Equipment for the Glass Industry
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Why components from SORG®?

Although SORG® is primarily known as a successful furnace engineering company, it also lays great importance on the design and specification of peripheral equipment. The key to SORG® success in this field is the fact that the furnace, working end and forehearts are viewed as a complete unit, so the equipment can be designed specifically to meet the various requirements. This is backed by a detailed knowledge of the difficult conditions under which the equipment must operate, 24 hours a day, 7 days a week, year in and year out.

This high level of reliability and quality was not achieved overnight. Many years of experience, both positive and negative, lie behind the development of almost every item of equipment described in this handbook.

Detailed descriptions

As the range of components is wide, not all details could be included here. However, we believe that the descriptions give a good general picture of the equipment we supply. The frequent heading “our standard equipment” refers to standard items that are supplied regularly. However, this does not mean that other sizes, capacities, shapes etc. are not available, and specials are almost always possible.

Regulations and standards

In some cases reference is made to certification standards, in particular to DIN-EN standards. Even where this is not specifically mentioned in this handbook, all equipment supplied by SORG® corresponds to either the relevant harmonised European Standards or, if these have not yet been agreed, to the relevant German Standards.

Finally, the equipment shown in this handbook is not limited to use on SORG® furnaces, working ends or forehearts. Many items can be, and are in fact, used on other installations.
The viscosity of heavy fuel oil is extremely temperature dependent, and two requirements must be met before the oil can be supplied to the furnace burners. The viscosity must be reduced to an acceptable level by increasing the temperature, and it must also be held constant, so that the control equipment and the furnace burners operate correctly.

**Components**

An immersion heater in the oil tank ensures that the oil temperature is at the correct level before the oil is fed to the system, where it is first passed through the electrically heated oil filter and then to the double pump unit (pump station). There the oil is heated to a suitable temperature by an electric flow heater (with a second as stand-by).

The overflow valve for the return flow is installed immediately before the oil control station. Another flow heater can be installed after the station (with a second as stand-by) before the branches to the individual burners. The viscosity on the burners should be 2 °E at a pressure of about 6 bar.

All components described above can be supplied separately.

**Our standard equipment**

- **Immersion heater:** Various standard units, up to a power of 120 kW
- **Double pump unit:** Units up to 4000 l/h, pressure 800 kPa
- **Electric flow heater (preheater or reheater):** Various standard sizes, 18 – 48 kW
- **Overflow control valve:** Two sizes available - DN 15/25

**Options**

- pipe insulation
- tracer heating for pipework
- hot oil tracer heating system

**Advantages**

- more constant viscosity in the total circulation system (overflow control valve – return flow)
- optimum oil temperature before the station and at the burner
- oil “freezing” unlikely (this depends on the distances between the components)
- fewer deposits in pipes or fittings (less cleaning required)
- increased flame stability due to less pressure fluctuation
Oil Control Stations for Recuperative and Regenerative Furnaces

The oil control station on a furnace is designed to carry out 4 functions:

- preparation of the oil supply for the heating system
- regulation of the oil volume according to the automatic control system requirements
- preparation of atomising air
- safety related functions

The open station design is flexible and can be adapted to suit site conditions. The stations are supplied completely piped and cabled. They are checked before delivery and are ready for connection.

Our standard equipment
Standard oil control stations can be supplied for capacities of 400, 700, 900, 1000 and 2000 litres/hour.

Options
- stations for single burner control, with metering and control equipment provided for each burner
- electrically operated control valves
- enclosed station, installed in a sheet steel casing

Advantages
- short installation time
- high quality and certified components ensure high operational security

SORG® oil stations are fitted with atomising air pressure control, oil pressure control, filters, safety equipment and metering and control equipment. The control valve is provided with an electro-pneumatic actuator, and the oil quantity is measured using an oval gear meter.

In the case of regenerative furnaces the oil and atomising air reversal equipment is also integrated in the station. All components which are needed to maintain operational security are fitted with by-passes.

The atomising air and oil pressures are maintained at a constant level in the station, whilst the oil quantity is measured and then regulated by the control system. The safety functions interrupt the oil flow if a fault, such as a combustion air failure, should occur. The oil pipes are insulated in order to reduce heat losses.
Gas Control Stations for Recuperative and Regenerative Furnaces

The gas control station on a furnace is designed to carry out 3 functions:

- preparation of the gas supply for the heating system
- gas quantity regulation according to the requirements of the automatic control system
- safety related functions

In the station the gas pressure is reduced to a suitable level and maintained at a constant value. If the pressure rises or falls too much the safety shut-off valve, integrated in the gas pressure regulator, closes the gas supply. The gas quantity is measured by means of a turbine meter and then regulated by the control valve. The safety functions interrupt the gas flow if a fault, such as a combustion air failure, should occur.

In the case of stations for regenerative furnaces the gas reversing function is also included in the station.

SORG® gas control stations are provided with filters, a gas control valve with electro-pneumatic drive, rapid-action safety valves and operating to normal cubic meter conversion of the gas quantity measurement. Stations for regenerative furnaces also have gas reversing valves. To ensure optimum operational security all parts are provided with a by-pass.

Advantages

- reserve pressure controller for optimum operational security
- short installation time
- high level of operational security as a result of the use of DIN-EN certified equipment

The open station design is flexible and can be adapted to suit site conditions. The stations are supplied completely piped, cabled, ready for connection, and have been checked before delivery.

Our standard equipment

The following standard stations are available:

- throughput: 150 – 3000 Nm³/h
- pipe size: DN 25 – 250

Options

- stations for single burner control with metering and control equipment for each burner
- enclosed station, installed in a sheet steel casing
- electric actuator for control valve
Gas Burners for Regenerative Furnaces

Gas burners form an important part of the regenerative heating system. They are used to influence flame size and shape, both of which can affect the melting process and the fuel efficiency of the furnace.

SJG Series

In the SORG® SJG series of burners the gas quantity is regulated by a perforated drum within the burner body. The drum can be adjusted by means of a hand wheel. The flame shape can be varied by adjusting the drum.

A compressed air connection is provided to cool the burner during the exhaust phase of the regenerative heating cycle.

Burners of the SJG series are ideally suited for standard applications as they have a simple construction and are easy to operate. The burners are supplied complete with holders which have height and angle adjustment, flexible gas hose, gas non-return valve, shut-off valve and cast iron sealing plate.

The burners operate with a gas pressure of 50 – 200 mbar at the burner.

Advantages

- low maintenance
- simple operation
- cast iron sealing plate produces an efficient and permanent seal at the connection between furnace wall and burner, to prevent the infiltration of

Our standard equipment

SJG 221: 0 – 300 Nm³/h natural gas
SJG 231: 0 – 700 Nm³/h natural gas

SORG® SJG gas burner installed on an end-fired regenerative furnace
SGB200 Series

The SORG® SGB200 series of gas burners offer two adjustments to vary the flame shape. Both adjustments are made at the rear of the burner.

By adjusting the position of an inner tube with respect to the burner body the actual cross section of the outlet nozzle can be varied to suit the gas flow.

In addition, the gas flow is divided into two streams by an adjustable perforated drum within the burner body. Most of the gas flows at a lower velocity through the main body, whilst a smaller amount flows at a higher velocity through an inner tube. The flame is produced when the two gas streams meet again at the exit nozzle. Increasing the amount of gas passing through the inner tube shortens and sharpens the flame, and vice versa.

Other features of the design, such as a rounded outside edge to the nozzle and a cast iron sealing plate, ensure optimum sealing between the burner nozzle and burner block, and eliminate cold air infiltration around the burner.

During the waste gas phase, the burner nozzles are protected against over-heating by a separate air supply. Another external cooling air supply protects the cast iron sealing plate and the outside of the burner tip.

The two adjustments for varying the flame shape ensure that the burner can be set to give optimum operation at all times. This means that SGB200 burners are particularly suitable for applications where NOx emissions must be reduced.

The burners require a pressure of 50 – 200 mbar at the burner.

The burners are supplied complete with holders with height and angle adjustment, flexible gas hose, gas non-return valve, shut-off valve and sealing plate.

Our standard equipment

SGB 221:
0 – 300 Nm³/h natural gas

SGB 231:
0 – 700 Nm³/h natural gas

Advantages

- adjustable outlet nozzle improves combustion adjustment (flame length and sharpness)
- NOx reduction is achieved by the combination of adjustable outlet nozzle and variable gas stream separation
- cast iron sealing plate produces an efficient and permanent seal at the connection between furnace wall and burner, to prevent the infiltration of cold air

Options

- rotameter flow meter, so that gas distribution between burners can be observed
- individual control valves on each burner, for regulation of gas distribution
- flow meter with electrical output, for registration of gas distribution
Oil burners form an important part of the regenerative heating system. They are used to influence flame size and shape, both of which can affect the melting process and the fuel efficiency of the furnace.

The oil exits the SORG® NL4 burner as a central stream enveloped in a peripheral stream of compressed air. The high velocity differential between the oil and compressed air streams pulls the oil stream apart and atomises the oil. The correct combination of oil/air nozzle and adjustment of the oil and atomising air gives a radiating flame with minimum NOx production.

The burner comprises a body with air and oil connections, the oil and air pipes, the nozzles and accessories, such as seals. The nozzle is available in short or long versions. The short version produces a shorter, wider flame for smaller furnaces whilst the long version is used in larger furnaces, where it provides a longer, narrower flame.

The burner is supplied complete with adjustable holder, flexible oil and air hoses and shut-off valve.

**Our standard equipment**

Burner type NL4
3 sizes of oil nozzle
- size 1: max. throughput ca. 150 l/h
- size 2: max. throughput ca. 300 l/h
- size 3: max. throughput ca. 600 l/h

**Options**
- oil and atomising air quantity measurement
- extraction valves to remove oil from the burner during the reversal period to avoid solid build-up and so extend cleaning intervals

**Advantages**
- the burner operates as a pure compressed air atomiser
- usable for all applications
- short, sharp or long and lazy flames can be produced with the correct oil nozzle diameter and atomising air quantity
Gas and Oil Burners for Recuperative Furnaces

In furnaces with recuperative heating systems the combustion air is preheated in the recuperator and passed through the actual burner, where it mixes with the gas or oil to form the flame.

