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OnLine

Substantial progress shown in Clean Coal Initiative results

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When the Department of Energy (DOE) and NeuCo, Inc., a leading provider of optimization software solutions, announced a $19.1m technology development initiative to deploy and demonstrate integrated optimization software systems at Dynegy's Baldwin Energy Complex (Baldwin), most people believed that it would take all of the four years budgeted for the project to see significant results. Now, six months after officially beginning the Clean Coal Power Initiative (CCPI) Round 1 project, NeuCo has announced substantial progress that is making even the doubters take notice of the work being done in Southern Illinois.

At POWER-GEN International, NeuCo and Baldwin announced that they have been able to optimize combustion with models developed for cyclone-specific stoichiometry, measure and model ammonia (NH3) using a UniSearch tunable diode laser, and develop highly accurate NOx models using flame quality/flame scanner outputs at Baldwin's two 600 MW cyclone fired units. Through these initiatives, NeuCo and Baldwin have been able to substantially stabilize cyclone performance, reliability and SCR response with a consequential reduction of stack NOx.

Project Overview

The CCPI is a ten-year, $2bn initiative to demonstrate advanced coal-based power generation technologies in the field that could help meet President Bush's "Clear Skies and Climate Change" directive to reduce power plant emissions by about 70 per cent by 2018.

CCPI Round 1 entails a cost-shared partnership between the industry and government, such that NeuCo will shoulder 55 per cent of its $19m project cost while DOE will provide the remaining 45 per cent, which will be repaid from commercial sales of the NeuCo-developed products. Baldwin is contributing the host site, human resources and engineering support to ensure the project is successful.

Over the course of this four-year CCPI project, NeuCo

will install and refine five real-time, closed-loop process optimizers that will address combustion, sootblowing and SCR operations, overall unit thermal performance and plant-wide economic optimization at all three Baldwin units - two cyclones and one T fired boiler. When completed, this installation will represent the first time multiple optimization software modules of this breadth have been integrated into a computerized process network in coal fired power plants.

These optimization systems will be built upon NeuCo's ProcessLink technology platform of neural networks, other advanced inductive algorithms, first principles engineering (thermodynamics) and expert systems, which together will maximize the operational and economic performance of the power plant's boilers, boiler cleaning systems, steam cycle, emission controls and auxiliaries.

A benefits analysis released by the DOE's National Energy Technology Laboratory (NETL) asserts that by installing such technologies, power companies could reduce NOx emissions by 13 420 tons per year (tpy) through cyclone optimization and 64 990 tpy through sootblowing optimization. Experts believe that generators could save more than $139m annually from improvements in combustion and post-combustion system operations, unit performance and plant profit optimization.

Challenges

Baldwin is an ideal candidate for integrated optimization because the plant has added substantial new equipment to its boilers in recent years, including low-NOx burners, overfire air and SCRs. These improvements have introduced Baldwin to new degrees of complexity in the relationships between sootblowing, SCR operation, combustion and unit heat rate.

Baldwin's cyclone boilers increase the operational challenges for two reasons: 1) most traditional combustion modifications cannot be deployed because of their unique design; and 2) these units are burning 100 per cent Powder River Basin coal, as opposed to the high sulphur Illinois coal they were designed for. Developing a commercial combustion optimization solution for cyclones will allow these typically large and NOx -intensive generating assets to capture some of the same benefits that optimization technology has already made available for pulverized coal boilers. A further challenge is relating the operations of the cyclone units and the T fired unit toward the common goal of plant-wide profit optimization.

NeuCo's optimization systems must also leverage the control and IT investments already made by Baldwin, such as its DCS platforms, local area network, plant data historian, sootblowing systems, and sensor technologies. The project will demonstrate the applicability of integrating the online optimization system with power plant operations to increase the thermal efficiency, fuel efficiency and reliability of the plant.

Status and Results to Date

The first step in the project was to optimize the combustion process and streamline the SCR operations within Baldwin's two cyclone units. The neural control models initially focused on minimizing either CEMS stack NOx or SCR inlet NOx before and during ozone season. While substantial NOx reductions (15 to 20 per cent) were achieved, NeuCo and Baldwin found that controlling for NOx alone allowed for too much variability in the sensitive cyclone stoichiometries. At this point, models and objectives for each of the cyclone stoichiometries (as functions of gross air and cyclone specific biases) were added to CombustionOpt. The optimizer was then configured to maintain specific stoichiometries. Other tuning changes also made the system most sensitive to these objectives and less sensitive to NOx, particularly during high-MW-value operations, thereby stabilizing unit operations, including slag-related outages and NOx emissions.

While the stoichiometric approach toward optimization showed significant results, there is evidence that stoichiometry is a flawed estimator of temperature due to fluctuations in oxygen efficiency at a given stoichiometry. Therefore, NeuCo began to look at flame scanner data and to explore spectroscopy as a tool for cyclone management, since flame quality is a better proxy for temperature. NeuCo has been able to use this flame scanner data to develop models that are of sufficient fidelity for use by CombustionOpt. The next step on Unit 2 may be to use flame quality models for cyclone optimization in place of the working stoichiometry models. Because the flame scanner models represent temperature and other key factors in cyclone stability and NOx creation, these models are expected to provide further operational enhancements.

NeuCo also worked with UniSearch, Inc. to install its LasIR TDL slip analyzer with four single traverse light paths on each unit, two per SCR section, just downstream of the SCR, above the air pre-heater. NeuCo was able to successfully model slip as a function of CombustionOpt fuel and air bias variables, thereby mapping actual boiler process biased controls to the slip analyzer at the SCR outlet. The NH3 slip models will be deployed during the 2005 ozone season to enhance SCR NOx removal efficiency and reduce NH3 slip. The ability to accurately measure, model, and optimize an on-line signal indicating NH3 slip has substantial implications for SCR performance.

Conclusions

As plant complexity increases through retrofits, re-powering applications, new technologies and plant modifications, the integrated process optimization approach being demonstrated at Baldwin can be an important tool to support a plant operator's control objectives and link them to corporate objectives of increased efficiency and lower emissions.

NeuCo, Baldwin and DOE hope that this CCPI project will extend optimization up the value chain to the level at which three units within the plant are responding in a single optimization environment to the plant's single real goal: profitability.