Flexible Bulk Containers

A practical guide to flexible bulk containers, covering the reader intent, the relationship to flexible bulk containers, key evaluation criteria, common risks, and the information the intended project audience should confirm before taking the next step.

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Flexible Bulk Containers (FIBCs), commonly known as big bags or bulk bags, have become a cornerstone of modern industrial logistics. These standardized containers, typically made from woven polypropylene (PP), are designed to transport and store dry, flowable products ranging from fine powders like flour and cement to granular materials like plastic resins and minerals.

In industrial automation, managing the inventory within these flexible bulk containers presents unique engineering challenges. Unlike rigid silos or metal tanks, the geometry of an FIBC changes during the filling and discharging process. For engineers and plant managers, selecting the correct level measurement technology is critical to prevent overfills, ensure a steady supply to downstream processes, and optimize warehouse space. This guide explores the principles of level measurement within the context of flexible bulk containers and provides a framework for selecting the right instrumentation.

Level Measurement Principles for Bulk Solids

Before selecting a sensor for flexible bulk containers, it is essential to understand the physical principles governing level detection in solids. Bulk materials do not behave like liquids; they have an angle of repose, varying bulk densities, and often generate significant dust during movement.

Radar Level Measurement (Non-Contact)

Radar level transmitters operate on the Time-of-Flight (ToF) principle. The sensor emits a high-frequency electromagnetic wave (typically in the 26 GHz or 80 GHz range) toward the material surface. The wave reflects off the product and returns to the sensor. The distance is calculated based on the time it takes for the signal to travel to the surface and back.

In the context of flexible bulk containers, 80 GHz radar is often preferred. The higher frequency allows for a narrower beam angle, which is crucial when measuring through the narrow filling spouts of an FIBC. Radar is largely unaffected by dust, temperature fluctuations, or the air movement common during pneumatic filling.

Ultrasonic Level Measurement (Non-Contact)

Ultrasonic sensors also use the ToF principle but utilize sound waves instead of electromagnetic waves. A transducer emits an ultrasonic pulse that reflects off the material surface. While cost-effective, ultrasonic technology has limitations in FIBC applications. Sound waves can be absorbed by soft, porous powders, and heavy dust clouds can attenuate the signal, leading to measurement errors. However, for non-dusty granules in stable environments, they remain a viable option.

Point Level Detection (Contact)

Point level sensors do not provide a continuous percentage of fill but rather indicate when the material has reached a specific height.

1. Rotary Paddle Switches: A small motor drives a paddle. When the material reaches the paddle, it stalls the motor, triggering a switch. These are robust and ideal for heavy materials.

2. Vibrating Level Switches (Tuning Forks): The sensor vibrates at its resonant frequency. When covered by material, the vibration is dampened, which is detected electronically. These are highly sensitive and suitable for light powders.

3. Capacitance Probes: These measure the change in electrical capacitance between the sensor probe and the container wall (or a reference electrode). Because FIBCs are non-conductive, capacitance probes often require a specialized setup or are used primarily for proximity detection through the bag wall.

Challenges Unique to Flexible Bulk Containers

Measuring levels in FIBCs is more complex than in rigid vessels due to several factors:

Structural Instability: As an FIBC fills, it expands and rounds out. During discharge, it may collapse or "bridge." This movement can shift the target surface away from the sensor's vertical axis.

Dust and Static: The process of filling flexible bulk containers often generates high levels of dust and static electricity. Static can cause fine powders to cling to sensor faces, while dust can interfere with optical or ultrasonic signals.

Filling Spouts: Most FIBCs are filled through a narrow neck. Mounting a sensor so that it has a clear "view" of the material without hitting the sides of the spout requires precise alignment.

Material Coning: Dry solids form a cone when poured. A sensor mounted directly over the center will record the peak, while a sensor at the edge will record the lowest point. This must be accounted for in volume calculations.

Selection Criteria for FIBC Level Sensors

When evaluating instrumentation for a project involving flexible bulk containers, consider the following criteria:

Criteria	Radar (80 GHz)	Ultrasonic	Rotary Paddle	Vibrating Fork
Measurement Type	Continuous	Continuous	Point Level	Point Level
Dust Tolerance	Excellent	Low to Moderate	High	High
Accuracy	±2 mm (0.08 in)	±0.25% of range	N/A	N/A
Mounting Ease	Moderate	Easy	Easy	Easy
Material Density	Any	> 100 kg/m³	> 100 kg/m³	> 5 kg/m³
Cost	Higher	Moderate	Low	Moderate

For comprehensive technical specifications and to explore specific models for your application, visit the Main Page of our product catalog.

Installation Considerations

Proper installation is the most significant factor in the reliability of level measurement for flexible bulk containers.

Mounting on Filling Heads

In many automated lines, the sensor is mounted on the permanent filling head rather than the bag itself. The sensor must be positioned to avoid the direct path of the falling material. If the material hits the sensor signal, it will cause a false "high" reading. Using a radar sensor with a narrow beam angle (e.g., 3 degrees) allows for mounting closer to the filling pipe without interference.

Proximity to Bag Walls

Because the walls of flexible bulk containers move, sensors should be mounted with sufficient clearance. If a radar beam is too wide, it may reflect off the moving polypropylene fabric, resulting in "ghost" echoes.

Grounding and Static

Since FIBCs can accumulate significant static charges, especially when handling combustible dust, sensors should be properly grounded. In hazardous environments, ensure the instruments are ATEX or IECEx certified for dust ignition protection.

Limitations and Common Risks

While modern sensors are highly capable, certain conditions can still lead to failure:

1. Signal Absorption: Extremely low-density powders (less than 50 kg/m³) may not reflect enough radar or ultrasonic energy for a reliable reading. In these cases, weight-based measurement (load cells) may be a necessary supplement.

2. Bridging and Rat-holing: If the material sticks to the sides of the FIBC and forms a bridge, the sensor may report that the bag is full even if the bottom has been discharged. Point level sensors installed at the discharge spout can help verify flow.

3. Vibration: If the FIBC is on a vibrating table (used to de-aerate and settle the product), the vibration can interfere with the electronics of some point-level switches. Heavy-duty vibrating forks or rotary paddles are usually required here.

Frequently Asked Questions (FAQs)

Q: Can I measure the level through the wall of the flexible bulk container?

A: Yes, certain high-frequency radar sensors and capacitive proximity switches can "see" through the polypropylene wall of an FIBC, provided the material inside has a significantly different dielectric constant than the plastic and the bag is not foil-lined.

Q: How do I handle the dust generated during the filling of powders?

A: Radar is the most effective solution for dust. If using ultrasonic sensors, ensure the sensor has a high power output and a self-cleaning face, though results may still be inconsistent during peak dust events.

Q: What is the best way to calculate the volume of material in an FIBC?

A: Because the bag shape is irregular, volume calculations based on height are estimates. For high-precision inventory, combining a continuous level sensor with a load cell system (measuring weight) provides the most accurate data.

Q: Do flexible bulk containers require specific sensor certifications?

A: The container itself does not, but the environment often does. If the material is flammable (e.g., sugar, flour, certain chemicals), the sensor must be rated for the appropriate hazardous zone.

Conclusion

Implementing effective level measurement for flexible bulk containers requires a balance between technology choice and physical installation strategy. While radar offers the highest reliability in the presence of dust and narrow filling constraints, point-level switches provide essential overfill protection at a lower cost. By understanding the material characteristics and the mechanical behavior of the FIBC, engineers can design systems that minimize waste and maximize process efficiency. For further assistance in selecting the appropriate instrument for your specific industrial application, please refer to the Main Page for detailed product support and engineering resources.