Radar, Ultrasonic and RF Level Transmitters

Both measures the time it takes the wave to travel between the transmitter and that reflected wave off the surface of the material to reach the transmitter again.

Radar

OHMART VEGA

Endress+Hauser ... Non-contact with microwaves for all liquids, and extreme process conditions such as product changes, out-gassing, vapours and vacuum.

Microwaves are hardly affected by temperature, process pressure or the composition of gases. ... pulsed time-of-flight principle ... has communication approvals and can be also used in hazardous areas.

Temperature / pressure limitations:
  Temperature up to 400°C
  Pressure up to 100 bar

Relative dielectric constant (dk-value) of the medium is important for this measuring principle.

Very popular, does not require extensive, expensive piping to install.
Endress+Hauser … all solids and liquids applications (in hazardous areas) is available that facilitates continuous, non-contact ultrasonic measurement of level.

Temperature / pressure limitations:
- Temperatures up to 150°C
- Pressure up to 3 bar

Unaffected by vapor pressure and product dielectric constant.

Watch the temperature specification of both these devices!
RF (Capacitance) Level Transmitter

As the media rises and falls in the tank, the amount of capacitance change between the probe and the ground reference also rises and falls. The electronics convert this capacitance change into a continuous level measurement.

The amount of capacitance developed in any vessel is determined by the size (surface area) of the probe, the distance from the probe to its ground reference, and the dielectric constant of the medium being measured. Considering that the probe’s mounting position is fixed and the dielectric of the medium is constant, then the amount of capacitance developed in a vessel becomes dependent upon the amount of the probe that is covered with media.

As the media rises and falls in the tank, the amount of capacitance developed between the probe and the ground reference also rises and falls. A circuit mounted on the probe changes the capacitance signal to a digital waveform proportional to the change in level. The amplifier then converts this digital signal into an isolated 4-20mA analog output signal.

MAGNETROL

Note: Signal can drift if the probe becomes coated or bridged at the top connection with process material, problems with slurries. Some probes have circuits that compensate for coatings, however not all coatings behave the same!
Displacer Level Transmitters

A displacer is buoyed by a force equal to the weight of the displaced fluid; Academies Principal.

Fisher type DLC3000 Series digital level controllers are loop-powered instruments. In conjunction with a displacer-type sensor, they measure changes in liquid level, level of an interface between two liquids, or density of a liquid. A level, density, or interface level change in the measured fluid causes a change in the displacer position. This change is transferred to the torque tube assembly and to the digital level controller lever assembly. The rotary motion moves a magnet attached to the lever assembly, changing the magnetic field that is sensed by the Hall-effect sensor. The sensor converts the magnetic field signal to a varying electronic signal, which is converted to the 4 and 20 mA digital level controller output signal.

The 249 Series Displacer can be Contained in a Rugged Cage for Mounting on the Side of a Tank, or the Displacer can be Suspended in a Tank without a Cage. Displacer length standard 14, 32, 48, 60, 72, 84, 96, 108, 120 inches; Volume 100 in^3 Lead shot placed in displacer tube to produce extra weight. Been in use for many years. The displacers can be fabricated out of many different materials. If the displacer has a leak, the displacer will sink, causing the signal to read low which creates a false reading. Need to back up with a separate level switch device.
Purge Pipe Level Transmitters

Perhaps the most common level transmitter is a purge pipe. This instrument makes use of a differential pressure transmitter measuring the difference between the back pressure created through a gas bubbling out of a pipe inserted in the tank and the tank’s head space.

Most of the problems with these instruments are as a result of improper installation. Many newer types of level instruments, such as radar and ultrasonic, are used where purge instruments fail to perform. Many of these installations are not necessary. Proper installation requires that:

The pipe, typically 1-inch schedule 80, must have a slot, or preferably several slots, at the end of the pipe. The idea is to sparge or create small bubbles of gas at the end of the pipe. If a large bubble occurs, the pipe will tend to plug because when the bubble collapses, the liquid enters the inside of the pipe and solids build up there. An older instrument publication detailed a short length of a larger diameter pipe at the end of the purge pipe with several ¼-inch slots.

The gas flow should be flow controlled to the pipe. This should be done with a constant flow controller or regulator rather than a needle valve. Without a flow controller, the needle valve will act as the only restriction and as the level increases, the flow will be reduced. Make sure the flow regulator can compensate for variable downstream pressure variations. This is what will be measured.

For aqueous slurry applications, a dry purge gas will cause caking across the end of the purge pipe. This is because the gas will dry out the slurry at that point. One way to prevent this is to purge a small quantity of water and mix it in with the purge gas. The moist gas will prevent the caking.

Placement of the low-pressure port is important too. It must measure the head space and not the outlet pressure piping. Frequently the off gas line pressure is made because no nozzles are available on the tank. This example shows the problem with this method. Assume a 6-inch schedule 10 pipe with a vapor flowing at 100 feet per second outlet velocity. A sudden contraction is assumed to be the only restriction.

From the CRANE manual:

\[ Y=1; \quad d=6.357; \quad K=0.78; \quad V=5; \quad vel=100; \quad A=0.2204; \]
\[ w=vel*A/V \quad w = 4.4080 \]
\[ dP=27.67*K*V*(w/(0.525*Y*(d^2)))^2 \quad dP = 4.6583 \quad \text{inches of water} \]

This difference is enough to cause false readings, premature alarms and interlock trips.
1" Sch 80 Pipe

Level Purge Pipe System

to D/P Transmitter

High Port

Low Port

Purge Gas Supply

Constant Purge Gas Flow Controller/Regulators

Add a small water purge to high side for slurry service

High side is the longest above the flange

Bore straight through the blind flange, back weld

Purge Gas Supply

1/4" V notches, to create small bubbles

1" Sch 80 Pipe
Use an integral flow controller to control the rate of gas purged through the pipe.

Brooks® flow controllers are designed to maintain a constant differential pressure across an integral manual flow regulating valve. An internal diaphragm-actuated control valve is positioned by the incoming fluid pressure on one side of the diaphragm, and outlet pressure plus spring action on the other side. Variations in the supply and/or discharge pressure disturb the balance of forces on the diaphragm, causing the control valve to open or close, thus maintaining a fixed differential across the manual flow regulating valve.

The Series 8800 controllers are designed for all liquid and gas flows with constant downstream pressures; Series 8900 controllers are for all liquid and gas flows with constant upstream pressures.

Fabrication of these instruments is a lost art. Many of the older purge pipe systems have been substituted with newer radar or ultrasonic instruments because one or some of the installation details were not followed.