Partial rebuild of a glass melting furnace

The decision to partially rather than completely rebuild a glass melting furnace towards the end of its campaign life is dependent on several factors, including costs and projected sales requirements. Michael Horsfield*, Managing Director of glass plant engineering company Dismatec, reflects on the process chain requirements for a partial rebuild.

Towards the end of the designed or extended campaign life of a glass melting furnace, the question commonly asked by the company's senior management is: 'Do we need to totally or partially rebuild the furnace and what campaign life are we looking for after the rebuild?' Significant factors affect the decision making process and ultimately the final decision. These include: Current, new and future technologies; marketing strategies; production scheduling to meet current and projected sales; what is happening in the market; capital cost of the project; payback period; and commercial aspects.

For the purpose of this article, the decision made is to partially rebuild the furnace for a campaign life of three years prior to a major overall, including a furnace design change and the introduction of up-to-date technology to meet future production and sales requirements.

Decision making

This decision process should start at least 12 months in advance of any proposed rebuild date in order to determine commercial aspects, projected marketing and sales requirements and to meet materials and equipment delivery lead times.

For a partial rebuild, the main section of the furnace to be addressed for the purpose of determining the major part of the scope of work is the refractory structure. It is normal for the supporting and bracing steelwork to be re-used, with the exception of any items that have experienced 'heat-attack' or are seen to be potentially structurally instable. The furnace service systems, including fuel, cooling and control, normally remain in their entity with an amount of maintenance work being included for each system and the replacement of thermocouples and electrodes of an electric boost system if installed.

Typical location of the tapping hole and draining of the furnace.

To make a total and comprehensive decision on the required scope of work for the refractory structure, while the furnace is operational, is very difficult. However, from the views of experienced factory personnel together with the use of available external services such as visual and thermography audits, a good assessment of requirement can be concluded for commercial budgeting and the initial bills of material purposes.

Because the scope of work is an assessment and it is very likely that items in addition to those identified will be required, an amount of money should be included for these in the commercial budget.

Materials selection

For partial rebuilds it is very important to select the correct type and grade of refractory that is 'fit for purpose' for each area of the furnace refractory structure.

The new refractories have to be compatible with the existing so as not to create a wear or corrosive reaction during the operation of the furnace. Therefore it is important to have all the existing refractory specifications to hand for reference when selecting the required new refractories.

It is not uncommon for each factory department involved in the partial rebuild to include a 'wish list' (a list of items to help rectify problems experienced over a period of time and spare parts to help with ongoing maintenance throughout a furnace campaign life) while determining a scope of work for the rebuild. A rebuild time is seen as an opportunity to obtain items that may have been rejected during the existing campaign period.

Scope of work

For a partial rebuild furnace campaign life of three years prior to a major overall, the main area of concentration is the furnace melting end. All other areas are assessed for present condition, problems experienced throughout the existing campaign life period, potential problems that may be encountered during the future campaign life period, future maintenance requirements and risks against decisions made.

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Depending on the actual condition and results of a risk assessment of the furnace refractory structure, it is not uncommon for parts of the melting end sidewalls, throat, superstructure, ports, regenerators and regenerator packing together with the distributor and forehearths to remain in position and be re-used for the new furnace campaign life.

The scope of work follows a sequence of events identified on a Gantt chart or similar project tool to aid with the planning, logistics and management of the project. By using the Gantt chart, progress of work can be tracked throughout the rebuild period and any conflicts of work disciplines, material logistic problems and problems with meeting milestone and target dates can be identified at an early stage, therefore minimising the risk of unforeseen problems and over-running on the project programme.

The given scope of work for the rebuild follows a sequence of events or tasks in order for work to be carried out correctly and logically. Work carried out in the UK is under the current Construction Design and Management (CDM) regulations and similar in overseas countries.

Refractory materials and equipment, if chosen to be included, should ideally arrive on site prior to the tap and drain of the existing furnace. This ensures that the partial rebuild can start on the chosen date, without the concern of waiting for materials to be delivered and the possibility of the construction programme being disrupted.

Materials should be checked against the order upon delivery and stored to meet the requirements of construction methods and build sequence.

Furnace tap and drain

A tapping hole is drilled at a designated location in the melting end and from this the existing furnace is drained of glass using specialist equipment. The glass is directed into a 'tapping bay' by means of chutes, then transferred to a clean storage area near to the cullet bay so that it can be mixed with the cullet, if required, for the 'fill-on' process during the pre-heating of the rebuilt furnace structure. During the draining process, the furnace temperature is regulated to meet the temperature and flowing characteristics of the molten glass exiting via the tapping hole.

The objective of the draining process is to leave as little glass in the furnace as possible (normally 50-70mm). This helps to reduce the amount of work required during the dismantling process of the existing furnace refractory structure and the amount of glass to be disposed of to landfill or another source. Generally, this glass is disposed of to landfill due to refractory materials being present when removed from the bottom of the furnace.

