



GLASS CONDITIONING TECHNOLOGY

SORG

NIKOLAUS SORG GMBH



DISTRIBUTERS AND FOREHEARTHS

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There is a direct relationship between glass conditioning and production. For optimal results the correct glass conditioning system must be chosen.

Once out of the furnace, our complementary conditioning systems will help you maintain the highest quality and efficiency. From distributors and working ends to forehearth, gathering bays and auxiliary equipment, we'll design an integrated system that works seamlessly throughout the process to keep everything running at full capacity.

We have experience with almost all commercial glasses used for the production of containers, tableware, stemware, insulating fibre, textile fibre, lighting ware, tubing, rolled plate, insulators, lenses and other products.

The SORG Glass Conditioning Technical Department has existed since September 1976. Over 50 years of continuous development in glass conditioning technology and equipment. Extensive experience across a wide range of applications in countries around the world.

In over 50 years SORG has supplied more than:

580 WORKING ENDS	180 SIDE WALL BOOSTING systems in forehearth and working ends
1620 FOREHEARTHS 340x (340; 340S®; 340S+® – since 2006)	45 COLOURING FOREHEARTHS
590 FOREHEARTHS	230 STIRRER UNITS
340 CONTI DRAIN® SYSTEMS	70 OMT SYSTEMS (>350 zones)

STW-DISTRIBUTERS

Our pioneering concept, now in its third generation, uses the working end or distributor as part of the glass conditioning system.

Heat removal is carried out through the glass bath surface, and so a wide channel is advantageous wherever cooling is to be applied. A shallow bath depth eases heat transfer within the glass bath and also assists the cooling.

Direct air cooling is often used in the central area around the riser of SORG® STW distributors. In this area, glass temperatures are usually high enough to ensure that there is no risk of overcooling the glass at the sides of the channel, and so the complete roof area can be used for cooling. Open radiation cooling can be applied in the outer areas of distributors to remove as much energy as possible before the glass enters the forehearth.

However, the flexible SORG® approach to cooling, involving all three cooling types, means that the best system can be chosen for each location to maximise the advantages and minimise any disadvantages.

ADVANTAGES

- High capacity heat removal
- Exact control of forehearth entry temperatures



CHARACTERISTICS

- All SORG® distributors utilise the VMC gas heating system
- Temperature measurement is typically done by immersed thermocouples installed vertically through the roof refractory
- The distributor is typically split up into several separate control zones. There will be one zone in the central area around the riser and one zone for each forehearth entry on a typical installation.
- Still, this arrangement may not be possible if the forehearth entries are unusually close together. In such a case, there may be two forehearth entries in one zone. Alternatively, if the forehearth entries are unusually far apart, it may be necessary to have an intermediate zone without a forehearth entry.

STF FOREHEARTHS

A highly flexible forehearth combining multiple cooling technologies to achieve high cooling capacity and optimised thermal homogeneity.

One of the most important principles of the STF forehearth is the extremely flexible application of different technologies. For example, four different cooling technologies can be utilized to achieve the optimal solution for each individual zone.

On some systems all four cooling systems are applied to different areas. STF-Forehearths are built in all lengths and in channel widths from 16" to 54". STF-forehearths are normally gas fired. These include the well-known and proven SORG® VMC combustion system. The shape of the superstructure conforms to the most important function of each zone. Therefore, the superstructure is different for the heating and cooling zones.



ADVANTAGES

- **Greater cooling capacity.** The consistent application of open radiation cooling leads to high cooling capacity.
- The following factors actively improve the thermal homogeneity through:
 - Higher cooling capacity. Left right trimming (optional)
 - Stepping control for cooling systems
- **Flexibility:** The flexible concept for the STF series offers the optimal solution for each application. There are multiple cooling systems available as well as the possibility to expand the standard design through add-ons.

340S+[®] FOREHEARTHS

The proven technology of the 340S[®] forehearth serves as the basis for the 340S+[®].

SORG has been developing forehearth technology continuously for decades. This enables us to provide the solutions our customers need for a successful production.

Technological advances, reliability, lower service costs and lower total cost of ownership are key factors of SORG forehearth technology. To keep pace with the higher requirements customers have regarding glass conditioning, SORG developed the new 340S+[®].

Distributors to remove as much energy as possible before the glass enters the forehearts.

