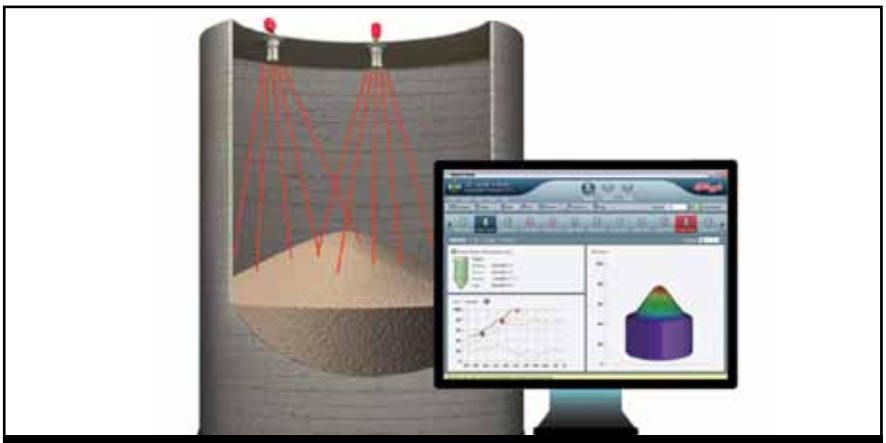
From Superman to lasers

Non-contact level sensors provide many benefits to the cement producer. These level measurement devices use 3D scanners, laser or radar technologies to ensure accurate monitoring of product levels. BinMaster compares the different technologies.

■ *by **Jenny Nielson Christensen,** BinMaster, USA*

Cement manufacturers find non-contact level sensors attractive for a number of reasons. Firstly, as nothing comes into 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. Secondly, they provide continuous level measurement for optimising inventory and preventing silos from running empty. No cement manufacturer wants to risk a bad batch due to missing key materials.

Today's most popular non-contact technologies are laser, radar and 3D scanners. The sensor best suited to a particular 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. Communications options for retrieving the required data can also vary, along with the price of the sensor and its mounting, wiring and installation costs.



For very large silos, two or more 3D scanners be used to measure and map the material surface

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, using the graphical option 3D scanners allows for the visualisation of the topography of what is inside the silo. The 3D scanner is mounted on top of the silo at an optimal location recommended for superior surface coverage, ensuring 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, if preferred, an HMI/PLC. The included software records the data and calculates level, volume and mass, creating an optional 3D visual of bin contents.

3D scanners, which come in a variety of models, are generally chosen based on vessel size, the desired accuracy, the need for a 3D visual and the operation's budget.

The 3D scanner is the only level sensor that measures multiple points on the material surface to account for irregular topography. In terms of a storage operation, that can convert to precise volume measurement within 1-3 per cent of total stored volume. For cement plants, it offers the added benefit of detecting cone-up, cone-down or sidewall build-up. When the MV or MVL models are used, 3D scanners are the only sensors that offer a 3D visual of silo contents.

A key advantage of 3D scanners to operational efficiency is volume accuracy in very large bins or domes. When silos are over 45ft in diameter, more than one 3D scanner can be used on a single vessel. The software takes into account measurements from multiple sensors and aggregates them to a single volume and single 3D visual. This can be very useful in domes or any very large vessel.

Redundancy is also an insurance of reliability. 3D scanners use three independent frequencies to transmit and receive to ensure accuracy. With self-cleaning transducers, they require minimal maintenance. An optional Teflon-coated sensor can be used if materials are excessively clingy or sticky. MultiVision software for managing multiple silos is also available for cement operations that have numerous silos or various locations where they want to monitor inventory throughout the operation.

Precise 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 8in opening on the roof for installation. Although sensor installation is fairly routine, it is recommended that the start-up and system configuration is carried out by a trained technician. This requires a site visit or temporary remote access to the company's network. A 3D scanner will have a slower update rate and tracking speed versus a laser or radar, with scanners taking a few minutes versus the others taking less than a minute.

