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It's the experience that counts...and it's the experience that measures!

The typical cement plant is an interconnected chain of diverse production environments, each one with its own unique set of process instrumentation challenges. Two of the goals of an efficient plant are to fully automate and integrate these processes, while simultaneously isolating staff from potentially dangerous environments. Although there are many means available to achieve these goals, one of the most commonly used is level measurement.

In search of the ideal level measurement solution

There are many ways to measure level in a cement plant. Of late, the preferred solution has been non-contacting continuous measurement methods, with the two technologies of choice being ultrasonics and radar. Each one of these technologies has its own set of preferred applications. For example, ultrasonics is the best choice for open settings such as crushers and stockpiles, while radar excels in contained environments such as silos, bunkers, and hoppers.

The level measurement options don't end there though, as there are other devices that are ideally suited for specific applications, especially those that are less aggressive. For example, many cement plants use guided-wave radar in vessels where there is no agitation, as well as point-level devices for high/low level alarms. In addition, some companies place weighing load cells under small vessels to measure the exact amount of material for precise batching or dosing needs.

The choice of solution depends upon the specific circumstances at each stage of production, as the following examples demonstrate.

Primary crusher

The first step in any cement production process begins with the primary crusher, where large rocks of raw material are crushed into smaller ones.

Since this environment isn't safe for workers, plant operators want a solution that isolates these employees from danger, yet can still continually track the amount of raw material in the crusher. An ultrasonic device, mounted above the crusher signals to the dump truck drivers when it is time to empty their loads into the crusher so that they don't ever have to leave their vehicles. In addition, another ultrasonic device placed in the rock box below the crusher monitors the level of the rock and signals an alarm if that level gets too high, which would indicate a blockage.

Secondary crusher

In this stage of the process, the raw material is reduced even further, and the level of this raw material within the crushers must be monitored at all times in order to maintain a consistent output size. However, it is a challenging location because the inherent vibration wreaks havoc with sensor readings, and exposed instrumentation is at risk of being hit by flying rocks.

These conditions led the technicians at Torr Works, a limestone quarry in Somerset, England, to install a rugged Echomax XPS-15 transducer above the crusher, with a Sitrans LUT400 con-

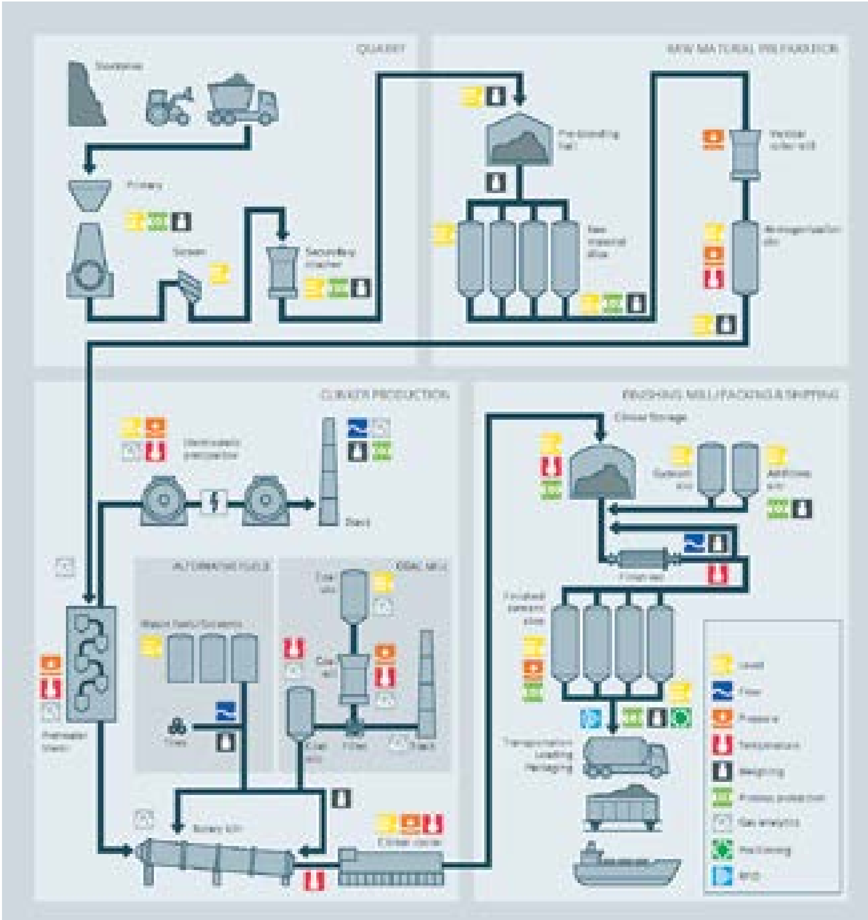

Fig. 1: Siemens has been in the cement industry for over 100 years, and offers a broad portfolio of process instrumentation solutions that includes flow, pressure, temperature, weighing, valve positioners, and, of course, level measurement.

troller mounted separately, well away from flying rocks. The installation was successful, causing Gareth Harries, the Electrical Engineering Team Leader, to offer the following compliment: "There is not a lot of equipment I have seen that can stand up to the environment we put measurement devices through."