However, the flexible SORG[®] approach to cooling, involving all three cooling types, means that the best system can be chosen for each location to maximise the advantages and minimise any disadvantages.

The refractory baffles effectively divide the superstructure into three longitudinal sections to provide separation between cooling in the central area of the channel and heating at the channel edges.

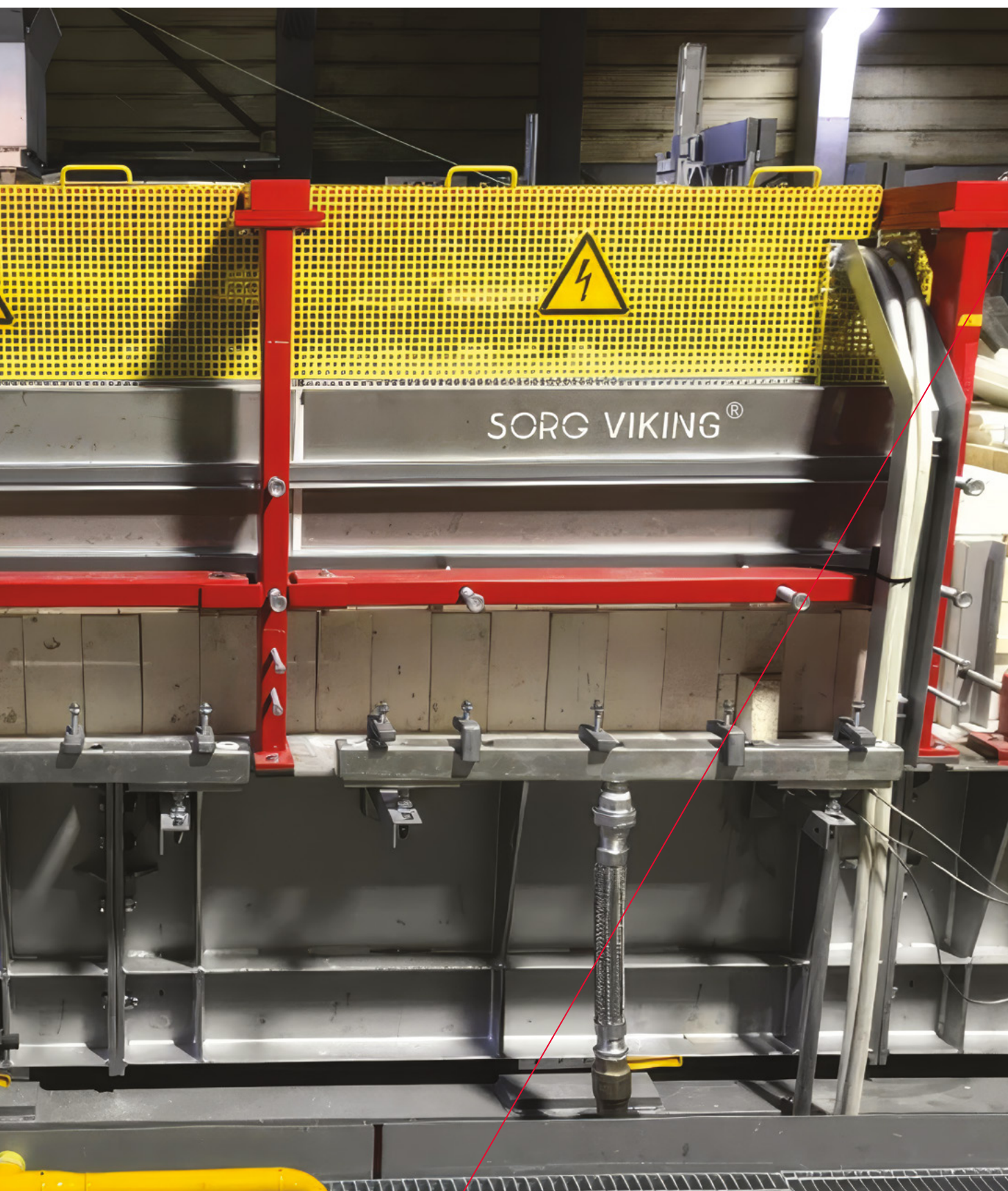
The unique double cooling system utilises both direct and indirect air cooling systems, thus increasing cooling capacity and improving controllability.

