GLASS MELTING TECHNOLOGY
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For over 140 years, we have been providing satisfied customers in over 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 program 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.

SORG – Value by Design.
This type of furnace is very common, because it is flexible and highly sophisticated with low operation costs. Very large furnaces of this type have a melting area of approximately 180 m², whilst small units of < 20 m² are also in operation.

The raw materials enter the furnace through one or two doghouses installed on the furnace sides, immediately next to the rear wall.

**ADVANTAGES**

- very flexible furnace type
- lower construction costs and energy consumption than with a cross-fired furnace
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 utilization.

**CHARACTERISTICS**

**Typical glass types**  
soda-lime glass  
sodium silicate

**Typical products**  
containers (bottles, jars, flacons)  
rolled plate (ornamental glass, solar glass)  
insulators  
lighting ware  
tableware

**Performance**  
20 - 700 t/24 h

**NOₓ emission**  
600 - 1000 mg/Nm³ (dry, 8 % O₂)
While end-fired furnaces are commonly used for melting areas of up to 180 m², regenerative cross-fired furnaces are used for larger melting areas with very high tonnages.

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

ADVANTAGES

- temperature profile more easily adjustable
- very high pulls possible
The two regenerators are situated along the furnace side walls. The number of burner ports depends on the furnace design. For cross-fired furnaces there exist three different types of regenerators:

One of them is the common box, which is one big regenerator chamber, installed at each furnace side. All ports of a furnace side are connected to it.

Alternatively, partially sectional chambers can be installed. The regenerator is divided into two (or more) parts, which are separated by a division wall. This allows for different adjustments in ratio between these sections.

When using full sectional chambers, there exists one own section for each port, which is completely separated from the other sections. Thus, each port can be adjusted separately.

CHARACTERISTICS

Typical glass types
soda-lime glass

Typical products
containers (bottles, jars)
rolled plate (ornamental glass, solar glass)

Performance
200 - 1000 t/24 h

NO\textsubscript{x} emission
1000 - 1800 mg/Nm³ (dry, 8 % O\textsubscript{2})
The name of this furnace comes from the special way of production as the molten and fined glass is floated on a tin bath to improve its surface quality.

Float furnaces are characterized 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. Besides clear glass and extra clear glass (or solar glass), also colored glass for automotive applications like green and bronze can be produced.

ADVANTAGES

- low energy consumption, 1.4 - 1.8 kWh/kg
- high glass quality
A special design feature of this furnace is the downstream by a waist connected working end with the function of a thermal homogenization and conditioning of the glass. Thus, the required glass quality and temperature can be achieved.

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

**CHARACTERISTICS**

<table>
<thead>
<tr>
<th>Typical glass types</th>
<th>soda-lime glass</th>
</tr>
</thead>
<tbody>
<tr>
<td>Typical products</td>
<td>float glass</td>
</tr>
<tr>
<td>Performance</td>
<td>400 - 1200 t/24 h</td>
</tr>
<tr>
<td>NO\textsubscript{x} emission</td>
<td>1200 - 1800 mg/Nm\textsuperscript{3} (dry, 8 % O\textsubscript{2})</td>
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</tbody>
</table>

This furnace concept is now primarily used 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.

ADVANTAGES

- low emission
- stable process
- low investment costs
The burners are located on the furnace rear wall, with the waste gas port immediately above. The burner flame travels along the furnace, turns upwards and back to exhaust above the burners. The flame path created is in the shape of a vertical "U".

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

**CHARACTERISTICS**

**Typical glass types**
- soda-lime glass
- sodium silicate
- C-glass

**Typical products**
- containers (bottles, jars, flacons)
- lighting ware
- tableware
- fibers

**Performance**
- up to 45 t/24 h

**NOx emission**
- < 600 mg/Nm³ (dry, 8 % O2)
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, that means for 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.

