

Oxygen technologies for recovery and boosting of glass furnaces

Neil G Simpson* examines the options available for increasing furnace capacity to cope with changes in product demand.

Conventional glass melting furnaces have capacity restrictions due to their long operating periods and reliance on heat recovery devices. At the start of a campaign, which could last anywhere between five and 15 years, it is difficult to predict what changes will occur in product demand that might require a capacity increase. Similarly, at the end of the furnace campaign there might be regenerator damage, which limits furnace capacity and requires capacity recovery. In both cases, oxygen can be used for both capacity boost and at least partial capacity recovery. Manufacturers can typically recover some capacity by using the existing fuel system and adding an oxygen skid, but boosting typically requires additional fuel and oxygen. In each case, the oxygen solution used is dependent on the furnace type and required tonnage.

Oxygen enrichment

Enrichment is the most basic form of using oxygen in glass melting applications. Enrichment is typically used in a furnace nearing the end of its campaign that is suffering from regenerator plugging or collapse. This regenerator damage is likely to have resulted in an increase in furnace pressure and reduction in air pre-heat temperature, necessitating more fuel and oxidant,

▼ **BOC CGM system,**
using an oil-flame, inside
an operating glass furnace.

which exacerbates the furnace pressure increase. Ultimately the furnace pressure will be too great for the now required gas and airflow, reducing glass pull rate. Applying oxygen through enrichment will result in a lower volume of exhaust gases. The most noticeable effect of introducing oxygen to replace air will be a reduction in furnace pressure, allowing the regenerators to breathe again. The lower exhaust volume will have an increased residence time in the regenerators and will increase the pre-heat temperature, allowing a small reduction in fuel usage. The reduction in furnace pressure will enable additional fuel to be applied to the furnace to enable the melting of previously lost, or "recovered" tonnage.

The installation of an enrichment system is relatively simple: oxygen is injected downstream of the combustion air fan prior to the reversal valve. The oxygen compatibility of the reversal valve materials frequently limits the maximum concentration of the enriched oxygen stream that can be used in the furnace. Compared with other technologies the enrichment process is less efficient, since the increased percentage oxygen goes to all burners and regenerator ports.

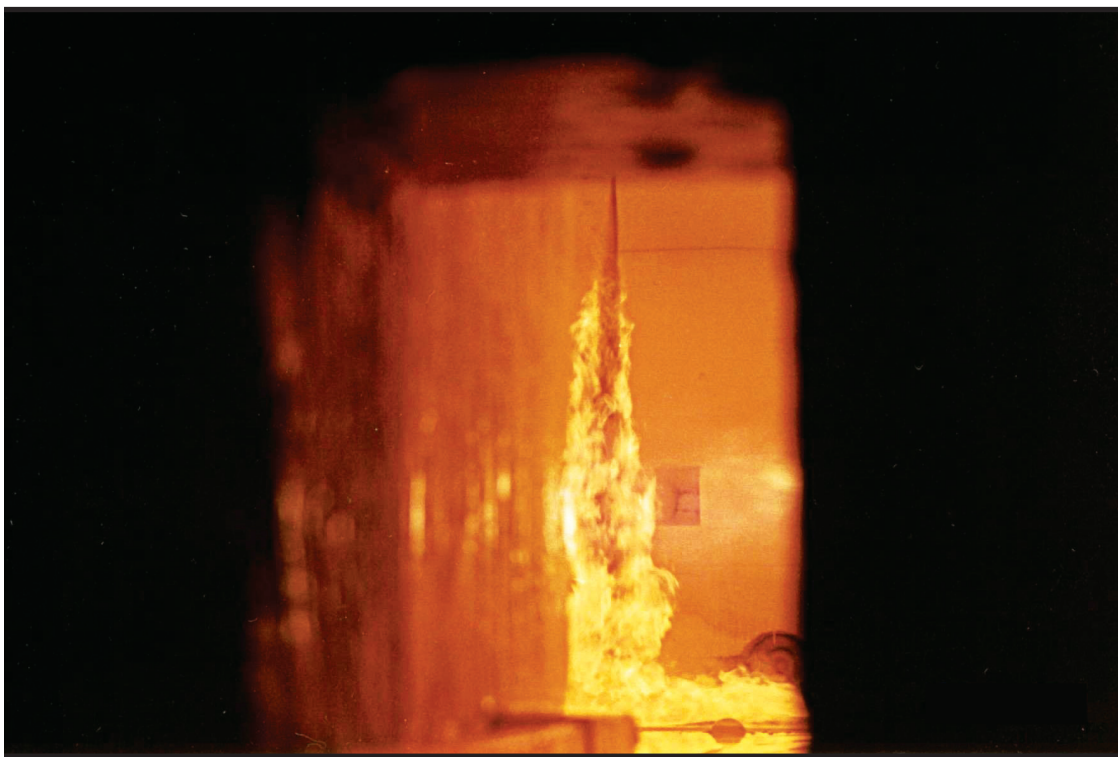
Enrichment is typically used on regenerative furnaces firing on either oil or gas and is applicable to all glass types. In the case of a recuperative furnace, manufacturers should consider injecting the oxygen downstream of the recuperator, since this may be a source of leakage.