The 340S+[®] is available for channel widths of 36", 42", 48", 54" and 60" and is now the standard SORG[®] forehearth design for the majority of applications, particularly for containers. For less demanding applications (tonnages) is the forehearth in the version 240S+[®] available in channel widths from 16" to 26".



ADVANTAGES

- Mature technology
- Excellent thermal homogeneity



VIKING® FOREHEARTHS

VIKING® is SORG's latest development in glass conditioning – a 100% electrically heated forehearth designed to support CO₂-free glass production. Suited to all tonnages, it features heating elements integrated into a specially designed superstructure, completely eliminating local overheating.

With a 100% electrically heated conditioning system that's suited to all tonnages, the forehearth benefits from heating elements integrated into its specially designed superstructure, which completely eradicates local overheating.

As the heating element material cannot fall into the glass bath, this design also protects the melt from potential contamination, meaning a cleaner and safer conditioning process. The versatility and sustainability of the Viking® forehearth represent a significant advance in reducing CO₂ emissions in glass manufacturing.

CHARACTERISTICS

Fully Electric Operation: Uses a 100% electrically heated conditioning system rather than traditional gas or oil burners.

Superstructure Heating: Heating elements are located in a specially designed superstructure, keeping them safely isolated from the glass bath.

ADVANTAGES

- **Zero CO₂ Emissions:** Dramatically reduces the carbon footprint of glass manufacturing.
- **Zero Melt Contamination:** Because the heating elements reside in the superstructure, electrode material cannot fall into or contaminate the glass bath.
- **No Local Overheating:** The superstructure design eradicates temperature spikes, ensuring a safer and highly consistent conditioning process.

SORG® COLOURING FOREHEARTHS

Offering flexible production for special markets and optimum colour homogeneity over a wide range of operating conditions.

Developed based on extensive physical and mathematical modelling, the SORG® colouring forehearth provides optimum colour homogeneity over a wide range of operating conditions.

The colour concentrate or frit is metered by a gravimetric feeding device and deposited at one or more locations on the glass surface at the beginning of the colouring system. For installations with throughputs of up to about 70 t/24 h, the main mixing is done by two large-diameter, four-paddle stirrers, installed in-line at the start of the mixing area.

A system with two skimmer blocks and a wall forces the glass vertically through the stirrers. Additional mixing is provided by two banks of spiral stirrers that act as brakes to slow down the fastest forward current, effectively increasing the time available for natural mixing of the coloured glass. For forehearth with larger tonnages, mixing occurs exclusively via spiral stirrers arranged in multiple rows.

A CONTI-DRAIN® in the stirrer zone helps speed up the removal of coloured glass during a colour change. To prepare glass for the production process, conventional cooling and conditioning zones are necessary after the stirrers. The times needed to change from flint to colour and vice-versa depend on many factors. Typical colouring times are from 2–4 hours. De-colouring takes from 8–16 hours. Through the use of the drain mentioned above, these times can be shortened.

CHARACTERISTICS

The following colours have been successfully produced in SORG® colouring forehearth:

Eco flint, all blue tones, all green tones, grey, pink, violet, black.

ADVANTAGES

- Flexible production for special markets



GAS HEATING SYSTEM

THE SORG® VMC

Automatically regulate heat output with intelligent controls that adjust the gas to air ratio.

The VMC gas heating system works based on the measurement in both air and gas lines. Metering orifice units are installed in the air and gas supply lines to monitor the respective flow.

Both signals are fed to the VMC gas control valve in the gas supply line, which adjusts the gas flow to give the required air/gas ratio. Any change in the airflow results in an immediate equivalent adjustment of the gas flow.

The air/gas ratio maintained by the system can be varied by adjusting the size of the metering orifice in the gas line. A simple mixer is installed to provide adequate mixing of the gas and air. The VMC system conforms to the strict and current EN746-2 regulations.

ADVANTAGES

- Wide working range
- Stable air/gas ratio over the complete working range



AIR/GAS CONTROL STATIONS

The air control valves with optional bypass, air/gas mixers, gas control valves, non-return valves in the gas supply line to each zone, gas filter and two gas safety valves are typically installed together in an air/gas control station. The equipment for all the heating zones of one forehearth can be combined in a single station or for each heating zone.

SPLIT LEFT/RIGHT HEATING

On a standard forehearth, the heating of the left and right sides are coupled together and controlled simultaneously as one control loop, usually based on a temperature reading made in the centre of the channel.

