Non Contact Level Sensor

A practical guide to non contact level sensor, covering the reader intent, the relationship to non contact level sensor, key evaluation criteria, common risks, and the information the intended project audience should confirm before taking the next step.

Main topic: Main Page
https://www.level-meters.com/

In modern industrial process control, the ability to monitor liquid and solid levels without physical contact with the medium has become a standard requirement for many applications. A non contact level sensor offers significant advantages in terms of maintenance, longevity, and hygiene, particularly when dealing with corrosive, viscous, or hazardous materials. By eliminating moving parts and physical probes that can corrode or become coated, these sensors provide a reliable, long-term solution for level monitoring across diverse sectors, including water treatment, chemical processing, and oil and gas.

This guide explores the underlying principles of non-contact measurement, compares the primary technologies available, and provides practical engineering considerations for selection and installation.

Understanding the Principles of Non-Contact Measurement

Non contact level sensors generally operate on the "Time of Flight" (ToF) principle. This involves emitting a signal—either acoustic or electromagnetic—from a transducer located at the top of a vessel. The signal travels through the air space (ullage), reflects off the surface of the material, and returns to the sensor. By measuring the time interval between transmission and reception, the sensor calculates the distance to the product surface.

Ultrasonic Level Measurement

Ultrasonic sensors utilize high-frequency sound waves, typically ranging from 20 kHz to 200 kHz. The speed of sound is the critical variable here. Because sound requires a medium to travel, the accuracy of an ultrasonic sensor is directly influenced by the composition and temperature of the air or gas in the tank. Most industrial ultrasonic sensors include an internal temperature probe to compensate for changes in the speed of sound as air temperature fluctuates.

Radar Level Measurement

Radar sensors use high-frequency electromagnetic waves (microwaves). Unlike sound, microwaves do not require a medium and travel at the speed of light. This makes radar inherently more robust in applications involving vacuums, high pressures, or varying gas compositions. Radar technology is further divided into two main types:

1. Pulse Radar: Sends short microwave bursts and measures the time delay.

2. FMCW (Frequency Modulated Continuous Wave): Transmits a continuous signal with a changing frequency. The distance is calculated based on the frequency difference between the transmitted and received signals, offering higher precision.

Comparison of Non-Contact Technologies

Choosing between ultrasonic and radar depends on the specific physical properties of the medium and the environmental conditions within the vessel. The following table provides a comparative overview to assist in the selection process.

Feature	Ultrasonic Level Sensors	Radar Level Sensors (26GHz / 80GHz)
Medium Requirement	Requires air/gas to transmit sound	Can operate in a vacuum
Accuracy	Typically ±0.25% of range	Up to ±1 mm
Maximum Range	Up to 15–30 meters	Up to 30–120 meters
Pressure Limits	Usually limited to 3 bar (43 psi)	Up to 160 bar (2320 psi) or higher
Temperature Limits	Typically -40°C to 80°C	Up to 450°C with specialized antennas
Effect of Dust/Vapor	Significant (attenuates sound)	Minimal (microwaves penetrate dust/vapor)
Cost	Lower	Higher (though 80GHz costs are normalizing)
Best Use Case	Water tanks, open channels, sumps	Chemical reactors, high-pressure silos, fuels

For a comprehensive look at specific hardware configurations and technical data sheets, engineers should refer to the Main Page of the instrument manufacturer’s documentation.

Technical Selection Criteria

When specifying a non contact level sensor, several technical factors must be evaluated to ensure the device performs within its intended accuracy parameters.

Dielectric Constant (DK)

For radar sensors, the dielectric constant of the material is paramount. Materials with a high DK (like water, DK $\approx$ 80) reflect electromagnetic waves very efficiently. Materials with a low DK (like plastic pellets or certain oils, DK $<$ 2) absorb more energy, resulting in a weaker return signal. If the DK is extremely low, a guided wave radar or a high-sensitivity 80GHz FMCW radar may be required.

Beam Angle and Narrowness

The beam angle determines the "footprint" of the signal at the bottom of the tank. A wider beam angle is more likely to hit internal obstructions like agitators, ladders, or heating coils, which create false echoes (noise). Modern 80GHz radar sensors offer very narrow beam angles (often as low as 3 degrees), allowing them to be installed in tall, narrow nozzles or tanks with complex internals without interference.

Blocking Distance (Dead Zone)

Every non-contact sensor has a "blocking distance" or "dead zone" directly beneath the sensor face. In this zone, the sensor cannot accurately process the return signal because the transducer is still vibrating from the transmission. If the liquid level enters this zone, the sensor may report an error or a fixed maximum value. It is vital to mount the sensor high enough so the maximum liquid level never reaches the blocking distance.

