# DACOMO

**Data Mining Based Combustion Optimizer**

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**INSIDE THIS INTRO**



*"Maximizing Energy Efficiency and Renewable Energy is the domestic epicenter in the War on Terror and it is imperative that we maximize the partnerships between the public and private sectors in new and creative ways with a sense of seriousness, national purpose and the urgency the situation merits."*

*—Alexander Karsner, Assistant Secretary for Energy Efficiency and Renewable Energy*

## Getting Started

*By Intelligent Systems Lab*

The DAta mining COMbustion Optimizer DACOMO maximizes the boiler 11 performance at The University of Iowa Power Plant. The DACOMO produces recommended control-setting changes that are posted in real-time on a web page for use by the process operators.

## Boiler 11 Operated at the University of Iowa Power Plant

Boiler 11 is a circulating fluidized-bed (CFB) combustor. Currently, it simultaneously burns coal and biomass (oat hulls). The total fuel input changes according to the steam load demand. The availability of oat hulls determines the co-firing rate of biomass and coal. Typically, if oat hulls are available, the boiler is operated at full load with a heat input of 50% from coal and 50% from oat hulls. The combustion air is composed of primary air, which enters the bottom of the furnace, and secondary air, which enters the furnace about ten feet above the bottom. The control loops for air are influenced by the amount of air required for combustion, the temperature in the furnace, and the oat hull burn rate. Limestone is added to the combustion process to reduce SO2 emissions by a minimum of 90%, compared to the uncontrolled SO2 emission rate. The amount of air and the ratio of primary to secondary air influence the effectiveness of the limestone SO2 removal process. With an optimum amount of air and the optimum ratio of primary to secondary air, limestone consumption is minimized significantly reducing operating cost of the boiler.

The DACOMO system optimizes several controllable parameters, e.g., bottom ash pressure, primary and secondary air. The optimal settings of the controllable parameters are derived based on the data stored by the PI data historian.

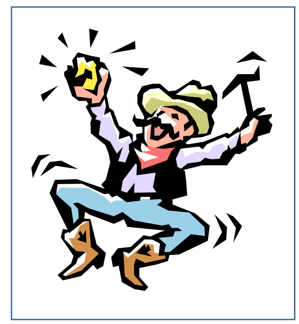
*The University of Iowa Power Plant*

## Methodology

**D**ata mining algorithms learn from the historical data and generate robust control settings displayed on the web page. Utilizing a technique known as clustering, DACOMO groups the historical data together to form control signatures. The groupings (clusters) are represented by a mean values called centroids. As new data is stored by the data historian, the incoming points are either assigned to an existing grouping or form a new cluster. The control signature space, consisting of all the developed centroids, is then searched to find more efficient settings. Recommendations for the controllable settings are then displayed to the controllers via the web page.

## Confidence Index

**D**ue to the shift in the combustion process, the control settings derived from the data that is too “old” may not apply to the current boiler conditions. The “aging” aspect of the process data is addressed using the concept of a virtual boiler that is used to calculate and assign a confidence index to the recommended control settings. Basically, when the difference between current boiler’s “age” and the recommended control settings’ “age” is large, the confidence is low. The confidence index is computed based on a statistical reliability model.



*Mining from data for gold (knowledge)*

## DACOMO Advantages

**D**ata mining is an emerging science which finds useful patterns from large volume of data. Compared with other combustion optimization methods (e.g., model predictive control, neural networks, fuzzy logic), the data-mining based combustion control excels in scalability, speed, ease of implementation, and the ability to control the time-shifting process.

**Scalability**: Data mining algorithms are designed to handle a large number of parameters and their instances to construct a highly accurate combustion model.

**Speed**: Data mining algorithms are computational time efficient. Optimal control settings can be generated in near real-time.

**Ease of implementation**: The DACOMO system runs on a standard PC. It learns from data stored in the data historian, and recommends control system set point changes through a web page. Thus, it does not need to be physically installed in the boiler control system or connected to plant controls. A connection between the process data historian and the DACOMO is required.

**Ability to handle the time-shifting process**: All changes in the combustion process are reflected in the process data directly or indirectly. The DACOMO system captures these changes in real-time and adjusts for the aged process. An example of process aging would be slag build up on furnace walls or tubes between boiler outages where the slag is removed. This build up reduces the heat transfer effectiveness of the furnace, but is restored when the unit is cleaned during an outage.

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