Newsfront

CONTROLLING AIR POLLUTANTS

While it's not always easy to determine what's required for compliance, new technologies can help achieve air-pollution control

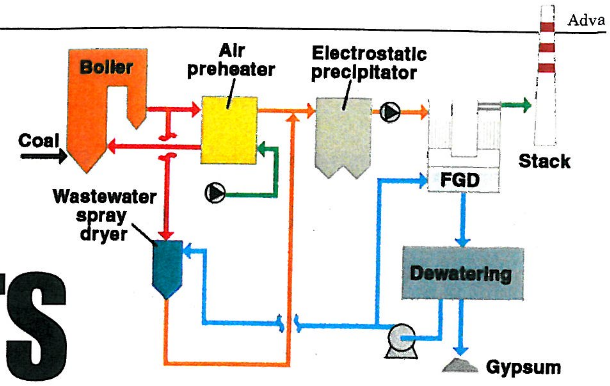


FIGURE 1. Because liquid discharge from wet fluegas desulfurization (WFGD) is of increasing concern for many plants, Advatech offers a wastewater spray dryer as an economical means of achieving zero liquid discharge from wet FGD processes at coal-fired power plants

Selecting air-pollution control equipment can be tricky. It's not only difficult to determine which pollutants must be controlled, but also which type of equipment will best control them to required levels for any given process or facility because there is no "one-size-fits-all" solution. Technologies that successfully control pollutants in one facility may not work as well in another. Permissible levels in one region sometimes differ from those in another. A similar process may result in different types or levels of pollutants from one plant to the next.

Fortunately, it is possible to solve this puzzle. Experts suggest determining which regulations apply to your facility's pollutants and region; learning about your particular process and the resulting types of pollutants; and, finally, looking, in detail, at the available technologies to figure out which one or which combination will provide the best solution for your worst-case pollution scenario.

Regulations to watch

Regulations concerning mercury, oxides of nitrogen (NOx) and sulfur (SOx), acid gases and particulate matter emissions are of the biggest concern to power plants and some chemical and industrial processors. There are several new or anticipated regulations concerning these pollutants that affected processors need to keep an eye on:

