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Performance Improvements Through Intelligent Sootblowing Optimization at Longview Power

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Abstract

Power plants are constantly challenged to minimize the cost of operation while maximizing unit availability. Sootblowing optimization has become an important low-cost tool for increasing efficiency and maximizing unit output of coal-fired plants. Performance-based intelligent sootblowing provides power plants with a cost-effective method of achieving unit cleanliness and performance improvements while reducing costs such as fuel usage, maintenance, sootblowing medium management, and tube failures due to sootblower erosion. By targeting the specific areas that have reduced heat transfer, sootblowing can be applied as necessary to maintain unit performance. This is achieved using a unit-specific boiler heat transfer model to calculate real-time heat transfer efficiency for every heat trap component in the unit, including the furnace.

This paper will show how performance improvements have been realized on Longview Power's 700 megawatt (MW) Foster Wheeler low mass flux vertical tube wall-fired advanced supercritical unit firing high-sulfur coal in Maidsville, West Virginia, USA. It will describe the successful implementation of the Babcock & Wilcox Titanium™ intelligent sootblowing system on the Longview power plant. The paper will also demonstrate how optimizing Longview's sootblowing process reduced slagging, improved overall cleanliness, reduced reheat spray flow, and improved unit heat rate.

Introduction

Unit History

The Longview Power plant is the newest coal-fired plant in the 13-state PJM Interconnection. The plant was commissioned in December 2011 following construction by a consortium of Siemens Power Generation Inc. and Aker Kvaerner Songer Inc. As built, the plant had a Foster Wheeler supercritical boiler, a Siemens steam turbine/generator set, and a Siemens distributed control system (DCS).

Soon after commencing commercial operation, the plant started experiencing a number of very serious problems which caused the unit to be offline for long periods of time. Some of the problems were related to material issues with the first-of-a-kind, once-through Benson low mass flux vertical tube advanced supercritical boiler. Other problems were related to inaccurate and unreliable process measurements. Additional problems were related to flawed control logic, hardware issues and software bugs in the plant's DCS.

The severe operational issues as well as major changes in the power markets lead to Longview Power filing for Chapter 11 bankruptcy protection in 2013. In early 2015, Longview Power reached a settlement of all construction claims and emerged from bankruptcy with a rehabilitation of the unit underway. The plant hired Black & Veatch as the owner's engineers and overall project managers for the rehabilitation project. As part of the rehabilitation, Foster Wheeler corrected the issues with the boiler and upgraded air quality control system to handle higher sulfur fuel and Siemens completed upgrades and modifications to correct the vibration issues with the turbine generator. Additionally, the plant hired Emerson Process Management to completely replace the original DCS with an Emerson Ovation DCS. In total, Longview Power and its contractors spent $120 million on the rehabilitation project which was completed in November 2015.

Today, Longview unit 1 is one of the most efficient coal-fired plants in the United States with a best-in-class heat rate of 8,900 Btu/kWh (9,390 kJ/kWh). Longview's advanced supercritical boiler, low cost fuel source, and other project efficiencies combine to produce the lowest cost of dispatch (delivery of electricity) of any coal-fired plant in the PJM region.

Sootblowing History

Prior to the installation of the Titanium system, the plant operated pre-made sequences of sootblowers on specified timing intervals. This mode of operation resulted in the erosion of tubes in some areas of the unit and excessive slag buildup in other areas of the unit. The slag buildup was most pronounced in the platen superheater and finishing superheater as well as on the nose slope. To control the slag buildup, plant operators would periodically drop load to shed the excess slag. The large slag falls resulting from the load drop would damage the lower furnace slopes and submerged flight conveyor. These large slag falls were also responsible for more than one unit trip due to furnace pressure swings.

