Innovation at Work in Corrosive Environments

Linas Mazeika, 3L&T Inc., USA, presents the company's latest anti-corrosion coating.

Summary

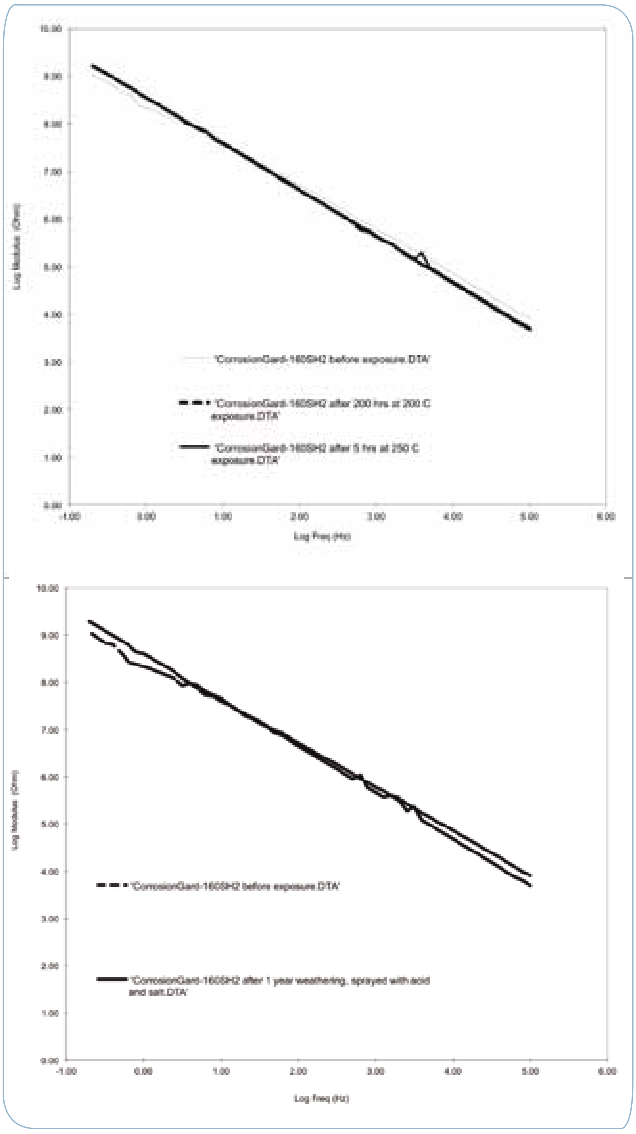
In the past, 3L&T has developed several different coatings for corrosion protection to be used in cement plants. Each one has a recommended temperature range for best performance and, typically, a maximum temperature limitation to prevent thermal degradation of the material. In the May 2011 edition of *World Cement*, the company published an article on the recently developed CorrosionGard™-160S protective coating, and this article will report the development of a material with a significantly increased resistance to brief high temperature excursions, up to 250 ºC (482 ºF), that can occur during plant operation upsets. This new, more robust material, CorrosionGard™-160SH2, can be used in ducts, fans, chimneys and baghouse filters.

Introduction

One of the main advantages of the existing CorrosionGard™-160S is that the coating cures at room temperature and does not need a high temperature cure beginning to protect the metal from corrosion. The coating can perform at temperatures up to 160 ºC (320 ºF) continuously and can resist peaks up to 200 ºC (392 ºF). This temperature range is suitable for much cement plant equipment that handles corrosive combustion gases. However, some plants have expressed concerns that under process upset conditions, gas temperatures can exceed

Figure 1. Heating to 250 ˚C for 5 hours.

Figure 2. a) EIS CorrrosionGard™ - 160SH2 after heat aging. b) EIS CorrosionGard™ - 160SH2 after long term exposure.



the 200 ºC limit of the coating, leading to a reduction of its useful life.

In its R&D lab, the company looked at different ways to increase the high temperature performance of the coating's formulation. After several trials, new additional components were found that significantly improved the resistance to thermal degradation, while allowing a strong bond to be maintained with the metal and the chemical resistance to acid gas attack. CorrosionGard™-160SH2 was born.

Research and development

The company considered several potential strategies to further increase the thermal resistance of a polymeric coating formulation. The main changes were the inclusion of novel organic and inorganic materials including nano-sized particle fillers. The final result was a combination of all of these factors.

The new formulation showed very good chemical resistance, strong bonding to the metal and outstanding high temperature resistance. The results of some of the main laboratory evaluations are summarised in Table 1.

