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Emerging Technology for Multi-Pollutant Control on the Emissions of a Biomass Fired Boiler

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ABSTRACT

Proposed modifications to the laws governing the emissions from biomass fired boilers require more stringent control on emissions. During biomass combustion there are several pollutants produced which require advanced pollution control measures to maintain environmental compliance. These pollutants include Particulate Matter, Hydrogen Chloride, Sulfur Dioxide, Sulfuric Acid Mist, and Oxides of Nitrogen. To ensure operational compliance of the boiler's stack emissions both now and in the future, proper pollution control technology is paramount. This presentation will address an emerging air pollution control technology that embodies all of these removal steps in a single device specifically designed to meet the needs of biomass fired boilers.

Historically, the control strategy for stack emissions from such boilers has included the use of various standalone systems. For example, Dry Electrostatic Precipitators have been used for PM reduction, Selective Non-Catalytic Reduction systems for NO_x control, Flue Gas Desulphurization for SO₂ removal, and single pass Wet Electrostatic Precipitators for H₂SO₄ abatement. The consolidation of these multiple, standalone systems into a smaller, less costly alternative tailored specifically for biomass fired boilers can address the new requirements.

EISENMANN's recently patented multi-pollutant control system includes the use of a pre-scrubbing chamber for large PM, SO₂, and water soluble NO₂ removal. Following the quench and pre-scrubbing region, a specially tuned downflow wet ESP field is responsible for finer PM and Sulfuric Acid

aerosol removal, as well as an important Ozone producing stage that oxidizes non-water soluble NO. As the gas continues to travel through the system, a secondary scrubbing chamber is used to further reduce NO_x by scrubbing the newly formed NO₂ that has been formed from the oxidation of NO through the use of Ozone produced by the electrostatic precipitator. The final polishing stage of the system includes an upflow wet electrostatic precipitator field for the removal of newly oxidized material such as mercury.

Research and testing on the aforementioned system took place through the development of a pilot sized unit. Expected performance was validated proving high removal efficiencies for pollutants specifically addressed earlier. Implementation of the technology within the biomass fired area is underway and is currently viewed as an acceptable solution to the environmental regulations associated with a biomass fired boiler because of the smaller footprint, lower operating costs, and overall condensed solution when compared to previously used technologies.

INTRODUCTION

Much commercial and technical interest has been focused on the potential opportunity presented by biomass fired energy as a reliable, alternate supply of energy, in various geographies such as in the US Northeast where large quantities of energy are still produced from oil fired sources of heat. The potential of such technology to reduce energy costs, and create domestic jobs is well understood. However, the implementation of such

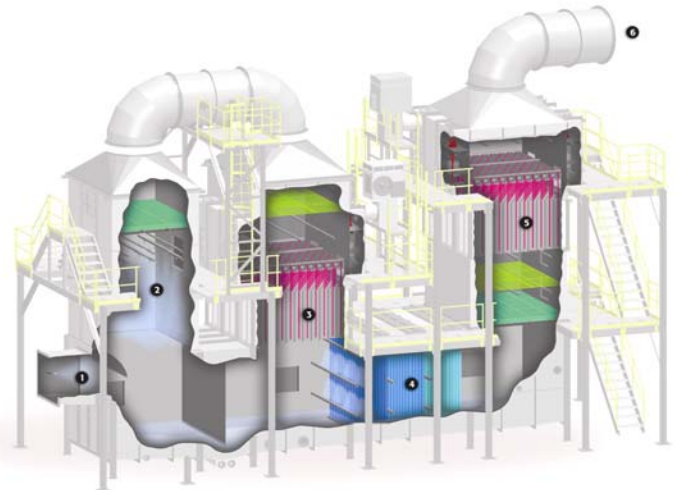
technology has been balanced with public policy concerns regarding environmental and health factors associated with the combustion of biomass from the standpoint of resulting air pollutants released. These concerns center around fine sized particulate matter under 2.5 microns in size ($PM_{2.5}$), acid gases in the form of halogens such as hydrochloric acid (HCl), in the form of sulfur compounds such as sulfur dioxide SO_2 and sulfuric acid such as H_2SO_4 , nitrogen oxides referred to generically as NO_x , and heavy metal most notably represented by mercury Hg in its various oxide and chemical forms. The presence and extent to which these individual pollutants are present in any specific application are as varied as the nature of the biomass feedstock used as the source of energy. This variability has led to challenges on the commercial side and to state and federal regulators on the public policy side in determining the appropriate air pollution control (APC) technology to permit / purchase for biomass fired projects.

