Operators of coal fired power plants have a lot to worry about today: The price of coal relative to natural gas, stack emissions, EPA regulations and the unpredictable nature of future potential regulations. With an uncertain future, one question hangs in the balance: is it economical to maintain a coal fired power plant and reduce its stack emissions?

This tough question is driving trends towards plant upgrades, early plant retirement and conversion to natural gas as solutions to control pollution. Producers of coal fired power are experiencing two hidden costs to early plant retirement or conversion which are important to understand. The first is the unpredictability of the future cost of natural gas and the second is the risk of prematurely converting a plant to natural gas and facing the unaffordable cost to convert back if the price and availability of natural gas becomes uneconomical. These choices have significant impact on the plant’s operational costs and the economy.

An alternative to avoid these issues is to use Dry sorbent injection (DSI). Dry sorbent injection is a pollution control technology that plays a role in the U.S. power sector’s compliance with the Mercury and Air Toxics Standard (MATS). The Environmental Protection Agency (EPA) finalized the MATS rule in December 2011. The MATS rule requires that all U.S. coal- and oil-fired power plants greater than 25 megawatts meet emission limits consistent with the average performance of the top 12 percent of existing units, known as the maximum achievable control technology (MACT). The rule applies to three pollutants: mercury (Hg), hydrochloric acid (HCl), and filterable particulate matter (fPM) and has a compliance deadline in 2015 (with opportunities for additional compliance time depending upon case-by-case circumstances).

While DSI systems do not control mercury, they can, when combined with a particulate control filter, meet this standard for two of the three controlled pollutants.

DSI systems remove hydrogen chloride (HCl) and other acid gases like SO\(_2\) and SO\(_3\), through two basic steps.

**Step one.** A powdered alkaline sorbent is injected into the flue gas (combustion exhaust gas exiting a power plant) where it reacts with the HCl and SOx. The sorbents most commonly associated with DSI are trona (sodium sesquicarbonate, a naturally occurring mineral mined in Wyoming), sodium bicarbonate, and hydrated lime.

**Step two.** The compound formed by the alkaline sorbent and the acidic gas is removed by a downstream particulate matter control device such as an electrostatic precipitator (ESP) or a fabric filter (FF), also referred to as a bag house. Testing has demonstrated that fabric filters are...
more effective (when combined with DSI) than ESPs, with respect to overall HCl and SOx reduction. For modeling purposes, the EPA estimates a DSI system with a fabric filter is expected to achieve 90% removal of HCl, while an ESP only achieves 60 percent removal, although actual performance will vary by individual plant.

As mentioned, DSI systems can also significantly reduce sulfur dioxide (SO₂) or sulfur trioxide (SO₃) emissions through the same process as HCl removal. While the MATS rule does not specifically address SO₂ or SO₃, it has similar qualities to HCl and other acid gases that enable it to respond similarly in a DSI system. SO₂ and SO₃ are also regulated under the Cross State Air Pollution Rule (CSAPR). Therefore, installing a DSI system to comply with MATS will also help plants meet or even exceed their CSAPR emission limits.

**The Application of a Mill in Processing Sorbents for DSI**

Dry Sorbent Injection, is part of a Flue Gas Desulfurization system (FGD), capable of SO₂ and SO₃ mitigation, as well as HCl, and mercury removal depending on sorbent selections. DSI treatment for mercury removal is similar to other forms of FGD but uses either powder activated carbon reactant or Amended Silicates, a patented process for mercury removal. Formed particulate is then captured in the same way that other DSI systems capture their reacted compounds as described above. When investigating the use of a DSI system the first consideration is typically the cost to operate the system. A DSI system has a far less cost to operate and install than a wet scrubber system for power plants, industrial boilers, incinerators or co-fired plants that are only partially converting to natural gas fired, or undecided to convert, or may want to fire oil or coal for 5 or more years. Research has shown that the capital and installation costs to operate a DSI system are only 10 percent on average, compared to that of a wet scrubber system.

SOx is mitigated most effectively by alkaline type sorbents like Trona and Sodium Bicarbonate (SBC), although hydrated lime or limestone, if locally obtained, can be a viable solution. SBC must be milled (ground finer), and Trona should be milled for maximum effect. The purposed of milling is both to reduce the amount of sorbent consumed by the system and increase the sorbent surface area which increases the availability of a reactive particle surface. As SO₂ is eliminated, blue plumes from sulfuric acid disappear, boilers run more efficient, system corrosion is lowered and mercury can be removed more easily. A variety of sorbents can be blended, as supplied to the on-site mill before DSI, or milled and injected separately if optimum injection points need to be considered. SO2 removal to levels of 95 percent can help control acid rain and is also a good reason to consider a DSI system with milling.

With the advent of the MATS and the ongoing EPA rule changes, litigation and state regulations, considering a DSI and mill can bring a plant quickly into a safe condition to comply cost effectively while still keeping all options open to future alternative fuel choices. Operators have found that relieving the pressure of making an early conversion decision, potentially pre-maturely, will save significant...
money and jobs for plant facilities due to less closures while meeting the future energy demands of the community.

DSI with mill systems can be pre-tested by engineering firms specializing in DSI installations and has proven its effectiveness over the last 10 years throughout the U.S.A.

Milled DSI systems have been installed for over twelve years and maintain constant operation. These mills are specially designed to meet both the rigors of DSI and the needs of the power generation community. It is important to understand that general, commercially available mills, are designed for many applications. These applications do not necessarily reflect the needs of power generators. The typical system installed for DSI will be installed in an out-building with no temperature control and must be operated 24/7 with minimum down time or cleaning time. Manufacturers have designed unique features to these mills to make them suitable for DSI. Some typical features include rotating round pin sections to minimize the wear caused by milling naturally occurring minerals which have abrasive properties, special metal coatings which also minimize wear and pre-heating and cooling systems for plants operating in ambient temperatures below 40°F or above 90°F. An important consideration in DSI systems is designing for use of these specific-duty pin mills.

The benefit of using a pin mill is in its ability to offer the smallest particle sizes to increase the reactive surface area and help the plant consume less sorbent. A pin mill for DSI operates by blowing sorbent into the top of the mill using a pneumatic conveying system. The sorbent then enters the mill where one rotor with a set of pins rotates between a second, stationary rotor. The sorbent works itself through pressure and force from the inside of the rotor to the outside of the rotor where the action of the pins reduces the particle size. Fine particles exit the outer edge of the rotor where they are then blown into the process to be added to back to the DSI system for injection. This simple process is the heart of DSI systems as it is responsible for controlling the effectiveness of the removal of gasses from the system. Particle size reduction has a key role in FGD and understanding the part sorbent milling plays in trona systems is the best example.

A typical example of DSI is the use of milled trona. Supplier-delivered trona with a particle distribution where 50 percent of the particle size is 30μm or less (referred to as d50) has an average per-particle surface area of about 2,800μm². The advantage of operating a DSI system is by reducing ongoing operating costs. This is where the pin mill plays its key role. A pin mill is capable of reducing the d50 from 30μm to 7μm which, in a single particle, is the equivalent of reducing a dust particle to the size of a red blood cell. This reduction in size has an exponential impact on particle surface area by volume, increasing the reactive surface area from about 4,000in² to 20,000in² for equivalent mass.

When considering the future of coal and oil-fired power, alternatives to conversion and early retirement exist. DSI is affordable, compliant and easy to operate and should be considered when planning the future of any plant.

To learn more about the Simpactor FGT & Powderizer FGT request the Sturtevant Air Pollution Control Brochure.

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