Advanced Material Technologies

Commodity and Systems Management for Energy

Environmental Chemical Mineral and Metal Industries

PRODUCT BULLETIN

FURNACE MINERAL PRODUCTS solve Corrosion Problems caused by Acidic Gases

We are the Australian/NZ partner to **Furnace Mineral Products** Canada and we are introducing their innovative and high quality coating materials for all industries.

Introduction

The type of corrosion mechanism and its rate of attack depend on the nature of the atmosphere in which the corrosion takes place. The first step in preventing corrosion is to understand its specific mechanism. The second and often more difficult step is to design an affective type of protection mechanism. Successful enterprises cannot tolerate major corrosion failures, especially those involving personal injuries, fatalities, unscheduled shutdowns and environmental contamination.

Typically, once a plant or any piece of equipment is put into service, maintenance is required to keep it operating safely and efficiently. This is particularly true for ageing systems and structures, many of which may operate beyond the original design life.

For example, corrosion issues in all manufacturing plants are frequent and costly. Some have experienced more corrosion than others and some process areas can be more susceptible to its effects than others.

In general, corrosion in industrial plants occurs when process gases containing moisture, SOx, HCl, and NOx, operate at dew point temperatures. This paper will bring forth some practical methods used to prevent corrosion and technology recently developed in a manufactring plant.

Corrosion Process

Carbon steel and even stainless steel corrodes in flue gas service. Equipment like electrostatic precipitators, bag houses, cooling ducts, conditioning towers and stacks frequently break down due to corrosion.

Corrosion is worse when there is a presence of acidic compounds in the flue gas. The source will be from sulfur content in the feed or the fuel, chloride content in the feed or in air and CO_2 and NOx from combustion. The moisture content in the gas produces hot acid condensation on the steel walls, in most cases intermittent for short periods of time the cumulative impact can be up to 1.0 mm/yr, meaning less than 5 years life.

Air pollution control devices, the fans and the stack are all candidates for corrosion. Water spray cooling towers used to control temperatures, amplify the problem. Some processes have acid gas scrubbers, which are also problematic if they are not protected. In these systems, the stack would also be a problem area. In general, equipment operating in the cooler end of a cement manufacturing process is where most of the corrosion develops. These areas are sensitive to cold air in leakage, low external temperatures, and startups and shutdowns.

Advanced Material Technologies Pty Ltd | 28 Charlton Street, Mt Warrigal. NSW 2528
john.pulbrook@bigpond.com | www.advancedmaterialtechnologies.com
T: +61(0)242956915 M: +61450695691 S: johnpulbrook1

Corrosion Control

There are different ways to reduce the corrosion impact. Adjust the operating conditions, for example higher temperature to avoid condensation. This is not always possible and is a substantial waste of energy. Use different materials of construction, like the use of 316L or higher alloys which lead to 3 to 5 times the capital investment and involves the risk of stress corrosion cracking.

Traditional coatings require a surface preparation that is expensive and critical and usually have a limited useful life due to blistering and delamination.

In many cases operators attempt to maintain process gas temperatures above the dew point and or remove corrosive gas constituents. Maintaining sufficient gas temperature to avoid condensation on the equipment walls can be expensive and limited by environmental regulations. This approach does not eliminate condensation during start up and shutdown, when temperatures rise and fall through the dew point. Removing corrosive gas constituents is costly and sometimes not feasible.

1. Insulation

Proper insulation and its maintenance can sometimes solve corrosion problems. However, insulated equipment with operating gas temperatures around the dew point can still have significant corrosion. **Figure 1** shows the inside of an insulated baghouse that has experienced severe corrosion. This baghouse operates in a high sulfur environment near the dew point. The walls are corroding and scale is falling on the tube sheet along the walls.

Figure 1. Severe corrosion damage in a reverse air bag house filter

2. Corrosion Resistant Metals

Stainless steels are alloys of iron that generally have a minimum of 12% chromium. More chromium can be added to increase the corrosion resistance. Alloys containing Molybdenum have improved resistance to pitting and crevice corrosion. The addition of nickel provides resistance to reducing environments. When nickel comprises more than 25% of the metal, it improves the stress corrosion cracking resistance.

