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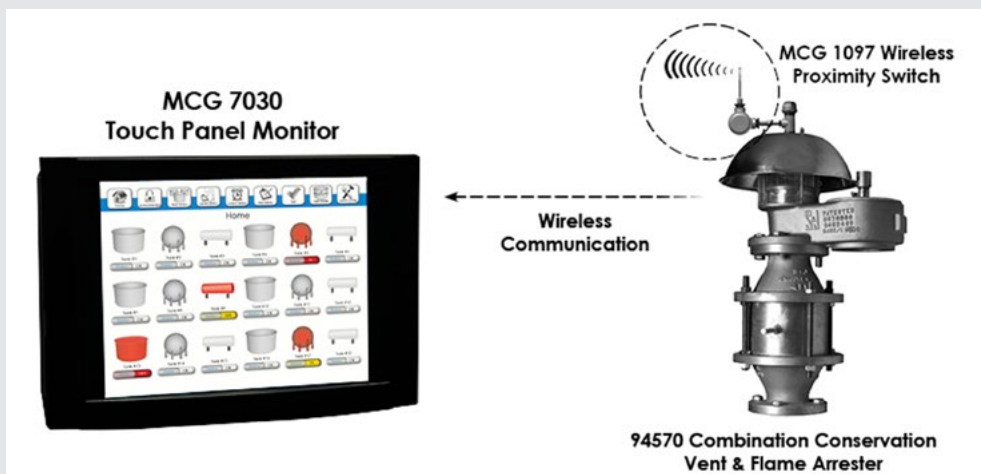


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PRODUCT FOCUS

VENT AND FLAME ARRESTER SENDS SIGNAL TO ALERT OPERATORS



In this new age of always wanting more information, L&J Engineering now offers a way to monitor when tank vents are relieving. The company's Shand & Jurs 94570 combination conservation vent and flame arrester now includes the MCG 1097 wireless proximity switch that can send a signal to notify the operator when a pressure device is relieving. This valuable information can be monitored and tracked. The instant reliable data will prove to be an asset that avoids the hassle of guess work and saving both time and money.

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PRODUCT FOCUS

EXPANDED RADAR LEVEL TRANSMITTER LINE SUITS RANGE OF APPLICATIONS

Three 24 GHz and three 80 GHz radar level transmitters have been added to the Optiwave product line, which complement the existing 6 GHz and 10 GHz devices. The entire range of Optiwave 2-wire loop-powered FMCW radar level transmitters cover liquid and solid applications.

With the Optiwave 1010 (6 GHz), the 5200 (10 GHz) and now the new series of 24 and 80 GHz radars, the company offers the appropriate frequency for each application. The new Optiwave 5400/6400/7400 (24 GHz) and 3500/6500/7500 (80 GHz) radars are each designed for specific industry needs, delivering reliable and accurate level measurement of liquids and solids, even in difficult applications.

An extensive choice of process connections start from $\frac{3}{4}$ -in. for each of the new radar level transmitters, as well as Lens, Drop and Horn antennas to suit all process and installation conditions. The transmitters offer a measuring range from the antenna edge up to 100 m (328 ft), with accuracy from ± 2 mm (± 0.08 in.). The transmitters can measure products with dielectric constants as low as 1.4, and feature a quick setup assistant for easy commissioning. An empty tank spectrum function eliminates false reflections. For more information, visit <http://goo.gl/2Anwdn>.



THINK TANK

When you think about level measurement all day, amazing things happen.

Introducing the Pulsar® R86 from Magnetrol®.

At MAGNETROL, we're obsessed with level measurement because we know how important it is to your operations and your bottom line. And all of that level thinking has led to a smarter non-contact radar. The new Pulsar® R86 is the 26GHz model that features smaller process connections, higher resolution, higher temperature ranges and an antenna that extends from 4" all the way to 72".

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Properly Measure Liquid/Liquid Interfaces

Follow a simple rule for location of level gauge nozzles

By Jonathan Webber, Fluor Canada, and Patrick Richards, Irving Oil

Detailed design of a vessel includes determining the proper locations for level gauge/transmitter nozzles. There's little debate on the correct nozzle locations for vapor/liquid interface level measurements — it's well understood to locate the upper nozzle in the vapor space and the bottom nozzle in the liquid phase. Martyn (1) discusses the challenges of liquid/liquid interface level measurements when using bridled (externally mounted) configurations. Our experience indicates that much confusion exists about the correct nozzle configurations for level measurements of liquid/liquid interfaces. Common questions include: "How do we know that the interface level in the gauge will be the same as the vessel?" and "Won't the light liquid get trapped on top of the heavy liquid in the gauge?"

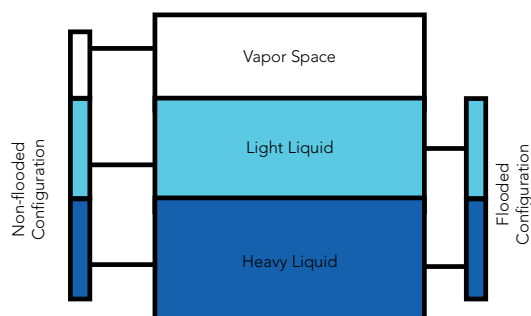
So, here, we'll provide a simple "Golden Rule" for nozzle placement that we have used successfully in numerous refinery interface measurement applications.

THE GOLDEN RULE

For proper location of externally mounted level-measurement nozzles, ensure that at least one nozzle is located in the top liquid phase and at least one nozzle is located in the bottom liquid phase.

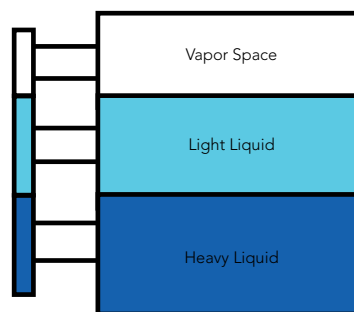
If this simple stipulation is satisfied and the top and bottom fluids are immiscible and have different densities, then we can be sure, at equilibrium, that the pressure balance will equalize the interface levels in the gauge and the vessel.