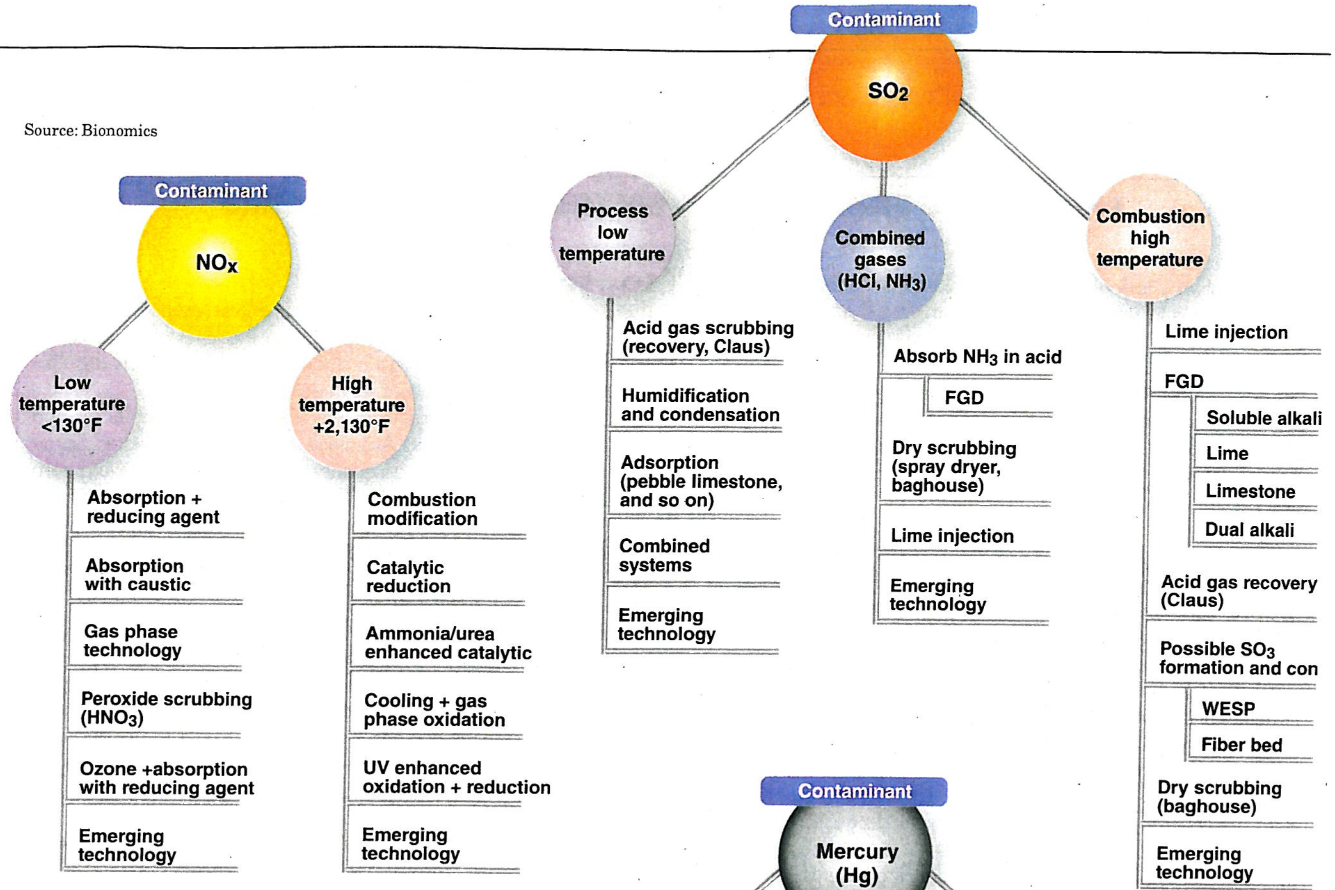
MATS. Revised twice and finalized on March 28, 2013, the U.S. Environmental Protection Agency's (EPA; Washington, D.C.; www.epa.gov) Mercury and Air Toxics Standard (MATS) created updates of emission limits for mercury, particulate matter, SO_2, acid gases and certain individual metals for new power plants. Additionally, certain monitoring and testing requirements that apply to new sources were adjusted. "Two things to know about MATS are that the particulates covered are not what many of us consider 'particulates,'" says Robert Hilton, vice president, power technologies for government affairs with Alstom (Knoxville, Tenn.; www.alstom.com). "They are actually aerosols that are classified by EPA as particulate. The other important thing to know is that the revised standards affect only new coal- and oil-fired power plants that will be built in the future. The update does not change the final emission limits or other requirements for existing power plants."

Interstate Air Pollution Transport. As part of the Clean Air Act (CAA), this "good neighbor" provision requires the EPA, states and processors to address interstate transport of air pollution that affects downwind states' ability to attain and maintain National Ambient Air Quality Standards. Emissions of SO_2 and NOx can react in the atmosphere to form fine-particle ($PM_{2.5}$) pollution. Similarly, NOx emissions can react in the atmosphere to create ground-level ozone pollution. The transport of these pollutants across state borders makes it difficult for downwind states to meet health-based air quality standards for $PM_{2.5}$ and ozone. Recently, EPA set dates and locations for meeting with states to discuss regulations regarding air-pollution transport. "What makes compliance with this difficult is that the ruling is technically in limbo," says Hilton. "And this makes it harder to figure out how to control these pollutants, as well as the pollutants regulated by MATS. A lot of what generators need to do to be in compliance with MATS will cover SO_2, which will also be covered by the Interstate Air Pollution Transport rule."

CAA and National Ambient Air Quality Standards. Under the CAA, EPA is required to set National Ambient Air Quality Standards for six common air pollutants and then review those standards every five to six years to determine if the technology to further lower the permissible limits exists and, if so, whether it is actually feasible to achieve these lower levels. "This is expected to happen this year and it is presumed that EPA will attempt to lower acceptable NOx levels," says Hilton. "If this happens, it likely will be further out, in a sequenced implementation plan, with a NOx compliance deadline in the timeframe of 2017 to 2019." Until then, processors in the 23 eastern states must comply with NOx levels currently set by the Clean Air Interstate Rule (CAIR), and the remaining western states must comply with NOx levels currently set by the CAA and regional haze rules.

