CORROSION

BY ACID GASES IN CEMENT PLANTS

LINAS MAZEIKA, 3L&T INC., USA, DISCUSSES CORROSION BY ACID GASES IN CEMENT PLANTS.

Introduction

Cement plant equipment exposed to hot and acidic gases show corrosion damage that is pervasive and costly. The severity of damage is getting worse with the increased use of high sulfur coal and alternative fuels containing chlorides. Additionally, many new plants try to improve their energy efficiency by recovering the heat of the hot and acid combustion gases, which reduces the gas temperature. At these lower temperatures there is more internal condensation and corrosion protection coatings that can perform without a high temperature cure after the application. This curing process is normally required to crosslink and bond the coating to the metal substrate. The drawback is that the high temperature cure needs additional downtime for the equipment and sometimes adds to the total installed cost.

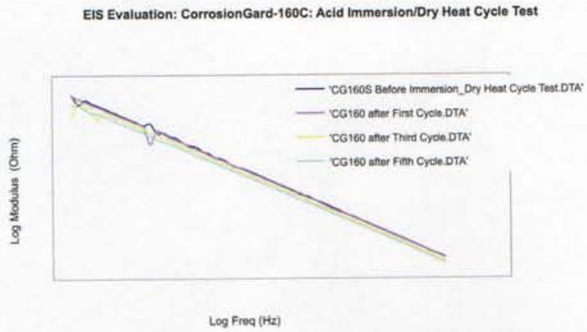

Figure 1. EIS spectra of the CorrosionGard -160S sample after immersion/dry heat cycles.

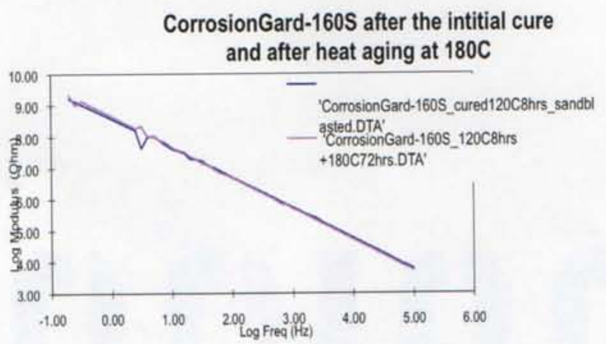

Figure 2. Thermal fatigue testing of CorrosionGard-160S.

Figure 3. Severely corroded baghouse filter after three years.

has found a new material technology that addresses the requirements of a room temperature cure coating, and which can perform at higher temperatures than most conventional corrosion protection coatings.

Additionally, this new coating has a very low surface energy, which makes it slippery, has a very strong bonding to the steel substrate and also has a tenacious resistance to undercut corrosion.

Product development

The product development process was focused on how to combine organic and inorganic materials to create a hybrid system that will maintain a good chemical resistance and mechanical strength at high temperatures. Additionally, the material was tweaked to increase thermal fatigue resistance and survive thermal shock. This new coating material was called CorrosionGard™-160S.

During the development of this new material, several accelerated tests were conducted to evaluate the different formulations. The most critical test description and results are described below.

Sulfuric acid immersion/dry heat cycle test

This test was performed to examine CorrosionGard-160S performance characteristics in an environment that is similar to the walls of a baghouse filter or a chimney. The steps for each cycle were as follows:

- 20 hours immersion in 35% sulfuric acid at 200 °F (93 °C).
- 3 hours dry heat exposure at 450 °F (233 °C).
- 2 hours cool down at room temperature.
- 3 hours dry heat at 200 °F (93 °C).

The coated panels were exposed to five full cycles. After the end of each cycle, the samples were subjected to an Electrochemical Impedance Spectroscopy (EIS) to measure the barrier properties. An EIS spectrum after several cycles is shown in Figure 1. The barrier properties show no signs of deterioration.

