The Sensor Is Not Always at Fault

Sometimes 'the process' makes it impossible for the level sensor to function properly. Such a situation was at the heart of the problem for a manufacturer that relied on hydrated lime as a scrubbing agent

'The hydrated lime absorbed contaminants from the exhaust gases. The result was a dramatic change in the dielectric constant.' By Joe Lewis

A level sensor protects dust-collection bags from damage by alarming and indicating a high level condition in the hopper of the collector baghouse if material backs up.

The sensor gets blamed for many problems faced at process plants around the world. It's often blamed by the controls engineer, process engineer and even maintenance technicians. Sometimes the blame is deserved, but is it always a sensor problem? Not necessarily. Let's look at an application where "the process" was associated with the root cause of the inability of a level sensor to function as desired. In our example, a manufacturer of construction materials uses hydrated lime as a scrubbing agent on the hot exhaust gases from the process. This is a typical use of hydrated lime. The lime reduces the pH of the exhaust gas and absorbs contaminants. The spent lime is reclaimed through a dust-collection system where the internal temperature can reach as high as 400&#176F (205&#176C). A level sensor is used to protect the very expensive dust-collection bags from damage by alarming and indicating a high level condition in the hopper of the collector baghouse if material backs up. Given the high temperature and high vibration at the sensor mounting location, and the fact that hydrated lime is known to have a dielectric constant of approximately 4.8, a split-architecture RF capacitance sensor was chosen. RF capacitance point-level sensors are generally very reliable. The state of the art today utilizes microcontroller technology, universal power-supply techniques, industrial and mil-spec grade components and surface-mount electronics. The resulting sensor has high sensitivity (0.5 pF) and automatic buildup immunity, and it also can survive in some of the harshest environments, including internal bin temperatures up to 400&#176F (205&#176C), on a routine basis. Level sensors of the RF capacitance variety operate by monitoring the change in resulting capacitance at and around the sensor probe. This change occurs due to the presence or absence of process material. It is important to understand that the dielectric constant of the target process material impacts success or failure for this type of level sensor. During initial setup, an adjustment is made in the sensitivity setting of the RF capacitance level sensor. This sensitivity is set based on the minimum change in capacitance that the unit will detect. The change in capacitance produced by the presence of the target material depends on its dielectric constant. The higher the dielectric constant of the material, the greater the capacitance change will be. Therefore, materials with high dielectric constants produce large changes in capacitance and require lower sensitivity in the sensor. Materials with

low dielectric constants require higher sensitivity in the sensor. An additional characteristic of RF capacitance level sensors is their response to accumulated material adhering to the sensor probe. Hydrated lime in this situation agglomerates on the probe. This requires an RF capacitance level sensor with special circuitry to ignore the presence of material buildup on the probe. Most RF capacitance level sensors can provide immunity to material buildup using some technique, typically that of a "driven shield." Driven-shield technology introduces an additional RF signal at the probe that repels the return signal from the active sensor probe through material buildup. However, the degree of success of buildup immunity technology depends on the amount of buildup and the conductivity of the buildup. Buildup immunity techniques reach their limit with highly conductive materials. Now, what happened in our example application? The processor manufactures two distinct types of product. The dust-collection system is designed to operate identically no matter what product is made. Soon after the dust-collection equipment was installed, the level sensors reportedly "failed to detect the material" and the material backed up in the baghouse hopper. The condition was caught and the baghouse cleaned out. Adjustments were made to the sensor settings by plant and other personnel but no acceptable results were obtained. Eventually, the situation was brought to the attention of the level-sensor manufacturer, and they responded immediately by sending a service technician on-site. The root cause was quickly uncovered. The level sensors were functioning properly and according to specifications. However, the process was unknowingly creating a situation that resulted in the problem. During the manufacturing process, the hydrated lime absorbed contaminants from the exhaust gases. The result was a dramatic change in the dielectric constant of the hydrated lime. With product "A," the resultant dielectric constant of the post scrubbing lime was a low 1.6. When product "B" was manufactured, the gases from this manufacturing resulted in a dielectric constant of more than 65. With product "B," the lime had become conductive. This dramatically changed the face of the application insofar as it impacts RF capacitance level-sensor technology. The application required an RF capacitance level sensor to detect target materials with both 1.6 and greater than 65 dielectric constants &#151 both ends of the dielectric spectrum. In addition, the tendency of the target material to agglomerate on the probe had to be addressed. Handling all of this together with an RF capacitance sensor with a single sensitivity setting was not possible. If the sensitivity was adjusted to reliably detect the low dielectric material, the buildup of the high dielectric conductive material created false signals. If the sensitivity was set low to detect the high dielectric conductive material reliably, then low dielectric material would not be sensed. While it is practical for an RF capacitance level sensor to detect changing materials within the same vessel, the variability of dielectric constant in this situation was extremely wide. RF capacitance units are not the best choice for widely changing dielectrics or highly conductive materials. In addition, the material agglomerates on the probe, which further complicates the situation. However, the level sensors did not fail to operate. It was an unknown in the process &#151 the fact that the dielectric constant of the hydrated lime was changed widely by the scrubbing process for each of the two products manufactured &#151 that ultimately led to the problem. While a solution for this specific application has been found, fully understanding the characteristics of the materials to be detected is essential to identifying the correct choice of level sensor the first time, in every application. *Joe Lewis is the vice president of*

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