The plant experienced other issues as a result of their historical sootblowing practices. The unit would exhibit a noticeable swing in operation when the furnace walls would go from heavily loaded to clean after the furnace sootblowers operated. The heavily loaded operation was accompanied by an increase in reheat spray flow which negatively impacted unit heat rate. Additionally, the furnace sootblowing activity caused erosion around the wall sootblowers which required frequent pad welding to repair. The unit would also exhibit swings in operation due to the variation in sootblowing practices between the different operating shifts. As a result of these issues, the plant operations and engineering departments had to constantly observe the growth of the deposits and balance between full load operation, cleaning frequency, and operational stability.

In early 2014, Longview Power hired Babcock & Wilcox (B&W) to evaluate the unit for potential rehabilitation. B&W performed testing of the unit and reviewed all aspects of operations. Along with the other findings and recommendations, B&W recommended employing an intelligent sootblowing system to help improve unit operations and stability by providing better, more consistent heat transfer management.

Unit Description

Longview Unit 1 is a wall-fired, supercritical Foster Wheeler boiler rated at 700 MW net. The unit is a mine-mouth plant and burns run-of-mine, high sulfur bituminous coal. The boiler has platen superheat surface, vertical and horizontal reheat surface, and a parallel back-end arrangement which splits the flue gas between the horizontal reheat and primary superheat sections. Design main steam conditions are 1112 °F (600 °C) at 3495 psi (241 bar) while the design reheat steam conditions are 1130 °F (610 °C) at 4192 psi (289 bar).   Figure 1 shows a side view of Longview unit 1.

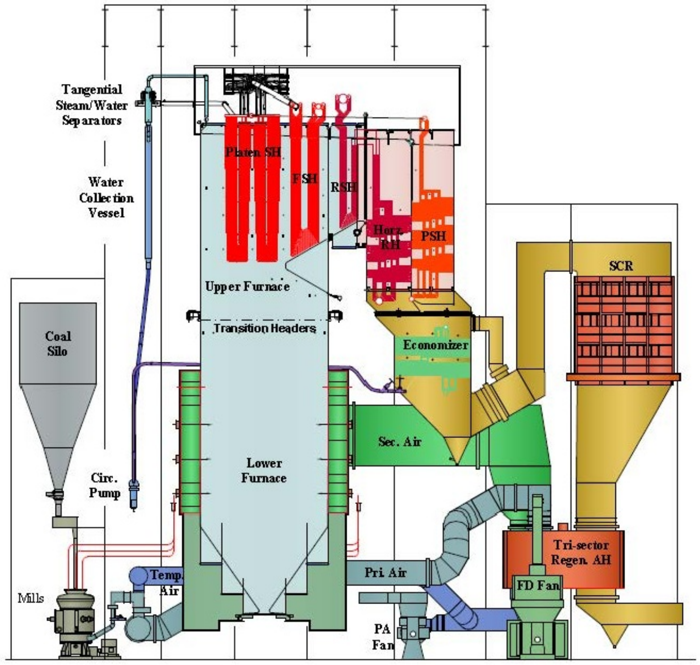

Figure 1 Longview Unit 1 Side View

Longview Unit 1 has 52 Diamond Power® IR sootblowers for cleaning the furnace walls. The unit has 70 Diamond Power long-retractable IK blowers to clean the tube sections in the convection pass. The unit also has 4 air heater blowers. Steam is used as the sootblowing medium for all blowers. All blowers are controlled by the Diamond Power SentrySeries™ control system. (Note: SentrySeries controls are now integrated into the Titanium control system offerings.)

Titanium Description

The Titanium system is a performance-based system which uses the actual heat transfer performance of the furnace and each tube bank to direct sootblowing operations. The system integrates with all sootblower control systems including DCS-based systems and is designed for fully automatic operation of the sootblowers. The Titanium system is composed of three major components: a detailed boiler performance model, a robust expert system, and a full-featured queuing system.

The boiler performance model is based on B&W's boiler design standards which have been developed from B&W's extensive experience designing, building, modifying, and testing all types of boilers. The performance model uses measured operational data and the actual design of the boiler to calculate cleanliness factors for each heat transfer section including the furnace. The model also calculates other important measures such as furnace exit gas temperature (FEGT), boiler efficiency, and heat rate.