So how do processors know which regulations impact their facility? "You have to look at all the rules, look at your plant, look at the fuel you burn and where you are located, because

Source: Bionomics



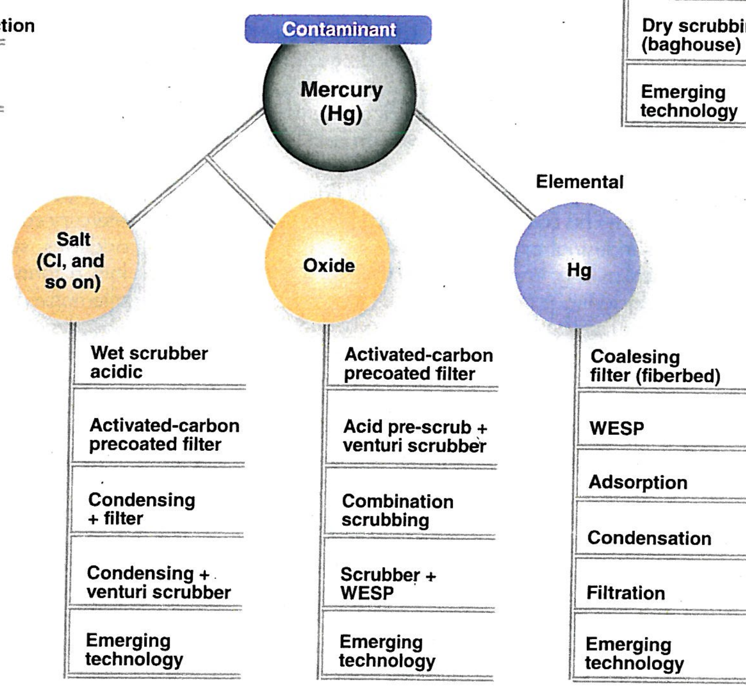


FIGURE 2. Decision trees for controlling a particular air pollutant can help identify the best possible solution for a given plant

some regulations are federal and some are state," says Hilton. "You have to work with both state and federal agencies to find out which regulations your facility is subjected to and which of those are the most applicable and important for your plant and location to obtain the permits it needs to operate. In most cases you have to meet the stricter of the guidelines to be in compliance."

One size does not fit all

"What makes compliance even more challenging is that what might work at one plant, won't necessarily work in another," says Scott Miller, director of engineering technology with Advatech LLC (Austin, Tex.; www.advatechllc.com), a joint venture of URS (San Francisco, Calif.) & MHIA Co. (New York, N.Y.). "Whoever is proposing air-pollution-control technologies needs to be familiar with the plant to maximize total pollution control, from fuel to stack."

Miller suggests first knowing the current emissions. "For example, when looking at mercury, not only is it important to know the total mercury emissions, but also what percentage is in oxidized form, elemental form and particulate form. It's also valuable to know what the speciation is all the way through the back end of the plant, such as at the outlet of the economizer and downstream of the SCR [selective catalytic reduction]."

Understanding the balance of the plant and the impact of each technology being evaluated is also helpful, suggests Miller. For example, to comply with some regulations for mercury and acid gases, many facilities are looking at dry sorbent injection upstream of a particulate control device. It might be possible to achieve regulatory compliance for capture through those technologies, but, as a result, the amount of reagent they have to use could detrimentally impact particulate matter emissions, he explains. Along these lines, disposal must also be considered, Miller urges. For instance, wastewater discharge requirements are expected to be tightened in the near future, which may force emit-

EMBRACING EXISTING AND EMERGING TECHNOLOGIES

The best way to look at the available air-pollution-control technologies is to start with the pollutant.

Particulate matter

For particulates, the commonly used technology is dry electrostatic precipitators. Alternatives to this technology include either low- or high-ratio fabric filters, which will capture finer particulate matter than electrostatic precipitators, but tend to have higher operating and capital costs.

NOx

Most facilities start with low-NOx burners, which are designed to combust coal while starving it of oxygen so that less nitrogen is converted into NOx. Typically, burners alone are not enough, so many facilities add selective catalytic reduction or selective non-catalytic reduction technology.

There have been advances in NOx technology as well. The BioNOxSolver NOx-scrubbing solution (Figure 4) from Bionomic Industries simplifies wet-scrubbing system operation and reduces scrubber system complexity and cost. Low-toxicity BioNOxSolver does not liberate flammable hydrogen sulfide gas at pH use conditions as is typical in NOx sulfide/caustic control chemistries, yet its formulation of nitrogen dioxide reducing agents can achieve over 33% greater removal efficiency with an addition to caustic, says the company.

