CASE HISTORY

Dry Scrubbing by Degree

Dry scrubbing systems clean coal-fired emissions at Virginia Tech, allowing the school's 80-year-old steam plant to exceed SO_2 permit requirements.

Virginia Tech, located in Blacksburg, VA, is home to eight colleges and graduate schools and 30,000-plus full-time students. The more than 125-building, 2,600-acre campus requires a great deal of power and heat. A central steam plant generates a portion of the school's electrical needs and all steam requirements needed to heat core campus buildings. Current total plant capacity on campus is more than 440,000 pounds of steam per hour using five boilers with superheaters.

The plant has gone through many changes in past decades. The first power plant on campus was built in 1901. In 1930, the existing plant was built and brought into service. As the campus grew, so did demand for steam and heat. In 1970, the school's four original boilers were replaced with five new units. Not long after, one of those was replaced, and a few years after that, the remaining four were upgraded to produce high-pressure steam to allow the installation of a new turbine generator rated at 6,250 kilowatts.

BACT Limits New Emissions

When campus demands for steam and heat surpassed the existing plant's available capacity at the time, the school decided to add another boiler. Since Virginia Tech's geographic location didn't offer a reliable gas supply, officials opted for a solid-fuel-fired coal boiler. The permitting process made it evident that this new unit would fall under the Best Available Control Technology (BACT) regulation enforced at that time. Emission limits set for the new boiler included a 92 percent minimum SO_2 reduction based on a 30-day rolling average.

With help from an outside engineering firm, Virginia Tech carefully reviewed the existing solutions and technologies available. School officials finally selected a relatively new technology at the time, a dry scrubbing system, which seemed to be a good fit with the new boiler capacity. The technology allowed for efficient removal of more than 92 percent of SO_2 using low amounts of hydrated lime ($Ca(OH)_2$) as a reagent. Also, since the boiler plant was located within central campus, the equipment's overall footprint had been a real concern. The system selected was compact and could be configured to fit in the space available, while dry waste could be disposed of using the existing ash system.

System Components

A schematic of the system (Figure 1) shows its three main components: the reactor, the filter, and the recycling system. The reactor is a round, vertical cylinder. Gasflow enters from the bottom, going up and through the reactor, and then enters the baghouse filter. Injection of fresh hydrated lime and recycled material takes place at the throat of the reactor. Gasflow is then filtered through the baghouse, where bags capture the dust/ash, lime reaction products, and recycled material. A convey-

ing system (screw conveyors, pneumatic conveying) continuously removes the captured material, taking it from baghouse hoppers to the conditioning drum.

The conditioning drum is an important part of the system. It is where a small quantity of water is thoroughly mixed with the recycled reagent to condition it before being injected into the reactor. Doing this outside the reactor allows for a more efficient SO_2 capture than if water and lime are injected into the reactor separately. Pre-mixing ensures that the hydrated lime particulates are well-coated with a microscopic film of water. Evaporation of this water results in dewpoint temperature at the surface of the lime particulates, achieving the highest level of reaction possible with SO_2.

Installation and Start-Up

Virginia Tech purchased the system and selected a contractor to complete the installation. Installing the boiler and new scrubbing system went well, without any major hiccups. Start-up, however, was not so easy. "The learning curve was pretty steep for us because it was a fairly new system, and the scrubbing systems were new to our operators, but it was a manageable thing and we got through it," says Byron Nichols, associate director of utility systems at Virginia Tech.

With the help of technical personnel from the system supplier, parameters were set based on the boiler's operating conditions to achieve, and even surpass, performance guarantees (Figure 2). Since the system was relatively complex and had many parameters that could be adjusted — lime injection rate, hydration rate, pressure drop through system, temperature drop through the reactor, recycled material rate — plant personnel also were properly trained in system operation and maintenance.

Preparing for Boiler MACT

In 2007, Virginia Tech approved plans to upgrade controls on its second coal-fired boiler. At the same time, officials also decided to install a second dry scrubbing system. This decision was made since new Boiler Maximum Achievable Control Technology (MACT) rules were supposed to be issued "in the near future," and the boiler would need to surpass new limits. This past December, five years later, standards finally were issued. (See sidebar box on page 17 for an update.) Officials were satisfied with the performance and reliability of the first dry scrubbing system, so they decided to install the same technology. Another factor in favor of the decision was that plant-management personnel already had navigated the system's operational learning curve.

Improving the Second System

After a decade of operating and maintaining the first system, Virginia Tech knew what improvements should be made to a new one. Supplier technicians, who had been making yearly site visits

Figure 1

Water and recycled reagent are mixed in the conditioning drum and injected into the reactor. Mixing them allows for more efficient SO_2 capture than if the two were injected separately.

