# Built with speed

## DARE TO TRY

Tailoring a new, quicker wall-building technique to suit Tata Steel's steelworks was an ambitious and challenging task, but one that could yield huge benefits.

Innovation, much like invention, is the child of necessity. When Tata Steel found that too much time and effort was wasted in rebuilding damaged walls in its coke ovens, a small team of employees put their minds to finding a solution.

During the course of operation, coke oven walls sustain damage and must be rebuilt. The resultant loss of production costs the company very heavily every year.

Any faster wall-building method could save the company crores of rupees. Management became especially interested in pursuing alternatives after a large number of ovens were down for repair during FY08 and FY09, and at the same time, a crisis in coke supply-demand gap surfaced worldwide. This simultaneous impact caused the company to be unable to meet its coke demand targets and caused huge cash outflow.

The walls of the coke oven battery (series of ovens) are maintained at such high temperatures (over 1300°C) that, when repairs are made, the two adjacent ovens must also be cooled to a sub-operational temperature for workers' safety. This means that each day of repair, three ovens are idle.

A team consisting of Sujit Kumar Haldar, Rakesh Agarwal, Arvind Nath Rai, Avijit Mukherjee and Ashim Biswas considered the problem of expediting repair. A US company was using a fast wall-repair technique in its top charge coke oven battery. The Tata Steel team had the idea of modifying the technique in a way that allowed it to work for their stamp charge coke oven battery. If successful, the team estimated, the proposed method would cut repair time in half, saving the company several crores of rupees per year.

Testing the process, however, would result in significant lost revenue. As would failure. Mr Agarwal estimated that a wall that failed would cost the company between two and three crore rupees. And a major wall failure could result in dangerous conditions.

Determined to find a better and more viable solution, the team set out to try the new process of building coke oven walls. "In our mind, there was always the desire to do something new," says Mr Haldar.

### Innovation

The walls of a coke oven battery are not simple solid walls. They are hollow. Fuel is burned inside them, heating both sides. These walls, in turn, surround and heat the chamber containing the coal. Heating the coal drives out the volatiles, yielding coke.

The expected problems lay in the fact that the method the team proposed had only been used with a top charge battery; Tata Steel uses a stamp charge battery, which reaches higher temperatures than a top charge battery, handles 1.5 times the bulk density, and causes the coal to expand more.

However, this method of wall repair, if it could be successfully implemented, had many benefits. Instead of using bricks, it requires moulds to be filled with a flowable refractory material that dries and hardens into a wall. The material is known as FosKast FSP, a fused silica-based pumpable castable. It creates one monolithic wall; this avoids the need for any mortar-sealed joints, which are susceptible to opening up and allowing leakage.

The castable method would overcome another problem with traditional walls. When silica-brick walls are heated, they expand, which must be accounted for when fitting a new wall to older adjacent ones, requiring very careful and precise work. Heat doesn't cause the castable to expand, eliminating that time-consuming problem.

This method would also alleviate all the logistics that go into stocking the right number of the right shape of brick to build the new wall.

The advantages over the traditional method were expected to be both a shorter construction time and a longer life — a huge boon for a problem that must be handled over 50 times a year.

## Hurdles

Despite its advantages, this method requires some precautions that are not necessary with traditional silica bricks. One is that the moisture of the castable has to be precisely controlled — it requires the addition of 5 per cent water during mixing. Any deviation from this could adversely affect how the material responds to operational stress. To manage this, an automatic moisture feeder was obtained and attached to the mixer to control the moisture levels.

Another difficulty this method presents is the fine silica dust released during mixing; safety precautions must be taken because prolonged exposure to such dust can cause respiratory diseases.

As the castable is poured, the mould is vibrated to ensure it settles correctly. The mould must be made sturdy enough to avoid being deformed by the vibration, or the resulting wall will also be deformed. To avoid this, the moulds were made from aluminium and a special support system was build to stabilise them. In addition to being sufficiently rigid, the moulds must also be made to accommodate CO nozzles and air ports, so highly skilled carpenters were brought in for that work.

The Tata Steel team receiving the Innovista, 'Dare to try' award from Mr Tata, at the JRD QV Award function on July 29, 2009

The castable solution avoids inter-brick joints, but if the liquid castable isn't fed into the mould at a consistent rate, lamination and joints will be created within the cast structure itself, increasing the likelihood of leakage when stressed. To avoid this, backup equipment was brought in that would switch on if the primary equipment failed.

## Lessons learned and hurdles remaining

The team spent a total of seven months studying the project and over a month building the coke oven wall.

The wall was built, then tested. For sixteen twenty-hour cycles, it worked. On the seventeenth cycle, a hole was found in the wall. It is suspected to have been caused by a tendency of the wall to become less solid and deform at high temperatures when under load — a greater load than top charge batteries are subject to.

The castable material was found to deform at 1,460–1,490°C, as opposed to silica brick, which can withstand temperatures up to 1,650°C before deformation occurs. This is probably due to the higher alumina content in the castable than in the silica brick (14.5 per cent as compared to 2 per cent). It was also shown that the castable shrinks excessively during the initial heating.

It is expected that it will be possible to lower the alumina content of the castable by adding some microfine particles, thereby raising the temperature at which deformation occurs.

Another problem that must be dealt with is the fine silica dust that was released during mixing — it is also released when the wall is dismantled.

The team also learned that the castable can change from non-crystalline to crystalline silica at temperatures above 1,200°C, which changes the volume of the walls. It is believed this can be remedied by incorporating some additives into the mix, but more research remains to be done; the R&D team of the FosKast FSP supplier is working on it.

The team says it received tremendous support for the project. Even now, management is encouraging it, with aid from the FosKast FSP supplier, to go ahead and set up another trial using an improved material.

If the team succeeds, they expect to have a battery wall-building method that takes half the time of the traditional method, is simpler to arrange (requiring no bricks) and is more robust, due to its lack of any brick joints. All of these will make it a quicker, more efficient and more economical method of repair. ●

*Matthew McHugh*