The recovered tonnage enables the furnace to operate above the minimum for profit but, more importantly, extends the furnace life, which will provide the capital avoidance of delaying a repair.

Oxygen lancing

Oxygen lancing is used similarly to enrichment, but is typically associated with more severe or complex conditions. Lancing is the precise injection of oxygen to the point where it is most needed, such as close to the furnace in an under-port or through-port location or even through a target wall. Whilst enrichment is indiscriminate in its injection and is less efficient, more total oxygen may be injected through lancing, since it does not face the compatibility issues of the reversal valve and associated duct-work.

In the event of a partial regenerator collapse or increased pluggage at a specific port, lancing provides the ability to inject the oxygen at the most compromised port. There is also additional flexibility to inject more oxygen on one side than another, depending on regenerator condition. The biggest limitation of a lancing system is the complexity of the installation process and the cost of the control systems required to operate the technology.



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Oxygen boosting

The difference between boosting and enrichment/lancing is that, in addition to the injection of oxidant, there is also the addition of fuel. Whilst boosting technologies can be used for recovery and furnace life extension, they also seek to increase the furnace throughput and/or improve quality. The following technologies are examples of boosting.

Hot spot boosting

Hot spot boosting is typically limited to end-fired regenerative furnaces but can also be applied to unit melters or recuperative furnaces firing on either oil or gas. It is applicable to all glass types. Typically, two conical oxy fuel burners are positioned at the furnace hotspot. By placing the burners at this position, manufacturers can enhance the glass convection currents, which improve glass residence time and increase quality. Adding more fuel means that more glass can be melted in the same furnace. But there typically needs to be a small reduction in the air fuel flows in order to allow the exhaust system to handle the additional volume from the oxy-fuel burners.

Hot spot is typically used on end-fired regenerative furnaces firing on either oil or gas and is applicable to all glass types. It is possible to increase furnace throughput by up to 10% using hot spot boosting. Since the impact on the existing air fuel regenerator or recuperator is minimal, oxy boosting can be switched off when it is not required at lower tonnage. Alternatively, depending on relative energy costs, oxy-boosting can be used to lower electric boost.

Conventional zero port boost technology

The use of oxy-fuel burners to boost glass furnaces is a proven technology, specifically in float furnaces that normally incorporate a 2-4 metre distance between the charge end wall and the first port jamb block.

The 50 furnaces worldwide that have implemented conventional zero port oxy-fuel technology over the past five years have provided the industry with significant understanding of oxy-fuel boosting's capabilities and limitations. The addition of 10-15% more energy into the furnace in the critical melting area can result in an increase in pull rate, quality and furnace life.

The four most common reasons for installing oxy-fuel boost in glass furnaces are to:

- ◆ Increase pull rate
- ◆ Improve product quality
- ◆ Extend furnace life due to regenerator checker failure
- ◆ Extend furnace life by preventing regenerator checker failure.

