SORG melting technologies for special glasses

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All over the world the majority of glass melting furnaces are used to melt soda-lime compositions, either for flat glass or containers. However there are still many furnaces melting other types of glass, and each glass poses its own particular problems, either in the melting/refining or in the conditioning areas.

In some cases, exactly the same furnace technology can be used for a special glass or a soda-lime composition, although details may vary. However, the application of the melting technology for soda-lime production may not be regarded as standard. A representative example is the use of an all-electric furnace design. This type of furnace is used for containers and other soda-lime applications, but the relatively high cost of electrical energy often prevents their widespread use. In the production of special glasses melting energy costs may be of secondary importance compared to product quality and environmental issues, and so electric melting technology is more commonly used in the special glass sectors.

As most furnace technologies are well-known, no detailed descriptions are given below. The aim is to indicate which melting technology will give the best results for each type of glass.

Pyrex type borosilicate glass
(α = 32 to 40 x 10^{-7})

This is a typical borosilicate glass with a very simple composition containing only SiO_2 (ca. 80 %), B_2O_3, Al_2O_3 and alkali (ca. 4 %).

The products

One of several useful properties of this type of glass is its low thermal expansion and this had led its use for ovenware. However, many other products are made from this glass, including laboratory ware, lighting ware and tubing for many applications. Many typical products are pressed but others, such as laboratory ware and some household items, are blown. Tubing is produced by both the Vello and Danner processes.

Special problems with melting the glass

High temperatures are needed to melt and refine the glass and in many applications the content of trace elements is limited, which severely restricts the choice of refining agents and exacerbates the refining problem. Surface loss of boron and alkali can lead to silica enrichment and crystobalite devitrification, causing major quality problems with cord and stones.

The furnace solution

The VSM® all-electric furnace with patented Top Electrodes and the revolving crown batch charging system has proven to be an excellent furnace design for this difficult glass.

The lack of an open glass surface and the enclosed superstructure limit surface losses and ensure best glass quality, whilst the direct electrical heating allows the energy to be developed in the glass bath to achieve the high temperatures needed for melting and refining of this glass.

Alternatively, the Boro-Oxy-Melter® is a fossil-fuel fired furnace concept specifically developed by SORG® for such glasses. The main heating is provided by an oxy-fuel system, and this is supported by an extensive electrical booster. Refining is assisted by the use of SORG® refining bank technology.

The largest unit of this type yet built has a maximum melting capacity of 70 t/24 h.

Recent installation for this glass

Country	USA
Furnace	VSM® all-electric furnace
Product	pressed lenses
Melting capacity	45 t/24h
Other features	SORG® all electric forehearths
Built	2003

Glass insulating wool

The typical glass for this product is C glass. This is a soft borosilicate composition with medium boron (ca. 5 %) and high alkali (ca. 16 %) contents.

The product

Glass fibre wool is commonly used as a bulk thermal insulating material and for special shape insulating items.

The fibre is normally produced in a two-stage process. A glass stream feeds onto a rapidly rotating metallic disc and is thrown to the sides by centrifugal force.

A large number of small holes are in the disc side and the glass passes through these holes to form the primary fibre. Around the disc high velocity gas burners stretch the fibres, making them longer and thinner.

Special problems with melting the glass

Boron volatilises very easily from the glass bath surface, especially together with alkalis. If the resulting vapours are allowed to condense the liquid/solid formed is extremely aggressive towards many refractory materials and all metals. This can lead to extensive and very rapid corrosion outside the glass bath.

The furnace solution

The VSM® all-electric furnace design is ideally suited to melting this glass. Volatilisation is restricted by the cold batch blanket, but the greatest advantage is the rotating crown batch charging system that allows the superstructure to be kept completely closed.

This virtually eliminates in-factory dusting and allows easy emission control with a simple bag filter.

Recent installations have also been made with oxy-fuel melters.

Recent installations for this glass

Country	Belgium
Furnace	VSM® all-electric furnace
Product	C glass fibre
Melting capacity	160 t/24h
Other features	SORG® all electric forehearth
Built	2004

Country	Czech Republic
Furnace	oxy-fuel melter
Product	C glass fibre
Melting capacity	170 t/24h
Built	2004

Mineral fibre

The glass is produced by melting naturally occuring raw materials, such as basalt: This is a volcanic rock of variable mineralogical composition but typically rich in MgO and CaO and low in SiO_2 and alkalis. Some raw materials exhibit a porphyritic structure, which makes them more difficult to melt.

