Ceramic Welding Used With High Temperature CCTV in Advanced Repair Technique for Glass Furnaces

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This article describes a technique which uses a closed-circuit television (CCTV) monitoring system to examine the refractory lining of a furnace prior to repair. This technique, known as ceramic welding, uses oxygen-rich refractory particles and fusion in a highly exothermic reaction to repair the furnace linings.

The refractory linings of glass furnaces are often repaired using an advanced technique called ceramic welding. The technique feeds oxygen-rich crushed refractory particles to the hot refractory lining, where the metals oxidize and fuse in a highly exothermic reaction between 2912° and 3992°F (1,600° to 2,200°C).

The high-temperature combustion melts the surface areas of both the particles and the lining, creating a durable repair bond. The key benefit of ceramic welding is that it is often performed while the furnace or vessel is at or near operating temperatures. There is no need for shutdown or cooldown, and minimal or no loss of production time. By detecting problems early, the technique can extend the life of a furnace or vessel and save the sometimes- staggering cost of a rebuild or reline.

FuseTech, Inc., Vermilion, OH, is using an advanced approach to ceramic welding which includes inspecting the refractory lining before, during, and after the welding with an advanced water-and-air-cooled CCTV monitoring system, called FireSight™. Developed by Lenox Instrument Company, Inc., Trevose, PA, the solid state system can withstand temperatures as high as 3,500°F while penetrating the flames inside operating furnaces and other vessels.

Fig. 1 Wearing fire-retardant gear, a technician inserts the periscope of the CCTV system into the regenerator chamber of a glass furnace to view checker packs used to regenerate heat during manufacture of glass.

Furnace Inspection

Usually, the first step at the site is to survey the entire furnace interior with the CCTV system. This is done by inserting the system's 48 inch long water-cooled periscope, which has a 90° lens at its tip, through an existing or specially-drilled "peep hole" in the furnace wall (Fig. 1). A technician can remotely control a motorized iris and spot filter in the lens system to easily adjust the amount of light admitted to the camera, helping ensure high-quality images in a wide range of light conditions and avoiding problems like "whiteout" (loss of picture due to intense light). A series of achromatic relay lenses within the periscope carries the images back to a compact, solid state CCD camera within a high temperature, air-cooled housing. The camera then transmits the images to the nearby color monitor (or to a permanent monitor in a control room).

Inspection technicians can view the TV images right at the furnace on a portable color monitor (Fig. 2). The survey will often also include recording the entire inspection on color videotape (with audio) which can then be evaluated to assess whether repairs are necessary and, if so, exactly what needs to be done. A video monitor printer can be added to produce on-site color photos of any area on the videotape. These

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photos can be enlarged for even closer scrutiny.

If the inspection has confirmed the need for repair, ceramic welding can then be performed—usually while the furnace is operating. This is done by conveying a dry mixture of refractory particles and oxidizable particles together, through specially-designed water-cooled lances, to the hot lining. Many different lance sizes and configurations may have to be utilized to reach damaged areas. The subsequent combustion and melting of the metals, creates a long-lasting bond with a weld-mass very similar to the substrate refractory being restored.

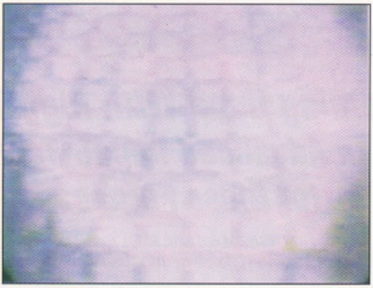

Fig. 2 Checker ports in the regenerator of a glass furnace as observed on the monitor of a CCTV system. The packs are specially shaped bricks which retain heat. Pulled back into the furnace, heat crosses the glass batch during the glass-making process

During the weld operation, technicians can view the repair area, including portions which would be otherwise difficult to see, on the CCTV monitor. Then, after the repair is complete, the system can be used to resurvey the interior of the furnace, checking the work and providing videotape documentation of results to the customer.

The ceramic weld repair may take only 10 or 15 minutes or can last several days. During this time, cooling water from the plant's water supply circulates in a closed-loop system through the cover of the stainless steel periscope probe which penetrates the furnace wall. Compressed air circulates in another system and cools both the lens at the tip of the probe and the housing for the CCTV camera behind the probe.

According to Carl Firestone, President of the furnace lining repair company, most repairs occur under emergency situations where a customer has seen a block of refractory fall into, or a hole develop in the side or roof of a furnace (Fig. 3). The CCTV system allows repair technicians to see what the brick looks like inside the furnaces and be able to inform the customers of the severity of the problem prior to beginning the repair.

About 95% of repairs occur while the furnace running at full production. The CCTV system can also be used for such purposes as checking for plugged checker chambers in furnaces in the glass industry or to see how burners are firing during the combustion process. This allows customers to adjust their fuel feed for the most efficient burn.

Fuse Tech has been successfully using the CCTV system as part of its ceramic welding for about 18 months. Usual procedure includes shipment of the system to the facility where the repair work is needed. The mobile CCTV equipment then can be moved to the furnace that is to be inspected.

The ceramic welding process was originally designed for in-situ repair of glass furnaces. The technology was introduced in the U.S. in 1979 as a method of repairing the walls of coke ovens in the steel industry. It is now employed primarily in the glass, aluminum, copper, cement and coke oven industries.

Applications

Using ceramic welding, furnaces have been repaired successfully at such companies as Libby Owens Ford, Toledo, OH (flat glass); Schuller International, Inc., Toledo, OH (glass fiber); Gallo Glass Co., Modesto, CA (glass containers); GE Lighting, Niles, OH (light bulbs); Guardian Industries Corporation, Carleton, MI (flat glass); and Holophane, Newark, OH (specialty glass).

Fig. 3 View of damaged port arch in a flat glass furnace from the regenerator side, using a straight viewing lens in the CCTV system.

SUMMARY

Designed to withstand, without failure, all hostile conditions inside furnaces or boilers, the new-generation CCTV system uses a quartz lens which can operate up to 3,500°F. This lens, at the tip of periscope, extends out into the furnace interior for optimal viewing. It captures clear color images of the refractory liner, combustion at burner nozzles, and other conditions. A fail-safe air filtration system removes aerosols, vapor, oil, and particles as small as 0.03 microns from the compressed air which cleans and cools the lens.

Further information is available from Carl Firestone, President, Fuse Tech, Inc., Vermilion, OH; tel: 1-800-301-3873; fax: (440) 967-0495, or from the author at tel: 1-800-356-1104; fax: (215) 322-6126. IH