Batch piles affect refractory corrosion

Michael Horsfield reflects on how batch piles can affect the rate of internal corrosion to the glass bath refractory structure of a fuel-fired glass melting furnace.

For end-fired and cross-fired furnaces, batch piles can enter the melting area of the furnace in different shapes and sizes, depending on the charging technology and batch charger operational criteria. Also, the same technology and criteria dictate the direction path and flow patterns of the batch piles.

The accumulation of the batch piles criteria has a significant effect on the internal corrosion and wear rate of the glass bath refractory structure, both above and below glass level. These criteria have a significant influence on the furnace maintenance requirement, overall economics and furnace campaign life.

One further factor that has an influence on the batch piles and internal corrosion of the refractory is the melting rate requirement throughout the furnace campaign life.

It is not uncommon for this factor to be raised as furnace life increases which, in turn, increases the batch feed rate and potentially the refractory internal corrosion rate.

This article identifies a number of batch pile patterns and glass bath refractory structure internal corrosion areas, while emphasising the importance of selecting the correct charging technology and batch charger operational criteria.

FURNACE TYPE

For the purpose of this article, the end-fired and cross-fired furnace types for the production of holloware have been selected. Each furnace type has both similar and individual batch pile patterns, together with internal corrosion areas. These patterns and wear areas are identified in sketch format with an accompanying description.

BATCH PILE MOVEMENT

As the batch is fed into the melting area of the furnace from the doghouse, the batch piles can follow different directions depending on the charging technology, type of batch charger and the operational set-up of the batch charger. Ideally, the batch piles are directed as not to move against the face of the glass bath refractory structure, although this is not always the case.

Identifying the route of the batch piles on the glass surface is relatively easy. However, identification of the actual batch route below the metal line, during the furnace campaign life, is to be said near impossible.

From the results of Dismatec's inspections of the internal glass bath refractory structure after a furnace campaign, together with results from the company's furnace refractory structure auditing during a furnace life, it is evident that the batch movement has a corrosion effect on the glass contact refractory structure at, above and below the metal line.

END-FIRED FURNACES

Depending on furnace size, there may be one doghouse or two, where each configuration of batch pile flow pattern can wear the glass bath refractory structure, either in a similar or unique way. A number of batch pile flow patterns and the corrosion criteria are given below:

Single doghouse corrosion criteria 1: Figure 1 shows batch pile path from the doghouse being directed onto the furnace backwall and moving round to the right sidewall - creating corrosion at local positions of the sidewall blocks at, above and below the metal line.

Corrosion criteria 2: Batch pile path from the doghouse being directed across the doghouse corner block and moving across the backwall - creating corrosion at the upstream doghouse corner and local positions of the sidewall blocks at, above and below the metal-line (see figure 2).

Corrosion criteria 3: Figure 3 shows the batch pile path from the doghouse being directed onto each doghouse corner block, first port area of the backwall and the sidewall blocks immediately downstream of the >

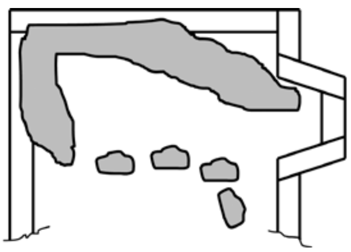

Figure 1: Batch piles leaving the doghouse and moving along the glass bath backwall and sidewall opposite the doghouse.

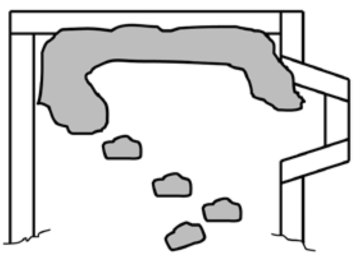

Figure 2: Batch piles leaving the doghouse, moving across the doghouse corner block and along the glass bath backwall.

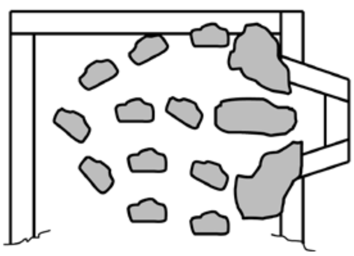

Figure 3: Batch piles leaving the doghouse, moving across the doghouse corner blocks and into the glass bath backwall and sidewall blocks downstream of the doghouse.

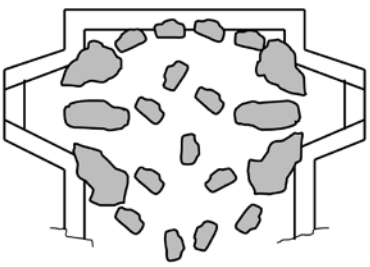

Figure 4: Batch piles leaving each doghouse, moving across the doghouse corner blocks, towards the central position of the glass bath backwall.

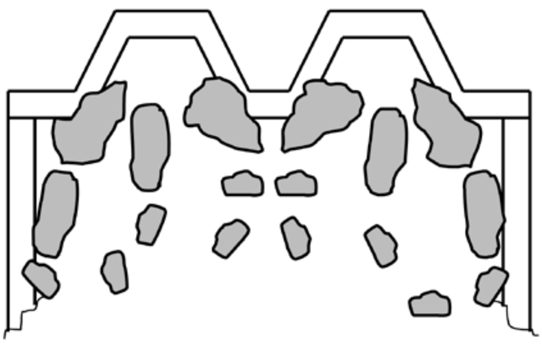

Figure 5: Batch piles leaving each doghouse moving across the doghouse corner blocks and following a pattern into the glass bath sidewall blocks.

