Level Measurement - Continuous

Some indicators like the Gefran 40 series have 32 point linearisation as a standard feature for visualisation and retransmission

Exactly how much do we have?

Whether we are talking about solids or liquids, it is the amount of material stored in a tank, silo or hopper that is important to a business. For the CFO this represents raw materials, works in process or finished goods, and the value can be very significant, and close control makes good business sense. For the Plant Manager it is necessary to be sure that raw materials are available for production, and for a Sales Manager finished goods have to be available for sale or for completion of supply agreements.

When we talk level, we are talking about material in a container, and this can be any size or shape. The contents can be determined by measuring the level and then calculating the contents based on the tank shape and material density.

It is feasible to weigh the vessel and contents and determine the contents by subtracting the weight of the vessel from the total weight - and this is done for high value materials - but the equipment is expensive and difficult to implement.

You will see from this Newsletter that there are different competing technologies for level measurement, and these balance equipment cost, installation cost, and achievable accuracy, with the efficacy of the technology to achieve the desired outcome.

To address your needs, the supplier needs to know enough about the application and your goals, to make a sensible proposal. Details include the material, the vessels, mechanical and chemical constraints, temperature and pressure, sensor access points and fittings, and range and accuracy.

If the measurement is used for level control or batch control, what is the dynamic behaviour?

Finally we can look at requirements for remote or distributed storage and vendor controlled inventory with centralised data on the internet.

Sometimes Mechanical is best!

Maybe its because I am a mechanical engineer - but there are TIMES when mechanical is best. For switches this can mean rotary paddle type or vibration types, but for continuous measurement the solution is a mechanical BOB. The implication is we are measuring a solid material - normally granular or in lumps, and the properties do not favour radar or ultrasonic solutions. A bob transmitter has a microprocessor controller and small winch with cable and weight. The system periodically lowers the weight until it hits the surface, than raises it again. An encoder on the shaft allows the cable length to be determined, and therefore the position of the surface of the material.
While this is very reliable, and easy to understand, it does have moving [mechanical] parts, and requires maintenance and service to achieve maximum life. If the material has repeatable angle of repose, and the sensor is positioned correctly, accurate and repeatable results can be obtained.
Modern systems such as the FineTek EE system, have fault detection for cable break, buried float, and lock up. They also incorporate strategies for fixed or variable cycle times for measurement. Output can be 4-20mA, pulse per unit cable length, or RS485 serial signal. The output status is fixed in between measurements.
As with most level measurements, each industry has ways that things "are done" and this is usually a good guide

as to what works and has proven reliable. These sensors are used in mining, cement, chemical and feed industries, and suit silos with dust, pressure, vacuum and heights to 30M - or 40M as special.
While they are most commonly used for solid materials, the system works perfectly well with liquids

Hydrostatic measurement is accurate and economical

Hydrostatic level measurement [for liquids only] means using pressure measurement at the maximum depth, to calculate the height of liquid above the sensor. The pressure depends on the density, value of gravity and the height of liquid =head. Pressure sensors are low cost, accurate, and reliable are are most often an excellent solution. They are not affected by froth, suspended solids, viscosity and have no moving parts. Often we use flush diaphragm including sanitary styles such as Tri Clover so there are no cavities which can get blocked. This style of diaphragm is available on Flanged transmitters and DP transmitters (with capilliary connection to remote diaphragms). Where a vessel is pressurised, the DP between the head space and the measuring point gives the liquid height. Linearisation can be applied for non uniform shaped vessels.

Sensors can be screwed, or (flange) mounted to the tank, or mounted from the top and submerged in the liquid.
Sensors can be fabricated into rigid structures, rather than being "suspended" in the vessel in case it is being stirred, or moving - as when used in a boat. Our **LevelStick sensor** is made from non metallic wetted components with a flush diaphragm, and suits harsh chemicals or contaminated liquids. These use standard PVC pipe for the main body and can be assembled on site
When using GP, the reference side of the pressure sensor must be exposed to atmospheric pressure - hence the use of vented cables in immersible sensors.
While it may be good to scale the exact height to 4-20mA, there is no reason to do so. Using a 1 bar sensor scaled 0-10.2M WG will give the same measurement accuracy as a 0-1M scaled signal.
Submersible sensors can be of small diameter to suit (preferred) installation in conduit - eg Gems 2400 = 19mm OD - for use in bores with depths to 300M and water depth 200M.
One source of unavoidable error in these measurements is variations in density. Density will always affect the level measurement output unless it is corrected. Correction may be done by using a smart DP transmitter to measure level from GP and density from DP reading.

