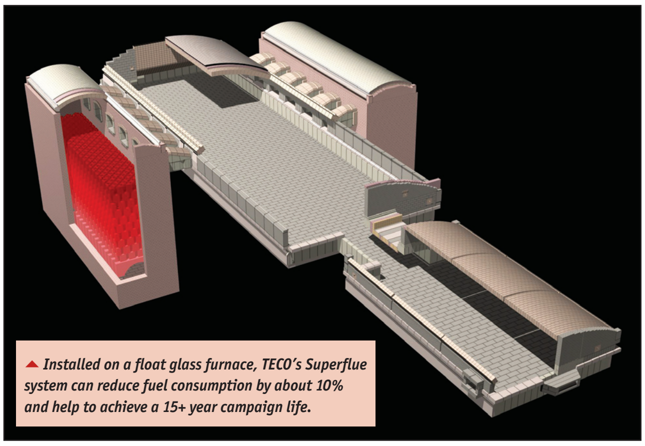
Optimising the glass manufacturing process

Larry McCloskey* and **Doug Burgoon**** show how technology influences energy efficiency, glass quality and production rates while reducing emissions, maintenance and downtime.



Installed on a float glass furnace, TECO's Superflue system can reduce fuel consumption by about 10% and help to achieve a 15+ year campaign life.

Although glass has been around since 4000 BC, and flat window glass dates back to the Roman Empire, some of the most revolutionary advances in glassmaking technology have occurred in the past 50 years. Today, glass industry engineers can evaluate each furnace application on a site-specific basis and thoroughly consider relevant design and operating parameters, including fuel and raw material costs, emission control constraints and batch integrity. As a result, glass furnaces can be built or modernised to achieve defined goals, such as improved glass quality, greater pack rate, better energy efficiency, longer campaign life and increased profitability.

This presents a challenge, because there is such a wide range of variables that affect how these objectives can be met. There are multiple types of furnaces – regenerative, recuperative, oxy-fuel and electric melt – which can be fuelled by natural gas, oil or electricity. There are site-specific energy costs and emission regulations to contend with. There are furnace accessories like electric boosting, bubbling and emission control schemes available to help satisfy these needs. There are also other elements that can make an impact on glass production, including high performance working ends and forehearths, process control systems based on mathematical models, statistical-based batch plants and cullet systems.

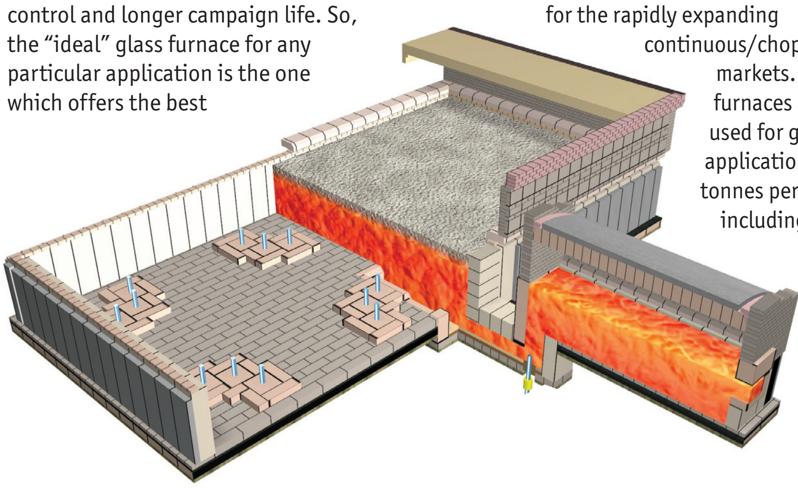
When this many variables are involved, it is clear no one solution fits all. Yet the most important aspects in today's glass furnace industry are clearly defined: capital cost, productivity, energy efficiency, emissions control and longer campaign life. So, the "ideal" glass furnace for any particular application is the one which offers the best combination of attributes in these areas at the lowest cost – and each type of glass furnace brings something different to the game.

Regenerative and recuperative

Regenerative and recuperative furnaces are renowned for relatively low fuel consumption, as well as long campaign life and high-quality glass production. In the early 1960s, the float process quickly swept the flat glass industry and the large high-tonnage side-port regenerative furnace was a natural for feeding a float forming line. Regenerative float glass furnaces can operate efficiently over long campaigns, producing high-quality glass for this demanding market. TECO's float furnaces are currently producing almost 35,000 tonnes per day.