Pre-blending yards and halls

After being crushed, raw material in the form of limestone is transported via a stacker conveyor to a stockpile where it is spread as evenly as possible to facilitate blending, something that improves the quality of the finished product.

From a control system perspective, an ultrasonic device provides the feedback that is used to control the conveyor (which is usually either a stacker or a tripper), adjusting its elevation, or moving it altogether when the height of the stockpile reaches a pre-determined level.

Ultrasonics is the best solution in this case, as it has a robust, remote-mounted sensor that is resistant to harsh conditions such as vibrations and inclement weather.

Auxiliary silos and tanks

A number of vessels serve important roles throughout the cement production process. Several are used to house the crushed limestone after it has been processed by the secondary crushers, while some store materials such as the sand, silica sand, iron ore, fly ash, gypsum, plaster, or grinding aids that are added during the final grinding of the clinker. Still others contain coal or other fuel additives used to power the kiln, or the numerous chemicals or lubricants used in the various processes or machinery in the plant.

The Heracles cement plant in Greece uses ten such silos to store raw material, and has updated its level measurement technology through the years. Traditionally, the company gauged the material level in these silos using a rope and weight, a method that is unreliable, time consuming, and dangerous. As a result, Heracles opted for an ultrasonic solution in the form of Echomax XPS-30 transducers with an LU10 controller.

"We can now rely on the level system from Siemens to provide us with the automated control we need for efficient raw mill feeding," said George Pischinas, Technical Consultant at the plant. "I would recommend it highly for level measurement on raw material silos for mills!"

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At the time, ultrasonics was a perfectly adequate solution, but dusty environments, even moderate ones like the ones at Heracles, reduce the accuracy of such devices because of signal loss due to severe attenuation. Currently, the preferred solution is radar, as it uses electromagnetic waves travelling at the speed of light that are unaffected by particulate matter in the air.

This was the reason that St. Mary's Cement company in Bowmanville, Ontario, sought to install a radar unit in the dusty conditions of the additive silo that held their sand. There was a problem, however, in that most radar devices at that time had a wavelength of 25 GHz, and this signal was being dispersed by the steep angles formed in the sand during filling and emptying.

The company solved this problem with the Sitrans LR560, a radar device that emits a wavelength so short (78 GHz), that it can accurately reflect a signal from solids with a steep angle of repose, like sand. What's more, the St. Mary's technicians discovered that, because the Sitrans LR560 transmitter had such a narrow, four-degree beam, they could install it practically

Fig. 2: The Sitrans LR560 is the ideal radar device for dusty environments. In addition, it emits a short wavelength (78 GHz), so is able to accurately measure the level of solids, even when the material is piled on a steep angle.

"These instruments were easy to install and set-up, and they have been working fine."

anywhere on the top of the silo, and still avoid silo wall obstructions and other installation interferences.

Homogenization silos

In the homogenization stage of the cement production process, the crushed limestone is blended with both clay and sand, and ground into a powder that is often referred to as "flour." During this process, the homogenization silos are continuously filled and emptied, while the flour is aerated to ensure good material mixing. This aeration creates a tremendous amount of dust, making it difficult to obtain reliable readings with traditional non-contacting measurement devices, a challenge that is often further exacerbated by the height of the silos.

These dusty conditions were exactly the challenge faced by the Lafarge Ciments plant in Meknes, Morocco in 2001. They found that the manual measurements that they had been using were neither accurate nor regular enough, and the tensile forces inside the silo meant that contacting measurement devices like mechanical, capacitance, or guided-wave radar would break and fall into the product.

Knowing the level of the silo was critical however because, if the silo emptied unexpectedly, there was nothing to feed into the 1500 °C (2732 °F) clinker kiln, which would result in an expensive waste of energy.

The company installed a Sitrans LR400 radar device that could easily see through the dust, saving the company both time and money.

"The trials we did at Meknes on the flour silo were to our full satisfaction concerning precision and stability of the measurement," said Mr. El Bachir Hajjoubi, the Instrumentation Manager from Lafarge Morocco.

Although the Sitrans LR400 has since been replaced with newer models (both the Sitrans LR460 and the Sitrans LR560 offer specific advantages based on the application), many of the cement plants that installed the older model fourteen years ago have not updated their equipment. They are so impressed with how well the Sitrans LR400 has continued to operate with little or no maintenance for more than a decade, that they just don't want to fix something that isn't broken.