The output from the performance model as well as plant operational data is sent to the expert system. The Titanium expert system is an easy to use and understand rule-based decision logic system. The expert system allows for the creation of different cleaning strategies for specific areas of the furnace and convection pass. The strategies can not only determine when blowing should be initiated, but also when blowing should stop and when blowing should be paused temporarily.

Once the expert system determines cleaning is needed in an area of the boiler, the sootblowers from that area are sent to the Titanium sootblowing queue for operation. The queue dynamically orders the sootblowers based on a combination of blower effectiveness and time since last operation. The effectiveness of each sootblower is based on historical data and measures how much impact a particular blower has on a target metric. After ordering, the queue operates the blowers until either the queue is empty or the expert system calls for sootblowing operations to cease.

Installation and Configuration

The Longview 1 Titanium system consists of a Windows server computer containing all required software. The server was installed in the control room to allow operators access to the Titanium graphical user interface. The Titanium system retrieves the required operational input data from the plant's PI historian via an OPC connection to the existing PI-OPC server. The Titanium system communicates with the Diamond Power sootblower control PLC via an OPC connection through the supplied RSLinx® software. Figure 2 shows the communications setup at Longview 1.

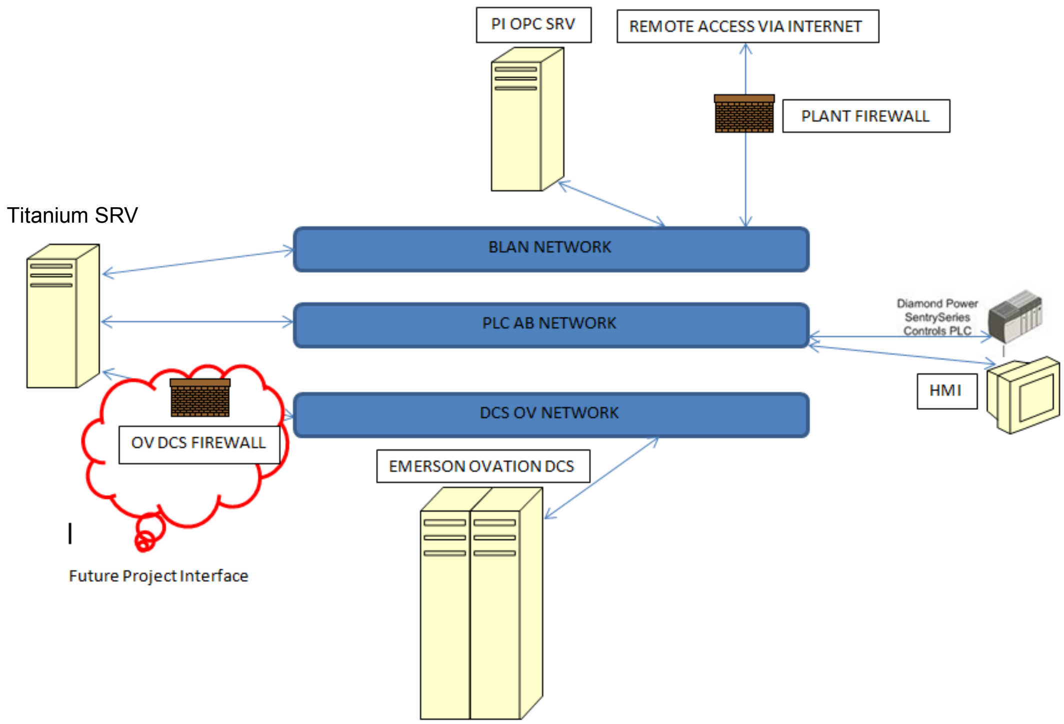

Figure 2 Longview Connection Diagram

The Titanium software was configured with ten cleaning regions in the furnace and convection pass. Additionally, the software was configured with a single cleaning region for the air heater. Each cleaning region was configured with its own set of rules in the expert system. The sootblowers in the convection pass region were set up to operate in left/right pairs. The blowers were paired up in this fashion to reduce the risk of upsetting the unit from side-to-side. The software was further configured to allow simultaneous operation of two sootblowers in the furnace, two sootblowers in the convection pass, and two sootblowers in the air heater.