SORG® burners for recuperative furnaces consist of a cast iron casing, a high temperature resistant refractory lining and either a gas or oil lance.

Advantages

- The cast iron burner casing provides a safe, permanent and sealed connection between the furnace wall and the burner. This prevents the infiltration of cold air.
- These burners ensure smooth and almost maintenance-free operation.
- The burner pressure can be adapted to suit that of the heating system.

The burners are available in three versions:

- the HTG series is used for gaseous fuels
- the HTO series is used for oil firing
- the HTK series can be used for either gas or oil, where-by the burner lance must be changed to convert from one fuel to the other.

Non-return valves, shut-off valves and gas or oil hoses are supplied as standard.

Our standard equipment

A total of 10 standard burners is available in each series, with maximum capacities ranging from 50 – 1500 kW (operation with preheated combustion air).

SORG® HTG gas burners installed on an end-fired recuperative furnace
Furnace Reversal Systems

When the firing is reversed, the reversal unit switches the incoming combustion air flow and the outgoing waste gas flow between the two regenerator chambers from one side to the other. Slide or flap reversing systems are used to do this.

Slide Reversing System

The slides themselves are manufactured from cast iron and fit into a cast frame. This produces the best possible seal. Slides are installed in the waste gas channels of both chambers. The two devices are connected to one another and are operated synchronously by a single drive. One valve is always open and the other closed, depending on which side is firing. The position of the two valves is changed during the reversing procedure. Simultaneously the passage of the combustion air is changed by a flap in a Y-pipe.

The reversing flaps are driven by special pistonless cylinders, which shortens the reversing time. This minimises the temperature drop during the reversing procedure and therefore influences the purge times for the regenerator chambers. As a result the NOx emission levels are also decreased.

Our standard equipment

The following reversal unit sizes are available from SORG®:

- Type 11/9
  - channel height 1100 mm
  - channel width 900 mm

- Type 13/11
  - channel height 1300 mm
  - channel width 1100 mm

- Type 15/13
  - channel height 1500 mm
  - channel width 1300 mm

- Type 17/15
  - channel height 1700 mm
  - channel width 1500 mm

Options

- a double drive chain for larger units
- a conventional pneumatic cylinder, or an electric motor, as alternative drive methods

Advantages

- improved sealing of the reversing unit and significant reduction in the amount of air induced
- shorter reversal times, resulting in a reduction in NOx emission levels

KomE/10.12.V2.2

SORG® slide reversal system for regenerative furnaces
Furnace Reversal Systems

Flap Reversing Unit

This type of reversing unit utilizes a single swivelling flap for the reversal of the combustion air supply and waste gas exhaust between the two regenerator chambers.

The reversal unit consists of a metal casing, that must be insulated with refractory material on site, two combustion air connections and a reversing flap with drive assembly.

The flap is driven by a pneumatic cylinder through a lever arrangement. The lever and flap shaft are connected by a spring clamp that operates as a slip coupling in order to protect the shaft from torsion stresses. Limit switches are provided to signal the open and closed limit positions.

This system is designed for use with double-pass regenerators, where it can be installed directly on the top of the second chamber. It is not suitable for installation in waste gas channels.

Our standard equipment

The SORG® flap reversal units have the following dimensions:

- **Type 18/37**
  - channel depth: 1800 mm
  - channel width: 3700 mm

- **Type 18/39**
  - channel depth: 1800 mm
  - channel width: 3900 mm

- **Type 18/41**
  - channel depth: 1800 mm
  - channel width: 4100 mm

- **Type 18/43**
  - channel depth: 1800 mm
  - channel width: 4300 mm

- **Type 18/45**
  - channel depth: 1800 mm
  - channel width: 4500 mm

- **Type 18/47**
  - channel depth: 1800 mm
  - channel width: 4700 mm

Advantages

- compact equipment to fit limited building space
- shorter waste gas paths – more economic solution
- short installation time
- long operating life

Options

- refractory material for insulation
- hand winch
The furnace waste gas system generally includes equipment for the control of the furnace pressure, and may also include a method of producing, or increasing, the suction effect which pulls waste gases from the furnace. These functions are important for stable operation of the furnace combustion system.

**Furnace Pressure Control Valve**

This valve is installed in the waste gas channel after the regenerators and is used to vary the draught, in order to maintain a constant pressure in the furnace superstructure.

This flap valve is made of a special cast iron, resistant up to 700 °C, as is the frame in which it sits and rests against when in the fully closed position.

A pneumatic actuator is used to move the flap.

**Our standard equipment**

SORG® furnace pressure control flaps are available in 4 standard sizes:

- Type 11/9
  - channel height 1100 mm
  - channel width 900 mm

- Type 13/11
  - channel height 1300 mm
  - channel width 1100 mm

- Type 15/13
  - channel height 1500 mm
  - channel width 1300 mm

- Type 17/15
  - channel height 1700 mm
  - channel width 1500 mm

**Advantage**

- the use of a pneumatic drive improves reaction time and helps to reduce NOₓ production

**Options**

- a vertical slide valve in place of the swivelling flap valve
- an electric actuator
Injector Chimney

In cases where it is not possible to achieve sufficient natural draught an injector chimney can be used. An injector nozzle is placed pointing upwards in the centre of the chimney base, and a jet of air is blown through the nozzle. The injector effect created by this jet of air is used to provide a draught to pull waste gases from the furnace and expel them through the stack.

The injection air is provided by a dedicated fan. The draught produced is dependent upon the amount of air passing through the nozzle, and this is varied by manipulation of the fan speed through a frequency converter. This method is used to control furnace pressure.

The injector unit is normally topped by a simple steel stack, typically between 15 and 60 m high. Higher versions may require a swing damper.

Design and engineering, the injector unit complete with nozzle, and the fan with a frequency converter are all included in the SORG® scope of delivery.

**Our standard equipment**

Each injector chimney is specifically designed for the actual operating conditions of the installation. SORG® injector chimneys can be designed for waste gas flows of 10000 – 50000 Nm³/h.

**Option**

- the steel stack can be supplied by SORG®

Waste Gas Exhauster

Wherever the natural draught produced by a stack is limited, or where the losses in the waste gas flues are too high, it may be necessary to use a method of producing a draught which is independent of the stack. This is often the case, for example, when an electrostatic precipitator is installed in the waste gas flue between the furnace and the stack.

A waste gas exhauster is basically a fan which is used to pull the waste gases from the furnace and expel them through the stack. The exhauster operates in a hot environment and is designed for waste gas temperatures of up to 500 °C.

The fan speed can be varied by a frequency converter, and so it is possible to use the exhauster as a method of controlling the furnace pressure, with the output of the furnace pressure controller being used to vary the exhauster speed.

**Advantages**

- simple method of creating sufficient draught when flue draught losses are high
- can also be used to control furnace pressure

**SORG® waste gas exhausters are supplied complete with inlet side flap valve, compensator and frequency converter.**

**Our standard equipment**

SORG® waste gas exhausters can be supplied for waste gas flows up to 60000 Nm³/h.
Metallic Recuperators

Recuperators are used to transfer heat from the furnace waste gases to the combustion air. Most recuperative furnaces in the glass industry utilise steel recuperators, which can give air preheat temperatures of up to 750 °C.

SORG® uses two basic types of steel recuperator: the double shell recuperator and the tube cage recuperator.

The Double Shell Recuperator

This type of 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 gap between the two tubes. The air may be passed in the same basic direction as the waste gases (parallel flow) or in the opposite direction (counterflow). Single modules of this type can be used alone, or can be placed one after another to form a complete unit.

In most applications the waste gases flow upwards through the recuperator, but it is also possible to design the recuperator for a downward waste gas flow.

Double shell recuperators are capable of giving a typical air preheat temperature within the range 450 – 650 °C. These units are normally used for small furnaces up to a melting capacity of approximately 50 t/24 h.

Our standard equipment

Recuperators are always designed for individual applications.

Advantage

- can also be produced as small units for small furnaces, working ends or forebays
The Tube Cage Recuperator

The tube cage recuperator consists of a large number of small diameter steel tubes, installed in a ring around the inner circumference of a large diameter outer tube. The outer tube is made of steel, but is lined with refractory material.

The waste gases flow through the large outer tube, whilst the combustion air passes through the inner tubes. The small diameter air tubes are suspended from the top, and are sealed at the bottom with refractory material in such a manner that the tubes are free to expand. The refractory material can be installed before delivery, or added on site after the recuperator has been placed in position.

This type of recuperator can give air preheat temperatures of up to 750 °C. They are usually installed on larger furnaces which require a greater quantity of combustion air.

Our standard equipment
Recuperators are always designed for individual applications.

Combination Aggregate
A tube cage and a double shell unit can be combined to produce a complete aggregate for high capacity installations. The air preheat temperatures produced by such combinations are similar to those produced by a tube cage recuperator, but the total heat exchange capacity is higher.

Advantages
- offers higher air preheat temperatures than double shell recuperators
- less susceptible to problems caused by the condensation of easily volatile components of the glass
TV monitoring equipment can be used for continuous and simple monitoring of important furnace parameters, such as flame shape and batch cover on the glass bath.

The SORG® sensor unit for the combustion chamber consists of a water-cooled casing, an air purge unit, lens and camera. The complete unit is mounted on a movable carriage, that can be removed automatically from the danger area if a fault should occur.

The camera can be fitted with different lenses in order to maximise the field of vision in each furnace. The aperture setting is automatically controlled. The output signal from the camera is a normal video signal.

Electricity, water and air are supplied from a free-standing control and supply station.

The image is shown on a 17" monitor, available either as a free-standing unit or for integration in a control panel.

**Advantages**

- robust camera system, suitable for continuous operation in the glass industry
- high quality lenses produce excellent image quality

**Our standard equipment**

Lenses with diagonal image angles of 70°, 94°, and 110° are available. Fisheye lenses can also be supplied.

The standard sensor diameter is 70 mm. Other diameters up to 129 mm are available, so that sensors can be adapted for use with existing camera blocks in the furnace superstructure.

**Options**

- a separate water cooler can be supplied if the customer does not have a cooling water circulation system
- video recording equipment, configured especially for long-term monitoring
Furnace Transformers

Transformers with steplessly variable voltage outputs are used for electric boosters and all-electric furnaces.

