Full Metered Boiler Control with O2 Trim
Combustion Control Systems (CCS)

Introduction

Combustion control is a critical function for all utility, industrial and institutional customers for the following reasons:

- Safety of operating personnel is paramount
- Reliability of utility operations is essential
- Energy usage is a major cost
- Value of boiler equipment must be protected.

To safely, reliably and efficiently operate package boilers, the engineers at MicroMod have developed and supplied automatic combustion control systems for many years. This Application Data Sheet discusses control strategy as applied to automatic combustion control systems for full-metered, single burner, dual fuel boilers.

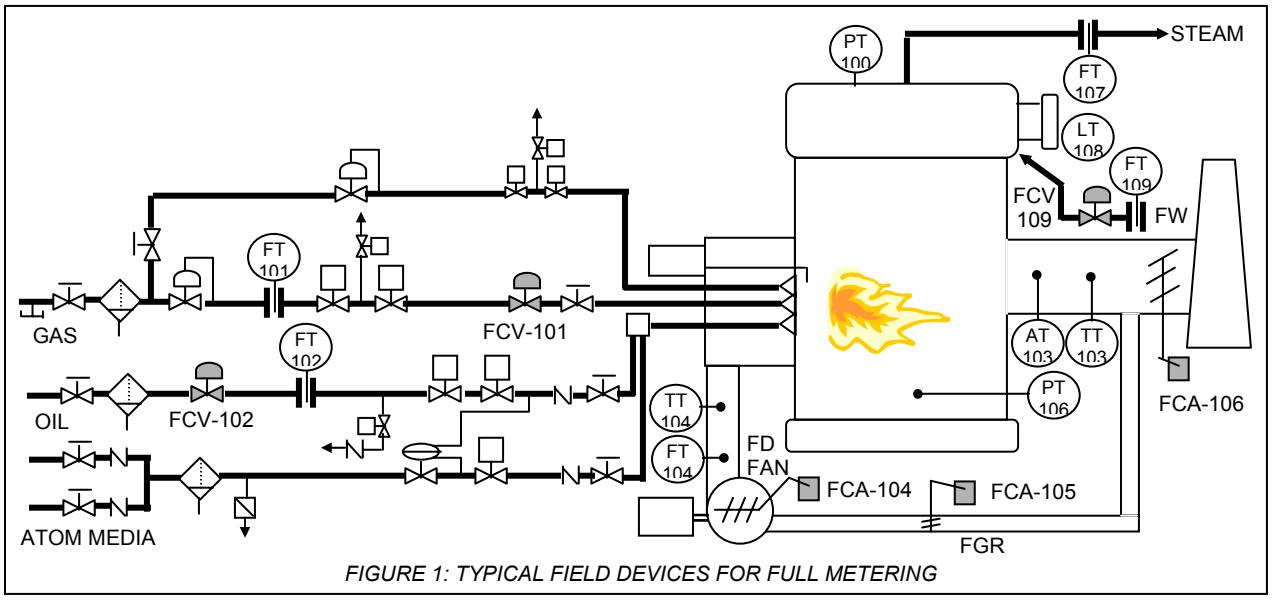

FIGURE 1: TYPICAL FIELD DEVICES FOR FULL METERING

APPLICATION DESCRIPTION

The automatic combustion control field hardware for a typical single burner, dual fuel package boiler is shown in Figure 1. The system shown is a full-metered system, i.e. the fuel and air are independently measured and furnished with closed loop control. This is the safest and most efficient method for boiler control. Measurement of excess oxygen is provided for automatic fuel/air ratio trim. Flue gas recirculation is shown for low NOx burners.