Thermal fatigue resistance test

CorrosionGard-160S samples were tested for thermal fatigue exposing coated steel plates to continuous heat at 180 °C during a period of three days. Samples were also cycled between ambient temperature and 180 °C with up to 1 hour excursions to 250 °C as described in ASTM D2485 standard test methods for evaluating coatings for high temperature service.

The company's new coating material passed the test without disbondment or deterioration. Electrochemical impedance also remained unchanged, as shown in Figure 2.

Field trials

One customer wanted to compare the performance of the FlueGard-225SQC material, which requires high temperature cure, with the new CorrosionGard-160S. Both materials were applied on the same steel plate and immersed for 11 months in the liquid stream of an SO_2/SO_3 gas scrubber. Table 1 summarises the test results.

	Method	FlueGard-225SQC		CorrosionGard-160S	
		Before	After	Before	After
Steel appearance in unprotected stripe	Visual	Clean shiny	Severely corroded	Clean shiny	Severely corroded
Coating thickness (average of five measurements) [mil]	Positector 6000	26	26	24	24
Pencil hardness	ASTM D3363	H	H	2H	2H
Shore D hardness	ASTM D2240	80	81	85	85
Elcometer pull-out adhesion	ASTM D2370	n/a	>1600 psi*	n/a	>1200 psi*
Log modulus at 0.1 Hz	EIS-method gamry	10 Ohm**	10 Ohm**	9.5 Ohm**	9.5 Ohm**

* Adhesive failure of the glue used to attach the tensile dolly, actual adhesion to the steel substrate is higher

** see Figure 7 for Electrochemical Impedance Spectra of FlueGard-225SQC and CorrosionGard-160S

Figure 4. Coating of lower section of a chimney in Missouri.

Figure 5. Coating of a baghouse in California.

Figure 6. Spray application of CorrosionGard-160S in Spain.

Field applications

Corrosion damage due to condensation of high acidity gases can be devastating. Figure 3 shows what is left of an alkali bypass baghouse filter after only three years in service. The filter had to be replaced with a new one.

To prevent this accelerated damage, several cement and other industrial companies are using the new CorrosionGard-160S to coat the exposed areas. Some of the recent projects using the material include a cement plant chimney in Missouri, a cement plant baghouse filter in Spain, a waste incinerator baghouse filter in France, a battery recycle plant baghouse filter in California, and a dust collector for a cement plant in Brazil.

Figure 4 shows the application in the base of a chimney that operates at less the 200 °F (93 °C). At this temperature there was heavy and continuous acid condensation with severe corrosion consequences.

The baghouse filter shown in Figure 5 was experiencing accelerated corrosion after only one year in service. During a shutdown, the walls were sandblasted and coated with CorrosionGard-160S, using an airless spray equipment. An interim inspection eight months later shows good protection.

A cement plant in Spain, based on previous experience, decided to protect a new baghouse filter before putting the equipment in service. Figure 6 shows the spray application at a contactor's shop on one of the lid covers. A recent inspection after

Figure 7. CorrosionGard-160S coating on a waste incineration baghouse in France.

Figure 8. Wall inspection after one year in service, no corrosion.

six months in operation shows the coating in excellent condition.

Internal corrosion of baghouses in waste incineration plants can be extremely severe. They do not have the benefit of alkaline dust, which in cement plants tends to neutralise the condensing acids and slow down the corrosive damage. Figure 7 shows a job in progress of the internal coating application in a baghouse that was experiencing substantial corrosion.

Figure 8 shows the condition of a baghouse wall in Brazil, coated more than a year ago with CorrosionGard-160S. The surface shows some dust and some condensation streaks but no corrosion.

Conclusion

The additional cost associated with corrosion damage in a cement plant can be considerable. This includes not only the maintenace cost but also the loss of production and the increased safety hazards. For equipments in a cement plant that operate up to 160 °C (320 °F), 3L&T has formulated an effective coating protection that has already been used by several cement plants and some other energy intensive industries with impressive results.