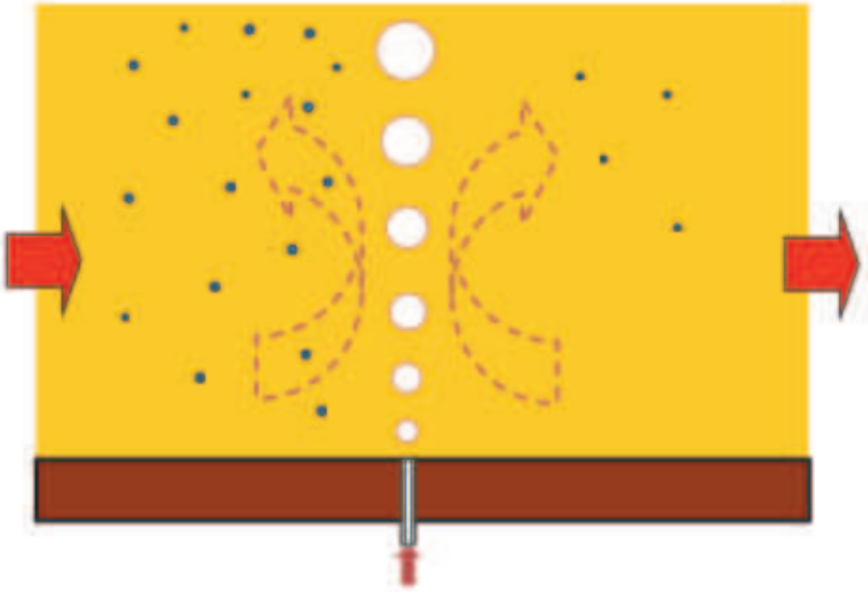
- Improved glass homogeneity
- Improved temperature homogeneity
- To fix the hot spot
- To control batch cover



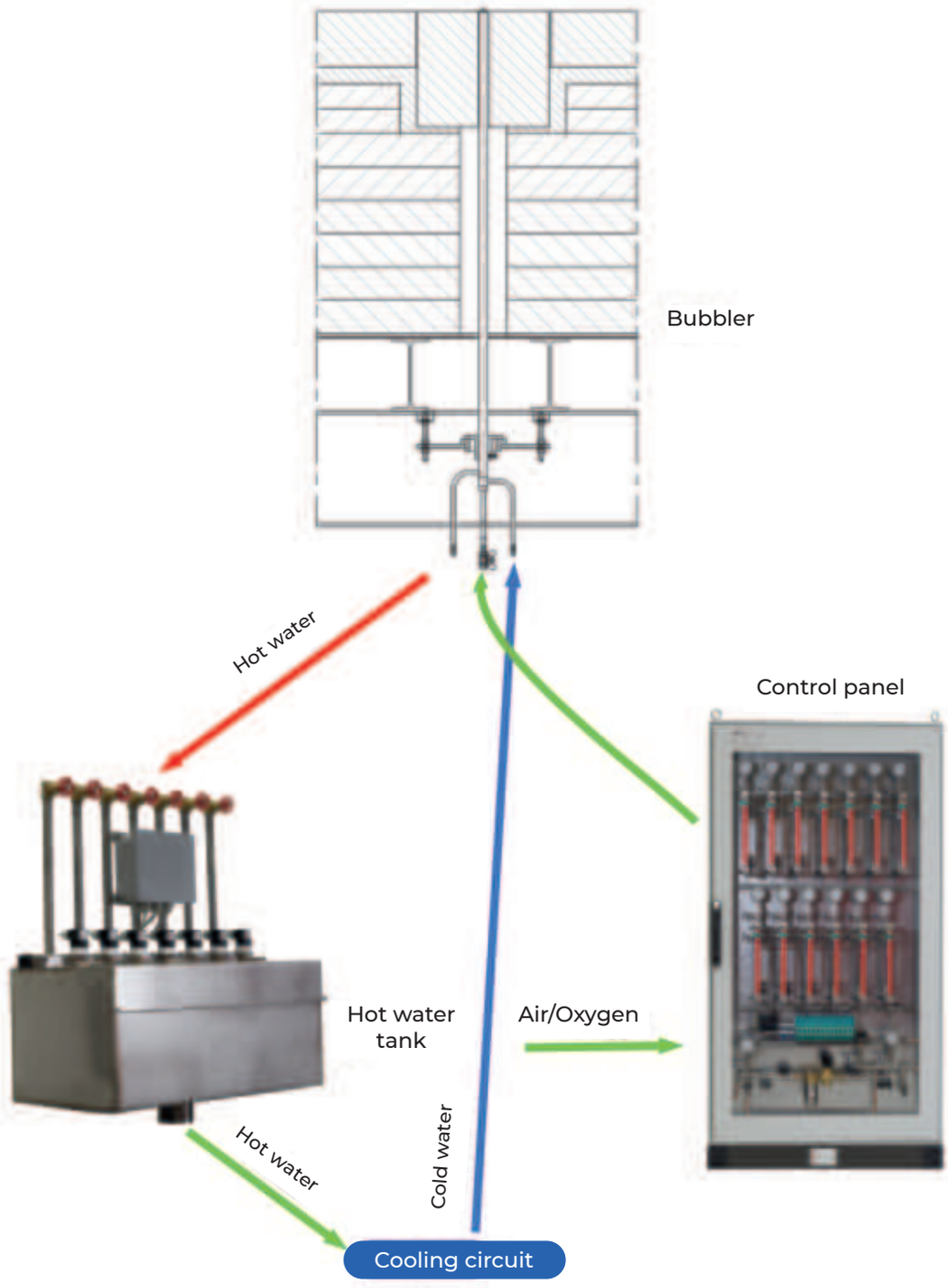
FUNCTIONALITY

The main benefit of a bubbler system is to improve homogeneity by reinforcing the natural upward currents at the hot spot which is particularly beneficial when melting coloured glasses.
A single or double row of bubblers installed across the furnace at the hot spot reinforces the vertical currents, and leads to a notable improvement in temperature homogeneity.
The number of bubbler tubes installed and the diameter of the nozzle diameter will be decided according to the furnace design, the glass to be melted and the anticipated bottom temperature.
The air pressure and flow is used to regulate the frequency and size of the bubbles, it should be noted that a reduction of molten glass viscosity (equal to a temperature increase) reduces the size of the bubbles generated and also increases their frequency.