Also, depending on the type of glass and its composition, the remaining glass left to be disposed of may fall into the category of hazardous waste, which is more difficult to dispose of to the correct environmental legislation.

Controlled cool-down

If prominent sections of the existing furnace refractory structure, including crowns, soldier blocks, throat, superstructure, regenerator structure and forehearths are to remain in situ for the next campaign period it is normal to cool down the existing furnace, after completion of the draining process, in a controlled way. This ensures that structural stability is maintained and that any given structure remaining is in the correct position for new structures or part structures to be built.

The controlled cool-down is carried out using specialist heating equipment to reduce the temperature of the furnace on a gradual scheduled basis. Working to a cool-down temperature schedule, the contraction of the furnace refractories is regulated from the end of the draining process to room temperature.

After the furnace has been drained of glass and the controlled cool-down complete, it is normal to inspect the internal areas of the existing furnace, to assess the actual condition of the existing furnace refractory structure and any areas of supporting steelwork that may have experienced 'heat attack'.

The results of the cold inspection can be checked against the partial rebuild scope of work and any additional work introduced into a final scope of work programme.

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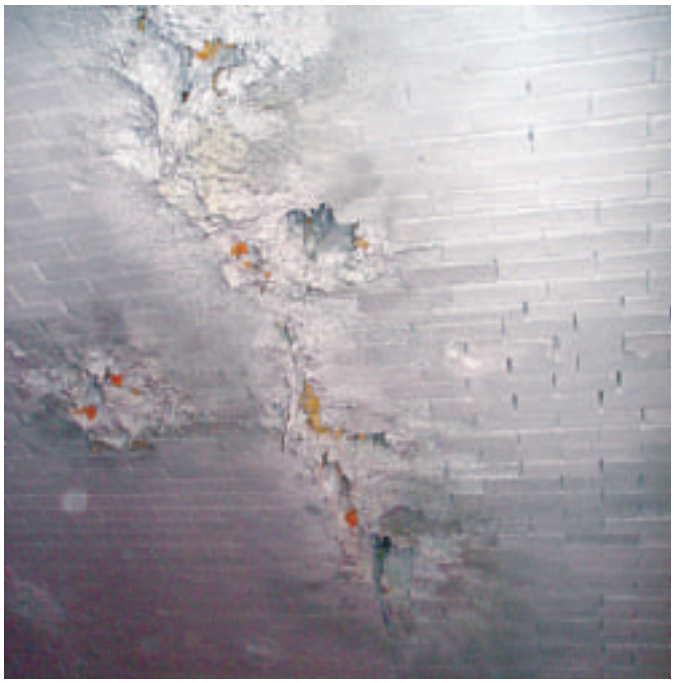
Internal wear of a melting end soldier block.



Internal wear of the melting end crown.

Execution

Work commences directly after the completion of the cold inspection with the dismantling of the existing furnace refractory structure to be replaced. Dismantling is carried out in a controlled and careful way so as not to remove more than is necessary. All the removed refractory materials are disposed of in the correct way following current environmental legislation, methods and requirements.

During the refractory dismantling process it may be necessary to remove an amount of pipework, ductwork, steelwork, electrical items and control monitoring equipment to allow access to the refractory structure and prevent any possible damage to equipment.

This work is carried out in sequence with the refractory dismantling process. Also, if any work is required on the steelwork structure this is done in the same way.

After the dismantling phase, the building of the refractory commences, with care being taken at all interface positions of the existing refractory structure in order to create a good and clean transition. Upon completion of the refractory rebuild, all the removed pipework, ductwork, steelwork, electrical items and control monitoring equipment are replaced at the correct time ready for the furnace pre-heat.

Health and safety

In order to optimise health and safety and minimise the risk of injury, a full and comprehensive method statement and risk assessment for all work tasks to be executed, together with any COSHH data, should be prepared in advance of work commencing and accepted by the site health and safety management, with copies given to a CDM co-ordinator. All personnel assigned to work on any task should have read and understood these prior to commencing any work.

To adopt a high level of health and safety, all partial rebuild work should be carried out to the current CDM regulations or equivalent, depending on the country where the work is to be carried out.

A well-executed rebuild reflects on good project management, including site and health and safety management. This is a key factor to problem solving during the rebuild period, maintaining workforce teamwork and communication together with following the rebuild schedule to achieve the final date set down on the construction programme and keeping the customer informed on the project at all required stages.

After the construction phase is complete, the refractory structure and systems are inspected and checked, the furnace pre-heat is started to bring the furnace up to operating temperature and ready for producing glass on a gradual temperature gradient basis. This is done with the use of specialist heating equipment and a pre-heat schedule. Within the schedule are timings for the introduction of the main furnace burners, cullet and batch fill-on. When the furnace is full of glass and the production machines are ready the new furnace campaign life can begin. ■

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