Integrated Boiler and Emissions Reduction Equipment Optimization (SNCR)

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KEYWORDS

Boiler, Combustion, Emissions, NOx, Power Plant, Optimization, Fuzzy Logic

INTRODUCTION

This paper will describe the SNCR optimization project at Wagner Unit #2 that significantly reduced the overall NOx emissions for Unit #2.

Constellation Energy owns and operates a national fleet of generating plants diversified by fuel, geographic location, and technology. The portfolio includes plants powered by coal, natural gas and oil, as well as green technologies, including geothermal, solar, hydroelectric and biomass. Constellation Energy owns approximately 8,700 megawatts of generating capacity in eight states with nearly 52 million megawatt-hours produced annually. The Maryland fleet is at the leading edge of Constellation's continuous efforts to minimize their impact on the environment.

Constellation Power Generation was interested in gaining the maximum benefit of the newly installed Selective Non Catalytic Reduction (SNCR) technology at the H. A. Wagner facility. Wagner Unit #2 is one of four generation assets at Wagner Site that has a capacity of 1,020 MW. Wagner unit #2 is a 1959 vintage B&W front wall fired boiler with a GE 136MW turbine operating at 1800 psi with 1000 degree F Superheat and Reheat temperature design parameters. Managing this environmental equipment with the Maryland annual NOx cap goal for the plant was a unique operational challenge. The SNCR uses Urea for an in-furnace reaction to reduce NOx.

The SNCR optimization project at Wagner Unit #2 was coupled with the new equipment, revised operational goals, and control system revisions required for the SNCR integration and automated operation. The SNCR optimization project at Wagner Unit #2 was found to significantly decrease the NOx removal from the injection of the reagent in the furnace coupled with a new type of adaptive optimization system that significantly reduced the overall NOx emissions.

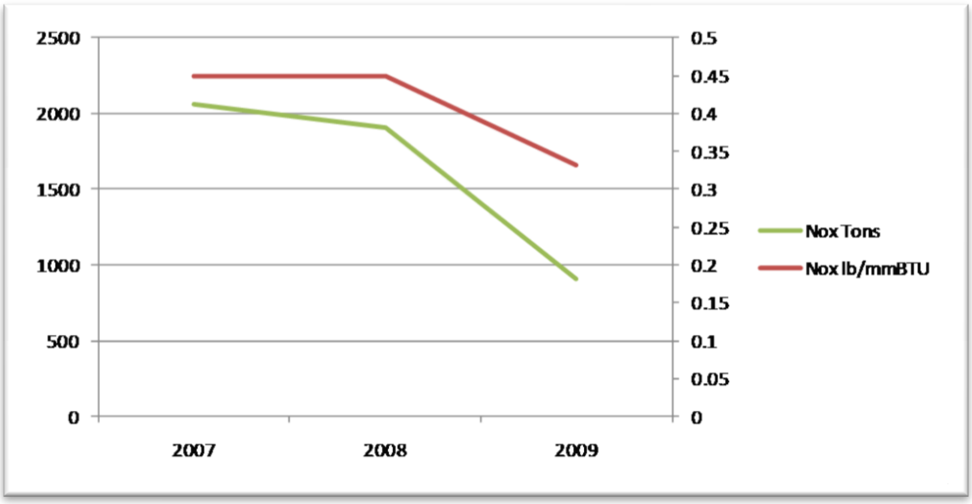
This paper will outline the results and benefits of using optimization technologies to keep the SNCR and boiler operating at the most efficient set points.

PROJECT RATIONALE

Utilities have several methodologies available to them to reduce the NOx emissions of a generating unit from fuel switching, mechanical revisions of the boiler such as over fire air and burner upgrades all the way to adding selective non catalytic reduction system and finally complete selective catalytic reduction systems of one, two or three catalyst elements. Constellation chose a SNCR system for H.A. Wagner #2 based on cost to benefit ratio. The plant already had a successful NOx software system provided by Emerson, and just need a little more NOx reduction to meet the upcoming state of Maryland cap on NOx emissions.

WAGNER UNIT 2 OPERATING PROFILE BACKGROUND

The EPA data history of the NOx emissions of the HA Wagner Unit #2 from 2007-2009



Data source:http://camddataandmaps.epa.gov/gdm/index.cfm

Figure 1

The Unit operational profile was not disrupted during the commissioning or installation of the optimization system. Below in Figure 2 the unit generation statistics are indicated. This unit participates in the PJM ISO region.

