On the level

Adrian Morris of Synatel looks at some of the many principles by which fixed point level detection can be achieved

Anywhere materials are being conveyed, transported, mixed or stored, there is a need for some form of level control. In some cases, continuous level control is required but the workhorse of the industry is the fixed point level indicator. This article looks at some of the many principles by which fixed point level detection can be achieved and the advantages and disadvantages of each method.

It concludes with details of a brand new approach which it is believed will handle a wider variety of applications than any other level probe principle with a high degree of reliability.

Firstly, the capacitive proximity sensor is now extremely popular, providing low cost, highly reliable detection in simpler applications. Usually self contained, these units have no moving parts and a single adjustment. They are available as two lead universal voltage sensors making them ideal replacements for old electro mechanical sensors with a simple mechanical switch output. They are also available with 3,4, or 5 wire outputs the latter incorporating a relay. Proximity Sensors are ideal for use in smaller containers and in applications where dust or material builds up is unlikely, as they cannot differentiate between product and dust or build up. Typical applications occur in seed treatment plants, and plastic granule hoppers for moulding machines.

Capacitance proximity sensor with protective sheath

In more arduous applications, these devices can still be used fitted within a plastic sheath or pocket to avoid abrasion. This is an important consideration because the electronic circuitry is contained within the body of the unit, most of which is inserted into the bin. Protection of the sensor is particularly important in applications where combustible dust may be present. These areas may well be certified as ATEX zone 20 (continuous hazard). Whilst the sensor may carry approval to 1D and hence be suitable for the zone, if the enclosure of the sensor (usually plastic) is worn away by passing material, internal circuitry, sometimes at mains potential, can be exposed.

Capacitance level probe

A further popular method of installing capacitive sensors is by fitting polycarbonate windows into the hopper wall and installing the sensor outside pressed against the window. This method has the benefit of removing the risk of abrasion and allowing visual inspection of the bin contents.

Using a similar principle but totally different in operation are radio frequency capacitance probes. These units generally have all of the electronic circuitry external to the bin and housed in a tough enclosure. Process parts are generally of solid stainless steel and plastic making them immensely strong and suitable for the most arduous environments. They are very adaptable, probe rods can be cut, extended or modified to suit the application. Units are now available with digital displays to aid calibration and show process parameters. Some incorporate automatic or semi automatic adjustment. Years ago, capacitance probes were considered unsuitable for applications where sticky products could adhere to the probe.

Many manufacturers now incorporate an electronic shield which eliminates the effect of material adhesion and this type of probe is now suited to most applications. Perhaps its biggest disadvantage is that non electrical users tend to regard it with some suspicion. "It doesn't move how it can work" Once people have used capacitance probes they often standardise on them for all applications.

Tuning fork or vibrating probes have also been widely used. These consist of either twin tubes (tuning fork) or a coaxial probe having one tube inside another. In both cases the principle is similar. One probe vibrates at high frequency and the vibration is picked up by the other which vibrates in sympathy. When covered with material, the vibration is damped and hence presence of material is detected.

Coaxial versions tend to have more general appeal as material can jam in the forks of the tuning fork version. In both cases however they have the benefit of no moving parts and no user adjustments. They are "fit and forget" devices with a long life expectancy. Their disadvantages are that the probe length cannot easily be altered by the user and by their nature, they are inherently less robust than many other types. In some applications material adhering to the forks will prevent vibration and give a false signal. In others, light material may not damp the vibration thus failing to detect the product. In these cases, lack of adjustment can actually be a major disadvantage.

Finally rotating paddles are perhaps the most common method of level detection They are available from many manufacturers and range in price from very low cost to extremely expensive depending upon quality and features. In their simplest form, they consist of a geared synchronous motor and clutch mounted on a spring loaded quadrant arm, which is in contact with either of two micro switches. The motor drives a shaft fitted with a paddle. When no material is present the arm is held against one micro switch by the spring and the motor turns freely. When material covers the paddle and jams it, the motor continues to turn forcing the quadrant arm to move against the spring away from the first micro switch thus giving a "probe covered" signal. The motor continues to rotate, eventually operating the second micro switch which cuts motor power. The system remains in this state until material falls away from the probe. The spring then pulls the quadrant arm back, reconnecting motor power and operating the first micro switch to indicate "uncovered". The process then repeats.

Step-a-Matic rotary level probe

Rotary level probe

One problem with this simple system is that should the motor / gearbox / clutch fail, the system will show a healthy state until the bin overfills. This can be overcome by monitoring rotation of the motor using an electronic sensor. If the motor stops without material present the quadrant arm will be in the rest position, and a simple logic circuit detects a fault and gives a "covered" signal. The addition of electronic circuitry also allows this type of unit to operate on 24v dc or 110/ 230v ac supplies rather than a single supply

Paddle probes have been produced for many years and can be very reliable. However, until recently, they have always contained a motor / gearbox and often a protective clutch in case the paddle is forced to rotate by passing material. Gearboxes and clutches are frequently prone to failure.

Recently, a new patented paddle probe has been launched by Synatel which uses a direct drive stepper motor connected directly to the paddle. This eliminates both the gearbox and clutch making the product virtually indestructible. It also allows paddle rotation both clockwise and anticlockwise to avoid compaction of material against bin sidewalls and the paddle also "shakes" to shed unwanted material. There is no quadrant arm, the motor position being fixed. Rotation and hence presence of material is detected by electronic circuitry. Torque control allows a single paddle to be used regardless of material density and the unit will operate on virtually any supply.

The system is more expensive, but provides reliable, fail safe operation for virtually any material and has a life expectancy running to decades.

In conclusion, there are a wide variety of probes available to suit every budget and every application. Modern electronic design and manufacture means that these products are inherently very reliable under the correct operating conditions. They need however to be matched carefully to the application. Often, a little extra spent at the outset will pay huge dividends over a products life.

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