Tank Level Measurement Options for Powders & Solids

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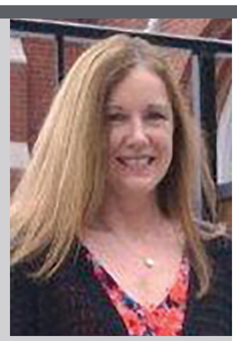
Inventory control. Inventory turns. Inventory accuracy. Inventory management. It's all about inventory and controlling its related costs.



So, your job is to figure out just how much material you have on hand, when you need more, and don't you dare run out. Simple in theory, not quite so easy when you are running multiple production lines or asked for month-end inventory in about an hour.

However, there are devices that can help make your inventory more accurate and your job easier. To select the appropriate device, it is helpful to consider the material being measured, whether the material surface is even or irregular, the regulatory environment, the size of the tank, and whether you need to know when inventory has reached a certain level in the tank (requiring a point level device) or you need continuous level measurement.

Rotary Level Indicators

Rotaries are used for high or low level point level indication in bins, tanks, and silos. A rotary sends an alert via a horn, light or to an alarm panel when material reaches (for high level detection) or falls away from (for low level detection) the rotary paddle.

Rotaries are used in a wide range of powder and bulk solid materials and can be used in materials with a bulk density of 1 lb/cu ft^3 to 150 lb/cu ft^3, so they can be used in light powders, granulars, pellets and even very coarse materials such as aggregates. Rotaries are applied in almost every industry including agriculture and food processing, chemical and pharmaceutical manufacturing, plastics and packaging materials, pulp and paper, mining, and many more.

The selection of rotary depends on how critical the role of the rotary is in the operation. For example, if a rotary is critical in starting, stopping, or controlling a process, or causing a work stoppage if a bin should become empty.

Most standard rotaries are designed to provide protection from system power failure. Some feature a motor that "goes to sleep" or "de-energizes" to automatically shut down when material is present. When it is crucial to confirm the continuous operation of a rotary, the application calls for a genuine fail-safe rotary that continually self-diagnoses, and in the event of a failure, sends an immediate warning and instantaneous corrective response.

Rotaries are increasingly applied in new ways. For high level detection at the interior of a bin, a vertical extension on a rotary can allow it to be extended up to 12 feet down into the bin. This configuration is recommended for a center fill bin when the operation wants to allow a specific amount of headroom in the bin.

Mounted on the top of the bin, a vertically- extended rotary can alert when material is higher toward the centre of the bin, versus simply detecting the level of material near the sidewall which could be at a lower level when filling the bin (cone up) and at a higher level when emptying the bin (cone down).

For thick bins walls, a horizontal extension allows for a rotary to be used to detect material levels through the sidewall. When a horizontal extension is combined with a collapsible paddle, the rotary can be installed through a 1-1/4 inch or 1-1/2 inch NPT opening without entering the bin.

Capacitance Probes

Capacitance sensors are designed for a wide array of applications and materials and may be used in powders, granulars, pellets and other solid or slurry materials. The sensors may be used for high, mid and low level detection in bins, silos, tanks, hoppers, chutes and other types of vessels where material is stored, processed, flowing or discharged.

Capacitance sensors operate by detecting the presence or absence of material in contact with the probe by sensing a change in capacitance caused by the difference between the dielectric constant of the material in the tank and the air. These sensors are able to detect very small changes in capacitance, typically one picofarad.

When selecting a capacitance probe, understanding the radio frequency range of the device and its impact on other equipment in the plant is an important consideration. According to the Federal Communications Commission, signals in excess of 9 KHz are classified as "RF" and are prone to radiate.

Capacitance sensors that emit RF signals may interfere with nearby electronic plant equipment. Conversely, capacitance probe designs that utilize RF may be prone to interference from other RF devices, such as two-way radios. There are capacitance probe designs that utilize electronic circuits incorporating frequency shift oscillators and balanced bridges and operate at frequencies between 100 KHz and 2 MHz in the RF range.

Alternatively, there are capacitance probe designs that use a discharge time constant detector circuit which sense capacitance changes of less than one picofarad and operate at only 6 KHz, which is well below the RF level of most plant equipment.

For food processing or pharmaceutical applications a shielded, Delrin-sleeved sanitary probe is often appropriate. A sanitary probe should be designed for quick disconnect from the device, so it may easily be removed from the tank for inspection and cleaning. Sanitary probes are also designed so there are no exposed threads where material can build up and become contaminated.

To guard against false readings from build-up on the probe or bridging between the sidewall and the probe, a portion of the probe should be shielded. A time delay feature can minimize false alarms in the case there is a sudden material shift caused by rapid filling or emptying of tanks or process activities.

If continuous process operation is critical, look for a capacitance sensor that features fail-safe protection to eliminate process shut-downs, overfills, empty conditions, or accidents. To prevent overfills or material shortages, a high/low selectable switch allows the sensor to be set for fail-safe high or fail-safe low. An extended, flexible cable extension can be attached to the capacitance probe in instances when the sensor is mounted on top of the tank and will be used for high, mid or low level detection.

A flush mounted probe can be used in narrow or space constrained areas or in applications where material flow or bridging may damage a standard probe. When the tank is small or has internal obstructions, a bendable probe can be used in the tank to avoid obstructions, while still allowing adequate probe surface area to detect the presence or absence of material.

