Corrosion in Pollution Control Equipment

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Summary

Corrosion starts as soon as new pollution control equipment begins to operate in an acid gas application. This type of corrosion is common in kiln baghouses, alkali and chloride bypass filters and coal mill filters. It also affects ESPs in similar applications. The damage is evident, in many cases, during the first inspection after starting new equipment, as shown in Figure 1. The economic impact of corrosion damage has become a significant problem in many cement plants. Corrosion causes plant shutdowns, a waste of valuable resources, loss or contamination of product, reduction in efficiency, costly maintenance, environmental fines and can also jeopardise safety. Many users worldwide have avoided these issues using a new generation of materials that effectively prevent corrosion. After multiple applications of these materials in existing corroding baghouses, users and OEMs have concluded that the best time to stop corrosion is before it starts. This article will illustrate several major applications of these materials in new baghouses in Europe, Africa and North America.

Introduction

In order to prevent different types of corrosion damage, it is essential to understand the specific corrosion mechanism. It then becomes possible to develop a suitable protection system. The corrosion of pollution control devices in cement plants is most severe during the acidic condensation of the process gases containing moisture: SO^3, SO^2, CO^2, HCl, and NOx. The condensation can be more frequent and more aggressive depending on several variables, such as moisture concentration, inlet gas temperature, defects in the thermal insulation, leaks of cold air into the filter and low ambient temperature. When there is a large fluctuation in the gas temperature entering the baghouse, an additional complication occurs: at lower temperatures there is severe corrosion and at higher temperatures there can be thermal degradation of the corrosion protection coating.

Corrosion mechanism

Carbon steel corrodes rapidly when exposed to the high temperature, wet and acid flue gases; even stainless steel corrodes badly if the gases contain chlorides. Pollution control equipment like baghouse filters and ESPs, frequently fail due to corrosion. Associated components such as conditioning towers, ducts, fans and stacks also suffer corrosion damage. Typically, equipment operating with cleaner gases in the cooler end of the process will show accelerated corrosion damage. These areas are exposed to frequent condensation, especially when there are cold air leaks, low external temperatures, and frequent shutdowns.

Corrosion is more severe when there is a higher concentration of acidic compounds in the combustion gases. The sources are usually sulfur content in the feed or the fuel, chloride content in the feed or in air near the coast, and CO^2 and NOx from the combustion process. The acidic condensate typically has a pH value below 1.0 and contains sulfuric and sulfurous acid mostly from the sulfur in the fuel. Additional acids may also be present. This high temperature acid condensate corrodes the metal very rapidly. It is common to have thickness loss of 1 mm per year or even higher. This leads to perforated walls in four years, or less in some cases.

Figure 1. Baghouse filter compartment showing severe corrosion

Trends in cement plant corrosion

There are at least five recent trends that can increase corrosion in cement plants. Financial consultants say that past performance is not a guarantee of future results. In the corrosion field, these future results are

Figure 2. New filter plate coated with FlueGard-225SQC.

Figure 3. New ESP filter in Mérida, México, coated with FlueGard-225.

clearly worse. The trends are:

- Higher sulfur in the fuel. Fuel is a major operating cost for a cement plant; a way to reduce cost is to use cheaper fuels like petcoke. Usually the sulfur content is in the 5 - 6% range. During the combustion, this sulfur produces higher amounts of SO^2 and SO^3.
- Lower inlet temperatures. During the operation of the raw feed mill, the flue gases used to dry and preheat it have a significant drop in temperature. These cooler gases tend to condense on the walls of the filter much more frequently.
- More burning of “alternative fuels”. More cement plants are burning different types of waste as a way to reduce fuel cost and also as an additional source of income. This waste can be a source of additional sulfur and even worse, can be a significant source of chlorides. Both components tend to accelerate the corrosion of carbon steel and chlorides even attack stainless steels.
- Conversion of ESPs into baghouses. Due to the introduction of stricter environmental regulations, many ESPs are gradually being converted or replaced by baghouse filters. The clean side of the filters has more aggressive corrosion because there is less alkaline dust present to neutralise the acids.
- Better filtration of particles. The new filter cloths available are more efficient and can reduce the emissions to less than 50 mg/t^3. The cleaner gas condensate is more acidic because there are fewer alkaline particles to neutralise it.

Corrosion control

Conventional protective coatings

Many corrosion protection coatings have been developed in the past. Epoxy based coating materials can resist the effects of temperature and acid condensation to a different degree. Silicones material can resist higher temperatures. Acrylics, alkyds, or polyesters will not withstand the normal operating temperatures. The typical failure modes for all of these coatings are blistering followed by undercut corrosion and delamination from the steel surface. Additionally oxidation damage occurs when the process equipment operates above 150 °C (300 °F). Undercut corrosion, disbonding and delamination occurs when there is any coating surface damage or imperfection in the surface preparation or in the application.

