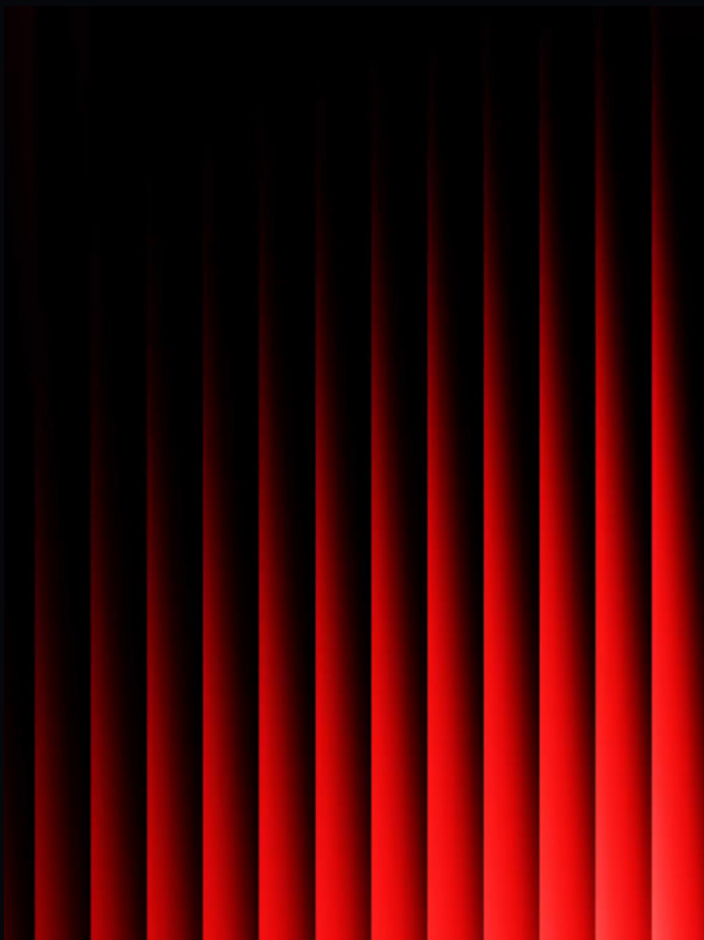




GLASS MELTING TECHNOLOGY



FURNACE TYPES

REGENERATIVE END-FIRED FURNACE

VSM® ALL-ELECTRIC FURNACE

CLEAN MELTER® HYBRID FURNACE

FLOAT FURNACE / REGENERATIVE CROSS-FIRED FURNACE

RECUPERATIVE END-FIRED FURNACE

RECUPERATIVE SIDE-FIRED FURNACE

LONOX® MELTER

FLEXMELTER

OXY-MELTER

OXECON® MELTER

BORO-OXI-MELTER®

FURNACES FOR SPECIAL GLASSES

ADDITIONAL SYSTEMS

SDR – SORG DEEP REFINER®

FINING BANK

BATCH3 INTEGRATED CONCEPT

ADVANCED REGENERATOR DESIGN (ARD)

ELECTRIC BOOSTING

03

04

06

08

10

12

14

16

18

20

22

24

26

30

30

32

34

36

38

GLASS MELTING TECHNOLOGY

For over 150 years, we have been providing satisfied customers in more than 80 countries with innovative furnaces to melt different glass types. At any one time, there are over 300 SORG® furnaces in operation.

SORG is a longtime technological leader and never a follower. At SORG, we believe in continuous innovation and furnace development. This has led to significant improvements in conventional furnace technology and to the development of completely new, innovative furnace concepts. SORG is able to supply many different types and sizes of furnace for the widest range of production and site conditions. Our furnaces are designed for low energy consumption, low emissions, low maintenance and maximum uptime to deliver the best possible operating results for your production.

With the right SORG® furnace, you can melt almost any type of commercially produced and special glass. Innovative individually designed furnaces are available for numerous applications.



REGENERATIVE END-FIRED FURNACE

Flexible and highly sophisticated with low operation costs, regenerative end-fired furnaces are very popular worldwide.

