White Paper
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Optimize Results and Save Money with Rosemount® Tuned-System Assemblies®

1.1 Executive summary

Emerson provides an extensive offering of DP level technologies that solve any application need. Each technology has its purpose and benefits, but a significant portion of the differential pressure level business can be solved using Rosemount Tuned-System Assemblies. This particular system allows for many benefits over traditional impulse piping or balanced system DP level technologies including improved performance and cost savings. Tuned-System Assemblies are available with all Rosemount transmitters, giving you the availability of all protocols and options including: wireless, advanced diagnostics, and QZ reports.

The advantages of the Tuned-System Assembly are apparent. The following paper will provide more detail on how this system can improve performance and most of all save money.

1.2 Overview of DP Level technology

1.2.1 Vapor pressure (vessel static pressure) is subtracted in DP measurement

Conventional DP 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 mmH_20 of pressure. However, in many applications, there is additional vapor pressure above the liquid. Being that the vapor pressure is not part of the liquid level measurement, it must be subtracted from the overall pressure measurement. The use of impulse piping or a Rosemount 1199 Remote Seal with capillary is required to measure the presence of vapor pressure at the top of the vessel.

1.2.2 Using impulse piping to measure vapor pressure

In an impulse piping configuration, the low-side reference leg is filled with either a column of liquid (wet leg), or with a suitable dry gas (dry leg). Wet legs are used when the vapor blanket in the tank will condense into a liquid form. Conversely, dry legs are used when the vapor will not condense. While relatively simple in concept, impulse piping installations can be difficult to maintain because evaporation often occurs in wet legs and condensation can occur in dry legs. Both conditions will cause a measurement error in the DP transmitter due to the low-side pressure measurement drifting. Impulse lines can also leak, plug, and may require insulation or heat tracing to prevent freezing or excess vapor condensation. Additionally, rigid impulse piping can complicate installations in dense plant infrastructures.

1.2.3 Capillary systems reduce the challenges associated with impulse piping

Capillary and seal systems eliminate many of the issues with impulse piping installations, such as plugging caused by viscous processes and suspended solids. A Rosemount 1199 Remote Mount Seal System consists of external sensing diaphragms mounted to the process and is connected to the DP transmitter with oil-filled capillaries. Changes in pressure cause the diaphragm membrane to deflect and the pressure is propagated through the oil-filled capillary and ultimately exerts the force on the transmitter sensor resulting in a measurement. Oil-filled capillary systems are carefully welded and manufactured so that the systems are hermetically closed for reliable performance. Careful construction and manufacturing eliminates leak points and plugging as well as any evaporation or condensation issues that can occur with impulse piping. Additionally, the capillary simplifies installation of the measurement point. Capillaries are not rigid like impulse piping, making it possible to easily install around permanent structures, which allows measurement points in locations previously deemed too difficult to instrument with impulse piping.

1.2.4 Balanced systems do not eliminate all temperature induced error

A common capillary seal configuration is the “balanced system”. A balanced system consists of two 1199 Remote Mount Seals with capillary lengths that 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 induced errors. 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 fluctuations in the internal pressure of the capillary system. These changes in pressure will result in measurement error, commonly referred to as “temperature induced volume effect” or “Seal Effect”. A balanced system was initially thought to cancel out this error because the same expansion and contraction of oil volume will occur on both the high and low sides of the transmitter due to the symmetrical construction. While the volume does expand and contract equally within a balanced system, there is another source of temperature induced error that does not affect the high and low pressure sides of the transmitter symmetrically.

The second source of temperature induced measurement drift occurs when a capillary seal system is installed with a vertical separation between the two seals. This measurement drift occurs on all vessels and distillation towers where there is a “head pressure” exerted on the low side of the transmitter from the weight of the fill-fluid within the capillary. If ambient temperature conditions change, the fill-fluid within the capillary will also experience a subsequent temperature change. The density of the fill-fluid within the capillary will fluctuate with the change in temperature and cause the amount of head pressure force that is measured by the transmitter to vary. This source of error is called “temperature induced density effect” or “Head Effect”. While balanced systems can cancel out the changes in volume within the system due to equal lengths of capillary, it does not compensate for this change in density as the low pressure side is generally mounted at a higher elevation than the high pressure side. Balanced systems also require the use of a pipe stand or other mounting hardware to facilitate the installation of the transmitter. In addition, balanced systems result in excess capillary on the high side of the transmitter that is often coiled up and adds unnecessary costs.