New material technologies

Operation up to 225 °C

There is a new coating technology available to solve these cases of severe corrosion. It is a polymeric alloy material, suitable for continuous operation up to 225 °C (437 °F) that can handle peaks for several hours up to 260 °C (500 °F). This material, known as FlueGard-225SQC, has a tenacious bond to steel and very good resistance to hot acids and abrasion.

The first successful applications were made more than four years ago with numerous installations to date in baghouses, precipitators, fans, stacks and ducts. There are currently multiple ongoing projects in different industries like cement, oil refining, power generation, steel mills, metal smelting, lime, waste incineration, and battery recycling.

Operation up to 425 °C

A different coating has recently been developed to address the corrosion problems at very high temperatures. This new material called FlueGard-425S, is a combination of an inorganic polymer binder and several reactive inorganic fillers, two of them with particle sizes in the nanometer range. The available surface of the nano-fillers is about 1 million times larger than conventional fine particle materials. The end result is a corrosion protection coating that works up to 425 °C (617 °F) and resists exposures for several hours up to 500 °C (932 °F).

New pollution control equipment

Based on the results of these new coatings on existing equipment, several large cement companies have decided to apply these protective technologies on their new filters. When the coating job is carried out during construction the total cost is lower, the time required is shorter, the quality control is better and there is less interference with the normal plant operation. The most


Figure 4. Airless Spray of FlueGard-225SQC in South Africa.

recent cases of new filters protected with FlueGard-225SQC and FlueGard-425S are as follows:

Case studies

San Sebastián, Venezuela
For a new kiln baghouse at this cement plant , the owner specified the use of the FlueGard-225SQC material, based on the successful previous experience. The filter is presently being constructed by Scheuch and will be coated during March 2007.

Siggenthal, Switzerland
A new kiln baghouse designed by Lurgi was built and coated in sections in Turkey, and then the components were shipped to Switzerland for assembly. The Figure 2 shows one of the plates after the application of the protective coating.

Castillejo, Spain
This plant has a kiln baghouse designed and built by Defisa, a local OEM. The equipment was built and coated in Córdoba, then the components were shipped and assembled at the plant site in Castillejo, Toledo. This new filter will be commissioned in April 2007.

Mérida, México
Another new filter, this one is an ESP for the raw mill drying, was supplied by FLSmidth, Mexico, to a cement plant in Merida. Again, the sections were coated with FlueGard-225SQC on the ground and then assembled in place. Figure 3 shows the hoppers already in place. The final cure in this case, was carried out with the hot gases from the drying burner, bypassing the dryer.

Dudfield, South Africa
This cement plant decided to install a new kiln baghouse to improve the environmental performance. Based on their previous experience, they expected severe corrosion in the new equipment. They specified the application of FlueGard-225SQC on the clean gas side of a jet pulse filter manufactured by Mikropul (Pty) Limited. This project was completed towards the end of 2006. Figure 4 shows the application of the coating material using airless spray equipment.


Figure 5. Air spray application of FlueGard-425S in Ireland.

Alicante, Spain
A large cement group in Spain decided to convert the kiln ESPs in the Alicante plant into a pulse jet baghouse filter. The project was executed by FLSmidth Airtech and it was protected with FlueGard-225SQC on the clean air side. This type of project needs close coordination in the field to avoid scheduling conflicts. It is, however, much more cost and time effective than coating later as a maintenance activity.

Hermosillo, Mexico
This plant has a new kiln filter, presently under construction by CAMMSA, a local OEM company. The peak operating temperature is up to 265 °C (509 °F). Due to the high temperature, the corrosion protection coating selected was the new FlueGard-425S. The application on site was expected to start at the time of writing.

Dublin, Ireland
This plant has a new coal mill baghouse designed and built by Redecam. The plant owner was concerned about the coating resistance to high temperatures in case of an internal fire in the filter. In this case the selected corrosion protection coating was the FlueGard-425S. This material will survive temperature peaks of 600 °C (1112 °F), and additionally it will not burn. The project was completed during October 2006. Figure 5 shows the spray application of the protective coating.

Conclusion
There are effective coating materials available to prevent corrosion, but different corrosion issues in a cement plant may require different technologies to solve them. If nothing is done, corrosion will increase the future cost of maintenance, down time, and decrease plant efficiency. By recognising the short and long term economic impact of corrosion damage, one can optimise the capital investment when selecting a cost effective corrosion control solution. With a good understanding of the expected operating conditions, it is possible to implement a suitable corrosion prevention scheme. This will increase the initial capital cost, but will be far more

effective than the subsequent cost of maintenance, lost production, and extra cost to run inefficient equipment.

Whether in new plants, plant expansions, or modifications, the need for corrosion prevention in new equipment must be evaluated. Some time and money up front will save a lot of time, production, and money over the operating life of the equipment. Many cement plants and OEM companies have already concluded that the best time to protect the pollution control equipment from corrosion is during construction, before corrosion starts.