Maximize Polyethylene Operations with 80-GHz radar

Accurately detect and measure flake and pellet density variations and anomalies

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Managing polyethylene silos and storage bins in the final stages of production can be a challenging and costly assignment. Polyethylene flakes, or fluff, can be difficult to measure accurately in silos or storage bins. These flakes can have varying densities, tend to collect and build up on any sensors and have low reflective properties. Use of an 80-GHz radar (Figure 1) is a more accurate and less expensive level measurement alternative to other traditional methods.

When polyolefin plants manufacture high-density and linear low-density polyethylene, a chemical reaction creates the product. Following this initial reaction, several steps and processes are taken to separate the product from the excess raw materials. The product, in this case, comes in the form of light, fluffy flakes. These flakes commonly are stored in a fluff silo or storage bin before moving on to the final extruder step, where they're turned into pellets and moved to a different storage silo before shipment. Alternatively, low-density polyethylene goes straight to the extruder and into similar storage silos.

The level inside these vessels is measured and checked in both of these steps — the fluff silo and the storage silo. Traditionally, the level has been tracked using load cell technology. Essentially, a scale is installed beneath the silo, weighing the silo and the material inside. However, these load cells are expensive to install and even more costly to maintain. The load cells cannot tell users whether or not they're maximizing the full vessel, either, because these

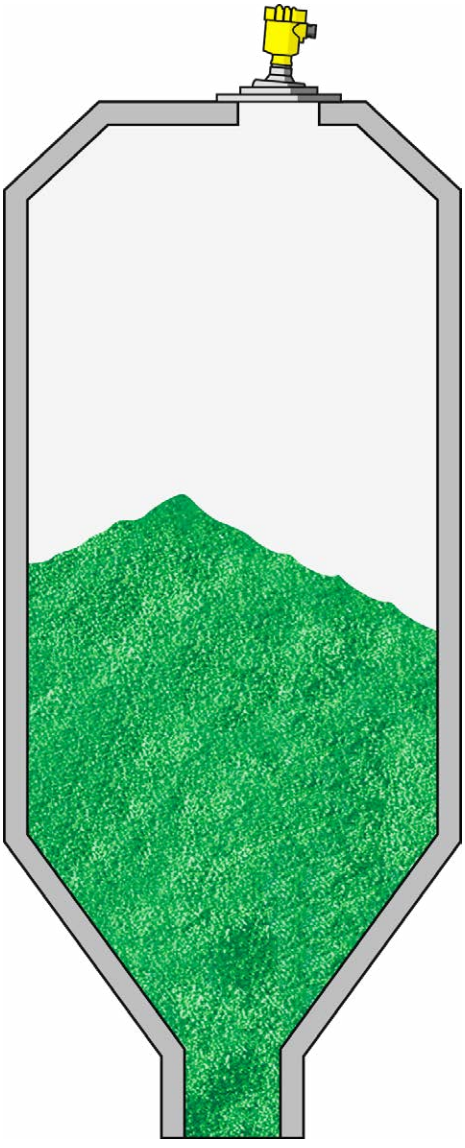
flakes and pellets have varying densities, so different weights will equate to different levels.

Polyethylene comes in many grades, and each grade has a different density. This means the weight of a full silo will be different for two different types of polyethylene. This can lead to an overflowing silo or not fully using a silo when the type of material isn't taken into account.

A DIFFICULT MEDIUM TO MEASURE

Both polyethylene fluff and pellets can be a problematic material for other level measurement sensors. Polyethylene flakes, by their nature, stick to anything and are prone to buildup. This buildup can prevent some sensors, such as ultrasonic devices and lasers, from working properly without constant cleaning and maintenance.

In the past, through-air radars have had trouble measuring polyethylene because of its low dielectric constant and poor reflective qualities. Water has a very high dielectric constant — approximately 80 at room temperature. Polyethylene and plastic pellets, however, have a dielectric constant closer to 1.2. This extremely low number gave previous generations of radars problems obtaining an accurate level measurement when they received a return microwave signal from the product's surface.



80-GHZ RADAR
Figure 1. An 80-GHz radar can more accurately detect and measure polyethylene flakes in silos or storage bins.

These hurdles — buildup and low dielectric constant — have led to the widespread usage of weigh scales (Figure 2) for inventory control in silos at polyolefin plants. However, these mechanical measurements are pricey to install or replace, especially

at older, established plants. Installing or replacing one of these means lifting the entire silo and installing the device underneath — a costly endeavor, especially if it requires shutting down operations. These weigh scales also are expensive to maintain — cleaning, calibrating, and repairing as needed all takes valuable time for maintenance crews. 80 GHz radar provides a less expensive method and also help prevent overflows while maximizing every storage vessel and silo.

RADAR LEVEL MEASUREMENT WITH 80 GHZ

Through-air radar works by emitting radio microwaves from the radar antenna system to the measured product where it is reflected by the product surface and back to the antenna system. The radar sensor uses time of flight to measure level of the product — polyethylene flakes or pellets in this case. The amount of time it takes from emission to reception is proportional to the distance to the product surface. The longer the time of flight, the greater the distance. The distance is inversely proportional to the level in the tank, so the greater the distance, the lower the level.

