Elessent™
MECS® TECHNOLOGIES

CASE STUDY NO. 53
DYNAWAVE®

PHOSPHATE KILN OFF-GAS CLEANING

APPLICATION

A DynaWave® scrubbing system was installed at a phosphate producer in the USA in 2001 to control emissions from their phosphate kiln. Pollutants included high levels of SO_2, very high levels of HF and particulate at a high temperature. The particulate contained highly abrasive materials including Al_2O_3 and SiO_2.

A DynaWave® system was designed with an alloy weir bowl and inlet barrel and a FRP vessel. The system has been operational since early 2002.

PROCESS PARAMETERS: QUICK FACTS	
Inlet gasflow	~165,000 Am³/h
	(97,000 acfm)
Inlet temperature	~540°C (1000°F)
Reagent	Limestone
System pressure drop	~13 kPa (52 in WC)
Inlet SO_2 concentration	~0.54% ppm v/v (5,400 ppm)
Outlet SO_2 concentration	<50 ppm v/v
Inlet HF concentration	~1.8% v/v
Outlet HF concentration	<50 ppm v/v
Inlet particulate loading	>12 g/Nm³ (5.4 gr/scf)
Particulate removal efficiency	>98%

DYNAWAVE® TECHNOLOGY

Conventional gas cleaning systems usually consist of various stages to efficiently address hot gases as well as particulate and acid gas removal. Further to this, the traditional views on wet scrubbing processes have been that gas streams with high acid gas concentrations (>0.5% v/v) cannot be scrubbed efficiently using calcium-based reagents. These applications have typically utilized sodium-based chemistry due to its higher reactivity and efficiency, but unfortunately at the expense of a higher operating cost. Another solution, dual alkali, is more complex and expensive. MECS® technologies has successfully implemented the DynaWave® technology in this application, addressing all of the above issues in a single vessel, while using limestone as the reagent.

The reason for the DynaWave® competitiveness in this application is due to:

- Cost-effective use and protection of the materials in contact with the hot gas
- Very effective gas/liquid contact is possible in a DynaWave® reverse jet scrubber
- A very high level of particulate removal is attainable
- Gas quenching, acid gas and particulate removal as well as oxidation achieved in a single vessel

In the DynaWave® system, the flue gas enters the system at the top of the inlet barrel and flows downward. The scrubbing liquid is injected upward in the inlet barrel countercurrent to the incoming flue gas. At the point that the flue gas and scrubbing liquid meet, a "froth zone" is formed. The froth zone is a very intense mass and energy transfer region. It is here that the flue gas is quenched, the acid gases are absorbed into the liquid and the particulate collides and is transferred to the liquid. Very large open-bore nozzles are used for liquid injection into the inlet barrel. These nozzles are non-plugging given the large openings and are used in applications with slurries containing 40+% solids.

Limestone is added as reagent to react with the acid gases, as per the following reactions:

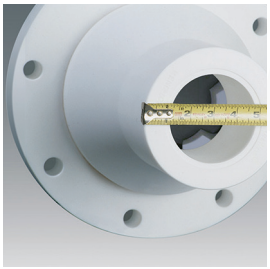
$$SO_2 + CaCO_3 \rightarrow CaSO_3 + CO_2$$
$$2HF + CaCO_3 \rightarrow CaF_2 + H_2O + CO_2$$

These reactions occur in the aqueous phase. Limestone, however, is poorly soluble in water. This means that the dissolution of limestone into the water is the rate-limiting step in the process. MECS® solves this limitation by and utilizing the unique advantages of the DynaWave® wet gas scrubber. The DynaWave® is capable of a very high rate of liquid renewal within the reaction zone of the scrubber. By utilizing this ability, the limited dissolution rate of limestone is overcome. The DynaWave® operates at a high liquid- to-gas ratio in this application, which enables it to obtain high removal efficiency in a single vessel.

This application also required that a stable effluent be produced, which necessitated the oxidation of the calcium sulfite. This was done with an in-situ oxidation system to convert the calcium sulfite to calcium sulfate according to the following reaction:

$$CaSO_3 + \tfrac{1}{2}O_2 \rightarrow CaSO_4$$

Given the presence of Al_2O_3 and SiO_2 in the particulate removed, the slurry being circulated is extremely abrasive. Erosion is minimized by proper selection of materials and the use of special linings in key areas proper selection of pumps, as well as the use of the MECS® proprietary DynaWave® reverse jet nozzles.