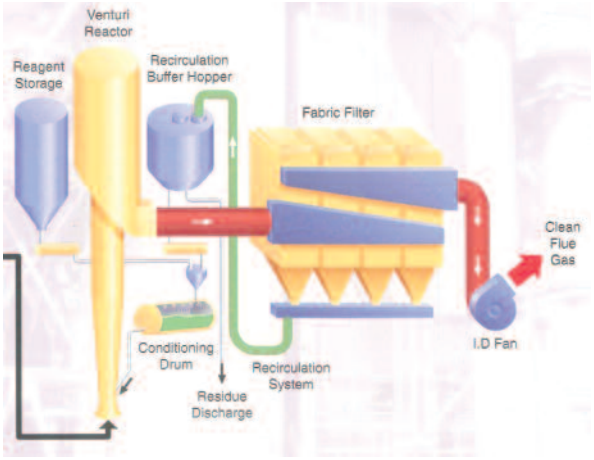
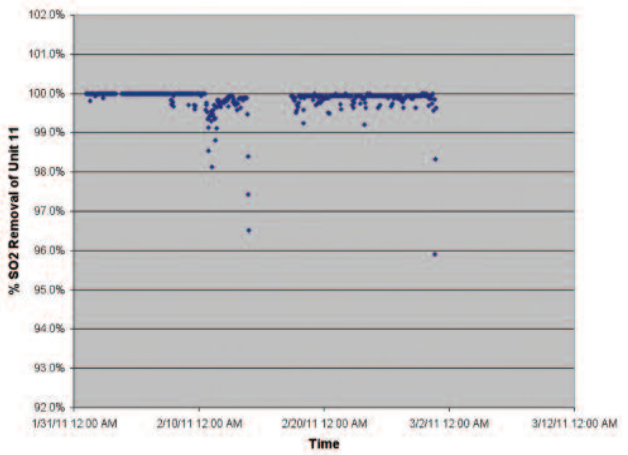


Figure 2

SO_2 Removal Efficiency — Three Months Recording



to check on performance of the initial system, also offered input. A meeting was held to review the new design.

The second system's main improvement was increasing the size of the recycled material surge bin to allow for more consistent system operation. In the first installation — due to lack of yard space — the system was compressed by reducing bin volume. Overall layout on the second system was slightly changed to allow for a volume increase.

"One of the things we noticed over time was that consistency of operation is the key for operating these all-dry systems," Nichols says. "If you can keep the lime moving steadily through the system, it doesn't tend to block up or cause other issues." This allows the system to better handle large fluctuations that exceed 25 percent of full load in less than an hour.

Load cells were incorporated on the fresh lime, recycle, and waste silos to get an actual weight reading instead of a point level system. This was a big improvement that allowed operators to know exactly where the recycled material and lime were at any given time in the system.

Training and Preventive Maintenance Are Key

Nichols, who holds a bachelor of science in mechanical engineering technology and a Master Chief and Technical Instructor's license with the American Society of Power Engineers, has been involved in Virginia Tech's boiler operations since 1982. He regularly speaks at industry conferences, where discussions typically involve stories of erosion and abrasion issues that can happen with wet scrubbing systems. He shares his dry scrubber experiences, emphasizing how the quality of the operator is key to keeping systems running smoothly and how regular training is imperative.

Another key element is preventive maintenance. As with any complex system, there needs to be an effective program in place. Operators need to regularly — daily, if possible — perform visual system inspections to get familiar with and be able to notice differences such as noises, leaks, and vibrations in day-to-day operation and performance.

Furthermore, mechanical equipment such as fans, bearings, and belts need to be checked regularly for wear and tear. During planned shutdowns, material-conveying parts — bins, conveyors, rotary airlocks, etc. — and the conditioning drum require internal inspection for signs of wear or plugging that would require cleaning. This usually isn't an issue if the system is operated with care and attention.

Trained, qualified personnel, in conjunction with a well planned and executed preventive maintenance program, will go a long way to ensure reliable operation of a dry scrubbing system and reduce emissions to comply with ever-tightening regulations. APC

After being satisfied with the performance and reliability of the first dry scrubber (right), Virginia Tech officials opted for the same technology and installed a second system (left) 10 years later.

The second dry scrubbing system installed at Virginia Tech in 2007 is helping the school meet all state and federal emission requirements.

Boiler MACT Adjustments Finalized

On December 20, 2012, the Environmental Protection Agency (EPA) finalized a specific set of adjustments to Clean Air Act standards for boilers and certain solid waste incinerators. Major source and affected area source boilers will have three years to comply and can be granted a fourth year, if needed, to install controls. EPA also has tools to address additional individual-source concerns on a case-by-case basis. For more information, go to www.epa.gov/airquality/combustion.

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Solios Environnement, a North American subsidiary of Five Solios, supplies turnkey, multipollutant dry scrubbing solutions to the cement, industrial kiln, and industrial boiler markets. Solios has successfully installed many EAD dry scrubbing systems in thr U.S. since 1987. Visit the company's website at www.fivesgroup.com/fivessoliosEAD