NOx Control Implementation
at
Deseret Power, Bonanza Station

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Introduction

Deseret Power is a member-owned, regional electrical cooperative providing power to over 40,000 people in six member systems throughout Utah, Wyoming, Colorado, Nevada and Arizona. The Bonanza Power Plant is a coal fired, 485 MW unit. The Foster Wheeler Boiler has five pulverizers in an opposed firing arrangement. The boiler does not have overfired air but has burners with low NOx nozzles.

In May 2000, the Unit completed a change out of the main turbine rotor to a new ruggedized rotor design. During this same outage, we replaced three pulverizers with B&W 89G+ mills; the controls were migrated to a Foxboro DCS system as well.

Project Background & History

We installed larger pulverizers in 2000 due to having to burn a lower quality of coal at the plant while maintaining the same rated steam flow. One of the effects was increased NOx output from the boiler. The EPA rules for New Source Review are baselined on the NOx production at the plant during the previous five years rather than actual permitted limits. In order to avoid a New Source Review by the EPA we needed to be able to stay under the NSR limit even though it is below our permitted limits. During the first few years after the outage, we kept below the NSR limits, but with continually decreasing coal quality, our ability to control NOx pushed the limits of our equipment.

We formed a team from Operations, Engineering, and E&C to evaluate and recommend solutions to help us in NOx control with minimal impact on Unit efficiency, availability, and capacity. We evaluated various approaches – mechanical vs. control based.

The recommendation from our team was to implement the CombustionOpt, the neural-network-based combustion optimization system from NeuCo. Our primary reasons for this choice were CombustionOpt's record of accomplishment in implementation, and NeuCo's ability to deploy their product without a unit outage or ramping for extensive parametric testing. In addition, there was the benefit of a potential integrated plant optimization system, which could extent the results seen in our boiler to other areas of the plant.

Implementation of a Combustion Optimization System

To get the CombustionOpt system up and running, there were a few hurdles to overcome. The first was to have something that would interface with the DCS, reading data in as well as the ability to write data back to the DCS. Our present DCS historian could not write data back to the DCS. We then installed an OSI soft PI historian as a secondary historian. The next step was to determine which controls we would allow CombustionOpt to manipulate and constraint ranges for each control point. We ended up with 43 manipulated variables with very conservative constraints.

The next step was to work with Operations personnel and develop models that reflected how the plant actually functions to obtain the desired results. NeuCo created the initial models. Plant personnel created subsequent models after seeing the effects of the various models and the desired outcomes. We learned how to focus the models to certain variables and constraints because the easiest way to achieve, lower NOx in this case, is not always the most desirable way. By selecting which manipulated variables used in each individual model, we could have the Neural Network bias controls in the area where we wanted it to function.

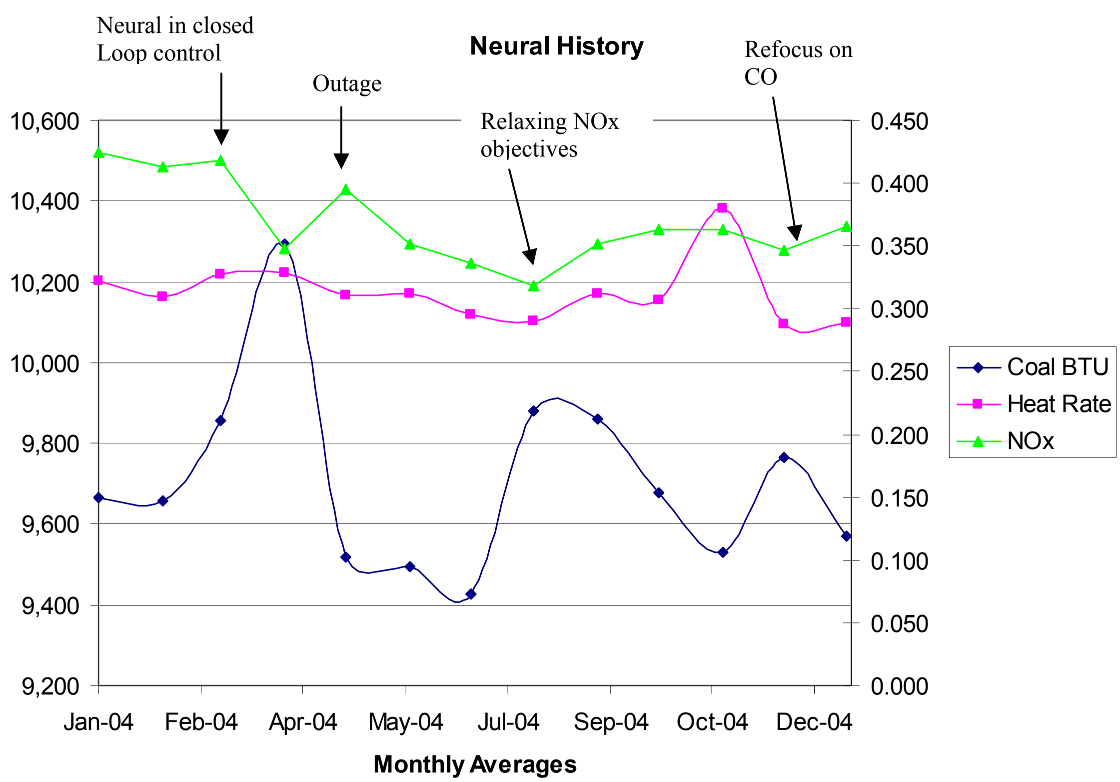
A schedule was setup for DOE (Design of Experiment) where subsets of control points were enabled so the neural network models used by the combustion optimizer could learn the relationships of that subset of variables. Model training went on for several weeks.