IMMERSIBLE HYDROSTATIC SENSORS & ACCESSORIES

Use Sound Waves to measure level?

Distance and level can be measured by generation a pulse of sound and measuring the time taken to reach to target and reflect back to the sensor. These devices are known as Ultrasonic Transmitters and are commonly use for level measurement. The use of an advanced microprocessor and new technology called “Echo Discovery” gives users the tools to maximize performance of this type of transmitter in adverse conditions. The function “False Echo Storage” can also be controlled to identify the correct measurement signal, and repeatable interference echos to assist in the process. With a graphic display of echo strength, the true echo and interference can be seen. Further signal corrections can be made with the “foam” parameter for liquids and “dust” for solids measurement to reduce errors BM Tecnologie Ultra Compact Level Instruments are two wire HART transmitters in ranges to 4 metres, 8 and 15 metres in 3 models. Sensors are PU/PC or PVDF and accuracy is 0.2-0.5%. Ultrasonic transmitters are commonly used for open channel flow, and water level measurement in the open, as well as liquids in tanks. With solids level measurement a good reflected level of energy is needed and depends on the material and its consistency. Things that can interfere with ultrasonic measurements include foam on the liquid surface, condensed liquids on the transmitter face and vapours in the air space that particularly absorb the signal. Systems are temperature compensated, since temperature also affects the velocity of sound. If these factors cannot be avoided, it may be wise to consider Continuous Wave and Guided Wave radar systems for increased reliability

Ultrasonic Level TX with graphic display

Use Microwaves to Measure Level - Radar

Using electromagnetic waves to measure distance overcomes most of the limitations experienced with ultrasonic sensors. The velocity[=velocity of light] is not temperature dependent, nor influenced by composition of the medium. The technology will work if the mechanical parts can withstand the conditions, and the reflected energy is sufficient to detect. The magnitude of reflected energy is largely influenced by the dielectric constant K of the material, and low dielectric materials demand better antenna or some signal concentration device. There are two groups of instruments - Continuous Wave and Guided Wave. CW radars use rod, cone or parabolic antennas depending on the geometry and materials being measured, but the instrument is mounted like an ultrasonic at the top of the vessel and only protrudes in the vessel to the extent of the antenna. Guided Wave radars depend of the property that keeps the microwaves close to a metallic wire or rod, thus concentrating the energy of the reflection. This can be enhanced by using twin rods or coaxial tube and rod for low dielectric materials. Silos up to 70M can be measured with resolution of 1mm and an accuracy of 15mm. The technology works for liquids or solids, with GW suiting cement, fly ash, grains, chemicals and coal. Special consideration is given to materials with K<2 which are uncommon. For GW in large silos some considerable forces can be generated in the cables due to friction of the material and this must be allowed for in the selection of the sensor and its mounting. Temperatures to 400C and pressures to 40 bar are acceptable with careful design using radar, and special units can be used even for molten steel.





Level Measurement with float based devices

Resistive Level Sensors. Operate using the mechanism of reed switches, tripped by the magnet in the float, switching in resistors to give an output in small steps equalling the spacing of the reed switches. This is usually from 3 to 6mm, and overall resistance depends on the length - usually less than 3M. A transmitter converts linear resistance to 4-20mA. The images illustrate two type of physical construction - standard float transmitter top mount - in this case with sanitary tri clover flange, or the indicating bypass level sensor that can have a resistive transmitter incorporated.

Magnetostrictive Level transmitters. These use a magnetic float, and look the same as resistive types, but measure using magnetostriction in which electric pulses generate a torque in a sensing wire at the [float] magnetic field, and by measuring the time between the pulse and the reflected force, the distance is VERY accurately determined. Distances to 6M in rigid sensors and 10M or more in flexible sensors are possible but commonly these are less than 3M. Accuracy better than 0.5mm is possible, and this is ,by far, the most accurate common level measurement technique.

Displacer Type Float Level Transmitters - This design uses a large float, the length being at least the measured height.. which may be heavier or lighter than the liquid being measured. As the liquid level rises and falls along the length of the float, the vertical forces on the float are measured as a force or a torque.[torque tube version] This translates into liquid level by some simple maths. The advantage is that the float does not move, and the electronics can be remote from the sensing point. It means high temperatures, viscous materials, contaminated and chemically aggressive materials can be measured - common in oil and gas industry.


SUMMARY - These are not the only level measurement technologies and ECEFast can supply Capacitive, and Potientiometric sensors - we cannot supply laser systems currently.

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