A No-Hands Approach to Material Storage

Once a dangerous, labor-intensive activity, material storage is now 'hands off' thanks to scanner technology that takes volume measurement to a new level

BY DONNA SCHMIDT, FIELD EDITOR

Safety and cost efficiency are just two primary advantages to scanner technology.

It used to be that the coal tonnage sitting at a facility's silos was, at best, known only by human estimation or, at worst, a near mystery. Short of constructing transparent storage vessels, the only way to truly know where a site's inventory stood was to send someone to check it — often.

Over time, technology emerged that allowed a slightly better way to pinpoint things, but not by much; there are several point-level devices available today that send an alert to the control room, but only when levels reached pre-set levels. While an affordable and safer option, it is a bit of a reactive solution; if an overfill is nearing or has occurred, the headache of rectifying the situation can be reminiscent of a terrible nightmare.

Continuous level sensors are another cost-efficient option for facilities, though coal, with an irregular shape and heavy overall weight, can leave damage to the system's cable in its wake. In addition, only one location of a silo can be measured at once.

According to BinMaster Level Controls' Mike Mossage, it is these shortfalls that today's scanner technology works to address, offering much greater accuracy, much less potential damage, and a greater level of safety for all involved.

"Today's scanner technology has been a game changer when it comes to inventory accuracy," Mossage said. "It measures and maps...continually, enabling inventory monitoring in real time. It's non-contact, so there's nothing to get bent or damaged by heavy lumps of coal. The acoustics-based technology penetrates dust, so it will work reliably in dirty, dusty coal silos. Plus, it's far more accurate than any single-point measurement device, because it takes into account irregularities in the material surface."

What makes coal a more difficult case, he noted, its inherent difficulty to measure and manage. Many have all-too-recent experiences such as those described above, and they become negated with non-contact technology.

"[Coal is] dirty and dusty, rendering some types of sensors useless or unreliable when operating in the harsh environment," Mossage said. "It's heavy and lumpy, potentially causing damage to when it falls off a belt into a silo. It piles randomly and doesn't flow easily, making it hard to know what's really left in the silo."

It is for these reasons that, in many cases, calculating inventory level data from a single measurement point just is not enough. What's more, with coal piling up irregularly, creating an uneven topography, a single measurement point may not be able to offer the best depiction of the levels that are really on hand.

Safety is another significant advantage of scanner technology, Mossage noted, because there are no longer workers climbing silos for measurements. Inventory monitoring becomes totally automated, saving time and the risks associated with manual checks.

"Plants today deal with rigorous OSHA requirements pertaining to climbing and entering silos and risk hefty fines when found in violation," he said. "Installing an automated inventory monitoring system allows for material management to be performed from a personal computer in the safety of an office."

Equipment safety, since the technology is hands off, also fares much better than other technologies. As Mossage noted, nothing comes into contact with the material when an acoustic sensor is used. Eliminating contact with material helps ensure long life with minimal preventive maintenance or cost. With a heavy lump material like coal, that creates a significant advantage from a reliability perspective.

The Measuring Equation: How Scanners Work

The advanced, acoustics-based technology used in 3-D Level Scanners, or more generically known as scanners, is different from other types of level sensors, according to Mossage, as they scan the material surface to take multiple measurements and factor in the silo's high and low spots.

By scanning the surface, the device can also identify cone-up or cone-down conditions along with sidewall buildup. The resulting

Scanners measure and map the material surface, generating a 3-D image of its topography.

data from the multiple measuring points can then be processed with advanced firmware and algorithms; using the silo's dimensions in the software ultimately will provide the user with the highly accurate volume estimate needed along with additional data, such as the highest, lowest and average levels of the material.

BinMaster has worked in tandem with silo owners as well as those managing bunkers and domes, as the two are parallel in terms of information needed.

"Scanners are the only type of level sensor technology today that can provide a precise volume of material for coal bunkers or domes," Mossage said, largely because of their vast size, multiple filling and emptying points, and irregular piles of material.