Either a non-flooded (i.e., top nozzle con-



NOZZLE FOR EACH PHASE

Figure 1. This arrangement satisfies the Golden Rule and ensures the same interface level in the vessel and gauge.



MULTIPLE NOZZLE CONFIGURATION

Figure 2. At least one nozzle must be connected to each liquid phase to comply with the Golden Rule.

connected to vapor space) or flooded configuration will allow the pressure balance to equalize the interface levels in the drum and the gauge (Figure 1). The non-flooded configuration offers the advantage of al-

lowing for a total liquid level measurement. Sometimes multiple nozzles are used to cover the expected range of liquid inventories. In these cases the Golden Rule is satisfied as long as at least one nozzle is con-

PRODUCT FOCUS

DISPLAY MODULE WITH BLUETOOTH DELIVERS REMOTE ACCESS TO SENSORS

A Bluetooth-compatible version of PLICSCOM, the modular display and adjustment unit, now enables users to remotely and securely operate a linked sensor via an app. This wireless solution is suitable for all industries and offers particular convenience for applications in difficult-to-access locations, harsh industrial environments, and hazardous areas. From a safe distance with a smart phone or tablet, users can immediately set up and adjust sensors using encrypted communications security. This allows for safe, convenient access to process instruments.



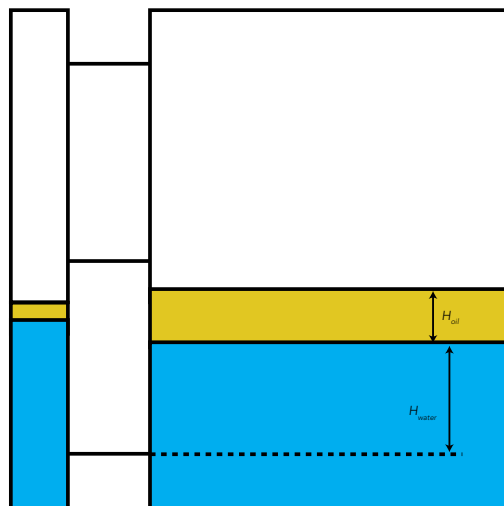
PLICSCOM display modules, part of the plics instrument platform, are designed for modularity. A quick 90° turn allows users to move the same small display puck from instrument to instrument within a facility. The device's copy function allows a display to store a vessel's measurement parameters and copy those parameters to the next vessel, saving hours of setup time. This enables operators in facilities with many vessels to only have to set up one instrument—the module does the rest. Vessel setup may only take a few minutes, but in applications with scores of tanks, those few minutes add up to several hours. The PLICSCOM copy function saves users a significant amount of time.

nected to each liquid phase at all operating conditions (Figure 2).

Oil/water interfaces are common in refining, and we often hear the question: “Isn’t it possible for the pressures to balance in such a way that the height of the interface in the gauge isn’t the same as the height of the interface in the vessel?” A common argument is that the extra head of water in the gauge will compensate for the smaller head of oil in the gauge, thereby allowing the equilibrium interface level in the gauge and vessel to differ (Figure 3). This argument is flawed — if the Golden Rule is followed, the two levels will equalize. The sidebar provides a simple mathematical proof by contradiction.

APPLYING THE RULE

In practice it can be difficult to locate nozzles to satisfy the Golden Rule under all operating conditions. If a vessel may contain widely varying levels of liquid inventories, then it’s worth considering multiple nozzle locations. Select nozzle positioning and spacing to minimize the chance that one no longer is connected to a liquid phase. It’s possible for light liquid to become trapped in the gauge, causing an error when the light liquid inventory no longer is connected to a nozzle (Figure 3). This could occur, for example, when the heavy liquid level drops and too large a nozzle spacing was used.



TRAPPED LIQUID

Figure 3. In this case liquid becomes trapped in the gauge.

Considerations other than nozzle locations can affect the accuracy of the level measurement. It’s well known that temperature differences between the fluid in the gauge and the vessel can lead to erroneous readings.

AVOID ERRORS

Adhering to our simple Golden Rule will ensure the liquid/liquid interface in the gauge matches the interface level in the vessel. If you can’t manage liquid inventories to satisfy the rule then errors may arise in the measurement. ■

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Don't Underestimate Overfilling's Risk

High level can pose serious hazards but seven simple steps can prevent them

By Angela Summers, SIS-TECH Solutions

LOSS OF level control has contributed to three significant industrial incidents:

- In Australia, the Esso Longford explosion in September 1998 resulted in two fatalities, eight injuries, and A\$1.3 billion (more than U.S. \$ 1 billion) in losses [1];
- In the U.S., the BP Texas City explosion in March 2005 caused 15 fatalities and more than 170 injuries, profoundly affected facility production for months afterwards, and incurred losses exceeding \$1.6 billion on BP [2]; and
- In the U.K., the Buncefield explosion in December 2005 injured 43 people, devastated the Hertfordshire Oil Storage Terminal, and led to total losses of as much as £1 billion (about \$1.5 billion) [3, 4].

These incidents involved different industries located in different countries. Each uniquely propagated, arriving at its final outcome

through different mechanisms. Yet, all suffered the same process deviation of high level and all resulted in devastating consequences. This article discusses significant factors contributing to these incidents and provides a simple seven-step solution for overfill protection.

KEY CAUSES

Five factors contribute to overfill events:

Lack of hazard recognition. Level usually has little significance to plant output or product quality. "Normal" operating level often isn't well defined or tightly controlled. Absolute level frequently varies over a large range but doesn't come close to threatening equipment integrity. In tank farms, operating level is simply inventory to be managed.

High level often isn't a hazard itself. Instead, the danger comes from too much mass or volume. Some overfills challenge the tank or

vessel where the level is accumulating, causing overpressure or collapse when retained mass exceeds equipment structural-design limits. Many overfills result in loss of containment when liquid passes to downstream equipment that isn't designed to receive it.

