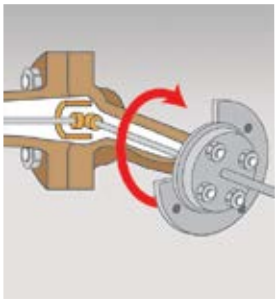
Comparing Displacer Transmitter Technologies for Liquid Level Measurement

Process level measurement has greatly evolved over the years with new technologies. Instrumentation engineers have more demanding requirements that make it essential to have reliable and accurate liquid level measurements. Although based on a more traditional level measurement technology, one of the most trusted devices for continuous liquid level measurement remains the displacer level transmitter. This transmitter operates on the Archimedes principle of buoyancy, which holds that any object, wholly or partially immersed in a fluid, is buoyed up by a force equal to the weight of the fluid displaced by the object. As liquid level moves upward on the displacer, the buoyancy force increases and there is a vertical motion that can be converted to liquid level using sophisticated software. The two main technologies that are used as displacer level transmitters in the industry are torque tubes and range spring/LVDT (Linear Variable Differential Transformer) technologies. A torque tube uses a torsion bar that rotates relative to the weight of the displacer in fluid to correspond to a level reading. The range spring and LVDT combination uses an LVDT core that moves as the spring is unloaded by having fluid on the displacer, causing voltages to be induced across the secondary windings and be converted to a level reading.

Range spring/LVDT technology

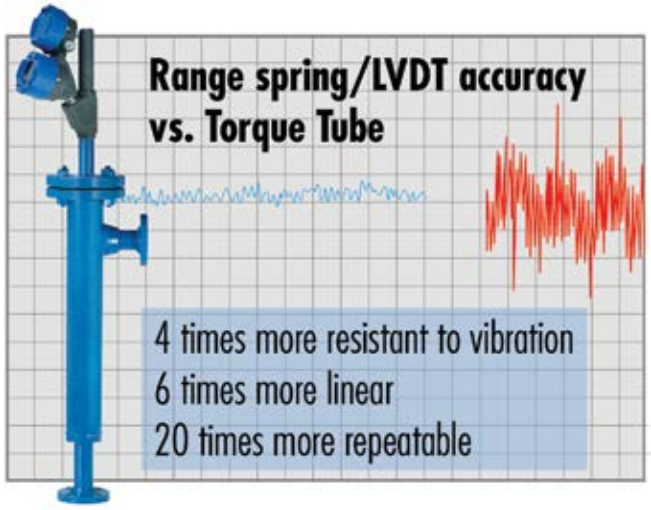


Torque tube technology

There are substantial technology advantages that can make using range spring/LVDT based displacer transmitters preferable to a torque tube based instrument. These include improved accuracy, structural integrity, footprint, and maintenance capability.

Measurement Accuracy

The main technology advantage is a more accurate level output provided by a range spring/LVDT displacer transmitter. Demonstrated through extensive testing[1], the output of a range spring/LVDT displacer transmitter is 4 times more resistant to vibration, 6 times more linear, and 20 times more accurate than a torque tube. The range spring helps dampen any vibration that may occur to the level instrument, maintaining a more stable output than a torque tube. The linearity and repeatability contribute to a consistent level output, ensuring the transmitter reads consistently throughout its operation.



1 – Vibration testing completed between Fisher 2500 Leveltrol and Magnetrol Modulevel. Linearity and Repeatability testing done between Fisher DLC3010 with 249BF torque tube and Magnetrol Modulevel.

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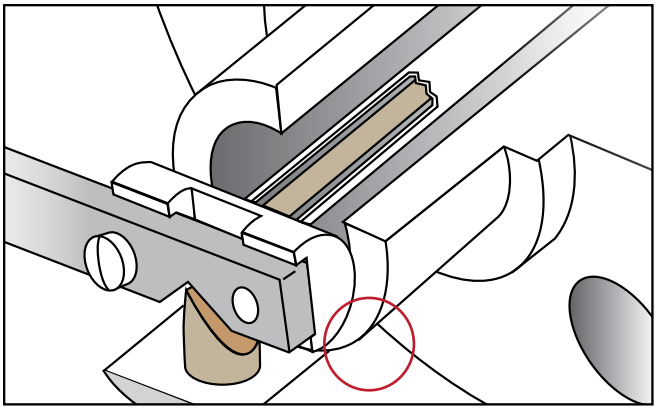
Structural Integrity

The structural integrity of the displacer transmitter is important to ensure minimal maintenance costs across the life of the instrument. There are two structural components that separate range spring/LVDT technology from torque tubes. The torque tube arm that holds the displacer is mounted on what is called a knife edge. This edge creates a stress concentration on the part, which can create wear over time to potentially a failure. The range spring and stem attached to the LVDT core move vertically, completely eliminating the occurrence of friction or wear. The LVDT core is coated with a polymer material to provide smooth vertical motion, and the range spring is protected by a spring cup.

The other component that affects structural integrity is the thickness of the pressure boundary components. In a torque tube displacer transmitter, the torque tube itself serves as the pressure boundary component and has a thickness of 0.25 mm (0.01"). In contrast, the enclosing tube for the range spring design is 0.9 mm (0.035") thick. The increased thickness helps contain pressure and has more tolerance against any type of corrosion that would erode material away, since these components are exposed to the process media. Also, because the torque tube rotates, there is shear stress induced into the material, to which the enclosing tube for the range spring/LVDT design is not susceptible.

Installation Footprint

Clearance can play an important role in the selection of the type of level transmitter. Some applications into which new level transmitters are being installed have space constraints and do not have the room to put a device with a large footprint. Torque tube and range spring/LVDT models have very similar sensing elements that use a displacer, but the difference is in the size and area of the transmitter heads. Torque tubes have a very large footprint to complete their level transmitter, which is also confined to a left-hand or right-hand display design. The left hand or right hand design can cause limitations on the wiring configuration, as the location of the electronics conduit is fixed. For range spring/LVDT designs, a vertical and fully rotatable housing head is available to cover a smaller area and allow for easier wiring.



Above: The Torque Tube is susceptible to fatigue failure and accelerated corrosion. Below: The static-pressure-retaining enclosing tube on the Modulevel® is not susceptible to either of these failure effects.

E4 vs. Torque Tube

Maintenance

Lastly, most level transmitters that have moving mechanical parts will typically require maintenance to keep them operating at peak performance. Displacer transmitters are electro-mechanical devices that require some level of maintenance during their operating life.

It is critical, therefore, to consider long-term maintenance efficiencies in device selection. One key consideration is the minimization of wear points in the device design. As discussed above, torque tubes consist of a knife edge that the sensing element rotates on and can wear over time. Another key maintenance factor is downtime. Since the torque tube itself is part of the pressure boundary, if the transmitter requires maintenance, the pressure vessel will have to be de-pressurized. This creates downtime which negatively impacts process optimization and profitability. For range spring/LVDT technology, the pressure boundary component is not part of the sensing element. Therefore, if troubleshooting is required on the transmitter, it can be removed without having to de-pressurize the entire system. This equates to less downtime and more cost savings.

Summary

In summary, there are benefits to choosing range spring/LVDT technology over torque tube technology. The chart below outlines the major differences highlighted on the previous pages:

Features	Range Spring/LVDT Benefits
1. Accuracy	4x more vibration resistant, 6x more linear, and 20x more repeatable
2. Structural Integrity	Thicker pressure boundary, no points of wear
3. Footprint	Takes up less room, 360° rotatable head
4. Maintenance Capability	Transmitter can be removed without de-pressurizing vessel

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Bulletin: 48-221.1
Effective: July 2023