The Titanium system was initially installed in mid-2014, but was not ready for full operation until September 2015 due to instrumentation and plant operational issues. The plant rehabilitation project delayed getting the Titanium system tuned and in full-time automatic operation until mid-January 2016.

Results

Plant operators and engineers have seen a number of benefits and improvements since bringing the Titanium system online. They have not had to drop load to shed slag and have not experienced any large slag falls. The plant hasn't had a forced outage from furnace pressure swings since operating with the Titanium system. Plant engineers also believe they have seen an overall reduction in sootblower operations even though some areas, such as the nose arch, are being cleaned more frequently. The change in sootblower operations is difficult to quantify because the blowers were operated in large sequences prior to the Titanium system. Plant engineers have seen an improvement in unit stability due to the consistency of sootblowing operations across all loads and operating shifts. Plant operators like the way the Titanium system cleans the unit and rarely operate the blowers manually. Other specific results are discussed in the following sections.

Unit Cleanliness

The cleanliness factors for each of the major heat traps in the boiler are shown in Figure 3. The data shown in the figure is for operation above 770 MW gross. Figure 3 demonstrates that unit cleanliness is being maintained even though overall sootblower operations have decreased. The decrease in cleanliness of the platen and secondary superheater (SSH) sections from November 2015 through January 2016 was caused by initial Titanium tuning adjustments.