"There just hasn't been a way to automate inventory management for these vast storage applications," he said. "Using multiple scanners strategically located above the material to span the entire surface is an innovative way to estimate inventory in bunkers and domes. Advanced software combines all of the measurements from multiple scanners and maps them three-dimensionally to estimate the volume."

A tilt switch point level device sends an alert when material reaches the switch and tilts it 15°.

The measuring range of scanners starts at 19 in. below the threads on the process connection, or the "upper dead zone," he added. When the site is complex, the solution is thankfully straightforward.

"Unlike any other technology, the 3-D Level Scanner takes measurements from multiple points within the silo," he said. "These points take into account irregular material topography to determine the volume of material in the bin. Measurement points are not simply averaged to calculate bin volume. Instead, an advanced algorithm assigns each point a 'weight' to determine the true volume of material in the bin."

Making the Most of Coal's Issues

Coal processing has inherent issues; these include dust and increased maintenance needs. Scanners can efficiently address both, especially compared to other types of measuring technologies.

Dust is one of the greatest challenges for coal silos, and excessive levels can result in inaccurate or unreliable readings for other sensors, at least until the dust (literally) settles.

"By operating at very low frequencies, a scanner isn't bothered by dust and can perform consistently and reliably regardless of the conditions in the vessel," Mossage said. "In addition to coal, this technology has been proven in many different challenging materials in the coal, power and mining industries."

Anything self-cleaning is a positive in the mining world, and in the case of scanners — a device that spends a great deal of time in the harsh environments of coal — such a design can equal time savings as well as reduced costs of personnel hours and maintenance.

"The unique design and materials used to manufacture scanners ensure that the surface resists the buildup of dust particles that are suspended in the air at the top of the silos," he said. "Plus the acoustic pulses emit a 'chirping' sound that resonates and creates an almost imperceptible vibration that helps keep the inside of the scanner clean. This way, the sensor stays clean and operational without...running an air purge to the top of the vessel, which can be costly."

Being an Educated Consumer

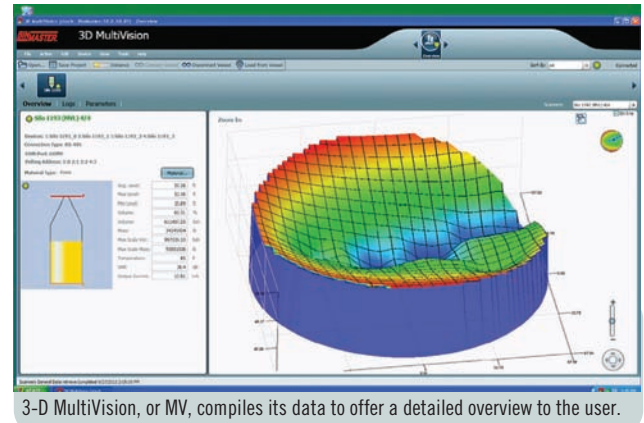
3-D Level Scanners — like most other measurement devices — come in a variety of models and offer a wide range of options to tailor the device to the application, according to Mossage, who noted that, when selecting the correct model for an application, it is extremely important to communicate expectations as well as how the data from the device will be used.

"Many plants are focused on having a very high level of inventory accuracy," he said. "Accuracy of the scanner is driven by a number of variables, starting with information about the size of the vessel, the presence of structure inside of it, and the material that is being measured. The installation location is also important as scanner technology measures multiple points, so the device needs to have a clear view of the material surface."

The RL is the basic model, the most affordable of the line. RL, reliable level, measures in a narrow beam directly below the device. With the capabilities to penetrate high levels of dust, the RL has the capacity to perform where other non-contact level sensors can become unreliable or inaccurate.