WATER-COOLED BUBBLING SYSTEM



The working pressure range is from 0.5 to 2 bar and the amount of air flowing through each bubbler is between 80 and 200 Nliters per hour.
When using compressed air from the factory network, suitable filters should be installed to completely remove any oil from the air in order to avoid clogging of the nozzles.
Upon installation the air is normally applied at a pressure of nominally 0,5 bar (to prevent the entry of glass particles, etc.), after heat-up the pressure is increased to the correct level by observing the size and frequency of the bubbles at the glass surface.
For some special glasses oxygen can be use in the bubbling system due to the easier chemical dissolution of oxygen into the molten glass.

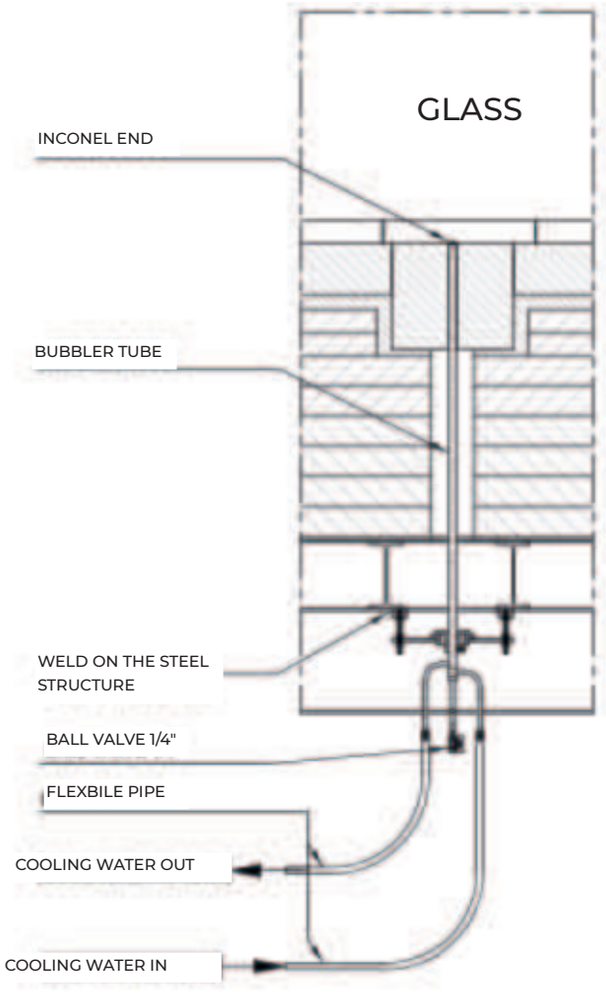
NEW WATER COOLED BUBBLER INJECTOR

This new technology provides the following features:
- Reduced bottom wear, due to the cooling effect in the area of the nozzles
- Bubblers can be hot replaced when required while the furnace is operating
- Bubblers can be unblocked using compressed air or with the aid of special tools
- Either oxygen or compressed air can be used

These bubblers are characterized by:
- Special stainless steel and Inconel nozzle
- Cooling with water jacket
- Proven long life
- Capable of being switched OFF and ON again

The system is completed with a control skid complete with filters, pressure regulators and a back-up tank to provide 30 minutes cover (in case of temporary lack of compressed air).
The water-jacket-cooled injectors assembly comprises:
- Support bracket
- Insulated support
- Insulating shield
- Straight connecting nipple for air and water input
- Bubbler tube

INSTALLATION SCHEME AND PICTURE



Bubbling control panel, the panel is supplied fully wired and tested, and contains all of the necessary instruments and controls to operate the system:

- A fully redundant reducing and filtering section for bubbling gas
- A flow regulating valve, pressure gauge and flow meter set for each injector
- Main control instrumentation positioned on front panel
- High pressure bypass for nozzle unclogging

A set of suitable mechanic tools for unclogging is provided with the system.

Cooling water return is achieved through a stainless steel water manifold with one flow detector for each bubbler.

TECHNICAL FEATURES

MODEL		BUB H 1 AA
MAX TEMPERATURE COOLING WATER INPUT	°C	20 TO 35
MAX TEMPERATURE COOLING WATER OUTPUT		45
MAX WATER CALCIUM CONTENT	ppm	40
WATER COLLING INLET PRESSURE RANGE	BAR	2 TO 4
AIR/OXYGEN INPUT PRESSURE RANGE		4 TO 8
AIR/OXYGEN INPUT PRESSURE REDUCED AFTER SKID		0,5 TO 2
AIR/OXYGEN FLOW RANGE	NLITERS/HOUR	60 TO 360
BUBBLING GAS		AIR/OXYGEN

The equipment design and the material use in construction are according the EU standards and best practice.

- Certified valves
- Certified welding and X-ray welding control for high pressure pipework
- Powder painting of pipework
- Certified sealing
- Certified leakage testing