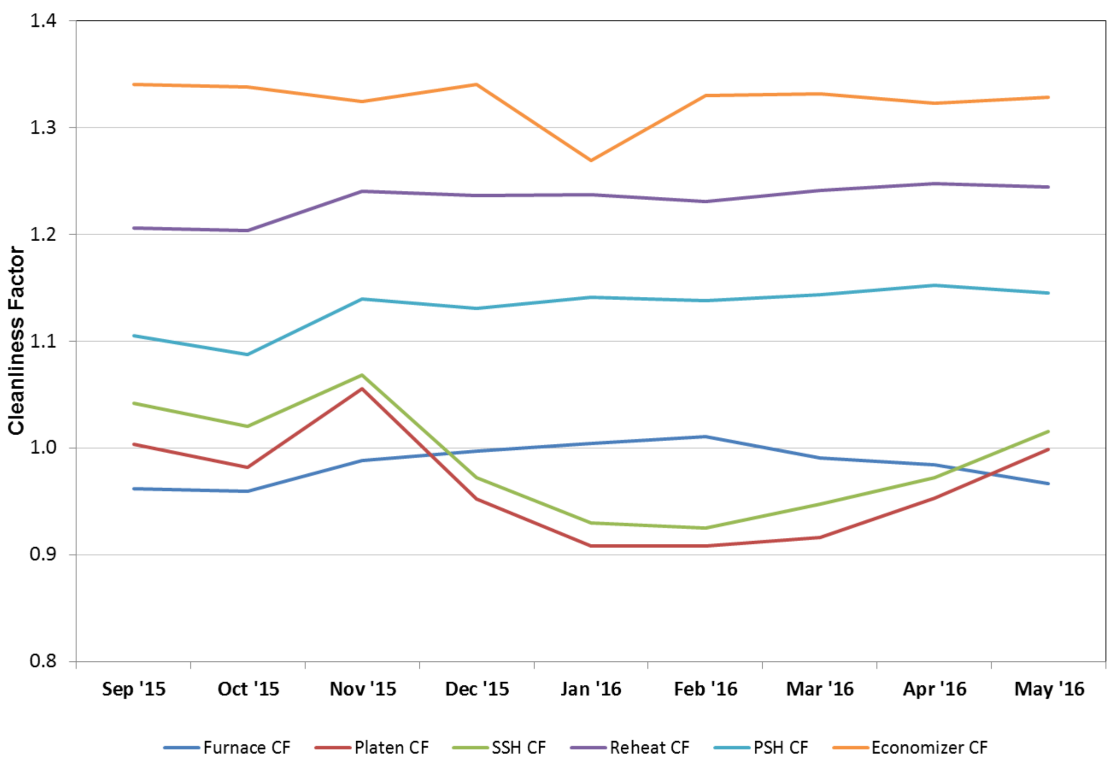

Figure 3 Unit Cleanliness Factors

Furnace Exit Gas Temperatures

The gas temperatures exiting the furnace are shown in Figure 4. The data shown in the figure is for operation above 770 MW gross. PIGT is the platen inlet gas temperature and is defined as the exit plane which extends from the nose arch to the front wall of the boiler. FEGT is the furnace exit gas temperature and is defined as the exit plane which extends from the nose arch to the roof of the boiler. The figure compares the average PIGT and FEGT for the period September 2015 through January 2016 (before Titanium was operational) to the averages for the period February 2016 through May 2016 (after Titanium was operational). Both PIGT and FEGT show a slight improvement (lower temperature) with the Titanium system in full operation.

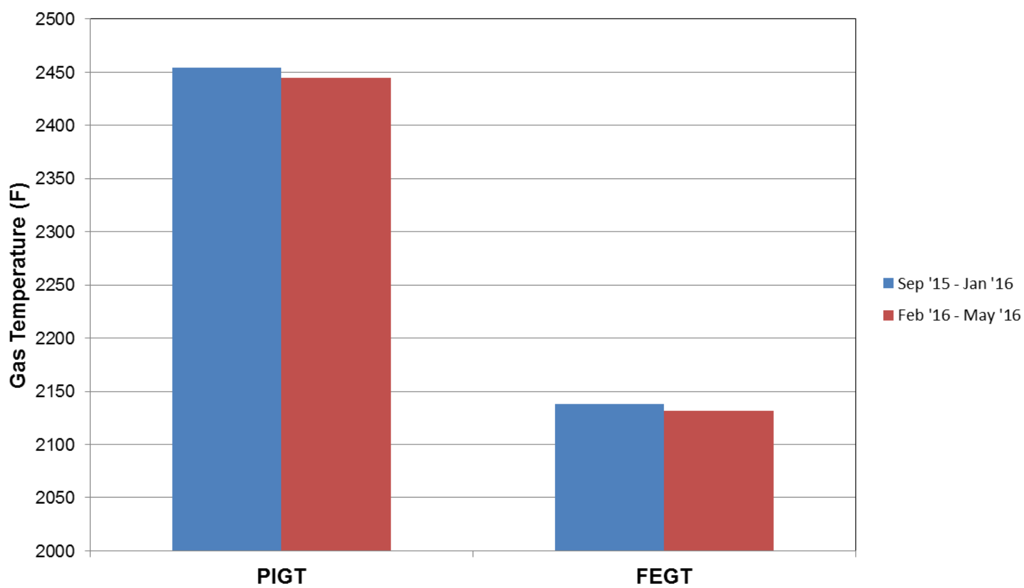

Figure 4 Furnace Exit and Platen Inlet Gas Temperatures

Reheat Spray Flow and Unit Heat Rate

The reheat spray flow and unit heat rates are shown in Figure 5. The data shown in the figure is for operation above 770 MW gross. The reheat spray flow was reduced significantly as a result of the Titanium system. This is because the Titanium system does a better job of managing the heat transfer in the components upstream of the reheater. The upstream components are absorbing more heat which reduces the burden on the reheater and subsequently reduces the amount of spray required to control the reheat steam temperature. The reduction in reheat spray flow was accompanied by an improvement (reduction) in unit heat rate as seen in Figure 5.

