# Ceramic welding for furnace repairs

Dominion NovoCOS spoke to Jean Hardy* on its ceramic welding techniques, which can deliver efficient glass furnace repairs without halting production.


Pic 1. Welding inside a furnace, with a 15m double water-cooled lance.

Ceramic welding technology was developed in the 1970s and is relatively simple: a reactive powder is projected on the hot walls of the furnace to rebuild the original refractory.

This operation is carried out without stopping the production of glass, by using a water-cooled lance introduced into the furnace, above the level of molten glass ***(Pic 1)***. Only the upper parts of the furnace are repaired with this technology: the crown, the superstructures, the regenerators above the stacks, etc.

Inside the lance, transported by an oxygen flow, is the "powder", which is composed of a mixture of refractory granules and fine metal particles.

When in contact with the hot wall of the furnace, the powder reacts with the oxygen through an exothermic reaction. That generates a local increase of temperature together with a partial melting of the refractory granules and it builds a new refractory.

The principle of ceramic welding looks relatively easy, but the implementation of this process is quite complicated. To better understand the challenges generated by ceramic welding, as well as the opportunities it offers, we went to the headquarters of hot furnace repair specialist Dominion NovoCOS in Mechernich, Germany.

## Success factors

NovoCOS has a light structure with around 25 workers, including the Administrative Department. In addition, the site is small due to the mixture of refractory granules being prepared by a German subcontractor; semi-finished products being stored in a warehouse across the street; and most jobs are completed internationally in customer plants.

Fortunately, NovoCOS works in close co-operation with its mother company, the Spanish group Dominion, which provides reinforcements of its teams when needed.

Bernard Somerhausen, Chief Technology Officer, took us on a tour of the site. In the workshop, our attention was drawn to a metal welder who was welding a lance for a future job repair (***Pic 2***).

Mr Somerhausen said the quality of the equipment is one of the three factors of the company's success. All lances and support devices, such as pressurised machines (***Pic 3***), are in-house manufactured. For each intervention, a special lance is configured so that the damage to be repaired can be reached the easiest way possible.

The second success factor is the quality of the powders. A good quality repair depends on it. The composition of the powder (refractory granules and metals particles) provides the possibility to do different types of repair: siliceous, silico-aluminous, magnesium, AZS, etc.

All the powders are produced in Germany by an expert in the handling of raw materials, according to the NovoCOS recipes and specifications, and with continuous control of raw materials, production process and finished products.

However, the third and the most important factor is the skill of the welders. This is for several reasons:

**1.** The move of the lance must be done smoothly, in a slow and regular tempo and keeping a constant distance (a few centimetres) between the tip of the lance and the refractory to be repaired:

- If the lance is too far away from the wall, the impact energy of the powder on the refractory is lower and will give a poor quality repair.
- On the other hand, if the lance touches the wall of the furnace, a plug of refractory is formed inside the lance and the lance must be removed from the furnace to eliminate this plug and be able to continue the work.
- Sometimes there can be an additional difficulty: the damage to repair may not be located directly in front of an opening done in the wall. Then the repair must be done using, together with the lance, an image provided by an endoscope moved inside the furnace. The length of the lances can sometimes

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Pic 2. A metal welder preparing a lance for a future job.

Pic 3. Ceramic welding machine.

reach 15 metres long.

**2.** Pure oxygen and reactive powder at high temperatures are used, which requires a perfect control of all so that the powder can react instantly on its contact with furnace wall:

- If the powder reacts too quickly, it catches fire in the machine and in the lance.
- If the reaction is not fast enough, the refractory granules bounce off the wall of the furnace, contaminating the glass bath.

When asked what his secret to success was, Mr Somerhausen said: "Younger welders are mixed with senior welders within a team of four or five so that they are in constant training. The less experienced welders participate in the work by loading and controlling the machines as well as in helping to introduce the lances in the furnace."

While ceramic welding is an old process, NovoCOS has found several new applications for it through completing hot repairs.

"Some customers use ceramic welding for sealing joints after heating up a new furnace. This has the double advantage of being faster and more durable. This technique is already widespread in hollow glass, while flat glass is starting to test it gradually." (***Pic 4***)

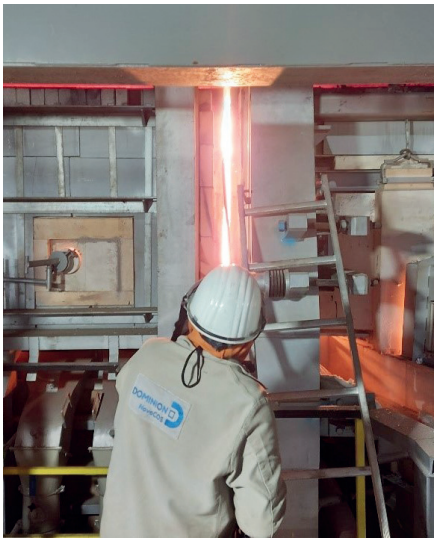
However, when applying these welds to cold areas of the furnace, three problems appear:

**1.** With the temperature of the refractory being lower, the energy of the oxidation reaction of the metal particles is not sufficient to start the reaction without external energy.