REVERSAL VALVE

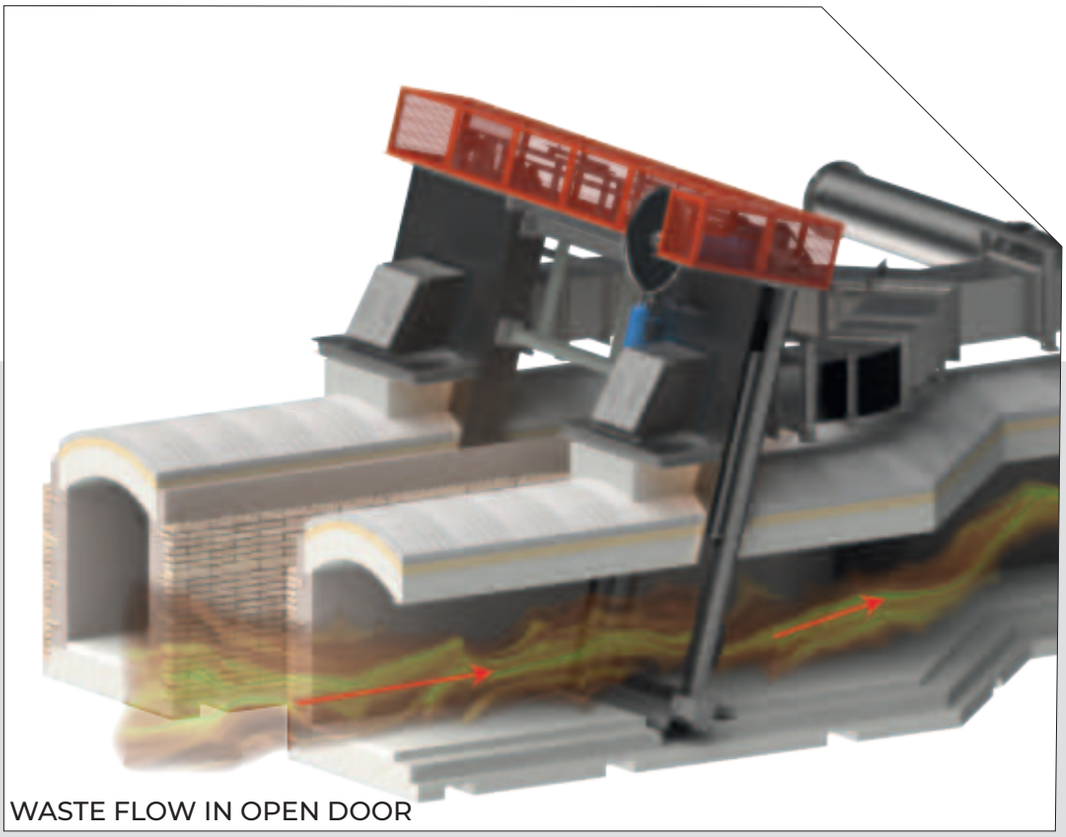
REVERSAL VALVE

Glass Service produces a very high reliable reversal valve for end port glass furnaces. The valve is composed by a strong steel supporting frame with high thickness slide gate in cast iron.

The main features of the valves are:

- High resistance steel frame
- Special high resistance steel guide for the gate
- Gate in cast iron high thickness
- Vertical gate movement by double metal chain
- Gate movement drive by electrical servomotor, handwheel for emergency, handwheel/motor mechanical connection by pneumatic clutch, one compress air tank is integrated for emergency operation in case of air supply fault.
- Each side gate can shut-off or open the waste and combustion air by the same gate.
- Inspection doors for easy maintenance.
- N.4 position inductive switch high temperature resistance, 2 for each stroke end
- N.2 electromechanical microswitch emergency stroke end
- Protection of chain mechanism by easy opening hinged cover

