The benefits of internal coating and other flue gas vessels

Corrosion of steel in cement kilns and other flue gas vessels such as stacks, bag houses and scrubbers can result in equipment failure, plant shutdowns, loss of production and remediation of affected areas (see Figure 1). Severe instances may compromise plant personnel safety. A cement plant kiln is considered the most important part of the plant. Production is dependent on the kiln's efficient, continuous operation.

Debra Ashley, Ashcoat LLC, Canyon Lake, Texas, USA

'Without a barrier coating, surface substrates deteriorate at an aggressive pace, leading to premature equipment failure and replacement. The cost of applying these coatings is minimal in comparison to the loss of productivity, replacement and lost production revenues.'

Steel corrosion in the interior portion of these vessels and stacks can result in more aggressive deterioration of the steel substrate than exterior corrosion, reducing the steel thickness from the inside out. It is imperative to find a cost-effective, time-efficient solution. However, the application of protective linings to these systems is providing positive results. The purpose of this article is to describe the situation and the findings of internal kiln lining case studies and present an ongoing study for flare stack internal linings.

Situation

Residue of the products burned in the kiln pass through the porous refractory brick insulation of the interior shell and come to rest against the cold steel face wall of the kiln. Corrosion is initiated in the presence of moisture and thus the corrosion progresses at an alarming rate. Reduction of shell thickness per million tonnes clinker production ranges between 140–200mm, resulting in annual repairs. The challenging solution is to find a heat- and chemical-resistant coating that can tolerate the environment without any detrimental effect on production. The following case study began in March 2001 when a kiln lining was applied to a portion of the upper kiln. Subsequent applications were applied in March 2002 and April 2003.

However, kilns are not the only plant equipment suffering from exposure to corrosive agents of this kind. It is important to recognise the need for an internal coating system to be used in bag houses, stacks, scrubbers and other vessels exposed to a similar environment.

An example of untreated kiln corrosion

In March 2001, the company was presented with an interior kiln shell with a diameter of 6 × 4m. The area presented was located in the upper part of the kiln. The original estimated steel thickness ranged between approximately 111 to 254mm. Inspection took place following the removal of refractory brick from the area during plant outage. The appearance of the substrate surface revealed severe corrosion. Numerous areas of pitted steel and peeling delamination were found. The delamination appeared to be approximately 1.6mm thick (see Figure 1).

The surface was abrasive blasted to a SSPC-10 near white blast with a profile of 0.025mm, as specified by the Steel Structures Painting Council[1]. An application of aluminium-filled, silicone-based, heat- and corrosion-resistant coating was then spray-applied to the surface substrate at a dosage of 4.0 wet mils thickness, which would dry at 1.5 dry mils thickness. The coating was aqueous-based volatile organic compound (VOC) compliant and would be dry to touch and handle within two hours after application, prior to installation of new refractory bricks. Full curing would occur when plant went back into service. This full procedure was performed within one eight-hour shift.

The effect of coatings

In March 2002, the company was presented with a different portion of interior kiln shell wall with the same area. It would have had the same original shell thickness and was experiencing the same type of deterioration. The company was also allowed to investigate part of the steel that had been coated one year previously and no further delamination of steel thickness was found. The coating was still evident on much of the surface and the substrate appeared smooth, with no evidence of deterioration (see Figure 2).

(Photo: Ashcoat LLC.)

Figure 1: The example of severe corrosion was found on the untreated internal surface of a cement kiln.

Figure 2: The kiln wall coating one year after application.

Figure 3: The kiln wall three years after application.

applications for cement kilns

The substrate of the new, hitherto untreated area, was blasted to SSPC-10 and the same coating was applied as before.

Study and application: April 2003

In April 2003, the company was presented with an additional 18.3m of the same kiln shell. Conditions, preparation and applications were the same as before. Time constraints did not make it possible to investigate previously treated areas for inspection. However, these areas were inspected during the June 2004 outage. There was evidence of coatings remaining intact and, furthermore, the appearance of the coated substrate appeared to be improved and smoother when compared with the uncoated substrate. This indicated that the density loss of steel was significantly reduced with the internal coating. This demonstrates that the protective coating has created a sacrificial barrier between the corrosion and steel, slowing the rate of deterioration due to corrosion (see Figures 3 and 4). A coating was applied to approximately 30.5m, located close to the burn zone. The material used was specified to withstand a higher temperature than the material for the upper section. Research will be undertaken to establish the status and condition of the coating at future dates.

Flare stack interior shells

There is a main flare stack of the preheating tower in most cement plants. Gases derived from the by-products burned in the kilns are expelled through this stack and are thus exposed to an aggressive environment akin to that of the kiln. Figure 5 shows how a flare stack interior has corroded. The stack was approximately 57m tall with a diameter ranging from 4–6m. This was exposed to a similar environment, but heat exposure was not as great as that of the kiln. The operating temperature of the stack is approximately 140°C, but once a week the temperature would rise to approximately 180°C. The degree of corrosion varied at different heights within the stack, thereby indicating that exposure to moisture and chemical attack is greater in those areas.

The substrate was abrasively blasted to an SSPC-10 near-white blast profile of 0.025mm. A high-performance silicone-based coating was spray-applied to a prepared surface at approximately 7 wet mils per coat which would dry at 4–5dft (dry film thickness) per coat. Three coats were applied to achieve a total dry film thickness of 14–15dft. Research will be undertaken the status and condition of the coating in the future (see Figure 6).

Solution

The available data indicates that treating the corrosion attack from the interior portion of the vessel is successful because:

- the media blasting of the interior kiln shell, flare stack and other related vessels removes chemical debris and contaminants from the substrate which can initiate corrosion.
- the application of a heat- and corrosion-resistant lining to the cleaned substrate creates a sacrificial barrier between the chemical contamination and the shell walls. This slows the corrosion rate of the interior shell walls.
- slowing the corrosion rate extends the life of the shell, thereby extending service life. It also enables the plant management to budget for future equipment needs.

Concluding remarks

This study illustrates how coatings extend the service life of cement kilns, stacks and similar vessels. Without a barrier coating, surface substrates deteriorate at an aggressive pace, leading to premature equipment failure and replacement. The cost of applying these coatings is minimal in comparison to the loss of productivity, replacement and lost production revenues. ■

'This study illustrates how coatings extend the service life of cement kilns, stacks and similar vessels. Without a barrier coating, surface substrates deteriorate at an aggressive pace, leading to premature equipment failure and replacement.'

Reference:

1. STEEL STRUCTURES PAINTING COUNCIL. SSPC-SP COM *Surface preparation commentary for steel and concrete substrates*, website: www.sspc.org/standards/spscopes.html, The Society for Protective Coatings, Pittsburgh, 2000.

Figure 4: The same wall four years after application.

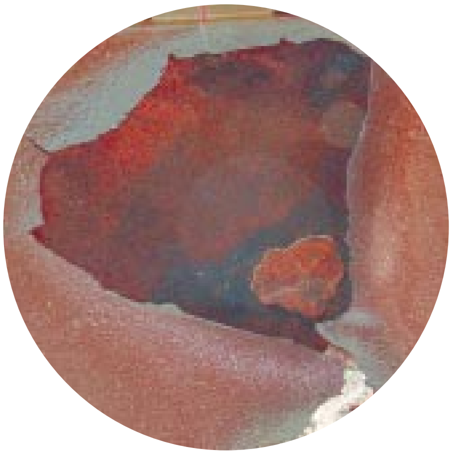

Figure 5: Advanced corrosion on the internal wall of a flare stack.

Figure 6: The coating applied to the internal wall of a flare stack.