To compare the high temperature performance, a test plate was coated with both materials and exposed to 250 ºC for 5 hours. Figure 1 shows the previous CorrosionGard™-160S severely damaged while the new CorrosionGard™-160SH2 is in perfect condition.

Long term exposure

Another performance test was conducted to expose test plates to high temperature, corrosive environments for long periods of time.

Figure 2a and 2b show the measurement of the electrochemical impedance spectra (EIS) of a coated test plate. The first measurement was taken from the new coating before high temperature exposure, the second EIS reading was taken after submitting the plate to 200 ºC for 200 hours, and a third reading was taken after 5 hours of exposure at 250 ºC. All readings are practically identical, indicating that there is no measurable degradation of the coating material. This is a confirmation of the very high resistance of the CorrosionGard-160SH2 to thermal degradation.

Another coated test plate was exposed to UV light and sprayed every other day with a salt solution and a sulfuric acid solution. This test generates an extremely aggressive corrosive environment. Again the EIS measurements on the new plate and after 1 year of exposure show no measurable difference. Figure 3 shows the test plate new, and Figure 4 shows the same plate a year later. This second test plate's coating is in perfect condition; the exposed metal is badly corroded but corrosion stops right at the edge of the coating. This highlights a unique characteristic of 3L&T's coating materials – their resistance to undercut corrosion. This is a destructive failure mode where an exposed edge starts corroding under the coating and propagates untill most of it disbonds and delaminates.

Table 1. Main properties of CorrosionGard™ 160SH2 compared to those of CorrosionGard™ 160S

Property		CorrosionGard™ 160S	CorrosionGard™ 160SH2
Colour		Dark Grey	Dark Grey
Viscosity A+B with 12% xylene 2.5 rpm, spindle #7		42 200 cP	98 200 cP
Viscosity A+B with 12% xylene 50 rpm Spindle #7		3600 cP	7000 cP
Volume ratio		2:1	3:1
Chemical resistance, immersion at RT (cured at 160 ˚C for 4 hrs)	% wt change after 1 week in 56% H_2SO_4	7.43%	2.84%
	% wt change after 4 weeks in 56% H_2SO_4	12.96%	5.42%
	% wt change after 24 hours in 37% HCl	-0.14%	-0.09%
Chemical resistance, immersion at RT (cured at RT for 1 week) % wt change after 1 week in 56% H_2SO_4		4.81%	2.51%
Chemical resistance, immersion at 75 ˚C (cured at RT for 1 week) % wt change after 14 hours in 30% H_2SO_4		7.61%	2.59%
Heat resistance (cured at RT for 1 week) exposed to 200 ˚C for 200 hours		Few hair-thick longer cracks Impedence remains the same	No deterioration or disbondment Impedence remains the same
Exposed to 250 ˚C for 5 hours		Cracked and blistered	No deterioration Impedence remains the same

Figure 3. New test plate coated with CorrosionGard™ 160SH2.

Figure 4. Exposed border corroded, no undercut disbondment.

Field applications

As explained in the introduction, this new material is aimed at severe corrosion in areas that can be exposed to high temperature excursions. A common case is in cement plant and other industrial stacks.

Figure 5 shows a severely corroded chimney in Italy. At this stage, the metal was beyond repair, the damaged section was replaced with a new construction cylinder and coated to protect from future corrosion.

Another interesting project was a new stack in Indonesia. In this case, the sections were coated on the ground and, once welded together, the weld seams were also coated with CorrosionGard-160SH2.

Baghouse filters can also fall victim to severe corrosion damage. Again, in this type of equipment, the new CorrosionGard-160SH2 can be a very cost effective way to extend the useful life of the unit. Usually, cement plant downtime is short and the repair work needs to be done under time pressure. After sandblasting, the coating is applied in one single layer and dry to touch in about 12 hours. As the coating does not need a high temperature cure to perform, the process gases during the start of the operation are enough to get the material to perform properly.

Conclusions

Corrosion damage can have short and long term economic impact on the operation of a cement plant. It is important to have a good understanding of the range of operating conditions and then implement a suitable corrosion prevention scheme. This will increase the initial costs, but it will be much more cost effective than additional maintenance, lost production, and safety hazards.

Whether in new plants or the maintenance of existing plants, the need for corrosion prevention in the exposed equipment must be evaluated. For equipment in a cement plant that operates up to 160 °C (320 °F), but experiences temperature excursions up to 250 °C, CorrosionGard™-160SH2 presents a new coating solution. This new material has already been used in stacks and coal mill baghouse filters with great results.

Figure 5. Severely corroded upper section of a stack.