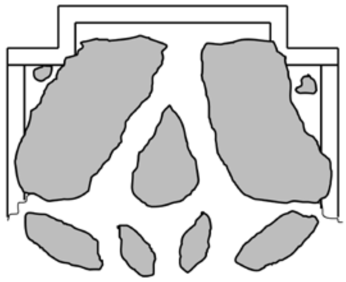

Figure 6: Blanket batch piles leaving the doghouse across the doghouse corner blocks, then following a pattern into the glass bath sidewall blocks.

doghouse corner - creating corrosion at the doghouse corners and local positions of the sidewall blocks at, above and below the metal-line.

Double (twin) doghouse corrosion criteria 1: Batch pile path from the doghouse being directed onto each doghouse corner block and the centre section of the backwall across each port mouth position - creating corrosion of the doghouse corners and sidewall blocks across the majority of the backwall width at, above and below the metal line (see figure 4).

CROSS-FIRED FURNACES

Depending on the furnace design, there may be a double (twin) doghouse or a single blanket-type doghouse, where each configuration of batch pile flow patterns can corrode the glass bath refractory structure either in a similar or unique way.

A batch pile flow pattern and the corrosion criteria for each are given below:

Double (twin) doghouse corrosion criteria: Batch pile path from each doghouse being directed onto the doghouse corner blocks and immediately across to the sidewall blocks (see figure 5) - creating corrosion at the doghouse corners and local sidewall block positions at, above and below the metal line.

After a period of time, into a furnace campaign life, the mid-position between each doghouse becomes a vulnerable area for high corrosion due to wear at each doghouse corner becoming close to each other or meeting.

Blanket-type doghouse corrosion criteria: Batch pile path from the doghouse being directed onto the doghouse corner blocks and immediately across to the sidewall blocks - creating corrosion at the doghouse corners and sidewall block local positions at, above and below the metal-line (see figure 6).

BATCH PILE LENGTH

For both end- and cross-fired furnace types, the batch pile length can have a corrosion effect on the glass bath front sidewall blocks. The amount of corrosion at, above and below the metal line can be variable depending on furnace output and melting characteristics.

BATCH PILE HEIGHT

For both end-fired and cross-fired furnace types, the batch pile height determines corrosion above the metal line.

Depending on the height of the batch piles, the burner block assembly sill blocks, front and underside face of the tuckstones can be affected by corrosion, leading towards loss of material and possible reduced stability of the refractory structure.

BATCH COMPOSITION

The batch composition and cullet ratio in the batch may affect the feed rate from the doghouse into the melting area of the glass bath, the movement rate of the batch piles and their pattern shape. Therefore, it is important to maintain a constant batch composition in order to maintain constant batch feed and charger characteristics, thus minimising the amount of batch piles contact with the glass bath refractory.

It is also important for batch feed to the charger to be constant to minimise the severity of internal corrosion of the glass contact refractory.

An example of this is to feed a high amount of cullet, followed by a high amount of batch. In this case, the glass contact refractory will become hot and cold on the internal face, creating a risk of a higher corrosion rate than normal at and below the metal line.

DESIGN CRITERIA

The design of a doghouse must be comparable to the selected batch charger type and its characteristics in order to meet the furnace output throughout a furnace campaign and minimise the risk of contact between batch piles and the glass bath refractory structure. Any such contact can result in significant corrosion of the glass bath refractory which will be increased with incorrect design and charger technology.

Other furnace design criteria to be considered in respect of batch piles movement and the minimisation of internal glass bath refractory corrosion include:

- Doghouse position.
- Furnace length-to-width ratio in respect of batch piles movement patterns.
- Flame characteristics.
- Glass melting systems, including electric boost and bubblers.

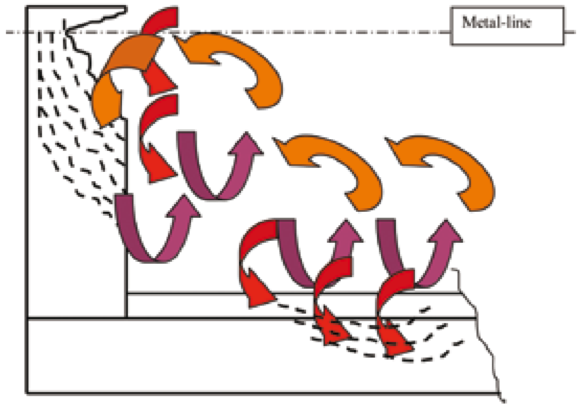

Figure 7: Increasing internal corrosion with time of the glass bath refractory structure below the metal line.

REFRACTORY STRUCTURE CORROSION BELOW METAL LINE

Batch pile movement below the metal line can create a localised swirling effect against the refractory structure, creating corrosion of the refractory at the mid to lower height of the sidewall blocks and glass bath bottom. The batch movement characteristics below the metal line can have the effect of increasing internal corrosion of the glass bath sidewall blocks and bottom during a furnace campaign life. This is indicated in figure7.

CONCLUSION

It is clear that the batch piles pattern is controlled by the charging technology and batch charger operational criteria. Furnace output requirement for a given campaign life and design criteria also have a significant effect on the batch pile patterns and internal corrosion of the glass bath refractory structure.

Selecting the wrong charging technology and batch charger operational criteria or making variations to these during the furnace campaign, together with selecting the wrong furnace design criteria and output requirement can have a significant effect on the internal corrosion of the glass bath refractory structure at, above and below the metal line.

It is critical to select the correct charging technology, batch charger operation criteria and furnace design criteria when identifying the parameters for a new furnace, in order to reduce the risk of batch pile patterns, making direct contact with the glass bath refractory structure and creating increased refractory corrosion. ■

ABOUT THE AUTHOR:
Michael Horsfield is Managing Director of Dismatec

FURTHER INFORMATION:
Dismatec Ltd, Sheffield, UK
tel: +44 114 279 2618
email: info@dismatecglassplant.com
web: www.dismatecglassplant.com