SIEMENS

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High performance in extreme dust: 78 GHz radar for solids level measurement

When you're dealing with an extremely dusty application, radar is by far the best choice of technology for solids level measurement.

SITRANS LR560, Siemens' 78 GHz radar transmitter, demonstrates high performance even in extremely dusty silos – making level measurement more reliable and normally maintenance free.

Compared to contacting technologies such as guided wave radar, capacitance, or plumb-bob systems, and even to non-contacting ultrasonics, radar is ideal in extremely dusty environments.

Most solids materials will generate some dust during a silo's fill cycle. Fortunately, the dielectric constant of the dusty atmosphere is very close to 1.0 (similar to air) and thus is practically transparent to microwaves transmitted by a radar device.

Any frequency in the microwave spectrum from one to 100 GHz will penetrate the dust in a silo equally well. But, a higher frequency radar transmitter has the added benefit of a small antenna. It also features a narrow 4-degree beam angle, which make installation simple – as the transmitter can be installed practically anywhere on top of a silo.

Application challenges

Most solids are dry and also have a low dielectric constant, so buildup of this type of material on a radar antenna causes minimal influence.

If the solid material has a high moisture content, however, there could be a potential problem with the dust building up on the sensor. Heavy buildup can cause a failure in the measurement, as high moisture means material has a higher dielectric and is therefore less transparent to microwaves.

For example, a cement production facility has a lot of very dry and extremely dusty environments. Radar transmitters can tolerate this dust buildup very well. A cement transfer terminal near the ocean, though, can be problematic for the radar device due to the increase in moisture present in the environment.

Similarly, a ship full of warm/moist coal being transferred into a cold silo is another environment where buildup on the sensor is likely, due to the condensation and dust near the top of the silo.

The normal effect of this buildup is a high level reading by the transmitter because the material echo is weak and the buildup on the antenna causes a reflection. Manual cleaning or air purge cleaning would be required.

Success in difficult environments

When it comes to the effects of severe buildup in an application, 78 GHz radar technology demonstrates significant improvement over lower frequency devices on the market.

Figure 1 and 2 show the difference between a 25 GHz radar with a horn antenna versus a 78 GHz radar with a lens antenna.

These two devices were installed on a small silo with a fixed metallic target inside at a distance of two meters. The contamination of dust on the antenna was viewed over time and the resulting signal profile captured.

The red plot line is the signal captured with a clean antenna – lower-frequency radar does fairly well here.

But compare this to the light blue line showing heavy contamination on the antenna – the effect of buildup on the lower-frequency antenna showed an increase in the signal from 0 to 0.5 meters (this area we call "antenna reflection") and a significant reduction in the target signal strength.

The main problem for traditional radar is that slight contamination results in a signal increase near the antenna, resulting in a false high level reading.

The transmitter therefore "sees" the layer of contamination on the antenna and thinks this is the material level reading in the silo. Fine-tuning is then required to filter this signal out. Or, the radar needs to be removed and cleaned or a costly air-purge cleaning system implemented.

The issue is much less severe with the high frequency SITRANS LR560, a 78 GHz radar transmitter from Siemens. This device can tolerate buildup, either indefinitely, or with much less expensive and less time-consuming cleaning needs. As well, since air purge cleaning can be expensive, the high frequency radar uses less air than traditional radar and at longer cleaning intervals.

SITRANS LR560 has a lens antenna constructed of a highly durable polymer called polyetheramide [Figure 3]. The smooth exterior surface prevents most dust types from accumulating.

For moist solids that would tend to stick to the transmitter's face, an integrated air purge feature will help. Users simply connect a clean and dry air supply to the transmitter through a timer valve. Just a few seconds every hour or two is usually sufficient. Clean, dry air is then channeled from the connection on the top of the flange through to the face of the lens in a vortex stream, creating a very efficient cleaning system.