**2.** The binder phase vitrified, which could lead to detachment of the weld after thermal shock.

**3.** The particle size of the powders is too large to penetrate deeply into the fine joint.

Therefore, NovoCOS has developed a new mixture, called SF01. This is used to close joints from the outside, which corrects these three drawbacks. Consequently, the company can: revise particle size curve to reduce the large ones; adapt the formation of metal particles to improve the oxidation reaction on a relatively cold refractory; and add a devitrification additive of the binder phase in the mixture.



Pic 4. Sealing external joints after heating-up a furnace.

## Hot repairs

NovoCOS is experienced in the hot repair of furnaces. The needs and expectations of its customers have evolved considerably in this area, as explained by Technical Senior Adviser Frank Spreckelmeyer.

He said: "Over the last 10 years, the working method of many glass manufacturers has changed. Whereas, in the past, major repairs were carried out by their own stonemason, today complete work packages are handed over directly to external companies.

"The reason is cost reduction of course. Considering that the life expectancy of a glass furnace is extended to 20 years for a flat glass furnace and eight years for a hollow glass furnace, this obviously requires increasingly numerous and complicated maintenance work. Furthermore, our clients were asking more and more often for work involving other hot work in addition to ceramic welding repairs."

NovoCOS can now offer all-in-one repair work, which covers:

**1.** Ceramic welding inside the regenerators and directly in the furnace.

**2.** Bricklaying activities in the hot area i.e. installation of suspended blocks.

**3.** Pinning refractories bricks.

**4.** Metalwork and design modifications to melting tanks.

**5.** External ceramic welding of joints, as mentioned above.

**6.** Drilling of holes for the installation of bubblers, thermocouples, or for thickness measurement, etc.

**7.** Repair of the furnace bottom by building up a new concrete layer after furnace's draining.

**8.** Furnace inspections using cameras or endoscopes.

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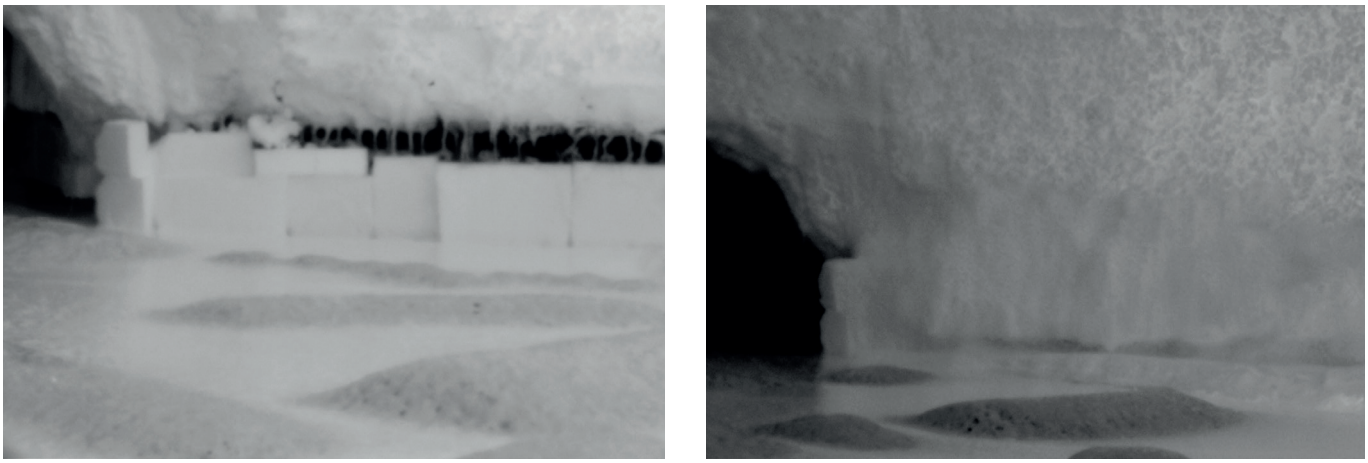

▲ Pic 5a / 5b. Repair of tuck stone area close to doghouse, before (5a) and after (5b) ceramic welding.

**9.** Also, some specific specialised jobs, such as the complete replacement of a port mouth side wall.

## The future

Mr Somerhausen said NovoCOS was "well aware" of the decarbonisation challenges it would face over the next 20 years, and that it was closely following recent developments. Full electric production in the world of glass would effectively lead to a complete redefinition of the company's main activity: ceramic welding.

However, both he and Mr Spreckelmeyer believed that the company was entering a period which would also be rich in innovative projects.

This includes combined production, i.e. mixed fuel such as electricity, hydrogen and other alternative energy sources.

They are confident that, with the support of their shareholder Dominion, NovoCOS will become an increasingly major player in the world of the maintenance and hot repair of glass furnaces. The company will be present at Glasstec in Hall 13, Stand A77. ■

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