Solids level detection – what method is best?

Questions have crossed my desk recently specific to solids level detection applications. People ask why I recommend rotary-paddle technology so often. The answer is simple, once you understand how each available technology fits into the application map.

We're talking about detecting the presence or absence of material in predetermined locations, such as for high- or low-level indication and control. In these point-level detection applications the primary technologies available for solid materials — powder or granular — include rotary paddle, RF admittance/capacitance, vibrating element, capacitive proximity sensors, pressure-sensitive diaphragm switches and tilt switches.

Point-level detection application characteristics fall into two categories: i.e., those related to installation and process, and those related to material characteristics, including temperature; mounting location; material bulk density, particle size and dielectric constant; and abrasion, corrosion and adhesion properties.

Process/installation issues

Temperature has the most impact. Most bins and silos are vented to atmosphere and only see pressures above atmospheric during pneumatic filling and thus are at ambient or very low gage pressure levels.

Process or internal bin temperatures range from ambient to 500 F or higher. Process or internal bin temperature impacts the ambient temperature seen by the level detector, especially when electronics or electrical devices are close-coupled to the invasive sensor and enclosure mounted to the vessel wall. Review the process/ambient temperature ratings for the technology choices considered.

Mounting location impacts sensor technology choice as well: 1) Will there be material "run-off" to consider that impacts the exact sensing location? 2) What is the required response time from the sensor? 3) Does the sensor mounting location imply a maximum size for the sensor? A final point is to verify no vessel-mounted items in close proximity to the sensor would damage it.

Material characteristics

Material related considerations that are relevant when choosing a point level sensor include bulk density, particle size, dielectric constant, corrosion, abrasion and adhesion.

Bulk density is the weight of the material per unit volume and is generally stated as loose bulk density or packed bulk density. Loose bulk density is more applicable for high-level detection. Packed bulk density is appropriate for low level detection where material is generally packed, due to material weight above the low level point.

No matter the bulk density, two issues need be considered in regard to point technology selection. First, some technologies respond to material density as part of the sensor method of operation. These technologies include the rotary paddle, vibrating element and the pressure-sensitive diaphragm switch. For example, the selection of the paddle for a rotary paddle bin level indicator determines the material bulk density range in which the unit will function properly. In the case of vibrating element units there is a minimum bulk density that the mechanical resonance system will respond to. And in the case of a pressure sensitive diaphragm switch there is a minimum density to depress and activate the diaphragm switch. Knowing the true bulk density and understanding how each technology responds to various density ranges can be the difference between technology success and failure.

The second issue regarding the material bulk density involves the long-term reliability of the sensor device. Heavy materials can sometimes damage the invasive sensor, especially vibrating element and diaphragm switch units. Installing level detection sensors out of the material flow and using protective shields to keep material from falling directly on the probe may be required for some or all sensor technologies.

Particle size, etc.

Particle size is less an issue. The larger the particle size, the more impact the material has on the sensor. Large, irregular-shaped granular particles can damage sensor elements or leave large air gaps in contact with the sensor probe in between particles, thereby lowering the

material's effective dielectric constant, which may impact operation of an RF capacitance type sensor. The lower the materials dielectric constant the more difficult it can be to sense.

Materials or applications with effective dielectric constants below 2.0 may be challenging for certain devices or brands. Also, in applications where the dielectric constant may change, the RF capacitance sensor may require recalibration.

Sensor construction materials can impact whether material being detected will cause significant corrosion or abrasion to occur on the invasive sensor element. Chemical compatibility tables can be consulted. Abrasion, the wear of one material on another, is more difficult to assess. The harder the material, the more abrasion can occur. Understanding material hardness, as well as application flow dynamics, helps in evaluating abrasion concerns.

Adhesion denotes the ability of two unlike substances to stick to each other. The more likely it is, the more problems may exist for certain sensor technologies, including vibrating element, capacitive proximity switches and diaphragm switches. If the material is dry and freely flowing then adhesion will not likely be an issue. If the material does not adhere to the vessel walls then the material is not likely to stick or build up on the sensor probe. If the material is not dry, doesn't flow freely and builds up on the vessel walls, then the above named technologies should be avoided.

Conclusion

Point level sensor applications in powder and bulk solid materials handling can be critical to the safe and efficient operation of your process. High-level detection devices control a vessel filling process, preventing overflow, which can otherwise impact safety and cost thousands of dollars in clean-up, production downtime and loss, if the sensor does not operate properly. Low-level sensing applications help prevent production shutdown due to material outages and can be used to alert the need for timely filling.

Choosing the most appropriate level detection technology is important. Why do I recommend the rotary paddle device so often? Based upon all the application criteria that needs to be considered, the rotary paddle level detector is the most universal and cost-effective device. It is compatible with a wider range of powders and granular materials, is universal in its range of bulk densities, is insensitive to dielectric constant, operates in a wide range of environments including very high temperatures, and uses materials of construction that are very corrosion and abrasion resistant and are typically of a food grade nature. The rotary paddle is still the king of the bin, while the vibrating element and RF technologies are the crowned prince and princess, in my humble opinion.

For more information about vibrating element sensors, rotary paddle bin level indicators, RF admittance/capacitance sensors and their application, go to www.blueleveltechnologies.com. Follow BlueLevel on Twitter @BlueLevelTech and check out their Facebook page at http://www.facebook.com/pages/BlueLevel-Technologies/97182916337. Their Expert's Blog is at www.blueleveltechnologies.com/blog.