

Wet Scrubbers for Dry Dust? Absolutely.

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Wet scrubbing in industrial processes sometimes can be an overlooked method for air pollution control. Whether the reasoning is reluctance to change from well-known, typical dry collection techniques, concerns over handling dirty water, or simply being unaware that the technology is available for an application, wet scrubbing is not typically at the forefront of engineers' or process personnel's list of equipment for controlling plant emissions. The purpose of this article is to highlight the benefits and potential advantages of using a wet scrubber system.

Wet scrubbers can be used for controlling exhaust from process equipment or as nuisance collectors designed to address housekeeping issues. There are many successful installations of wet scrubbers downstream of furnaces, dryers, mixers, bucket elevators, bagging stations, and other emission points. The versatile technology is not only an alternative to more traditional pollution control equipment, in some cases, wet scrubbers are the best option.

Combustible/Hazardous Dusts

For instance, if you have an application where the particulate being collected is combustible, a wet scrubber can be an ideal choice. Using water to scrub particulate from an airstream eliminates the explosion potential of the dust. There are no re-

quired design modifications needed on the scrubber, as there are with dry dust collectors. A dry collector requires special grounding for the tubesheet and filter bags, along with the use of explosion vents or chemical suppression. These safety devices require periodic inspections and preventative maintenance to ensure that they function properly if an accident occurs.

Due to several tragic and fatal events in recent years, the National Fire Protection Association (NFPA) and Occupational Safety and Health Administration (OSHA) have broadened the application and tightened the enforcement of safety measures with regard to both plant housekeeping and equipment design. The increased safety requirements have been implemented to protect workers, plants, and equipment.

Although not all explosions occur inside dust control equipment, as happened in a housekeeping-related explosion that occurred recently at a sugar refinery, dust collectors provide ideal environments for deflagration to occur. Examination of explosions shows that there are five elements necessary for an explosion to take place: fuel (combustible dust), enclosure, dispersion (dust cloud), oxygen, and an ignition source. All five of these elements must be present to have a deflagration. Baghouses and cartridge filters can create an environment that fulfills four of the requirements. The fifth one — the ignition source — could be provided by the process (spark), careless workers (cigarette), or maintenance/construction near the collector (welding or grinding spark). Dust carrying a static charge also can arc inside the dirty air chamber, causing igni-

tion. All of these situations are real and do happen. Baghouses and cartridge filters can be successfully protected by equipping them with explosion vents and suppression systems. The process and plant are protected by isolating the system ductwork with fast-action dampers or suppression to prevent the flames from moving down the inlet ductwork and back into the plant and process. Statistics show that the majority of damage to a plant is caused by secondary explosions. All of these protection devices are expensive and require ongoing maintenance and inspections that add costs to plant operating budgets.

Wet scrubbers can be a viable alternative to using a dry collector in these types of applications. Using water as the collection media, a scrubber inherently eliminates the dust cloud and explosion potential by immediately wetting the dust and saturating the airstream. There is no threat from an external (or internal) ignition source — provided that the conveying media is not a combustible gas. Therefore, a wet scrubber eliminates the requirement for explosion and isolation protection, saving capital and long-term operating costs.

The previously cited example of an industrial explosion in a sugar refinery would be an excellent example of when a wet scrubber should be considered. Other such applications where combustion concerns are present include handling metal fines, chemicals, and many organic materials.

High-Temperature Gases

High-temperature applications also can be very fitting for wet scrubbers. With a dry dust collector, you have special high-temperature construction requirements that need to be addressed during the design, as well as expensive high-temp filter bags that are very costly to replace. With a wet scrubber, the standard designs can handle the high temperatures of the process without any special design considerations or expensive replacement parts.

In many of today's processes, extremely high temperatures are required. Baghouses and cartridge filters — generally designed for lower temperatures — can be designed for temperatures up to 550°F using filter media such as fiberglass or PTFE. Ceramic or stainless steel media can push operating temperature over 700°F, but they are extremely

expensive. Decreasing inlet temperatures can be accomplished by dilution (adding ambient air), radiant cooling, or water sprays. All of these methods dramatically add to baghouse system costs, and, in the case of using water to reduce the temperature, expensive controls are required to make sure an excess amount of moisture does not find its way to the collector.

An alternative approach would be a wet scrubber. Because adding water into the system does not affect scrubber operation, quench systems can be employed prior to the inlet to the scrubber. A scrubber that includes a pre-quench section is capable of handling temperatures in excess of 2,000°F. While these quench systems add to the cost of equipment, the reduction in air volume reduces scrubber size, and there is no concern about moisture carryover into the unit.

Examples where scrubber technology has been successfully implemented would be furnaces, kilns, and incinerators.

Moisture in the Gas Stream

If your process has a moisture content in the gas stream that would foul or plug a dry dust collector, a wet scrubber could handle these difficult conditions without any issues. Since the scrubber uses water to saturate the gas stream for particulate removal, the moist process gas is easily introduced into the scrubber. These same gas stream conditions in a dry dust collector can result in severe caking on filter bags, plugging of discharge equipment, high differential pressures, and frequent filter changes and maintenance attention.

