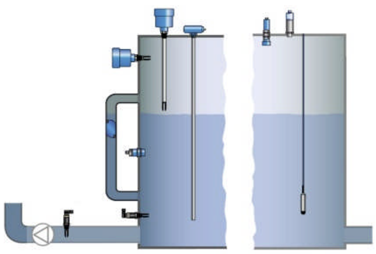
8 Most Common Level Sensing Methods:
A Guide for Reliable & Cost-effective Applications

Level sensors have been a part of manufacturing processes for several decades, in industries as diverse as food and beverage, semiconductors, and pharmaceutical. However, equipment manufacturers and users may be surprised at both the breadth and sophistication of level sensing alternatives currently available.

Measurements and actions that used to require large, mechanical, and expensive devices can now be performed using advanced, highly versatile technologies that are also durable, precise, and easy to implement. What's more, a variety of level sensing technology options work well with what have traditionally been challenging substances such as sticky fluids (e.g., molasses, glue, ink) and foam (beer, pulp, hydraulic fluid, soap).

Some users may question the need for such technology—or any level sensing device, for that matter—arguing that existing, "tried-and-true" methods are well-suited for the basic nature of most level sensing tasks. But today's manufacturing environment is hardly that simple. Given the increasingly competitive nature of the marketplace, plus the ongoing drive to minimize inefficiencies and waste, no operation can afford processes that are merely "close enough." Dependability is also paramount if caustic or otherwise hazardous materials are involved.

In other words, level sensing is like any other part of the manufacturing process; it has to be precise, reliable, and cost-effective.



Level sensing 101

To determine the best sensor for a particular application, it's important to first understand what technology options are available, as well as their advantages and limitations. Following are some of today's most frequently used level sensing methods.

- **Laser**. This technology offers the broadest availability of offerings, flexibility, ease of set-up and alignment, and cost. While lasers work well for bulk and liquid, continuous, and switching applications, it's not as well-suited for clear materials, foam (light loss due to dispersion), or sticky fluids (lens contamination).

- **Microwave.** Because of its ability to penetrate temperature and vapor layers that may cause problems for other techniques, guided microwave technology (also known as guided radar) compares well with lasers as they don't need calibration and have multiple output options. Guided microwave is also among the handful of technologies that works well with foam and sticky materials. However, guided microwave sensors do have a limited detection range in some applications

- **Tuning Fork**. This vibrating-style sensor technology is ideal for solid and liquid detection, including sticky substances and foam, as well as bulk powders. However, tuning forks are limited to detection applications (i.e., overfill and dry run), and do not provide continuous process measurement. The mounting position of the devices is also critical.

- **Ultrasonic.** These devices, which gauge levels by measuring the duration and intensity of echoes from short bursts of energy, share the same capabilities as lasers and offer flexibility in mounting and outputs. The technology is ideal for many types of liquids, but performance drops off in applications involving foam. Range is more limited than laser offerings and alignment of the emitting/detection and reflection components is also critical.

- **Optical Prism.** Inexpensive and simple to set-up and operate, optical sensors detect variations in emitted light. However, optical prisms work only in clean translucent to transparent liquids, while their limited "on/off" functionality also restricts their use to protecting from overflows and dry runs.

- **Pressure.** Used for a variety of liquids, pressure sensors measure the hydrostatic pressure of the liquid at the bottom of the tank with respect to atmospheric pressure to determine the level of the liquid. Though highly accurate, pressure sensors' setup and calibration requirements make them more of a specialty solution in situations where all other options are not viable due to the type of liquid, or configuration of the tank itself. For example, the tank bottom may have a funnel or cone shape, or there may be a motor or agitator positioned in the middle that prevents a straight-down view.

- **Capacitance.** Capacitance level sensors operate with a variety of solids, liquids, and mixed materials. There are also a wide range of device types, some of which can be attached outside the vessel. Users need to be cautious when selecting a device, as not every capacitance senor works with every type of material or vessel. In addition, some capacitive probes can give continuous output much the way guided microwaves or conductive probes do, but need to be calibrated to the material being measured. And because capacitance probes are a contact-based measurement system, the technology is not always suitable for use with sticky fluids.

- **Floats.** The oldest and simplest measuring technology can still be found in automated manufacturing processes. Being a mechanical device, however, floats offer little other advantage to users for all but the most basic applications.

Decision time

In some respects, matching a level sensor with a particular application may seem relatively simple.

One question—the desired result, is usually a matter of either switching/detection for dry-run and overflow protection, or continuous monitoring for process management.

Here, the continuum from basic performance to "smart" sensors is rather straightforward. Tuning forks, optical prisms, and some capacitance sensors are restricted to switching applications. Other technologies work for both switching and measurement—laser, guided microwaves, ultrasonic, pressure, and float.

But the other key consideration—what is being measured—is not so simple. Solids and liquids have multiple dimensions and characteristics, any one of which can influence its ability to be accurately measured.

For example, both solids and liquids can be clear, translucent, or opaque. Minute texture variations of some powdery substances may also affect how a sensor reacts, as can a liquid's viscosity and density. Color variations may also be an issue with some types of level sensors. And, as noted earlier, particularly challenging applications further restrict the range of options. When dealing with foam, sticky liquids, or clear liquids, for example, guided microwaves and vibrating forks may well be the only option.

The table to the right can serve as a helpful starting point to find the best level sensor technology for a particular application. In making these evaluations, users and equipment manufactures should also ask operations-related questions.

	Liquids	Solids	Clear	Opaque	Sticky Fluids/Foam
Laser	Yes	Yes	No	Yes	Material dependant
Microwave	Yes	No	Yes	Yes	Yes
Tuning Fork	Yes	Yes	Yes	Yes	Yes
Ultrasonic	Yes	Yes	Yes	Yes	No
Optical Prism	Yes	No	Yes	No	No
Pressure	Yes	No	Yes	Yes	No
Capacitance	Yes	Material dependant	Yes	Yes	No
Float	Yes	No	Yes	Yes	Material dependant

For example, what kind of control capabilities do the sensors have, and what training operator training is required. Will the material being measured affect the sensor's performance over time, requiring maintenance for cleaning and/or replacement? If so, how often should preventative work be scheduled, and what are the downtime implications? What is the expected life of a particular sensor? And if the process involves multiple types of materials with varying characteristics, will changeovers be an issue?

The above information is designed to provide a basic guide to the growing range of level sensing technology. Because most of these approaches continue to evolve with the introduction of new and enhanced products, the best way to ensure a full evaluation of available options—especially for unique or challenging applications—is via a collaboration involving the manufacturing system owner, machine builders, and technology suppliers. Thorough and thoughtful assessments of sensor technologies will lead to better decisions, resulting in better product quality and optimized production efficiency.

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