SORG® can supply two different types of transformer:
- oil-cooled, three-phase induction regulators
- air-cooled, single-phase, fixed ratio transformers with thyristors

Induction Regulators

The output voltage is varied under load by the rotation of an induction winding. An electric drive motor for the induction winding permits either remote operation or fully automatic control.

There are no moving electrical contacts, and the principle is characterised by a high level of reliability and low maintenance requirements.

Induction regulators are normally supplied as three-phase units for high voltage connection up to 30 kV. The transformers are oil-cooled and are suitable for indoor operation with natural air convection. Double-chamber Buchholz relays, primary voltage surge arresters, an oil temperature gauge with limit contact, air de-humidifier, and transport rollers are supplied as standard accessories.

Our standard equipment
SORG® induction regulators are available for nominal powers of 300 – 4500 kVA.

Options
- bus bar distributor system on secondary side
- secondary current transformers for current and power measurement
- transformers with combined forced air/oil or water/oil cooling for difficult locations
- tapped transformers with off-load tap change, up to 1000 kVA

Advantages
- improved furnace operation, owing to stepless power variation under load
- extremely reliable, low-maintenance operation, as a result of non-contact voltage adjustment

Double-Wound Fixed Ratio Transformers with Thyristors

Air-cooled, double-wound transformers with thyristors are very well suited to installations with relatively low powers (e.g. less than 200 kVA), and where extremely fast voltage adjustment is necessary. Typical systems on which these transformers are used are throat boosters and melting boosters for certain borosilicate glasses.

The transformers are provided with two or more voltage taps, so the voltage range can be pre-set. The thyristors operate on the phase angle control principle and provide stepless adjustment of the output voltage under load, making remote or fully automatic control possible.

The transformers are designed for capacities between 40 and 200 kW, as single-phase units for connection to the low voltage network (normally 380 – 440 volts).

Our standard equipment
60 to 100 kVA as throat booster units, 100 kVA as booster units for furnaces

Options
- bus bar distributor system on secondary side
- secondary current transformers for current and power measurement
- transformers with combined forced air/oil or water/oil cooling for difficult locations
- tapped transformers with off-load tap change, up to 1000 kVA

Advantage
- high flexibility – even in temporary exceptional circumstances – owing to selectable voltage ranges

All components are installed in enclosed steel casings, to protection standards IP23. Current transformers and transport rollers are supplied as standard.

Our standard equipment
60 to 100 kVA as throat booster units, 100 kVA as booster units for furnaces

SORG® 2100 kVA induction regulator
Electrode Holders and Electrodes for Furnaces

Molybdenum electrodes are utilised in all-electric furnaces and in additional heating systems (boosters) in conventional furnaces. A very pure form of this metal is used, that does not contaminate the glass.

Normally, water-cooled holders are used to protect the molybdenum from damage caused by oxidation in the transition area between the glass and the air.

Standard Electrodes

Rod electrodes are used for normal applications in boosters and all-electric furnaces. The individual rods are usually provided with a male and female thread so that the electrodes can be screwed together.

Our standard equipment

SORG® can supply electrodes with the following nominal diameters:
- 32 mm (1 1/4"")
- 48 mm
- 2"
- 2 1/2"
- 3"

Standard rod electrodes have nominal lengths of 400 or 800 mm.

Option
- Rod electrodes in non-standard lengths

Advantage

- SORG® molybdenum rod electrodes are bought solely from reputable manufacturers and therefore meet the stringent quality standards for glass melting furnaces

SORG® Top Electrodes

Electrodes are normally installed through the side walls or bottom of the tank. This method increases the wear on the refractory material and creates potential weak spots.

SORG® Top Electrodes are L-shaped, and consist of an electrode shaft, which contains the cooling water and electrical supplies, and the molybdenum electrode itself. The holder is inserted through an opening in the superstructure side wall above the glass melt, and the electrode enters the glass bath vertically through the surface.

The condition of the electrode can be checked at any time as the complete holder and electrode unit can be swung out of the furnace.

SORG® Top Electrodes are suitable for use as main electrodes in all types of cold-top electric furnaces.

The complete initial package of SORG® Top Electrodes comprises holder, swivel bracket and a set of connection items.

Advantages

- No access holes or water-cooled electrodes holders in tank blocks
- Electrodes can be checked at any time and re-inserted as required

Our standard equipment

The standard diameters for SORG® Top Electrodes are 2 1/2", 3" and 4". Standard electrode lengths are between 600 and 1200 mm.

A set of connection items consists of pressure hoses (2 x 2.5 m per electrode), needle valve for the cooling water supply, copper connection plate with insulators, flexible connecting straps and a connection clamp.

Option
- The electrodes can be surface-treated to provide temporary protection against oxidation
Water-Cooled Electrode Holders

Water-cooled electrode holders are used for the conventional installation of electrodes in boosters and in the lower areas of electric furnaces. SORG® electrode holders have an enclosed water circulation channel and are therefore suitable for both side and bottom installation.

The operating temperature of the holder is registered by a replaceable NiCr-Ni mantle thermocouple.

The initial electrode holder package includes a set of connection items.

Our standard equipment

SORG® can supply electrodes with the following nominal diameters:

- 32 mm (1 1/4")
- 48 mm
- 2"
- 2 1/2"
- 3"

Standard nominal lengths are between 700 and 900 mm for side wall installation and between 1000 and 1500 mm for bottom installation.

Advantages

- proven design
- universal application

Tin Oxide Electrodes

Special ceramic electrodes made of tin oxide are installed in furnaces for lead crystal glasses, especially in the throat and riser areas.

Owing to the characteristics of the ceramic material these electrodes cannot be advanced. Therefore tin oxide electrodes are installed permanently, with a water-cooled holder. Corrosion is limited as the electrodes are operated at a low current density.

Normally rod-shaped electrodes are used. The electrodes are quite short and thick as this material has a relatively low mechanical strength.
**Water Cooling Systems**

Electrode holders and other metal components used in hot areas must be cooled continuously with water. In the majority of cases enclosed cooling water circulation systems are used in order to maintain control of the water quality and minimise the quantity of fresh water needed.

A typical cooling water circulation system comprises a water storage tank, cooler, pump and distribution stations, and all piping.

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**Evaporation Cooler**

In an evaporation cooler the circulation water is fed through closed pipes that are cooled externally by a combination of a rising air flow and the evaporation of external water dripping from above. The circulation water and cooling media are kept separate, and there is no loss of circulation water.

There is no risk of blockages or deposits as no untreated water is fed through narrow pipes or channels.

Evaporation coolers are installed outside, which can also help to save space in the factory building.

The electrical control equipment is installed in a separate control panel.

**Our standard equipment**

Evaporation coolers must be designed to suit the specific climatic conditions on site. The coolers used by SORG® have cooling capacities up to 170 kW.

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**Plate Cooler**

A plate cooler consists of two pipe systems in close contact with one another. One system is a part of the water circulation system, and the cooling water used for cooling the electrode holders or other components flows through these pipes. Untreated water from the factory mains flows through the second pipe system.

Heat is exchanged between the two systems, whereby heat is removed from the cooling water of the circulation system.

Both systems are totally enclosed and the unit is completely unaffected by the surrounding conditions. It can therefore be installed anywhere, including outside.

**Our standard equipment**

The number of units required can be combined as the system is modular. Systems with cooling capacities up to 170 kW are available.

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**Pump Station**

Equipment for a number of functions is installed in the SORG® pump station.

Two identical circulation pumps are installed for the cooling water circulation, so a standby is available if a pump fails or maintenance work must be carried out. Both pumps have a filter. A pressure switch is provided to monitor the operating pressure in the system.

A small top-up quantity of fresh water is required to compensate for water losses, and this is added at this station.

An anti-scale magnetic treatment (AMT) unit is installed in the main water circulating pipe to eliminate problems caused by solid deposition in the pipework.

The magnetic valve that controls the emergency supply of factory water during a power failure is also mounted on the station. This valve is open when there is no power, and is normally kept closed by the network voltage. It opens if there is a power failure to allow water from the factory system to enter the cooling circuit.

The station is compact, and is supplied ready for connection, complete with all necessary minor components, and the complete pipework. Copper or plastic is used for all pipes.

All electrical connections are centralised in one control cabinet.

**Our standard equipment**

Standard stations with capacities of 10 m³/h, 15 m³/h and 25 m³/h are available.
Water Cooling Systems

Distributor Station

The cooling water is normally distributed to the individual consumers from a distributor station. In SORG® distributor stations the water is monitored by a flow meter in each return pipe. This method offers more operational safety than monitoring in the supply pipes. The flow meters have an adjustable limit contact, and issue a warning if the required flow volume is not reached. After the flow meter all return pipes lead into a common collecting trough, covered to prevent contamination of the circulation water. The cover can be raised so that the water temperature can be hand tested. The return flow to the water tank is by gravity. All electrical connections are grouped in one control panel.

Our standard equipment

Standard water distributor stations can be supplied for up to 20 consumers.

SORG® Compact Water System

The SORG® compact water circulating system contains all the equipment required for a complete small water circulating system for a limited number of consumers. The equipment comprises a water storage tank, two circulating pumps (one as reserve), a closed circuit cooler, an AMT (Anti-scale Magnetic Treatment) unit that prevents solid deposition in the system, a distributor and a collecting trough. Magnetic valves to provide an emergency supply from the factory mains supply in case of loss of water pressure, are also included.

The unit only requires connection to the main water supply pipe, the electrical connection and the installation of the pipework to and from the consumers to complete the water cooling circulating system. The unit is supplied completely piped and wired and ready for connection.

Advantages

- compact design
- all important equipment in one place
- low water consumption
- low maintenance
- low total cost solution for small systems
- added security by flow rate monitoring in return pipes

Our standard equipment

The SORG® compact water circulating system is available in 5 standard sizes with circulating capacities of 1 – 5 m³/h. At a temperature increase of 10 °C at the consumer this is equivalent to between 2 and 10 standard electrode holders.

Water Tank

SORG® water tanks for cooling water circulation systems are manufactured in stainless steel, and are fully enclosed. This prevents the water from becoming contaminated by rust or foreign bodies.