Overfill hazards vary depending on the type of vessel and associated upstream and downstream equipment. It's rarely effective to allow a high level event to propagate and to depend on downstream process variables being fast enough to prevent equipment damage. For example, high level in a knockout drum requires immediate response to avoid

compressor damage; you can't wait until high compressor vibration is detected.

Underestimating the likelihood of overfill. Level seems so simple to detect that anyone should be able to recognize overfilling and respond in a timely manner. Unfortunately, operators rarely can directly see high level. It's just one of many process variables on the display. Worse yet, level often doesn't affect unit operation or cause any other significant process-variable disturbance — until safe fill level is exceeded and, suddenly, mechanical integrity of the vessel or interconnected equipment is threatened.

PRODUCT FOCUS

Smart Non-Contact Radar Transmitter Displays Diagnostics to Reduce Downtime

The Pulsar Model R86 non-contact radar transmitter is an advanced level control solution that offers radar technology with improved performance for a wide range of level measurement applications.

The transmitter is designed to provide outstanding accuracy, reliability and safety for virtually all process industries, the company says. The 26 GHz radar signal has a narrower wavelength, allowing for smaller antennas and improved resolution. Its circular polarization eliminates the need to adjust the antenna to avoid false targets. It simplifies the installation process and delivers proper alignment in every application.

Nozzle extensions to 72 in. (1.8 m) allows the transmitter to be installed into nozzles longer than 12 in. (300mm), to accommodate non-standard nozzle lengths and underground vessel standpipes. The graphic LCD display clearly communicates performance issues and displays troubleshooting tips when necessary. The benefit is reduced downtime.

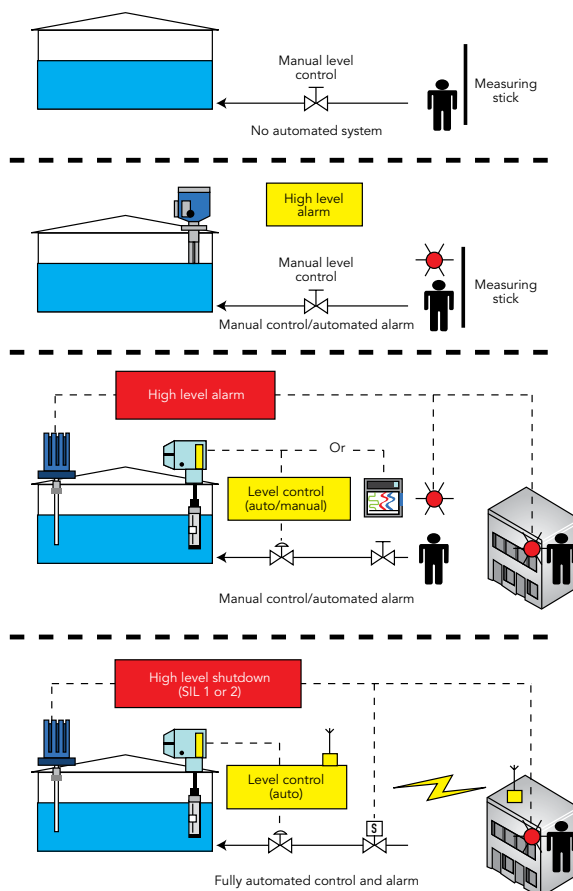
The transmitter features SIL 2 capability. The Safe Failure Fraction (SFF) of 93.2% reflects high reliability. The high temperature, high pressure antenna range of 750 °F (400 °C)/ 2,320psi (160 bar) allows installation into many new applications.



High level may have different causes in each mode of operation, e.g., start-up, normal or upset conditions. Start-up may require accumulation of level, so the outlet control valve initially is in manual operation and closed until normal operating level is reached. Level may vary over a large range during normal operation. During upsets, operators may run vessels at higher-than-normal levels, using available capacity to dampen impacts on upstream or downstream equipment.

Some hazard-analysis teams erroneously believe that overfill isn't a credible event because it generally takes minutes or hours rather than seconds to fill a vessel. Some events propagate slowly, such as rise of level in a product storage tank, while others occur quickly through a random event, such as a process upset sending excess liquid to a knockout drum for a compressor. The slower the event, the greater the tendency to believe the operator can adequately address it; likewise, the more sporadic the event, the greater the tendency to believe it won't last long enough to cause overfill. Believing high level isn't credible is especially attractive when the existing design doesn't provide for a high level alarm or trip.

Estimating the likelihood of overfill is complicated by the combination of manual and automated control that's necessary as equipment is started up and operated. Figure 1 shows the range of automation commonly found in tank farms and terminals. The degree



LEVEL CONTROL OPTIONS

Figure 1. Automation found in tank farms and terminals can range from none whatsoever to full.

of automation generally relates to the expected rate of level rise and operator workload. Automated control and safety systems typically are added when control changes must be made too often to be continuously managed by the operator or when work complexity has increased to where the expected human error rate is no longer acceptable.

It's important to specify the safe fill limit and explain in operating procedures the consequence of exceeding it. Without clearly stated limits and consequences, the

operator may not adequately monitor level, especially during intense work periods. Overfill is a credible event; it takes good operating procedures to reduce its likelihood.

Excessive reliance on the operator. The length of time required to reach overfill encourages a tendency to “blame the operator.” In many applications an operator does have adequate time to control level within acceptable tolerance — but human error always is possible. Workload and piping network complexity decrease the operator’s ability to reliably control level and maintain process safety. Debottlenecking and expansions to increase production often raise operator workload and erode time available to respond to abnormal events. In some cases available time has been reduced to where manual response is no longer effective and automated overfill protection must be implemented.

Don’t neglect hazards to operators posed by manual actions such as draining knock-out drums. Local response generally moves the operator into the hazard zone, increasing risk to that individual. Consequently, the design must provide sufficient time for the operator to take action and means to verify the intended process response. Further, there should be time to evacuate the area if the action doesn’t work as expected. When fast response is required, consider drills to allow the operator to practice the response and to verify the time required to detect and respond. These drills can identify issues

with the design, installation and labeling, as well as with procedures and training.