**ADVANTAGES**

- low emission
- good adjustment of temperature profile along furnace axis
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
- E-glass

**Typical products**
- containers (bottles, jars, flacons)
- rolled plate (ornamental glass)
- tableware
- fibers
- glass bricks

**Performance**
- 20 - 400 t/24 h

**NOx emission**
- < 600 mg/Nm³ (dry, 8 % O₂)
LoNOx® MELTER

The LoNOx® Melter is a special kind of recuperative furnace developed to operate with very low NOx emission levels.

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.

ADVANTAGES

- lower energy consumptions compared to standard recuperative furnaces
- high level of heat transfer between the waste gases and the raw materials
- very low NOx emission
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.

The biggest part of the waste gas energy remains in the system. By using integrated cullet or batch preheating systems, the energy consumption of LoNOx® Melters is comparable with regenerative furnaces.

### CHARACTERISTICS

<table>
<thead>
<tr>
<th><strong>Typical glass types</strong></th>
<th>soda-lime glass</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Typical products</strong></td>
<td>containers (bottles, jars, flacons)</td>
</tr>
<tr>
<td><strong>Performance</strong></td>
<td>150 - 450 t/24 h</td>
</tr>
<tr>
<td><strong>NOx emission</strong></td>
<td>&lt; 400 mg/Nm³ (dry, 8 % O₂)</td>
</tr>
</tbody>
</table>
The FlexMelter® is designed for continuous or discontinuous production of high quality glass. It is not necessary to drain glass during periods when the furnace is not being pulled.

**ADVANTAGES**

- high flexibility due to consequent splitting of the three main process steps involved in the glass melting – melting, fining, and refining
- high level of heat transfer between the waste gases and the raw materials
- very low NO₂ emission
The furnace concept is based on a special internal radiation wall inside the combustion chamber. Intermediate arches in the superstructure prevent direct heat transfer by radiation from the hottest part of the furnace to the colder raw materials. This produces a high level of heat 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 return flow of glass.

**CHARACTERISTICS**

**Typical glass types**
- soda-lime glass

**Typical products**
- tableware
- stemware
- high-quality flacons
- pharmaceutical containers

**Performance**
- 6 - 180 t/24 h

**NOx emission**
- < 500 mg/Nm³ (dry, 8 % O₂)
The SORG VSM® all‐electric furnace is a cold-top, vertical melter, in which the processes of batch charging, melting, fining and refining all take place in a vertical direction.

VSM® furnaces use the SORG® patented rotating crown batch charging system. This type of system requires no moving parts within the furnace superstructure. The rotating crown batch charger as well as the enclosed superstructure ensure a simple dust retention and almost no in‐factory dusting.

**ADVANTAGES**

- no dusting
- Top Electrodes ensure longer campaign and easy maintenance
- very low waste gas volume (only batch gases)
- low energy consumption
- no NOx emission
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 less damage caused by temperature changes.

**CHARACTERISTICS**

**Typical glass types**
- soda-lime glass
- C-glass
- borosilicate glass \((\alpha = 32 - 40 \times 10^{-7} \text{ K}^{-1})\)
- fluoride opal glass

**Typical products**
- containers (bottles, jars, flacons)
- lighting ware
- tableware
- fibers
- stemware
- high-quality flacons
- tubing

**Performance**
- 3 - 200 t/24 h

**NOx emission (from combustion)**
- “zero” (dry, 8 % \(O_2\)
The EMDR is a specially designed, mainly electric furnace with the capability to melt all glass colors.

The aim of this furnace is to use as much electricity as possible for furnace heating. However, specific glass types require a certain percentage of fossil fuels for heating, albeit a low one. That is why the EMDR combines electric and fossil fuel melting and is also called mixed melter.

**EMDR (ALL-ELECTRIC MELTER DEEP REFINER)**

**ADVANTAGES**

- very low emission
- mainly electric energy used
- low CO₂ emission
The furnace operation is possible with or without air preheating and the doghouse can be installed either on the furnace rear wall or the furnace side.

