

APPLICATION NOTE

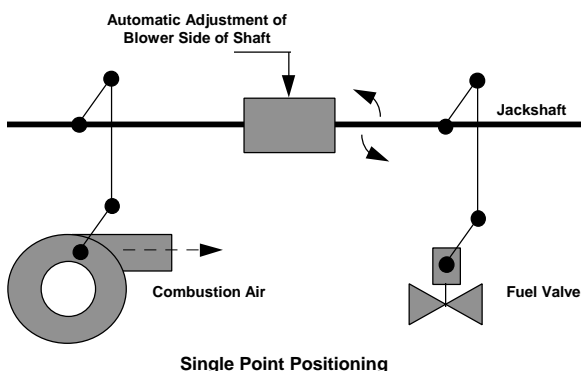
YS1700 Boiler Combustion Control

OVERVIEW

The boiler combustion control system is designed to maintain a proper air/fuel mixture under varying load conditions and within safe limits. The system should provide nearly complete fuel combustion as efficiently as possible. Discussions here are limited to oil and/or natural gas fired industrial boilers. Control systems that perform these functions can be classified as positioning or metering systems. Positioning combustion systems use mechanical linkages between the fuel control valve and air damper to adjust for the proper ratio. Both single point positioning and parallel position systems are common.

SINGLE POINT POSITIONING

One of the most common combustion control system on oil and/or gas fired boilers is the single point positioning system, commonly referred to as a jackshaft. Refer to the drawing below. The fuel valve(s) and air damper are mechanically linked to a common rotating drive mechanism controlled by a master drive unit. Simple and safe, but requires a constant fuel pressure and BTU content. Maintaining the optimum air/fuel ratio throughout the



load range is difficult.

PARALLEL POSITIONING

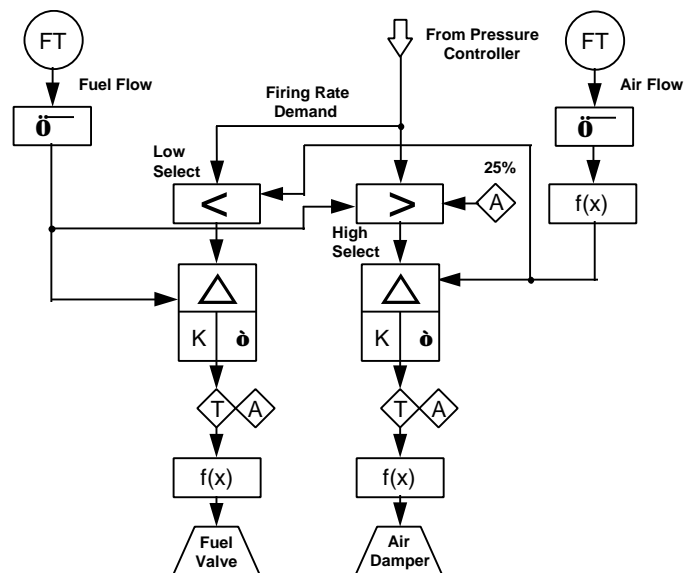
This system uses a master pressure controller to position the fuel valve(s) and air damper. An air/fuel ratio station is placed in the air damper circuit. Advantages are low installed cost and simplicity with only one controller to manipulate. The disadvantage is that it is not fail-safe. There is no inherent fuel cut back or air tracking the fuel if either drive were to fail.

PARALLEL METERED CROSS LIMITED SYSTEM

In this combustion system, the air and fuel flows are measured and are the process variables of two controllers. The air and fuel controllers receive a setpoint value from a master steam pressure controller. In the fuel controller, this value is compared to a modified air flow signal in a low signal selector. The lower value is selected as the remote set point of the fuel flow controller.

Conversely, the pressure controller output is compared to the fuel flow using a high signal selector in the air flow controller. The higher signal is selected.

Refer to the SAMA diagram below. This configuration is called a cross limited or lead-lag system. If an increase in firing rate is needed due to an increasing steam demand, the air flow leads the fuel. As the load curtails, the fuel decreases first, followed by a decrease in combustion air flow. A low limiter is used in the air controller to prevent the air flow set point to be reduced less than 25% of full span. This minimum setting is required by NFPA code and ensures safe operation in the event of loss of signals.



The YS1700 Dual Loop Programmable Controller is the logical choice for boiler combustion control. The controllers can be easily implemented to perform the full metering cross limited system configuration. The YS1700 fuel controller can transmit the fuel signal as an analog output to the air controller for the cross limiting action. Conversely, the YS1700 air controller can transmit the air flow to the fuel controller. The limiting

APPLICATION NOTE

signal selectors reside in each controller.

Using discrete inputs and outputs, the fuel controller can track the air control MANUAL status and logic can be incorporated to not permit automatic fuel control until the air controller is in AUTO. These signals can be hard-wired between controllers or an optional peer-to-peer digital communications network can transfer analog and status information over a single pair of twisted wires.

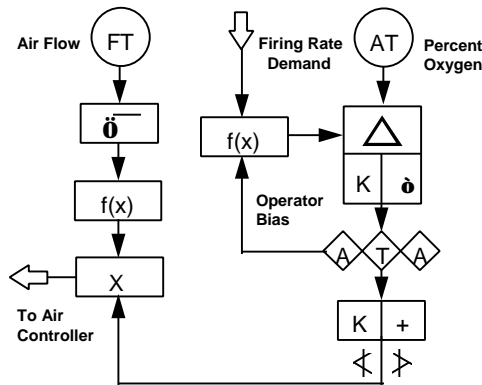
Diagnostics of flow inputs allows the controllers to transfer the fuel and air outputs to safe conditions in the event of transmitter failure. The controllers can be forced into MANUAL mode (holding the last calculated output) and discrete outputs are available to activate an annunciator or other alarm device.

If the YS1700 controller were to fail, an integral **hard manual** station allows immediate backup. By raising the front panel assembly of the instrument, the manual station can be activated by a slide switch. A knurled thumb wheel can be adjusted to provide the appropriate output to the control element. A FAIL discrete output can be wired to an alarm device.

FLUE GAS ANALYSIS

Flue gas analysis is a method of providing a more precise control of the air/fuel ratio. The intent is to minimize the amount of excess air rising through the stack which results in lower operating costs by using less fuel. An oxygen trim controller can be used to bias or *trim* the combustion air controller.

A *load index* is created from the firing rate demand signal. The amount of excess oxygen varies inversely with steam demand, i.e., low loads have a higher excess oxygen. The operator can apply a manual bias to the *index* set point without changing the *index* slope or shape. Refer to the SAMA diagram below.



The output of the percent oxygen controller is adjusted for gain and bias and applied to the combustion air flow signal. Additionally, low and high limits are used to ensure continued operation during analyzer outage.

The YS1700 can be programmed to perform two independent P+I+D control algorithms. This is ideal to incorporate the combustion air and oxygen trim controls into one instrument. The multiple input/output capabilities permit air flow, percent oxygen, and firing rate demand inputs. Function generators residing in the microprocessor-based controller allow calculation of the load index described above and characterization of the air flow measurement. By implementing these two control strategies in one device, the purchase cost is lowered and installation costs are reduced.

SUMMARY

YS1700 Programmable Loop Controllers can be installed in a variety of applications. As discussed here, boiler combustion control can be implemented easily and cost effectively. Multiple analog and discrete inputs/outputs permit interaction with burner management equipment. YS1700 controllers have been installed in dozens of boiler installations. Users are glad they selected this versatile easy-to-use controller.

YS1700 - The Logical Choice in Combustion Control!