The tanks have flanged connections for the inlet and outlet, drain and vent.

Our standard equipment

SORG® water tanks are available in sizes up to 3 m³.

Option

- tanks made of plastic, suitable for regions with particularly aggressive water quality
**Bubbler Systems**

The upward movement of the bubbles from bubbler systems creates vertical currents. This stream can produce an homogenising effect in the glass, but more frequently the aim is to transport hot glass to the bottom in order to increase the bottom temperature.

Various types of bubbler tube are available:
- molybdenum disilicide (also known as Kanthal Super)
- ceramic
- ceramic with platinum tip

The supply equipment is normally installed in a common panel. The flow volume for each bubbler tube is set and displayed on the control panel.

### Molybdenum Disilicide Bubbler Tubes

The material is very heat resistant and also resists attack by the glass. It has a good electrical conductivity (it is primarily used for heating elements for high temperatures) so, in order to prevent earth faults, it must be electrically insulated against earth.

The bubbler tubes are cylindrical, with a hole running through the centre. Those parts of the bubbler tube that project below the furnace bottom are protected by a fibre insulating sheath against any damage caused by temperature changes.

The material is suitable for use in furnaces producing soda-lime glasses, and where the bubbling medium is air.

All bubbler tubes are supplied with an insulating sheath, fixing clamp, short insulating hose and a connector for the air supply pipe.

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**Advantage**
- excellent material properties

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Our standard equipment

Molybdenum disilicide bubbler tubes have an external diameter of 15 mm and are supplied in nominal lengths of 1000 or 1200 mm.

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**Ceramic Capillary Bubbler Tubes**

If the gas pressure on the bubbler tube is temporarily reduced or cut off, there is the risk that glass will enter the hole, where it freezes and blocks the tube. It is very difficult, if not impossible, to clear a tube that has become blocked in this way.

SORG® ceramic bubbler tubes have several capillaries, all of which are too small for the glass to run into. As a result there is much less risk of a bubbler tube becoming blocked during a break in operation. These tubes also operate successfully in pulsed bubbler systems.

**Our standard equipment**

SORG® ceramic bubbler tubes have an external diameter of 15 mm and are supplied in nominal lengths of 1000 or 1200 mm.

**Options**
- ceramic bubbler tubes with a platinum sheath at the hot end for use in special glasses, such as borosilicate compositions
- ceramic bubbler tubes can also be embedded in water-cooled steel tubes

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**Advantage**
- does not become blocked if bubbling interrupted

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SORG® ceramic bubbler tube installation
Bubbler Systems

The equipment in a bubbler control panel comprises a pressure controller with a filter installed in the supply line, a flow meter with automatic pressure stabiliser and a manometer for each bubbler tube. Each flow meter is provided with a needle valve as a by-pass.

The pressure stabiliser provides a constant flow rate, so the quantity of bubbling air is stable, even when temperature fluctuations in the glass cause a change in the viscosity at the outlet of the bubbler tube. If it is necessary to exchange a flow meter, the by-pass and the needle valve are used to maintain operation of the bubbler tube affected.

Owing to the electric conductivity of the molybdenum disilicide bubbler tubes the voltage to earth of the individual tubes must be monitored in order to identify earth faults. This is achieved by a multiplexing system, using a small PLC. It is not necessary to monitor ceramic bubbler tubes in this way.

Bubbler control panels can be equipped for operation with either air or oxygen. The basic equipment is the same for both versions but, if oxygen is used, all components and tubes are produced in stainless steel, and are absolutely fat and grease free.

The panels are supplied complete with all pipework and cabling.

Our standard equipment
The control components for up to 6 bubbler tubes are installed in a standard SORG® bubbler control panel. Two or more panels are erected side by side for bubbler systems with more bubbler tubes.

Option
• For special applications the installation can be designed as a pulse bubbler. The pressure pulses are produced by magnetic valves installed in the feed pipe to each bubbler tube and controlled by a PLC

Advantages
■ stable operation achieved by the use of flow meters with automatic pressure stabilisers
■ flow meters can be replaced during operation
■ operational security ensured by continuous monitoring of voltage to earth (with molybdenum disilicide bubbler tubes)
Glass Level Measurement

Glass level measurement is used as the basis for automatic control of the raw material feed to the furnace. In many cases the stability provided by the system is also an important prerequisite of stable production.

Mechanical Dipping Probe System

This mechanical dipping probe system has a sensor that moves vertically, and normally operates without glass contact.

Immediately above the glass surface there is an electrically conductive layer of ionised gas. A capacitive measuring method is used for accurate determination of the proximity between the descending sensor and the glass surface.

The drive unit is mounted on the side of the channel, and the non-cooled, platinum-tipped ceramic probe is inserted vertically through the roof. The electronic evaluation system used to determine the glass level is integrated in the drive casing. The output signal is a comparative value for the deviation between the set point and actual value of the glass level.

The glass level is controlled by an external controller. However, an emergency controller is available within the system electronics to provide temporary control, if the normal glass level control system should fail. The emergency controller operates by switching the batch charger on and off.

The system is suitable for installation in working ends and forehearth channels. It is used with soda-lime glasses, but can also be applied to other types of glass.

If required, the system can be set up to operate as a contact system which reacts when the probe touches the glass surface.

Our standard equipment

The standard device is equipped with a non-cooled ceramic sensor. The length of the sensor depends on the height of the superstructure, and is supplied to suit individual projects.

Options

- water-cooled sensor for glasses with heavy volatilisation
- air purge device to avoid the aggregation of condensate in the access opening: this is especially important for use with special glasses, or if there is high internal pressure at the measuring location
- water-cooled base plate when ambient temperatures are very high

Advantages

- non-contact glass level measurement
- compact design
- little corrosion on sensor
- simple fault diagnosis
- internal emergency controller

SORG® dipping probe glass level detector – drive unit

SORG® dipping probe glass level detector – probe
Glass Level Measurement

Optical Glass Level Detector

A light beam created by a lens system is directed diagonally onto the glass bath surface, from where it is reflected. A receiver installed opposite the light source registers the exact position of the reflected beam and uses this to evaluate the level of the glass bath surface. The light source and receiver are installed in suitable free-standing casings.

An air purge unit is used to prevent the collection of condensates in the access openings by maintaining a small over-pressure.

The signal is evaluated by a unit installed in a separate control panel. This type of measurement is suitable for soda-lime glasses, but has also been used successfully for other glasses that exhibit heavy volatilisation.

Our standard equipment

The standard system is suitable for all normal applications.

Option

- a laser system, which operates on the same principle as the optical system described above

Advantages

- no mechanical wear as this is a non-contact measuring technique
- if little space is available, it is possible to site the source and receiver several meters from the measuring point

Radioactive Glass Level Measurement

A weak radioactive source is positioned so that the radiation cone runs partly through the glass bath and partly through the atmosphere above the bath. More radiation is absorbed by the glass bath than by the atmosphere. A detector installed opposite the source receives more or less radiation, depending on how much of the radiation cone is covered by the glass bath. Therefore the intensity of the incoming radiation can be used as a comparative value for determining the height of the glass bath surface.

The system comprises a suitable low level radiation source, housed in a protective casing, a detector and an evaluation unit.

Our standard equipment

The standard system is suitable for all normal applications.
Batch Chargers for Conventional Furnaces

The raw materials for the glass melt – batch and cullet – are introduced into the furnace by batch chargers that operate with various charging methods. The most suitable type of charger for an installation is usually established during the planning stage. The size and shape of the doghouse must be chosen to suit the batch charger to be used.

All machines described below are designed and constructed according to current EN mechanical engineering regulations.

The EME-NEND batch charger

The new EME-NEND batch charger features a unique combination of multiple screw conveyors that deliver batch to the glass bath surface in the doghouse, and a pusher arm. The latter gives the batch piles that important positive impetus away from the charging area and out into the main part of the furnace.

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.

With conventional chargers it is necessary to swivel the complete machine to achieve this effect but with the EME-NEND variation it is possible without any machine movement. This feature assists in the creation of a better charging pattern in the furnace.

The use of multiple screw chargers produces smaller, thinner batch piles, a further contribution to an improved charging pattern. Operational experience has shown that the new charger can operate successfully with high cullet ratios of 80 – 85 % with no sign of wear on the screws.

The only movement of any part of the charger that enters the actual doghouse area is the simple, two-dimensional movement of the pusher arm. It is relatively easy to create a seal around this type of movement and so an advantage of the EME-NEND charger design is the fact that it is possible to seal the doghouse completely.

A completely sealed doghouse effectively eliminates external dusting, a fact that has already been verified by operational experience.

However, the most important advantage of a completely sealed doghouse is the fact that the uncontrolled and often unstable entry of induced air through the doghouse is eliminated, and this leads to a reduction in the production of NOx.

Comparative measurements were made on a typical large end-fired regenerative furnace on which a conventional pusher has been replaced by an EME-NEND charger. The NOx emissions were reduced by 10 %, a saving that can be attributed directly to the new batch charger.

Advantages

- no dust
- no emissions
- optimal batch piles
**The Type SB Chute Charger**

The raw materials stored in a furnace bunker are transferred directly to a feed hopper installed on the charger, from where they descend by gravity onto a water-cooled chute. The special backwards and forwards movement of the chute, produced by an eccentric, moves the material into the furnace.

The basic charging rate and pattern can be varied by setting the speed of the chute, and the stroke length and height of a slide baffle installed on the discharge outlet of the feed hopper. The glass level is then controlled by switching the chute on and off. Operation can be controlled manually or automatically by an external glass level controller.

This type of charger is normally installed as a single machine on furnaces with lower capacities, e.g. from 40 – 70 t/24h. The chargers are supplied complete with frame, feed hopper, chute with replaceable water-cooled front end and an adjustable drive motor.

**Our standard equipment**

- **Type SB 400:**
  - chute width 400 mm
  - max. capacity 40 t/24h

- **Type SB 500:**
  - chute width 500 mm
  - max. capacity 50 t/24h

- **Type SB 600:**
  - chute width 600 mm
  - max. capacity 60 t/24h

- **Type SB 700:**
  - chute width 700 mm
  - max. capacity 70 t/24h

**The Type SBN Chute Charger**

This charger is of the same basic design as the type SB chute charger, but in this case the chute is not water-cooled.