During this time, the Operators were educated on what the system would do for them as well as how the system was affecting unit operations. This interactive approach helped us to refine both the models and constraints used.

Results to Date

Prior to the CombustionOpt implementation, NOx averaged around 0.43 lbs/mmbtu. Currently we run around 0.35 lbs/mmbtu. During the implementation phase, we allowed CombustionOpt to take NOx as low as it could. We were able to achieve a NOx level of 0.26 lbs/mmbtu but with a large increase of LOI and CO. Once we achieved our goals for NOx control, we then shifted the focus of CombustionOpt to improving boiler efficiency and lowering CO. With the highest priority models focused on boiler efficiency, we gained as much as 1.5% efficiency. Later on, we added new models to focus on CO and lowered our CO by nearly half.

In order to get a good balance between opposing priorities, our boiler efficiency increase normally runs near 1%. The chart below shows the monthly averages from the beginning of 2004 through January 2005. One of the first things you might notice is that we have a lot of variation in the coal that we burn in the plant. If you follow the heat rate line you will see a peak around October 2004, where a large amount of rain occurred in what is normally a very dry climate, causing a large impact on unit heat rate.



Keys to Success and Sustaining Benefits

The major factor in making a project of this kind successful is in its acceptance by those who are using it. This requires several things: management support, responding to Operator concerns, the ability to make changes to the Neural Network parameters, and some demonstrable improvement to make all the effort worthwhile.

The Operators that run the Unit can make or break a project of this type. They have control of enabling the system and/or individual points. If they are not convinced and motivated to use the system, no real results will follow. This requires having at least one person who can work with Operations and the vendor so that there is open communication, to address Operator needs and system configuration. When there is adequate feedback to the Operators to show them the benefits of using the system they will then become advocates of it and help in its continuing success.

How the Project Fits Within the Plant's Overall Goals

Now that we have had the combustion optimization system in place for over a year, we have been able to refocus the system several times to the changing plant goals and constraints. Due to the beneficial results achieved so far, we are in the process of adding drives and controls to our lower furnace air ports (underfire air). Experience has shown us that these have a large impact on the operation of the boiler and with our experience with CombustionOpt's Neural Network; we feel it will enhance our ability to achieve our future goals.

Concurrently with CombustionOpt, we have been working with NeuCo on deploying their PerformanceOpt solution that uses on-line, first principles-based models to measure unit/equipment performance and identify potential areas for improvement. This will allow us to accurately monitor unit performance, provide real-time feedback to the Operators on how well the plant equipment is functioning, and prioritize actions to address any performance gaps. We plan to use this to deliver shift performance reports to the Operators and Management.

We are also exploring using a Neural Network system to help us in our wet scrubber to improve limestone utilization. Limestone is our second largest consumable product after coal and can have a large impact on plant O&M cost.