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Lechler VarioCool gas conditioning systems

All of these points underscore the importance of an effective cooling system to support efficient particulate control. These two working together form the core for controlling almost all the pollutants in the new standards. A water spray gas conditioning system can help prevent the formation of toxic gasses, support the use of carbon injection and provide a platform for SO_x abatement. These together are a major step in coming into compliance with the new regulations.

Lechler's VarioCool product line offers a wide range of gas conditioning options, with a breadth of choices unequalled in the industry. These ensure that your system will be designed for the best and most cost effective performance.

Designing a system begins by analyzing your situation:

- Do you already have a system that can be improved?

- Do you need more than one for various stages of production: Main kiln? Clinker cooler? Bypass tower?
- What are the temperatures and gas volumes involved in your process?
- How high is dust loading?
- Are there points where dust tends to accumulate?
- Are there towers or ducts adequate to the task?
- Does your tower and supporting ductwork provide uniform gas flow without turbulences?
- What is the most economical approach given your specific plant's needs?
- Is cooling alone enough, or is chemical injection required for SO_x control?

From there we use our analysis and modeling methods to configure the optimum setup for your installation. This can include air atomizing or hydraulic cooling nozzles with the required support and control equipment, ready to install and interface with your plant operation system.

Lechler has the largest selection of nozzles and control mechanisms from which to draw when designing your specific system. We have built systems around the world that include everything from a single nozzle lance to a complete cooling system with controls as a turn-key installation. From one extreme to the other and everything in between, Lechler can design your specific system. This is a major step to environmental compliance.

Contact us by email:
CementInfo@LechlerUSA.com

www.Lechler.com



Lechler Inc.
445 Kautz Road
St. Charles, IL 60174

1-800-777-2926
Fax 1-800-444-7069



Lechler Gas Conditioning systems: Key to Compliance with the New EPA NESHAP

It's time to take a good look at your pollution control system with new tighter EPA regulations on the way. A good place to start is by checking your gas cooling and particulate removal systems. Performance here will be more critical than ever with new particulate and toxic gas limits.

Gas conditioning systems have always been beneficial for many reasons:

- Reducing gas temperature also reduces volume resulting in less work for the ID fan, lower velocity in ducts and less volume through the bag house.
- ESP's can run at higher power levels due to reduced dust resistivity for more effective particle collection.
- Bag houses can use less expensive low temperature bags.
- Spray cooling can quench large volumes of gas quickly to allow higher production levels with the same gas handling equipment.

Additionally, as the scope of regulation grows to include additional classes of pollutants, gas conditioning with water sprays offers a critical weapon in the arsenal against toxic gasses.

In 1999, the EPA finalized and promulgated two new

NESHAP's (National Emission Standards for Hazardous Air Pollutants) that put an additional mandate on the cement industry to reduce toxic gasses and heavy metals along with particulates. Over the next few short years, cement kiln operators will be required to monitor and reduce a larger group of pollutants.

The two standards in question are:

- **National Emission Standards for Hazardous Air Pollutants for Source Categories; Portland Cement Manufacturing Industry**
- **Revised Standards for Hazardous Waste Combustors**

The first covers non-hazardous waste kiln operators and the second a broader category of waste incinerators, including cement kilns that burn hazardous wastes. Between the two, the entire portland cement industry is covered. You can find the full text of both of these on the EPA's web site: www.epa.gov.

What, in general, do the standards require?

As expected, there are tighter requirements for particulate emissions including toxic metals. Mercury is in the

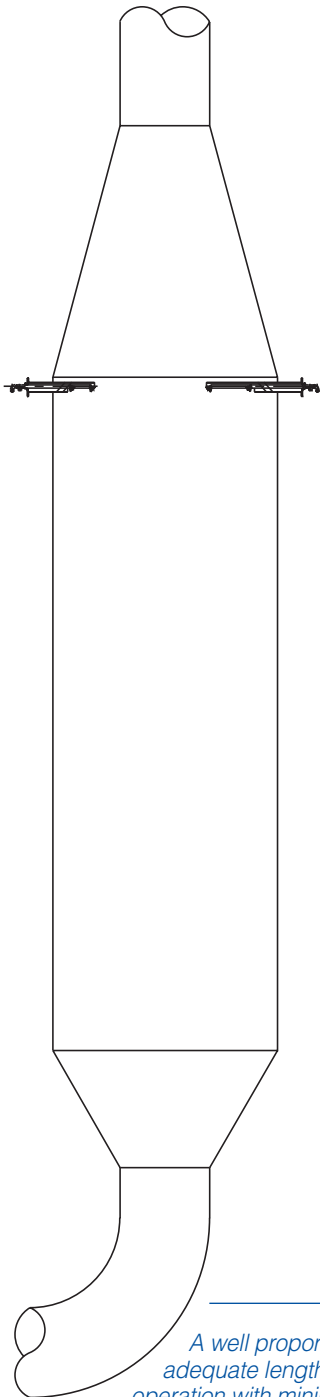
picture and even certain hydrocarbons. (The non-hazardous waste kiln standard does not address mercury in any depth, so at this point it is primarily a concern for the hazardous waste burning operators. However, there is at least one lawsuit demanding that the EPA include mercury restrictions. It would be short sighted to suggest that non-hazardous waste kiln operators will escape this for any length of time.)