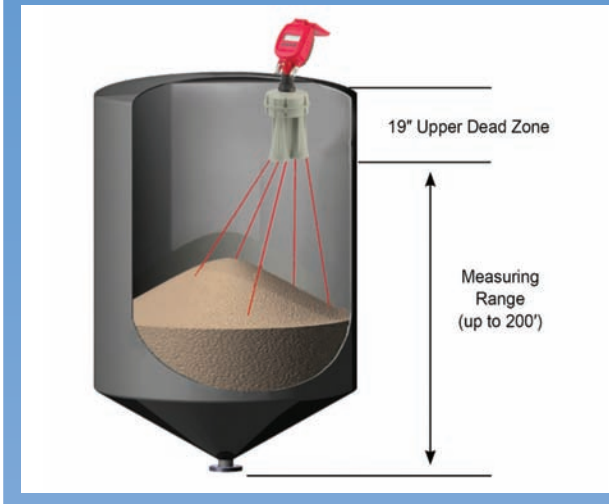
This BinMaster model is most often utilized in cases where continual, highly reliable level measurement data is needed; as such, it is often chosen for applications less prone to excessive buildup, or in narrow or smaller silos.

The S model is designed for facilities that need more than simple-level data, and can determine volume using average levels across multiple measurements compiled within a 30°-beam angle. This model is ideal for use in narrower silos (up to 16 ft) and heights as tall as 200 ft; while wider silos can implement the S



3-D MultiVision, or MV, compiles its data to offer a detailed overview to the user.

Pros and Cons of Scanner Systems



PROS

- Multiple point measurement;
- Continuous level measurement;
- Nonintrusive, non-contact design;
- Measures uneven solid material surfaces;
- Detects cone up, cone down and sidewall buildup;
- Provides minimum, maximum and average distances;
- Performs in extreme levels of dust;
- Calculates highly accurate silo volume due to mapping the surface of the material with multiple measuring points;
- Measuring range up to 200 ft;
- Self-cleaning with minimal maintenance;
- Models for high temperature applications available;
- Automatic compensation for temperature changes;
- Analog and digital communication options;
- Networkable PC software available for multiple vessel monitoring;
- Can generate a 3-D image of material surface;
- Wireless interfaces available to reduce the need for cabling;
- Approved for hazardous locations; and
- Not affected by material characteristics or low dielectric constants.

CONS

- Elevated background noise can impact performance of acoustics technology;
- Setup requires care in mounting the sensor in the proper location and accurately mapping the vessel dimensions;
- Time required to process multiple pulse echoes limits the sample rate;
- Corrugation on small vessel walls can cause false echoes; and
- Not recommended for materials with a bulk density under 11 lb/cu ft due to absorbing the acoustic pulse.

Point level devices, such as this rotary switch, can help facilities prevent overfilling.

model, the entire material surface may not be covered by the beam angle, thus reducing overall accuracy.

BinMaster's M model takes measurements from a broader beam angle, 70°, and is the better solution for silos with a larger diameter or uneven material topography, including coal. With additional data generation such as lowest, highest and average distances based upon multiple measurements, as well as an ability to include the factor of irregularity, it can provide a very high level of volume accuracy in silos diameters up to about 45 ft.

Finally, the M model goes visual with the model MV, at the top of the company's model spectrum. It does everything the M does, plus it features a unique visualization feature.

"Using complex algorithms and a lot of processing power, this model generates a 3-D image that indicates where the high and low spots are in the silo, shows if the cone is up or down, and detects sidewall buildup," Mossage noted. "This additional feature can be used to help manage filling and emptying points and detect if maintenance is needed to clean out buildup. This model is often used in large silos where materials tend to pile up unevenly."

No matter the manufacturer of a facility's solution, the decision of the ideal scanner technology is not always black and white. No two sites are alike in needs, data collection requirements or infrastructure.