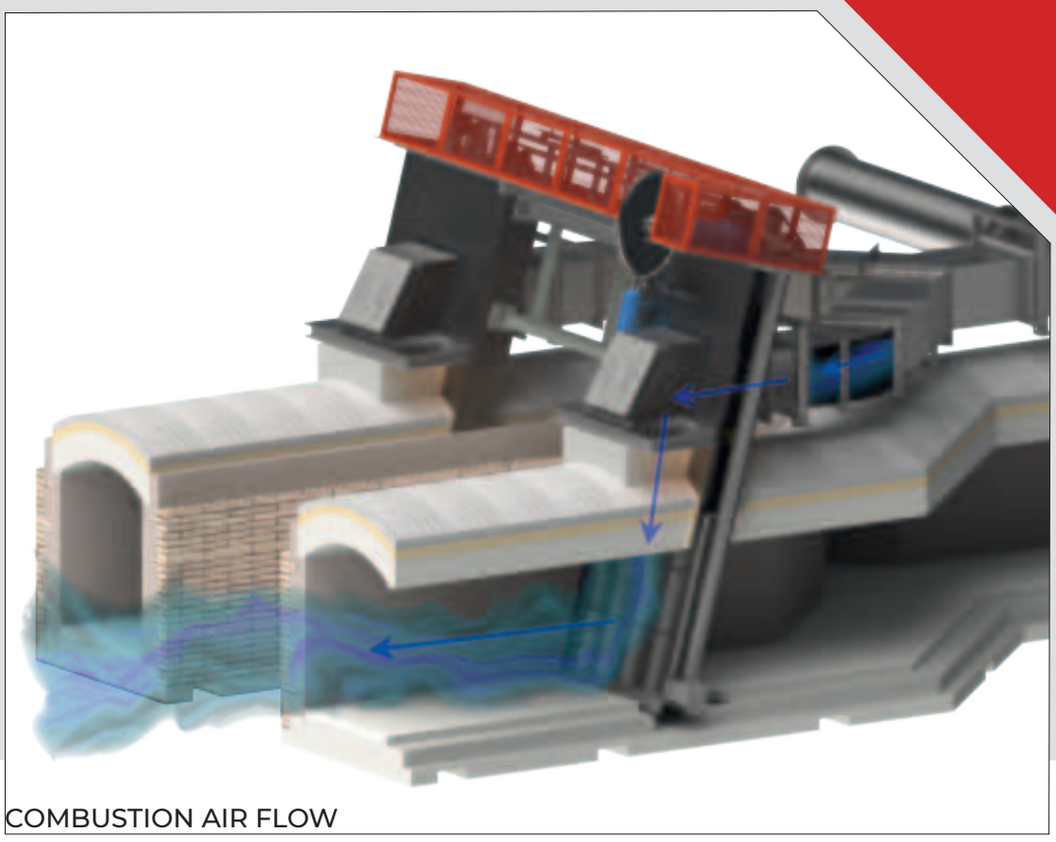
FUNCTIONALITY



WASTE FLOW IN OPEN DOOR

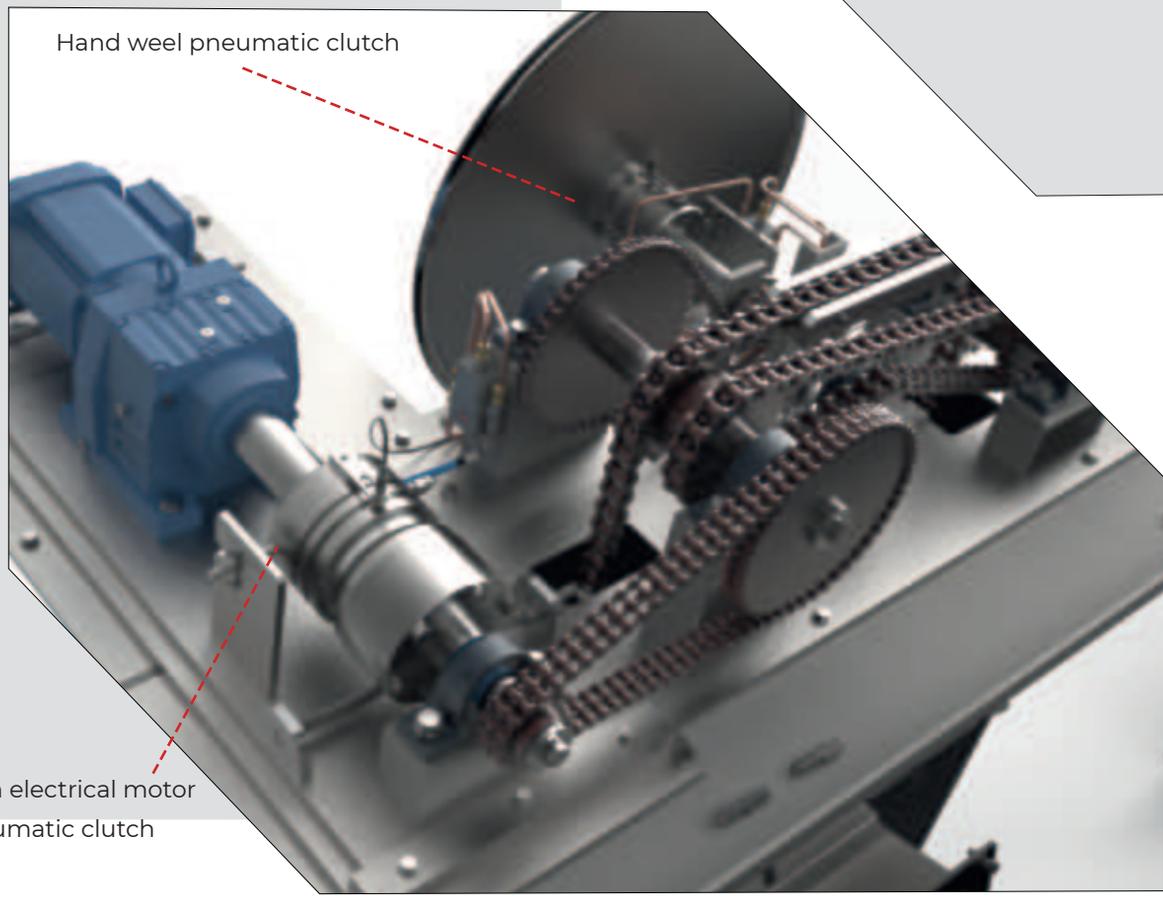
With the gate open, exhaust fumes flow directly to chimney

With the gate closed, combustion air, fed by the combustion fan, flows into the regenerator



