Illinois Power's Online Operator Advisory System To Control NO_x, Reduce LOI And Improve Boiler Efficiency

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Summary

Introduction

In the spring of 1995, Illinois Power Company (IPC) inaugurated a program to reduce NO_x emissions at the utility's fossil fired plants in compliance with the 1990 Clean Air Act Amendments (CAAA) and at the same time improve the thermal performance of their generation units. After installing low-NO_x burners on two Phase I units, an important element of IPC's strategy was to utilize advanced optimization technology to achieve their compliance and performance objectives. A technology that would enable simultaneous achievement of both objectives would allow IPC to meet its NO_x emission targets while securing cost savings and a rapid return on investment. The solution should also provide for continuous improvement and response to boiler system dynamics through an online, operator advisory capability.

IPC launched the first stage of its program by optimizing the boiler combustion of Unit 2 at Hennepin Power Station. The utility commissioned Ultramax Corporation to apply its ULTRAMAX® Dynamic Optimization, an "intelligent" software-based approach[1], to tune the operation of this boiler. Unit 2, which has separate reheat and superheat furnaces, is a tangential, coal-fired boiler rated at 235 MW. The initial evaluation project had dual objectives of NO_x reduction and boiler efficiency improvement while maintaining LOI and other parameters at acceptable levels.

Dynamic Optimization was first applied in stand-alone mode at full load and resulted in NO_x reductions of more than 15% from previously untuned baseline conditions, a boiler efficiency improvement of more than 2%, and maintenance of LOI levels from both the reheat and superheat furnaces at below 2%. Similar results were obtained at low load conditions. IPC can now average Unit 2 with two other Phase I boilers that were retrofitted with low-NO_x burners. Using tuning as a part of its compliance strategy saved $9.4 million in avoided cost of low-NO_x burners.

In addition to tangential units as at Hennepin, ULTRAMAX has been applied to opposed-wall[2], cyclone[3], turbo, and cell types of boilers as well as boilers fired with coal, gas[4], oil[5], and fuel blends[6]. It has often been applied in stand-alone mode to problematic boilers to determine their true improvement potential in NO_x emissions[7], efficiency and LOI. It has been effective in improving performance and reducing ammonia slip on an SNCR unit[8].

The Hennepin Online Operator Advisory System

In September 1996, IPC installed ULTRAMAX Dynamic Optimization on Hennepin Unit 2 in integrated, online Operator Advisory System mode. Integration with the Westinghouse WDPF II Distributed Control System (DCS). greatly enhances the value of the Dynamic Optimization technology as a support tool for the operator when operating conditions change, and it serves as a means of simplifying data entry and model updates. This continuous use of an integrated solution offers the opportunity for greater emissions control, fuel savings, and the ability to respond rapidly and flexibly to changes in operating conditions, compliance regulations, and the market

environment. The Advisory System enables the operator to respond to changing load and fuel conditions, burners out of service, mill conditions, and other situations that affect performance. Models are updated daily with operations data to reflect the current status of the boiler system.

Putting the Advisory System to Work

The Hennepin staff continues to develop and incorporate additional models to support a variety of operating scenariosto complement the initial full load models. In the strategy employed at Hennepin, the operator can collect data and build models according to scenarios reflecting fuel variations as well as the number and type of mills in service.

The ULTRAMAX/WDPF advisory system is tailored to fit the operating practices of the plant. Only the software functions that are most relevant in assisting the operator are available on screens designed with a familiar "look and feel". This customization greatly reduces the training and transition time the operator needs to become comfortable using the system.

Hennepin Station also has the capability for advancing to full automation in a closed-loop supervisory control mode with ULTRAMAX Dynamic Optimization. This would allow the software to automatically collect data and implement new control settings directly to the DCS without operator intervention.

The strategy employed by the staff at Hennepin is to create models for each burner configuration and its associated load range. When load is reduced sufficiently that a row of burners is taken out of service, separate models are created from data for each combination of rows of burners. Likewise, co-firing or blending of fuels, such as petroleum coke, cause differences in combustion so this data is also segregated and individual models created for each condition. In this way, the plant can operate at its best regardless of the conditions at that time. Significant improvement was achieved with burner configurations of two, three and four rows in service including 15% blends of petroleum coke.

Conclusions

The 1997 NO_x emission level for Unit 2 was 0.498 lbs/MBtu meeting the present operational constraint of 0.50 lbs/MBtu imposed on the ULTRAMAX Operator Advisory software while boiler efficiency was up by 3%. LOI continued to be maintained below 2%.

The successful utilization of ULTRAMAX Dynamic Optimization technology at Hennepin Power Station has provided IPC with solid evidence that:

1. Dynamic Optimization is an effective approach to rapidly optimizing a boiler unit to achieve multiple objectives of NO_x control, boiler efficiency improvement and LOI maintenance.
2. The Operator Advisory System can be effectively utilized by operations personnel as a support tool for continuous improvement and response to changing conditions.

As a result of the success with Unit 2, IPC is now moving ahead with similar Operator Advisory Systems for all of its fossil-fired generating units. The implementation of these systems is scheduled for completion at all five plants by late 1998. With these tools in place, IPC will be in an excellent position to meet the competitive challenges of a deregulated electric industry, as well as to respond to changing emission compliance requirements

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