Automated controls are often added to increase operating efficiency and reliability. They also should be provided to reduce reliance on operator response near a hazardous event. For significant hazardous events, automated trips ensure continuous protection even when an operator is focused on other duties. A safety instrumented system (SIS) detects high level and prevents filling beyond the safe fill limit. The SIS can be a simple hardwired system using an independent level sensor (e.g., switch or transmitter) to spot high level and an independent final element (e.g., motor control circuit or block valve) to terminate or divert feed. The SIS is automatically initiated at a setpoint that allows sufficient time for the action to be completed safely. Risk analysis determines the safety integrity level (SIL) required to provide adequate protection — usually SIL 1 or SIL 2.

No defined safe fill limit. In many applications the entire level range from empty to postulated failure point isn’t displayed. Instead, the measurement device only covers the expected operating range. While this provides the most accurate measurement across the operating range, it unfortunately leaves the operator with no indication of level when it rises above that range.

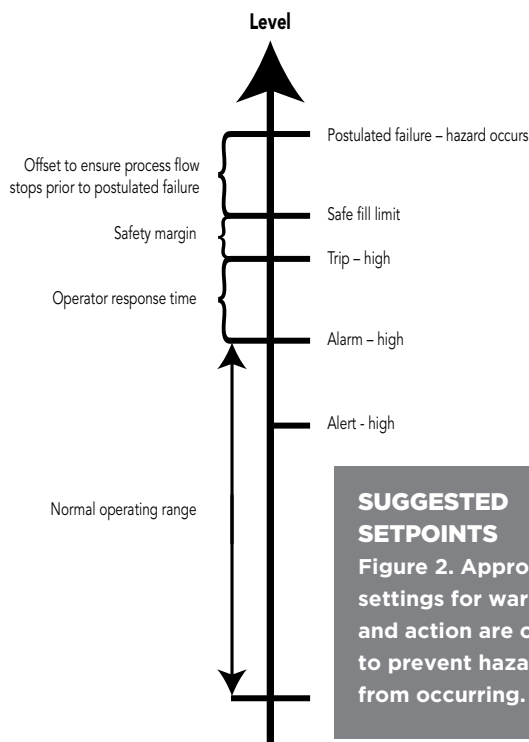
The design basis should clearly establish the safe fill limit, based on an understanding of

postulated failure level, analytical capability of instrumentation used for measurement, fill rate, and time required to achieve a safe state. The safe fill limit should ensure that action can be completed prior to reaching the postulated failure level. It should account for expected measurement drift in the process and environmental conditions.

Figure 2 shows the transition of level from normal operating range to postulated failure point. Providing an alert can support level control; its setpoint should allow enough time for the operator to respond to prevent the level from reaching the safety alarm or trip setpoints. The safety alarm should give the operator enough time to bring level back under control or to take equipment to a safe state.

The offset between trip setpoint and safe fill limit is the design safety margin. When an alarm also is implemented, its setpoint should be far enough below the trip setpoint to allow the operator sufficient time to take the process to a safe state prior to trip initiation. Otherwise the alarm loses merit as a protection layer and simply serves as a pre-trip notification.

Inadequate mechanical integrity. Many technologies are available for level measurement and detection, from simple float-type discrete switches to complex guided-wave radar transmitters. Each technology has characteristics that make it the right



choice for a particular application [5]. There are no bad level devices, only technology misapplications, improper installations and inadequate mechanical integrity programs. A properly maintained level switch can provide years of cost-effective satisfactory service. On the other hand, neglect can cause the most expensive device to fail.

For most safety applications the main considerations for equipment selection are required accuracy, process operating mode, operating environment, historical equipment performance, and ease of maintenance and testing.

No matter the technology selected, it's crucial to maintain mechanical integrity of equipment over its life. Functionality is demonstrated by forcing the sensor to "see the process variable" and to generate

the correct signal at the specified setpoint. Testing must prove that equipment can operate as required to prevent overfill. Although diagnostics can detect many types of failures, a proof test is necessary to demonstrate operation at the required setpoint.

Some companies only allow transmitters in safety services, banning direct-mounted switches due to their lack of continuous signal. For columns and storage tanks, the safe fill limit usually is significantly outside normal operating level, resulting in high level alarm or trip sensors being at a very low output for long periods of time. In such a circumstance, a discrete sensor like a switch may be a better choice. Consequently, it's an acceptable practice to implement an automated control system that uses an analog measurement covering expected normal operating range and a level switch to initiate feed shutdown.

You can implement a high level alarm and trip with separate level switches at appropriate points on the vessel or with a transmitter that covers both setpoints. Although transmitters may not improve diagnostics in services that don't normally have level, they do provide the ability to monitor over a chosen range and to alarm at various points in the range.

THE SOLUTION

You can easily prevent catastrophic overfills. When overfill can lead to a fatality, follow these seven simple steps to provide proper protection:

1. Acknowledge that overfill of any vessel is credible regardless of the time required to overfill.
2. Identify each high level hazard and address the risk in the unit where it's caused rather than allowing it to propagate to downstream equipment.
3. Determine safe fill limit based on mechanical limits of the process or vessel, measurement error, maximum fill rate and time required to complete action that stops filling.
4. When operator response can be effective, provide an independent high level alarm at a setpoint that gives the operator sufficient time to top accumulation of level before the trip setpoint is reached.
5. When an overfill leads to release of highly hazardous chemicals or to significant equipment damage, design and implement an automated overfill-protection system.
6. Determine the technology most appropriate for detecting level during abnormal operation. This technology may differ from the one applied for level control or custody transfer.
7. Finally, provide means to fully proof test any manual or automated overfill-protection system to demonstrate its ability to detect level at the specified setpoint and take action in a timely manner. ■

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Monitor Your Vents When They Are Relieving

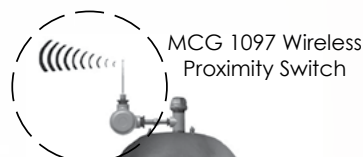
Shand & Jurs 94570 Combination Conservation Vent and Flame Arrester with MCG 1097 Wireless/Battery Operated Proximity Switch

In this new age of always wanting more information, L&J Engineering now offers a way to monitor when tank vents are relieving. Our MCG 1097 Wireless Proximity Switch can send a signal to notify the operator when a pressure device is relieving. This valuable information can be monitored and tracked. The instant reliable data will prove to be an asset that avoids the hassle of guess work and a saving of both time and money.