Robert Richardson, president of Know-NOx (Reno, Nev.; www.know-nox.biz), says his company is offering a unique NOx removal technology for industrial applications, such as: exhaust gas treatment in chemical milling; brightening and pickling of metals; chemical and manufacturing processes that use nitric acid; and cooled stationary-source combustion process fluegas and tail gas from plants; and other sources of waste gas containing NOx.

The process uses a single- or double-scrubbing stage (depending on client requirements) with less than 1.5 s of residence time (treatment time within the scrubber) to treat more than 99% of the NOx (both NO and NO_2) in an ambient-temperature gas stream. Because of the very fast reaction time, the process removal efficiency is tunable to appropriately meet users' compliance requirements and also provide an optimized cost of operation. This process, which uses chlorine dioxide gas in a new way, is less expensive to install and operate than currently available industrial technologies for NOx treatment, according to Richardson. "The single- or two-stage process has the ability to produce higher removal efficiency than can be obtained from conventional two-, three- and six-stage scrubbing systems, using a smaller equipment footprint," he says. "The reason we can reach greater than 99% for both NO and NO_2 is because we can cost effectively increase residence time. The technology removes more NOx in 1.5 s than conventional wet scrubbing technology can do in 5 to 120 s of residence time."

SO_2, SO_3 and acid gases

These pollutants have the largest fleet of control technologies available. What is used typically depends on the level of removal required, but typical equipment includes wet or dry fluegas desulfurization (FGD) or, possibly, duct-injection processes.

Because liquid discharge from wet FGD (WFGD) is of increasing concern for many plants, Advatech offers a Wastewater Spray Dryer (WSD; Figure 1) as an economical means of achieving zero liquid discharge (ZLD) from WFGD processes at coal-fired power plants. The WSD makes use of waste heat in the fluegas to completely evaporate the purge stream from the WFGD process. The WSD consists of a spray dryer installed in a small slipstream that bypasses the air heater. The differential pressure across the air heater provides the motive force for the fluegas, so in most cases, a fan is not needed. The liquid purge from the WFGD process (in the form of filtrate) is added to the spray dryer through either dual-fluid nozzles or a rotary atomizer. The chlorides and other dissolved substances present in the purge stream form solid particulate in the WSD, which are then removed from the fluegas, along with the fly ash, in the existing particulate-control device. By retaining the ability to purge chlorides from the WFGD, the process can be controlled to chloride levels for which materials of construction are more compatible, and process performance is maximized.

Mercury

Mercury can often be controlled via pre-combustion or combustion additives, such as bromine injections, which change the mercury into a form that is more easily captured in a wet scrubber. An alternative to this technology is activated carbon, which captures, absorbs and holds the mercury until it is collected in a particulate device (as opposed to a scrubber).

However, circulating dry scrubbers are becoming a popular technology in this area because they are effective at collecting mercury, as well as acid gases and aerosols or very fine particulates, says Hilton. "These dry scubbers are often considered multi-pollutant devices."

Alstom's solution in this area is the NID system, comprised of a hydrator/mixer, J-duct reactor and, typically, a fabric filter. The NID can be used with electrostatic precipitators, as well. In the J-duct reactor vessel, SOx, acid gases and mercury react with quick or hydrated lime under humid conditions. Once bound to the particulate matter, the gaseous pollutants are removed from the fluegas in a downstream particulate collection device. The collected particulates are recycled to the mixer where fresh lime and water are added to the process. The inclusion of the integrated hydrator/mixer eliminates the need for slurry handling, simplifying the operations, maintenance and power requirements of the process. The high rates of sorbent recycling also contribute to the low cost and high efficiency of the NID process. ❑

ters to use zero-liquid discharge technologies or install expensive wastewater-treatment processes.

"Based on all these considerations and different processes at each facility, it is just not possible to buy an item off the shelf and have the problem go away," says Ken Schifftner technical director with Bionomic Industries Inc. (Mahwah, N.J.; www.bionomicind.com). Instead, he suggests using a "decision tree" to determine the best possible solution. (Figure 2).