1.3 Tuned-System Assembly technology

Tuned-System Assemblies offer a better solution compared to balanced systems by offering improved performance and easier installations at a lower cost. Tuned-System Assemblies consist of a Rosemount 1199 Direct Mount Seal on the high-side of a DP transmitter and a single length of capillary connected to another seal which is welded to the low side of the transmitter. The asymmetrical design purposely minimizes the fill-fluid volume on the high side in order to counteract the temperature induced density effects always present on any vertical installation. For example, when ambient temperatures increase, the fill-fluid expands (negative shift in Tuned-System Assembly, no shift in balanced system) but the density decreases (positive shift in both systems). The total cumulative temperature effects will lower the total error in a Tuned-System Assembly as the temperature induced effects shift the measurement in opposite directions.

Tuned-System Assemblies can be directly mounted to the vessel without the need for additional transmitter mounting hardware. Installation costs are often reduced by 20% by eliminating this hardware as well as the unnecessary length of capillary and oil on the high side of the transmitter. Using Instrument ToolKit Software to specify your system will also allow you to decrease excess capillary on the high side, adding to your overall cost savings of the system.

1.3.1 Tuned-System Assemblies tighten process control and reduce variability

The unique technology of the Tuned-System Assembly allows for improved performance. As stated previously, a typical balanced DP level system encounters a density effect with changing temperature that may cause measurement drift, but is not affected by volume change because of the same lengths of capillary on both sides. A Tuned-System however, encounters both of these effects which work in counteracting ways. With increasing ambient temperatures, the high side volume effect is greater than the low side, but is counteracted by the low side density effect. This results in a reduced temperature-induced measurement drift by 20%. In a Tuned-System Assembly the fill fluid only has to travel through half of a typical balanced system in order to get the same response; this combination of direct mount and one remote seal also results in an 80% improvement in time response.

1.3.2 Tuned-System Assemblies result in reduced instrumentation costs by 20%

Rosemount Tuned-System Assemblies help you achieve significant cost savings on installation and maintenance. You can save $15/ft ($50/m) of capillary by eliminating the additional remote mounted seal that would be necessary on a balanced system. Using Instrument ToolKit Software to more accurately specify your system will also help you eliminate additional, unnecessary capillary and allow more cost savings. The unique configuration of the Tuned-System Assembly also simplifies mounting hardware by omitting brackets, pipe stands, and capillary spools, which also keeps inventory at a minimum. The combination of these benefits gives you a total cost savings of 20% over a traditional balanced DP level system.

1.3.3 Available with latest transmitter innovations

The Tuned-System Assembly is also available with all of Emerson's latest transmitter innovations and protocols. Make sure to retrieve and analyze all of your process variables using Advanced Diagnostics. Using a Rosemount 3051S transmitter and scaled variable capability, you can obtain all the variables and functionalities needed to understand everything that is happening in your system. Optional Wireless technology is also available on Rosemount Tuned-System Assemblies. Monitoring remote tanks and integrating into already existing wireless networks allow for long range capabilities and cost savings. Wireless is available on all Rosemount Level Transmitters and high gain remote antennas allow for even longer range monitoring! Optional certifications and performance reports can be ordered as well; QZ reports allow for your system to be validated, quantified, and configured prior to installation. Get the right system the first time every time.

1.4 Complimentary technologies

Overall Emerson offers a breadth of technologies that will support any DP Level application need. Tuned-System Assemblies are just one technology that compliments the entire offering. In addition to traditional DP Level systems, the new 3051S ERS System is available for improved performance on distillation towers and tanks with long spans. Always make sure to verify your application with Instrument ToolKit Software for the best performance.

Additional information on the Rosemount DP Level product offering including more detailed success stories, videos, and product specifications can be found online at:

http://www.Rosemount.com.

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