APPLICATION DATA

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PAC 353™ COMBUSTION MANAGEMENT SOLUTIONS
BOILER DRUM LEVEL (FEEDWATER) CONTROL

BENEFITS

◊ Maximizes steam quality.
◊ Maintains proper drum level to prevent damage to boiler.

INTRODUCTION

This paper is one in a series that discusses Moore Products Co.'s Combustion Management Solutions. This installment discusses Boiler Drum Level Control.

BACKGROUND

The cylindrical vessel where the water-steam interface occurs is called the boiler drum. Boiler drum level is a critical variable in the safe operation of a boiler. A low drum level risks uncovering the watertubes and exposing them to heat stress and damage. High drum level risks water carryover into the steam header and exposing steam turbines to corrosion and damage. The level control problem is complicated by inverse response transients known as *shrink* and *swell*.

Simply put, shrink and swell refer to a decreased or an increased drum level signal due to the formation of less or more vapor bubbles in the water, and not a change in the amount of water in the drum. This condition produces level changes during boiler load changes in the opposite direction of what is expected with a particular load change. Although only temporary, this can cause severe control system overshoot or undershoot.

MEASUREMENT

Several different measurements are required for feedwater control depending on the control strategy being used. The following measurements are marked as 1E, 2E and 3E to indicate they are required for single, two or three-element feedwater control strategies.

Boiler Drum Level [1E 2E 3E]
The boiler drum level has a typical span of 30 inH_2O, often with some suppression required depending on the physical location of the transmitter. The boiler will be pressurized so the transmitter must be able to operate with a static pressure of up to several thousand PSI. In addition, chemicals injected into the feedwater need to be considered when specifying the transmitter's materials of construction.

Drum Pressure [1E 2E 3E]
Since the density of steam and water at the saturation temperature change with pressure, the drum level calibration will only be accurate at a single boiler drum pressure. The drum level signal can be compensated for all pressures by using a drum pressure transmitter. Generally, both industrial and utility boilers run at constant drum pressure. Pressure compensation is typically employed with utility boilers which operate at much higher pressures than industrial boilers.

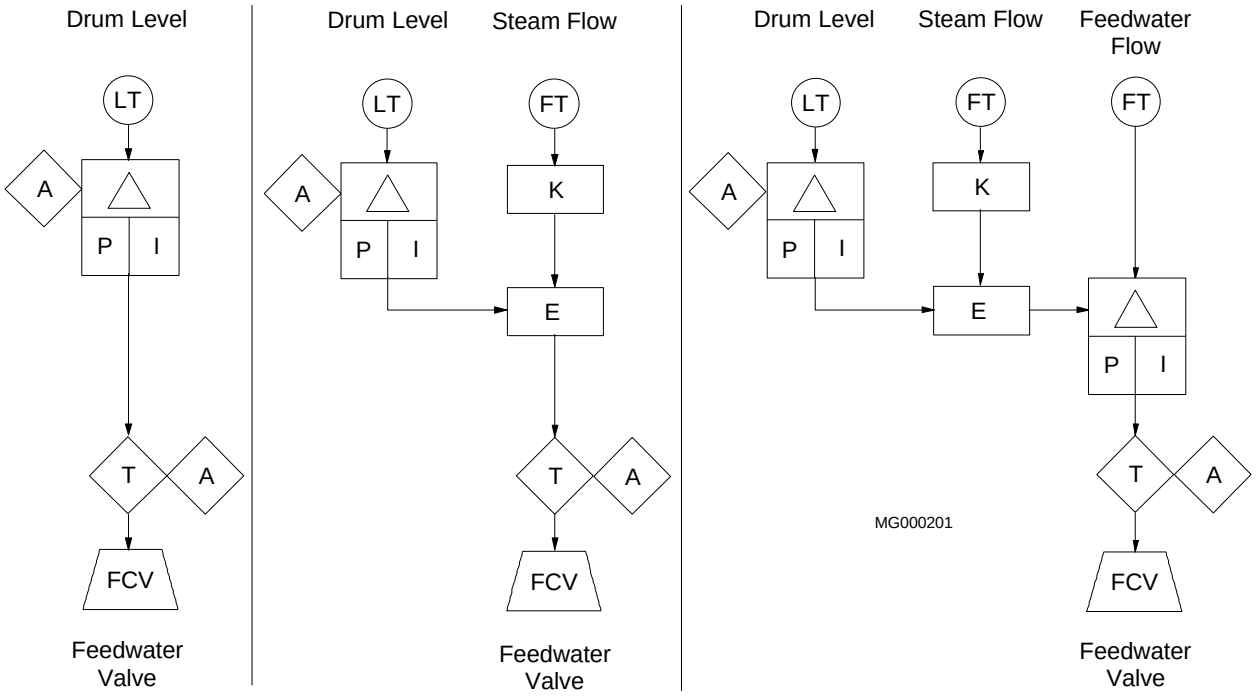
Steam Flow [2E 3E]
Steam mass flow is required to compensate for shrink and swell during load changes. This measurement can be made using a multi-variable differential pressure type flow meter and an orifice plate to provide a mass flow output.

Feedwater Flow [3E]
Feedwater flow is typically used in a cascade control strategy to ensure that proper valve characteristics are maintained.

CONTROL

Typically one of three control strategies is employed to control the boiler drum level.

Single-Element Drum Level Control
The single element system is the simplest type used for controlling packaged firetube and watertube boilers. In this strategy, control is based on the boiler drum level measurement only. This does not allow for compensation of any shrink or swell and, therefore, is not usually an acceptable control strategy. However, for small boilers with slow load changes this may be acceptable.



Single, Two, and Three Element Drum Level Control

Two-Element Drum Level Control
In two-element control, steam flow is measured along with boiler drum level. The steam flow signal is used in a feedforward control loop to anticipate the need for an increase in feedwater to maintain a constant drum level. This strategy requires the differential pressure across the feedwater control valve to remain constant as well as the control valve signal vs. flow profile. Boilers with moderate load changes can usually be controlled with this strategy.

Three-Element Drum Level Control

Three-element drum level control adds a feedwater flow signal to the steam flow and boiler drum level signals used in two-element feedwater control. The drum level controller manipulates the feedwater flow setpoint in conjunction with feedforward from the steam flow measurement. The feedforward component keeps the feedwater supply in balance with the steam demand. The drum level controller trims the feedwater flow setpoint to compensate for errors in the flow measurements or any other unmeasured load disturbances (e.g. blowdown) that may effect the drum level. Three-element control is used in boilers that experience wide, fast load changes.

The following table lists typical instruments for drum level control. This list is a guide. Consult your Moore representative for more information.

Instrumentation List

ITEM	MODEL
Drum Level Transmitter Drum Pressure Transmitter	340DDBHAAB5N113 340GGBHAAB5N113
Steam Flow Transmitter	340SDBHAAB5N113
Feedwater Flow Transmitter	141SxxAAAF; xx = Line Size
Controller	353A2FNNNNNNNA4

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