Both standards have specific requirements for toxic gasses, especially dioxins and furans (D/F). These include tetra-, penta-, hexa-, hepta-, and octa- chlorinated dibenzo dioxins and furans. There are more than 200 variations of these in total, with some regarded as the most toxic substances known. This is nothing new to hazardous waste incinerators, however to the larger cement industry it will be unexplored territory.

Mercury is also under tighter restriction since it is not normally captured in a particulate control device in its gaseous phase. It can pass through the whole system and go out the stack since all the temperatures typically involved in the process are high enough to keep it from condensing.

While SO_x and NO_x are not included in the NESHAP, individual states are forcing tighter control on these as well.

This brochure is provided to give suggestions on how Lechler gas conditioning systems can help control many specific pollutants that are receiving particular attention under new EPA regulations. However it is general in nature and cannot go into the depth you need as you address all aspects of the new requirements. Examine the full EPA text carefully in the context of your facility and make sure you understand all the ways in which these new standards can affect you.



A well proportioned gas conditioning tower with adequate length goes a long way to ensure smooth operation with minimal maintenance. Good duct design practices combined with long transitional sections produce even gas distribution. This increases evaporation efficiency and allows the maximum amount of cooling. More cooling means more production.

Droplet size, spray trajectory, gas distribution and lance placement make all the difference between an efficient dry tower and one that clogs with wet cement dust. Inlets with abrupt direction changes and extreme size transitions cause gas distribution problems which result in violent velocity concentrations dead zones and even back flows. These invite wet areas with dust buildups, robbing the system of cooling capacity.

SPECIFICS FOR KILN OPERATORS

Toxic gasses

For non-hazardous waste (NHW) kilns, the EPA is allowing a dual D/F (dioxin/furan) standard of 0.2 ng TEQ/dscm or 0.4 ng TEQ/dscm with a particulate matter control device (PMCD) inlet temperature of 400°F or less. The rationale for this is that D/F compounds form in specific temperature windows (450°-650°F) and a rapid cool down, such as is provided by evaporative spray cooling, prevents their formation once the temperature is below 400°F. This allows an operator the choice to continue running at a higher temperature if D/F is not a problem (below 0.2 ng TEQ/dscm) or remaining between the two figures simply by lowering the inlet temperature at the inlet of the PMCD. In some situations, thanks to good combustion control, feedstocks free from D/F precursors or the presence of compounds in the feedstock that inhibit D/F formation, additional abatement may not be required. In other cases it may not be possible to go below the 0.4 ng TEQ/dscm level even when the temperature is below 400°F. For those situations there are additional methods

for controlling D/F.

Hazardous waste kilns do not have the dual standard.

Operators are required to reach the 0.2 ng TEQ/dscm level. There is a great deal of discussion in the text as to the temperature at the PM control device. The conclusion is the same, specifically that D/F formation is minimized when the temperature is below 400°F. The standard cites a case study at Ash Grove Cement in Chanute, Kansas. During testing in 1992, the D/F level with the PM device inlet temperature at 435°F was 1.7 ng TEQ/dscm. Two years later during similar testing when the temperature was down to 375°F, the level dropped to 0.5 ng TEQ/dscm. With a 60° change in temperature, the emission level dropped by more than two-thirds. (The EPA does not mention that any other process parameters changed during that time that would have influenced the results.)

Toxic metals

In the hazardous waste standard, toxic metals are divided into three groups: Low-volatile (Sb, As, Be, Cr); Semi-volatile (Pb, Cd); and High-volatile (Hg).

Low-volatile heavy metals condense very easily if they become gaseous at all, and are normally captured in the PMCD (the bag house or ESP, or as it is known in the standard, the particulate matter control device), so they can be included with particulates in general. In this capacity, the particulates serve as surrogates, so the assumption is that if you can reach the required level of output per unit of dry feed and the opacity level, the heavy metals emission will be under control. Even semi-volatile metals, while vaporized in the

kiln, condense at normal PMCD temperatures and are captured at that point.

Mercury is the only high-volatile metal for the purpose of the standard. It is particularly troublesome since it remains in its gaseous state at all the temperatures normally encountered in cement production and is released into the atmosphere. The only means to capture mercury is through the use of powdered activated carbon injection or lowering the gas temperature sufficiently to condense the vapor before the PMCD. (A wet scrubber can capture some specific mercury compounds.) In a few select cases, Lechler gas conditioning systems have been used to push the gas temperature down as low as 270°F to ensure that the gas and dust temperatures allow condensation of mercury on dust particles for capture in the PMCD.