This type of charger is frequently used in cross-fired furnaces, where it is possible to install several chargers adjacent to one another, so that the raw materials are charged across the full width of the furnace. The chargers are supplied complete with frame and feed hopper, in various chute widths, and with an adjustable drive motor.

**Our standard equipment**

- **Type SB 900 N:**
  - chute width 900 mm
  - max. capacity 90 t/24h

- **Type SB 1100 N:**
  - chute width 1100 mm
  - max. capacity 110 t/24h

- **Type SB 1200 N:**
  - chute width 1200 mm
  - max. capacity 120 t/24h

**Advantages**

- robust system
- chute movement produces intermittent charging
Batch Chargers for Conventional Furnaces

The Screw Charger

The raw materials are charged into the furnace by a rotating screw, whereby the charging rate is varied by altering the rotation speed of the screw. The equipment is supplied with a frequency-controlled drive system.

Screw chargers are normally used on small furnaces for the melting of special glasses. In the majority of cases there is no conventional doghouse and the charger is installed in a simple opening provided in the superstructure side wall.

Our standard equipment

The chargers are designed to suit specific applications.

Advantage

- the system provides optimum sealing around the charger

The Type ESE Enclosed Doghouse Pusher Charger

The batch stored in the furnace bunker is transported by a vibratory or screw conveyor to a feed hopper installed on the batch charger. From here the batch falls onto a water-cooled tray that oscillates backwards and forwards and thereby pushes the batch in individual portions into the furnace. The whole charger can also be turned from side to side by a freely programmable swivel mechanism, so that the batch is charged in several directions. This gives the best possible batch coverage on the glass bath surface.

The charger is mounted directly on the doghouse and seals off the whole area. This has the advantage that heat losses are reduced, dusting is low and no false air can enter the furnace.

Advantages

- sealed doghouse
- optimum charging pattern in the furnace

Our standard equipment

<table>
<thead>
<tr>
<th>Type</th>
<th>Tray Width</th>
<th>Max. Capacity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type ESE 400</td>
<td>400 mm</td>
<td>190 t/24h</td>
</tr>
<tr>
<td>Type ESE 500</td>
<td>500 mm</td>
<td>240 t/24h</td>
</tr>
<tr>
<td>Type ESE 600</td>
<td>600 mm</td>
<td>330 t/24h</td>
</tr>
</tbody>
</table>

SORG® screw batch charger

SORG® enclosed doghouse pusher batch charger in operation
Batch Chargers for Electric Furnaces

The batch charging method selected is one of the most important design decisions for cold-top all-electric furnaces. In the majority of cases the batch/cullet mixture must be spread as evenly as possible over the whole surface.

The Distributor Arm Batch Charger

The batch is charged into the superstructure by one or more vibratory chutes and spread over the glass surface by a rotating, water-cooled distributor arm.

This arm is L-shaped and it enters the furnace through a slit in the crown. Its holder and drive motor are installed outside the furnace. A hand winch is used to remove the distributor arm from the furnace superstructure if the temperature in the superstructure becomes too high.

The system is designed for hexagonal or round furnaces and it is used on small electric furnaces with melting areas up to about 5 m².

Our standard equipment

The distributor arms must be dimensioned exactly to suit individual furnaces, and therefore standard chargers are not built.

Advantages

- simple and robust design
- excellent batch distribution

The Rotating Crown Batch Charger

Several small vibratory chutes are installed above the crown at various distances from the centre of the furnace. Batch is charged by the chutes through small openings in the crown, whilst the complete crown construction (including the vibratory chutes and the hoppers) rotates around the vertical axis of the furnace. As a result the chutes deposit the batch in concentric rings on the glass bath surface. The thickness of the batch blanket can be influenced by adjusting the amount of batch charged by each chute.

A sand seal is provided between the side walls and the rotating crown. It is also easy to seal the small openings for the vibratory chutes in the crown. The rest of the superstructure is completely sealed.

If it is necessary to reduce the dust emission level, the batch gases can be drawn off and passed through a simple bag filter. No cold air is drawn into the enclosed superstructure.

The system can be used for hexagonal or round furnaces, with melting areas between 5 m² and 80 m².

Our standard equipment

No standard equipment is available as each rotating crown must be individually designed to fit the specific furnace.

Advantages

- completely enclosed superstructure – no dust in factory building
- can also be operated at high crown temperatures

SORG® rotating crown batch charger in operation
Fans
SORG® supplies fans for:
- combustion air for furnaces
- tank and throat cooling for furnaces
- combustion air for working ends and forehearths
- cooling air for working ends and forehearths
- emergency combustion air for recuperative furnaces

All fans are of welded construction and are suitable for industrial applications. Motor, bearings, impeller and casing are all installed on a common steel frame. Blade design is based on state-of-the-art flow technology. The mechanical parts are designed for continuous operation at ambient temperatures from -10 °C to +40 °C.

The nominal capacities are calculated for an air temperature of 20 °C and an ambient pressure of 1013.25 Pa.

The fans are supplied with compensators, rubber mounting blocks, shut-off valves on the outlet side and inlet filters as standard.

Advantages
- fans are designed for specific installations, so that energy is not wasted as a result of over-sizing
- the fan characteristics prevent unwanted pressure variation when the throughput changes
- high quality material is used for the equipment, to ensure a long operating life under difficult conditions (heat, dirt etc.)

Combustion Air for Regenerative Furnaces

Normally two identical radial fans are installed on these furnaces. One fan supplies the furnace, and the second is kept in working order, as a stand-by.

The equipment is supplied complete with a Y-pipe connection between the two fans.

Our standard equipment
SORG® can supply fans with capacities between 5000 and 30000 Nm³/h.

Option
- axial fans are also available

Combustion Air for Working Ends and Forehearths

In order to save energy and maintenance costs, the combustion air supply for the working end and all forehearths of a furnace is usually centralised. Two identical radial fans are installed, one runs during normal operation, whilst the second is a stand-by that can be run up at any time.

The fans are supplied complete with a Y-pipe connection between them.

Our standard equipment
Combustion air fans with capacities between 300 and 6000 Nm³/h are available.

Option
- an automatic control system for the air pressure, comprising pressure transmitter, controller and frequency converter, designed to improve the operation of large fans at low speeds
Air Supply Equipment

Tank and Throat Cooling for Furnaces

Two identical radial fans are usually provided for the tank cooling. During normal operation only one fan runs, and the other is kept in working order, as a stand-by.

For operational security a separate radial fan is provided for the throat cooling.

Our standard equipment

Cooling air fans with capacities from 15000 to 65000 Nm³/h are available.

Air Cooling for Working Ends and Forehearths

Cooling air for working ends and forehearths is normally provided by single fans for each part of the system (working end or forehearth). Stand-by fans are not installed, as an emergency supply can be provided by making connections to other fans.

The cooling air is produced by radial fans.

Our standard equipment

Cooling air fans with capacities between 300 and 3000 Nm³/h are available.

Emergency Air Supply for Recuperative Furnaces

A radial fan with a diesel motor is installed so that an air supply is ensured even during a power cut. The volume of air is sufficient to cool and protect the recuperator. However, the fan is not large enough to provide the complete combustion air supply.

The fan has an automatic starter so that it runs up automatically if there is a power failure.

Options

(applicable to all fans)

- a conventional control system for the fans using star/delta starters, mounted in a local control cabinet
- a control system with an electronic soft-start function for larger fans installed in a local control cabinet
- all fans can be fitted with a suitable frequency converter for a smooth run-up and fully automatic air volume and/or air pressure control, with all components installed in a local control cabinet

Hot Air Pipework for Recuperative Furnaces

In furnaces with recuperative air preheating, the hot air from the recuperator must be fed to the burners. As the air should lose as little energy as possible between recuperator and burner, special insulated hot air pipework is required.

The pipes are made of heat-resistant steel and are surrounded by mineral fibre insulation. This is protected against mechanical damage by an outer steel casing. In order to facilitate transport and handling on site, the pipes are delivered in pre-assembled sections that can be connected easily during construction.

SORG® hot air pipework for preheated combustion air on a side-fired recuperative furnace

Advantage

pre-assembled sections result in short assembly times
**Temperature Measurement**

Temperatures are measured at many locations in furnaces, working ends and forehearths – either in the air, in the refractory material or in the glass bath itself. SORG® can supply a range of sensors, in the form of pyrometers or thermocouples.

**Thermocouples in the Furnace**

Thermocouples with protective ceramic sheaths are used for measuring the temperatures in both the superstructure and substructure of the furnace. For the most important measuring points SORG® provides:

- **type B** (Pt. 30%Rh–Pt.6%Rh) thermocouples for high temperature areas
- **type K** (Ni.Cr-Ni) for waste gas areas

**Our standard equipment**

SORG® thermocouples are available in nominal lengths from 710 to 1800 mm.

**Options**

- **type R** (Pt–Pt.13%Rh) and **Type S** (Pt–Pt.10%Rh)
- other nominal lengths

**Advantage**

- the equipment is suitable for the particular operational requirements of the glass industry

**In-Glass Thermocouples**

These thermocouples have a platinum sheath and are used for measuring the temperature of the glass in difficult areas, such as the throat, melting end bottom and side walls of all-electric furnaces.

**Option**

- pyrometers can be used to monitor the control thermocouple and this temperature measurement is used for comparative purposes

**Advantage**

- these thermocouples provide important information relevant to the glass quality and the thermal homogeneity

**In-Glass**

Thermocouples with a platinum sheath are used for measuring the temperature of the glass in difficult areas, such as the throat, melting end bottom and side walls of all-electric furnaces.

**Options**

- pyrometers can be used to monitor the control thermocouple and this temperature measurement is used for comparative purposes

**Advantage**

- these thermocouples provide important information relevant to the glass quality and the thermal homogeneity
Advantages

■ special design ensures long operating life
■ channel – easy to replace as installation from above

Thermocouples in Working Ends or Forehearth Channels

SORG® thermocouples for working ends and forehearths have protective ceramic tubes and platinum sheaths. The mechanical stability of the precious metal is augmented by an inner ceramic tube.