The raw materials enter the furnace through one or two doghouses installed on the furnace sides, immediately next to the rear wall. This type of furnace can have sizes varying from 20 m² up to 180 m². Heating is done by two burner banks beneath the burner ports, located in the furnace rear wall. The combustion air is preheated up to a maximum of 1350 °C in the regenerators, which are alternately flowed through by hot waste gases and combustion air. Therefore a periodical reversal of the firing side, typically between 20 and 30 minutes, is necessary. Due to the U-shaped flame and waste gas path, the combustion gases in the furnace have a relatively long residence time, which produces good energy utilisation.



CHARACTERISTICS

- Typical glass types: soda-lime glass and sodium silicate
- Typical products: containers (bottles, jars), rolled plate (ornamental glass, solar glass), float glass (clear glass and extra clear glass – or solar glass), coloured glass for automotive applications like green and bronze)
- Performance: 20–700 t/24 h – NO_x emission 600–1000 mg/Nm³ (dry, 8% O₂)

ADVANTAGES

- Very flexible furnace type
- Lower construction costs, reduced specific energy consumption, and lower emissions than other furnace types.

VSM® ALL-ELECTRIC FURNACE

An all-electric furnace with low energy consumption and zero NO_x and CO₂ emissions.

VSM® furnaces use the cold-top melting process. The patented SORG® rotating crown batch charging system is used to charge batch across the whole melting surface. This type of system requires no moving parts within the furnace superstructure. The rotating crown batch charger and the enclosed superstructure ensure a simple dust retention and almost no in-factory dusting.

Specially developed SORG® Top Electrodes are installed in all VSM® furnaces. They are inserted through the furnace superstructure and enter the glass bath through the surface. They can be swung out of the furnace for inspection and exchange. Using these electrodes, the refractory material is subject to much less wear and damage.



CHARACTERISTICS

- Typical glass types: soda-lime glass, C-glass, borosilicate glass, fluoride opal glass
- Typical products: containers (bottles, jars, flacons), lighting ware, tableware, fibres, stemware, high-quality flacons, tubing
- Performance: 3 – 200 t/24 h
- CO₂ emissions from combustion: zero (dry, 8% O₂)

ADVANTAGES

- 100% electric: Zero CO₂ and NO_x emissions from combustion
- Low energy consumption
- Top electrodes ensure longer campaign and easy maintenance
- Very low waste gas volume (only batch gases)
- No in-factory dusting

CLEAN MELTER®

SORG's latest technology, developed to significantly reduce carbon emissions while delivering the flexibility of an end-port furnace and supporting high pull rates.

The CLEAN Melter® combines electric melting with proven furnace technology. With up to 80% electric share, the CLEAN Melter® emits significantly less CO₂ than conventional fossil-fuelled furnaces, offering greater flexibility and substantial cost savings for larger tonnages.

The radiation wall keeps the energy of the superstructure heating in the melting area. In principle, the SORG technology for reduced dust in the furnace atmosphere is applied: SORG IRD® doghouse and EME-NEND® Batch Charger. Electrode arrangement in the furnace bottom designed by mathematical modelling for highest efficiency. The superstructure is proven in melter type furnaces SORG has built successfully over many years. Electrode holder with special SORG design for longest lifetime. SORG electrode data monitoring for optimal operation and on-time maintenance. Refining shelf has stabilised the melting process and secured the glass quality since 1985 in various furnace types.

ADVANTAGES

- Electric share on melting energy as high as possible – up to 80%
- Flexibility in regard to pull variations
- Flexibility in regard to raw materials and raw material changes (no glass quality instabilities)
- Melting of oxidising and reduced glasses
- Fossil share on melting energy without restriction in the application of CO₂ neutral combustibles
- CO₂ neutral combustibles possible, like hydrogen, biogas and synthetic fuels
- Neutral combustibles (hydrogen)
- Flexibility in the mix of different heating sources (fossil/electric)

CHARACTERISTICS

- Typical glass types: soda-lime glass
- Typical products: containers (bottles, jars), flat glass, tableware
- Performance: up to 400 t/24 h
- NO_x emission: depending on electric share of energy input: at 80% electric share reduction by 80% *
- CO₂ emission: depending on electric share of energy input: at 80% electric share reduction by 80% *
- Energy consumption: at 80% electric share reduction by 16%

* From combustion process



FLOAT FURNACE / REGENERATIVE CROSS-FIRED FURNACE

Used for high-tonnage float glass production, with flexible temperature control and large melting areas.