**MCG 7030
Touch Panel Monitor**



Wireless Communication



MCG 1097 Wireless
Proximity Switch



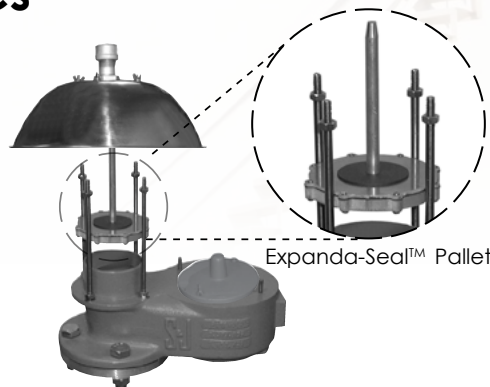
94570 Combination Conservation
Vent & Flame Arrester

MCG 7030 Touch Panel Monitor: Monitors open/closed pressure pallets & can alarm on pressure relief to monitor emissions. Using L&J proprietary algorithms, it instantaneously sends back any alarm conditions as well as continually checking battery conditions. It can also be used for overfill protection to monitor MCG 109X Series Level Alarm Probes.

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To reduce emissions, Shand & Jurs designed and patented a high performance valve sealing technology called Expanda-Seal™, which offers reduced tank emissions and odors for every process environment imaginable.

This innovative design actually uses the internal vessel pressure to create a tighter seal the closer the pressure gets to the set point. Expanda-Seal™ ensures less than 0.5 SCFH air at 95% of the set point; the end result is a nearly bubble-tight seal.



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company

Select the Correct Non-Contact Sensor

3D, radar and laser scanners all provide continuous level measurement but suit different applications.

By Jenny Nielson Christensen, BinMaster

Chemical processors find non-contact level sensors attractive for many reasons. Because nothing comes in contact with the material, there is no risk of equipment interfering with the process or rogue parts breaking off and getting stuck in equipment or contaminating materials. Plus, they provide continuous level measurement for optimizing inventory and preventing silos from running empty. No chemical processor wants to risk rejecting product because of a missing key material.

Popular non-contact technologies include 3D, radar and laser scanners. The sensor that might be best for your application is determined by a number of factors, including the material being measured, the amount of dust in the environment, the size

of the silo and the desired inventory accuracy. Many options are available for data communications, mounting, wiring and installation, depending on project needs.

SEE THROUGH SILO WALLS WITH 3D SCANNERS

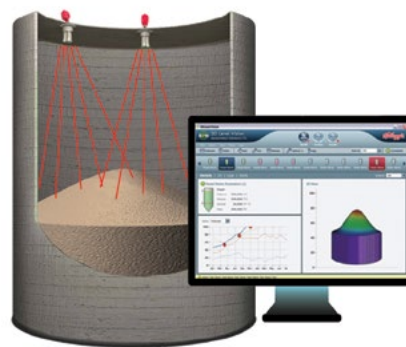
Using a 3D scanner level sensor is like having Superman's X-ray vision. With its dust-penetrating technology, you can see the topography of material inside the silo using the graphical option in the software. The 3D scanner is mounted on top of the silo at an optimal location recommended for superior surface coverage, so the scanner can "see" the utmost material surface. It sends acoustic pulses that sound like chirping crickets to the material surface in a 15°, 30° or 70° beam angle depending on the model. It then measures and maps

the material surface at multiple points to detect uneven topography.

Distance is calculated using advanced algorithms that convert the difference between the timing the echo was sent and received to a distance. Data is sent via 4-20-mA or RS-485 output to software or a human-machine interface (HMI) or programmable logic controller (PLC). The software records the data; calculates level, volume and mass; and creates an optional 3D visual of bin contents (Figure 1). These 3D scanners come in a variety of models, which generally are chosen based on the vessel size, the desired accuracy, the need for a 3D visual and the operation's budget.

The 3D scanner level sensor measures multiple points on the material surface to account for irregular topography. Its precision measurement can calculate accurately within 1-3% of total stored volume. For chemical processors, it offers the added benefit of detecting cone up, cone down or sidewall buildup. Some models even offer a 3D visual of silo contents.

Different models of the 3D scanner are available based on a vessel's diameter. A common application for 3D scanners in the chemical industry is with plastic additives and resins. The 3D software can communicate via RS-485 or transmit a 4-20-mA signal to an HMI in a centralized control room. These long-lasting sensors offer Class I and



VISUAL REPRESENTATION

Figure 1. 3D scanners measure the topography which can then be sent to software that provides operators with a 3D visual of the material scanned.

II hazardous location approvals important in the chemical refinery market.

One advantage of 3D scanners to operational efficiency is volume accuracy in large bins or domes. When silos are over 45 ft. in diameter, more than one 3D scanner can be used on a single vessel. The software takes into account measurements made by multiple sensors and aggregates them to a single volume and single 3D visual. This can be especially useful in vessels containing materials that pile unevenly such as boron, bentonite, lime and fertilizers.

3D scanners offer built-in redundancy for reliability; they use three independent frequencies to transmit and receive to ensure accuracy. They require minimal maintenance because of their self-cleaning transducers. An optional Teflon-coated sensor

(Figure 2) can be used if materials are excessively clingy or sticky. Software is available to manage multiple silos for chemical operations that have more than one silo or multiple locations to monitor inventory throughout the operation.

