The Radar Solution to Dust

By Tim Little

A breakthrough in radar technology has solved level measurement challenges for a cement producer in Mexico

A leading global producer and marketer of cement and ready-mix products located in Mexico has for many years faced a level measurement challenge common in the cement industry. There seemed to be no way to achieve accurate, reliable level measurement on dusty applications.

The dusty challenge

Obtaining reliable level measurement has traditionally been a severe challenge because cement production is such a dusty process. During homogenization, for example, silos are continuously filled and emptied, and the component materials are constantly aerated to ensure good mixing. This creates a tremendous amount of dust that makes it difficult to obtain reliable readings with traditional non-contacting measurement devices. The concentrated dust blocks the signal, especially in this long-range application.

Some plants have relied on manual measurements taken from the top of the silo using a rope. This is time consuming and provides only periodic readings. Tensile forces in these high silos can reach several tons, causing cables or moving parts inside the silo to break off and fall into the product. For this reason, contacting technologies such as TDR (cable radar) and yo-yo systems are problematic. Non-contacting ultrasonic systems have a hard time penetrating the extreme dust created by the powdery materials being mixed and aerated throughout the homogenizing process.

The intense heat of cement production is also a limiting factor for many level instruments. High process temperatures, along with the severe dust, make level measurement in cement silos very difficult.

Nonetheless, reliable level measurement is essential for good process control.

The petroleum coke silo

At one site, the company sought a level measurement solution for its petroleum coke silo. Petroleum coke, or pet coke, is a petroleum industry by-product that is often used as a fuel by the cement industry. It is a cost-effective alternative to oil, gas or coal, and generates a lot of heat.

The plant uses petroleum coke to fire its kiln, and also transports pet coke to the company's other nearby plants. The pet coke is conveyed from a train-unloading station and pneumatically fed...
into a storage silo, and then is either loaded into trucks for local delivery, or fed to the kiln. The pneumatic filling and emptying generates extreme dust. For level measurement, operators had to rely on manual measurements using a rope.

Trial and error
The petroleum coke silo is 18 meters (59 ft) high, with a straight section of 11 meters (36 ft) and a 7-meter (23 ft) conical section at the base.

The company previously tried a TDR instrument for continuous level, using a high-point level device for backup. The results were less than satisfactory.

Similar to pulverized coal, pet coke is a very fine, dusty and sticky powder. Product build-up on the TDR cable and product touching the cable during aeration created false readings with high amplitudes. Another limitation of TDR was that the cable was hanging free in the silo and could move around during filling and emptying. To avoid the cable touching the conical bottom, the cable length was limited to a measuring range of only 11 meters (36 ft), so TDR could measure only the straight section.

Despite extensive efforts to service and fine-tune the TDR instrument, it could not produce reliable readings, and they decided to disconnect it.

Operators were very frustrated with this situation. They needed accurate measurement over the full range of the silo. They concluded that non-contacting radar would be a good choice, but could not find an instrument that could measure through the dust. Then Rafael Sierra from IDN Ingeniería y Soluciones Industriales, an instrumentation supplier located in Monterrey, approached them with a new radar device and they agreed to conduct a trial on the petroleum coke silo.

The radar solution
The company installed a Siemens SITRANS LR 400 radar instrument on the flange where the high level probe had previously been. Because it fit easily on the existing nozzle, there were no custom fittings or silo modifications required. The standard radar device was equipped with a 4” 150-lb flange and a 4” (100 mm) horn antenna. The analog output was connected to the PLC and was monitored in the control room.

After programming the first eight “Auto Setup” parameters, the SITRANS LR 400 immediately displayed the right level. It was fully operational just 15 minutes after installation.

The level information was recorded during the fill cycle, which takes about an hour. Pneumatic filling creates a lot of dust, but the signal remained strong during these harsh conditions. Over three weeks, the reading was compared with a rope measurement. The echo profile was checked during different conditions – stable level, during filling and during loading trucks. In all conditions, the echo profile was strong and correct.

The TDR unit is still installed but is no longer connected. The analog input from the PLC previously used for the TDR is now used for the SITRANS LR 400.

The operators were able to increase the range in the PLC from 11 to 18 meters because they can now measure the full range of the pet coke silo. This has greatly enhanced process control and efficiency. The operator can monitor how much material is available to maintain the kiln process, and also how much inventory is available for local deliveries.

Following this successful trial, they tried the radar instrument on another tough application.

The homogenization silo
The homogenization silo at the Monterrey plant is 40 meters (131 ft) high with six product inlets and an outlet. The silo is continuously filled using a pneumatic conveying system, and is simultaneously emptied. It is also aerated from the bottom to promote mixing and aid the flow of the product through the silo outlet. The constant movement of material with aeration creates extreme dust.

Level measurement in this silo is critical for maintaining sufficient material for production and to reserve space for delivery of product from the six mills in the plant. Unfortunately, no devices could measure reliably through the dust and they had to rely...
on manual rope measurements.

The operators installed a SITRANS LR 400 on the homogenization silo and monitored its performance for two months. The display readings were compared with daily manual rope measurements. The radar instrument maintained a signal output at all times, even during filling, unlike other technologies which might only be able to measure during static conditions.

The successful tests proved they could have confidence in the readings. It gave operators accurate, reliable readings to use for production decisions. Also, operators no longer had to climb the silo which saves valuable staff time and enhances plant safety.

As a result of these successful tests, the company has already installed additional SITRANS LR 400 transmitters. The technical manager at the main plant has made an inventory of the plant’s dusty applications on the silos and hoppers to propose SITRANS LR 400 as the preferred level measurement solution for these applications. The company has also qualified the SITRANS LR 400 radar for its plants worldwide.

Why did this new radar instrument succeed where other technologies have failed?

The SITRANS LR 400 is a 24 GHz, high power radar transmitter using FMCW (frequency-modulated, continuous wave) technology. High power, high frequency and narrow beam angle combine to produce excellent reflection characteristics and exceptional measurement performance on virtually any solids medium, regardless of the particle size. The strong signal-to-noise ratio and advanced echo-processing technology produce reliable readings even through severe dust. This makes it ideal for applications in the cement industry such as petroleum coke, homogenizing silos or vessels storing clinker, kiln dust, or finished cement. These same capabilities can also serve applications on fly-ash, flour, powders and other dusty materials.

Its long measuring range of 50 m (164 ft) makes it suitable for tall cement silos. It can handle the high temperatures up to 250°C (480°F) often found in hot clinker and kiln dust applications in cement plants.

Installation is simple and usually without interruption to the process. A special feature called Auto-Setup makes start-up easy with its eight menu-driven steps. An optional infrared handheld programmer is available for non-intrusive local programming, so there’s no need to open up the instrument. It can also be programmed remotely with Siemens SIMATIC PDM. It is HART compatible, with optional Profibus-PA.

The instrument uses non-contacting technology and there are no moving parts, so it is low maintenance, with no risk of broken or tangled cables. The benefit is reduced maintenance costs and trouble-free, reliable measurement.

At last, there is a solution to the dusty problem of level measurement for the cement industry. It bodes well for enhancing process control in cement production.

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