COMBUSTION AIR FLOW

DETAIL OF SERVOMOTR AND PNEUMATICS CLUTCH

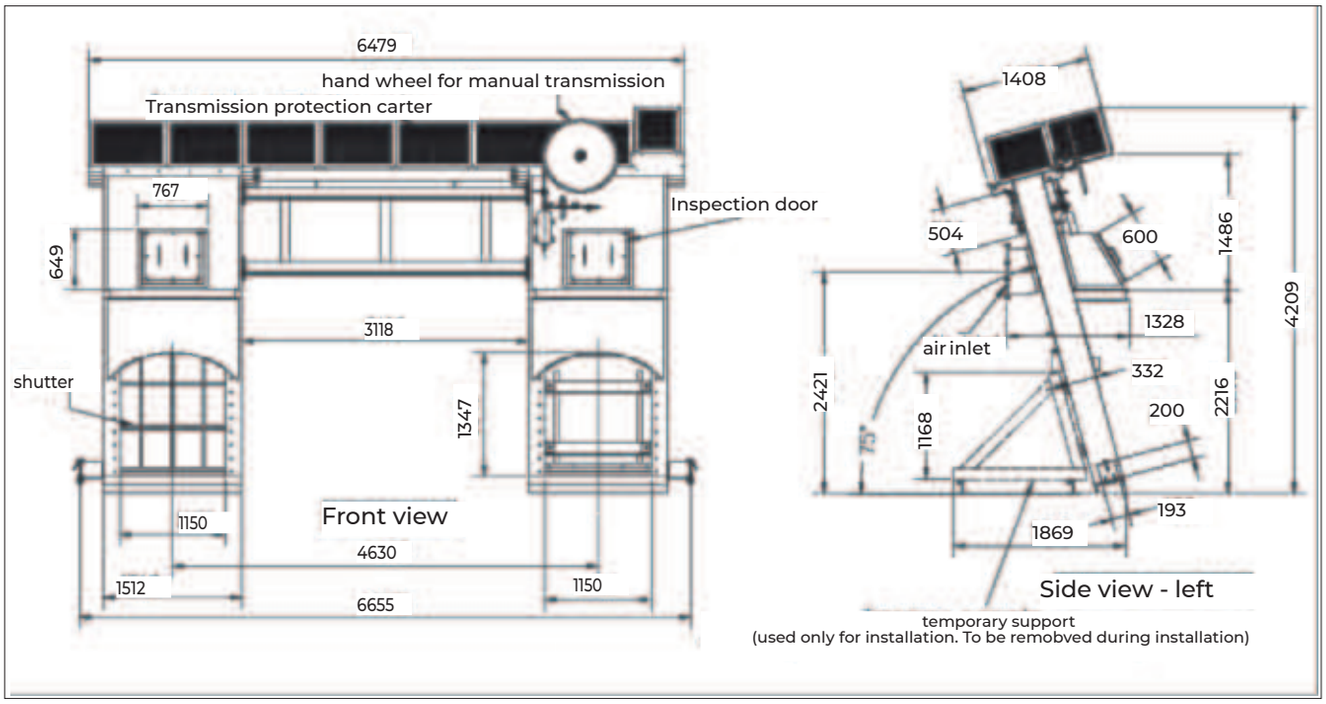


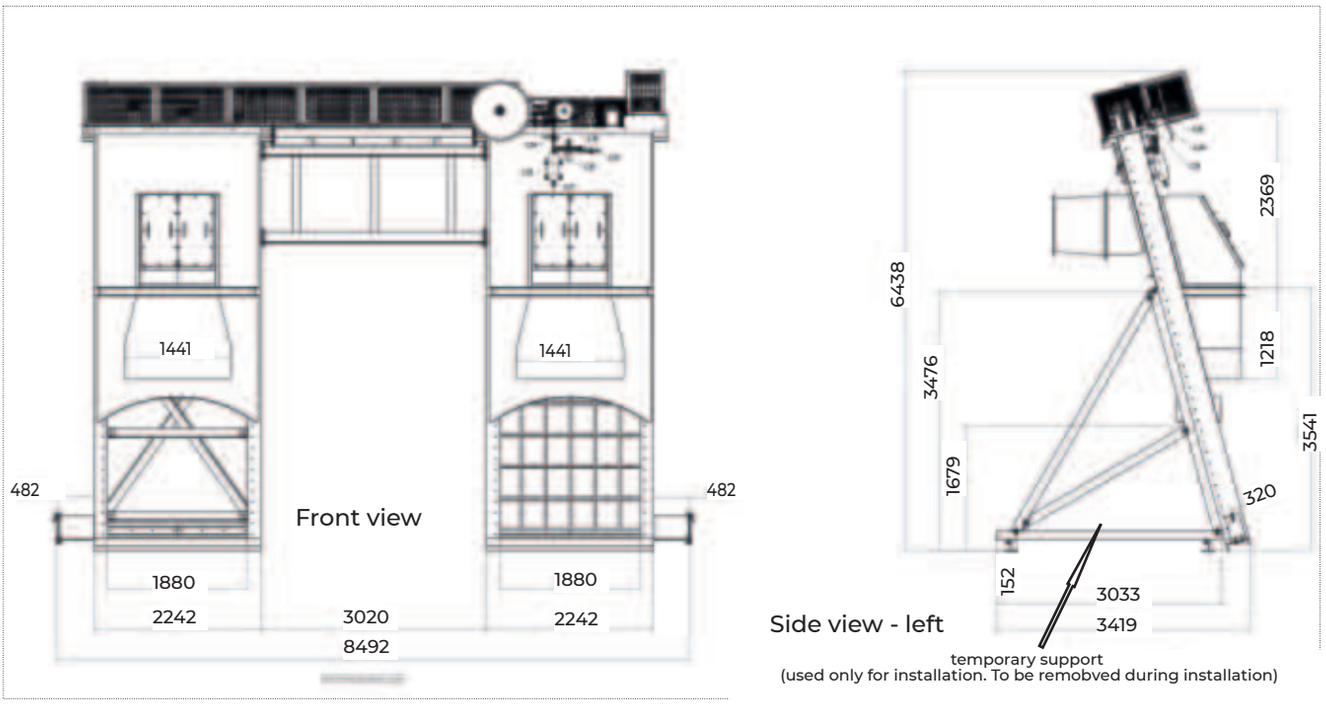
MAIN FEATURES

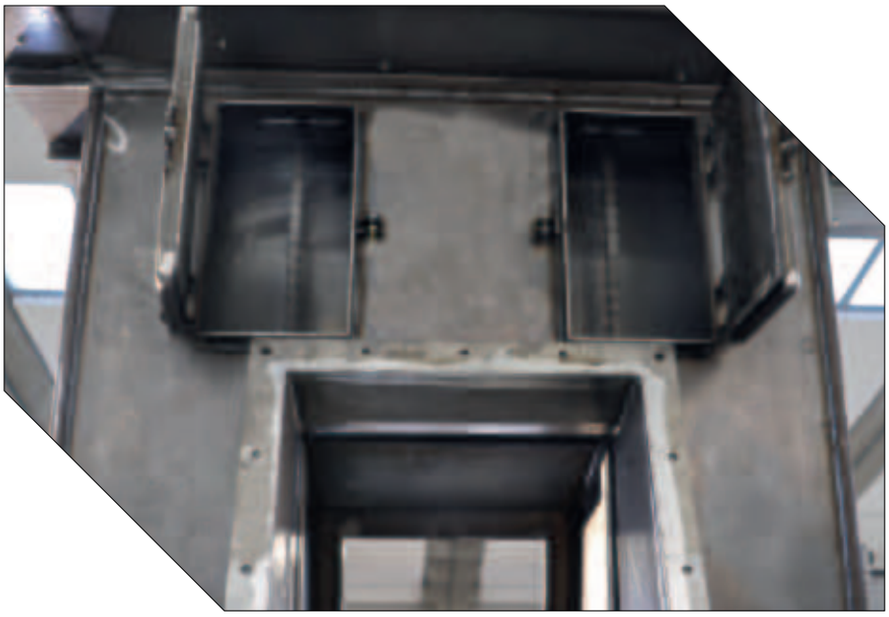
ELECTRICAL MOTOR	POWER 380 VAC, 3PH POWER 1,5 KW
EMERGENCY COMPRESSED AIR SUPPLIED AT A PRESSURE OF 4 BAR	CLEAN AND DRY
MAXIMUM OPERATING TEMPERATURE	600 C
REVERSAL TIME	2 SEC FOR MOTOR AT 50 HZ FREQUENCY

Valve will be supplied complete with a supporting structure for easy installation on the chimney.
It can be customized to respond to the needs of every client.