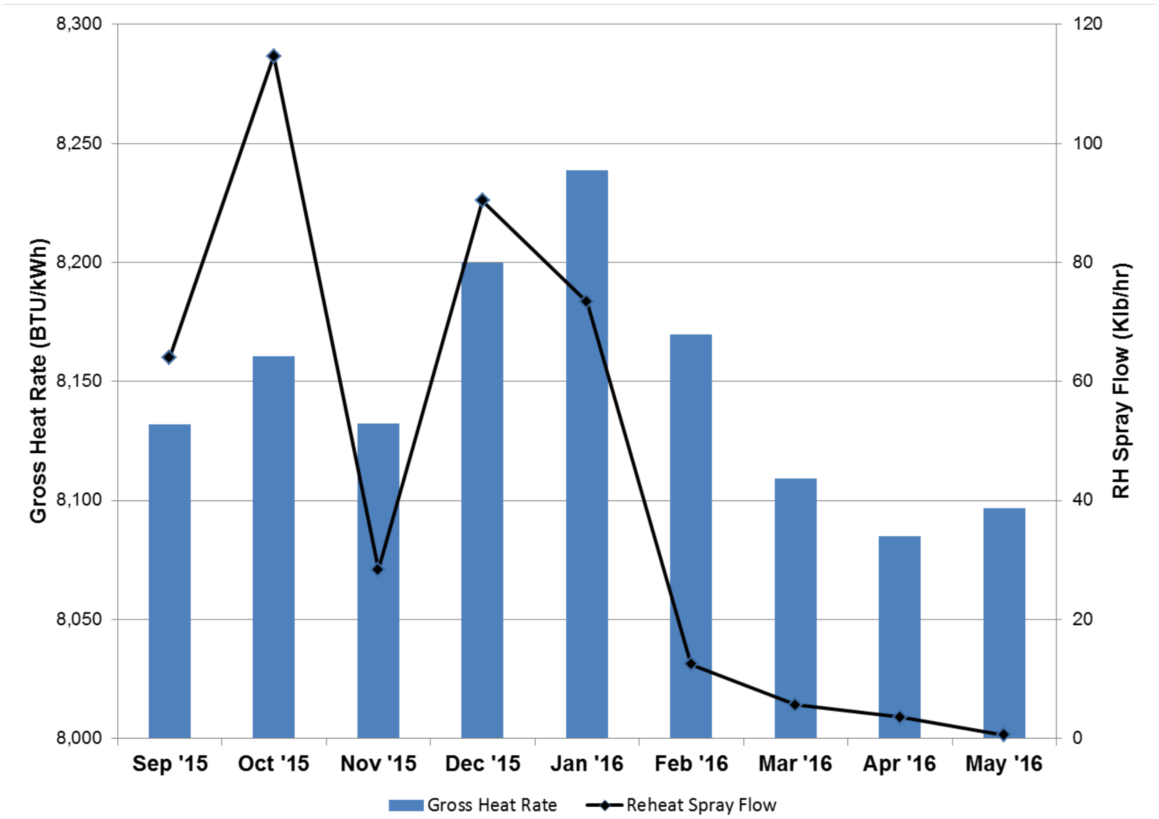

Figure 5 Reheat Spray Flow and Unit Heat Rate

Conclusion

The Titanium intelligent sootblowing system was installed on Longview unit 1 to help control slag accumulation and improve unit operations and stability. The system was configured to run a real-time, detailed boiler performance model to determine the heat absorption throughout the unit. The system was also configured to control pairs of blowers in seven different cleaning regions. Each cleaning region was configured with its own cleaning strategy using the Titanium expert system. Once in full operation, the Titanium system eliminated the need for periodic load drops, reduced sootblower usage, reduced reheat spray flow, improved unit heat rate, and stabilized unit operations. The Titanium system helps make Longview unit 1 one of the most efficient, low-cost coal-fired plants in the United States.

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