Dryers, kilns, and other process equipment are designed to drive off moisture from the product. The result is that the air or gas used in the process picks up this moisture and carries it to the dust collector. Baghouses and cartridge filters are popular collection devices for these applications but bring with them potential problems with moisture. Even wet compressed air, the method for pulse cleaning bags and cartridges, can cause operating problems by adding unwanted moisture, causing operating and maintenance issues with pulse valves, solenoid valves, and filter media. Moisture issues are difficult to overcome with special media, which can be expensive and may only offer temporary

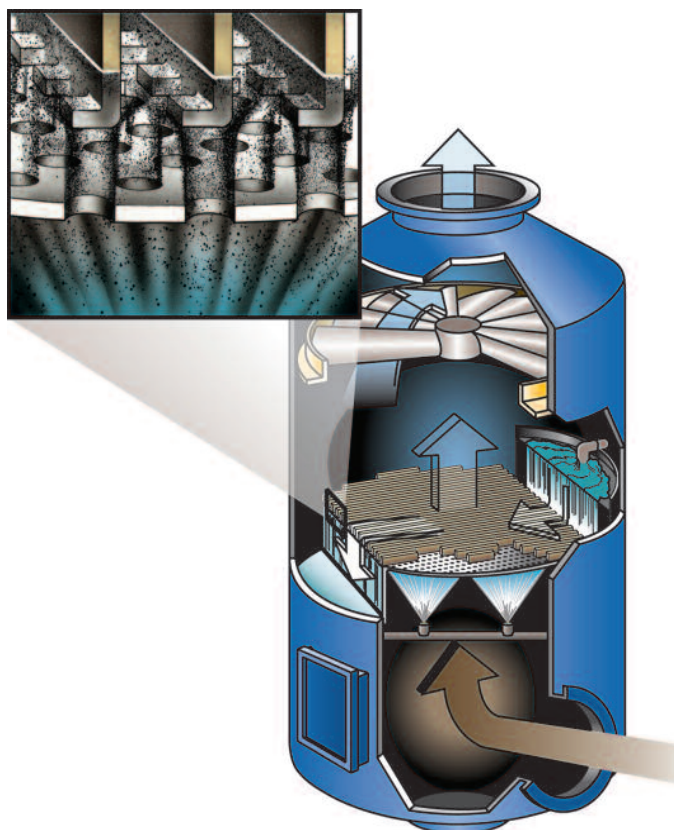
fixes. Many installations will require insulating the collector and, at times, the addition of auxiliary heat to control condensation during startup and shutdown of the process.

Wet scrubbers are not affected by moist or wet air and require no compressed air, insulation, or auxiliary heat. No filter media means no expensive bag change-outs and no unscheduled down time.

Particulate and Gaseous Contaminants

Wet scrubbers are a logical choice for applications that have both particulate and gaseous emissions to be removed from the airstream before it vents to atmosphere. With a dry dust collector, gaseous emissions cannot be addressed as it will only collect the solid particulate. There would need to be a secondary piece of equipment, such as a scrubber or RTO, installed to remove the gases. Wet scrubbers can collect the solids, as well as scrub the gaseous components from the airstream all in one piece of equipment.

Impingement Plate Scrubber



Airflow is drawn into scrubber and passes through plate water, which traps contaminants. These designs are suitable for applications that require collection of both particulate and gaseous contaminants.

For example, a process that produces solid particulate and contains HCl in the airstream can easily be filtered within a scrubber system. The water will collect the solid particulate through inertial impaction and interception. By adding a caustic solution (such as sodium hydroxide) to the water stream, the HCl will be scrubbed from the gas stream and converted to NaCl (sodium chloride) in the recirculated water. With the particulate and the harmful gas removed from the airstream, the scrubber exhaust now can vent to atmosphere. And since the scrubber solution is nonhazardous, dealing with the wastewater can be easily managed.

Financial Advantages of Wet Scrubbers

Besides addressing aggressive process-related environments, wet scrubbers can provide financial relief as well. In many cases, a wet scrubber has a lower initial capital cost, better energy savings, lower maintenance costs, and no replacement filter bags / media to account for. Wet scrubbers are fairly simple in their design and do not have any internal moving parts.



Impingement plate scrubbers collect particulate and absorb vapors and gases. High collection efficiencies (99+ percent) can be achieved with low water consumption and minimum pressure drop.

Chart 1 shows the comparison of a typical 10,000 cfm, low energy scrubber and dust collector. Note that even excluding the added cost of replacement filter bags for a baghouse, a scrubber can be less expensive to purchase and operate.