Avoid installing 3D scanners where there is excessive noise that may interfere with the acoustic technology. They also are not recommended for very narrow bins that have corrugation. If there are excessive

Radar can be mounted on flat or angled roofs and in segmented silos

internal structures that may interfere with operation, a neck extension or alternative sensor technology will need to be 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 cement industry since the recent introduction of 78-80GHz frequency radar level sensors to the market. Unlike the 26GHz radar, radars using these higher frequencies are quite reliable in dust. Their principle of operation is the same, but they are less prone to erratic data or lost signals. They have a 4˚ versus 10˚ beam angle for better precision and a substantial 393ft measuring range.

Radar works by emitting an electromagnetic pulse through the antenna where the emitted signal is then reflected off the material and received by the antenna as an echo. The frequency of the received signal 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.

Since high-frequency radar works in high dust environments, it is quite reliable for measuring inventory of just about every component of cement. It is suitable for all kinds of rock, sand and aggregates, including limestone, silica, sand, clay, alumina, bauxite, gypsum and fly ash.

As it is powerful across long ranges it can also be used in very tall, narrow silos for single-point level measurement at distances up to almost 400ft. With its 4˚ beam, it can be used in segmented silos with narrow compartments. It is proven to work in silos with excessive noise from falling materials, extreme dust or high temperatures. Radar technology is ideal for silos where precise aiming is needed to avoid internal structures, the flow stream, or sidewall build-up.

It can be mounted over piled material, on dome roofs, or in storage bunkers. In large operations radar is used over conveyors belts to prevent overloading or detect when belts are running empty.

One of the things cement operations like best about the newest models of non-contact radar is their ability to work in dust. The narrow beam can be targeted to avoid measuring internal structures such as ladders versus the material in the bottom of the silo. The signal is not affected by corrugation, if material is stored in such a vessel. Fast reaction and updating times allow for the tracking of filling or emptying activity. Radar is also versatile enough for use in solids or slurries and it offers loop power capability to simplify installation.

The potential downside of non-contact radar is that it measures only a single point, as does laser technology. Therefore, it is not the recommended instrument when very precise volume accuracy is needed for inventory management. Since it cannot detect topography of material 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 where there is 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 expenses can add up quickly.

The lowdown on laser

A laser sensor is mounted on top of the silo using an adjustable 10˚ mounting flange at aim the laser at the desired location, generally toward the output of the cone. During configuration, the minimum and maximum distances are set using four and 20mA inputs configured on the sensor. The sensor sends timed laser pulses to the material surface. The distance to the materials is calculated using complex algorithms that convert the laser pulses to a data output. A compensation for 'slant range' is made based upon the angle of the beam to ensure accurate level measurement.

A laser level sensor is best employed in tall narrow silos with a minimum of dust

Laser is not always ideal for the cement industry because it is best suited for low- or no-dust environments. However, because of its very narrow beam, it is a good option for level control in narrow vessels containing solids, so long as it is not used on high-dust materials. It can also be used for plugged chute detection or restrictive chutes and hoppers where precise targeting is needed. For materials that do not flow freely, it can be used for monitoring build-up when installed above the monitoring point or directed toward the sidewall.

Some of the advantages of laser are that its adjustable, swiveling mounting flange is flexible up to 10˚. This may allow for use of an existing mounting location and eliminate drilling another hole in the silo roof. A laser's extremely narrow beam can be directed to avoid obstructions that could interfere with sensor operation. It is easily configured in the field using a USB port, while configuration can be performed without filling or emptying the vessel. Laser has a fast update rate of eight times per second and also features integrated dust protection for minimal maintenance.

Laser's major disadvantage is that it is not recommended for use in dusty environments. Plus, it only measures a single point in the silo, which could be problematic for materials that do not flow freely or may 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.

One size does not fit all

When it comes to non-contact level sensors, one size does not fit all. In fact, many cement operations use a combination of sensors – both continuous and point level – to keep their plants running smoothly. Different size silos, different materials, and different material management objectives will all come into play when selecting the right sensor solution for your operation. ■