The thermocouples are installed from above through the superstructure to take measurements in the glass bath. Virtually maintenance-free type S (Pt–Pt.10%Rh) thermocouples are supplied as standard.

Our standard equipment

SORG® working end and forehearth thermocouples are available with nominal lengths of 1100 mm for working ends and 825 – 925 mm for forehearths.

Options
- triplex unit with extended platinum sheath and 3 thermocouples
- version with extended platinum sheath for glasses with strong volatilisation, such as C glass
- type B (Pt.30%Rh–Pt.6%Rh) or type R (Pt–Pt.13%Rh)
- other nominal lengths

Advantages

■ contactless measurement, independent of fluctuations in the glass level

Bowl Thermocouples for Forehearth

These thermocouples have a heat-resistant steel tube and a platinum sheath and are installed in the side wall of the bowl. Measurements are made in the glass bath.

Our standard equipment

A type S (Pt–Pt.10%Rh) thermocouple with a nominal length of 300 mm

Options
- type B (Pt.30%Rh–Pt.6%Rh) or type R (Pt–Pt.13%Rh)
- other nominal lengths

Pyrometers for Working Ends and Forehearths

Only a lens is needed on the working end or forehearth itself. The radiation from the glass bath is transmitted by a fibre optic cable to the actual sensor, which can be installed at a more acceptable location nearby.

Clean, oil-free air for purging the sight path must be available.

Pyrometers are supplied with an air purge unit, fibre optic cable and transmitter unit as standard.

Our standard equipment

Standard SORG® working end and forehearth pyrometers can be used for all applications.

Option
- an air supply unit for the purge air, comprising filter, pressure controller and combined adjustment valve/flow meter
Oxygen Measurement

Oxygen Measurement in the Furnace

A measurement of the oxygen content in the waste gases is an important prerequisite for optimum furnace operation. The lower the oxygen content, the lower the waste gas losses and the lower the fuel consumption.

The requirement to minimise NO_x emissions can only be achieved with a near-stoichiometric combustion. However, CO may be produced in the regenerators if there is a near-stoichiometric combustion, with less than 1 % O_2 in the waste gases. The CO value can be estimated on the basis of oxygen measurements.

An oxygen content measurement can also be used for automatic air/fuel ratio control. However, for this a reliable method for continuous measurement of the oxygen content is necessary.

The Sensor

The sensor is a zircon oxide sensor, which measures the oxygen concentration difference between the furnace atmosphere and the surrounding air outside the furnace. A thermocouple is provided in the sensor as the differential concentration measurement is temperature dependent.

In end-fired furnaces sensors are normally installed at the top of both regenerator chambers. In the case of cross-fired furnaces they are placed at the top of the chamber on the axis of the burner ports.

The Signal Processor

The signals from the sensor and the thermocouple are processed in an electronic unit, that analyses the data and determines the oxygen concentration at the sensor.

Advantages

- furnace operation can be optimised on the basis of the oxygen measurement, so that minimum NO_x values can be achieved
- the quality of the combustion can be monitored and recorded continuously
Oxygen Measurement

Oxygen Measurement in Forehearts

For certain applications it is advantageous to be able to check the combustion in forehearth zones. This may be the case, for example, in the melting zone of a forehearth colouring installation, but it could also apply in any zone where a very sensitive glass is involved.

To check the combustion, a small part of the air/gas mixture being supplied to the forehearth burners is diverted and burnt in a reference burner. A small zircon oxide sensor is installed in the waste gas chimney of this burner, to measure the oxygen content of the waste gases from the reference combustion of the sample.

The Measuring Unit

The reference combustion, the measurement of the oxygen content of the waste gases and the processing of the resulting data all take place in a single cabinet. A representative value for the oxygen content is shown on a digital display.

The cabinet can be configured for one or more zones, the maximum number in a single cabinet being 5 zones. The reference combustion for all zones takes place in the same burner, the samples from the various zones being switched into the measuring circuit one after another.

The cabinet produces an output signal for each zone, and this can be used for an external indicator or to implement fully automatic control of the air/gas mixture.

Our standard equipment

Complete cabinet, configured for 1–5 zones

Advantages

- the air/gas ratio production of the heating system is monitored
- an exact and reproducible setting of the air/gas ratio can be found
Control Equipment

Accurate measurement and good control of furnace working end and forehearth parameters are important prerequisites for successful operation. Furnace pressure control can have a significant effect on energy consumption and refractory wear, whereas air/fuel ratio control influences both energy efficiency and environmental emissions.

Temperature control of the furnace, working end and forehearts is the basis for stable operation and high-quality production.

Furnace Pressure Control

The furnace pressure is measured relative to the atmospheric pressure outside the furnace.

Two pressure probes are installed through the superstructure side wall refractory, on the two sides of the furnace and opposite one another. The pressure connections of these two probes are connected beneath the furnace. Two further probes are located directly alongside the furnace probes, at the same height, but outside the furnace. These two probes are also connected to one another beneath the furnace.

The pressure connection of the probes inside and outside the furnace are attached to a differential pressure transmitter, which produces an output signal in relation to the difference between the two pressure measurements, i.e. in relation to the furnace pressure.

The pressure connections to the transmitter are made through a special triple valve assembly, so that the connections can be short-circuited for calibration of the transmitter. A water-filled equalising vessel is installed in the pipework between the furnace probes and the differential pressure transmitter to prevent the deposition of condensates in the pipes and shield the sensitive differential pressure transmitter from the gases of the furnace atmosphere.

The transmitter output signal is passed to the furnace pressure controller, the output of which controls either a flap valve in the waste gas channel, the air supply to an injector chimney or the speed of an exhauster, depending on which method is used to influence furnace pressure.

Our standard equipment

The SORG® furnace pressure control system comprises the following parts:

- 2 furnace pressure probes
- 2 atmospheric pressure probes
- 1 differential pressure transmitter with triple valve block
- 1 PI single loop microprocessor-based controller

These items are applicable to all furnace types and sizes.

SORG® furnace pressure sensor
Furnace Temperature and Fuel/Air Ratio Control

The temperature and fuel/air ratio controls are combined in a single control system, which utilises three independent single loop controllers for temperature, fuel and combustion air.

In fossil-fuel fired furnaces the temperature is measured by a thermocouple installed in the superstructure, usually in the crown. The signal is passed to a transmitter which converts the millivolts into a standard mA signal, which is passed to the furnace temperature controller.

Fuel flow is measured by the meter installed in the fuel control station, and the output signal is passed to a transmitter, which converts the signal to a standard mA signal. With liquid fuels this signal is then passed to the fuel controller. For gaseous fuels the signal is taken to a small PLC for conversion to normal cubic metres on the basis of temperature and pressure measurements made in the gas station.

The corrected output signal is passed to the fuel controller. Air flow measurement is normally made with an orifice plate in the fan inlet nozzle. A differential pressure transmitter produces a standard mA signal, which is used as an input signal for the combustion air controller.

The output of the temperature controller is connected to an input channel of the fuel controller, where it provides an external set point. The output of the fuel controller is taken to the fuel control valve, which varies the fuel flow rate, depending on the requirements of the temperature controller. The fuel controller output also passes to an input channel of the combustion air controller, where it forms an external set point, which allows the controller to act as the ratio controller. The output of the air controller is connected to the air control valve, and the air quantity is varied to maintain the required fuel/air ratio.

Our standard equipment

The SORG® furnace temperature and fuel/air ratio control system comprises the following parts:
1. temperature transmitter
2. metering inlet nozzle units for the combustion air fans
3. differential pressure transmitters for air quantity measurement
4. fuel flow transmitter
5. PI single loop microprocessor-based controllers

Options
- separate left/right ratio control for reduced NOx production
- multiple zone control for side-fired furnaces
- individual burner control for reduced NOx production
- air-led ratio control

Glass Level Control

The glass level controller receives a signal from the glass level detector (see page 26 of the catalogue). The controller output is a continuous signal (4 – 20 mA) which is used for variable control of the speed of the batch charger.

Our standard equipment

The SORG® glass level control system comprises the following:
1. PI single loop microprocessor-based controller

This item is applicable to all furnace types and sizes.

Option
- the controller can be configured for on/off operation of the batch charger
Control Equipment

Working End and Forehearth Temperature Control

SORG® temperature control systems for working ends and foreheaths normally utilise in-glass temperature measurement by means of thermocouples (see page 35 of this catalogue). Temperature control is carried out exclusively through the heating system.

The millivolt output of the thermocouple is passed to a transmitter, which converts the signal to a standard 4 – 20 mA signal. This is passed to the temperature controller.

The 4 – 20 mA temperature controller output signal is passed to the actuator of the air control valve for the relevant zone.

Our standard equipment

The SORG® working end and forehearth temperature control system comprises the following parts for each zone:

1. temperature transmitter
2. PI single loop micro-processor-based controller

These items are applicable to all working end and forehearth zones.

Cooling Control Systems

SORG® working end and forehearth cooling systems are controlled by a unique stepping control system based on a PLC. The PLC monitors the output of the heating controller and adjusts the position of the cooling step-wise in order to keep the output of the heating controller within acceptable limits.

The output of the heating temperature controller is passed to the PLC parallel to the connection to the air control valve. A check routine based on a specially developed logic is carried out in the PLC and, if the heating controller output exceeds certain programmable limits, the PLC sends a step signal to the cooling system actuator to change the position of the cooling system.

Operator access to the stepping control system is provided by a small operator panel with LCD display.

A single PLC can be used to operate the stepping control system for several cooling sections. The stepping control system can be used for open radiation, direct air or indirect air cooling systems.

Our standard equipment

The SORG® working end and forehearth stepping control system for cooling systems comprises the following parts:

1. PLC unit
2. operator terminal

These items are applicable to all working end and forehearth types and sizes.
Many pieces of equipment installed on the furnace, working end and forehearts produce warning signals to alert the operator to the existence of unusual operating conditions or a fault.

Centralised operation supervision makes it necessary to collect all such warning signals at a single location, so that the operator can easily detect the existence of a fault warning and identify the source of the signal.

The SORG® safety system is available in two forms: the PLC version and the single instrument version.

### PLC Version

A version of the SORG® alarm warning system based on a small PLC is available.

