

# Stack Corrosion: A Serious Problem

Linus Mazeika, 3L&T, USA, describes the company's method for preventing and stopping corrosion in cement plant chimneys.

## Abstract

Most chimneys in cement plants are built using carbon steel. In the past, internal corrosion was not a major issue but recently it has been getting much worse. The aggressive corrosion now observed seems to be related to three current trends: more sulfur in the fuel, an increase in use of alternative fuels and better efficiency of the baghouse filters. There is a new material technology called StackGard-255SQW that is simple to install, easy to cure and has excellent corrosion protection characteristics.

Several new stacks worldwide have been protected with this coating and many other projects are ongoing, including a new chimney in Arkansas. Considering the overall investment for a new chimney, it is very cost effective to stop the corrosion and add more years to its useful life.

## Introduction

Most chimneys have the ideal conditions for severe internal corrosion. The combustion gases consist of acidic compounds like  $\text{SO}_2$ ,  $\text{SO}_3$ , HCl and  $\text{NO}_x$ , they also contain a large amount of moisture. The metal temperatures are, in most cases, below the acidic dew point temperature of these gases, especially towards the top of the chimney. Additionally, many chimneys do not have external insulation and this guarantees that there will be significant amounts of acid condensation on the internal walls.

In many cases the corrosion effect is dramatic. After 4 - 5 years, there is significant wall thickness loss and the

chimney becomes structurally unsafe. Figure 1 illustrates a case where the top of the chimney fell down.

## Corrosion process

It is well known that carbon steel corrodes rapidly when exposed to the hot, acidic, condensing flue gases produced in a cement plant. Where the plant is close to the coast, the corrosion can be more severe due the additional effect of the chlorides present in the atmosphere.

Even if the condensation is not continuous, the effect of



Figure 1. Part of a corroded chimney.



Figure 2. Rust scales inside a chimney.



Figure 3. The effect of chlorides in a coastal location.



Figure 4. A severely damaged chimney.

corrosion is accumulative. As the thickness of the rust layer increases, eventually corrosion flakes disbond from the metal surface and the flue gases push them out. This is often visible in the neighbourhood of a corroding chimney. Figure 2 shows these rust scales inside a chimney.

## Corrosion is becoming more severe

When there is a higher concentration of acidic compounds in the combustion gases, corrosion is accelerated. Usually there is high sulfur content in the fuel. In many cases, there is often significant chloride content in the alternative fuels as well as CO<sub>2</sub> and NO<sub>x</sub> emissions from the combustion process. Figure 3 shows the effect of chlorides in a coastal location.

Corrosion is getting worse due to the following factors:

- **Higher sulfur content in the fuel.** Fuels like petcoke and high-sulfur coal are more common because they are less expensive. The sulfur content can be in the 4 – 7% range. The combustion of this high-sulfur fuel produces much increased amounts of SO<sub>2</sub> and SO<sub>3</sub>.
- **Increase in the use of alternative fuels.** Cement plants are burning more waste fuels as a way to reduce fuel costs and in some cases as an additional source of income. In many cases, this waste is a source for additional chlorides. The combination of sulfur and chlorides tends to accelerate the corrosion of steel and also can damage stainless steel.
- **Better filtration of particles.** The new baghouse filters are more efficient and can reduce particle emissions to below 50 mg/t<sup>3</sup>. This is beneficial for the environment, but a side effect is less alkaline dust on the chimney walls and less neutralisation of the acid condensation, in other words more corrosion.

## Corrosion control methods

### Conventional protective coatings

There are many different types of corrosion protection coatings. Most of them can survive either high temperatures, aggressive chemicals or high degrees of abrasion, but is very difficult to withstand all the above at the same time.

The failure mode for most coatings is either through oxidising degradation at higher temperatures, or by blistering and delamination from the steel surface.

Oxidation damage occurs when the metal surface operates above 150 °C (300 °F). Delamination, as a result of undercut corrosion, occurs when there is coating surface damage or imperfection in the surface preparation. It usually starts as a small spot, and from there the propagation is relentless. Figure 4 shows a chimney where the coating applications did not protect it from severe damage.

### New material technology

Many cement plants complain of corrosion issues and the need for a better protection of steel chimneys, and this has led 3L&T to develop a suitable material.

The binder is an interpenetrating network made of organic and inorganic polymers. This produces a very densely cross-linked material with excellent thermal, mechanical and chemical resistance.

The formulation includes several corrosion protection mechanisms that are effective within different temperature ranges. This is necessary because of the wide temperature difference that is common from the base to the top of most

chimneys.

Additionally, the StackGard-255SQW also has a wide temperature range for the final cure, 100 - 180 °C. This is important because in most chimneys it is very difficult to heat the metal at the same temperature.

This new material is an evolution from the company's FlueGard-225SQC, which has been used successfully in many cement plants baghouses, electrostatic precipitators, ducts, fans and chimneys worldwide.

## Recent projects

3L&T has already made several major applications and is currently working on new projects in Australia, South Africa and the USA.

### Application in Indonesia

A large cement plant near Jakarta experienced severe corrosion in its kiln chimney. This chimney is 6.5 m dia x 100 m high. The top 70 m were rebuilt during January 2008 in 10 m sections and coated on the ground. Figure 5 shows the application of StackGard-255SQW on one section.

### National Cement, Lebec (CA), USA

National Cement's plant, located near Lebec, California decided to coat the whole length of its 100 m chimney using the StackGard-225SQW. This project was completed in April 2008. Figure 6 shows the application in progress.

### Cemex Andorra, Spain

Cemex is building a new cement plant in Teruel, Andorra, and decided to coat the chimney to prevent corrosion damage. The 10 m sections were coated on the ground before assembly. This approach makes the application easier, lowers the total cost and facilitates quality control of the job. Figure 7 shows the application in one section.

### Ash Grove Cement, Foreman (AR), USA

The kiln chimney at the new Ash Grove cement plant will be coated with StackGard-255SQW. The application was due to commence in March this year.

## Conclusion

Corrosion is always a fearsome and costly opponent. There are many different components to it and it is always a continuous battle to keep it under control. In cement plant chimneys, corrosion has been more aggressive in recent years. This is due to a combination of increased sulfur and chloride content in the gases, and fewer dust particles.

Many plant managers are concerned about the deteriorating condition of their chimneys and have expressed their worries to 3L&T. This growing market need has led the company to develop a new material based on the successful previous experience with the FlueGard-225SQC material. This new coating, StackGard-255SQW, can be cured and operated within a wide temperature range which is the normal case in most chimneys. The recent StackGard-255SQW applications described in this article are just the beginning. The company is pleased to be able to provide an effective solution. 🌍



Figure 5. The application of StackGuard-225SQW.



Figure 6. Application in progress.



Figure 7. Application on one section of the chimney.