The single doghouse is situated on the furnace rear wall, and the batch is usually charged over almost the complete tank width.

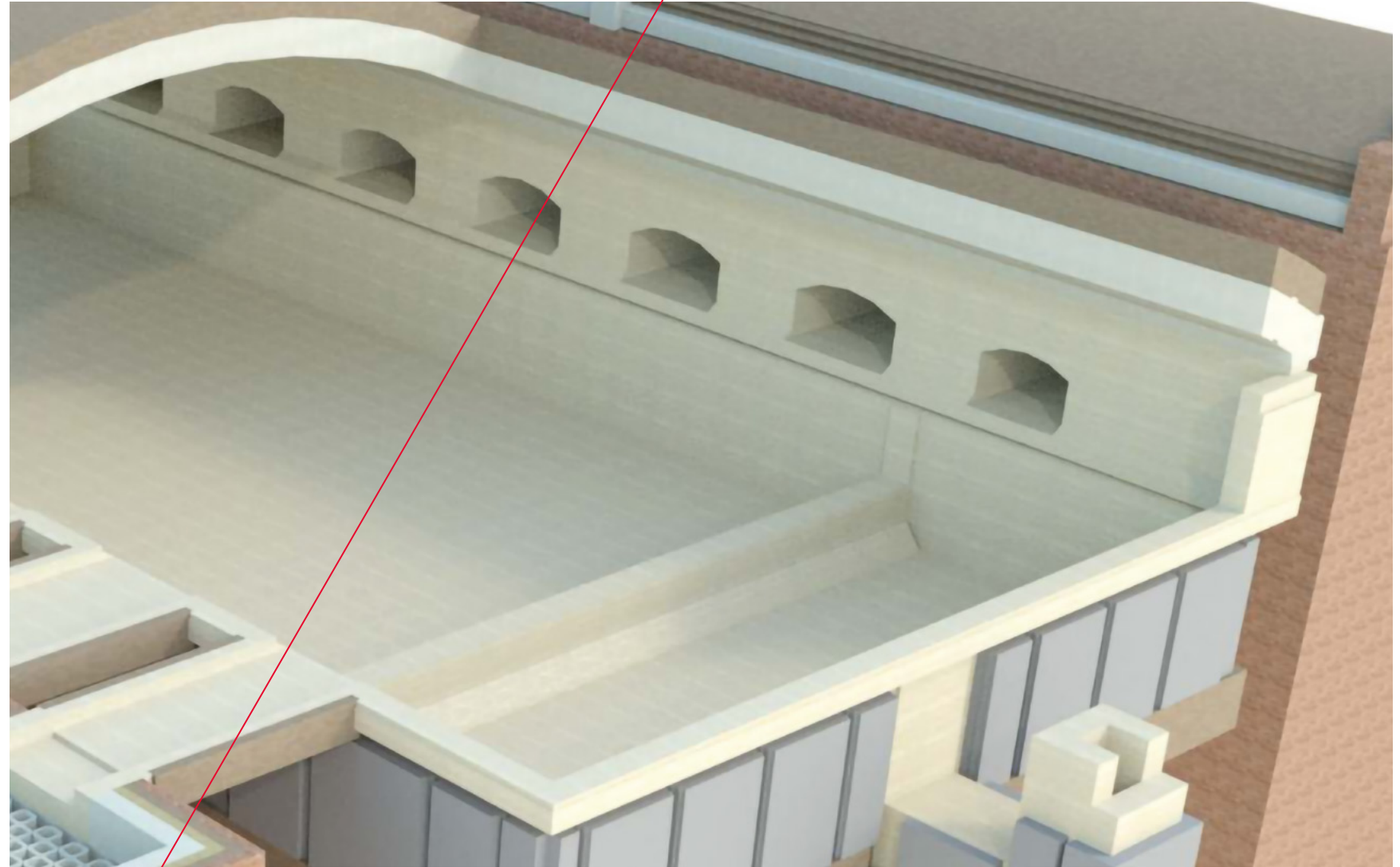
The two regenerators are situated along the furnace sidewalls with the number of burner ports depending on the furnace design.

