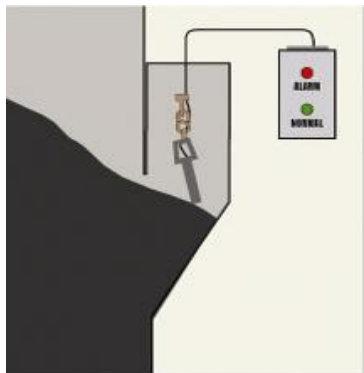


Tilt Switches Come of Age

Technology Review White Paper

The Tilt Switch has been used for high level detection of bulk solid materials for decades. This device is simple to understand and apply. It has relatively good life and reliability when properly applied. Most devices have been based on mechanical means of actuation or on the use of mercury-switches to sense the presence of the material. Recently this technology came of age and the potential for its use is greater than ever.

The Tilt Switch is a level sensor is most commonly used for high level detection of bulk solid materials in open piles (Figure 1) and silos. Due to their principle of operation they are not typically used for low level detection applications, but this is also possible when installed in a bypass chamber (Figure 2). A specialty application includes plugged



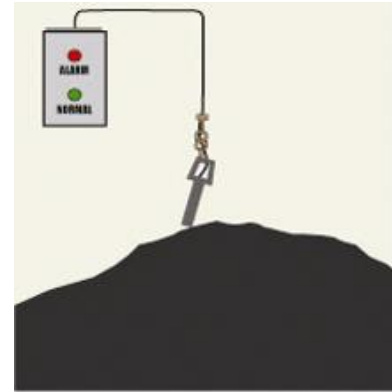
Low Level

Figure 2: Low Level Application

chute detection (a form of high level) and being used to detect material flow on a belt conveyor (a form of high level). Refer to Figure 3. Most applications exist either with aggregate material or in large grain storage silo applications.

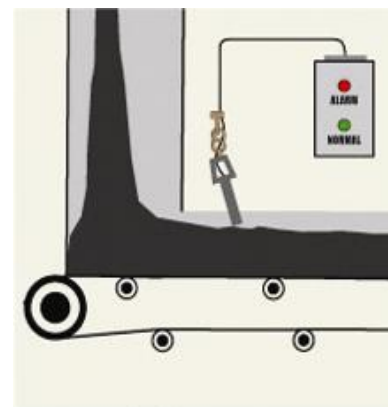
Principle of Operation

The Tilt Switch is used to detect a pile of material by sensing the tilt condition of a sensor probe. The Tilt Switch is commonly suspended over a pile of material. As the pile accumulates and builds it eventually contacts the tilt switch. As the pile continues to build it moves the Tilt Switch out of its normal plumb position. When the Tilt Switch is tilted 15° the output from the unit indicates material presence. Conversely as the material level decreases the Tilt Switch will eventually return to its normal plumb state and when the unit returns to a tilted position less than the 15° its output will indicate a normal condition.



High Pile

Figure 1: Tilt Switch Used to Indicate High Level in an Open Pile



Material Flow

Figure 3: Material Flow Indication on a Belt Conveyor

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In a material flow application the Tilt Switch is suspended over the belt conveyor at a height that will allow the unit to tilt the required 15° when the normal pile of material on a moving conveyor is present. When the flow of material onto the belt at its source is stopped the level of material on the belt reduces below the normal flow condition level and the Tilt Switch returns to a tilt position less than 15° and eventually to its plumb position.

In the past there have been two types of Tilt Switches. One type is activated mechanically where internal to the Tilt Switch probe a steel ball centers itself over an electrical switch resulting in switch actuation. Refer to Figure 1. When the Tilt Switch probe is adequately tilted by the presence of the material pile the steel ball rolls off the electrical switch plunger and the electrical switch position is reversed. The advantages of this design is the non-mercury switch nature of the sensor, however, the disadvantage of these probes are not available for hazardous location use because of the 15A switch rating at up to 250VAC. This rules out grain elevator use, some mining applications and anywhere the electrical classification is hazardous for dust or vapor. These Tilt Switches are standalone and are not available with local control and indication devices. The output has such a high current rating that they may be used to switch process equipment on/off as well as to signal alarm systems, lights, as well as for input to a PLC or control system. However, the switch rating is over-rated for most of these uses.



Figure 4: Tilt switch uses encapsulated mercury-switch

and it is “open” when the probe is tilted 15° by the rising pile of material. These Tilt Switch probe elements are nearly always used in conjunction with a control unit that interfaces with the probe and provides local visual indication as well as the electrical output of the Tilt Switch.

The control unit provides 15VDC signal voltage to the probe. This low level voltage allows the probe to be certified as intrinsically safe for use in hazardous dust locations when combined with a control unit that also includes an intrinsically safe probe interface. The power supply for the control unit is typically line powered 115 or 230VAC. The control unit will indicate normal or vertical Tilt Switch position with a green light and indicate the alarm or tilted position with a red light. The control output is a relay output with time delay settings and capable of 5A @ 250VAC for signaling or input to a PLC or other type of control system.

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Recent Developments – Eliminating Mercury Switches

The most recent advancement in Tilt Switch point level monitors appeared early in 2008 when a mercury-free Tilt Switch with solid state circuitry was introduced. Refer to Figure 3. While the mechanical actuated Tilt Switch mentioned previously is mercury-free, it is not solid state and does not fit the traditional split-architecture configuration offering a separate probe and control unit.



Figure 2: Mercury-Free Tilt Sensor (MFTS) and Control Unit

The advantage of this latest development is that the mercury-free solid state Tilt Switch will appeal to environmentally conscious users that do not want the mercury switch based devices within their facility. Disadvantages of the mercury-free tilt switch include an apparent 10% premium and a probe element that cannot be used without the control unit. The mechanical and mercury switch based designs can interface probe elements direct with a PLC or control system. This may prove to be a minor issue and offers room for product evolution to meet user demand.

Conclusion

The Tilt Switch serves a vital role within the technology mix for point level monitoring of bulk solid materials. According to market study reports nearly 10,000 Tilt Switches are sold worldwide and that number is growing at a higher rate than for all other point level technologies for powder and bulk solids! That is an amazing claim. Are the market reports correct? Perhaps it is. There has been a great boom in the global growth of automation within the mining and aggregates industries and this may be a driving cause.

With the advent of viable mercury-free switches becoming available there may be even greater opportunities to use these switches for more high level detection applications within large grain elevators. However, a cost-effective Tilt Switch probe with a direct interface between a non-mercury intrinsically safe, or Class II rated, probe and the PLC control system will be needed to maximize its applicability. The Tilt Switch should certainly be considered for virtually any high level application whether open pile, silo for aggregates, whole grain and almost any other type of bulk solid material.