# Robust protection of environmental control systems: How vinyl ester linings can help defend against aggressive conditions experienced in FGD processes.

## Introduction

The control of sulfur dioxide emissions is increasingly a regulatory requirement in many countries, where it has been recognised as critical to reducing the impact on both human health (air pollution) and climate (when sulfur dioxide mixes with rainwater it forms corrosive “acid rain”). Coal-fired power plants have long been associated with the emission of pollutants and consequentially, methods to control these emissions had to be developed.

The Flue Gas Desulfurization (FGD) unit works to reduce the amount of sulfur dioxide emitted into the atmosphere and is a critical area in a modern power plant – its continued operation is often necessary to ensure compliance with air quality regulations. FGD design is continually evolving and there exists within the market several key types to meet individual plant’s needs.

Corrosion and temperature are major issues in FGD units due to the severe exposure conditions from a combination of hot acidic gases, as well as wet conditions found in the FGD absorber unit.

Additionally, high abrasion areas found in limestone FGD units can cause premature coating wear subsequently leading to corrosion of the underlying equipment, making this a critical area for robust corrosion protection. Expertise and experience are required to make the correct coating selection for these important areas and systems must have proven ability to withstand the tough conditions inside an FGD unit, including when the units are operated in full or partial bypass mode.

## The FGD process

There are several filtering processes the large volumes of waste gas generated in a power plant must pass through before being released into the atmosphere. The first process is the electrostatic precipitators (or fabric filters, depending on the plant design), which function to remove most of the solid particles that remain after combustion. This is typically followed by the removal of nitrogen oxide. What remains at this point is the sulfur dioxide and sulfur trioxide containing flue gases. Without an FGD unit these gasses, along with their contaminants, would be released through the stack and into the air, with harmful effects to the environment. The FGD unit is therefore positioned before the stack, so that the gases can be treated to remove the sulfur based contaminants.

The FGD process differs depending on the scrubbing method but there are several pieces of equipment which are common across all units and require corrosion protection.
**Steel ducts** are used to transfer the gases from the power plant around the FGD unit and out to the stack. Ducting is typically made of lined carbon steel and usually consists of multiple box sections (although in some cases tubular ducting is used). GRP is also used though generally in smaller diameters. The temperature and composition of the gas within the ducts will depend on where they are located in the FGD process unit, with the highest temperatures immediately following the boiler and particle removal system.

**Gas to Gas Heaters (GGH)** serve a dual role of cooling the gas exiting the boiler via the precipitator and heating the clean gas exiting the absorber. Within this equipment the hot dry flue gas enters the GGH rotating drum with alloy fins that remove heat from the gas. In some FGD processes this is achieved using a quencher instead. Once cooled to a lower temperature the gas enters the scrubber via ducting. The gas then passes through the scrubber or **absorber** where the majority of the sulfur dioxide is removed. The salts formed drop to the bottom and the saturated gas exits at the top. This cooled gas then re-enters the other side of the GGH rotating drum where it is heated by the fins (which were heated earlier by the dry gas). The resulting heat ensures that the scrubbed gas exits the stack efficiently. The construction of gas to gas heaters is very complex requiring careful surface preparation and coating installation.

**Bypass damper**. This part of the FGD unit (particularly the exhaust ducting adjacent to the bypass area) can experience highly corrosive conditions if the unit is operated in partial bypass mode, as the acid condenses when the saturated cool gas is subsequently exposed to the hot dry gas.

The **absorber** is the heart of a FGD unit and allows the absorption of sulfur dioxide with the chosen neutralising agent. This is where FGD facilities differ depending on the type of neutralising agent used to “treat” the dirty gas. The two main types are Limestone Slurry (Wet) FGD and Seawater FGD, although increasingly Dry Scrubbers are becoming more common.
Wet scrubbing uses a slurry of alkaline sorbent, usually lime solution produced from limestone, to scrub the gases. Hot gas enters the scrubber and the sulfur dioxide is removed by passing through the spray tower, where the limestone reacts with it creating gypsum. These scrubbers are considered aggressive, due to the potential for exposure to harsh flue gases, as well as the possibility of abrasion during both normal and upset conditions.

