

NEW LEVELS OF PROTECTION

Linas Mazeika, 3L&T Inc., USA, asks how we can protect equipment from corrosion and abrasion at very high temperatures.

Summary

Over the last several years, 3L&T has developed different materials for corrosion protection in cement plants, covering a wide range of requirements. The equipment damage can be more severe if there is not only corrosion, but also fine particle abrasion and very high temperatures.

The company's most recent material development combines a ceramic precursor with a proprietary

combination of nano size active fillers to achieve very high abrasion resistance and exceptional corrosion protection at temperatures up to 455°C (851°F).

Extensive laboratory testing was carried out to measure and certify the properties of this new material, and a field trial was completed in California with good results. Currently the company is evaluating two field applications to protect refractory anchors and gas ducts.

Introduction

Several years ago 3L&T developed a high temperature coating for corrosion protection. This material, called FlueGard™-425S, has been applied to many filters and electrostatic precipitators with very good results. The only practical limitation is that the abrasion resistance is not high enough for more demanding applications. As several customers requested a high temperature material with more resistance

to abrasion, the company looked into ceramic chemistries to achieve this. The result was the new FlueGard™-455CHT, which has a 10-times higher abrasion resistance.

Research and development

The company evaluated numerous potential ceramic components to increase the abrasion resistance of the coating while retaining the corrosion resistance at high temperatures. The main finding was that by using a combination of inorganic materials, including nano size particle fillers, it was possible to obtain the desired performance.

The new material showed very high abrasion resistance, 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.

Accelerated corrosion test

A coated test plate was exposed to UV weathering and sprayed every other day, alternating between a sodium chloride solution and a sulfuric acid solution. This test produces a very aggressive corrosive environment.

A unique characteristic of 3L&T's coating materials is their resistance to undercut corrosion. This is a destructive failure mode where an exposed edge starts corroding under the coating and propagates until most of it disbonds and delaminates. Figure 1 shows the test plate a year later: coating is in perfect condition; exposed

Table 1. Main FlueGard™-455CHT properties		
Typical properties (cured at 250°C/1 hr)		
Hardness shore D	(ASTM D2240)	>80
Abrasion resistance-taber (1kg load/1000 cycles/ CS17 wheel)	(ASTM D4060)	<0.1 g
Impact resistance (Q-panel)	(ASTM G14)	
	Front	>40lbf-in
	Back	>40 lbf-in
Elcometer adhesion (sandblasted carbon steel)	(ASTM D2370)	>1000 psi



Figure 1. Exposed border corroded, no undercut damage.



Figure 2. Test plate coated with ceramic FlueGard™-455CHT.

Table 2. Comparison of testing data before and after 8 months of exposure			
	Test method	Before exposure	After exposure
Coating colour	Visual	Red	Red
Coating appearance	Visual	Matte	Matte – no defects
Carbon steel appearance in uncoated portion of plate	Visual	Shiny metallic rough surface	Some corrosion
Coating thickness (geometric centre of the plate)	Thickness gauge	16 mm	16 mm
Carbon steel thickness – under coated/protected area		3 mm	3 mm
Carbon steel thickness – uncoated/exposed area		3 mm	3 mm
Pencil hardness	ASTM D3363	6H	6H
Shore D hardness	ASTM D2240	84	84

metal is badly corroded but corrosion stops right at the edge of the coating.

Test plate after 8+ months field exposure

The test was performed on a 6 x 6 x 1/8 in. sandblasted hot rolled steel panel. The test panel was prepared by applying FlueGard™-455CHT ceramic coating and cured according to 3L&T specifications for the product.

The sample was then hung inside the kiln baghouse compartment by the wires and exposed to the service environment for more than 8 months. The exposure temperatures were in the range 240 – 440°F (116 – 226°C) with peaks up to 560°F (293°C).

Findings

Inspection of the test plate coated with FlueGard™-455CHT ceramic material, which is rated

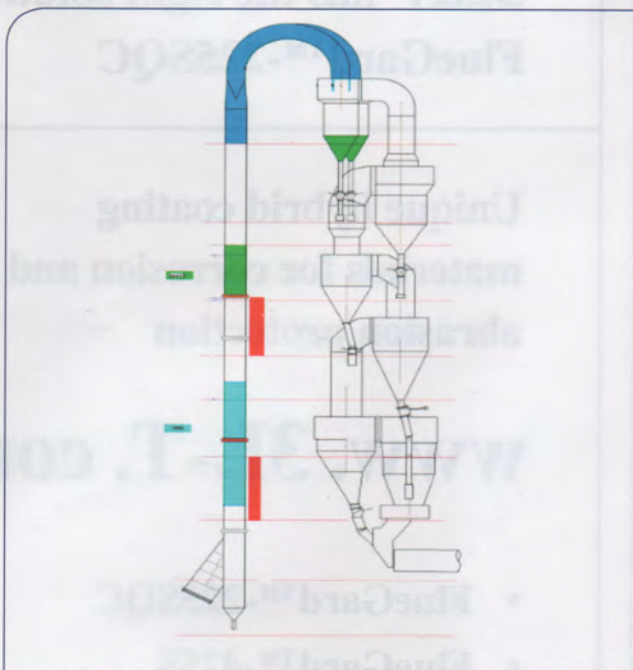


Figure 3. Coloured sections of the duct replaced in the last 2 years.



Figure 4. Replacement of damaged anchors.



Figure 5. Roofing corroded due to refractory failure.

for higher temperatures, showed no signs of coating deterioration. No defects in the coating film were detected. The coating retained its strong bonding to the steel surface. The coating thickness and hardness also remained the same. Based on these results, FlueGard™-455CHT is deemed to be well suited to the corrosion protection of the equipment in which it was tested.

New field applications

3L&T is currently working with two cement plants that have high temperature corrosion problems. One is in Peru, where the duct from the preheating tower outlet is experiencing failures after less than two years, and the other is in Mexico, where the plant needs to protect the refractory anchors from corrosion.

Figure 3 shows in different colours the sections of the preheater tower outlet duct that have been replaced recently due to internal corrosion and abrasion. The proposal is to coat with FlueGard™-455CHT the section that is replaced next and follow up the protection performance.

The other serious problem that is being evaluated with 3L&T's partner in Mexico is the protection of the refractory anchors, as shown in Figure 4.

Anchor failure can lead to severe refractory damage and corrosion of the equipment walls, as shown in Figure 5. The company recommended the application of the FlueGard™-455CHT coat on the anchors and on the inside of the shell. The ceramic material will bond to the metal and protect it from any damage whenever the refractory cracks during the plant operation.

Conclusion

Severe corrosion problems are difficult to fix. Usually they require a team effort between the company dealing with the damage, the coating developer that has the research and testing resources and often the raw materials providers, who can present new chemicals with improved characteristics.

3L&T has been on this tortuous path several times. Fortunately it has led to new and improved formulations. FlueGard™-455CHT is a recent one; others will follow.

The planned field applications will allow the company to confirm the benefits of this new material and save many plant operators from headaches and monetary losses. 🌐