Accuracy comes with a few considerations. The 3D scanner must be installed in the recommended location on the silo roof to obtain the best accuracy results. This may require a new 8-in. opening on the roof for installation. Although sensor installation is fairly routine, it is recommended that the startup and system configuration be done by a trained technician. A 3D scanner will have a slower update rate and tracking speed versus a laser or radar; scanners take a few minutes, while the others take less than a minute.

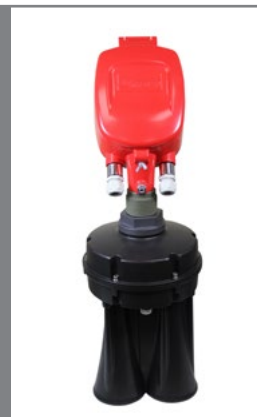
Avoid installing 3D scanners where excessive noise may interfere with the acoustic technology. These scanners also are not recommended for very narrow bins that have corrugation. If an excessive internal structure may interfere with operation, a neck extension or alternative sensor technology is used. Due to its robustness, there is no loop power option.

THE NEW REALITY OF RADAR

Non-contact radar has become increasingly popular in the chemical industry since the recent introduction of 78- to 80-GHz frequency radar level sensors to the mar-

VISUAL REPRESENTATION

Figure 1. 3D scanners measure the topography which can then be sent to software that provides operators with a 3D visual of the material scanned.



ket. Unlike the 26-GHz radar, radars using these high frequencies are reliable in dust. Their principle of operation is the same, but 80-GHz radar is less prone to erratic data or lost signals. High frequency radar has a 4° versus 10° beam angle for better precision and a 393-ft. measuring range.

Radar works by emitting an electromagnetic pulse through the antenna where the emitted signal then is reflected off the material and received by the antenna as an echo. The received signal's frequency is different from the emitting frequency, with the frequency difference being proportional to the distance and the height of the material being measured. The difference is calculated using special algorithms contained in the sensor's electronics, where the material height is converted and output as a measured value.

Because high-frequency radar works in excessive dust, it is reliable for measuring solid and powdered chemicals of any bulk density. Radar is powerful across long rang-

es, allowing it to be used in narrow or segmented silos for single-point level measurement at distances up to almost 400 ft. The 4° beam is suitable for silos in which precise aiming is needed to avoid internal structures, the flow stream or sidewall buildup. It's proven to work in silos with corrugation, excessive noise from falling materials or high temperatures. Fast reaction and updating times allow for tracking the filling or emptying activity. Radar also offers loop power capability to simplify installation.

Radar level sensors (Figure 3) can be mounted on top of silos, over piled material, on dome roofs or in storage bunkers for large-scale operations such as fertilizer plants. In material processing, radar is used over conveyor belts to prevent overloading or to detect when belts are running empty.



DIRECTIONAL AIMING

Figure 3. Radar scanners can be swivel-mounted to target the silo output and accommodate angled roofs.

Radar sensors are available in three housing options, including plastic, stainless steel and aluminum. Mounting options include swiveling directional mounts designed to target the silo output and angled roof mounts. Data can be sent to a local display console; an HMI or PLC in a control room; to inventory desktop software such as Binventory; or web applications such as BinView for viewing on a phone, tablet or desktop computer.

The potential downside of non-contact radar is that it measures only a single point, as does laser. Therefore, it is not the recommended instrument when precise volume accuracy is needed for inventory management. Because it can't detect material topography such as uneven piling or cone up or down, inventory accuracy will be similar to dropping a tape measure at a single point on the material.

In extreme conditions with both harsh dust and excessive humidity, an air purge may be required for optimal performance. In that case, between the cost of running compressed-air lines and paying for compressed air, preventive maintenance costs can add up quickly.

THE LOWDOWN ON LASER

A laser sensor (Figure 4) is mounted on top of the silo using an adjustable 10° mounting flange to aim the laser to the desired location, generally toward the cone's output. During configuration, the minimum and

maximum distances are set using 4 and 20 inputs configured on the sensor. The sensor sends timed laser pulses to the material surface. The distance to the material is calculated using complex algorithms that convert the laser pulses to a data output. A compensation for “slant range” is made based on the beam’s angle to ensure accurate level measurement.

Laser can be a good fit for the chemical industry when it is installed in low- or no-dust environments. Because of its very narrow beam, it is a good option for level control in narrow vessels common to chemical storage. It also can be used for material detection in space-constrained equipment in which precise targeting is needed. For materials that don’t flow freely, it can be used for monitoring buildup when installed above the monitoring point or directed toward the sidewall.

Other advantages of laser are its adjustable, swiveling mounting flange, which is flexible up to 10°. This may allow for use of an existing mounting location and eliminate drilling another hole in the silo roof. Laser’s narrow beam can be directed to avoid obstructions that could interfere with sensor operation. It is configured easily in the field using a USB port; configuration can be performed without filling or emptying the vessel. Laser has a fast update rate of eight times per second

LASER SENSOR

Figure 4. A laser sensor is mounted on top of the silo using an adjustable 10° mounting flange to aim the laser to the desired location.



and features integrated dust protection for minimal maintenance.

Laser’s major disadvantage is that it is not recommended for use in dusty environments. Plus, it measures only a single point in the silo, which could be problematic for materials that don’t flow freely or pile unevenly in the silo. It can be subject to interference from falling materials that can temporarily render the readings inaccurate. If used in a silo with any dust, it may need an air purge option to keep lenses free of buildup for reliable performance.

When it comes to non-contact level sensors, one size doesn’t fit all. In fact, many chemical processors use a combination of sensors — both continuous and point level — to keep their plants running smoothly. Different sized silos, different materials and different material management objectives all come into play when selecting the right sensor for your operation. ■

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Increase Ultrasonic Sensor Reliability

Familiarity with application environments, transducers and product design can help inform purchasing decisions.

By Dawn F. Massa Stancavish, Massa Products Corporation

When determining the overall value of a product, users look at reliability, performance, quality, accuracy and cost to drive decisions. Identifying what makes a product reliable and understanding the relationship between the application environment and product reliability are critical.