Installation Guidelines for Optimal Performance

Proper installation is as critical as selecting the correct technology. Incorrect mounting is the leading cause of signal loss or measurement drift in non-contact systems.

1. Nozzle Height and Diameter: The sensor should be mounted such that the transducer face extends slightly into the tank or is flush with the tank roof. If the nozzle is too long and narrow, the signal may reflect off the nozzle walls before even entering the tank.

2. Positioning Relative to Inflow: Never install a sensor directly above the point where the tank is filled. The turbulence and the falling stream of material will scatter the signal and cause erratic readings.

3. Avoiding Obstructions: Ensure the signal path is clear of ladders, pipes, and agitator blades. If an obstruction is unavoidable, many modern sensors, such as those from Welk, feature "False Echo Suppression" software that allows the user to map out and ignore static reflections.

4. Orientation: For solids measurement, the sensor may need to be mounted on an aiming flange (swivel mount) to point the beam at the angle of repose of the material, ensuring the best possible reflection back to the transducer.

Environmental Limitations and Mitigation

While non-contact sensors are versatile, certain environmental conditions pose challenges that require specific mitigation strategies.

Foam and Turbulence

Heavy foam on a liquid surface can act as an insulator, absorbing ultrasonic sound waves or scattering radar signals. In cases of light foam, radar is generally more effective than ultrasonic. For extremely thick, dense foam, a contact-based technology like a magnetic level gauge or a hydrostatic transmitter might be more reliable, though high-frequency radar can sometimes penetrate thin foam layers.

Condensation and Buildup

In high-humidity environments, condensation can form on the sensor face. For ultrasonic sensors, droplets can attenuate the signal. For radar, specialized PTFE (Teflon) lens antennas are designed to shed moisture. Some radar sensors also include a compressed air purge connection to blow away dust or heavy condensation from the antenna face.

Temperature Gradients

In large outdoor tanks, the air temperature at the top of the tank may differ significantly from the air near the liquid surface. Since ultrasonic sensors rely on the speed of sound through air, these gradients can introduce errors. Radar is unaffected by these temperature variations, making it the preferred choice for large outdoor storage tanks.

Industry-Specific Applications

Water and Wastewater Treatment

In this sector, ultrasonic sensors are the dominant choice for open-channel flow measurement (using flumes or weirs) and for monitoring chemical storage tanks like alum or sodium hypochlorite. The non-contact nature prevents the sensor from being fouled by raw sewage or corroded by chemicals.

Chemical and Petrochemical

Radar sensors are preferred here due to the presence of vapors, high pressures, and varying temperatures. Because radar does not require a physical seal that could be a leak point for hazardous gases, it is often used in tanks containing volatile organic compounds (VOCs).

Food and Beverage

Hygiene is the priority in food processing. Non contact level sensors are ideal because they do not touch the product, eliminating the risk of contamination and making Clean-in-Place (CIP) processes easier to manage. Sensors with stainless steel housings and hygienic process connections (like Tri-Clamp) are standard.

Frequently Asked Questions (FAQ)

Q: Can a non contact level sensor measure through a plastic tank wall?

A: Radar sensors can often measure through the top of a plastic or fiberglass tank without a hole, provided the material is not metallic or carbon-filled. Ultrasonic sensors cannot do this, as sound reflects off the plastic surface.

Q: What is the maintenance requirement for these sensors?

A: Maintenance is minimal. Periodically check the sensor face for heavy buildup or debris. If the sensor is equipped with self-diagnostics, it will often alert the operator if the signal strength (echo quality) is degrading.

Q: How do I handle a tank with a heavy agitator?

A: Use a radar sensor with a narrow beam angle (80GHz) and position it as far from the agitator shaft as possible. Utilize the "False Echo Mapping" feature during commissioning to tell the sensor to ignore the reflections from the agitator blades.

Q: Is calibration required?

A: Most digital non-contact sensors are factory-calibrated. On-site configuration involves setting the "Zero" (empty tank distance) and "Span" (full tank distance) points. Unlike hydrostatic sensors, they do not usually require periodic re-calibration unless the process conditions change significantly.

Conclusion

Selecting a non contact level sensor requires a balance between understanding the physics of the medium and the mechanical constraints of the vessel. While ultrasonic sensors remain a cost-effective solution for simple liquid applications, the increasing accessibility of high-frequency radar has made it the go-to choice for complex industrial environments. By following proper installation practices and accounting for factors like dielectric constants and beam angles, engineers can ensure highly accurate and maintenance-free level monitoring. For further technical support and to explore a range of industrial-grade measurement solutions, please consult the resources available on the Main Page.