However, on some installations, the glass temperature may be quite different on the two sides of the channel, possibly due to a corner in the channel.

If this is a possibility, the operator can separate the left and right heating within a zone and measure and control the temperature individually. The separated heating can be implemented in any number of zones in the distributor and forehearths as needed.

THE OXYGEN TRIM SYSTEM OMT

The VMC gas heating system used on all SORG® forehearths will maintain an accurate air/gas ratio at all times. However, there are situations when being able to check and adjust the ratio manually is better.

Some heavily-reduced glasses are more susceptible to thermal reboil, and it may be necessary to keep the oxidation level of the gas heating as low as possible.

With many colouring forehearths, precise control of the atmosphere is necessary in the melting zone. The patented SORG® OMT oxygen trim system is ideal for this application. The air/gas mixture supplied to the burners is burnt in a special combustion chamber on the forehearth, and the waste gases from the combustion are passed over a zircon oxide oxygen sensor.

The sensor signal is passed to a transmitter and a ratio controller. An air bleed line and a control valve add a small amount of air to the air/gas premix downstream of the central air/gas mixer.

The control valve varies this bleed air supply to modify the air/gas ratio according to the output of the ratio controller. The system provides additional security in terms of accurate maintenance of the required air/gas ratio. It also permits easy and precise adjustment if regular changes in the ratio are needed.

ELECTRICAL HEATING SYSTEMS

Lower energy consumption with a fast reaction range.

There are two ways in which electricity can be used for forehearth heating:

- Electrodes are inserted directly into the glass and the electricity flows through the glass
- For very special applications, electric heating elements are placed above the glass surface

ADVANTAGES

- Low energy consumption
- Fast control reaction range

DIRECT ELECTRODE HEATING

Molybdenum electrodes are used for most applications. The electrodes can be installed vertically through the channel bottom or horizontally through the side walls. Still, experience has shown that horizontal installation through the side walls gives the best results.



Long electrodes can be installed at a certain distance from one another so that the current flows from one electrode to the next along the length of the channel. Alternatively, short electrodes can be installed along both sides of the channel, so the current flows travel across the channel from one side to the other.

In all cases, power for the electrodes is provided by several small to medium transformer units. Individual thyristor units provide stepless variation of the voltage supplied by each transformer. The electrodes are divided into control zones, and in many cases more than one transformer is used in each zone.

In addition, a safety earthing function is provided for use in the bowl area. Auxiliary burners are supplied to heat all-electric electrode forehearths, using either gas or light oil. The same burners are then retained for use in case of an extended power failure.

Molybdenum electrodes can be used in amber and green soda-lime glasses without causing any problems. However, in some flint soda-lime compositions, complex chemical reactions between the glass and the molybdenum electrode may lead to blister formation and the occasional production of dark-coloured streaks in the glass. Electrodes can also be used in gas-heated forehearths or working ends for boosting.

GLASS COOLING SYSTEMS

Almost all cooling systems used in the glass conditioning process rely on heat transfer by radiation. This takes place from a hotter body – the glass bath – to a cooler body, usually either in the surroundings or part of the refractory roof. A number of different cooling systems are used on SORG® distributors and forehearths, depending on the particular application.

RADIATION COOLING SYSTEM

The open radiation cooling system uses the surroundings to absorb heat radiated by the glass. It involves the provision of openings in the superstructure, sized and located accordingly to the planned cooling capacity. The actual heat loss through the opening is changed by the movement of a damper block to adjust the size of the opening. This system is usually applied to distributors and the rear forehearth zone.

INDIRECT AIR COOLING SYSTEM

The area to be cooled is covered by a thin refractory tile, made of an excellent thermal conductivity material. A small duct running parallel to the forehearth axis is provided in the superstructure refractory above the tile. When cooling air is blown along this duct, the upper surface of the thin tile is cooled.

This reduces the temperature of the lower surface of the tile. Energy is removed from the glass bath by radiation. The cooling effect is varied by adjustment of the volume of cooling air blown along the duct. This system is easy to control and is highly stable. This type of cooling system is usually applied to 240S+® forehearths, 340S+® forehearths and all-electric forehearths.

