PROCESS INSTRUMENTATION

Radar vs. Ultrasonic – **The Municipal Battleground**

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Free space radar and ultrasonic have emerged as the two most commonly used non-contact measurement technologies for continuous level measurement. Both work on the Time-of-Flight measurement principal to determine the distance to the media surface (distance = velocity x time) – ultrasonic is a sound based system while free space radar uses electromagnetic waves.

Ultrasonic has long been the gold standard at water treatment and wastewater treatment plants but as the price point for radar transmitters has dropped through the years due to continued developments and competition, the demand for the technology has increased.

Ultrasonic transmitters use piezo crystals in the sensor to send and receive mechanical sound wave to-and-from the media to calculate distance for the measurement of level, volume or available space in a tank, channel or basin. The speed of sound is a known variable (1096' per second through air at 68°F) and the ultrasonic sensor is looking for a reflection of the signal based on the density of the media as it travels through air which has a much lower density than the materials measured in treatment plants (ie: water, chemicals, sludge, etc.). Most ultrasonic transducers have inherent temperature sensors that compensate for changes - the level measurement will only be accurate if the space between the sensor and the media are the same temperature. The presence and type of any gaseous media above the media must also be considered since this also will affect the propagation of the sound waves and have to be accounted for. Ultrasonic level measurement cannot be used in applications where a vacuum is present or pressures are high – in a vacuum the old adage of "you can't hear some scream in space" applies and in higher pressures the process will literally push back against the sensor and impede its ability to generate a signal. Foam is a

potential challenge since it may not have a high enough density to reflect the signal – foam typically will either allow the signal to pass through (light foam, big bubbles, low density) to measure only the liquid level, will absorb the signal or will become part of the level measurement (condensed foam with small, heavy bubbles). The amount of turbulence has to be accounted for since it may cause multiple reflections – undulating surfaces are easily dealt with but deep, mixing vortices have to be accounted for. Dust (often found in lime and carbon black silos) challenges ultrasonic signals because it can absorb the energy of the signal and often requires the use of large, powerful transducers to penetrate and register the density shift when it reflects off the powder.

Free space radar transmitters use three different frequencies – 6 GHz for challenging applications (ie: digesters, carbon black silos), 26 GHz for inventory measurements (ie: chemical storage tanks) and 78-80 GHz for high accuracy liquid level and solids measurement. The speed of light is also a known variable (186,000 miles per second) and the electromagnetic waves are looking for a change in the dielectric constant of the measured media and are often immune to effects from gases, temperature and pressures that impact ultrasonics. The dielectric of the measured material, though, must be closely vetted and be generally > 2 for a viable measurement to be made. The number(s) associated with a material's dielectric indicate its ability to store a charge vs. air. Commonly measured materials in the treatment process often have higher dielectrics (water has a dielectric of 80, sodium hypochlorite has a dielectric of ~7, lime powder has a dielectric of ~3, as examples) and tend to work well with radar due to their strong reflective properties. Turbulent surfaces and foam also must be taken into consideration when specifying/applying radar level transmitters. The FCC has defined guidelines that must be taken into account when installing, applying and specifying free space radar transmitters in open air applications like basins, channels and plastic storage tanks – transmitters cannot put out too much energy at the 60° boundary so the beam width must be limited to 12° and this will dictate the size of the antenna required.

Many free space radar and ultrasonic level transmitters offer process intelligence algorithms that help to better manage difficult applications.

Ultrasonic still has a price point advantage over radar and is a proven technology but as the price for radar transmitters have dropped they are being applied in more-and-more in applications. This price point will continue to drop as demand and development dictate.

When you look at the landscape of typical municipal level measurement applications, a well-defined line can still be drawn when looking at the best-fit measurement technologies but that line is becoming increasingly blurred with the wider acceptance of radar level transmitters.

When looking at the price/performance benefits, ultrasonic level transmitters still are a viable solution for the measurement of water reservoir levels, lime milk tank levels, process/storm water storage tank levels, filter bed levels, bar screen/rake measurements (dual-channel systems), open channel flow measurements, pump control and wet wells. Radar level transmitters are the best-for non-contact level measurement technology for anaerobic digesters (6 GHz), lime silos (78 GHz) and carbon black silos (78 GHz).

The applications where radar has made its biggest in-road where ultrasonic has long been the kingpin is in the world of chemical tank storage level, especially in non-vented tanks.

In conclusion, radar level measurement is a good choice for many applications, but it may not be the best choice in all water/wastewater wastewater applications. Many ultrasonic level transmitters have features included specifically for the municipal market (ie: alternating pump control, dual channel bar screen/rake differential measurement, open channel flow) and are still remain a cost-effective and beneficial measurement technology.

The SITRANS LUT400 ultrasonic controller and the SITRANS LR560 78GHz radar level monitor.

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