WORLD CEMENT

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The Silver Lining

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review how finding the right solution for a very persistent wear-problem came to be seen as a silver lining in a granulated blast furnace slag grinding system in the Midwest, USA.

Introduction

Slag cement has been used in concrete products in the US for over one hundred years, and even longer in Europe and elsewhere around the globe. And while there are various methods of processing slag, which is primarily a waste by-product of the steel manufacturing process, one common system is the granulated blast furnace slag grinding system. In late 2002, one such system in south Chicago was in desperate need of a liner replacement in two of its main components: the dryer shaft and cyclone. This particular system was relatively new and had only been on-line for approximately two years, but the OEM (Original Equipment Manufacture) material on the inside of the dryer shaft and cyclone was showing constant wear, requiring repairs approximately every few months (Figure 1). Both the dryer shaft and the cyclone came lined from the factory with a liner that by all rights was a relatively good wear-resistant material, but only when used in the right application. When used for repairs in this system, the old liner material had to be applied as a wet, mud-like consistency to the worn areas, which made repairs slow and tedious. Furthermore, the old liner material was also weather-dependent, which meant shutdowns to make the repairs could only be scheduled at certain times. The bottom-line was that for this type of application and wear, it was obvious the old liner material was not the right solution and a new alternative solution would need to be found.

Numerous repairs had been attempted, but the repairs amounted to basically applying more repair material to the worn areas, which only compounded the wear-problem and resulted in more costly downtime. This particular slag grinding system handled material on a relatively large scale with a feed rate of 85 stph (actual material feed) and a velocity of 18 - 22 m/s up the shaft, so it was crucial that the new solution eliminated as much unnecessary downtime as possible. At one point, 50% of the worn liner was missing from the elbow at the top of the dryer shaft and the roof showed wear as well. Therefore a longer lasting solution was sought and Wear-Concepts, Inc., a specialist in normal day to day wear-problems as well as tough to solve wear problems, was selected.

The challenge

In order to fully understand the problem, a couple of wear specialists were dispatched to the site to take photographs and measurements for the engineering department and look at the wear first-hand and fully assess the problem before making a recommendation. It was clear that the old lining would have to be completely removed, which would be no easy task as the dryer shaft alone stood seven stories tall. Also, the inside of the main body of the dryer shaft was just slightly over 4 ft wide making the installation of a seven storey scaffold and the slow trek up the dryer shaft extremely cumbersome.

What made this particular liner replacement even more challenging was the fact that there was only a three week window for the entire project to be completed, and the average temperature during that period was just 10 ˚F for daytime highs.

The solution

Approximately one year prior to this, Wear-Concepts had relined a similar slag grinding system in another part of the country, and many of the deciding factors

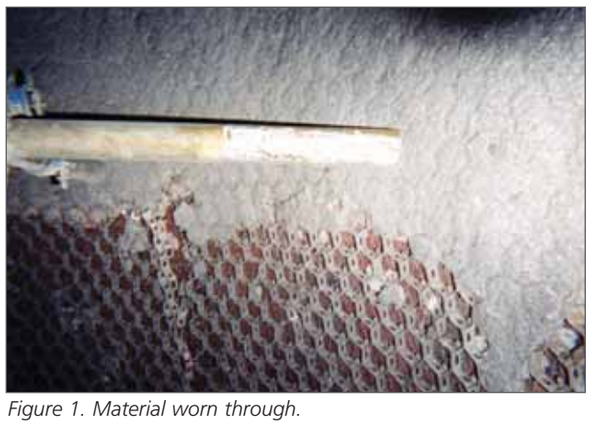

Figure 1. Material worn through.

Figure 2. Installed WC90 ceramic.

remained the same with this project, with the exception of the extremely low outside temperatures. This allowed them to base a recommendation both on knowledge of the components being relined, the materials the system handled, as well as the best teacher of all: experience. Therefore, after a thorough evaluation it was determined that due to the temperature differences in the dryer shaft (275 ˚C at bottom of the shaft and 65 ˚C in the cyclone), the velocity of material flow up the shaft and at the upper elbow, as well as the amount of wear evident in certain areas throughout, more than one material was required. The turnkey solution proposed would require a complete tear-out of all existing lining as well as the hex expanded metal underneath, then a full install of Wear-Con's WC90 alumina weldable ceramic tiles throughout the vertical portion of the dryer shaft, as well as the inner portion of the cyclone. In the higher wear area at the top of the shaft in the upper portion of the elbow where impact and sliding wear was extremely evident, Wear-Con recommended the use of the custom engineered 1 in. thick WC700 chrome carbide wear plate. This would not only replace, but would be an upgrade from the factory installed 3/8 in. thick lining that showed signs of extreme wear. In addition, all of the ceramic used would be sealed with the company's premium grade silicone sealant, which would be able to withstand the temperature extremes at either end of the dryer shaft. Based on costs, as well as the fact that Wear-Con's own field crew could oversee the entire tear-out and installation, the plant maintenance manager gave the approval for the job to begin and a date was set.