Kiln fuel silos

In the kiln, pre-blended materials such as limestone, silica, and clay are mixed and fused together through a series of chemical reactions resulting in a material that is known as "clinker." These kilns can burn a range of fuels, including coal, petroleum coke, or alternatives. No matter what kind of fuel used though, the plant must know exactly how much of it is stored in the silo(s) in order to maintain production.

The Ash Grove Cement Company in the United States powers its kilns with alternative fuels in the form of waste products from other industries. The company uses a Sitrans LR200 radar to monitor the agitated storage tanks to prevent spillage. This device is ideal for this situation because it is programmed with "Process Intelligence," proprietary software that minimizes the effects of, and dynamically adjusts for, obstructions and agitator blades.

"We have had very good results," said Heath Murray, Instrumentation Supervisor. "These instruments were easy to install and set-up, and they have been working fine."

There are many fuel types, and radar devices with a frequency of 25 GHz or less work best with liquids, and those with a frequency of more than 25 GHz are ideal for solids.

Kiln dust

A key by-product of the production of clinker is the dust from the mixing and grinding of powdery materials. Called kiln dust, it can be filtered into a silo where it can be drawn out and used again in the production process.

A major cement plant in Texas has learned the hard way that, when the

Fig. 3: Sitrans LR400 units such as this one were installed well over a decade ago, and continue to provide reliable level measurement readings to this day.

kiln dust builds up to the bottom of the dust filtration bag, it not only damages this very expensive bag, but ultimately shuts down the entire kiln. To keep this from happening again, the company installed a Pointek CLS300 to monitor for the critical high level of the dust, and trigger an alarm should it reach this point again.

Clinker cooler bed level control

The clinker exits the kiln at temperatures of over 1000 °C (1800 °F) and must be cooled before it can be moved via conventional rubber belts to the clinker silos.

At the St. Mary's Cement plant in Bowmanville, Ontario, this clinker is pushed with a metallic grate, and air is directed from below to cool it. Traditionally, the bed depth of the clinker on the cooler had been 'inferred' by measuring the secondary effects of either hydraulic pressure or air pressure, but the company now uses non-contacting radar technology in the form of a Sitrans LR560 mounted on an extension pipe that is one meter long. Directly measuring the level of the clinker means that readings are immediate, more accurate, and less costly.

Clinker silo level

Often, even though it has gone through a cooling process, clinker can be loaded into a silo while it is still very hot. This heat, in combination with the fact that it is very dusty at this stage, makes this a challenging environment for level measurement.

For example, although the technicians at the St. Mary's Cement plant in Bowmanville, Ontario, found that high temperature ultrasonic transducers could sometimes be used in either of their two 70 meter (229 feet) clinker silos, they had the most success with Sitrans LR560 radar devices mounted at the top of the storage containers. St. Mary's presently has four such radar transmitters monitoring clinker silo levels reliably, effectively avoiding dangerous over-flow conditions or production stoppages.

Finished cement silo

The final step in making cement is putting the clinker and the appropriate additives through a ball mill, where it is reduced to a very fine powder. This finished cement is then put into silos to await further processing, such as packaging or shipping. Given the dusty environment, the level in these vessels has most successfully been measured using non-contacting radar.

At the Holcim Zementwerk in Untervaz, Switzerland, technicians had attempted to use a guided-wave radar in the very tall and narrow silo that housed their finished cement, but the probe kept making contact with the sides of the silo. As a result, they turned to the Sitrans LR560, its narrow beam works very well in this tight silo.

Conclusion

In summary, it is clear that reliable level measurement is a key component in a cement industry that demands robust, designed-to-purpose products to measure material that is often aggressive, and in an environment that is frequently hostile.

As a whole, cement companies employ a broad range of technologies to measure level, and for increased safety and environmental protection, point level devices are a best practice as part of the overall solution. Historically however, the non-contacting technologies of ultrasonics and radar have presented the widest range of solutions for applications.

One thing is clear though: cement is an industry that embraces new technology, which has certainly been the case with the introduction of a 78 GHz radar level measurement device with a narrow beam. This new radar technology isn't affected by dust, vapour, or temperature, and can effectively measure solids, even those with a steep angle of repose. Since its introduction in 2011, cement producers have collectively rushed out to adopt a product that, because it can be applied in virtually all areas of the cement plant, is one of a kind.

Fig. 4: Siemens has taken the experience of how to differentiate between false echoes and true echoes from over a million individual applications, and distilled it into the "Process Intelligence" software that goes into each one of its radar devices, like this Sitrans LR200 unit.

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