# *BATCH3:* The integrated concept for batch handling at the furnace provides economic and ecological benefits

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The industry is under huge pressure to reduce energy consumption but further improvements are difficult to find. The energy distribution of a typical end-fired container furnace shows little room for further reductions. However, the waste gases leaving the regenerators contain 20 - 25 % of the total applied energy, The recovery of some of this waste heat can lead to an important reduction in energy consumption. (figure 1)

The most efficient energy recovery systems are those that return the energy directly to the glass melting process, and the use of the waste gases to preheat raw materials would be a good example of this.

We can look at a specific furnace for an example of the potential offered by batch preheating. The furnace is an end-fired regenerative unit with a melting capacity of 240 t/24 h, used to produce green glass, with 50 % cullet and 400 kW electrical boost. The temperature of the waste gases leaving the regenerators is 470 °C, which means that the gases have an energy content of approximately 3000 kW, equivalent to approximately 25 % of the total applied energy. (figure 2)

Operation of the electrostatic filter downstream requires a certain minimumtemperature, so not all the waste gas energy is available for recovery. Nevertheless, more than one third, equivalent to about 1100 kW, could be returned to the process.

Calculations based on operating data collected during an extensive development and testing programme show that the use of a batch preheater on this furnace would lower the specific energy consumption from 983 to 874 kcal/kg glass, a reduction of more than 10 %. (figure 3)

Claims of energy savings of 11 – 20 % can be found in the published literature. The relatively wide range of such figures can be explained, at least partially, by the fact that the potential for energy saving by waste heat recovery outside the furnace depends initially on the efficiency of the furnace itself. Higher thermal efficiency of the furnace diminishes the potential for external systems such as batch preheaters.

Another interesting aspect of furnace performance is the drop in efficiency of the regenerators during the furnace life. Measurements taken over the lifetime of an actual furnace show a gradual increase in the waste gas temperature, equivalent to a 10 % increase in specific energy consumption. This effect can potentially be compensated by the use of a batch preheater.

## Batch preheating

In view of the well-documented potential advantages of batch preheating it may be surprising to discover that very few systems are actually in commercial use. The reason for this is simple – there is a major technical problem with batch preheating. Preheated batch readily forms solid clumps that can easily cause mechanical blockage of the preheater. (figure 4)

The problem can be reduced if a cullet ratio of at least 50 % is used. But this is impractical for many manufacturers. To ensure stable operation it may also be necessary to reduce the water content of sand and cullet, which is both difficult and costly.

The problem of clumping is caused by the ability of soda ash to absorb water, which is then released during the preheating. Soda ash can exist as a monohydrate (1 molecule of water), heptahydrate (7 molecules) or
decahydrate (10 molecules of water). The decahydratecan form easily at
ambient temperatures if sufficient water is available, but then degrades to hepta and then to monohydrate as the temperature rises above 35 °C. This leads to the release of vast quantities of water.

The process is described by :

$Na_2CO_3.10H_2O = Na_2CO_3.H_2O + 9H_2O$

A temperature of 35 °C is reached near the entry to the batch preheater. In existing designs the water cannot escape from the preheater and so it remains in contactwith the batch materials. It begins to react with sand and limestone to form cement-like compounds that are both extremely stable and very hard. This leads to clumping in the low temperature area of the unit, causing blockages.

## The SORG batch preheater

The new SORG batch preheating concept combines innovative features to allow a large part of the water released by the soda ash to leave the preheater, so there is much less water available to cause clumping of the batch materials.

The batch in the collecting chamber at the top of the preheater has an open surface. Fresh material is charged and distributed onto this surface automatically. The waste gases are passed through closed heating pipes in the batch, and these pipes can be vibrated as and when required to destroy any residual clumps.

As the batch temperature rises above 35 °C water is released by the soda ash and most of this can leave the system through the open batch surface in the collecting chamber. Any remaining clumping is destroyed by the vibration of the heating pipes. Water vapour and dust are removed continuously from the collecting chamber by a suction fan.

A 250 ton per day unit has been in operation since October 2011.(figure 5) This preheater was added on the fly during the furnace campaign. With the exception of a planned inspection, all of the batch materials for this container furnace have been preheated and fed through the preheater resulting in increased tonnage, reduced electrical boosting and 12% overall energy savings.

## Dusting

The advantages of batch preheating are well documented, and the new SORG preheating system provides a practical solution to the problems normally associated with the process. However, the use of batch preheating can lead to another significant problem – that of dusting in and around the furnace.

External dusting can cause damage to nearby equipment or result in attack of crown refractories.

Internal dusting is potentially a far greater problem. Increased batch carry-over into the regenerators can lead to attack and blockage. There are reports of the necessity to clean the regenerator packing regularly from below when batch preheating is used – a dangerous and expensive procedure.

In order to solve the dusting problem SORG has developed an integrated concept for batch handling at the furnace - BATCH3. This is specifically designed to alleviate the dusting problems caused by batch preheating.