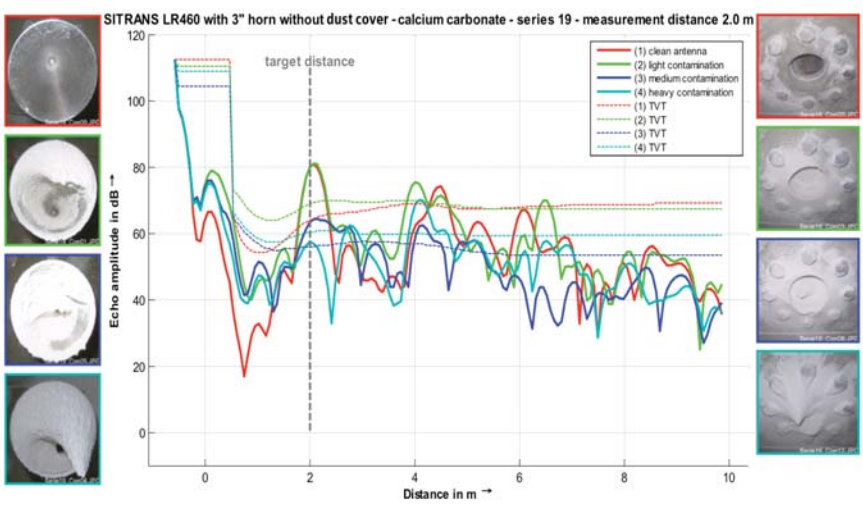

Figure 1: Effect of calcium carbonate buildup on 25 GHz SITRANS LR460 antenna lens. The signal near the antenna increases significantly with buildup, while the signal from the target decreases in strength.

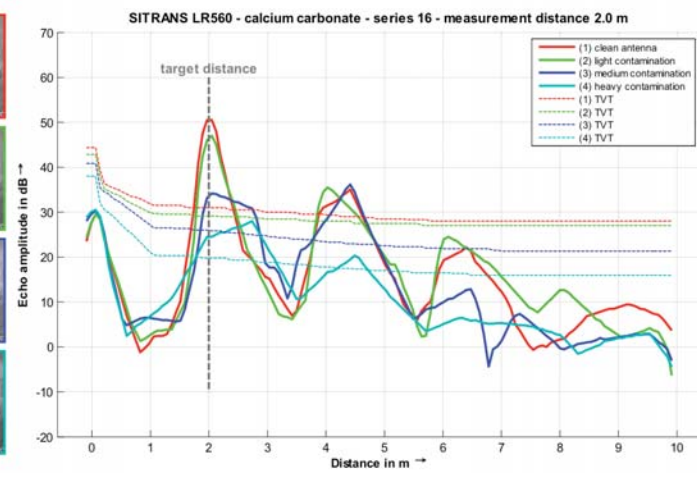

Figure 2: Effect of calcium carbonate buildup on 78 GHz SITRANS LR560 antenna lens. Even with buildup on the lens, signal strength remains high with no false echoes reported.

Choosing the right tool for the job

For extremely dusty environments, choosing high-frequency radar over lower-frequency devices means lower cost of ownership. How?

First, many applications will not require any maintenance or air-purge systems for reliable measurement. Applications currently using 25 GHz and requiring routine cleaning may work acceptably with 78 GHz technology without any cleaning.

Second, the time interval between air-purge cleaning cycles can be increased. Supplying clean and dry air to a level device is costly, but higher frequency radar will consume less air because it can tolerate material buildup for a longer period of time.

High-frequency radar is the first choice for these challenging, dusty applications. Compared to other contacting and non-contacting technologies alike – and even compared to lower-frequency radar transmitters – 78 GHz technology proves itself in industrial applications around the world.

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Figure 3 (left) and Figure 4 (right): SITRANS LR560's highly durable polyetheramide lens antenna (left) can tolerate significant buildup, such as in this photo (right), where it has been coated with finished cement powder.

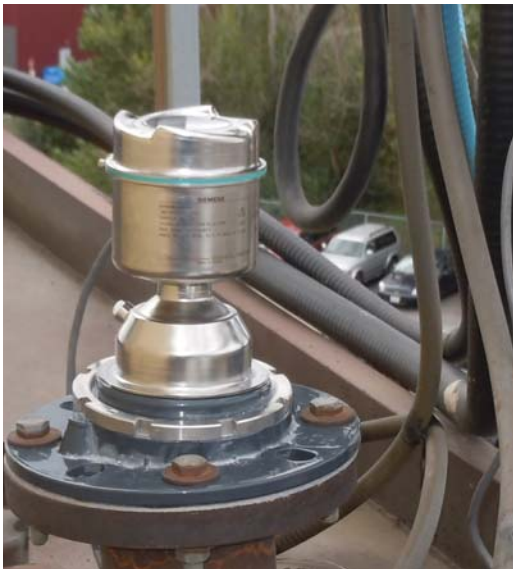

Figure 5: SITRANS LR560 avoids false echoes in a silo with its high frequency antenna, and no advance parameters are required for reliable operation.