REVERSE JET NOZZLE

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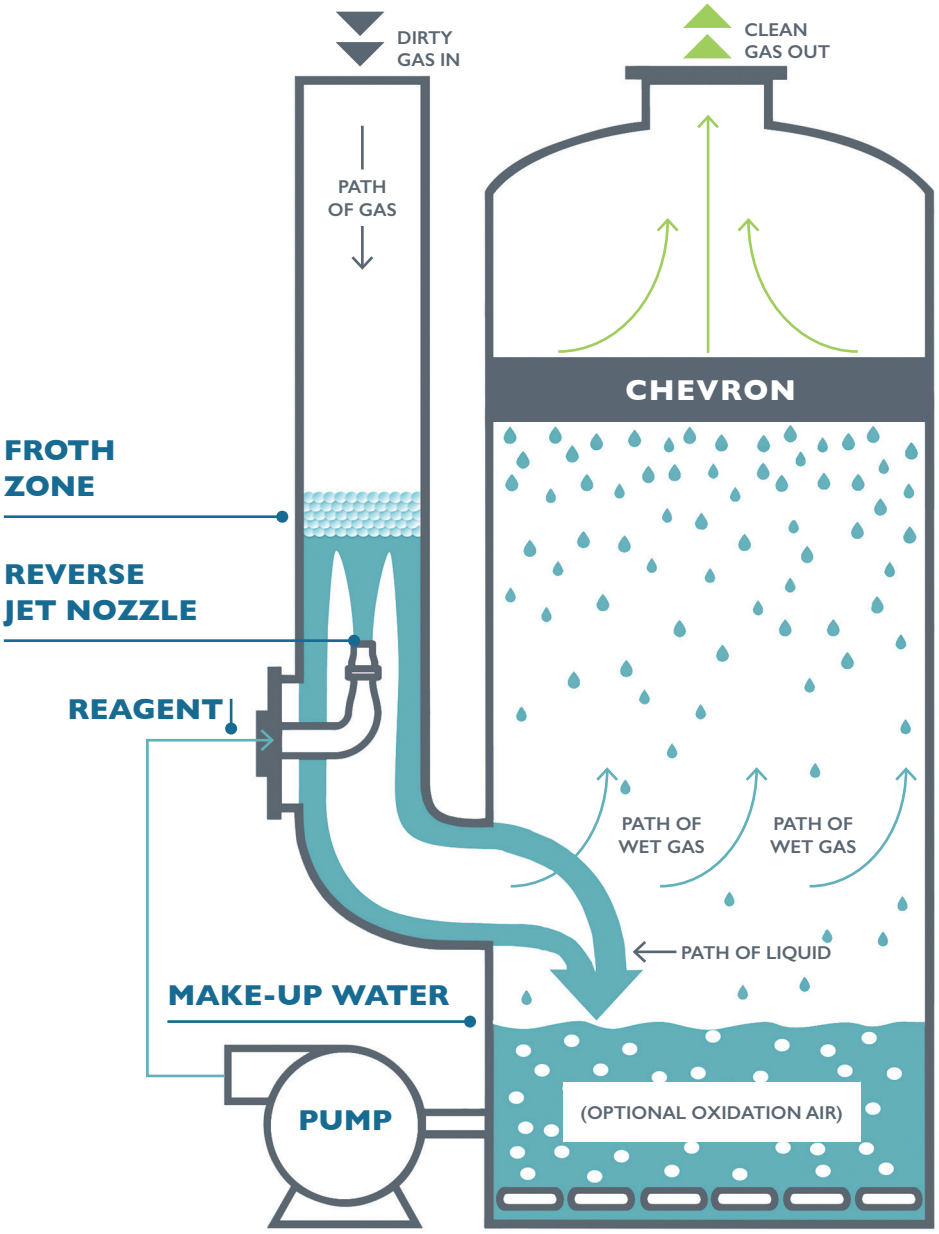
PHOSPHATE KILN OFF-GAS CLEANING

TYPICAL DYNAWAVE® REVERSE JET SCRUBBER



DYNAWAVE® ADVANTAGES

- Gas quenching, acid gas and particulate removal as well as oxidation achieved in a single vessel
- Its ability to remove pollutants in a very dirty, erosive and corrosive application
- Very high SO_2 and HF removal efficiencies obtained while using fairly unreactive reagent (limestone)
- The use of large, open nozzles, piping and vessel design which avoid plugging
- The use of specific materials to limit erosion in this highly abrasive application
- Costs and the scrubber footprint are minimized due to the multiple functions performed in a single vessel

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