## BATCH3

The BATCH3 concept consists of 3 elements :
- the batch preheater
- a new batch charger
- a new doghouse concept

The batch preheater can recover energy from the waste gases, and is capable of continuous operation

without blocking. The other components of the concept ensure that the use of the batch preheater does not cause
additional problems.

## The EME-NEND batch charger

The new **EME-NEND charger** (figure 6) features a combination of multiple screw feeders and a pusher. The screws are controlled by individual frequency converters that provide independently variable chargingspeeds. The pusher drive is independent of the charging function.

The design offers important advantages compared with a conventional pusher charger :

- multiple screws produce smaller batch piles (figure 7)
- independent control of the screws gives a better charging pattern without having to move the charger
- the independent and effective pusher action gives a positive impetus to the batch piles
- the use of screw feeders reduces local dusting
- the doghouse is completely sealed

The sealed doghouse eliminates external dusting. More importantly, it also prevents uncontrolled entry of air through the doghouse.

The new charger significantly improves the charging pattern in the furnace with more, smaller batch piles.

The **EME-NEND charger** represents a major advance in charging technology, as well as being an important part of the SORG **BATCH3** integrated concept for batch handling at the furnace.

## The IRD doghouse(figure 8)

Early glazing of the batch surface is an effective method of preventing dusting in the doghouse and reducing batch carry-over. The SORG IRD doghouse incorporates two major changes to conventional doghouse design to ensure that surface glazing of the batch piles is completed before the piles leave the doghouse :

- the doghouse is larger to increase residence time
- the doghouse crown is raised to allow more radiation into the doghouse from the hotter areas of the melter.

The combination of more time and higher temperatures is sufficient to ensure that glazing of the surface takes place before the batch piles leave the doghouse.

Mathematical modelling shows that glass temperatures below the surface remain high enough even without additional heating. Very low gas velocities are found in the super-structure of the new doghouse. This means there is no dust pick-up from the rear of the doghouse where the batch piles have not yet had time to glaze over. The testing also indicates that use of the new doghouse design will result in a decrease in the extent of the batch coverage in the furnace.

## The BATCH3 concept – where are we today?

The **EME-NEND batch charger** was the first part of the **BATCH3 concept** to be introduced. The first installation on an operational furnace was commissionedin March 2010. Operational experience has confirmed the expected improvement in the charging pattern, whilst the ability to seal the doghouse has eliminated external dusting.

On one furnace a conventional pusher was replaced by an **EME-NEND charger**. Comparative measurements made before and after the change show a 10 % reduction in the $NO_x$ emission from a base level of less than 800 mg/Nm³ The values found with the new charger are lower and more stable than the preceding values (see figure 9).

Over 30 machines have already been sold, and interestingly, the glass manufacturer that hosted the initial installation has now installed **EME-NEND** machines on all 4 of theirregenerative furnaces. On three of them the conversion was carried out during normal operation – surely a remarkable testimony to the capabilities of this machine.

At the end of 2010 the first **IRD doghouse** was commissioned on a 250 t/24 h furnace producing green containers. Standard green, olive and dead leaf have already been produced. The installation has confirmed the
modelling predictions in terms of temperatures and residence times. The atmosphere in the doghouse is not affected by that in the melter.

Thermgraphic mapping shows the much higher internal temperature of the **IRD doghouse** (figure 10, right) compared with a conventional doghouse (figure 10, left).

Most importantly, the surface of the batch piles leaving the new doghouse are clearly glazed over (figure 11), and so the primary purpose of the new design is being achieved.

There is no doubt that the **IRD doghouse** reduces batch carry-over from the doghouse area and so makes the use of a batch preheater possible without the normal dusting problems.

Some question has been raised about the influence of the new doghouse design on the
energy consumption of the furnace as the **IRD doghouse** has a significantly greater surface area than conventional doghouse designs.

The conventional doghouse has considerable radiation losses from open areas, even though the areas themselves may be quite small. It also loses energy as a result of the inflow of cold air or the outflow of hot waste gases (depending on the furnace pressure in the melter). Summating all losses the conventional design
actually has higher total losses than a comparable **IRD doghouse**.

Another benefit of the IRD doghouse has been a significant reduction in regenerator plugging due to batch carryover.