This paper discusses the reliability of ultrasonics used in chemical level sensing. More specifically, it focuses on how a reliable transducer is the driving factor in a long-lasting, well-performing ultrasonic sensor.

Ultrasonics can be used effectively in a variety of environments, even those once believed to be incompatible with the technology. Understanding which features in

the ultrasonic design of the transducer and sensor influence sensor reliability when used in or with chemicals can help achieve ultimate performance results. Ultrasonics are a cost-effective solution for level sensing, and recognizing how to choose the most reliable products allows control over the outcome, helps to lower cost of ownership and may minimize the need for more expensive technologies.

ULTRASONIC USAGE

Ultrasonic sensors often are used for a variety of non-contact distance measuring applications such as monitoring the level of liquids or solid materials in tanks. These devices all work in the same fundamental manner: They transmit a short burst of ultrasonic sound toward a target, which then

Ultrasonics can be used effectively in a variety of environments, even those once believed to be incompatible with the technology.

reflects back to the sensor. These types of sensors measure the time from when the sound pulse is transmitted until the echo returns to the sensor and then computes the distance to the target using the speed of sound in the medium.

However, not all ultrasonics are created equal. To be a quality product with high reliability, it is imperative that all aspects of the sensor work properly and dependably to ensure that accurate distance measurements are obtained continually.

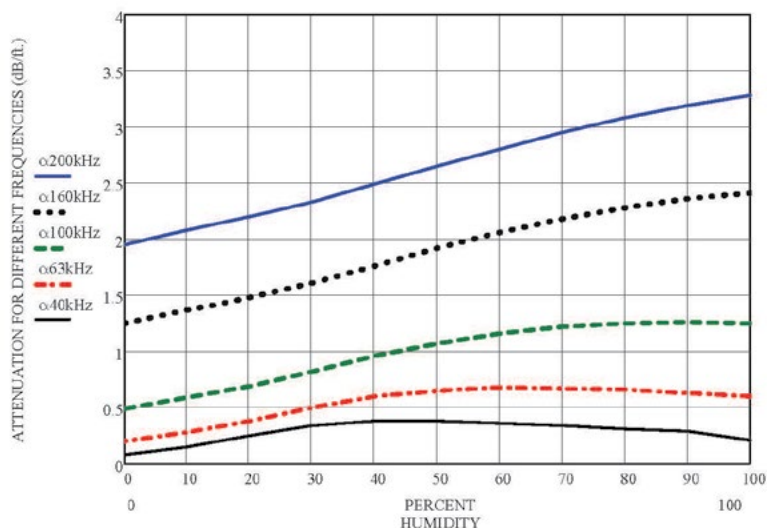
Some people may think that quality doesn't affect the overall reliability of an ultrasonic sensor, but that's simply not the case. True quality results in long-lasting products that continue to perform and meet specifications for years, even decades. Those who learn this simple point will save money on their projects, and for their companies. High-quality sensors, made with high-quality components, likely will perform above expectations for an incredible period of time.

The most critical components in ultrasonic sensors are the electroacoustic transduc-

ers that transmit the sound pulses and receive the return echoes. The transducer's quality and design can affect the sensor's reliability and performance. Two major factors affect transducer reliability: the transducer's electroacoustic and mechanical design for a given application and the fabrication environment.

ACOUSTICAL AND MECHANICAL DESIGN

The acoustic and the mechanical design are interrelated in many respects because one affects the other, so understanding both is critical for proper transducer design. Some clear differences exist between the two. The acoustic items include frequency, beam type, beam angle and sound attenuation, to name a few. The mechanical items include the materials used in fabrication, so that the transducer not only holds up but also performs well in multiple environments, mediums and applications. The relationship between the acoustic and mechanical design items with the environment is imperative for the design and the assessment of ultrasonic sensor and transducer reliability.



ATTENUATION VS. HUMIDITY

Figure 1. This chart depicts attenuation of sound in the air in a typical transducer.

Various chemicals can affect the attenuation, thereby affecting the perceived reliability and performance of ultrasonic level sensors. Designing a transducer that is adjusted for attenuation will deliver more accurate results and will help the ultrasonic in its performance within the medium for a longer period of time.

Figure 1 depicts the attenuation of sound in the air of a typical transducer. This relationship becomes more complex when various chemicals are introduced. If this is not accounted

for and adjusted within the transducer design, the ultrasonic sensor, when used with certain chemicals, can appear unreliable. In reality, ultrasonics themselves are not unreliable but rather have been misused. Therefore, if a transducer is designed with respect to such influencing factors as specific chemicals' effects, ultrasonics can achieve reliable and desirable level measurement.

Many chemicals also can attack certain materials, which in turn can affect the transducer within a sen-

sor housing. Using just any off-the-shelf transducer is not the most reliable sensor design approach. The transducer must be designed to withstand the challenges in its performance setting. This means the transducer needs to be built to withstand the attenuation of sound issues and be constructed with proper materials that can hold up to the environment without interfering with the transducer's acoustic performance.

Dependable transducer design begins by characterizing conditions the sensor will be exposed to and the environment in which it will operate. The environment's acoustic properties and potential mechanical challenges also must be understood to optimize performance and durability. This is true for both ultrasonic and sonar transducers.

The materials need to work well with the acoustics, and both the materials and the acoustics need to be fashioned to achieve desired

A sensor is actually a system that includes the transducer, the electronics and the sensor housing.

operation in the environment. Again, the sensor's quality and reliability are enhanced by the quality of the transducer within. Understanding the materials and the acoustics can give you an edge whether you are building or using a sensor.

Acoustic properties change in different mediums and can give a false impression that they won't work as well as other technologies. Be sure to choose a transducer and sensor supplier that knows about acoustic properties and the materials and is skilled in manufacturing electroacoustic devices.

