UDC 3500 Application Note

Combustion Control
Flue Air Ratio

Problem

Until recent years, only the largest boilers could justify sophisticated combustion controls. Now, higher fuel costs and occasionally limited fuel availability make it necessary for users to improve boiler efficiency. Government regulations force compliance with stringent air pollution and safety standards. Combustion control have also become more important because boiler loads are being varied to meet needs, rather than operating at full capacity and wasting fuel and steam. Similar concerns are causing the metals-processing and heat-treating industries to consider improved combustion control for their furnaces and other fuel-fired processed.

Solution

Use of more advanced digital controls for automatic combustion control provides improved efficiency and stability under carrying loads and eliminates the need for operator input during load changes. A fuel-air ratio control system is required to perform the following functions;

- Maximize boiler combustion efficiency and minimize fuel use
- Minimize smoking and air pollution, especially on load changes
- Help ensure safe operation
- Maintain steam pressure of furnace temperature at the desired level
- Minimize oxidation of product during heat treating.

Honeywell can provide a control system featuring *UDC3500 Process Controller*. The package is well-suited for boilers in the range of 15,000 to 150,000 lbs/hr. It offers;

- Pre-engineered compatibility
- Single source convenience
- Pre and Post-sale technical support
- Field Proven equipment
- On and Off-line configuration and alarms capability

Combustion Process

The most common fuels consist of carbon and hydrogen. Combustion is the rapid oxidation, i.e., rapid combination with oxygen, of a fuel release heat. Stoichiometric, or perfect, combustion combines the exact proportions of fuel and oxygen to obtain complete conversion of the carbon and hydrogen to yield water vapor, carbon dioxide, and heat. The ideal proportions of fuel and air vary directly with the BTU content of the fuel. Too much air results in energy losses up the stack. Insufficient air results in loss of heat generation due to incomplete fuel combustion.

A certain amount of excess air is required to ensure that complete combustion occurs within the combustion chamber and to compensate for delays in fuel-air ratio control action during load changes. The ideal amount of excess air varies with the type of fuel and the equipment design. When combustion air is preheated and forced into the burner, it may be necessary to provide both temper and pressure compensation to ensure accurate measurement o air flow. It may also be necessary to provide flow compensation for gaseous fuels. Flow compensation for temperature and pressure variations can be economically provided using a single Honeywell SMV 3000 transmitter for each flow steam. The correct fuel-air ratio established during initial start-up and is then re-checked periodically.

Combustion Control System Description

A fuel-air metering control system is essential for efficient combustion in boilers, furnaces, and other large fuel-fired heating processed. These systems vary in complexity from the simple metered approach to the complex cross-limiting system, which is used to ensure safe firing during load changes. Automatic oxygen trim of the fuel-air ratio via feedback control is a further refinement to ensure safe and efficient operation.

Cross-limiting Meters Systems

The cross-limiting metered approach, shown in Figure 1 is used for boiler combustion controls when large or frequent load changes are expected. This is a dynamic system that helps compensate for the varying speed of response of the fuel valve and air damper. It prevents a "fuel-rich" condition and minimizes smoking and is pollution from the stack.

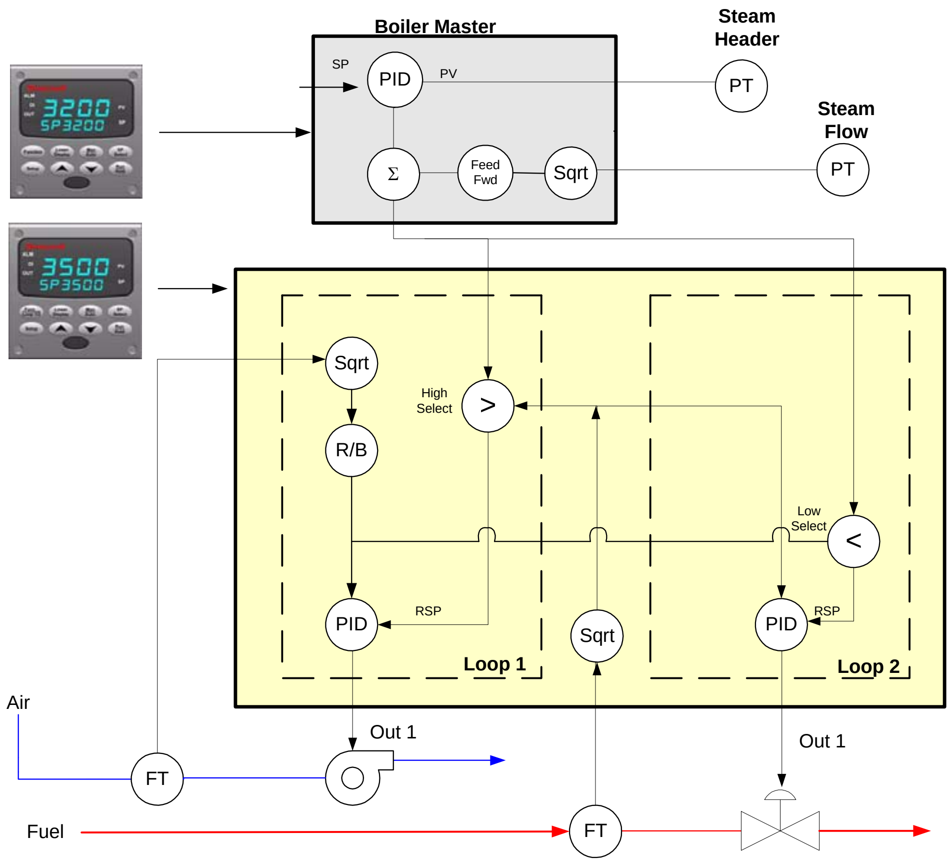

Figure 1 Lead-Lag, fuel/air ratio control plus demand control

The system, also know as a lead-lag parallel-series metering system, operates as follows. In steady state the steam demand, fuel flow, and air flow signals to the high and low selectors are equal. Upon a demand increase, the selector blocks the increase, forcing the air flow process variable to become the set point for the fuel flow controllers. The high selector passes the demand signal to the air controller's set point. This means fuel flow cannot increase until air flow has begun to increase, i.e., air increase leads fuel increase.

When demand drops, the low selector passes the signal to the fuel flow controller set point, while the high selector passed the fuel flow process variable signal to the air flow controller setpoint. This means air flow cannot decrease until fuel begins to drop; i.e., fuel decrease leads air decrease.

This strategy avoids a fuel-rich condition, regardless of the direction load change, by automatically switching to the appropriate series metering system during transient conditions.