Seawater scrubbing is where a natural alkaline (the seawater) is used to absorb sulfur dioxide. The neutralising capability of seawater is much less efficient than that of limestone (although much more widely available), so the scrubbers need to be significantly larger to accommodate the large amounts of water, and as such, are often constructed in concrete. With dry scrubbing, the gas is injected into a finely atomised alkaline slurry and the acid components react to form solid salts. The heat of the flue gas is used to evaporate the water droplets leaving a non-saturated gas to exit the tower.

## Robust protection with vinyl ester linings

In this critical area of the power plant correct coating selection and provision of internal lining systems which have the ability to withstand the aggressive conditions is vital to ensuring continued operation. Due to their high chemical resistance, including against acids, vinyl ester resins are the coating of choice in this application area. The Hempaline Defend range of vinyl esters has been designed to provide robust protection across all types of FGD processes.

Throughout standard FGD equipment areas such as the ducting, vinyl ester linings such as Hempaline Defend 740 provide the necessary protection. This is a Novolac glass flake filled vinyl ester known for its chemical and temperature resistance due to the high cross-linking in its backbone. The same product would be recommended for use in the GGH, though it may be applied in several more coats in these more intricate pieces of equipment.
Where the linings requirement differ slightly is in the absorber itself. Here two key factors come into play; what is the substrate it is applied to, and is it a Limestone or Seawater FGD unit?

Limestone FGD units always use a steel absorber, and here the key issue is erosion-corrosion. As such, systems with a high dry film thickness, as well as good abrasion resistance, are recommended for this area, often trowel applied to reach the high

thicknesses. Hempaline Defend 560, which is trowelable to a high film thickness for increased abrasion and chemical resistance, would be used here. Certain parts of the absorber are also more abrasive, such as the reaction tank at the base of the absorber which is stirred or oxygenated. Additionally, the steel support beams around the spray nozzles higher up may also require this level of protection. The same linings systems are also often used in the ancillary tankage, where high amounts of abrasion are seen as the limestone slurry is produced and processed, although less abrasion resistant products may be used on the walls and roof of these tanks.

For seawater units, absorbers built of steel can be protected with a standard vinyl ester system such as that used in the ducting. For concrete absorbers, however, trowel applied systems will often be necessary. Here the key function of the coating is to prevent attack from the resulting acidic seawater which could cause the concrete to fail. However, trowel applied systems are used not only to achieve a higher thickness, but also to provide some element of crack bridging properties and filling of voids in the concrete arising from surface preparation.

For many years FGD units were protected using rubber linings. The use of organic coatings offer significant advantages, namely: -

- Monolithic linings reduce the risk of loss of adhesion and delamination
- Reduced installation times offer a positive impact on construction schedules.
- Reduced overall installation cost can improve project economics.

Dry scrubber units are more efficient and less aggressive by nature of the process. There is less demand for chemical resistant linings in these scrubbers and they can be protected with more conventional lining systems.

## Conclusion

With the increased emphasis on reducing global emissions, the FGD unit is one of the most important areas in coal-fired power plants. As such, it's critical that the unit is suitably protected to withstand the aggressive conditions that it experiences to maintain optimum performance and availability during operation, thus reducing costly environmental penalties for failing to comply with emissions legislation.

With different pieces of equipment requiring varying levels of protection and often more intricate paint systems than standard, there is even more emphasis on making the correct coating selection and choosing manufacturers with experience in this area.

The Hempel Defend range of Novolac vinyl ester and vinyl ester products provide the chemical and temperature resistance required throughout the full FGD unit, ensuring this critical area of the power plant is protected for longer.