

Wet Electrostatic Precipitator Removes Sub-Micron Heavy Metals

Removing sub-micron particulates from stack gases presented the Erie Sewer Authority (ESA), Erie, Pennsylvania, with a difficult challenge. Burning sludge from a combined industrial/municipal waste feed, their incinerator emits sub-micron particulates including heavy metals and compounds. Using a wet electrostatic precipitator system downstream of a conventional wet scrubber, ESA is achieving a greater than 90-percent collection efficiency for most heavy metal sub-micron particulates and meeting all relevant regulatory standards on sludge incineration emissions for both of their furnaces.

ESA operates a biological waste treatment plant and two MHF sludge incinerators for their combined waste system. The sludge produced in their treatment plant is dewatered to about 25 percent solids and then incinerated to reduce volume and make it suitable for disposal.

The hearth-type, auxiliary-fueled incinerator gradually moves the sludge from the feed section to the discharge section with a rake or "ramble arm." As the sludge first enters the incinerator, the sludge "smolders" as water is evaporated. Volatile material evaporates from the sludge in this section, entraining sub-micron particulates that contain heavy metal compounds.

As the flue gas leaves the incinerator, it is first cleaned with a venturi scrubber that removes particles as small as five microns and provides some agglomeration of sub-micron particles. The gas then enters an impingement plate scrubber that further cools the gas to about 100° F. This process condenses any volatiles that may contain heavy metal compounds and assures that the gas is sub-cooled with water before it enters the wet electrostatic precipitator.

After passing through a chevron entrainment separator to remove large water droplets, the sub-cooled gas enters the top of the wet electrostatic precipitator. The precipitator is configured similarly to a vertical tube-and-shell heat exchanger with an electrode inserted in the center of each of the 64 metal tubes. The electrodes are negatively charged, while the metal tubes are grounded.

A typical wet electrostatic precipitator such as this one can achieve greater than 90-percent collection efficiency for most heavy metal sub-micron particulates. ▶

The electrons passing between the negatively charged electrodes and the grounded tubes produce a corona effect inside each tube. As the cooled, water-saturated gas flows through the tube side of the tube bundle, the corona charges water droplets in the gas as particulates are attracted to the inside wall of the grounded metal tubes where the water produces a falling film that irrigates the wall and captures the charged particulates. The water/particulate mixture flows down the inside wall of the tubes, is collected at the bottom of the unit and is pumped to an ash slurry system.

To ensure that there is sufficient water mist to create a continuous film of water on the inside wall of the tubes, it is essential that the gas remain wet. While the tray cooler usually is able to provide sufficient water, a water fog nozzle installed upstream of the precipitator can be used if necessary.

Periodically, especially if particulate loading is high, the falling film will become overloaded with solids, causing more frequent "sparkling" within the tubes. When this occurs, the collection tubes should be flushed with additional water. At ESA, the tubes are flushed

automatically every few hours for about two minutes. The flushing is done on-line. The precipitator continues to operate while flushing.

The AirPol wet ESP maintains high efficiency by keeping the collection walls clean for long periods of time. The down-flow configuration also permits gravity to aid in particulate collection and keeps the tubes clean during normal operation. The large (10" diameter) round tubes in the precipitator provide uniform field strength and allow the use of high operating voltage (20 kV per inch) to enhance particulate collection efficiency.

Using two identical gas scrubbers and wet electrostatic precipitator trains with a combined design capacity of 25,000 SCFM, ESA maintains its emissions of heavy metal particulated well within the acceptable range. Overall, more than 15 heavy metal particulates are controlled in the wet electrostatic precipitator.

All gas treatment equipment for this project including venturi, wet precipitator, ducts, fans, slurry-handling and instrumentation was provided by AirPol, Parsippany, New Jersey.

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