Precision control bubbling technology

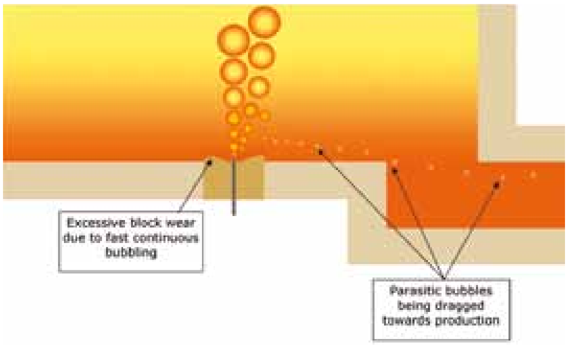
Bubbling has long been recognised as an economical and effective means of assisting the melting and refining process in fuel-fired glass melting furnaces, as Richard Stormont and Grahame Stuart explain.

The stirring action of bubblers, lifting glass from the lower levels in the tank towards the surface, can be extremely effective in improving both chemical and thermal homogeneity. The barrier effect of a row of bubblers across a furnace can also significantly reduce stone losses, reducing the risk of unmelted batch materials making their way along the furnace bottom towards the throat or other delivery point of the glass.

In addition, bubblers can help control the distribution of batch on the glass surface, helping to prevent surface batch piles from progressing too far along the furnace. Finally, the homogenising action of bubblers can significantly speed up colour or composition changes.

Most bubbler systems comprise one or more rows of bubblers, reasonably closely spaced, arranged across the width of the furnace. These barrier bubbler arrangements are by far the most common. Other arrangements have been used for special purposes, including so-called 'carpet' bubbling, an array of bubblers in the melting end of the furnace, designed to accelerate the primary melting phase of the process.

Bubblers may be used in other positions, with individual points sometimes being used to prevent the build up of stagnant glass in certain positions, such as corners in a working end or distributor arrangement. This use of bubbling can be highly effective in helping colour and composition changes where it is important to 'flush out' old composition or colour from stagnant or slow moving areas.



Problems associated with continuous bubbling.


Studying bubble formation in the large test tank at Electroglass.

The mixing or homogenising effect of a row of bubblers is restricted to a relatively small zone around the row of bubblers itself. Studies by Electroglass in test tanks indicate that the effective mixing zone created by a row of bubblers extends to approximately 1.5 x the glass depth. This relatively limited mixing zone is quite different to the long range convection currents created by Electroglass Convection Current Control (CCC) boosting systems.

However, despite the effectiveness and economy of bubbling, there are a number of significant problems typically associated with conventional bubbling systems. To achieve homogenising effectiveness and at the same time, avoid blockage of bubbler tubes, conventional bubbling systems usually operate at anything between 20 and 80 bubbles per minute and sometimes faster. Such high rates of bubbling inevitably lead to a level of refractory wear affecting the bubbler tube, the bubbler block and surrounding refractories.

Some extreme cases of refractory wear caused by conventional bubbling have been observed. In one case, Electroglass was asked to install electric boosting into an existing furnace equipped with bubblers, using the bubbler blocks for installation of electrode holders by hot drilling. Test drilling established that a high level of wear had taken place in the bubbler blocks during only approximately 18 months of bubbler operation, to the point where continued operation of the bubbler would almost certainly have resulted in a major glass leak within a short period.

Another significant problem with conventional, relatively fast bubbling is the risk of parasite seed generation. Observation of bubbling in the Electroglass test tanks shows clearly that some bubbles rising in the glass can catch up with the previous bubble, distorting the previous bubble into a balloon-like shape, the edges of which disintegrate into tiny bubbles, causing potentially high levels of seeds in the glass.

A third area of significant potential problem with conventional bubbling is the high risk of bubbler tube blockage, especially if an attempt is made to reduce bubbling speed in a conventional bubbling system, in order to minimise the effects of refractory wear and seed generation. However, when an attempt is made to reduce bubbling speed, the actual effect with conventional bubbling systems is to greatly reduce bubble size (which therefore reduces the effectiveness of the bubbling) and to greatly increase the risk of bubbler tube blockage.

A DIFFERENT APPROACH

Around 1994, Electroglass developed and introduced the first precision control bubbling system, specifically designed to overcome problems typically associated with conventional bubbling. The objective was to develop an innovative control system, with each bubble being individually created in the glass by a timed injection of gas (usually air or oxygen). At the same time, a key objective was to control bubble size, independently of bubbling speed, so that even at slow bubbling speeds, effective homogenisation would be obtained through the use of a relatively large bubble size.

Test tank observations showed that effective homogenising action could still be obtained even with bubbling speed of less than three bubbles per minute, provided the bubbles were of a good size. Clearly, with bubbling at typically between three and six bubbles per minute, the refractory wear rate created by bubbling is hugely reduced, to the point of being almost negligible.

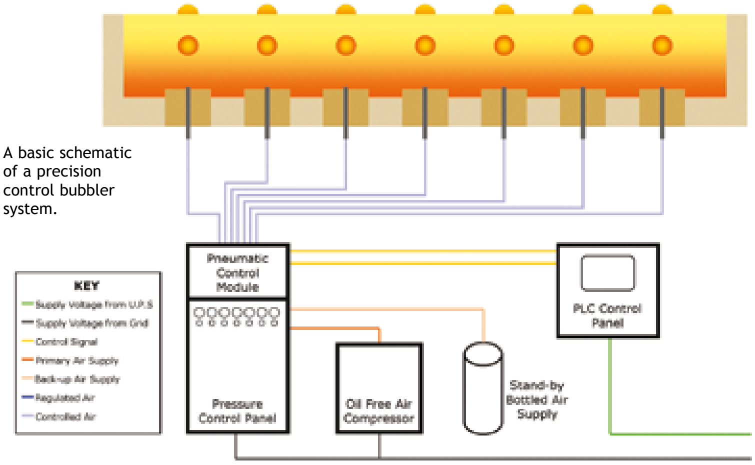
Equally, with such slow bubbling speeds, the interaction of successive bubbles, with the risk of seed generation, is also virtually eliminated.