For cross-fired furnaces, there are several types of regenerators. One of them is the common box – a big regenerator chamber – all ports of a furnace side are connected to it. Alternatively, partially sectioned chambers can be installed. The regenerator is divided into two (or more) parts separated by a division wall. This allows for different firing adjustments in the ratio between these sections.

When using full sectional chambers, there is one section for each burner port, which is completely separated from the other chamber sections. Thus, each port can be adjusted separately. Float furnaces are characterised as regenerative cross-fired furnaces with a large melting area. They meet the requirements for high glass quality necessary for automotive, coating and architectural applications. They can produce clear glass, extra clear glass, solar glass, and coloured glass for automotive applications.

A unique design feature of this furnace is the downstream by a waist connected to the working end. The equipment is responsible for the thermal homogenisation and conditioning of the glass. This characteristic allows the furnace to achieve the glass quality and temperature required.

In general, float furnaces have a melting capacity from 400 up to 1200 t/24 h. They are provided with different installed equipment like electric and oxy-boasting and other heating systems for natural gas, oil, LPG, and oxy-fuel.



CHARACTERISTICS

- Typical glass type: soda-lime glass
- Typical products: containers (bottles, jars), rolled plate (ornamental glass, solar glass), float glass (clear glass and extra clear glass – or solar glass), coloured glass for automotive applications like green and bronze)
- Performance: 200–1000 t/24 h, float glass up to 1200 t/24 h
- NO_x emission: 1000–1800 mg/Nm³ (dry, 8% O₂)

ADVANTAGES

- Temperature more easily adjustable
- Very high pulls possible
- Low energy consumption: 1.4–1.8 kWh/kg
- High glass quality



RECUPERATIVE END-FIRED FURNACE

Perfect for special glasses and small installations with melting capacities of up to 45 t/24 h.

The single doghouse is located on a side wall, immediately next to the rear wall.

The burners are located on the furnace rear wall, with the waste gas port immediately above. The burner flame travels through the furnace, turns upwards and back to exhaust above the burners. The flame path created has the shape of a vertical "U".

Combustion air is then preheated with a recuperator, providing stable heating without the flame/waste gas path reversal necessary with regenerative systems. Most recuperative furnaces use steel recuperators, like double shells or tube basket recuperators, which are always installed vertically.

CHARACTERISTICS

- Typical glass type: soda-lime glass, sodium silicate and C-glass
- Typical products: containers (bottles, jars, flacons), lighting ware, tableware, fibres
- Performance: up to 45 t/24 h
- NO_x emissions: less than 600 mg/Nm³ (dry, 8% O₂)

ADVANTAGES

- Low emissions
- Stable process
- Low investment

RECUPERATIVE SIDE-FIRED FURNACE

This furnace can be designed with either a single or a twin doghouse, located either on the rear wall of the tank or on the side.

Temperature control of larger furnaces can be divided into a number of control zones along the length of the furnace. A single burner control is also possible.

For heat recovery (preheating of the combustion air), recuperators are used. For this furnace, different types of recuperators can be applied: the double shell recuperator, the tube basket recuperator or a combination of both.

The double shell recuperator consists of two concentric high temperature resistant steel tubes. The hot waste gases pass through the inner tube, whilst the combustion air passes through the annular slit between the tubes. Single modules of this type can be used alone, or they can be placed one after another to form a complete unit.

In a tube basket recuperator the combustion air is led through a large number of individual small diameter steel tubes. They are arranged in a ring around the inner circumference of a large diameter outer tube. This type of recuperator can give air preheat temperatures of up to 750 °C and is usually installed on larger furnaces.

CHARACTERISTICS

- Typical glass types: soda-lime glass, C-glass and E-glass
- Typical products: containers (bottles, jars, flacons), rolled plate (ornamental glass), tableware, fibres, glass bricks
- Performance: 20–400 t/24 h
- NO_x emission < 600 mg/Nm³ (dry, 8% O₂)

ADVANTAGES

- Low emissions
- Good adjustment of temperature profile along furnace axis



LONOX® MELTER

A special kind of recuperative furnace with integrated internal batch preheating and external cullet preheating developed to operate with very low NO_x and CO₂ emissions.