CONTROL STRATEGY

The control diagram for this combustion control strategy is shown in figure 2. The component descriptions are as follows:

Boiler Master

The boiler master controller receives the plant demand signal from the plant master pressure controller and adds an operator-entered bias. This output is the boiler demand for steam. The operator may adjust the bias in automatic or place the controller in manual to fire the boiler manually. When the fuel control is not in auto mode, this controller tracks the total fuel signal and any difference between plant and boiler demand is calculated as a bias in order to provide a bumpless, balance-less transfer to auto. The control

rejects to Manual on bad signal quality. The boiler pressure is indicated and a high/low pressure alarm is shown.

Fuel / Air Cross Limits
Operational safety is greatly improved during automatic control by fuel/air cross limiting. This technique utilizes a high select between boiler demand and actual fuel flow as the airflow setpoint. A low select between boiler demand and actual airflow is used as the fuel flow setpoint. The net effect of these selectors is that on a load increase, the fuel must remain within a certain percentage of the airflow or the fuel setpoint cannot increase. On a load decrease, the fuel must remain within a certain percentage of the airflow or the air setpoint cannot decrease. If at any time the fuel exceeds the air, the fuel setpoint is decreased. The limiting dead-band is provided by gains on the flow measurements provided to the selectors. A 1.05 gain on air and 0.95 gain on fuel are typical, providing a +/-5% dead-band.

Fuel Flow Control
The gas and oil flows are measured, totalized, and summed by heat value before being sent as a total fuel signal to the fuel flow controller. The total flow is compared to the fuel demand setpoint and added as a trim signal to the feed forward for fuel demand. This combined output modulates the gas or oil valve (whichever is selected) to eliminate any error when in the auto mode. Adaptive gain and reset allow separate tuning constants for gas and oil. The demand for oil or gas is linearized through the use of function generators on the outputs. The operator may place the controller in manual mode to provide a manual fuel demand signal. A logic interface to the BMS is provided where a contact closure will position the fuel valves to a pre-programmed light off position. The control rejects to Manual on bad signal quality. The controller also contains logic to prevent fuel automation until the airflow is automated.

Air Flow Control
The airflow is measured, temperature compensated, and sent as a total airflow signal to the airflow controller. The total flow is compared to the air demand setpoint and added as a trim signal to the feedforward for air demand. This combined output modulates the FD damper to eliminate any error when in the auto mode Adaptive gain and reset allow separate tuning constants for gas and oil. The air demand for oil or gas is linearized through the use of function generators on the output. The operator may place the controller in manual mode to provide a manual air demand signal. A logic interface to the BMS is provided where contact closures will position the air damper to pre-programmed light off or purge positions. The control rejects to Manual on bad signal quality. The controller also contains logic to prevent air automation until the furnace pressure is automated (If provided).

Excess O2 Trim
The excess O2 leaving the boiler is measured by an O2 analyzer and compared to setpoint by the O2 master. Load programmed setpoints for oil and gas, are provided by function generators, for the fuel selected. The O2 controller output will modify the demand for airflow to eliminate any error in the auto mode. This modification is limited to +/-5% for safety. The operator may bias the setpoints in auto or provide a manual fuel/air ratio in manual mode. The control rejects to Manual on bad signal quality. The controller tracks actual fuel air ratio when the airflow is not auto.

FGR Control (If required)
The demand for air provides a signal to the pre-programmed positions for the FGR damper which are located in function generators for oil or gas. The operator may bias the setpoints in auto or provide a manual FGR position in manual mode. The control rejects to Manual on bad signal quality.

VFD Control (If required)
When the fan is equipped with both a damper and a Variable Frequency Drive. The demand for air provides a signal to the pre-programmed positions for the fan VFD and damper that are located in function generators for oil or gas. The fan operates in a split range control mode with the damper controlling flow at low loads and the VFD controlling flow at high loads. The control rejects to Manual on bad signal quality.

On Line Boiler Efficiency
The addition of flue gas temperature allows the on line calculation of boiler efficiency by the Heat Loss method.

Other Loops

Note that Furnace Pressure control and Drum Level control are shown for completeness. See individual Application Data Sheets for details on these loops.

