PROCESS INSTRUMENTATION

Ultrasonic and Radar Level Technologies: **Bringing Clarity to the Water and Wastewater Market**

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If your head spins after reading how amazing one level measurement technology is in comparison to another, understanding the key attributes of these technologies and their applicability to specific processes may help to clear the waters.

When it comes to devices that monitor the level of clean or not-so-clean water – be it in filter beds, wet wells, lift stations, water towers, chemical tanks or open channels – ultrasonic technology emerges on top, followed by radar. It's true that some level application challenges can be solved by more than one level technology. Yet, no single technology can handle every process, regardless of cost, how powerful the instrument is or how new the technology is.

Ultrasonic level technology has been proven for decades in the water and wastewater industry. Even though both ultrasonic and radar technologies have the required muscle, ultrasonic instruments also possess the intelligence to comprehensively meet industry needs. This is important to keep in mind when considering which technology is best for a given application. Simply comparing the attributes of ultrasonic vs. radar devices may not be the best course of action. Rather, consider their features within the context of where and how the technology will be used.

For example, if you are trying to decide which instrument is better suited for monitoring level in a lift station and controlling pump operation, it won't be helpful to learn that radar transmitters can function in a vacuum, withstand high pressures and drastic temperature changes, and are capable of handling temperatures more than twice as high as ultrasonic-based level devices. Such features sound impressive, but none of these conditions exist in lift stations. The marketing of extravagant attributes tends to clutter the message and adds to confusion within the industry.

To gain clarity, rely on what you already know and evaluate whether a newer technology offers tangible benefits. If your current level solution has proven reliable, is it really worthwhile to make major changes due to factors like ease of commissioning or cost? Once a reliable instrument is set up and configured, commissioning becomes secondary. And if the price of a newer model is attractive, consider what might be lacking in terms of functionality. A lower price does not imply low performance, but the scope of operation is likely to be limited to simpler functions. Thus, in considering an alternate technology, make sure that the new solution will not open the door to a set of problems that weren't present with the proven technology already in place.

What's the common ground between these technologies, and what sets them apart?

Both ultrasonic and radar are non-contacting level technologies, which means that they measure level through air using the time of flight principle. As a result, it is not necessary for this type of level device to contact the surface of the material. In contrast, a contacting technology is equivalent to the dip stick used to check the oil level in your car. Capacitance and guided wave radar are examples of contacting level technologies.

A significant benefit of non-contacting level instruments is that they are truly low maintenance. There's seldom a need to clean the transmitter section of the instrument (the antenna, emitter, lens or transducer face) because, in most cases, the material level remains many inches away from the sensor. In a wet well or a lift station, the clearance between the highest level and the sensor is usually several feet.

In certain applications, however, it is possible for buildup to occur. Although these instruments are designed to be non-contacting, water treatment facilities must deal with overfilling due to excess water during severe storms, hurricanes, flooding, etc. In such instances it is possible for level devices to become submerged. The potential for buildup increases if an instrument regularly encounters debris or sticky substances during submergence. Additionally, condensation can form on the sensing area of the instruments due to large temperature swings (warm days and cold nights) inside tanks, wells or any vessel not in a controlled environment. Understanding how ultrasonic and radar technologies deal with these adverse conditions is crucial in making the right choice.

Under submergence conditions, the best-case scenario for a level device is to consistently report a maxed-out level measurement indicating the abnormality. However, many instruments yield random values when submerged and thus aren't reliable. With recent technological advances, some radar level transmitters fare better under these conditions because they are capable of holding a high level. But there remains the issue of buildup over time. A small amount of non-conductive buildup is usually not a problem for radar devices, but when buildup increases, it can trap more conductive debris. Signal degradation and random operation will ensue. Since radar transmitters generate electromagnetic waves with no electromechanical action, there is no inherent mechanism to reduce the accumulation of buildup.

The SITRANS LUT400 ultrasonic controller with transducer and the SITRANS LR120 radar transmitter.

Ultrasonic technology offers both transmitters and controllers for level and open-channel flow monitoring. Like radar transmitters, ultrasonic transmitters are compact devices encapsulating the electronics and sensing mechanism in one instrument. In contrast, ultrasonic controllers consist of a receiver and a transducer, and only the completely sealed transducers are placed inside the process with no sensitive electronics exposed to the conditions in a lift station, wet well or tank. Additionally, unlike radar transmitters, ultrasonic transducers create electromechanical action during the process of ultrasonic wave generation. The mechanical action on the face of ultrasonic transducers renders them inherently self-cleaning, thereby reducing the amount of buildup and condensation that accumulates on the face of the sensor. When submergence conditions are prevalent, transducers can also be fitted with a submergence shield or hood. Because two bodies can't occupy the same space, the air trapped inside the hood prevents debris from reaching the face of the sensor. Also important is the fact that, due to the mechanical action taking place, the signal signature during submergence can be differentiated from that during normal operation. Thus, the controller knows to keep the level locked at over 100 percent to indicate the submergence event. This happens reliably, time after time, with no need for maintenance after the event.

Is one technology more accurate than the other – and does it matter?