DIRECT AIR COOLING SYSTEM

Cooling air is blown directly into the combustion space of the superstructure just below the roof, to cool the roof refractories. Heat transferred from the hotter glass bath by radiation to reheat the roof is therefore removed from the glass. The amount of heat removed can be adjusted by varying the volume of air blown into the superstructure. This system is usually applied to the central area of distributors and 340S+® and STF forehearths.

BOTTOM COOLING

Cooling air is blown through ducts in the substructure refractories below the centre of the channel and aligned with the channel centreline. The cooling effect can be influenced by adjusting the air quantity. This is an indirect air cooling system applied below the channel bottom.

ADVANTAGES

- Radiation Cooling System: high heat transfer rate
- Direct Air Cooling System: good controllability
- Indirect Air Cooling System: no overcooling risk and stable operation
- Bottom Cooling: the only system specifically designed for cooling bottom glass

EQUALISING SECTION BOOSTING SYSTEMS

An electric boosting system to improve thermal homogeneity, especially for NNPB.

An electric boosting system in the equalising section is a simple and effective method of improving thermal homogeneity, especially for NNPB, TG and QG.

The electrodes are specially designed for use in forehearths and consist of a molybdenum inner part attached to a high-temperature steel connector. They are installed horizontally through the channel sidewalls, are naturally air-cooled and do not normally require additional cooling.

The electrical equipment comprises several single-phase, doublewound transformers, each with a thyristor unit to give stepless control of the applied power.

All electrical equipment is installed in totally enclosed sheet steel cabinets, built and tested to current European harmonised EN standards. The heating circuit can be arranged to heat either the glass at the channel side or the bottom glass.



CHARACTERISTICS

All systems feature two special safety functions:

1. A unique firing pattern that results in a very low carry-over voltage into the bowl.
2. A safety earthing function ensures there is absolutely no voltage to earth in the bowl when work is being carried out.

The electrodes are often installed during a cold repair of the forehearth, but they can also be added to an existing line during operation.

ADVANTAGES

- Direct influence on the glass at the channel sides and/or bottom – areas that are usually difficult to influence
- Rapid reaction to adjustments makes it easy for operating personnel to optimise performance
- Very low power requirement (usually less than 10 kW)
- Can be installed on working forehearths with minimum disturbance

FOREHEARTH CONTI-DRAIN® SYSTEM

Patented CONTI-DRAIN® technology to effectively remove zircon cords in glass.

After extensive model tests and tests under operating conditions, SORG® has developed a patented CONTI-DRAIN® system for forehearths, specifically to remove contaminated glass, especially zircon cords (cat scratches).

The drain itself consists of a high-temperature resistant steel plate that acts as an outlet nozzle. The equipment is placed up against the underside of the outlet hole in the channel block.

A simple ceramic holder assembly is used to keep the metal plate in position and provide electrical insulation. A thermocouple measures the temperature of the outlet nozzle. The electrical heating system comprises a small double-wound transformer with a thyristor unit to provide stepless voltage variation. A temperature controller is used to maintain a constant temperature at the outlet nozzle, which results in a continuous flow of the glass.

Adjustment of this temperature gives a change in the amount of glass being drained.

On a new installation or repair, the drain block can be installed without the drain equipment. It is possible to install drain equipment and activate the system later if it becomes necessary.