The LoNOx® Melter has a long, narrow tank divided into melting and refining zones. The fining bank is the essential part of this furnace concept.

The batch can be charged over the complete width of the furnace rear wall through one doghouse. There is also the possibility to install two doghouses alongside the rear wall. Most of the waste gas energy remains in the system. By using integrated cullet or batch preheating systems, and also recuperators for preheating the combustion air, most of the waste gas energy remains in the system. Through this, the energy consumption of LoNOx® Melters is comparable with those on regenerative furnaces.

CHARACTERISTICS

- Typical glass types: soda-lime glass
- Typical products: containers (bottles, jars, flacons)
- Performance: 150–450 t/24 h
- NO_x emissions: less than 400 mg/Nm³ (dry, 8% O₂)

ADVANTAGES

- Lower energy consumption compared to standard recuperative furnaces
- High level of heat transfer between waste gases and raw materials
- Very low NO_x emissions





FLEXMELTER

Designed for both continuous or discontinuous intermittent production of high-quality glass.

The furnace concept is based on a unique internal radiation wall inside the combustion chamber.

Intermediate arches in the superstructure prevent direct heat transfer from the hottest part of the furnace to the colder raw materials.

Without heat loss, there is a high level of radiation transfer between the waste gases and the raw materials. The batch is charged over the complete width of the furnace through a doghouse on the back wall. A fining bank is installed to improve the fining process and prevent any returning flow of glass.

CHARACTERISTICS

- Typical glass type: soda-lime glass
- Typical products: tableware, stemware, high-quality flacons, pharmaceutical containers
- Performance: 6–180 t/24 h
- NO_x emissions: less than 500 mg/Nm³ (dry, 8% O₂)

ADVANTAGES

- The glass melting is split into three processes (melting, fining, and refining), improving the furnace's flexibility
- High level of heat transfer between the waste gases and the raw materials
- Very low NO_x emissions

OXY-MELTER

An energy-efficient, side-fired furnace that uses oxygen-fuel combustion for heating.

The oxygen-heated furnace uses typically delivered oxygen with a very high purity. If the oxygen demand is high, it makes sense to install an oxygen-production system on site. Batch charging is delivered from the rear wall via one or two doghouses. The waste gases leave the furnace near the back wall or the front wall.

The installation of an Oxy-Melter is helpful in case of strong emission regulations as an alternative to installing an air pollution system.



CHARACTERISTICS

- Typical glass types: soda-lime glass, C-glass, E-glass, borosilicate glass
- Typical products: containers (bottles, jars, flacons), rolled plates (ornamental glass, solar glass), tableware, fibres, tubing, laboratory ware
- Performance: 30–600 t/24 h
- NO_x emissions: 0.3–0.7 kg/t (dry, 8% O₂)

ADVANTAGES

- Stable process
- High energy efficiency
- Lower NO_x emissions (related to pull)
- Less waste gas volume

OXECON® MELTER

A conventional oxy-fuel firing furnace with internal batch preheating to reduce energy consumption.

The application is used for high-quality glasses, with an output of up to 300 t/24 h, like the FlexMelter®.

This furnace design is also based on a special internal radiation wall inside the combustion chamber. This creates a burner-less zone where the batch is preheated before entering the melting and conditioning zones. Preheating is obtained by the transfer of thermal energy from the waste gases exiting the furnace. By using the radiation wall, waste gas temperatures are reduced to approx. 1200 °C.



CHARACTERISTICS

- Typical glass type: soda-lime glass
- Typical products: containers (bottles, jars, flacons), tableware
- Performance: 50–300 t/24 h
- NO_x emissions: 0.3–0.7 kg/t (8% O₂)

ADVANTAGES

- Energy savings of up to 10% compared to a conventional oxy-fuel melter
- Lower NO_x emissions and carbon footprint
- Low waste gas temperature



BORO-OXI-MELTER®

Designed to melt difficult glasses such as borosilicate and TFT glass.