The **batch preheater** was the initial target of the development programme that has resulted in the **BATCH3 concept**. The first installation was so successful that we have a repeat order from our initial customer. The second SORG® batch preheater will be going into operation in spring 2013

*Figure 1 : the reference furnace*

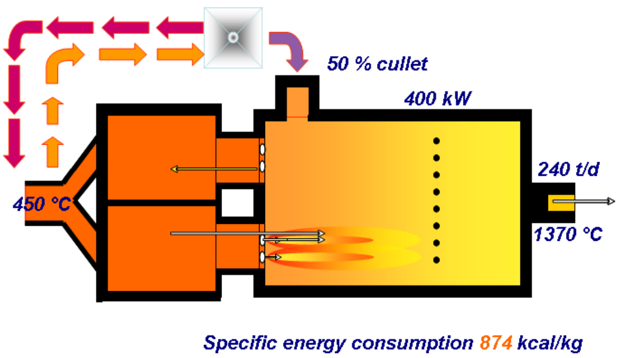


*Figure 2 : the reference furnace with a batch preheater*

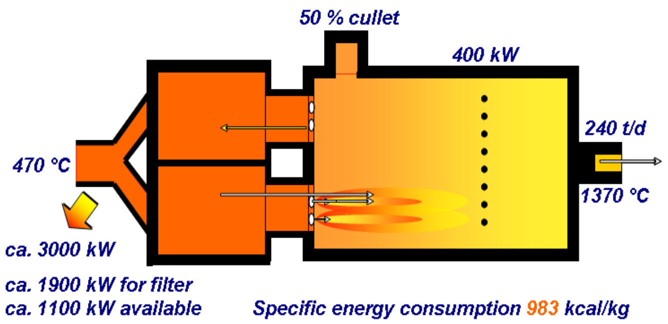


*Figure 3. Effects of regenerator aging*

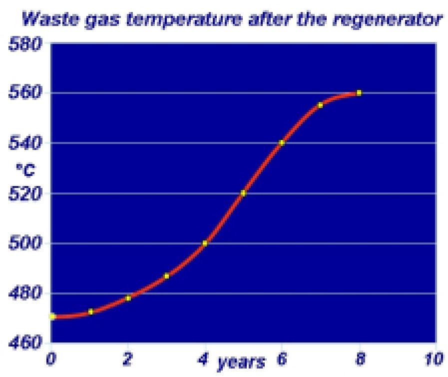

*Figure 4 : typical batch clumping*

*Figure 5 : Production Preheater 250t/d*

*Figure 6 : The EME-NEND batch charger*

*Figure 7 : The improved charging pattern*

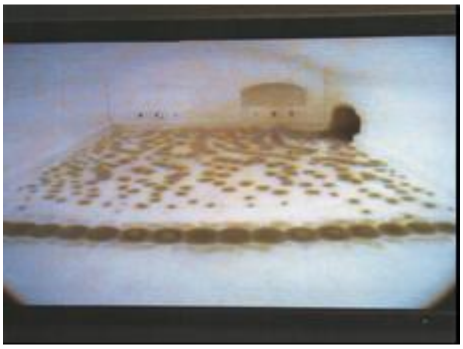

*Figure 8 : The IRD doghouse*

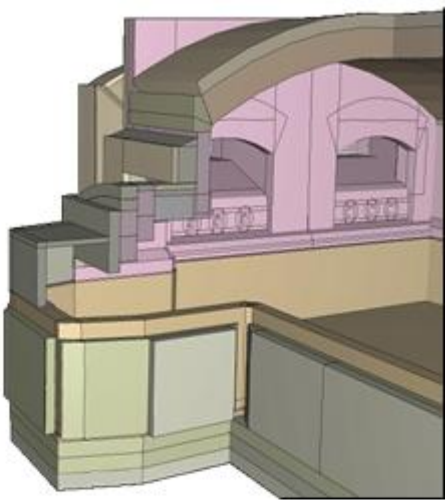

*Figure 9 : direct continuous $NO_x$ measurements, grey - conventional pusher charger, red - EME-NEND charger*

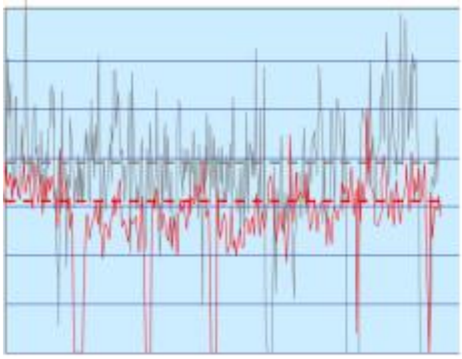

*Figure 10 :Thermographic maps, conventional doghouse (left) and IRD doghouse (right)*

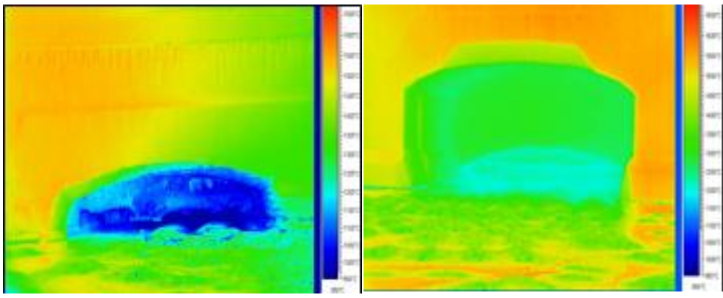

*Figure 11 : glazed-over batch piles leaving the IRD doghouse*