UDC 3500 Application Note

Two Element Boiler Drum Level Control

Problem

Until recent years, only the largest boilers could justify sophisticated boiler controls. Now high fuel costs and occasional limited fuel availability make it necessary to improve boiler efficiency and minimize costly steam losses and disturbances. Drum level controls have become more important because boiler loads are being varied to meet needs, rather than operating at full capacity and wasting fuel and steam. The effects of pressure surges and steam flow on drum level dictate more complex controls on this important parameter.

Solution

Use of more advanced automatic controls on critical boiler control loops provides improved efficiency and stability under varying steam demands and eliminates the need for operator input to trim out load changes. Honeywell can provide a cost-effective drum level control system featuring the *UDC 3500 Process Controller* to meet these requirements. The package features:

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

Boiler Drum Level Control

The Steam drum is an integral part of a boiler. This vessel's primary function is to provide a surface area and volume near the top of the boiler where separation of steam from water can occur. It also provides a location for (1) chemical water treatment, (2) addition of feedwater, (3) recirculation water, and (4) blowdown which removes residue and maintains a specified impurity level to reduce scale formation. Because these functions involve the continual addition a loss of material, the water-steam interface level is critical.

Low level affects the recirculation of water to the boiler tubes and reduces the water to the boiler tubes and reduces the water treatment effectiveness. High level reduces the surface area, and can lead to water and dissolved solids entering the steam distribution system. The objective of the drum level control system is to maintain the water-steam interface at the specified level and provide a continuous mass balance by replacing every pound of steam and water removed with a pound of feedwater.

The interface level is subject to many disturbances, steam pressure being a major one. As steam pressure changes due to demand, there is transient change in level due to the effect of pressure on entrained steam bubbles below the steam interface level. As pressure drops, a rise in level, called swell, occurs because the trapped bubbles enlarge. As pressure rises, a drop in level occurs. This is called shrink.

There are three basic types of drum level control systems; single-element, two-element, and three-element. Their application depends upon the specific boiler size and load changes.

Drum Level Control Systems

The *Single-Element System* is the simplest approach. It measures the system drum level and regulates feedwater flow to maintain the drum level. This system is only effective for smaller boilers supplying steady processes which have slow and moderate load changes. This is because shrink and swell causes an incorrect initial control reaction. As steam demand increases, lowering the pressure, the drum level increases sending a false control signal to reduce feedwater flow when actually the feedwater flow should increase to maintain mass balance. More complex systems are required to handle significant shrink and swell effects.

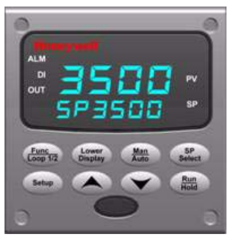
The *Two-Element Drum Level Control* is suitable for processes with moderate load swings and can be used on any size boiler. The Two-Element Drum Level Control uses two variables, drum level and steam flow to manipulate the feedwater control valve. Steam flow load changes are fed forward to the feedwater control valve providing an initial correction for the load changes. The steam flow range and feedwater flow range are matched so that a one pound change in steam flow results in a one pound change in feedwater flow. The summer combines the steam flow signal with the feedback action of the drum level controller which makes trim adjustments in feedwater flow, as required, to compensate for unmeasured blowdown losses and steam flow measurement errors. The UDC 3500 can be placed into Manual mode to permit manual control of the feedwater valve.

Two-element control is adequate for load changes of moderate speed and magnitude, and it can be applied to any size boiler. It has two drawbacks which must be considered. It cannot adjust for pressure or load disturbances in the feedwater system and it cannot eliminate phasing interaction between the various portions of process because only the relatively slow responding drum level is controlled. If these disturbances are a concern, than three-element drum level control an correct the drawbacks

Drum Level Controller

This device is usually an indicating two-mode (proportional and integral) controller with high and low alarms regardless of which type system is being considered. Honeywell can supply the single loop *UDC 3500 Universal Digital Controller* for this function. It also includes, as a standard feature, the feedforward summer function as well as square root extraction to account for changes in feedwater flow rates required to linearize the system.

This configuration uses the Drum level input as Input 1 and the Steam Flow as Input 2. The steam flow measurement is used as a feedforward input to anticipate changes in steam demand. The PID output from the Drum level is summed with the feedforward signal from the steam flow measurement to adjust the feedwater for the proper drum level. This feature saves cost and panel space while providing a simple operator interface.



Two-Element Feedwater Control