Fault warning signals generated by external (field) equipment are connected to the input channels of the instrument. Each warning signal must be provided in the form of a potential-free contact.

Operator access is by means of a separate operator panel, suitable for mounting in the front face of a control panel. Fault warnings are shown as text messages on the operator panel, and can be acknowledged on the panel by the operator. If the alarm is still present the warning message remains visible.

The PLC has connections for a warning horn and a flashing light. When an alarm is acknowledged the horn is switched off, but the lamp continues to flash until the warning is no longer present.

Stand-alone systems utilise an operator panel with a small LCD display, whereas larger PLC-based systems use touch panels for operator access.

**Our standard equipment**

Input channels (for potential-free contacts on field equipment) are provided in groups of 8 (standard input blocks for the PLC).

### Single Instrument Version

This is a panel-mounted instrument, which combines illuminated indication fields, outputs for optical and acoustic warnings, and acknowledgement function.

Fault warning signals must be available on external (field) equipment as potential-free contacts.

When a fault signal occurs, the relevant warning field on the instrument is illuminated, the optical and acoustic warnings are initiated and a master warning lamp on the instrument flashes. The warning can be acknowledged by pressing a button on the front of the instrument, at which point the external acoustic warning is switched off, and the master warning lamp on the instrument itself changes to steady illumination. The external optical warning remains activated. These warnings are only eliminated when the fault signal has been removed.

The acknowledge function can also be provided from an external source by means of a binary input to the instrument.

**Our standard equipment**

The instrument is available with 8 or 16 input channels for warning signals.
Sometimes glass must be removed from the lower regions of the glass bath through a bottom drain. It may also be necessary to remove glass from the bath surface. Drains can be installed in the furnace, working end or forehearth, or even a gathering bay. On some installations a drain is installed to maintain the necessary minimum melting capacity when production rates are low.

Regardless of the location, and whether glass is to be removed from the surface or the bottom, the glass must always be drained in a controlled manner, and in the majority of cases, slowly as well.

SORG® offer a series of drain systems for different applications.

The CONTI DRAIN® System

This system has direct electric heating, whereby a current flows between the heat resistant steel outlet nozzle and a counter electrode in the glass bath. The amount drained can be regulated as required and maintained at a constant level by the heating control system.

The CONTI DRAIN® system can be used in the front part of furnaces, for example before or after the throat, or in forehearth channels. It is suitable for the majority of glasses produced commercially, including opal and borosilicate compositions.

The system consists of mechanical components – the actual outlet nozzle with its holder and electrical connections – and the corresponding electric heating system. This comprises primary switchgear, double-wound transformer with thyristor unit and a control system, including a thermocouple and 50 m of compensating cable.

Our standard equipment

A standard system is suitable for use in both furnaces and forehearths.

Option

- under certain circumstances the CONTI DRAIN® system can be retrofitted in a furnace or forehearth channel

Advantages

- easy to operate
- reliable
- nozzle simple to replace, even when installed in a furnace
Drain System Equipment

Standard Drains for maintaining the Minimum Melting Capacity

Sometimes it is necessary to drain glass in order to maintain the melting rate above a certain minimum level. This can be achieved by installing a stub forehearth at a suitable location in a working end and adding a conventional forehearth spout to it.

Glass is drained through the spout, using a suitably sized orifice ring. The amount drained is regulated by means of a vertically adjustable ceramic tube above the drain outlet.

The channel and feeder spout are normally gas-heated, using manifold burners in the channel and spout, and a single burner for the drain.

The system consists of a gas burner with supply station (for mixture production), a height adjustable holder for the ceramic tube, and a steel bowl for the spout, including a holder for the orifice rings, and a thermocouple with 50 m of compensating cable for recording the temperature. Automatic control is not required.

Our standard equipment

The systems are individually designed to suit site conditions and required capacities.

Option

- the complete refractory material for the superstructure of the channel and bowl

Advantages

- simple adjustment of the amount being drained
- replaceable orifice rings mean that capacities from less than 1 t to more than 20 t/24 h can be achieved

Surface Drain Systems

With certain types of glass it can be necessary to draw off poor quality glass from the surface, in order to maintain the production quality required. It is possible to install surface drain systems at various locations, but they are normally located in the forehearth spout or a gathering bay.

The surface drain consists of a narrow channel with a metallic baffle plate that is installed from above and sits on the channel bottom. The amount of glass drawn off is determined by the height of the glass bath above the baffle plate.

The overflow channel is usually heated by a combination of manifold and single gas burners. Temperature control is not required, as the overflow quantity is only temperature dependent to a limited degree.

Our standard equipment

The systems are designed individually according to site conditions and the capacity required.

Advantage

- space saving design

SORG® overflow drain for the production of water glass
Gas and Air/Gas Stations for Working Ends and Forehearths

The incoming gas supply for the installation is prepared in the gas station, whereas the air/gas control station is used to vary the fuel volumes according to the requirements of the burner control system, and for setting the air/gas ratio.

Gas Supply Station

Here the inlet pressure is reduced and maintained at a constant level. If over or under pressure occurs, the shut-off valve installed in the gas pressure controller shuts off the gas supply. If a fault occurs, such as a combustion air failure, gas pressure loss or activation of an emergency-off switch, the safety system interrupts the gas flow. The total gas volume is measured by a turbine meter.

In order to increase operational safety, all components, except the quick-acting safety valve, are fitted with reserve equipment or a by-pass.

The station is designed according to DIN-EN 746, part 2 standards, and all components have the relevant certification. The stations are supplied complete with all necessary minor components, such as filters, shut-off cocks etc. and all pipework. They have been checked and are ready for connection.

SORG® gas stations for working ends and forehearths are designed for use with either LPG or natural gas. No modifications are required if a changeover is made from one fuel to the other.

The space-saving standard unit is designed for wall installation.

Our standard equipment
Various standard stations for capacities from 300 – 6000 kW

Options
- multiple gas meters to provide individual consumption data for all parts
- support frame for floor installation
- gas quantity conversion m³ – Nm³

Advantages
- pressure controller with stand-by
- short installation times as pipework already complete
- high operational safety as components are DIN-EN certified
- designed for both LPG and natural gas
- space-saving wall installation

SORG® gas station for a working end and forehearth
Gas and Air/Gas Stations for Working Ends and Forehearths

**Air/Gas Control Stations**

All control components for the combustion air and gas for several zones are installed together in the air/gas station. Basically as many zones as required can be supplied from one station. However, in practice the zones are grouped to correspond to clearly defined parts of the installation, such as the working end or a forehearth.

Each station contains the control valves for the air quantity, by-pass valves, gas quantity controller and air/gas mixer for each individual zone. The SORG® VMG2 system for regulating the air/gas mixture is used. A shut-off valve and a non-return valve are also installed in the gas pipe for each zone.

All components for the gas or air/gas mixture have been certified in accordance with DIN-EN 746, part 2. The stations are supplied complete with all minor components, such as shut-off valves etc. and pipework, and have been checked before delivery.

A standard station has a distributor pipe for the combustion air in the lower part of the station. The pipework runs upwards in a vertical direction, for connection to the mixture pipes at the top of the station. The stations have a frame and are free-standing.

SORG® air/gas control stations for working ends and forehearths are designed for use with either LPG or natural gas, and can be operated without modifications, if a changeover from one fuel to the other is made.

**Our standard equipment**

- for 2 to 6 zones for working ends
- for 2 or 3 zones and spout zone for standard forehearths

**Advantages**

- compact, space-saving design
- short installation time
- high operational security as components are DIN-EN certified
- designed for use with either LPG or natural gas

**Options**

- version without mixer for use with individual burners (e.g. in working ends or gathering bays)
- special versions for limited space locations
- with gas meter and/or gas supply equipment
- alternative mixture systems
The majority of working ends and forehearts are gas-heated. Normally, so-called manifold burners are used, installed a short distance apart, and supplied with a mixture of gas and air. Individual burners are occasionally installed in working ends, but they are almost always utilised in forebays or gathering bays.

**Manifold Burners**

Manifold burners provide a simple and economic method of distributing the heat evenly along a channel or elongated working end. The individual burners are mounted on a distributor manifold that runs parallel to the channel. The burners project into the refractory burner blocks which form part of the superstructure side walls. The burner manifold supplies a number of burners – normally between 4 and 12.

Burners of various lengths and with different nozzle diameters can be supplied.

The capacity of the individual burners depends on the mixture pressure available (heating system dependent) and the nozzle diameter. It is possible to achieve maximum capacities between 4 and 17 kW at each burner.

The burner manifolds are supplied with a height-adjustable holder as standard.

**Advantages**

- simple system – operates without problems on most installations
- wide range of burner lengths and nozzle diameters available

**Our standard equipment**

Burners can be supplied in 6 standard lengths from 145 – 375 mm, and with nozzle diameters from 4 – 9 mm.

Standard manifolds are designed for 4 – 12 burners.

**Options**

- ceramic nozzles that are less susceptible to heat or dirt contamination
- multiple-head burners, where 2 or 3 burner heads are combined and provided with a common connection; used for heating corners and other restricted locations
Individual Burners for Working Ends and Gathering Bays

Sometimes individual burners are required for working ends when burner manifolds cannot be installed, either for space or other reasons. Such burners are also used in gathering bays.

Gas and air are supplied separately to the burners and then mixed directly at the nozzle. The air/gas ratio is maintained at a constant level by an external system.

The burners are designed for operation with non-preheated combustion air.

As they are of compact design, and operate with a short flame, the burners are especially suitable for heating narrow combustion chambers with limited access from outside.

The burners are supplied complete with connecting hoses for gas and air, shut-off valves and rotameter flow meters for gas and air.

Individual Burners for other Applications

Individual burners are also used for heating outlets and drains, and during the heating-up, or as emergency heating for all-electric forehearts.

In such instances, the burners are sometimes operated at combustion space temperatures lower than the ignition temperature of the gas. Therefore it may be necessary to monitor the ignition or flame.

For these applications the burners are normally supplied without flow meters. The gas and air quantities are adjusted individually and manually.

Our standard equipment

The burners are available in 4 sizes between 40 and 230 kW.