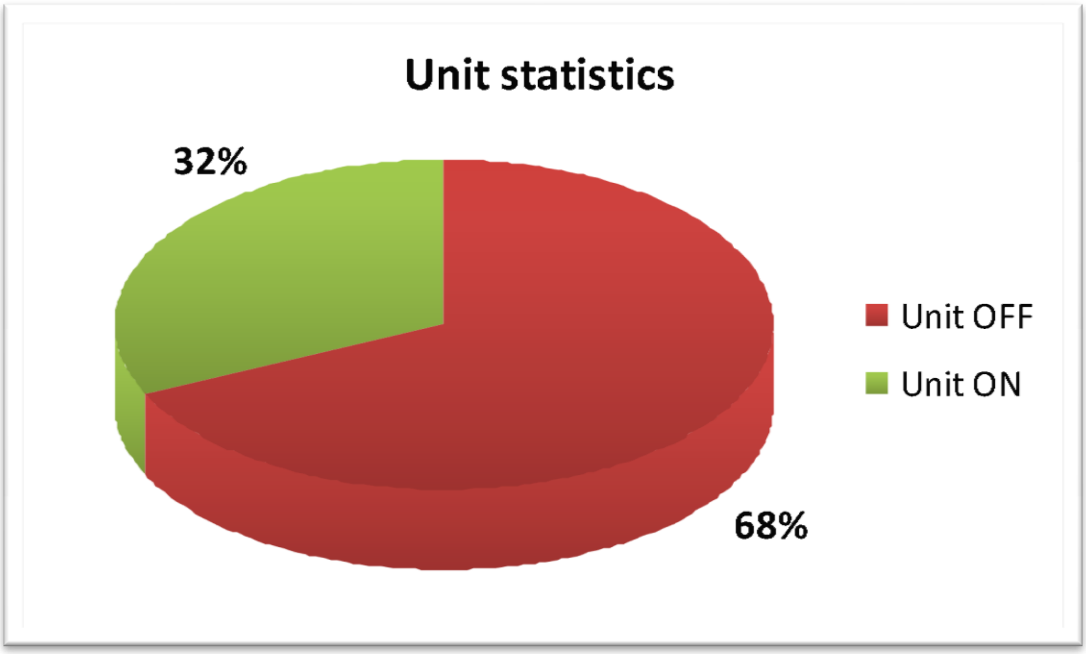


Figure 2

Theory Of Optimization

Optimization Model

The optimization algorithm is a unique technology under the patent application process. The Stochastic Immunological Layered Optimization (SILO) system a self-learning, controller that helps optimizes plant's processes in the on-line mode. SILO performs on-line economic optimization of various process operation points. Due to unique combinations of various control techniques, SILO can easily deal with process transition states as well. The SILO system is a new, very efficient solution in the process optimization and control field that is inspired by operation of the immune system. The self-adapting knowledge base developed by this approach creates a solution that efficiently adapts to current process operating points. The SILO system is able to handle process non-linearity, as well as changes of process characteristics considered in a long-term horizon, resulting from wear or failure of devices, plant modernizations, and changes of chemical properties of components used in a process or as external conditions change.

Design, Implementation, and Commissioning Of The Boiler Combustion Optimization System

The integration is engineered to seamlessly permit the optimization system to switch between SNCR on or SNCR system off and continue to run with NOx minimization as the primary goal. The SNCR switch is an operator selected mechanism.

DCS Control Modifications

The first major step of the optimization project was defining and implementing the DCS control modifications which would permit the optimization system to apply supervisory setpoints where operations staff would normally have an adjustment window.

System Graphics

Following graphics were provided as interface to the Combustion Optimizer to facilitate the running of the combustion and SNCR optimization strategies. Figure 3 is the operator DCS level display designed by the project team using the previous optimization system display as the basis for the new SNCR optimization.