If process gas temperatures operate above 300ºC (570ºF), then these materials are frequently a solution to corrosion. Equipment, ductwork, and stacks fabricated of these alloys, however, are very expensive.

Proper understanding of process variables, raw materials, and fuels is used to determine what type of materials to use to prevent corrosion. Problems may arise when raw material, fuels, and temperatures are not as expected. Examples are alternative fuel utilization, raw material substitution, or changing to high sulfur coal or petroleum coke.

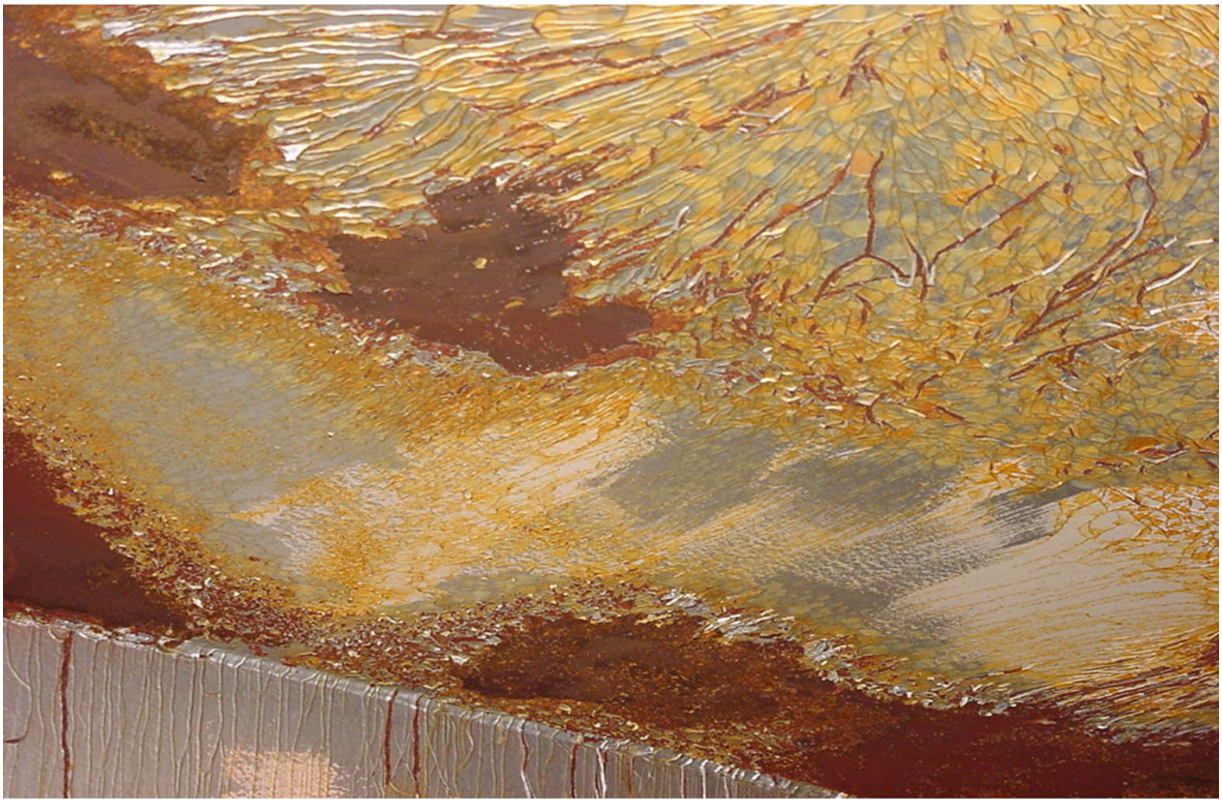

Figure 2. Catastrophic failure of a silicone high temperature coating.

3. Conventional Protective Coatings

Many coatings have been developed in the past. Epoxy and silicone coating materials can resist the effects of acid condensation to some degree. Acrylics, alkyds, or polyesters will not withstand high operating temperatures.
The failure modes for these types of coatings are oxidative degradation and delamination. Oxidation damage occurs when the process equipment operates above 150ºC (300ºF). Undercut corrosion, de-bonding and flaking happen when there is any surface damage or preparation is poor. **Figure 2** illustrates a typical failure mode of a high temperature silicone coating on a baghouse after being exposed to high temperature condensing acid.