Regenerative furnaces are separated into either end-port or side-port types depending on capacity. End-port regenerative furnaces produce glass for containers, tableware, tubing, lighting and other soda-lime based products, and are usually used for applications up to 450 tonnes per day. Side-port furnaces are generally used for float glass and container glass applications, producing 300 to 1000 tonnes per day.

Recuperative furnaces permit preheating of air in spite of higher emissions from their borosilicate glasses. The use of recuperative furnaces also surged in the early 1960s, as they provided the growing glass fibre industry glass for the rapidly expanding continuous/chopped strand markets. Recuperative furnaces are commonly used for glass melting applications up to 250 tonnes per day, including melting E-glass for textile fibre, as well as some soda-lime glass for container manufacturing.



Truly environmentally friendly, TECO cold-top electric furnaces absorb and recycle volatiles from molten glass.

Super fuel savings

One of the biggest advancements for regenerative glass furnaces is TECO's patented Superflue technology, which was invented for float glass furnaces during the mid 1970s. TECO is one of the global glass industry leaders, headquartered in Toledo, Ohio, USA (see boxed text).

Superflue technology assures uniform checker temperature from port-to-port, without the use of division walls. This equalisation of temperature from the first to the last port extends checker-pack and furnace campaign life and increases energy efficiency. In addition, the device itself requires minimum maintenance.

Most important, the Superflue is helping the float glass industry reduce fuel consumption by about 10% on average and helping to achieve a 15+ year campaign life, when pulled at design capacity.

Longer campaign life

Oxy-fuel furnaces can provide improved fuel efficiency, reduced NOx and lower capital cost. Glass quality can be improved due to steady-state operation.

Since nearly pure oxygen is used, nitrogen is virtually eliminated from the oxy-fuel flame. NOx emissions are significantly reduced and fuel efficiency is increased; the lower NOx emissions make oxy-fuel furnaces more environmentally friendly.

Oxy-fuel firing eliminates the need for regenerators or a recuperator, which are major factors affecting the campaign life of air-fuel furnaces. With no regenerators or recuperator, furnace operations and maintenance are simplified.

In addition, when regenerative or recuperative furnaces are in use, oxy-fuel technology also can provide some benefits. For example, when an air-fuel fired furnace begins to deteriorate, oxy-fuel firing can be added to help maintain the production level and extend campaign life.

Environmentally friendly electric

Electric furnaces, which utilise Joule-effect heating, can be among the most energy-efficient and environmentally friendly available. Typically, they are used for melting glass for glass wool, as well as soda-lime, lead and borosilicate glass.

With electric melters, the NOx emissions common with fossil fuel firing are eliminated because no combustion takes place. In fact, "cold-top" electric furnaces absorb and recycle components volatilised from the melting batch.

There can be thermal efficiency benefits as well. The insulating batch blanket (cold-top) absorbs energy and creates a natural-energy recovery system to enhance the melting process.

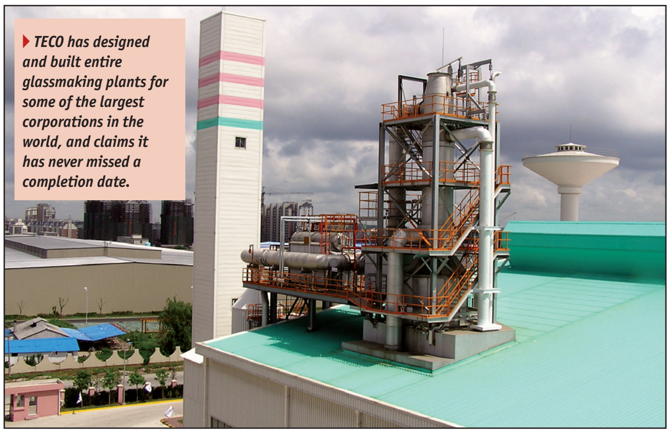
Granted, electrical energy is generally more expensive when compared with fossil-fuel energy. However, all of the cost factors of each process should be compared based on site-specific parameters and cost factors before deciding which melter-type best suits the operation.