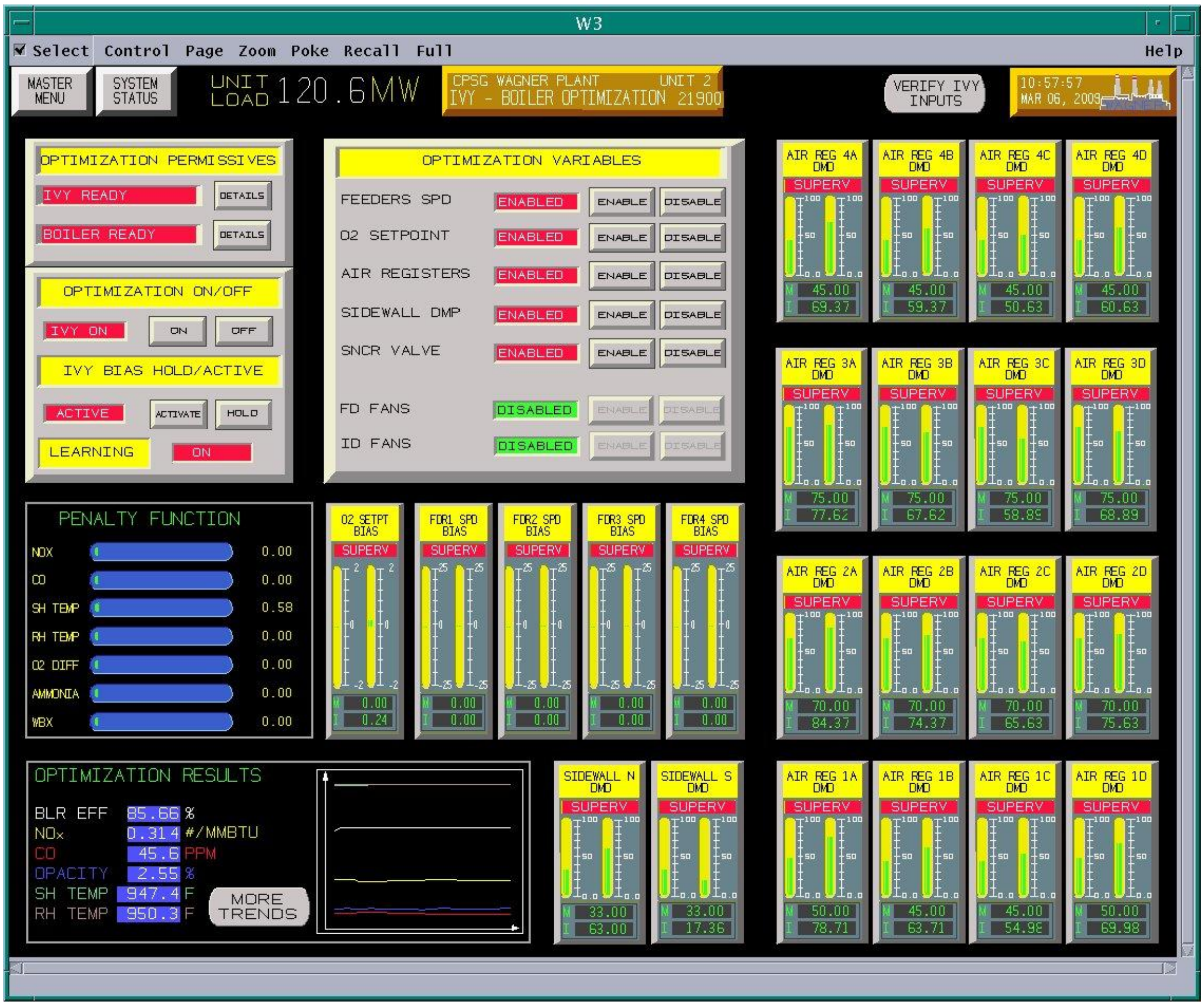


Figure 3

Parametric Testing

This new technology eliminates manual parametric testing, and this novel feature enables a faster deployment and operational readiness than previous technology like neural network based systems.

Model Building and Open and Closed Loop Testing

After initial set up was completed, data analysis was performed on the system responses and models of those responses are built by the application for the combustion model.

Commissioning Tests and Results

The final step in the combustion optimization project was to execute a series of "ON/OFF" tests to benchmark the results of the optimization system. The basic methodology for the ON/OFF tests was to run the unit at stable loads for a period of time (between 3-4 hours) for each MW level.