The task

The first step in the planning and execution stages of installing the new liner was to determine which scaffolding system could best allow workers to move freely up the dryer shaft and still have plenty of room to pass materials through and to work in such a confined area. Due to the short time interval from start to finish, the decision was made to hire a scaffolding crew and have it put in place at the onset of the job (Figure 3). The next consideration was to accurately determine the quantity of each material (WC90 Ceramic, silicone, etc.) required. It was estimated during the costing phase that approximately 15 000 WC90 ceramic tile pieces would be used, so that much, plus a little overage, was shipped in.

Removing the worn liner and hex expanded metal was a tedious process as the old lining had to be air-hammered and chiseled out, using the old-fashioned method, and transported away. Next, grinders were used to remove any areas where welds or other matter would prevent the new ceramic tile liner from adhering securely to the surface of the walls. Once all

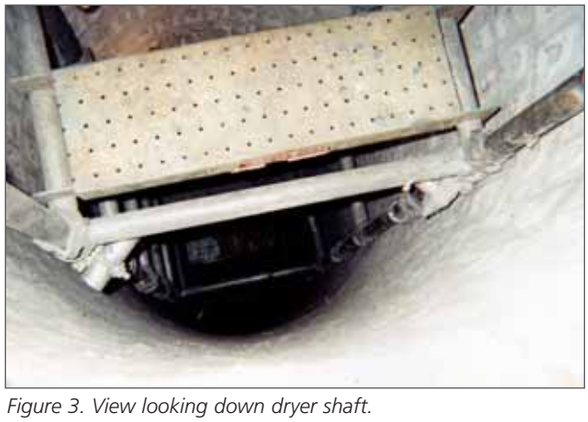

Figure 3. View looking down dryer shaft.

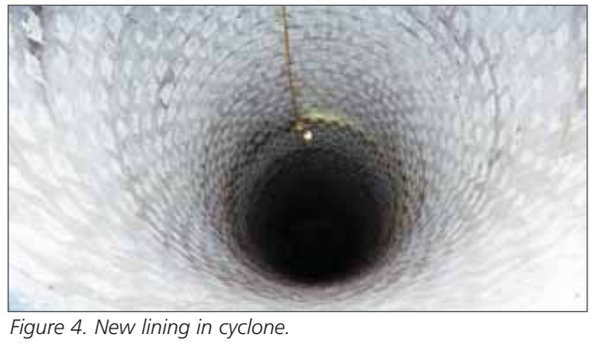

Figure 4. New lining in cyclone.

Figure 5. Inside view of custom engineered WC700 liner.

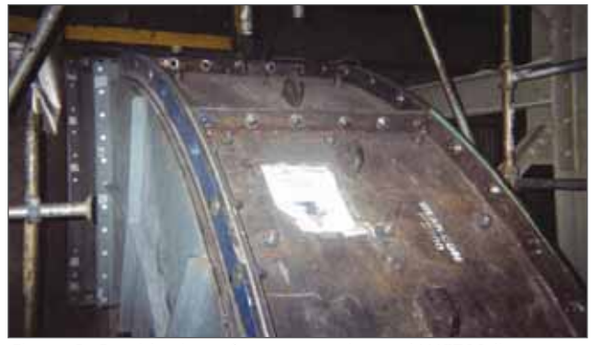

Figure 6. Outside view of custom engineered WC700 liner.

Figure 7. Close up of WC700 liner.

this was removed and the surface of the walls ground smoothly, the crew was required to clean all the interior surfaces to ensure proper adhesion with the premium silicone that would eventually seal every brick (ceramic tile) that was to be installed.

To begin the ceramic installation, an initial 'starter row' was put in at the base of the shaft, keeping it level in order to serve as a guide for the rest of the linings that would line the walls for seven storeys. Each brick had to be spot-welded to the surface of the wall and then a ceramic cap inserted into the hole where the weld was located. The cap was then sealed with silicone, as were all the edges and joints. Keeping warm with heaters placed strategically every few floors, the crew worked their way methodically up the dryer shaft until they reached the impact zone of the elbow at the top of the shaft. Here, they installed a customised pre-engineered replaceable piece of WC700 chrome carbide, 1 in. thick wear plate (Figures 5 and 6). This piece was bolted into place so that the same custom part could easily be replaced in the future if necessary. The crew then moved into the large cylindrical-shaped cyclone which measured approximately 11 ft across and 16 ft in height. The special scaffolding system allowed them to access all of the sidewalls and install and seal the balance of the ceramic tile.

The job went as planned and was completed two days ahead of schedule. This was the result of thorough planning and estimating.

Conclusion

To date, over a year since the relining project was completed, the customer reports 'zero' noticeable wear so far with any of the WC90 ceramic lining, and only slight ripples in the impact area of the elbow at the top of the shaft. As an added bonus, once the new ceramic liner and chrome carbide liner were installed, all that was required was a little tweaking of the temperatures inside the shaft and the usual buildup of materials virtually disappeared.

Finally the customer remarked that he was impressed with the solution and installation. And when asked what colour that lining was, the author believed that 'silver' would come to mind.◆