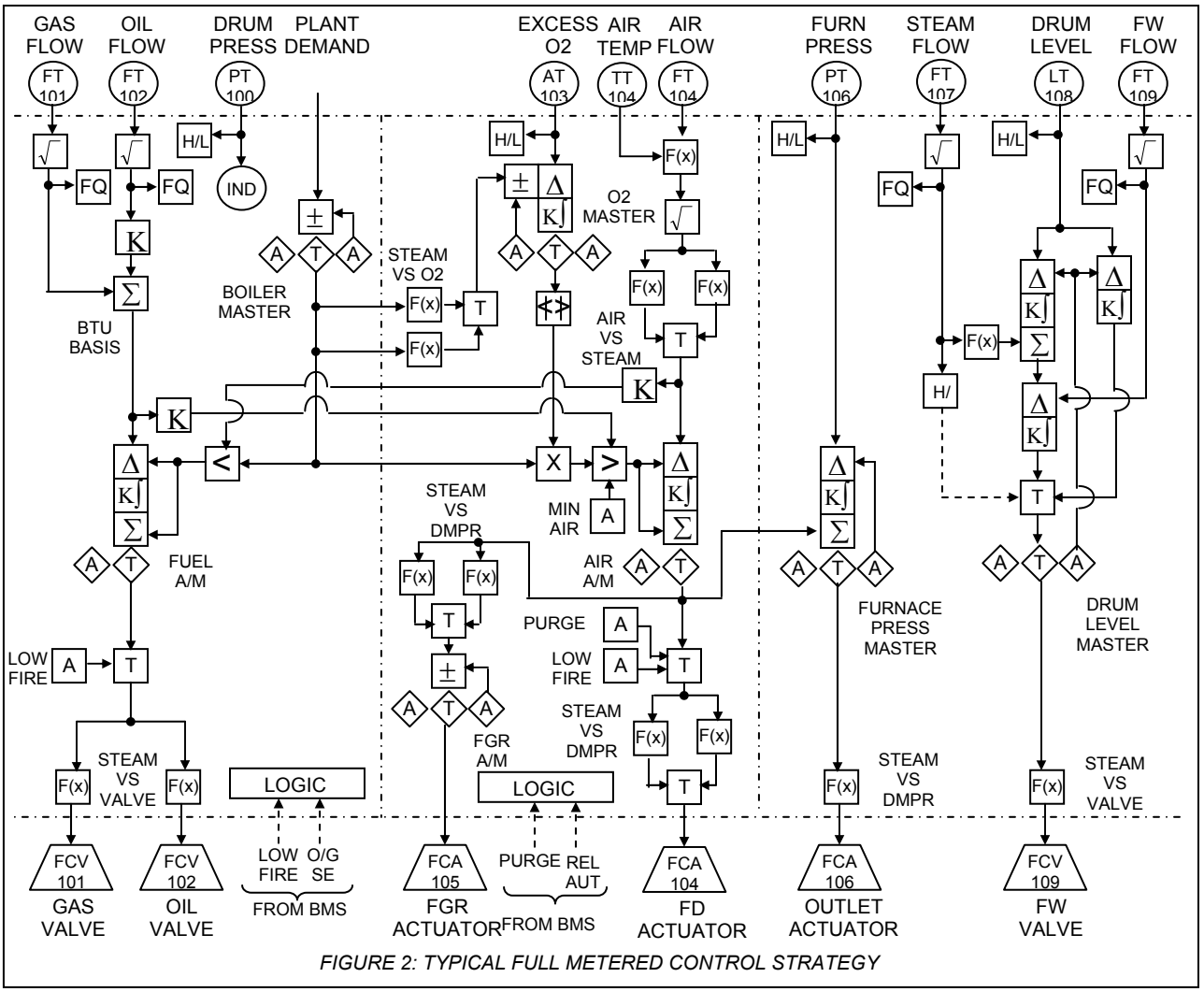

FIGURE 2: TYPICAL FULL METERED CONTROL STRATEGY