DIMENSIONS





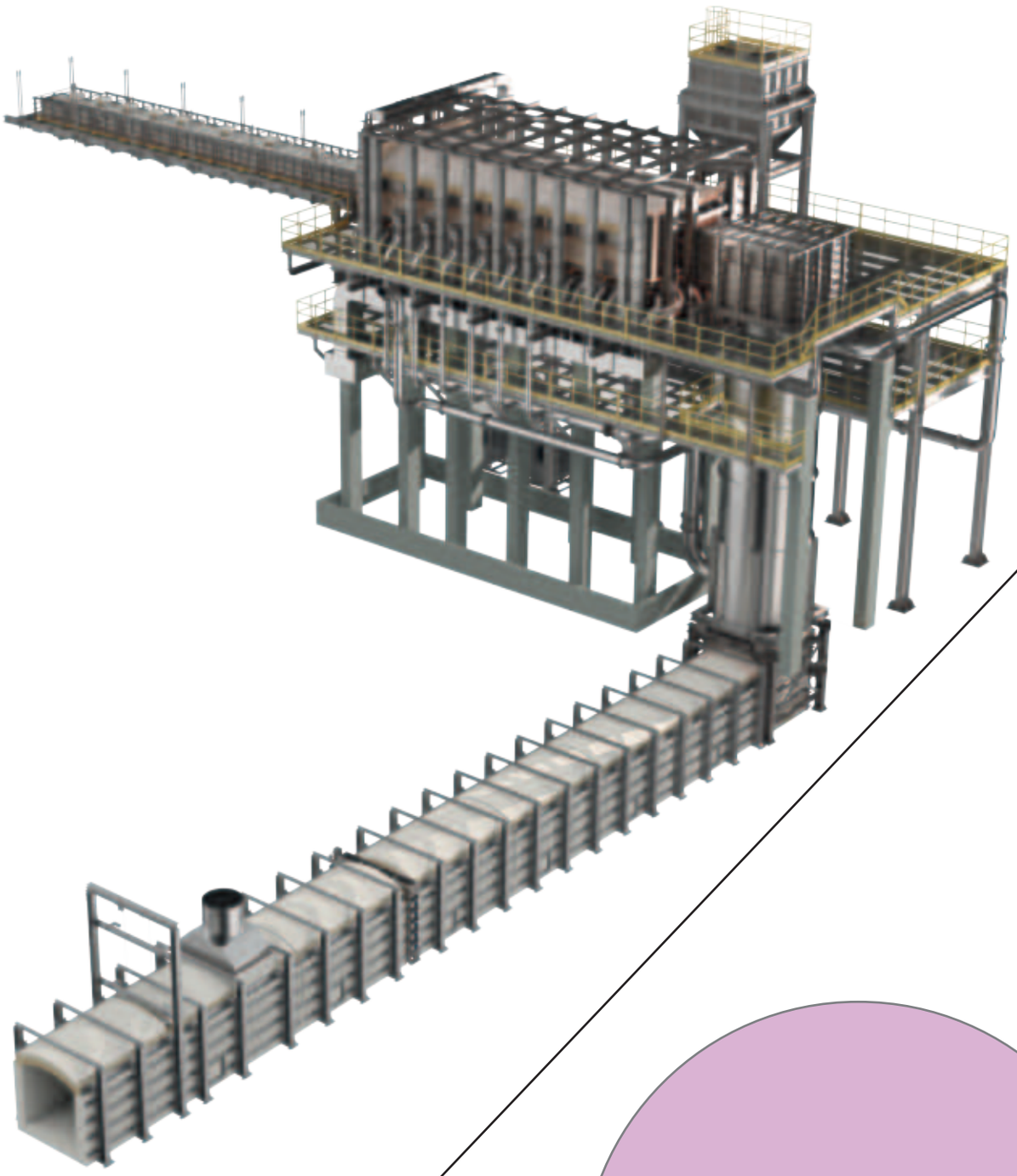


INSPECTION DOORS

The inspection door provides easy access to the chain regulation system connected with the gate. The regulation of this system is usually done during the commissioning, but in case further adjustments are needed, the operator can open the door and easily regulate the mechanism.

COMPRESSED AIR TANK FOR EMERGENCY CLUTCH

If the main compressor on-site fails, the Compressed Air Tank functions to provide the necessary amount of pressurized air to activate the clutch and allow for manual movement of the hand wheel. The system also includes a check valve, that prevents pressure drops in the tank once the main line cuts off the service.



HEAT RECUPERATORS

The glass industry is very energy intensive and measures to save or recover energy is a key factor in the design of glass melting furnaces.
Glass Service has developed several technologies to save energy including the recovery of thermal energy from the waste gases using metal recuperators.
Metal recuperators are a simple and low cost investment for the recovery of waste heat and preheat the combustion air.

GENERAL DESCRIPTION

The Glass Service technology has developed two different recuperator types:

- Double shell
    - o Low investment
    - o Temperature of combustion air preheating max 600°C
    - o Easy maintenance and easy installation
- Tube bundle
    - o Temperature of combustion air preheating max 800°C
    - o External refractory shell can be used for several campaign

Both recuperators can be installed with either bottom/top waste gas flow or top/bottom flow.

The steel quality used is a function of the glass type to be melted and the fuel used (NG or heavy oil) as well as the pollutants in the fuel (e.g. Sulfur). Thanks to over 30 years experience designing and constructing metal recuperators for continuous use, the Glass Service, design plus the selection of the correct steel quality can guarantee a long recuperator life.
The fuel saving from recovering waste heat can be calculated as approximately 5% for each 100°C of combustion air preheat. Glass Service can calculate the specific fuel saving for each specific application.

Typical configuration with double stage recuperator

DOUBLE SHELL RECUPERATORS

Double shell type heat exchanges are manufactured from stainless steel with refractory and outer insulation. These types of recuperators are made from one inner and one outer stainless steel shell with a suitably positioned axial expansion joint. The assembly is then insulated with ceramic fiber and rock-wool and clad with 0.6 mm thick aluminum sheet.

