EMERSON Process Management has released the industry’s first digital DP Level architecture, the Rosemount 3051S Electronic Remote Sensor system. With over ten patents, the 3051S ERS system is a breakthrough technology that replaces mechanical impulse piping with two 3051S pressure sensors that are linked together electronically. Differential pressure (DP) is calculated in one of the two sensors and is transmitted using a standard two-wire 4-20 mA HART signal.

Overview of Traditional DP Level Technology

Conventional differential pressure transmitters are used in level applications by measuring the amount of pressure exerted by the liquid level in a vessel. For example, a 500 mm column of water will exert 500 mmH2O of pressure. However, in many applications, there is additional vapour pressure above the liquid. Being that the vapour pressure is not part of the liquid level measurement, the use of impulse piping or capillary with seals is required to compensate for its presence.

In an impulse piping configuration, the low side reference leg is either filled with a column of liquid (wet leg) or with a suitable dry gas (dry leg). Wet legs are used when the vapour in the tank will condense into liquid form. Likewise, dry legs are used when the vapour does not condense. While relatively simple in concept, impulse piping installations can be difficult to maintain. Evaporation often occurs in wet legs and condensation can occur in dry legs. Both conditions will cause measurement error in the DP transmitter. Additionally, impulse lines can leak, plug, and may require insulation or heat tracing.

Capillary and seal systems eliminate many of the issues with impulse piping installations. These systems consist of external sensing diaphragms that are connected to the differential pressure transmitter with oil-filled capillaries. Changes in pressure cause the diaphragm membrane to deflect, and the pressure is transferred through the oil-filled capillary to the transmitter. Oil-filled capillary systems are carefully welded and manufactured so that it is a hermetically closed system for reliable performance. This type of construction eliminates leak points and plugging that can occur with impulse piping, and there is no need to fill or drain the lines.

A common capillary seal configuration is the “balanced system”, where the seals and capillary length are identical on both the high and low side of the DP transmitter. This type of system is traditionally specified because it supposedly compensates for all temperature effects. For example, as the outdoor temperature changes (whether from night to day or season to season), the oil volume in the capillary will expand and contract, causing changes in the internal pressure of the capillary system. These changes in pressure will result in measurement error, called “seal temperature effect”. A balanced symmetrical system was initially thought to cancel out this error, because the same expansion / contraction of oil volume will occur on both the high and low sides of the transmitter. While this may be true, there is another source of temperature error that is not addressed.

Anytime a capillary seal system is installed and there is a vertical separation between the two seals (such as on all vessels and distillation towers), there is “head pressure” that is exerted on the low side of the transmitter from the weight of the oil in the capillary. Again as the temperature conditions change, the density of the oil in the capillary will fluctuate and cause a change in the head pressure that is measured by the transmitter. This source of error is called “head temperature effect.” While balanced systems can cancel out seal temperature effect, they do not compensate for head temperature effect. Additionally, balanced systems result in extra capillary on the high side of the transmitter that is often coiled up and adds unnecessary costs. Balanced systems also require the use of a pipe stand or other mounting hardware to facilitate the installation of the transmitter.

Rosemount Tuned-System assemblies offer a better solution compared to balanced systems by offering improved performance.
Pressure Level Measurement

vessels and distillation towers, writes Michael Olivier.

performance and easier installations at a lower cost. Tuned-System assemblies consist of a direct mount seal on the high-side of the transmitter with a single length of capillary and seal on the low side of the transmitter. The asymmetrical design purposely induces seal temperature effects to counteract the head temperature effects that will always be present on any vertical installation. Also, Tuned-System assemblies can be directly mounted to the vessel without the need for additional transmitter mounting hardware, and installed costs are often reduced by 20% by eliminating the unnecessary length of capillary on the high side of the transmitter.

Limitations of Traditional DP Level Technology

While Tuned-System assemblies are a proven and reliable technology, tall vessels and towers have traditionally been difficult applications. In particular, these require longer lengths of capillary to facilitate the installation, resulting in head temperature effects that are often too great to “tune” out. For example, an installation that requires 50 feet (15 meters) of capillary will experience as much as 15 in.H20 (383 mmH20) of measurement drift for a 50°F (28°C) change in temperature. Additionally, time-response can be sub-optimal on tall vessels and towers, and installations become increasingly difficult with longer lengths of capillary.

Electronic Remote Sensor Technology

Electronic Remote Sensor technology solves many of the problems that are traditionally seen when making a DP measurement on tall vessels or towers. Rather than using a single DP transmitter with mechanical impulse piping or capillary, the Rosemount 3051S ERS System uses two direct mount gage or absolute sensors that are connected with a non-proprietary electrical wire. One of the two sensors calculates the DP and transmits it back to the host system / DCS using a standard two 4-20 mA HART signal.

ERS is the digital architecture that eliminates the mechanical limitations of capillary solutions.

The unique digital architecture of the 3051S ERS System enables many benefits when used on tall vessels and distillation towers including:

• Improved Performance: The 3051S ERS System replaces mechanical components with a digital architecture, resulting in faster time response and a more stable and repeatable measurement even in applications with wide varying temperatures.

• Simplified Installations and Maintenance: Cold weather installations often require heat tracing or insulation. Impulse lines need to be checked for leaks, condensation, evaporation, and plugging. The digital architecture of the 3051S ERS System eliminates these practices, resulting in cleaner installations with less maintenance and upkeep.

• Additional Process Insight and Diagnostics: The 3051S ERS System is a MultiVariable solution that provides additional process information for optimised control. In addition to the DP calculation, the 3051S ERS provides real-time access to the readings from each pressure sensor and a scaled output for tank level or volume measurement.

Complimentary Technologies

While the 3051S ERS System is great for tall vessels and towers, there are applications where a traditional Tuned-System assembly will continue to be the preferred technology. The sensors in a 3051S ERS System are specified and sized based on the combined static pressure and the DP column from the liquid level, where as a Tuned-System assembly is sized just on the DP column. Because of this, Tuned-System assemblies will continue to be the optimal solution for smaller, higher pressure vessels, and Electronic Remote Sensor technology will enable new success on tall vessels, towers, and other similar applications.

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