If such slow bubbling were attempted using conventional bubbler tubes, there would be a high risk of bubbler tube blockage. Therefore, Electroglass developed a bubbler injector which, by its design, is extremely difficult to block. The blockage-resistant bubbler injector and control system combination became the Electroglass Precision Control Bubbling System.

The first precision control bubbling systems featured electro-mechanical control of bubbling speed and bubble size, combined with manual adjustment of bubbling pressures. Approximately two years after the system was introduced, a PC-controlled version was announced, giving substantially more flexibility and individual control of each bubbler point, with the ability to save and recall bubbler settings, optimised for different furnace operating conditions such as clear and colour glasses, colour change situations etc.

Today, all Electroglass precision control bubbler systems feature PLC control, with the same flexibility and ability to save and recall settings, as well as on-board diagnostics and operating manual extracts that allow the operator to interface easily with the system.

On screen setting and storing of pulse time and interval time for every individual bubbler point is achieved quickly and easily. Bubble size is a function of the pulse time and pressure. Bubbling speed is a function of the interval time set on screen. Bubble size and bubbling speed at each point are individually controllable, independently of each other. The system is also equipped with standby air or oxygen facilities, with automatic changeover in case of failure of the main source of air or oxygen. The PLC control system should be supplied from a suitably rated UPS, to ensure continued operation during power failures.



A basic schematic of a precision control bubbler system.

Finally, the control system features a series of alarms, enabling easy diagnosis of certain fault conditions, including accidental blockage of the bubbler tube, failure of the bubbler air supply and low volts-to-earth on systems where electrical boosting is also installed.

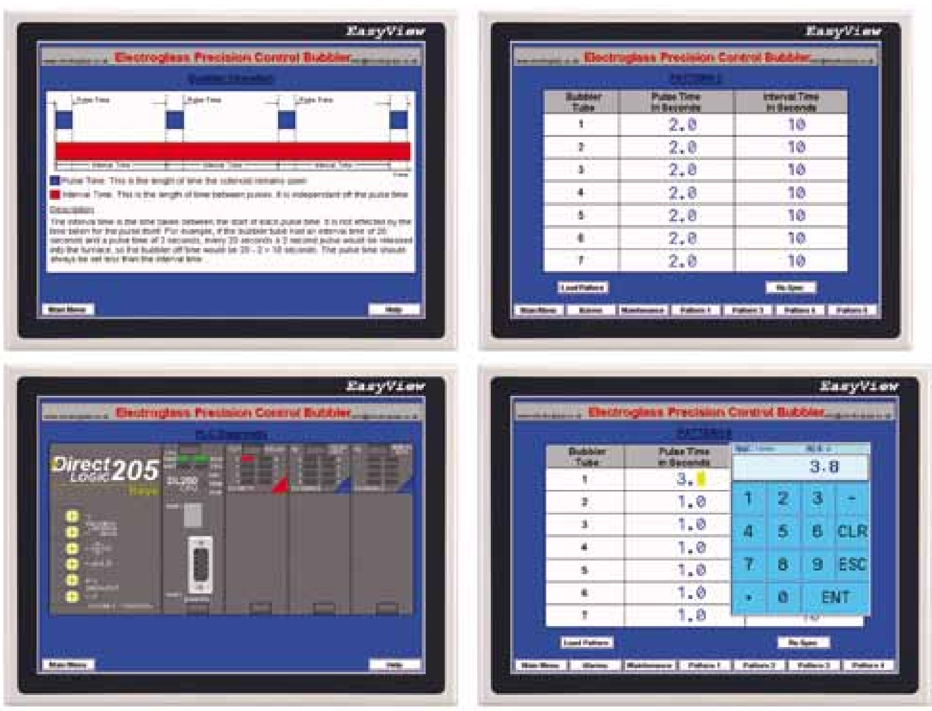
The Electroglass bubbler injector, specially developed for the precision control system, has proved extremely successful in resisting blockage. In the unlikely event of a blockage occurring, usually due to improper operation of the system, it can generally be unblocked by following simple procedures issued by Electroglass.

To summarise, key features of the Precision Control Bubbling System are independent control of bubble size and bubbling speed; individual control of each bubbler point; ability to save and recall bubbler settings; minimal bubbler block wear; the ability to stop and start bubbler operation without causing bubbler injector blockage.

INSTALLATION OPTIONS AND APPLICATIONS

The system can be installed at the beginning of the furnace campaign, or where suitable refractory construction is present through hot drilling by specialist Electroglass engineers. One such system installed in this manner in South America replaced a continuous bubbler that had failed in operation barely one year into the campaign. The Electroglass bubblers were installed by over drilling and removing the old inconel-type bubblers. The system continues to operate almost eight years after the hot installation.

To date, 97 Systems have been supplied to customers in 28 countries worldwide, ranging from 3 to 34 bubbler points. Glass types have included soda lime flint and coloured glass for containers and tableware, various borosilicate glasses, TV, LCD and TFT glasses, C and E glassfibre and lighting and medical tubing. Approximately 54% of these systems are repeat orders from existing users or their direct associates, the clearest possible indication of satisfaction with the performance of this advanced bubbling technology. ■ ■



Screen shots from a typical precision control bubbler system.

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