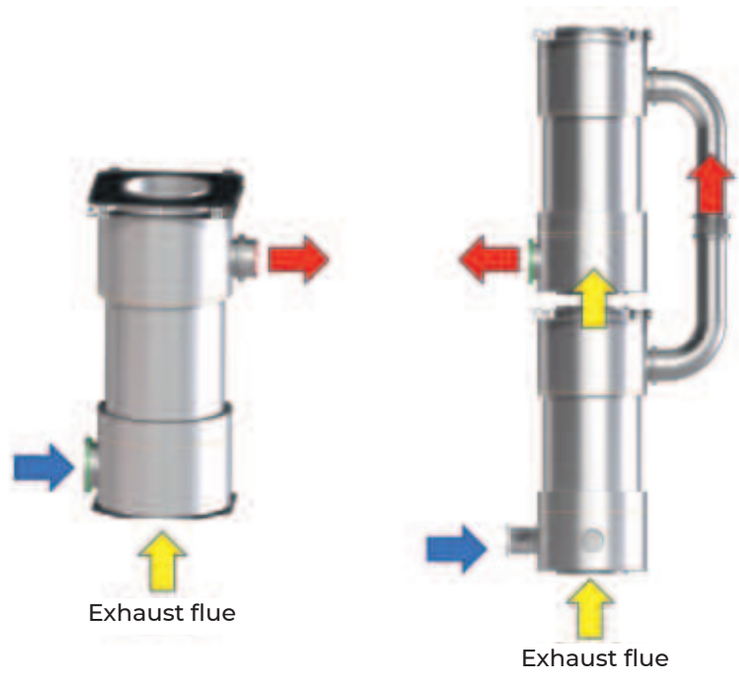
Combustion air flows between the inner and outer shell while melter exhausts flow inside the inner shell. To improve the heat exchange, stainless steel fins are fitted to the inner tube. For a double shell recuperator, the maximum preheat temperature is 600°C depending on the application.

The combustion air is introduced at the base of the recuperator and exits at the top (parallel flow - for combustion air and exhaust gases).

Double shell recuperators can be supplied in two versions:

- SINGLE STAGE, comprising a single recuperator
- DOUBLE STAGE, comprises two recuperators, installed one over the other.

In the DOUBLE STAGE configuration, after the combustion air leaves the lower recuperator, it flows into the upper recuperator from the top and exits from the bottom as shown in the picture. Each recuperator is suspended from a steel structure with 4 supporting rollers to allow lateral movement for maintenance



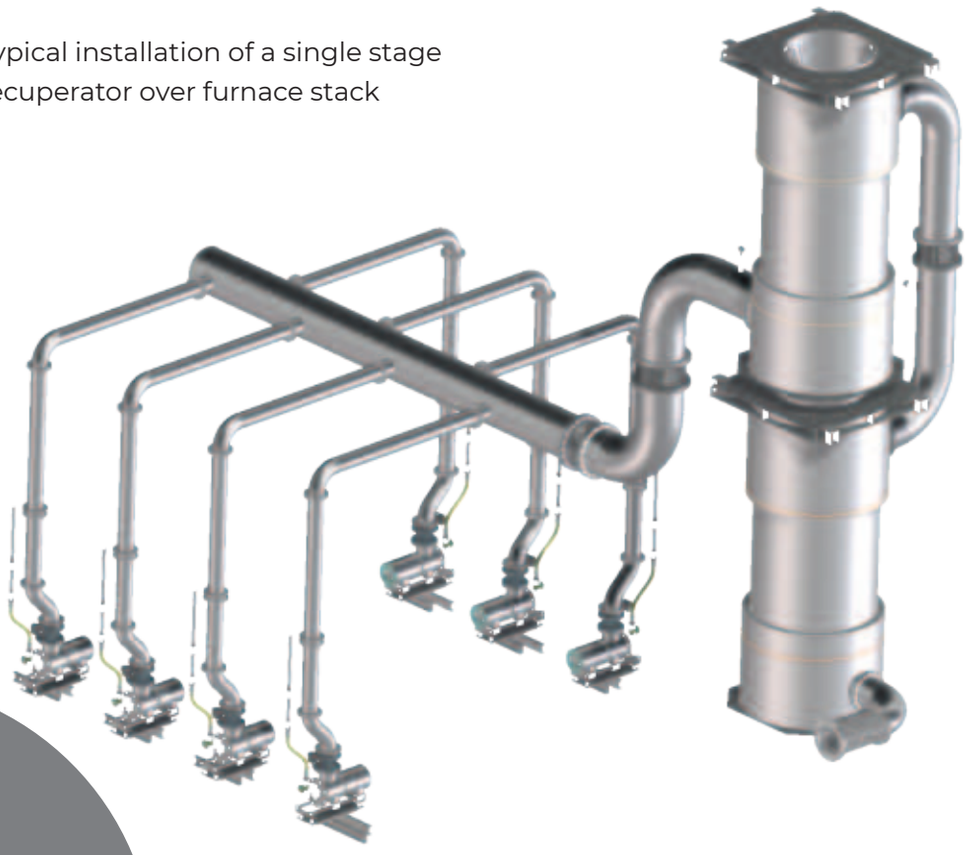
SINGLE STAGE DATA

TYPE		*DOUBLE SHELL - SINGLE STAGE*				
MODEL		REC-C-080/200-..-S-AA	REC-C-095/300-..-S-AA	REC-C-095/450-..-S-AA	REC-C-120/450-..-S-AA	REC-C-120/550-..-S-AA
NUMBER OF STAGES	mm	1	1	1	1	1
INTERNAL DIAMETER		800	950	950	1200	1200
TOTAL HEIGHT		2000	3000	4500	4500	5500
THEORETICAL PREHEAT TEMPERATURE	°C	550				
EXCHANGE SURFACE	m^2	5,0	9,0	13,4	17	21
NATURAL GAS MAX FLOW P.C.I.: 8500 KCAL/NM^3	Nm^3/h	65	110	170	220	270
STAINLESS STEEL FLEXIBLE JOINT DIAMETER TO BURNER MANIFOLD	Inch	10	12	16	16	16