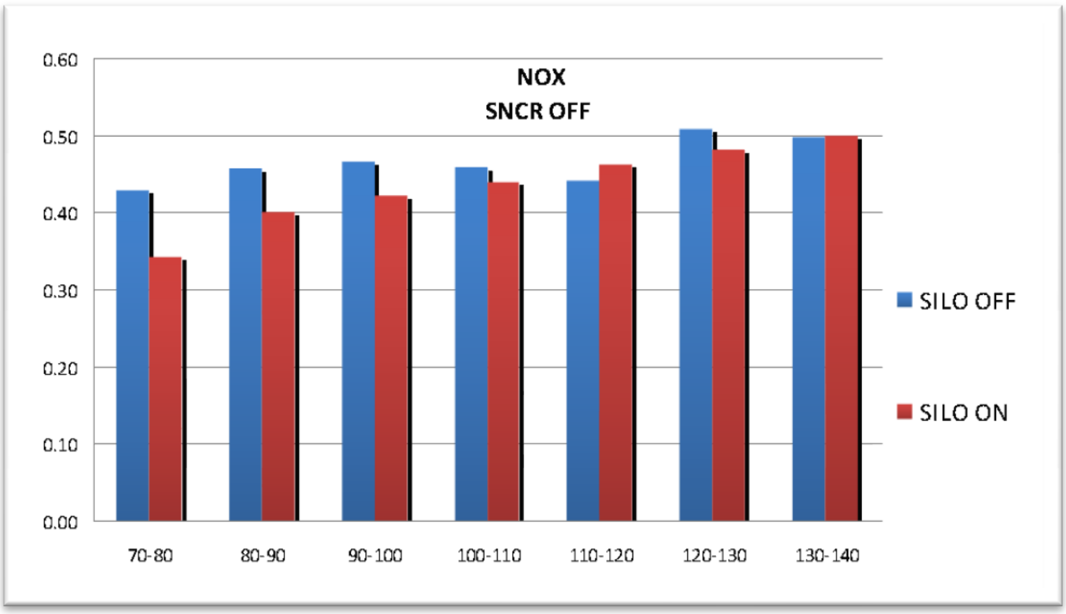


Figure 4

The following information shows the performance with the SNCR in service.

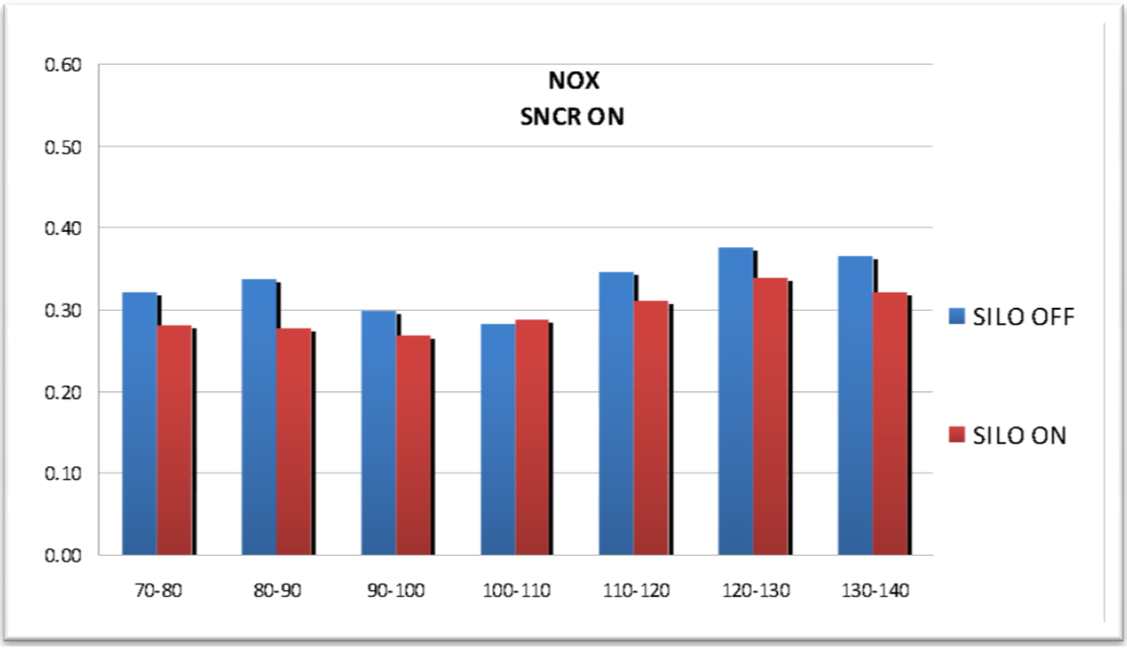


Figure 5

The commissioning tests included the carbon monoxide levels as found in Figure 6 below.

