

Application Note

Boiler Drum Level Control System

Drum Level Control Systems are widely used within the utilities and process industries to maintain a constant steam supply. It helps control the level of boiling water in boiler drums on process plants. In this process, it is critical and challenging to measure steam drum level, as the water level in the drum must be precisely regulated. When the water level is too high, water carryover into the steam piping is created. If the water level is low, the generating tubes (down comers) get exposed, preventing the drum's water from cooling the furnace tubes, including possible damage.

Several circumstances make this measurement challenging to acquire. The steam drum itself may not be ideally level, and even at steady-state circumstances, considerable disturbance in the drum can allow the level to oscillate. In addition, a changing rate of water inflow and steam outflow adds to the potential for measurement error.



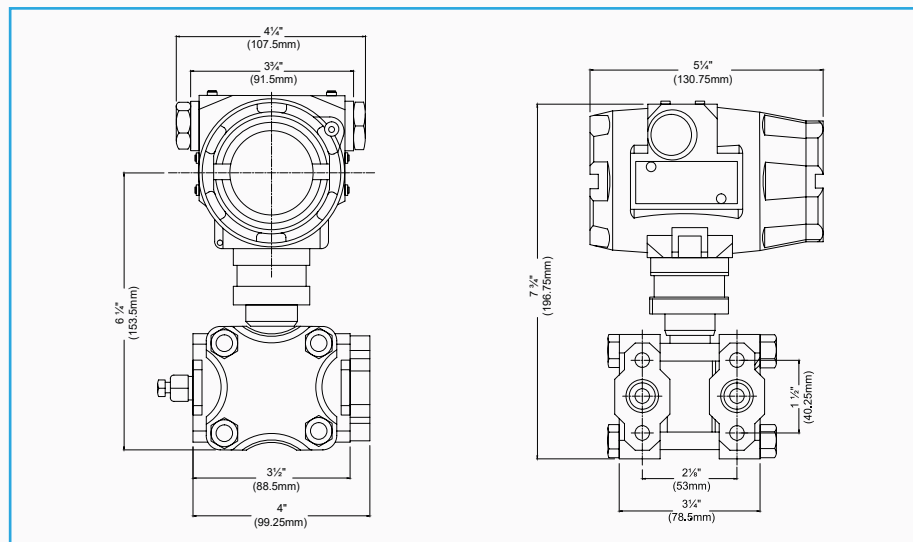
Tek-Bar 3110B

**Explosion-proof
 Differential Pressure Transmitter**

Application

Boiler Drum Level Control System is used in institutional and industrial heating plants where steady process condition, continuous type process with good feedwater pressure regulation is essential. It is also used in combination of batch and continuous type operation plant where, steam load characteristics are continuously changing and unpredictable.

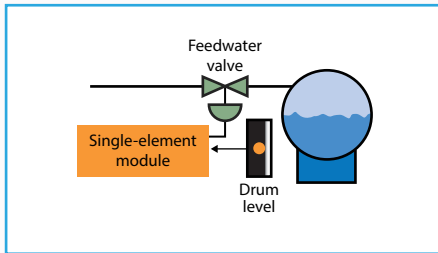
Dimension for Tek-Bar 3110B Explosion-proof Differential Pressure Transmitter



Different Methods for Drum Level Control

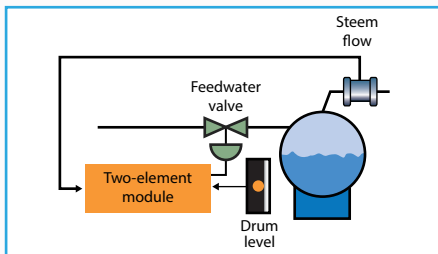
• Single-Element Drum Level Control

The Single-Element Drum Level Control System is used in steady process condition in industrial heating plant.



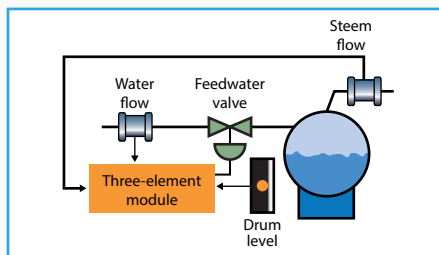
• Two-Element Drum Level Control

The Two-Element Drum Level Control method is mostly used where the feedwater is available at a constant pressure in a single drum boiler.



• Three-Element Drum Level Control

The Three-Element Drum Level Control System is most suitable for multiple boilers with multiple feedwater pumps, where feedwater pressure changes constantly.

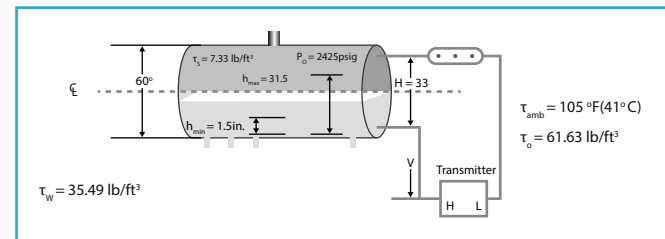


Solution

Tek-Bar 3110B Explosion-proof Differential Pressure Transmitter with three element drum level control system is used to measure boiler steam drum level. When the level of the boiler steam drum is measured by differential pressure transmitter, some physical properties must be considered as following:

- At saturation, the steam drum contains a two-phase mixture of water and steam.
- The densities of water and steam vary with temperature and pressure saturation.
- The density of saturated steam above water, and water in the drum, must be considered.

The Explosion-proof Differential Pressure Transmitter calibration is needed for accurate measurement of boiler steam drum level. The above factors are considered in the method of calibrating transmitters. Process of Tek-Bar 3110B Explosion-proof Differential Pressure Transmitter Calibration: Figure 1 shows a simplified diagram of the Differential Pressure Transmitter Calibration process. The thermodynamic operating conditions of pressure and temperature, the geometry of the steam drum, and the equation of



Calibration Calculation:

From the equation of continuity:

$$P_h = P_o + (H-h)(\tau_s) + h(\tau_w) + V(\tau_o) \quad \text{--- (1)}$$

$$P_l = P_o + H(\tau_o) + V(\tau_o) \quad \text{--- (2)}$$

$$\text{Thus, } \Delta P = (H-h)(\tau_s) + h(\tau_w - \tau_s) \quad \text{--- (3)}$$

Equation 3 is used to calculate differential pressure on transmitter. Thermodynamics properties of steam table is used to perform transmitter calibration:

1. Determine minimum and maximum water levels, i.e., h_{min} and h_{max}, for the safe operation of the boiler. These water levels are measured from the bottom tap of the steam drum.
2. Using the saturated steam tables, find the values of the drum operating pressure. Use this value for compressed water in the reference (wet) leg at the expected ambient temperature and the drum operating pressure.
3. Use the reciprocal of the specific volume of saturated water at the ambient temperature if the compressed water table is not available. This provides accurate drum measurement due to water is nearly incompressible.

Conclusion

We can successfully measure and control the boiler steam drum level using Explosion-proof Differential Pressure Transmitter calibration. We can set the drum level controller's desired setpoint through properly calibrated Differential Pressure Transmitter calibration. Using this calibration, we can maintain the boiler steam drum level.