The material is simply melted (melting point approximately 1400 ℃) and transported to the fiberising plant.

The product

Mineral fibre is extensively used as a bulk thermal insulating material as an alternative to glass fibre.

The fibres are usually produced by the centrifugal-multiroll system, comprising a number of high speed rotating wheels. The stream of molten material flows vertically down onto the surface of the first wheel, where it is thrown sideways by the wheel motion. Further strategically placed wheels continue the process until finally fibres, with a typical diameter of approximately 10 microns, are produced.

Special problems with melting the glass

The raw material typically has a very high iron content compared with normal glasses, which limits the radiation transmission in the melt. This makes it very difficult to achieve acceptable bottom temperatures in the furnace. In addition, the temperature/viscosity curve is very steep and the material solidifies very quickly, so care must be taken to avoid low temperatures.

The furnace solution

A tank furnace heated by gas (or oil) and using recuperative combustion air preheating is a good solution, but the most important feature is the electric boosting system which ensures that energy is added to the lower areas of the melt bath

Recent installation for this glass

Country	Russia
Furnace	gas heated recuperative melter with booster
Product	mineral insulating wool
Melting capacity	120 t/24h
Other features	SORG® gas/electric forehearths
Built	2003

Opal glass

In this case the glass is similar to a soda-lime composition, but with the addition of fluorine as an opalising agent. In the molten state the glass is clear, and the opalisation occurs as a result of controlled devitrification after the forming process.

The product

Opal glass containers are extensively used for cosmetic and related articles. The production of these articles involves much specialist know-how and is currently limited to a small number of companies.

Similar glasses are also used in the lighting ware and tableware industries.

Opal glass containers are manufactured on IS machines in the same way as conventional containers.

Special problems with melting the glass

The fluorine used to provide the opalescence is highly susceptible to volatilisation from the glass bath surface and this can lead to emission problems.

The loss of fluorine can lead to uneven opalisation and stripes in the product, and results in higher batch costs as the missing material must be compensated by additional raw material in the batch.

The furnace solution

The VSM® all-electric furnace design has been used to melt this glass for more than 35 years, the first installations were built in 1970. Fluorine volatilisation is restricted by the cold batch blanket, but the greatest advantage is the rotating crown batch charging system that allows the superstructure to be kept completely closed. This virtually eliminates in-factory dusting and allows easy emission control with a simple bag filter.

Recent installation for this glass

Country	Belgium
Furnace	VSM® all-electric furnace
Product	Opal containers
Melting capacity	70 t/24h
Other features	2 SORG® gas/electric forehearths
Built	2004

Textile fibre

The typical glass composition is referred to as E glass, and it was initially developed to have a high electrical resistance (hence the name "E glass"). It is a borosilicate composition with about 6 % B_2O_3 and 15 % Al_2O_3, but less than 1 % alkali.

The product

Continuous filament textile fibres are extensively used for reinforcement of polymer materials. A typical product example, but by no means the only one, is the printed circuit boards of modern electronic devices.

Continuous individual fibres are drawn from holes in platinum alloy bushings, whereby a single bushing may contain up to 4000 holes, and therefore produce 4000 fibres. The fibres are sprayed with size and wound onto a bobbin.

Special problems with melting the glass

The melting and refining processes must be carried out to absolute completion as any solid or gaseous inclusion in the glass will lead to breakage of one fibre. This in itself may not be critical but may result in a knock-on effect as a result of the close proximity of neighbouring fibres.

The furnace solution

Most SORG® installations for this glass are side-fired, recuperative, fossil-fuel fired melters but the latest and largest is an oxy-fuel melter.
E glass furnaces operate at relatively low specific melting rates as a result of the very high quality requirements. The refractory selection is extremely important as inclusions from refractory wear must be avoided

Recent installation for this glass

Country	China
Furnace	oxy-fuel melter
Product	E glass textile fibre
Melting capacity	305 t/24h
Built	2006

This is thought to be the world's largest E glass furnace.