First, an electric melter, with its large resistive load, is a natural power-factor correcting device. The plant power-factor will be improved with the addition of the electric melt load, so there is the potential for negotiating a lower power rate with the utility company.

Second, the capital and operating costs required for emission control on cold-top electric melters are only a fraction of what is needed on a fossil-fuel fired melter. Furthermore, with fossil-fuel melting you have a much greater volatile loss. So, it is wise to consider all the parameters before making a final decision on melter type.

Computer modelling

The most recent advance in furnace design involves tailored computer modelling programs, which allow engineers to evaluate all furnace parameters at the outset. The result is an optimised furnace design, not only for new furnace construction, but for rebuilds as well. Alternative options and "what ifs" can be factored in the considerations. Computer modelling can help determine the lowest capital cost while maximising campaign life, operating efficiency and glass quality.



TECO has designed and built entire glassmaking plants for some of the largest corporations in the world, and claims it has never missed a completion date.

Better batch

Glass "pack rate" efficiency (glass packed as a percentage of glass melted) is directly tied to batch plant performance. In fact, attention to detail when building or modernising the batch facility can increase glass quality, production and product pack rate as it reduces the need for operator and maintenance attention – all essential to improving profitability.

Modern batch plant architecture is based on raw material storage requirements, site conditions, local construction economics and more. The structures can be built with steel, concrete stave, concrete jump-form or concrete slip-form types of construction.

Batch plant design is determined by the characteristics of the raw materials, so evaluating the flow characteristics of each ingredient is essential to assuring unrestricted mass flow of batch ingredients. Avoiding segregation is of crucial importance. To get the best glass quality, the system has to ensure homogeneous mixed batch is delivered to the furnace.

TECO is now engineering batch plants so that premixing of micro and minor ingredients is not necessary. The key is the scale system. Weigh-feeders are designed for capacity and resolution to achieve the desired statistical weighing accuracy. Undiluted micro-materials are weighed and handled automatically, with scale capacities as low as 5kg and resolution as fine as 0.5g.

Turnkey projects

Sound project management is the key to success with any project, whether it is a batch plant, furnace or turnkey plant. Project management encompasses supervision and coordination of all aspects of a project, as well as procurement control and expediting purchases for timely delivery. TECO's project team regularly reviews purchases, budgets, expenditures and delivery to the site. They also take responsibility for securing subcontracted labour and all critical construction deadlines.

Sound project management has a significant impact: TECO typically constructs a turnkey glass plant in 15 months, from concept to start-up. TECO claims it has never missed a completion date and in a world where time is money, that is worth a lot.

Conclusion

Given all the variables and considerations that can affect furnace selection, the single most important aspect in the construction or modernisation of a glass manufacturing facility is this: seeking out a firm with enough experience and capabilities to offer unbiased solutions for a wide range of glass industry projects. That is because no one solution "fits all" when it comes to glass furnaces, and to optimise the glass-manufacturing process, the best solution should be a custom fit. TECO can provide this total service. ■

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Going global from Glass City, USA

TECO's precursor opened its doors in 1925 in Glass City, USA; Toledo. Even now O-I, Owens Corning, Libbey and Pilkington North America all call Toledo, Ohio, home.

Today Toledo Engineering Co., better known as TECO, is one of the largest full-service engineering, construction and project management firms serving the global glass industry, specialising in batch plants, furnaces of all types and glass conditioning systems. TECO has installed furnaces and glass manufacturing processes in countries around the world, from Eastern Europe to Korea, South America to China. Also, since building its first turnkey container glass plant in Mexico in 1947, it has handled four more container plants and 12 float glass plants on a turnkey basis.

Along with a Pennsylvania-based subsidiary, KTG Systems, Inc. (KTGSI), the TECO Group includes several operations in Sheffield, UK. Tecoglas Ltd. is an engineer/project manager that handles the scope of projects similar to TECO. KTG Engineering Ltd. provides furnace accessories, such as batch chargers, electric boost, electrodes and bubblers. Zedtec Ltd., acquired in 2004, is well-known for its wide selection of glass conditioning systems.

From all these facilities, TECO has designed and built more than 1000 fossil fuel furnaces, more than 150 electric melters, 16 batch plants and 17 complete turnkey plants, to date.