If your facility has an explosion proof requirement, you will need to specify a capacitance sensor designed and certified for hazardous location applications. If the application is in a high temperature environment or in an area where there is excessive vibration, it is appropriate to install a capacitance probe that houses the electronics and probe in separate enclosures. This will protect the electronics from heat or vibration.

Vibrating Level Sensors

The vibrating level sensor or vibrating rod is a piezoelectric driven vibration type level switch can be used for level detection in bins, silos, and hoppers filled with powders or dry bulk solid materials. A vibrating level sensor can detect extremely light, fluffy materials as light as 1.25 lb./ cu. ft.3, such as powders and flakes or can be used for heavy materials such as granulars or pellets. A vibrating level sensor can be utilized as a high, mid or low level alert and can be mounted on the top of the tank as a high level detector or in the bottom cone of a tank to sense when the tank is nearly empty.

Vibrating level sensors are piezoelectric devices with a single rod shaped vibrating element. The rod of the sensor vibrates when there is no material covering the active rod. When the rod is covered with material, the vibration is dampened and an electronic circuit causes a relay to switch and sends an alert. When the rod becomes uncovered, the vibration restarts and the relay will switch back. A vibrating rod features a single probe design that prevents material from bridging and giving a false signal.

Vibrating level sensors are known for high performance and reliability and since the sensitivity is located at the tip of the sensor, material built up on the vessel wall will not influence the function of a vibrating level sensor. Plus, the combination of low energy and tip sensitivity will reduce false alarms due to rat-holing around an active sensor. Most vibrating rods do not require calibration and easily adjust to the desired sensitivity level. For process-critical applications, be sure to look for features such as a fail-safe alert that will provide notification when power is interrupted to the unit to avoid overfills and empty tank situations.

Bob-Style Sensors

If minimal contact with the material in the tank is acceptable, a weight and cable-based sensor is an economical and accurate continuous level measurement choice. Weight and cable-based or bobstyle sensors can be ideal for diverse applications for most any industry as they are not affected by dust, humidity, temperature, dielectric constant, or fumes that may be present. Since there is limited contact with the material, there is minimal risk of contamination.

This type of sensor works in virtually any material regardless of particle size or bulk density including very light materials like fine powders to heavy, dense materials like aggregates. A bob-style sensor can be used in bins up to 180 feet tall, but are also often used in smaller, active process bins under 40 feet tall. Properly mounted on a center-fill, centre-discharge bin, bob-style sensors will consistently provide5% to 7% accuracy. They work by releasing a cable with a weighted sensor probe that stops and retracts when the probe comes into contact with material. Redundant measurements are taken when the sensor probe is both descending and retracting to guarantee every measurement is precise. Bob-style sensor networks can be integrated utilizing various communication options. For example, a control console mounted at ground level can report the data from one up to over 100 bins.

Ultrasonic and Radar

These types of measurement devices are popular as they eliminate contamination or interfering with the internal bin structure since the device does not come into contact with the bin material. They are also ideal for liquid applications. Ultrasonic and radar-based technologies are single-point, continuous measurement devices that can be used for on-going level measuring and monitoring of tanks that are up to 100 feet tall. An ultrasonic device generates an ultrasonic pulse that is sent to the surface of the material in the tank. The pulse reflects off the product and returns to the sensor in the form of an echo. The amount of time the echo takes to return to the sensor determines the distance to the material.

Radar-based devices generate an electromagnetic wave that travels to the material surface being monitored that is reflected off the surface back to the sensor. The calculated distance is based on the length of time it takes the wave to return from the surface.

Ultrasonic and radar may not perform consistently in high dust environments, where their signals can become "confused" and provide inaccurate measurements or no data at all. Since they only measure a single point in the tank, they may offer compromised accuracy in materials like powders that are more prone to bridge or have an irregular surface area. When selecting an ultrasonic or radar device, choose one that is self-calibrating, or easy to calibrate due to the variability of materials that may be measured.

3D Scanners

A 3D scanner is a non-contact, dust-penetrating bin volume measurement system that uses acoustics-based technology to measure bin contents at multiple points within the bin and uses these points to help estimate the volume of material in the bin. Sampling measurements from multiple points when the material surface of the bin is uneven enables the 3D scanner to calculate bin volume for powders and solids with greater precision than any single point measurement device.

A 3D scanner is able to map the topography of the bin and create a computerized profile of the bin contents. This allows for greater accuracy as it detects cone up, cone down, bridging and sidewall build-up and accounts for these variations when it provides the volume estimate. A 3D scanner performs in tanks up to 200 feet tall and in materials with bulk densities greater than 12 pounds per cubic foot. Facilities that install 3D technology are seeking improved inventory accuracy, with a 3D scanner proven to deliver .5% to 3% volume accuracy when mounted in the proper location and used in a bin that is less than 45 feet in diameter.

For bins greater than 45 feet in diameter, a multiple scanner system can record measurement data from multiple devices and combine the data to report volume to a PC and provide a single graphical representation of the bin contents. A 3D scanner is desirable when highly accurate volume inventories are needed to help in optimizing purchasing, delivery logistics, production planning, and financial management. Mapping the contents provides a realistic view of inventory levels.

By detecting build-up, a 3D scanner allows timely preventive maintenance and cleaning. The need for inventory accuracy can vary from one operation or one tank to the next. Getting an accurate measurement for a single point in the tank can be done easily, but it might not give you the volume accuracy you need.