Gas conditioning with activated carbon injection

Injecting powdered activated carbon (PAC) into the gas stream provides another approach to eliminating D/F and mercury. Both are adsorbed by the particles and then collected in the PMCD. This technology has been proven after many years of use in a wide variety of applications, and can help where lowering the gas temperature alone does not reach the required emission level. So far, PAC has seen little use in the cement industry, however these methods, used routinely in applications such as municipal solid waste incinerators, should prove adaptable.

PAC has limits to its effectiveness based on temperature. Here again, 400°F is a critical

point in the range. When operating below this level, the adsorbates are less energetic and attach more easily to the particles. They tend to remain attached to the carbon and are not driven back into the gas stream. PAC cannot perform adequately when the temperature is too high, so it needs to be combined with an effective gas conditioning system.

SOx control and acid gas scrubbing

SOx abatement is not covered in either of the NESHAP's in question. SOx and NOx are criteria pollutants and are regulated under state implementation plans. None the less, in certain areas these are already under tight regulation and expansion of this is only a matter of time.

An effective gas conditioning system can also be the platform for acid gas abatement. In cement manufacturing sulfur compounds in the fuel and feedstocks can be vaporized anywhere from the kiln through the preheaters. While alkali substances in the feedstock tend to suppress this naturally to some degree, sulfur and other acid compounds liberated in the earliest stages of the preheater phase have the least time for neutralization.

The traditional methods for acid gas scrubbing involve providing an interface where the acid laden gas can interact with a liquid containing an alkali reagent which prompts an acid-base reaction. In the process the acid forms a more benign compound and is removed from the gas stream. Generally this is performed in a reactor or scrubber tower with large volumes of recirculated liquid as is common in the electric utility industry. This typically uses lime or pow-

dered limestone which becomes gypsum after it has reacted with the sulfur compounds.

However such large scale installations are not always needed. Lechler has built systems using the same type of nozzles and gas conditioning equipment to introduce the reagent in a way that allows the reaction to take place as the gas is being cooled in the existing gas conditioning tower. The result is complete evaporation of the liquid as the acid is neutralized. Any resulting dry product is captured in the PMCD. Such a system requires two levels of control. One regulates the amount of water injected for cooling purposes while the second injects the

proper amount of reagent for acid neutralization. The system can adjust for both variables, always operating at peak efficiency.

Like powdered carbon injection, this technology has not been used widely in the cement industry, but it has proven itself in countless incineration applications. It is particularly attractive since it does not require the construction of a scrubber vessel with its host of support equipment.

Cement kiln dust management problems

With these new requirements, the growing number of substances captured in the PMCD has the potential to contaminate the dust with

large volumes of hazardous materials. Given that the normal practice is to reintroduce the dust into the process as a feed stock, all the pollutants captured return to the system to be captured again. Eventually this can reach a point where the dust actually becomes a hazardous material when enough pollutants have accumulated in the dust after multiple times through the system. Pollutants are not the only substances which are considered contaminants, so most plants have a procedure to remove some portion of the dust before reusing it. With the new requirements, this procedure will need to be reevaluated and possibly adjusted.

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BASIC CONCEPTS OF GAS CONDITIONING

Lechler VarioCool gas conditioning systems use spray nozzles to atomize water and inject it into the gas stream. The droplets absorb heat as their temperature increases until they evaporate completely. As the vapor superheats, it absorbs additional heat until the vapor temperature equals that of the gas.

Since the amount of heat required to evaporate a specific volume of water is easy to calculate, determining how much water to inject is not difficult. The key of system design is making sure all the liquid evaporates before it has an opportunity to hit a wall or bottom and wet the surface. A wet surface provides an excellent point for dust to collect in the tower and robs the system of cooling capacity.

Creating an effective system requires two important skills: The ability to create droplets small enough to evaporate before they hit a surface combined with trajectory modeling that determines the directions the droplets will travel. From these calculations, the system designer then chooses the nozzle capable of producing a small enough droplet and determines how they should be positioned in the tower or duct. The liquid will not evaporate effectively if it is not mixed sufficiently in the gas stream to avoid hot and cold areas.

Since a cement kiln can run at various production levels, there are frequent changes in the volume of gas and the temperature. An effective system has to be able to respond to these changes in a way that will stabilize the outlet temperature and keep it steady in the face of changing conditions. This depends on a well integrated package of nozzles, pumps and control equipment combined with careful design and tuning to ensure reliable performance across a wide range of operating conditions.

Most gas conditioning systems use hydraulic nozzles featuring an internal mechanism that allows a portion of the flow to bypass the orifice or a twin fluid atomizer that uses compressed air to break up the liquid. Each approach has its own advantages related to the turn-down ratio, droplet size and energy consumption. Lechler VarioCool systems have the widest range of nozzle types and configurations in the industry so finding the best option for your installation is always possible.