Typically, these furnaces use screw chargers for batch charging and do not require a doghouse. The screw chargers are introduced into the furnace through circular openings in the rear wall of the superstructure.

The primary energy source is an oxy-fuel heating system with the appropriate burners installed along both sides of the superstructure. Typically, the Boro-Oxi-Melter® is also equipped with electrical boosting. The waste gases are cooled down in a quench chamber operated with air or water, or a combination of both. A fining bank is installed to improve the fining process and prevent any return flow of glass.

CHARACTERISTICS

- Typical glass types: borosilicate glass, TFT glass
- Typical products: tubing, pharmaceutical containers, flat glass (TFT), laboratory ware
- Performance: up to 80 t/24 h
- NO_x emissions from combustion: 1.5–3 kg/t (dry, 8% O₂)

ADVANTAGES

- Excellent glass quality
- Low energy consumption

BASALT AND ROCK WOOL

Basalt and rock wool as insulation material provide an alternative to C-glass fibres. They can also be used for reinforcement fibres. The basic material is melted in recuperative furnaces with strong melting boosters, which support the fossil-fuel heating due to the specific glass qualities. SORG has built furnaces of this type with melting capacities of up to 200 t/24 h.

E-GLASS

E-glass is used to make fibres for textile applications or reinforcement fibres, which require absolutely clean glass without any gaseous or solid inclusions. Recuperative side-fired furnaces are mostly used for this glass type. SORG has built such installations with a daily capacity of up to 200 t/24 h. In combination with oxy-firing, such furnaces can also reach a capacity of almost 400 t/24 h.

LEAD-CONTAINING GLASSES

Lead-containing glasses are most successfully melted in VSM® all-electric furnaces. Alternatively, it is also possible to use a FlexMelter® with fossil-fuel heating, although here the emission levels must be considered.

FLUORIDE OPAL GLASS

The SORG VSM® all-electric furnace provides the ideal solution for melting fluoride opal glass.

The cold batch blanket on the glass suppresses the fluoride volatilisation. This is necessary for a constant opalisation and for emission.



C-GLASS

C-glass is used to produce fibres for insulation wool. In conjunction with boron, C-glass has a high alkali content, which is why evaporations from the glass bath surface can be a problem. Since 1975, C-glass has been melted in SORG VSM® all-electric furnaces with excellent results and performances of up to 200 t/24 h. Furthermore, fossil-heated recuperative furnaces with performances of up to 120 t/24 h are used for this glass type, whereby oxy-fuel-fired furnaces with melting capacities of almost 300 t/24 h are increasingly used for C-glass in recent years.



BOROSILICATE GLASS

Very high temperatures are required to melt and refine hard borosilicate glass. With the Boro-Oxi-Melter® and the VSM® all-electric furnace, SORG offers two different solutions for that glass type. The Boro-Oxi-Melter®, especially developed for such glass, combines oxy-fuel-firing with electric boosting and a refining bank and makes melting capacities of up to 100 t/24 h possible. With the VSM® a melting capacity of up to 45 t/24 h is possible.

SDR - SORG DEEP REFINER®

Improves glass quality by increasing the residence time of the glass in the furnace.

The use of the Deep Refiner® increases the residence time of the glass in the furnace, especially in the refining area, thus improving the glass quality. This also leads to lower glass temperatures in the throat and the working end. This concept can be applied to all types of conventional fossil-fired furnaces.

ADVANTAGES

- Increases the residence time and improves the refining process
- Improves the homogeneity of the glass



FINING BANK

Added to the tank, the fining bank raises the glass temperature across a shallow area of the fining zone, helping improve glass quality.

A higher glass temperature in the fining zone results in lower glass viscosity, making it easier for the fining gases to reach the glass bath surface. The shallower glass bath means that the actual distance to the surface is shorter – another advantage.



ADVANTAGES

- Improves fining and therefore the achievable glass quality
- Can be installed on nearly all furnace types

BATCH3 INTEGRATED CONCEPT

The Batch3 Integrated Concept for batch handling at the furnace represents an economical and viable solution to reduce the specific energy consumption and the CO₂ emission of a glass melting furnace by using the energy in the waste gas.