It is sometimes argued that radar technology is more accurate than ultrasonic because it is not affected by wind and because the speed of sound varies with changing temperatures. However, for more than 20 years, ultrasonic transducers have been manufactured with integral temperature sensors to monitor the surrounding temperature. This allows ultrasonic technology-based transmitters and controllers to correct for the speed of sound and accurately track the level in a vessel or the head in an open channel. Nevertheless, it is a good practice to use protective covers on all instruments to shield them from direct sunlight and avoid heating up the electronics.

There is an error associated with level measurement for every degree change in temperature. But, thanks to advancements in design that include digital filtering and signal processing algorithms, some ultrasonic level controllers can deliver accuracies down to +/1 mm. With regards to extremes, it will take several minutes for an ultrasonic level sensor to acclimate to a drastic temperature change – for example, when the unit is brought from a control room or storage into an environment that is significantly hotter or colder – but thereafter it will consistently provide correct level measurements.

In addition, remember that accuracy depends on more than just temperature's effect on electromagnetic or sound waves. Radar transmitter accuracy is also affected by the temperature of the electronics, and it, too, can be correlated to an error per degree change. Add to the mix the expansion and contraction of vessels and substances themselves, and millimeter differences in accuracy become trivial. The key question to ask is how crucial accuracy really is within the context of your industry and the material being monitored. In general, tight accuracy is not considered to be overly important for level measurement in water tanks, chemical tanks, lift stations, scum wells, filter beds or clarifiers. One reason for this is that sewage is not viewed as a valuable commodity. Most radar- and ultrasonic-based level instruments offer accuracies of 0.25% or better, which is well accepted within the water and wastewater industry.

An area where accuracy has more relevance is flow measurement. In some cases, primary devices (weirs and flumes) are fitted with secondary devices (level instrumentation) to monitor and bill customers according to how much they discharge into a municipality's collection infrastructure. Additionally, reconciling the influent and effluent flows at a plant (e.g. due to water losses from major leaks) may require more accurate measurement than at wet wells.

One of the most stringent standards for flow measurement in the water industry is the MCERTS Class 1 certification in the UK. The resolution requirement that must be met is ≤ 1mm. To date, no radar transmitter has ever met this standard, while a few advanced ultrasonic level controllers have been able to achieve MCERTS Class 1. Although MCERTS certification applies specifically to the UK market, the intrinsic value of 1 mm remains equal to 1 mm wherever the location. Additionally, with regards to the concerns raised about ultrasonic technology being affected by wind, this is not a factor for the short distances found in open channel applications. If wind truly affected ultrasonics in open channels, this type of transmitter would not be capable of passing such stringent certification standards.

Should cost be the deciding factor for moving from one technology to another?

In the past, radar technology was more expensive than ultrasonic since radar transmitters can be used in applications that are more demanding and require longer measurement ranges. However, the newest compact radar transmitters on the market have not only decreased in cost and size, but their operating frequencies have also increased significantly. The clear benefit is that radar instruments operating in the 80 GHz range can produce a narrow signal without the need for large antennas. In constricted spaces where many objects can obstruct the transmitted and returned signals, a narrow beam suffers less degradation from unwanted interference. Additionally, radar transmitter setup can be carried out quickly for simple applications, meaning that the devices can be up and running within a few minutes.

If a level indication is all that's required, a simple radar level device can certainly handle the task. But, by design, radar and ultrasonic level transmitters alike have a limited scope for the water industry beyond level measurement. Some of these transmitters can also provide low-resolution flow measurements, but not to the extent and complexity that is possible with ultrasonic controllers. Many newer radar transmitters can be connected to a controller for additional functionality – but doing so minimizes or eliminates the cost advantage associated with these less expensive transmitters.

Further complicating the matter is the fact that some newer controllers that are designed to interface with low-cost radar transmitters are more basic than their advanced counterparts for both level and open channel flow. Functions that are included with most advanced controllers but may be lacking from more basic models include:

- Differential level
- Gate or screen control
- Smart pump control
- Volume calculation
- Energy-saving algorithms (pump operation during off-peak electricity rates)
- Fat ring reduction (in wet wells)
- Dual-point operation capabilities (solids and liquids, level and flow, or any combination)
- Multiple measurement ranges (transducer dependent)

Before committing to a lower-priced level solution, it is important to carefully consider what will be gained or lost to avoid creating gaps in functionality that didn't previously exist.

Conclusion

There is room for both ultrasonic and radar level measurement technologies in the water and wastewater industry. Ultrasonic devices have been relied on by the industry for several decades, and the technology has evolved over the years to meet and exceed the demands of this market. Both technologies offer the clear benefit of being non-contacting and, therefore, low maintenance – but in the world of level measurement, there are additional factors to consider. Understanding the process and its unique challenges (submergence, buildup, condensation, pump demands, etc.) will provide the clues to selecting the ideal instrumentation for ensuring seamless operation.

Don't let enticing attributes such as high accuracy and low cost be the sole factors that persuade you into choosing one level technology over another. The key is to be objective about what your challenge entails. When unsure, a good rule of thumb is to work with a supplier who offers a well-balanced product portfolio backed by years of experience in the field – experience that can provide you with much-needed clarity.

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