MONITOR TECHNOLOGIES LLC

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White Paper: Why use continuous level sensors?

Introduction

It can be hard to decide between a continuous level system and a point level indicator when selecting a new or replacement bin level sensor, especially if cost is an issue. Many companies still just use a “visual” check or a point level sensor, like a “rotary paddle bin indicator” or an “RF capacitance probe”, to let them know when the material in the silo reaches or departs a particular “point” in the vessel. Most often, customers want to know when the material reaches a “high” level to shut off fill, or a “low” level to begin the refill or reorder process. Point level sensors certainly have their purposes and will continue to offer reliable material detection when all that is desired is to know when material reaches or departs a certain “point” within the vessel.

Continuous level sensors however can provide you with much more information. In addition to detecting “high and low” levels, a continuous level sensor can actually help cut inventory costs by providing you with better control over re-ordering materials. It will also offer an obvious increase in personnel safety since employees would not have to climb up silos to check levels. Although a continuous level inventory measurement system sounds like a good idea, the inclination may be that “a point level works ok, no need to spend any money to upgrade or change.” So how does one justify the extra initial cost of a continuous level system?

44W320 Keslinger Road ▼ P.O. Box 8048 ▼ Elburn, IL 60119-8048
800-766-6486 ▼ 630-365-9403 ▼ Fax: 630-365-5646
www.monitortech.com ▼ monitor@monitortech.com

Continuous level sensors in action

One example of a continuous level sensor application is a concrete batch plant located in North America. They were interested in replacing their older level units installed on their 20ft (6.1m) cement and slag storage silos. The company wanted a measurement system that would provide “true” continuous level readout, provide the accuracy they require, would not require much maintenance, and could also be retrofitted into the existing mounting portals on top of their silos. Flexar® guided wave radar from Monitor Technologies met all of those expectations and system requirements. Additionally, Flexar provided the batcher in the control room the ability to track the progression of the fill cycle right to its completion. Plus to prove that there is still a place for point level sensors, they have a rotary paddle level unit top mounted for indication of high level to alert the cement delivery to shut down when the vessel is full.

Figure 1. A Flexar® guided wave radar level sensor being used in a concrete batch plant

Another example is a company in the northern area of Illinois, USA with 13 silos who provides pre-blended masonry products and automated mixing stations to construction sites was looking for a way to better control the inventory levels of their raw materials instead of having to do a “visual”. After some research they decided to go with the SiloPatrol® weight and cable based “smart” sensor (SMU) with the SiloTrack™ inventory management software from Monitor Technologies. Even though the system did cost a little more than they initially were thinking of spending, they were able to justify the expenditure because of the added benefits of time saved from manually measuring the material levels and for the personnel safety reasons. Now with automatic or on-demand readings, they have more confidence of when they need to re-order raw materials to avoid downtimes waiting for more materials. They can also have a very accurate indication of when the silos are getting full during refilling to prevent the downtime and clean-up costs of an over-filled silo. Plus, personnel make a lot fewer trips up the silos which reduces the risk of injury.

Figure 2. SiloPatrol® weight and cable level system on top of a raw material silo.

Their first purchase was for 6 SMU's and the SiloTrack inventory management software. Once they realized the value of the continuous "on-demand" level measurement system, they were able to justify the purchase of additional SMU's for more of their silos.

Other aspects of the SiloPatrol that they mentioned they appreciated were the simplicity of installation (including wiring and set-up) for the sensor and the inventory management software and that the software works with the current PC on their desk.

Many companies involved with dry bulk materials have adopted systems like these for many of the same reasons. There are several different technologies available for use in "continuous level" and "inventory management" applications. The main technologies used for continuous level measurement and inventory control of powder and bulk solids stored in bins, hoppers and silos are: Guided Wave Radar, Weight & Cable (plumb-bob, yo-yo, etc.), Ultrasonic, Through-Air Radar, Laser, and Load Cells. Following is a brief summary for each of these technologies.