The concept comprises three components, each of which can make an important contribution to at least one operational aspect: the SORG® Batch Preheater, the EME-NEND® Batch Charger, and the IRD® Doghouse.

The SORG® Batch Preheater features a combination of closed and open heat exchanger modules. Through this combination the problem of clumping caused by water is now eliminated. The water can leave the system through the open batch surface. Bonding and clumping are destroyed by activating the heat exchanger modules.

The installation of a SORG® Batch Preheater is only possible in combination with the EME-NEND® Batch Charger and the IRD® Doghouse. The EME-NEND® Batch Charger can be equipped with either one, two or three screws. By combining the screws with a pusher arm, the batch is delivered to the glass bath in the doghouse and further into the main part of the furnace.

With the twin or triple solution, the screws are controlled by individual frequency converters that provide independently variable charging speeds. This independent control allows variation in the amount of batch moved out of the doghouse – without any machine movement. Instead of screws the EME-NEND® is also available with vibratory chutes.

The IRD® Doghouse utilises two major changes to conventional doghouse designs to increase the heat transfer to the batch and does not create problems with dusting and carry-over by glassing the batch surface. The doghouse is made larger to longer expose the batch surface to the heat from above inside the doghouse. Furthermore, the doghouse crown is raised to allow more radiation into the doghouse from the hotter crown areas of the furnace. Due to this energy and the longer residence time in the enlarged doghouse, the batch surface will be glazed. The most important advantage of a completely sealed doghouse is that the uncontrolled and often unstable entry of false air through the doghouse is eliminated. This also leads to a reduction of NO_x in production.

ADVANTAGES

- Reduced energy consumption and NO_x emissions
- Increased efficiency (higher pull, lower electric share, reduced specific energy consumption)
- IRD® sealed doghouse – effectively eliminates external dusting and reduces heat losses
- IRD® Doghouse: Reduced internal dusting by glassing the batch surface
- EME NEND® Batch charger: Improved charging pattern





ADVANCED REGENERATOR DESIGN (ARD)

The ARD is designed for conversions from recuperative to end-fired furnaces, as well as installations with challenging ground conditions.

The Advanced Regenerator Design (ARD) is typically used for the conversion from a recuperative melter to an end-fired furnace. The design is also a suitable option in cases where the foundation depth is limiting the regenerator height, e.g. former doublepass regenerators, by a high groundwater table or by rock in the ground. The vertical redirection of flue gas allows for a reduced foundation depth with no reduction in packing volume.

ADVANTAGES

- Shorter construction time
- Higher regenerator efficiency
- No need for a regenerator pit
- Better homogeneous flow of the waste gases through the regenerator packing

ELECTRIC BOOSTING

Give your system an extra boost with power delivered directly to the glass bath.

A boosting system in the melting area (melting booster) supplies additional energy directly to the glass bath. Whereas small and medium-sized furnaces are normally equipped with a single electrical booster, for larger installations it is advantageous if the installed electrical energy is split between two separate systems. This exerts the maximum influence on the convection currents and can produce high specific melting capacities.

The installation of an electric booster around the hot spot (barrier booster) increases the convection currents and this stabilises the glass flow in the furnace. This has a positive effect on the glass quality.

Both boosting systems lead to a higher melting capacity. The substitution of fossil energy by electricity reduces CO₂ emissions. SORG designs and delivers the whole spectrum from single components to complete systems. All parts and systems are tailor-made according to the special requirements. For the energy supply, SORG has a wide range of possibilities, from fixed transformers to very efficient individual developments.



CHARACTERISTICS

The installation of an electric booster around the hot spot (barrier booster) increases the convection currents, stabilising the glass flow in the furnace. It has a positive effect on the glass quality. Both boosting systems lead to a higher melting capacity. The substitution of fossil energy by electricity reduces CO₂ emissions.

ADVANTAGES

- Higher melting capacity
- Increase of efficiency and glass quality



Phone: +49 (0) 9352 507 0
Fax: +49 (0) 9352 507 196
Email: nsorg@sorg.de
Website: sorg.de

HEAD OFFICE

Nikolaus SORG GmbH
Stoltestraße 23
97816 Lohr am Main, Germany