Typical Wet Scrubber Designs and Applications

There are various designs of wet scrubber technology available today, developed to meet a wide range of collection needs, process conditions, and

emission requirements. Impingement plate (or tray) scrubbers use a flowing bed of water across a perforated surface. The airflow is drawn into the scrubber and passes through the plate water. The water traps the contaminants, removing them from the airstream. Impingement plate systems typically use lower energy / lower pressure drop to scrub the gas and can have efficiencies of 99 percent for particles of 5 microns and larger. Impingement scrubbers are suitable for particulate scrubbing and applications where particulate and gaseous contaminants need to be collected.

For high-efficiency collection of fine particulate, venturi scrubbers with cyclonic separators are typically a better selection. The venturi scrubber design has a higher water usage rate and requires higher pressure drop to remove particulate. The converging section of the venturi throat (where the water and airstream merge), however, creates atomized water droplets to provide efficiencies of 99 percent on particles 1 micron in size and larger. The efficiency can increase to 99.8 percent for particles 5 microns and larger.

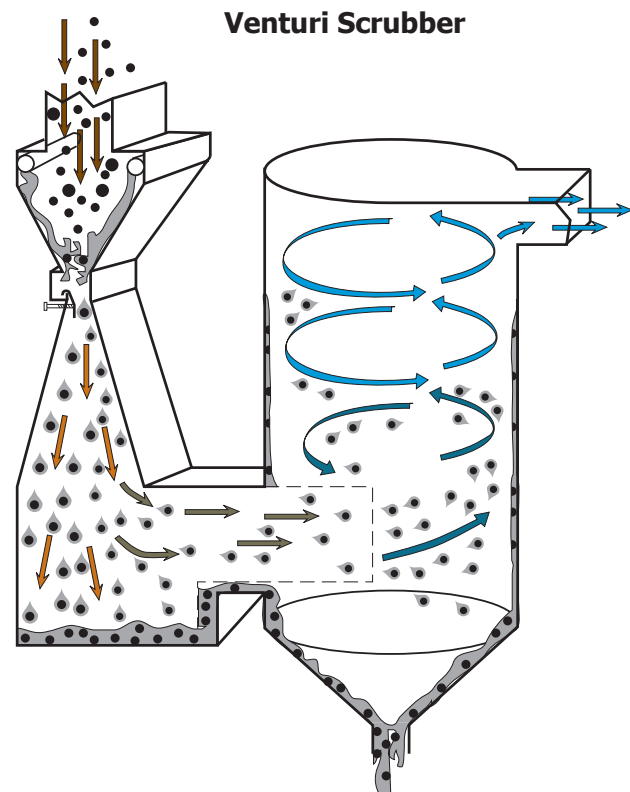
If an application has a gaseous contaminant with a very low particulate concentration in the gas stream, a packed tower typically is selected due to its longer residence time (contact time) between the gas and scrubbing liquid. A packed tower is a

Chart 1

Cost/Energy Comparison, 10,000 CFM

| Cost/Energy Comparison 10,000 CFM | | |
|--|--------------------------|-------------------|
| Type of Device | Baghouse | Scrubber |
| Operating Parameter | 5.5:1 air-to-cloth ratio | Single stage |
| Filter Media | Polyester bags | Impingement plate |
| Base Cost | \$ 29,660 | \$ 24,700 |
| Exhaust Fan Electrical Cost Per Year/HP | *\$ 4,598/30 | *\$ 3,814/25 |
| Pump Electrical Cost per Year/HP | _____ | *\$ 695/5 |
| Compressed Air Electrical Cost per Year/HP | *\$ 1,112/7.5 | _____ |
| Delta P | 6" wg | 4" wg |
| Total Initial & First Year Cost | \$ 35,370 | \$ 29,209 |

* Based on electrical cost of \$ 0.095/kW-hr



Venturi scrubbers provide high-efficiency collection of fine particulate. Venturi is coupled with a cyclonic separator, which provides non-clogging mist elimination.



Venturi scrubbers offer more advantages in separating and recovering ultra-fine particulate and liquid mists than other gas-cleaning methods.

tall column that encloses a bed of packing material to achieve mass transfer for chemical absorption applications. The systems offer relatively high removal efficiencies of harmful gases at low pressure drops but require airstreams with very low solids loading. Airstreams containing high particulate concentrations can plug the packing medium, resulting in reduced performance and high pressure drop.

Handling Scrubber Wastewater

One of the biggest concerns people have with using a wet scrubber for their dust collection requirements is handling the wastewater after the contaminant has been removed from the gas stream. In many cases, scrubber systems will recirculate water so that the only wastewater to deal with is a small amount of blowdown or overflow. (Blowdown or overflow is needed to keep the overall solids concentration in the recirculated water low enough to continue scrubbing the incoming process air.) Some companies already have a method for disposing of wastewater so it is not a major concern. Others may be able to “bleed in” the wastewater to an existing process without issue. Handling the wastewater is an issue to be addressed, but the potential long-term benefits of a wet scrubber system should not be dismissed without thoroughly investigating a solution.

In closing, a wet scrubber system can pose many advantages over dry dust collection systems depending on the process conditions and project requirements. For future dust control projects, evaluate if a wet scrubber will work for the application — it could end up being the best overall solution. **APC**

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