Guided Wave Radar (GWR)

Guided Wave Radar systems offer many technological advantages for a variety of severe and tough to measure applications. Guided wave radar units, like the Flexar®, are a true continuous system and will provide "real time" bin levels. Many companies have successfully used guided wave radar systems on cement, fly ash, grain, plastic pellets and many other materials. Guided wave radar systems have earned a great reputation for being able to work well in very dusty applications. The radar pulses are "focused" down to the material surface by using the unit's cable as an antenna which guides the signal or the radar wave. The time-of-flight of the pulse reflection back to the instrument electronics is directly related to the empty distance in the vessel and the material level. There is very little dispersion of the signal as it travels toward the solids surface, or after it is reflected. Dust does not affect the pulse as it can with the signal

from non-contact technologies. Another positive is that the unit is electronic and has no moving parts that need maintenance.

A concern with the guided wave radar system is that there will be contact with the stored materials. Determining the correct cable guide (wave guide) size and proper installation will help to lessen this concern. For example, traction loads (roof loading) should to be considered for heavy materials using longer GWR guide cable lengths. A customer should consult the manufacturer regarding this and other installation considerations. Overall, guided wave radar offers a good balance of reliability and affordability.

Weight & Cable

Weight and cable systems, like the SiloPatrol® mentioned earlier, are one of the more economical choices for measuring the level of solids in vessels and providing inventory management. Weight & cable systems are not “true” second-to-second continuous; however, they are successfully used in applications where level measurement updates as frequent as once every 30 minutes are acceptable. If updates are needed more often, consider a guided wave radar level measurement system. In addition to automatic (timed) measurements, the weight & cable system can be used “on-demand” which means that the customer can request the unit to initiate a reading when desired to provide them with material level information when they need it. These units are used to determine the current level of material and calculate volumes and weights based on the distance the plumb bob travels before contacting the target material. Vessel geometry and material bulk density combined with the measured distance the bob travels are used to calculate distance, level, volume, weight, and percentage.

World-wide, thousands of current weight and cable system users are satisfied with both the economy and performance of these systems and continue to use them as they expand their facilities. In fact, the dependability and performance of weight & cable designs has improved significantly over the last few years. Many manufacturers have weight and cable products that offer “state of the art” designs that can interface with the most current integration systems on the market.

Weight and cable systems offer great accuracy (+/- 0.25% of the distance reading) and an outstanding repeatability of 0.1ft (30mm).

Weight and cable systems are electro-mechanical devices that can easily be maintained by plant maintenance personnel. A good PM (periodic/preventative maintenance) program will keep the units operating for many years of trouble free performance.

Ultrasonic

Ultrasonic continuous level systems, like weight & cable systems, are a mature technology that now offer improved performance and reliability due to advances in technology, primarily in the transducer and in the signal processing techniques embedded in the electronics of the instrument via software.

In the past there were concerns over the set-up and performance of ultrasonic units. Some believed that you must be prepared to spend time making adjustments to their ultrasonic systems to get them to work properly. The newer products no longer have as many issues as products designed in the past.

Other possible concerns include that ultrasonic sensors were unable to make measurements in dusty conditions like the heavy dust usually created in fly ash applications, that they would be affected by pressure fluctuations, changing temperatures, the changing angle of repose, large particle sizes, and internal vessel obstructions.

While some of these conditions can affect the way the “sound wave” reflects off the surface of the target material possibly creating “false” echoes that mask the true level, proper consultation with the company providing the ultrasonic system can address these issues and determine if an ultrasonic system will be a good solution in your application.

Through-Air Radar

Through-air radar, also known as “open air radar”, helped lead the way for the use of radar for level measurement. While used widely on liquid and slurry applications in the past, it is becoming more popular for harder-to-measure powder and bulk solids applications as well.

The through-air radar energy diverges as it shoots down into the vessel in order to reflect off the surface of the target material. As with ultrasonic level systems, internal vessel obstructions, changing angle of repose, clumps of material adhering to the bin walls, etc. may affect the reflected level signal and create reflections inside the vessel.

As with any equipment, proper installation and set-up is critical for good performance. Newer through-air radar systems allow the user to map the vessel during start-up to identify and eliminate false signal reflections. With some manufacturers, not all, the use of a laptop PC loaded with proprietary software is required for set-up. This software incorporates all the experience gained in previous applications to discern the true level signal. Through-air radar systems often use digital signal processing (DSP) and signal averaging techniques to successfully search for the level signal.