Transducers can be designed to operate at different ultrasonic frequencies and to have different acoustic radiation patterns. Sound energy is absorbed as it travels through the air. The higher the frequency, the larger the attenuation of the sound pressure for each inch in the path from the transducer to the target and then back to the transducer. The farther the distance to the target, the lower the transducer's frequency will be.

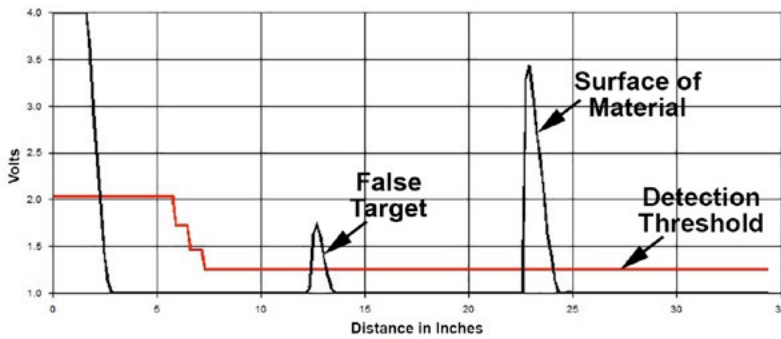
An acoustic specialist can identify the proper frequency and beam pattern for any application. Don't assume that certain applica-

tions require a standard frequency or beam width. The more that is understood about a project, the more that can be designed into a transducer to ensure desired measurements and long-lasting performance.

The transducer's radiation pattern design also is important. Most ultrasonic sensors use transducers that utilize the teachings of U.S. Patents 3,928,777 and 4,011,473, which were issued to Frank Massa in 1975 and 1977, respectively. Transducers of this design have a 10° beam angle (8° system beam angle) for any operation frequency. This is good for flat, reflecting surfaces; however, a broader beam angle is necessary if the reflecting surface is turbulent or uneven.

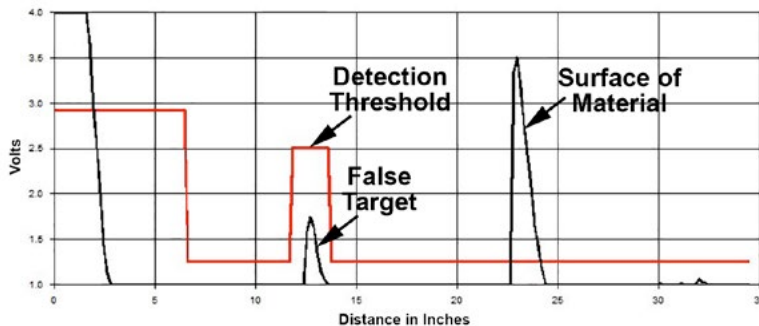
SENSOR RELIABILITY

A sensor is actually a system. The system includes the transducer, the electronics and the sensor housing. Ultrasonic sensor reliability is affected greatly by a transducer's quality and the relationship between the electronics and the materials. The higher-quality transducer and a lower level of complexity in electronics result in a better sensor that also is lower in cost.



ULTRASONIC WAVEFORM

Figure 2. The ultrasonic waveform from a MassaSonic Pul-Star Plus sensor shows a false target being detected instead of the echo from the surface of a liquid or solid material.



ADJUSTING DETECTION THRESHOLD

Figure 3. With the same targets as Figure 2, the detection threshold now has been modified to ignore the false target.

Ultrasonic waveforms can be used to determine whether any reflecting objects are present that could cause false alarms or unwanted echoes. The ability to adjust the thresholds of detection to rule out false echoes in a material increases an ultrasonic sensor's overall reliability.

Waveform capture also allows for troubleshooting, which enables fast assessment in real time. Figures 2 and 3 depict how sensors such as MassaSonic can make such adjustments.

ULTRASONICS FABRICATION

To maintain quality con-

trol, ultrasonics manufacturing involves more than simple assembly. In addition to knowledgeable employees and skilled workmanship, cooperation between production and design engineering helps to ensure correct fabrication of transducers and sensors. Ultrasonics should be built, sealed and thoroughly tested to reduce or even eliminate a product's failure rate, and maintain quality control.

CONSIDER THE APPLICATION ENVIRONMENT

Transducers are not plug-and-play. If a transducer and sensor are optimized for the challenging and caustic environment in which they are being used, ultrasonics are an excellent choice for level measurement and can result in a lower cost of ownership. ■

DAWN F. MASSA STANCAVISH is new products manager for Massa Products Corporation. Email her at sensors@massa.com.

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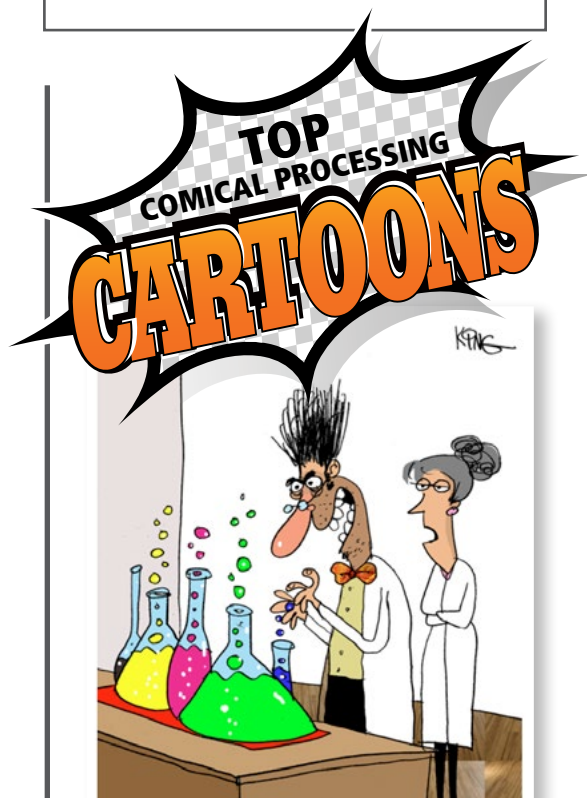
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