Each of these objectives requires a different approach for adapting oxy-fuel boosting to a regenerative furnace. For example: when increasing the pull rate of the furnace, the batch entering the charge end of the melter absorbs most of the additional energy supplied by the oxy-fuel burners, while the air-fuel combustion system remains essentially unchanged. However, when extending the life of the furnace due to regenerator checker failure, the objective is to minimise the overall products of combustion within the system. To be most effective, the applied oxy-fuel energy must be removed on a total or overall basis from the air/fuel port energy, since there are very limited means of reducing the air flow on a given port. This may require a change in the furnace temperature operating schedule.

MELTING TECHNOLOGY

The BOC CGM Technology

The zero port breastwall area limits the amount of energy that can be introduced from conventional boost technology. If this limited production, quality, or life extension is sufficient to meet the glass manufacturer's objectives, then conventional (breast wall mounted) combustion is the preferred technology.

The BOC CGM technology increases the rate of heat transfer to the batch and thus increases the melting rate. This effectively removes many of the limitations of conventional zero port boost and can provide increased performance improvements to many glass melters.

BOC, in cooperation with Owens-Corning's composites glass fibre division, introduced the first, successful, vertically oriented, crown mounted oxy-fuel burners on a commercial size glass melting furnace in 1995. A three-month test concluded that the BOC CGM technology could substantially increase the rate of batch melting over a side-fired air-fuel or oxy-fuel furnace. Since these burners are located in the crown, the technology overcomes space limitations and the number of burners that can be installed to meet the project objectives. In many other installations, BOC has fired over 50% of the total energy of the furnace through the CGM system's burners, with less than 50% remaining on the air-fuel burners.

Since the first commercial installation of the BOC CGM technology in 1996, it has been installed in more than 20 operating glass melters. They include:

- ◆ The float, container, glass fibre and tableware markets
- ◆ Oxy-gas and oxy-oil burners
- ◆ Air-fuel and oxy-fuel furnaces
- ◆ Furnaces in Asia, North America and Europe.

The BOC CGM technology has proven effective in float furnaces in a zero port boost or hybrid configuration as a furnace life-extender or load-recovery agent. At one Pilkington commercial facility, using the CGM system resulted in 51,000 tonnes of load recovered in a span of 14 months.

BOC has filed patents to protect the CGM process as the technology continues to be developed. The first patent, US 6,237,369, was filed jointly with Owens Corning on December 17, 1997 and issued on May 29, 2001. The second patent US 6,422,041 was filed on August 16, 1999 and issued on July 23, 2002. This patent discloses the use of CGM burners positioned over the raw batch materials in an air fired furnace. It details the use of the CGM burners to initially boost a three-port side-fired furnace by blocking off the first port and installing CGM burners. A CGM hybrid configuration was then achieved by additionally blocking off the second port, installing CGM burners and continuing to fire the third port with air-fuel.

Summary

From general enrichment to specific oxy fuel boosting, oxygen can be used to recover or boost both production and glass quality from an existing air fuel furnace. Enrichment is the simplest and most cost effective method of using oxygen, either from a liquid or waste oxygen source. Lancing is more specific in the location of the oxygen injection and is therefore more efficient but more costly. Boosting either

by hot spot or zero port is an effective way to achieve an increase in furnace throughput.

The CGM technology, patented by BOC, provides improved heat transfer in furnaces. It uses oxy-fuel burners, located in the crown of a glass furnace, to significantly increase furnace capacity and improve glass quality. It can also be used to extend the life and improve the performance of ailing furnaces. CGM was developed by BOC in partnership with Owens-Corning in 1996, and has since been applied to float, container, tableware, television and glass fibre sectors, in furnaces ranging in size from 16 to 700 tons per day.

The BOC Group, the worldwide industrial gases, vacuum technologies and distribution services company, serves two million customers in more than 50 countries. It employs 44,500 people and had annual sales of some \$7 billion in 2003.



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