New Material Technologies

There are new coating technologies available, one is a hybrid organic-inorganic polymeric alloy material, suitable for continuous operation up to 225ºC (437ºF) that can handle peaks for several hours up to 260ºC (500ºF). This material, manufactured and supplied by our Principal FURNACE MINERAL PRODUCTS, has tenacious bonding to steel and very good resistance to hot acids and abrasion.

Figure 3. Inspection of coated steel after 2 years in a bag house filter. No corrosion.

The first successful applications were made more than 4 years ago with numerous installations to date in baghouses, precipitators, fans, stacks and ducts. There are currently many ongoing projects in different industries like cement, oil refining, power generation, steel mills, metal smelting, lime, waste incineration, carbon black and battery recycling. Figure 3 shows the effectiveness of this corrosion protection system in a cement plant bag house filter after more than 2 years in service.
This hybrid polymeric alloy coating technology is a revolutionary solution to corrosion protection in a high temperature equipment environment. Research and development is further increasing the limits on operating temperatures. The coating can be applied during original fabrication as well as after the equipment is in operation, when actual conditions indicate excessive corrosion.

A coating application requires proper surface preparation, correct application technique, and complete high temperature curing, all performed by a qualified contractor. Figure 3 shows a baghouse coated with the new polymer alloy coating. After two years in service, there is no corrosion.

Summary

The serious consequence of corrosion processes in cement plants and other industrial plants has become a problem of worldwide significance. Corrosion causes plant shutdowns, waste of valuable resources, loss or contamination of product, reduction in efficiency, costly maintenance, expensive over design and also can jeopardize safety. Corrosion damage is expensive and is a major issue in all manufacturing plants. Many methods have been developed trying to prevent metal corrosion, most of them are not effective. This paper does focus on some major issues regarding corrosion caused by acid gases, from formation to mitigation, and finally to prevention and control.

Recent Material Development.

There is a very recent material developed to address the corrosion problems at very high temperatures. This new system is a combination of an inorganic polymer binder and two reactive inorganic fillers that have particle sizes in the nanometer range.
The available surface of these fillers is about one million times larger than conventional materials and the end result is a corrosion protection coating that works well at 425ºC and resists exposures up to 600ºC.

CONCLUSIONS

There are solutions to corrosion. Different corrosion issues in a plant may require different controls. If nothing is done, corrosion will cost in maintenance, down time, and efficiency. If the wrong solution is chosen, it will again add to maintenance cost. Recognizing the short and long term economic impact of corrosion can rationalize the capital investment when selecting a cost effective corrosion control solution. A good understanding of the operating conditions and then determining suitable corrosion prevention methods increases the capital costs, but will be far less than the subsequent maintenance, lost production, and cost to run inefficient equipment. Whether in new plants, plant expansions, or modifications, the need for corrosion prevention 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. Corrosion, when understood, can be controlled with cost effective solutions.

EXAMPLES OF FURNACE MINERAL PRODUCTS:

Ceram Clad ULX high temperature chemical and erosion resist coating, dry service temp 260C.

Green Shield MaxMohs high temperature erosion resist coating, temperature resistance to 1200C.

Blackstone HE high emissivity Coating, temperature resistance upto 850C.

RefraxXE energy enhancement refractory coating, maximum temperature rating 1550C.

INSULCORR waterborne insulation coating, maximum temperature rating 200C.

CAPSEAL AP12 Active thermal spray capillary Sealer, this low viscosity product is designed to penetrate deep into thermal spray coating to offer improved resistance to high temperature corrosion and erosion.

(Technical Data sheets are available on request.)

Advanced Material Technologies Pty Ltd | 28 Charlton Street, Mt Warrigal. NSW 2528
john.pulbrook@bigpond.com | www.advancedmaterialtechnologies.com
T: +61(0)242956915 M: +61450695691 S: johnpulbrook1