ControlSoft INTUNE+ Process Navigator recently optimized a 350 MW coal-fired power generation unit for one of the fastest growing power companies in China. This power producer had been experiencing performance issues with boiler response, load changes, and main steam pressure regulation. By using INTUNE+ control monitoring and diagnostic software, the process was optimized within one week, and is capturing up to an additional $300,000 in annual revenue from improved steam temperature performance and better ramp rates.

The primary unit performance issues centered on the instability of superheat temperature and main steam pressure. While technically adept, the plant staff were not able to tune these critical boiler loops for optimal response during load changes. ControlSoft’s INTUNE+ deployment and applications team, which possesses a deep domain expertise in power generation process control, was contacted and, after review of the situation, quickly established communications to the plant DCS, and initiated analysis with its INTUNE+ software.

INTUNE+ indicated control deficiencies at several load levels, and provided a clear path to operational improvements. Relying on the documented analysis, the applications engineers implemented the needed improvements to drive immediate results in boiler stability and response. ControlSoft then deployed INTUNE+ KPI diagnostics to continuously monitor the performance, document improvements, and detect any degradation that might occur over time.

ControlSoft’s technical expertise in power plant engineering and sophisticated diagnostic software applications proved to be exactly what was needed to stabilize the unit performance. The team of engineers and industry consultants applied their technical expertise in power plant control and strategy development, as well as their deep experience in fault diagnostics, to diagnose and identify profitable solutions to hidden process performance issues.

In this case, the INTUNE+ software was deployed for boiler optimization, and the unit experienced improved control for both main steam and reheat steam temperatures. The resulting unit performance was stabilized, and the unit finally achieved its desired Automatic Generating Control (AGC) ramp performance.

**Looking for Answers in all the Right Places**

The INTUNE+ package was applied to a coal-fired, single furnace, single drum, natural circulation 350 MW Unit boiler operating at subcritical pressure with a single reheater. The reheater includes a spray desuperheater located at the inlet. Normal steam temperature is controlled by flue gas recirculation. The control is a supervisory system in CTF (Coordination by Turbine Following) mode for the CCS (Coordinated Control System).

INTUNE+ was used to tune all of the core PID loops, evaluate loop performance, and monitor the entire CCS functionality over a two-day analysis period.

The focus of this optimization effort was 50 key control loops within the plant, including fuel, steam temperature, furnace, flue gas, turbine, and unit coordinated control. These loops were tuned and maintained with INTUNE+ via real-time monitoring that ensures that control performance remains at optimal levels.

If degradation of loop performance occurs, INTUNE+ diagnostics deployed at the plant can be used to pinpoint the source of the degradation the moment that it begins to occur.

The power of the INTUNE+ system lies in its ability to seamlessly identify the true process dynamics of the monitored system. At this power generation facility, INTUNE+ safely connected to the real-time data on the unit’s control system, and collected and analyzed the relevant process data to identify the appropriate performance models of the plant.

INTUNE+ then automatically generated robust PID parameter values for the monitored applications. Once optimal PID parameters were in place, the performance of the targeted controllers improved dramatically.

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Stabilizing Steam Temperature on a 350 MW Coal Unit

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Eliminating the Excursions
A comparison of the main steam temperature control is a key indicator of the project effectiveness. Over a two-day analysis period, the superheat temperature achieved and maintained a 75% reduction in variability during normal operation (from 10.8 degrees F to 2.7 degrees F) and an 83% reduction in variability during coal mill startup (from 21.6 degrees F to 3.6 degrees F). Even during periods of large load disturbances, main steam temperature was maintained within 5 degrees F and the actual Average of Absolute Error (AAbsE) of the reheat steam temperatures was less than 4 degrees F. This drastic variability reduction is now translating into significant financial benefits for the plant, estimated at up to several hundred thousand dollars annually. (See Trend Displays.)

Here’s how: Before INTUNE+, process fluctuations often caused operators to input lower value setpoints to ensure that superheat temperature would not exceed upper limit design constraints. Temperature excursions above the design limits also shorten boiler tube life, and can lead to increased unit shutdowns. By reducing the variability of major control loops and maintaining the improvement through continuous monitoring, the staff can now safely increase the setpoint on superheat steam temperature.

According to various studies conducted by EPRI over the last two decades, it is estimated that every 1 degree of safe increase of superheat temperature allows for almost an entire extra MW of production, translating into approximately $300,000 of additional annual revenue for a 350 MW fossil-fired station.

Real Results - Benefits Beyond the Boiler!
Improving the control response and stability of the fuel, steam temperature, furnace, flue gas, turbine, and unit coordinated control applications led to multiple key benefits for the plant beyond more profitable steam temperature control. These included:

- Enhanced overall unit stability. Before tuning, the main steam pressure variations were greater than 0.2 Mpa. After tuning, variability was reduced to less than 0.1 Mpa.
- Greatly improved air-fuel ratio. The remaining oxygen error (i.e., [SP-PV]) of the furnace was maintained within 0.3%.
- Faster ramp rates with smoother responses to load changes (now achieving 2.2% per minute, nearly 8 MW/min, with less than 2% overshoot).
- Safely achieved stability target requirements for AGC.

Maintaining Optimal Performance for Long Term
While unit tuning was the key to optimization for this 350MW coal-fired plant, identifying problems and pinpointing the root causes of degradation as soon as they begin will be the key to maintaining this outstanding performance. Diagnostic tools that allow the user to actually see vital performance information in real time help to accomplish this goal efficiently, proactively, and cost effectively. INTUNE+ provides such diagnostic tools that summarize and then visualize critical performance information so that users can maintain their operational gains and continuously improve.

These tools include a suite of over 100 common Power Plant KPIs - from heat rate to EFOR - that can be calculated automatically in real time, as well as the ability for users to create their own plant-specific KPIs. This same suite of tools can also help to pinpoint potential areas of process improvement and predict degradation before it can be detected in HMIs and historians. Visualizing all of this in real time allows for a more efficient use of plant resources to correct issues in their order of economic priority to the plant.

Instead of a traditional reactive response, which usually results in downtime and potential safety issues, plant staff will now have predictive control performance diagnostics to mitigate failures and further impact the bottom line by reducing costs and increasing efficiency.

Big Gains from the Best Technology
All power company management teams are aware that safe and reliable operation translates to a strong bottom line through higher efficiency and lower total costs. Additional energy output (created by more production time with reduced maintenance costs from reduced equipment wear and tear) is a direct result of a more stable unit.

Using extensive technical expertise and the sophisticated INTUNE+ tuning and diagnostic tools, the ControlSoft team was able to stabilize the performance of this 350MW power generation unit through a variety of operational modes. Ultimately, this optimization improved overall unit stability and achieved the goals for the unit’s desired AGC ramp rates and primary frequency regulation. In addition to responsively reacting to changing demand load, the unit operators reduced costs through improved efficiency and lower maintenance costs. Total annual financial benefits for the project are estimated to be worth up to $300,000.

This one-week project stands as another example of ControlSoft’s unique ability to provide major performance gains in short periods of time with outstanding technologies for the power generation industry.

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