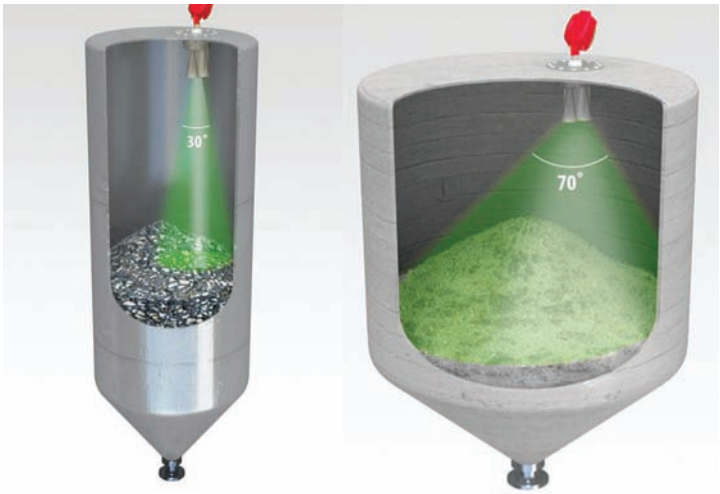
"If a silo is very wide or large, or bunkers or domes need to be measured, two or more scanners can be combined into a multiple-scanner system," Mossage said. "By adding a controller that synchronizes the measurements from all of the scanners on a silo, the MVL model is able to provide high volume accuracy in some of the largest silos. The number of scanners needed...is determined by how large the silo is and the desired level of accuracy."

Further, with the MVL, the generation of a 3-D visualization of the material surface taken from all scanner measurements is a plus; however, if visualization is not a priority, the ML multi-scanner will offer the same accuracy without the visual and is thus more economical for a budget-conscious site.

"Silos can be challenging structures to measure, and often they come with some surprises that need a little 'work around,'" he said, noting silos with structures at the top that may cause a measurement device to see the structure itself rather than the material inside.

"Neck extensions have been designed for scanners that allow them to clear structure and see beyond it to get an accurate measurement of the material; angled mounting flanges are designed to keep the device level, while angled mounting adaptors can be used when it's necessary to aim the device in a problematic silo.

"Although they have only been in the North American market about five years, acoustic sensors have already revolutionized inventory management by adding ability to accurately estimate volume in a silo without leaving the safety of an office. The data



The S model (left) measures multiple points within a 30°-beam angle and is ideal for smaller silos. For larger silos, the M model (right) measures multiple points within a 70°-beam angle to accurately calculate volume.

derived from these devices improves operations by allowing for timely replenishment and purchasing, reducing safety stock, and making inventory valuation far more accurate. For plant personnel, the scanner has been a game changer, keeping personnel safe from climbing silos and making them more efficient. Scanners truly have taken volume to a new level," Mossage said.

Once armed with knowledge, the only other factors still outstanding are the cost, implementation and installation.

When it comes to this crossroad, Mossage makes an interesting metaphorical scenario of the technological maze.

"Selecting the right sensor for your bin level monitoring application can seem like ordering off of a menu when you don't speak the language," he said. "There are volumes of information about different...continuous level measurement technologies and technical data about how they work. Although helpful, it's likely you don't have time for TMI (too much information) and bin level sensors are only a fraction of the equipment you need to worry about."

An educated mind, as noted above, paired with a solid idea of the site's needs, is all that is needed to make sure the most cost-efficient selection is made. No one wants to make the wrong choice, especially when it comes to light after the solution has been installed and implemented. BinMaster offers assistance in this area, and reminds facilities to be armed with all of the facts to get the most from the investment.

Beyond knowledge of the material and its bulk density in lb/ft^3 as well as moisture level, the silo's temperature and pressure is key. Excessive noise or vibration levels are important, as are the presence of dust, steam, vapor or foam.

Operations that need to know the volume, and not just the level of a single point in their silos, will benefit from scanner technology. More is better, when it comes to measurement points. "There's a big difference between 'how high' versus 'how much' when it comes to managing the vast inventory of coal at a facility," concluded Mossage. "Scanners are a proven, low-maintenance solution that arms facilities with the data they need to operate efficiently, comply with safety regulations, and simplify the task of inventory management."