MEMBRANE WESP – A Lower Cost Technology to Reduce PM2.5, SO_3 & Hg^{+2} Emissions

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Summary

Multi-pollutant control technologies will become more important in the future. Fine particulate, PM 2.5 and H_2SO_4 mist (acid aerosols) is of concern to coal-fired utilities because it effectively scatters light, leading to increased stack opacity. Acid aerosols form when an acid (notably sulfuric acid) condenses, providing excellent condensation nuclei for water accumulation, eventually creating acid aerosol particles 1-2 µm in diameter. Sulfuric acid condensation nuclei are prevalent when SO_3 concentrations are high, either because of burning high sulfur coal or when selective catalytic reduction (SCR – used for NOx control) catalyst beds oxidize significant amounts of SO_2 to SO_3. Several coal-fired utilities have been experiencing increased SO_3 emissions from their existing WFGD Scrubbers, especially after installing a Selective Catalytic Reduction (SCR) for NOx Control. Achieving co-benefits of Hg removal by installing SCR's and WFGD systems is also becoming a key strategy for reducing mercury levels after coal fired Power plants. This new Membrane Wet Electrostatic Precipitator (WESP) System is ideally suited to, and very cost effective for, removing PM2.5, SO_3 and Hg^{+2} after limestone Wet Flue Gas Desulphurization (WFGD) Scrubbers in the Utility Industry.

WESP can readily collect acid aerosol and fine particulate due to greater corona power and virtually no re-entrainment. The WESP can also enhance collection of Hg (both Hg ash & Hg^{+2}). The main historical limitation associated with Wet Precipitators has been the higher cost of special alloys and stainless steel material used in their manufacture. This new technology WESP, based on fabric membrane for the collecting electrodes, dramatically reduces weight and cost, compared to conventional, metallic WESPs.

In conventional metal plate WESP, both tubular and flat-plate, the flushing liquid (water) passing over the collecting surface tends to "bead" due to both surface tension as well as the initial geometric surface imperfections ("hills and valleys"). Because of this, flushing liquid can not be uniformly distributed over the surface. To get uniform distribution of water over the collecting surface, most "old-design" employ atomization or spraying. However, any spraying provides the conductive path to ground to high voltage electrical field. To avoid this grounding, called sparkover, the field voltage is usually reduced or switched off during intermittent spraying for collection plate cleaning. In this new Membrane WESP, cleaning of the corrosion resistant fabric colleting membranes is facilitated by capillary action between the fibers. This provides uniform water distribution, & continuous flushing, which removes collected material without spraying. Because of no spraying is required for colleting membranes cleaning, entire WESP remains in operation for a longer period of time.

Several pilot units using the Membrane technology have been operated successfully to demonstrate excellent PM removal efficiency. Testing in three pilot units has shown outstanding particulate collection efficiency comparable to, and in some cases superior to, a conventional metal plate WESP. The pilot unit test results, along with test parameters, will be discussed. In membrane WESP, because of continuous flow and uniform distribution of water, membrane collecting surfaces stay free of any particulate build-up. The experiment conducted at SEI's metal plate WESP at Excel/Sherborg showed no build-up on membranes. The details of this experiment will be described. The first commercial application of the membrane WESP technology is at Smurfit Stone Container Corporation's, Stevenson, AL Plant. This WESP system is a two-module, upflow, single field, membrane WESP installed on two boilers burning No. 6 fuel oil with 4% sulfur content. The vanadium in the oil converts a significant portion of the SO_2 to SO_3 (about 20 PPM inlet to the WESP). This WESP system demonstrates high

fine particulate and SO_3 removal efficiency, after an existing sodium hydroxide scrubber. The operation and performance of this two-module membrane WESP system will be described.

Cost estimates comparing the Membrane design to conventional metal plate WESP's will be presented. Recommendations will be made to show how the membrane technology can be used after Utility-size, limestone WFGD scrubbers. Capital cost comparison of both vertical up-flow and horizontal flow WESP's will be made.