The general historic approach on the commercial side has been to purchase individual pieces of APC specialized at removing certain specific air pollutants arranged in a serial arrangement. As such, on a “typical” biomass to energy project, one might deploy a physical filtration technology to remove the $PM_{2.5}$, a chemical scrubbing technology to handle the acid gases, a selective or non-selective catalytic technology to reduce NO_x , perhaps a form of activate carbon technology to address Hg and heavy metals. As with any exercise in specialization, the integration of multiple technologies, often from separate vendors, and requiring specific operating parameters for each technology creates challenges. Very often these challenges constrain the ability of the APC in its entirety to handle variations in biomass feedstock or future regulatory permitting to the least adaptive individual technology. The chain of APC solutions is only as adaptive as its weakest individual link.

On the public policy side, uncertainty exists in advance of the US EPA’s ruling on the Industrial Boiler Maximum Achievable Control Technology (IB MACT) requirement which is expected to be released in draft form in April 2010, with a final ruling not expected prior to the end of 2010. The rule would regulate emissions of air pollutants from likely all biomass fired industrial boilers. The uncertainty surrounding this specific regulation has been cited as a prime reason behind the delay of several substantially sized biomass projects over concerns about final required APC controls.

In response to the above commercial and public policy drivers, EISENMANN has developed and patented an integrated single embodiment technology, the WESP 2-F that offers single solution answers to $PM_{2.5}$, acid gas, and NO_x removal, well suited to treating a wide variety of biomass fired emissions in a single flexible package.

Following is a description of the technical approach:



1. Inlet Quench Section

Entering process gas travels through the quench system to lower the gas temperature to saturated conditions.

2. Pre-Scrubber Section

The process exhaust is directed through an upflow absorption tower that will remove large particulate, scrub acid gases such as HCl or SO_2 , and absorb the water soluble Nitrogen Dioxide (NO_2) element of NO_x .

3. Downflow WESP Section

The downflow WESP is preceded by a sub-micron mist generator that adds fine water based particulate to the air stream. The sub-micron particles are then charged by negative ions and collected on the WESP collector tube walls. The downflow design allows for continuous self-cleaning and accumulation of the collected particulate in the recycle tank below.

4. NO_x Scrubbing Section

The exhaust gas enters a horizontal rod deck scrubber to further reduce NO_x emissions. This is accomplished by scrubbing additional NO_2 that was formed from the Ozone (O_3) produced in the downflow WESP and the other primary element of NO_x , Nitrous Oxide (NO).

5. Final Upflow WESP Section

The last stage is the upflow WESP which will remove any remaining fine particulate and provide a final mist

elimination step by removing sub-micron liquid droplets.

6. Clean Exhaust Outlet

The clean exhaust gas exits the WESP-2F system and is discharged to the atmosphere.

The result is a single APC solution for multiple pollutants, offered in standard compact sizes, pre-engineered to offer great flexibility for whatever mix of biomass fuel emissions, or required environmental targets are needed for a specific project, all offered from a single source of supply.

RESULTS AND DISCUSSION

Case Study: Wild Turkey Distillery-> Multi-Pollutant Control for Variable Opportunity Fuels

Wild Turkey Distillery in Lawrenceburg, KY purchased the EISENMANN WESP-2F technology to handle the emissions from two 1,500 HP hybrid boilers, designed to produce 100,000 lb/hr of steam at 135 psig.

Broad multi-pollutant control was required due to the flexible fuel requirements of the biomass, based on wood chips with 20% moisture and 6,600 BTU/lb heating values, while still retaining the capability of the boilers being able to run on bituminous coal with 7% moisture, and 13,000 BTU/lb heating value. As such, the supplied APC needed to handle a broad spectrum of potential PM_{2.5}, sulfur, NOx, and potential trace heavy metals over a wide variety of dewpoints loadings.

After internal piloting of the requirements of this application, EISENMANN was able to offer all appropriate commercial guarantees required for final permitting of the project.

The final design basis of the application required the system to handle 60,000 + ACFM at 450 degrees F, with PM loadings as high as 42 lb/hr, SO₂ as high as 580 ppmv, SO₃ as high as 18 ppmv, and NOx as high as 230 ppmv.

The technology was deployed in parallel trains to handle the emission of each boiler on an individual basis to allow for common shutdown and maintenance.

CONCLUSIONS

The ability of the WESP-2F technology to accommodate the difference in emission characteristics from biomass fired fuel up to bituminous coal in a single APC embodiment while meeting the required permitted emissions of the facility aided the advancement of the commercial project by removing the uncertainty as to what mix of conventional technologies would be needed for each of the potential plant operating scenarios. As such, it may be argued that this sort of technical solution

offers a potential solution pathway for biomass commercial interests looking for a measure of certainty on the APC side for handling the issue of variable biomass feed materials, and developing environmental guidelines.