Real-world benefits of 80-GHz radar can be seen across many applications, including polyethylene silos. The VEGAPULS 69 from VEGA, which is designed for bulk solids, uses enhanced focusing, a dynamic range that can receive more of the microwave signal and software to generate an accurate and reliable echo curve to interpret the level inside the vessel.

SILOS WITH WEIGH SCALES
Figure 2. Weigh scales commonly are used for inventory control in silos at polyolefin plants. However, these mechanical measurements are pricey to install, replace and maintain.

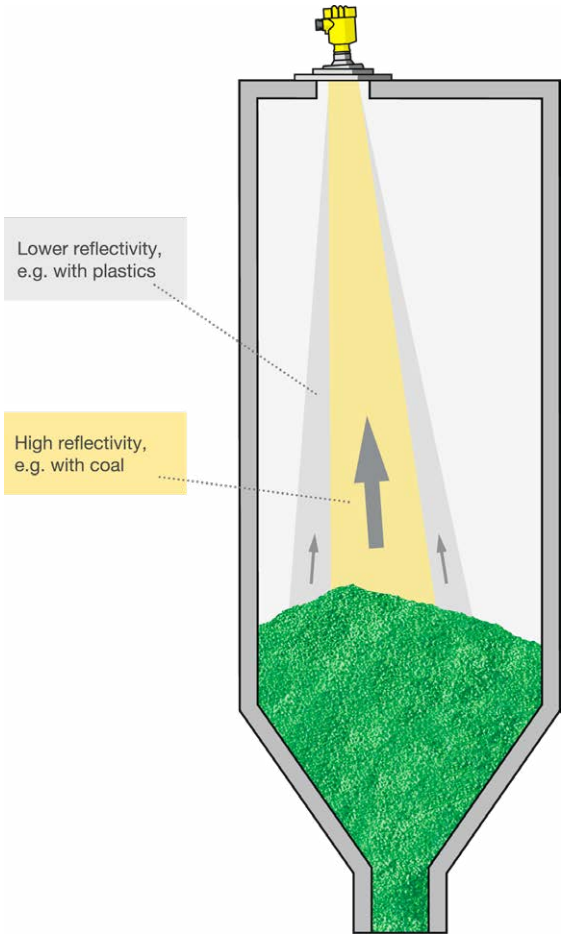
Many factors determine a returned radar signal's strength. Buildup on the antenna

POLYETHYLENE SILOS
Figure 3. The narrow focus of an 80-GHz transmission frequency works well for use in the narrower dimensions of polyethylene silos.

and poorly reflective materials both can influence the return signal, making it difficult to get a precise measurement.

The 80-GHz transmission frequency has a number of benefits, but when it comes to polyethylene silos (Figure 3), which typically are tall, narrow vessels, the narrow focus is especially helpful. The microwave beam's focus depends on a radar transmitter's antenna size and its transmission frequency. As the antenna or the frequency shrinks, the wider and less focused the beam becomes. Conversely, if the antenna or the frequency grows, the beam becomes narrower and more focused. The VEGAPULS 69's beam angle is anywhere between 7° and 14° with process fittings ranging from 3 to 1½ in., giving a range of possibilities for silos of any dimension.

Conductive products reflect almost all microwave energy, but nonconductive products with low dielectric constants, like polyethylene, reflect only a portion of the energy (Figure 4). This means there's a weaker signal from the surface of the product inside the silo. To combat this, some radar sensors use a higher dynamic range. The dynamic range is the measure of which signals a radar sensor can detect, meaning sensors with a large dynamic range are sensitive enough to register weak signals as well as strong ones. This radar sensitivity varies across manufacturers and even among a single manufacturer's instrument line.



REFLECTIVITY
Figure 4. Conductive products reflect almost all microwave energy, but non-conductive products with low dielectric constants, like polyethylene, reflect only a portion of the energy.

This higher sensitivity may lead users and technicians to think a more sensitive radar would be more susceptible to buildup on the sensor itself. Some radar sensors can prevent this by using software to filter out signals the buildup causes. Users can then measure the product as though the sensor is buildup-free.

MORE EFFICIENT OPERATION

Managing polyethylene flake and pellet inventory is now more simplified and more economical with 80-GHz radar. The VEGAPULS 69 can track the level inside the fluff silo accurately before the extruder step and inside the storage silos before shipping. Installation is significantly less expensive than weigh scales, and, in most cases, these sensors can be installed and commissioned without a plant shutdown.

After it's installed, the amount of maintenance and cleaning required for one of these radar sensors is nearly zero, even in the presence of buildup. Recent 80-GHz radar instruments are more focused and more sensitive with more intelligent software than previous versions, allowing users to monitor polyethylene levels effectively and with confidence all throughout the process. ●

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