**CHARACTERISTICS**

**Typical glass types**
- soda-lime glass
- C-glass

**Typical products**
- containers (bottles, jars, flacons)
- insulating glass

**Performance**
- 40 - 300 t/24 h

**NO\textsubscript{x} emission**
- < 400 mg/Nm\textsuperscript{3} (dry, 8 % O\textsubscript{2})
This type of side-fired furnace is similar to recuperative side-fired furnaces, but uses oxygen-fuel-combustion for heating.

For small installations, there is typically used delivered oxygen with very high purity. If the oxygen demand is high, it makes sense to install an oxygen production on site.

**ADVANTAGES**

- stable process
- high energy efficiency
- lower NOx emissions (related to pull)
- less waste gas volume
Batch charging is done from the rear wall via one or two doghouses. The waste gases are leaving the furnace near the back wall or near the front wall.

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

**CHARACTERISTICS**

| Typical glass types             | soda-lime glass
|                                 | C-glass
|                                 | E-glass
|                                 | borosilicate glass ($\alpha = 32 - 40 \times 10^{-7} \text{ K}^{-1}$)

| Typical products                | containers (bottles, jars, flacons)
|                                 | rolled plate (ornamental glass, solar glass)
|                                 | tableware
|                                 | fibers
|                                 | tubing
|                                 | laboratory ware

| Performance                     | 30 - 600 t/24 h

| NO$_x$ emission                 | 0.3 - 0.7 kg/t (dry, 8 % O$_2$)
The innovative Ox Econ® Melter incorporates conventional oxy-fuel firing and combines it with the advantage of 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.

**ADVANTAGES**

- energy savings of up to 10% compared to a conventional oxy-fuel melter
- lower NOx emissions and carbon footprint
- low waste gas temperature
Just 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 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 types**
- soda-lime glass

**Typical products**
- containers (bottles, jars, flacons)
- tableware

**Performance**
- 50 - 300 t/24 h

**NOₓ emission**
- 0.3 - 0.7 kg/t (dry, 8% O₂)
The Boro-Oxi-Melter® is a SORG development designed to deal with the problems of melting difficult glasses such as borosilicate and TFT glass.

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

**Boro-Oxi-Melter®**

The Boro-Oxi-Melter® is a SORG development designed to deal with the problems of melting difficult glasses such as borosilicate and TFT glass.

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

**ADVANTAGES**

- excellent glass quality
- good energy consumption
The main source of energy is an oxy-fuel heating system with the appropriate burners installed along both sides of the superstructure. Mostly, the Boro-Oxi-Melter® is also equipped with electrical boosting.

The waste gases are cooled 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

<table>
<thead>
<tr>
<th>Typical glass types</th>
<th>borosilicate glass ($\alpha = 32 - 40 \times 10^{-7} \text{ K}^{-1}$)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>TFT glass</td>
</tr>
<tr>
<td>Typical products</td>
<td>tubing</td>
</tr>
<tr>
<td></td>
<td>pharmaceutical containers</td>
</tr>
<tr>
<td></td>
<td>flat glass (TFT)</td>
</tr>
<tr>
<td></td>
<td>laboratory ware</td>
</tr>
<tr>
<td>Performance</td>
<td>up to 80 t/24 h</td>
</tr>
<tr>
<td>NO$_x$ emission (from combustion)</td>
<td>1.5 - 3 kg/t (dry, 8 % O$_2$)</td>
</tr>
</tbody>
</table>
The SORG Deep Refiner® is a part of the furnace between the barrier wall and the throat where the glass bath is much deeper than in the melting area.

The use of the Deep Refiner® increases the residence time of the glass in the furnace, especially in the refining area, and thus improves 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 refining
- improves the micro-homogeneity of the glass
FINING BANK

The fining bank is an additional device in the tank, designed to raise the glass temperature in a shallow area in the fining zone, without increasing the superstructure temperature.