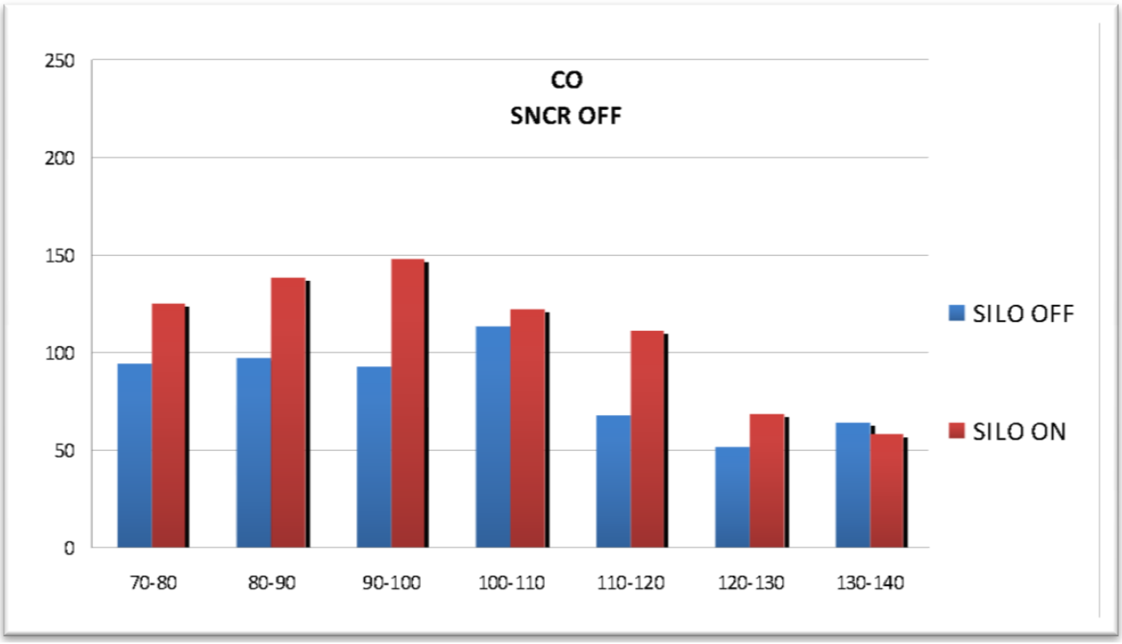


Figure 6

The urea usage with and without the optimization system was analyzed as well. Please refer to the table shown in figure 7. The operation with combustion optimizer ON showed urea usage was reduced on average 2.2%

	SNCR ON	
MW	**SILO OFF**	**SILO ON**
0-80	46.75	45.21
80-90	51.41	49.67
90-100	55.17	56.42
100-110	74.54	70.29
110-120	84.12	82.37
120-130	87.33	88.61
130-140	95.89	91.47
Average	**70.75**	**69.15**

SNCR ON urea usage tabular data.

Figure 7

Overall Project Conclusions

The combustion optimization system will help meet current emission regulations as well as more stringent regulations which may come into effect in the future. The combustion optimization system will optimize the combustion process with a software system that is very user friendly, very flexible with an easy to use web interface. The combustion optimization system with SNCR system ON was able to reduce the NOx emissions to an average value 0.298 lb/MMBTU compared to 0.332 lb/MMBTU with optimization system off-line.

The combustion optimization system with **SNCR** system **OFF** was able to reduce the NOx emissions to an average value **0.435** lb/MMBTU compared to **0.465** lb/MMBTU with optimization system off-line.

With SNCR system in service the optimization system was able to maintain the RH and SH steam temperatures at or above optimization targets. SH temperature averaged at 962F at high load (net MW >130) and 920 F at low load (net MW<80). RH temperatures averaged at 943 F and 855 F for high and low loads respectively.

Boiler efficiency averaged 85.76 with optimization ON and 85.25 with optimization OFF.