"The 'decision tree' should start with the contaminant," he says. "In the case of NOx, the contaminant may be emitted at high temperature (favoring insoluble NO) or low temperature (favoring soluble NO_2, N_2O_4 and so on), or the gas mixture could contain a variety of NOx species. We usually start with a request for an NO-to-NO_2 ratio test report. Based on this information, there are a variety of possible

Bionomic Industries

FIGURE 4. The BioNOxSolver NOx scrubbing solution from Bionomic Industries simplifies wet-scrubbing system operation and reduces scrubber system complexity and cost

technologies to apply." (The logic tree lists just a few.)

A similar process should occur for SO_2, says Schifftner. The emission could come from a process or be combined with other gases or from combustions. "We usually start with a questionnaire that helps define the emission source," he says. In the case of a process-emission source, perhaps wet scrubbing with caustic can be used. If the SO_2 must be recovered, humidification (or scrubbing with sulfuric acid) can be applied. If the SO_2 concentration is low, sometimes humidifying then passing the gases through a bed of pebble lime or limestone can be used. Sometimes lime or limestone is injected into the ductwork (or even into the boiler) to control SO_2. If ammonia is also present, the ammonia is removed first. If the source is from combustion, various proven FGD technologies are available. If SO_3 (aerosol forms), the problem shifts from gas absorption to aerosol capture, thus a fiberbed or wet electrostatic precipitator (WESP) is often used.

"For mercury, it can get complicated," warns Schifftner. "We start by determining the state of the mercury as it leaves the source." If the mercury is elemental and at high concentration, the mercury could possibly be condensed and recovered. Perhaps it could be adsorbed onto carbon or a zeolite. If the mercury leaves the process as a salt (usually a chloride), it is often possible to use wet scrubbing, since the salt is soluble. At times, gas cooling followed by scrubbing is used. If the mercury is emitted as an oxide, to use wet scrubbing, usually conversion to a soluble salt is required. This is done by using an acidic first stage. That stage may be followed by a venturi scrubber and possibly a WESP. If the mercury comes from a combustion source, the mercury is usually in the form of an oxide and an activated-carbon precoated baghouse might be appropriate. If the mercury arrives along with SO_2 or HCl, the

PULLING IT ALL TOGETHER

While it may seem like a lot of disparate technologies are available, most can and do work together to reduce multiple pollutants and keep facilities in total compliance. Consol Energy Inc. Research & Development (Pittsburgh, Pa.; www.consolresearch.com) leads teams that work in conjunction with power plants and power companies to install and test pollution control systems to determine whether it is possible and feasible to be in compliance using a variety of technologies.

One example includes the Greenidge Multi-Pollutant Control Project. Consol worked with AES Greenidge LLC (Dresden, N.Y.; www.aes.com) and Babcock Power Environmental (Worcester, Mass.; www.babcockpower.com) to install and test an integrated multi-pollutant control system on one of the nation's smaller existing coal-fired power plants — the 107-MW_e AES Greenidge Unit 4.

The multi-pollutant control system included a hybrid selective non-catalytic reduction/selective-catalytic reduction system and a circulating fluidized-bed dry scrubbing system. The overall goal of the 2.5-yr project, which was conducted as part of the U.S. Department of Energy's Power Plant Improvement Initiative, was to demonstrate that this multi-pollutant control system could cost-effectively reduce emissions of NOx, SO_2, mercury, acid gases and particulate matter from coal-fired electric generating units.

Performance testing data collected during the project showed average removal efficiencies of 96% for SO_2, 95% for SO_3, 97% for HCl and 98% for mercury. NOx emissions were reduced by more than 50% and particulate-matter emissions were reduced by more than 98% relative to the emission rates achieved prior to installation of the technology.

Other examples of control technologies at work can be seen on Consol Energy Inc. Research & Development's website at www.consolresearch.com/pollution/pollution-control.html. ❑

baghouse precoat may include lime or limestone.

The codes basically dictate not only the technology, but also how many stages are used, says Bionomic's Schifftner. For example, years ago, a hazardous-waste incinerator may have used a quencher, venturi scrubber and absorber to meet codes. Now, it may need a WESP on the end to control that very small amount of residual particles. If mercury is present, the quencher may be run highly acidic (to convert the Hg to chloride), then the venturi, the absorber and the WESP are used.

"No one ever bought these products because they wanted to," says Hilton. "It's a get-out-of-jail-free card and a difficult one to obtain at that. But at the end of the day, it is possible to meet the regulatory requirements for air-pollution control if you employ the right equipment." ■

Joy LePree