Higher glass temperature in the fining zone results in lower glass viscosity, so the fining gases reach the glass bath surface more easily. 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
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. Also common problems of batch preheating, e.g. dusting in and around the furnace as well as batch clumping are eliminated. 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 new SORG® Batch Preheater features an open batch surface as well as enclosed heat exchanger modules, which can be activated.

Fresh batch is automatically charged and distributed onto the open surface. The problem of clumping caused by water is now eliminated. The water can leave the system through the open batch surface. Water vapor and dust are removed continuously from the collecting chamber by a suction fan.
Any remaining bonding and clumping is destroyed by activating the heat exchanger modules. The preheater can be operated even with low cullet percentage at 3 % moisture (a typical practical value).

The installation of a SORG® Batch Preheater is only possible in combination with the EME-NEND® Batch Charger and the IRD® Doghouse.

The new 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 surface 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 of the amount of batch moved out of the two sides of the doghouse – without any machine movement.

Instead of screws the EME-NEND® is also available with vibratory chutes.
The IRD® Doghouse utilizes 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 and cullet surface to the heat from above. 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 and cullet surface will be glazed.

The most important advantage of a completely sealed doghouse is the fact that the uncontrolled and often unstable entry of false air through the doghouse is eliminated. This also leads to a reduction of NOx in the production.

ADVANTAGES

- reduced energy consumption and NOx emissions
- increased efficiency
- sealed doghouse – effectively eliminates external dusting
- improved charging pattern
- reduced internal dusting by glassing the batch surface
ARD (ADVANCED REGENERATOR DESIGN)

The ARD has promising advantages regarding flow distribution in the top space of the regenerator and of course in the packing.

It is typically used for the conversion from a recuperative to an end-fired furnace. The design is also a suitable option in case that the foundation depth is limiting the regenerator height, e.g. by a high ground water 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 regenerator pit necessary
- more homogeneous flow of the waste gases through the regenerator packing
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 stabilizes 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 the CO₂ emission.

ADVANTAGES

- higher melting capacity
- systems with electrodes increase efficiency
FURNACES FOR SPECIAL GLASSES – AN OVERVIEW

Lead-containing glasses are most successfully melted in VSM® all-electric furnaces (see p. 18). Alternatively it is also possible to use a FlexMelter® with fossil-fuel heating (see p. 16), although here the emission levels must be considered.

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 volatilization. This is necessary for a constant opalization and also for emission.

Very high temperatures are required to melt and refine hard borosilicate glass. With the Boro-Oxi-Melter® (see p. 26) 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.
**E-glass** is used to make fibers for textile applications or reinforcement fibers, which require absolutely clean glass without any gaseous or solid inclusions. Recuperative side-fired furnaces *(see p. 12)* 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.

**C-glass** is used to produce fibers 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 is 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 the recent years.

**Basalt and rock wool** as insulation material provide an alternative to C-glass fibers. They can also be used for reinforcement fibers. 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.
SORG® SERVICE

THINGS YOU CAN COUNT ON

By choosing our high quality glass melting furnaces and conditioning systems you get access to our first-class service around the clock. It is our ambition to support your production as reliable and fast as possible.

EXPERIENCE

For over 140 years, we have been providing satisfied customers in over 80 countries with innovative furnaces to melt different glass types. At any one time there are over 300 SORG® furnaces in operation.

TECHNOLOGY

SORG® technology has been driving the glass industry for decades. Innovations such as our endport furnaces, the Deep Refiner®, VSM® cullet and batch preheating as well as equipment for use under severe conditions speak for themselves. Also in the future we will be emphasizing innovation. The result: Safe investments for our customers with the lowest total cost of ownership.

EXPERTISE

We are specialized in glass melting and conditioning and offer a wide range of services. Over 100 experts are available to offer competent help. They support the process from concept development through operations. On site services complement our offerings and maintain the quality of our equipment.

GOOD REASONS TO PARTNER WITH SORG:

- lowest total cost of ownership
- minimize technological risk
- first class service
- you profit from our continuing research and development