Through-air radar has two basic types, pulsed radar and FMCW (frequency modulated continuous wave) and produces a high power energy wave that is able to blast through all vessel atmospheres to the solids surface. The only possible concern would be if vapors or moisture combine to provide an atmosphere that has a dielectric constant higher than that of the solids material itself. Guided wave radar systems may be more energy efficient, have a radar pulse that does not diverge or create false reflections, and have a reflected pulse with a higher signal-to-noise-ratio.

Any system may be at a disadvantage on low dielectric target materials depending on the maximum distance of measurement needed. Low dielectric target materials produce a weaker reflected signal and may limit the usable range for a through-air radar system.

In addition, the limited sampling rate due to the extra signal processing in through-air radar systems may not be sufficient for reliable level measurement in applications with fast filling or emptying rates. This may be more of an issue in smaller vessels, but not usually in true storage situations with larger bins, silos, of hoppers.

While guided wave radar systems are highly recommended for dusty applications, through-air radar systems can also be used. However, through-air radar sensors are not self-cleaning and material build-up on the antenna will impede sensor performance. Manufacturers may offer options such as a Teflon dust cap as an accessory (Teflon is "invisible" to radar pulses). Moisture, combining with dust to produce sticky, clinging-type coatings may also be a problem for through-air radar. A manufacturer may offer an "air purge" as an option for the sensor to keep it clean.

Laser Level

The laser is a narrow beam that does not scatter on reflection when it hits the surface of the target material. Laser is easy to aim, especially useful if there are internal obstructions in the vessel, and manufacturers state that laser is easy to set-up. Laser systems can be directly connected to the vessel if the temperature is 150 degrees F (65 degrees C) or less, and the pressure is 3 psig or less. For process conditions outside this range the laser is mounted outside the vessel and shoots through an appropriate sight glass installed in the top of the vessel. Such an option increases the purchase and installed cost of the system.

Laser systems offer pinpoint accuracy for measuring level compared to thru-air-radar or ultrasonic signals which diverge or "spread out" as the signal travels further into the vessel. Laser accuracy is particularly superior to other systems in longer ranges (over 50ft / 15.2m). Laser Level systems designed for long ranges can have a higher purchase price. They have primarily been used on extremely difficult applications where lower cost systems would not be compatible.
Manufacturers state that lasers can penetrate dust if the lens can be kept clean. There are options out there for a sensor dust cover and air purge. Lasers are usually recommended for light to moderate dust applications. In general, if you can see the material from the mounting locations through dust it should work.

Load Cells

Load Cells are non-intrusive and are generally placed under the supporting structure of the vessel and actually weigh the vessel. Load cell systems offer a very high level of accuracy of measurement (± 0.2% or better). Load cells have a very high initial cost (purchase, installation and calibration costs combined), and are primarily used for "certified for trade" or internal accountability applications (where mass measurement is required), or on severe applications where other systems, especially intrusive systems, will not work. They are widely used in the aggregate, food processing and pharmaceutical industries. These systems are designed by the manufacturer for specific applications. Load cells are used more often in new bin installations rather than existing bins since they are usually installed under the storage bin structure.

In Conclusion

Continuous level sensors can provide practical solutions for “real-time” level measurements and material inventory control. They can also help with safety issues since using this type of sensor would considerably lessen the amount of times personnel would need to climb the silos to check levels or perform maintenance. Plus, many varieties of continuous level sensors have been proven to be dependable in dusty, severe conditions like the guided wave radar and cable-based units. If the decision is made to go with a continuous level sensor, there are a few important questions to answer when choosing a continuous level measurement / inventory control system to ensure the system will completely fit your application.

How often do the levels need to be determined, is a “true” continuous system needed or will an “on demand” system work?

Is a completely electronic sensor desired or will an electro-mechanical device best serve the application?

What type of “real-world” accuracy is needed?

How much is the company looking to invest in a system?

These are only a few items to be considered. One can contact various level sensor companies and talk to their sales / technical support staff that can assist in clearly identifying the application needs and then propose some solutions.

For more information please visit Monitor’s Web site at www.monitortech.com or call one of our Technical / Sales Support Representatives at 1-800-601-5982 or 1-630-365-9403.