DOUBLE STAGE DATA

TYPE OF HEAT EXCHANGE	*DOUBLE SHELL - DOUBLE STAGE*				
MODEL		REC-C-080/200-..-S-AA	REC-C-080/200-..-S-AA	REC-C-095/450-..-S-AA	REC-C-120/550-..-S-AA
NUMBER OF STAGES	mm	2	2	2	2
INTERNAL DIAMETER		800	950	950	1200
TOTAL HEIGHT		2000	3000	4500	5500
THEORETICAL PREHEAT TEMPERATURE	°C	550			
EXCHANGE SURFACE	m^2	5,0	9,0	13,4	21
NATURAL GAS MAX FLOW P.C.I.: 8500 KCAL/NM^3	Nm^3/h	65	110	170	270
STAINLESS STEEL FLEXIBLE JOINT DIAMETER TO BURNER MANIFOLD	Inch	10	12	20	22

Typical installation of a single stage recuperator over furnace stack



TUBE BUNDLE RECUPERATORS

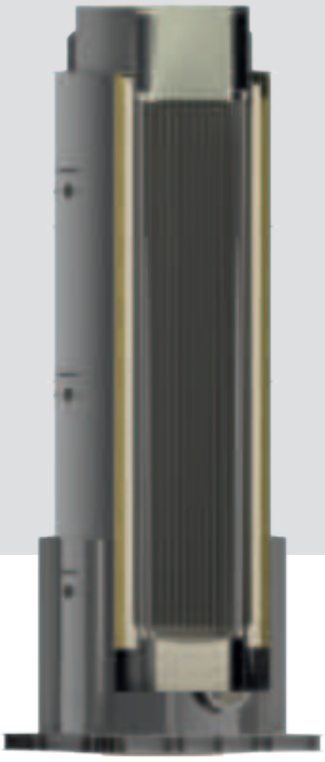
Tube bundle recuperators can be supplied in two versions:

- SINGLE STAGE, comprising a single recuperator
- DOUBLE STAGE, comprises two recuperators, installed one over the other

In this case first one is a tube bundle recuperator, the second in the top position is a double shell recuperator.

The tube bundle recuperator comprises:

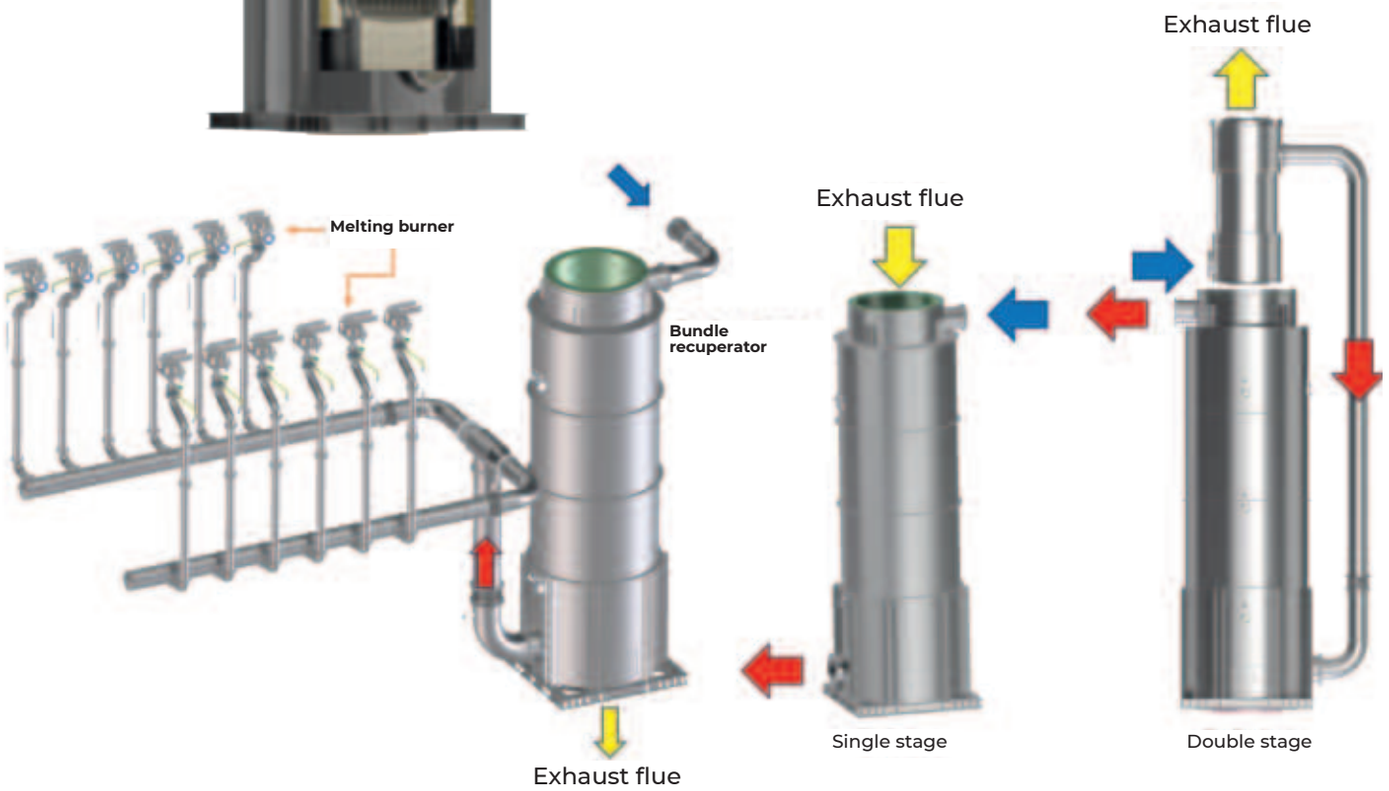
- An external metal cylindrical shell lined with a layer of insulating refractory with a high temperature, high resistance layer, the material selected being dependent on the nature of the glass being melted
- The tube bundle cage, includes special finned stainless steel tubes for improved heat exchange
- Monitoring thermocouple in several locations



For a single stage tube bundle recuperator, the typical maximum preheat temperature is considered to be 650°C, a two stage recuperator, 850°C depending on the application.

The design and resulting design of a recuperator is specific to the application taking into consideration:

- Temperature of exhaust gases
- Exhaust gas flow
- Preheating conditions
- Excess air
- Glass type, etc.



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