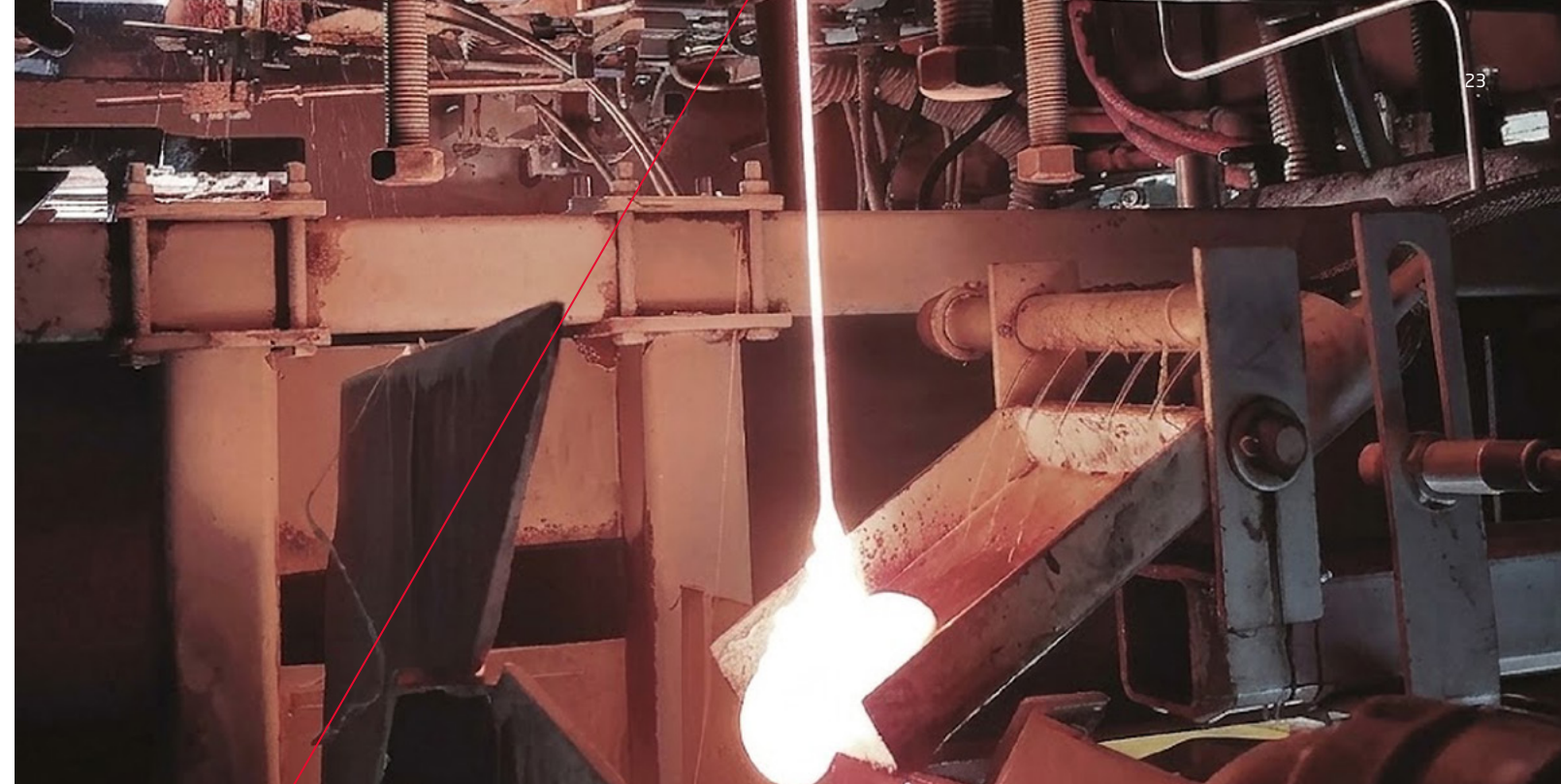
Under some circumstances, it is possible to install a forehearth CONTI-DRAIN® on an existing forehearth with no special channel block by drilling the required profile from outside of the forehearth.

The standard CONTI-DRAIN® system utilises a molybdenum counter electrode in the glass bath. In the case of highly oxidised soda-lime flint glasses, this can lead to blister formation and, although most of these will be removed by the drain, a few may be found in the production. We have developed a version of the forehearth CONTI-DRAIN® that does not need a counter electrode for these applications.

Experience has shown that the forehearth CONTIDRAIN® is capable of reducing or eliminating visible zircon cord in the production.

ADVANTAGES

- The only system that has consistently reduced or eliminated zircon cord



FOREHEARTH STIRRER SYSTEMS

SORG can supply three different stirrer unit systems: the UNIVERSAL and TURNABLE systems for conditioning zones and the MODULAR system for colouring forehearths.

The application of stirrer systems in forehearths is well known. The two most common examples are eliminating cords or mixing colourant in a forehearth colouring installation.

The UNIVERSAL system sits directly above the forehearth, and the stirrer changes must be above the forehearth. This system needs less space than the TURNABLE one.

The TURNABLE unit is custom-made and installed beside the forehearth, and needs a beam underneath.

The MODULAR system sits above the forehearth, but the stirrer changes occur on the forehearth platform. The stirrer unit can be moved out to the side.

Each stirrer system is supplied with variable speed control.

ADVANTAGES

- The stirrer can reduce or eliminate zircon and other cords



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