Application Solution

IMV31 Density-Compensated Multivariable Level Transmitter

Improving accuracy and reducing costs of boiler drum level measurement

Summary

The Foxboro IMV31 density-compensated level transmitter provides highly accurate level measurement and is based on hydrostatic measurement and advanced multivariable sensing technology. The device uses differential pressure, absolute pressure, and temperature measurements to compensate for liquid and vapor density changes that would otherwise cause level measurement errors.

Business Value

Regardless of the size of the drum and the saturation pressure, the IMV31 multivariable transmitter significantly improves the accuracy of drum level measurement over conventional DP transmitters and automatically provides dynamic compensation for varying pressures and temperatures.

BENEFITS

- Accurate level measurement of ±0.3% of maximum level
- Increased reliability due to fewer transmitters and related equipment
- Reduced cost of equipment, installation, and wiring
- Improved process integrity from fewer field devices and connections

ABOUT THE IMV31 DENSITY-COMPENSATED MULTIVARIABLE LEVEL TRANSMITTER

The Foxboro® IMV31 density-compensated level transmitter provides highly accurate level measurement. Based on hydrostatic measurement and advanced multivariable sensing technology, the device uses differential pressure, absolute pressure, and temperature measurements to compensate for liquid and vapor density changes that would otherwise cause level measurement errors. The IMV31 transmits a 4 - 20 mA output signal proportional to level and provides HART® digital communications of level, pressure, and density, as well as transmitter temperatures and an external RTD temperature.

TECHNICAL CHALLENGE

The traditional approach has been to use a conventional differential pressure (DP) transmitter with external water-filled "wet" legs connecting both the high- and low-pressure sides of the transmitter to the drum. A pressure transmitter is also used to measure the steam pressure in the drum. The use of DP transmitters for drum level is ideal because of their low cost, ease of installation, and high reliability. However, the output of a conventional DP transmitter in this application will have inaccuracies caused by changes in static pressure, the densities of the water in each leg, and the densities of the steam and water in the drum. Although water is normally thought of as an incompressible fluid, high pressure causes density changes independent of those created by temperature variations.

THE FOXBORO SOLUTION

The Foxboro IMV31 density-compensated level transmitter provides a new approach to drum level measurement. While maintaining all the advantages of DP transmitters, it uses multiple measurements and on-board level calculations to provide a more accurate measurement. This eliminates the need to make similar level calculations in the control system.

The IMV31 is based on Foxboro's proven multivariable transmitter technology, which was originally developed for flow measurement.

The heart of the IMV31 is its ability to conduct onboard level calculations based on multiple measurements and fluid density calculations. The IMV31 transmitter has a

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pressure sensor and a differential pressure sensor, as well as two internal temperature sensors. It also has the ability to power and monitor an external RTD temperature sensor.

The IMV31 continuously calculates four unique fluid densities, based on measured pressures and temperatures, and uses this information along with the DP measurement to calculate an accurate density-compensated drum level. The densities of the water and steam are separately calculated, based on the pressure measurement and drum temperature. Although the IMV31 has an RTD input, the transmitter can be configured to use the saturation temperature corresponding to the measured drum pressure in the calculation of water and steam densities. The densities of the water in each external wet leg are similarly calculated based on the measured pressure and temperatures.

Because the IMV31 transmitter measures pressure and differential pressure, it has the unique ability to self-compensate for static pressure effects on the DP measurement, a feature not available on conventional DP transmitters.

RESULTS

Regardless of the size of the drum and the saturation pressure, the IMV31 multivariable transmitter significantly improves the accuracy of drum level measurement over conventional DP transmitters and automatically provides dynamic compensation for varying pressures and temperatures. The following two examples show the diversity and results that can be achieved.

Application 1: A 300 psi boiler with a 30 inch drum (-15 to +15) where level is measured from the midpoint of the range (0 inches) down to -15 inches or up to +15 inches. Using a conventional DP transmitter without density compensation, the following errors can be expected during critical startup conditions when the drum pressure is at 50 psi:

- At -15 inches, the indicated level would be 0.25 inch high (0.84% of span).
- At 0 inches, the indicated level would be 1.1 inch low (3.7% of span).
- At +15 inches, the indicated level would be 2.5 inches low (8.2% of span). The density-compensated IMV31 can reduce these errors to ±0.3% of span or less than ±0.10 inch.

Foxboro's density-compensated IMV31 can reduce these errors to ±0.3% of span or less than ±0.10 inch.

Application 2: A 1000 psi boiler with a 60 inch drum (-30 to +30) where level is measured from the midpoint of the range (0 inches) down to -30 inches or up to +30 inches. Using a conventional DP transmitter without density compensation, the following errors can be expected during critical startup conditions when the drum pressure is at 100 psi:

- At -30 inches, the indicated level would be 2 inches high (3.3% of span).
- At 0 inches, the indicated level would be 4.4 inches low (7.3% of span).
- At +30 inches, the indicated level would be 10.75 inches low (17.9% of span). The density-compensated IMV31 can reduce these errors to ±0.3% of span or less than ±0.20 inch.

Foxboro's density-compensated IMV31 can reduce these errors to ±0.3% of span or less than ±0.20 inch.

These examples demonstrate the improvement that density compensation brings to the level calculation. Now you can obtain this improved accuracy right from the transmitter. Regardless of the size and pressure rating of your boiler, Foxboro's IMV31 provides precise drum level accuracy.

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