Option

- flow meters with an electric output signal so that the flow volume can be displayed on an external instrument or system

Advantage

- the compact design renders the burners suitable for many applications
Electrical Heating Equipment for Forehearths

Two types of electric heating systems are used for forehearths:
- direct heating by means of electrodes immersed in the glass
- indirect heating using radiation elements installed above the glass surface

However, irrespective of the type of heating involved, the electrical equipment normally comprises the following major groups:
- primary switching equipment
- thyristor unit
- double-wound transformer

Primary Switching Equipment
All-electric heating systems for forehearths are connected to the low voltage network. Depending on the installed power, either power contactors with fuses or compact low voltage circuit breakers are used.
A set of primary switching equipment is normally provided for each heating zone, so each area can be switched individually and is also fully electrically protected.

Transformers
Air-cooled, single-phase, double-wound, fixed ratio transformers are used. The double winding is an important safety factor as it provides a galvanic separation between the power supply and the glass bath.
The secondary output voltages can be steplessly adjusted by means of the thyristors. Temperature sensors installed in the windings provide additional overload protection.
Taps are provided so that the available secondary voltage range can be adjusted to suit the actual operating conditions. Current transformers for secondary current measurement are normally included.
Transformers with nominal powers above about 20 kVA are usually provided with separate steel casings, offering IP23 standard safety protection. These can be installed at suitable locations in the factory. Smaller transformers are usually installed in communal panels built to IP54 safety standards. The units are designed for permanent operation at ambient temperatures up to 40 °C.

Our standard equipment
Standard components are available for nominal powers between 5 and 100 kVA. All components can be supplied individually, or in a complete package.

Heating Elements
Silicon carbide or molybdenum disilicide radiation elements are used for indirect forehearth heating.
Rod-shaped silicon carbide elements are employed in conventional forehearths for soda-lime glass. They are normally installed horizontally above the glass bath. A special glaze must be applied to the elements to protect against attack by the volatile components from the glass.
Molybdenum disilicide elements are usually U-shaped and are installed vertically through the superstructure roof. One application is in covered forehearths for glasses that suffer from volatilisation problems. Air purge units are required for use in open forehearths. They create a slight over-pressure to prevent the formation of condensation deposits around the element connections.
The characteristics of the two materials differ, as do the most important factors to be taken into consideration when designing the electrical equipment.
The heating elements are provided with flexible connection straps, fixing clamps and refractory sheaths or blocks.

Our standard equipment
A wide range of rod and U-shaped radiation heating elements are available.

■ SORG® has extensive experience of the use of radiation heating elements, and is therefore able to advise on and select the correct type and size of element for each individual application.
Thyristor Units

Only thyristor units with phase angle control are used. These are installed on the primary side of the transformers so they are galvanically separated from the glass bath. This prevents DC components being transferred to the glass bath.

The thyristor units employed by SORG® have an adjustable current limit and an overriding current controller. The nominal current depends on the power of the transformer, taking the special characteristics of the heating type into consideration.

Molybdenum Electrodes

Molybdenum electrodes are used in all-electrically heated installations and for forehearth boosters.

The electrodes comprise a molybdenum head and a heat-resistant steel connector. They are installed without water cooling and are sealed against oxidation by the glass in the installation hole. No supplementary air cooling is required on the majority of installations.

In order to prevent bubble formation, the electrodes are operated with very low specific current loadings. This means that there is virtually no corrosion of the electrode material and the electrodes do not need to be advanced.

The electrodes are supplied complete with a steel sealing ring, copper connection plate, fixing clamp and insulator.

Our standard equipment

Electrodes with molybdenum head diameters of 32, 48 and 60 mm are available. The head and total length can be varied to suit site conditions.

Option

- a special protective coating against oxidation for applications where electrodes are subject to an oxidising atmosphere for a limited period of time, such as during the heat-up

Advantages

- simple installation
- maintenance-free

Tin Oxide Electrodes

Special ceramic electrodes made of tin oxide are used in installations in lead-containing glasses.

Owing to the characteristics of the ceramic material it is not possible to advance these electrodes. Therefore tin oxide electrodes are installed permanently, with a water-cooled holder. Corrosion is limited as the electrodes are operated at a low current density.

Tin oxide electrodes are usually rod-shaped. As the material has a relatively low mechanical strength the electrodes are quite short and thick, quite unlike molybdenum electrodes.
Stirrers

Stirrers are normally used to improve the chemical homogeneity of the glass. In only a few circumstances are stirrers installed in an attempt to improve thermal homogeneity. The use of stirrers in colouring forehearths is well known.

The SORG® Modular Stirrer Unit

The SORG® modular stirrer unit is a flexible basic design that can accept between 1 and 5 stirrers at varying centre distances, depending on the form of the refractory stirrer blades and the relevant dimensions of the channel at the installation location.

The complete stirrer unit can be raised and moved to the side, so that it is possible to exchange the refractory stirrers in the relatively amenable conditions alongside the forehearth.

The drive unit comprises an electric motor and a cardan drive shaft. Therefore the motor can be installed at a location alongside the channel where it is protected from direct radiation. The steplessly variable rotation speed is produced by a three-phase motor and a frequency converter.

The equipment includes the stirrer unit holders with heat resistant bearings, vertically and horizontally adjustable support frames and all drive components. The electric drive components are installed as standard in local control panels, that are also supplied.

Our standard equipment

The module stirrer unit is available with between 1 and 5 stirrers.

The Equalising Section Stirrer Unit

Stirrers are often installed in forehearth equalising sections – mainly to improve the chemical homogeneity of the glass before it is processed. SORG® have developed a stirrer unit especially for this application.

Space at the front of the forehearth is limited, therefore a space-saving design is required. The complete construction is borne on a single, rotatable column.

This makes it possible to swing the complete construction to the side in order to exchange the stirrers.

The basic design is suitable for small paddle stirrers, as this type of stirrer produces the best possible mixing results. Between 2 and 5 individual stirrers can be installed, depending on the channel width at the installation location.

The stirrers are driven by a three-phase motor, integrated in the unit. A frequency converter is used to provide stepless variation of the rotation speed of the stirrers.

Our standard equipment

Equalising section stirrer units can be supplied for between 2 and 5 stirrers.

Option

- A simplified unit for 2 stirrers, a fixed distance apart, for 16’ wide channels. These stirrers can only be moved vertically.

SORG® modular stirrer units installed on a colouring forehearth
Stirrer Units for Forebays

When glass is extracted from a gathering bay – regardless of whether extraction takes place manually or with a ball gatherer – bubbles and thermal inhomogeneities occur as a result of the extraction process. In addition, with certain glasses, volatilisation from the bath surface can also cause a reduction in the glass quality. These problems can be decreased if a stirrer is installed in the bay itself, as it creates currents in the glass bath, so that fresh glass can be transported to the gathering location.

A relatively large paddle stirrer is used for this, normally positioned in the centre of the gathering bay. The refractory stirrer is screwed into a water-cooled shaft installed vertically through the roof. The electric drive motor and water connections are located outside the gathering bay. The height of the stirrer is adjusted by a hand winch.

Stirrer replacement takes place through the gathering hole, using special tools, so it is not necessary to create a roof opening as large as the stirrer.

The stirrer rotation speed is steplessly varied by the combination of a variable speed motor and frequency converter. All electric control components are installed in the local control panel supplied.

The refractory stirrers for this application can be supplied for clockwise and anti-clockwise rotation to suit site conditions.

Our standard equipment
Standard units are available for clockwise or anti-clockwise rotation.

Refractory Stirrers

Several types of stirrer are used according to the different installation locations and type of operation. Two and four paddle stirrers in various sizes, and spiral stirrers are available. For normal applications, the stirrers are made of zircon mullite as this is resistant to thermal shock. For special glasses fused silica paddle stirrers are available for gathering bays.

Advantages
- flexible design – can be used for many applications
- compact design to suit tight areas
- operator-friendly as the stirrers can be replaced alongside the forehearth
- stirrer unit operation greatly improves the quality when glass is extracted from the surface
To change the glass colour in a forehearth, a colouring agent is added and mixed in by stirrers. During this process the feed rate of the colouring agent must remain constant, to maintain a stable colour throughout a production run.

Experience has shown that the grain size distribution of the colorant material covers a wide spectrum, so the colouring agent must be metered gravimetrically.

Metering Equipment

The metering equipment has a small hopper, from which the colourant material is transported along a small vibratory chute to a weighing cell. From here the material is fed along a second vibratory chute. The control system automatically controls the vibration rate of the chutes.

Material is automatically replenished from the main bunker when the control system detects the minimum level of material in the small hopper.

The conveying equipment is controlled by its own computer, and all operating parameters can be set on the monitor.

A screw conveyor is supplied as standard for the feed from the main bunker to the small hopper.

Our standard equipment

The metering equipment can be supplied for maximum capacities of 50 kg/h or 100 kg/h.

Option

- a vibratory discharge device for the replenishment (instead of screw conveyor)

Advantages

- stable material flow rate gives even colour intensity
- simple to operate

Experience has shown that the grain size distribution of the colorant material covers a wide spectrum, so the colouring agent must be metered gravimetrically.
Delivery Pipes

The metering equipment is installed above the forehearth, and the colourant material is transported by gravity along delivery tubes to the forehearth.

On larger installations the colourant is deposited on the glass surface at two or more locations. The material is roughly divided by a separating funnel below the delivery conveyor and fed to the individual feed locations down separate delivery pipes.

The delivery pipes are made of pre-formed elements, with straights, elbows, bends, etc. that can be clamped together easily to suit site conditions.

Our standard equipment

Standard components are supplied as required for each project.

Feed Pipes

The colourant material is fed into the forehearth through water-cooled feed pipes installed in the refractory superstructure. The pipes are provided with a compressed air supply to prevent condensate deposits forming in the pipe.

A NiCr-Ni mantle thermocouple in the feed pipe monitors the operation of the water cooling. The operating temperature is shown on a digital display, which is normally installed in the control panel for the colouring forehearth stirrer units.

The pipe is supplied complete with holder, thermocouple and 50 m of compensating cable.

Our standard equipment

The standard pipe for all normal applications has an external diameter of 102 mm and a nominal length of 600 mm.

Advantages

- Colourant does not stick to the pipe
- Simple installation
- Can be dismantled quickly for cleaning
For your notes