

Wastewater Level Measurement Techniques

Level monitoring and control is a fundamental requirement in any wastewater treatment process. You will find level instrumentation installed at even the simplest treatment plants for pump control, chemical storage tanks and process level controls or alarms. Operators have only limited or emergency control over treatment plant influent, so level controls and instrumentation play an important role in managing the wastewater treatment process.

By careful planning of process elevations, engineers can design treatment systems where gravity manages wastewater levels—and therefore flow—through most of the treatment process. The type of plant and topography of the site are big factors, but the requirement for pumps, controls, instruments and operator intervention can be minimized by good treatment plant design.



Figure 36.1 Albany County North Sewage Treatment Plant, Albany NY

Wastewater treatment plant operators overwhelmingly endorse simple plant designs and instrumentation. “We try to keep things simple. More complicated equals more expensive.” comments Susan Salvetti, Instrument Technician at the Albany County Sewer District. Corrosive atmospheres in wastewater treatment plants attack everything from instrumentation to the mechanical structures and fixtures at a treatment plant. To be reliable, instruments must be designed to withstand the harsh operating environment.

36.1 LEVEL CONTROL AND ENVIRONMENTAL REGULATIONS

Environmental standards for wastewater treatment plants are becoming increasingly stringent. Although enforcement varies from region to region, both public and private treatment plant operators may now be held legally responsible for proper operation of their wastewater treatment facilities. New regulations are constantly being introduced with higher and higher standards of safety and effectiveness of the treatment process. Tank overflow protection and combined sewer overflow monitoring are current examples where regulators are imposing new requirements for level controls and instrumentation.

36.2 COMMON TERMS USED IN WASTEWATER LEVEL INSTRUMENTATION

SENSOR - any device that directly measures a physical condition. A Float is an example of a Sensor.

TRANSDUCER - a device which contains a sensor and converts its signal into an electrical signal for communication with other devices. A hydrostatic pressure sensor is an example of a Transducer.

INSTRUMENT – is the combination of sensors or transducers into a communication device that may transmit a signal, display a variable and provide control functions. An ultrasonic level indicating transmitter is an example of an Instrument.

TRANSMITTER – an instrument that transmits a continuous process signal to a remote device. A 4-20mA analog signal is the most common where each Transmitter uses a pair of wires (“twisted pair”) to deliver an analog current proportional to the measured variable. Modern serial, or digital transmitters are rapidly entering the market where a number of “multidrop” transmitters can share the same wire by taking turns, or by transmitting data only when “polled” by a remote controller.

ACCURACY – How closely an instrument measures the actual value of a material being sensed.

RESOLUTION – The smallest increment of change that the instrument can measure.

36.3 CONSIDERATIONS IN THE SELECTION OF LEVEL INSTRUMENTS

1. Price is always important, but operational life and maintenance requirements of an instrument should be the first factors in your selection process.
2. Determine if point level or continuous level is required.
3. Check compatibility of exposed sensor materials, plus temperature and pressure specifications.
4. Check if the instrument or sensor locations are rated hazardous.
5. Determine any restrictions in sensor mounting location.
6. Consider the application and select an appropriate technology.
7. Select instrument functions: 4-20mA, display, control relays, serial outputs, etc.

36.4 LEVEL INSTRUMENT TECHNOLOGIES USED IN WASTEWATER TREATMENT

36.41 Ultrasonic Level

Common Level Applications

- Pump Control in wet wells and sumps
- Chemical storage tank inventory
- Aeration basin level
- Aerobic Digester level
- Chlorine contact tank level
- Sludge tank level
- Bar screen differential level

The operating principle of ultrasonic level instruments is quite simple. They use a transducer with combined transmit and receive capability. The instrument measures the time it takes for a sound pulse to travel from the transducer to a target and then for the echo to return. Because we know the speed of sound in air (1086 ft/sec or 331 m/sec), the distance to the target can be accurately calculated.

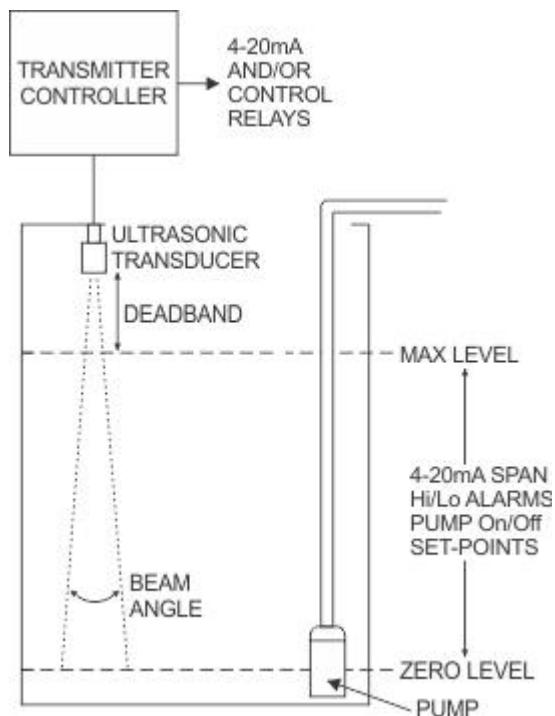


Figure 36.2 Noncontacting ultrasonic level controller transmitter

Ultrasonic level instruments have become one of the most popular technologies used in wastewater treatment applications. The obvious advantage is that they use a non-contacting acoustic sensor. That means minimal fouling of sensors and consequently little or no maintenance. Ultrasonics also offer relatively high accuracy ($\pm 0.25\%$ of full scale is typical) at low cost.

Adoption of ultrasonic instruments in wastewater treatment did not come about easily. In the early 1980's most operators considered them an exotic solution to wastewater level application problems and applied them where a non-contacting sensor seemed to be the only solution. "If nothing else works, try an ultrasonic" was a typical attitude. Early converts to ultrasonic instrumentation were pioneers, often developing calibration, installation and maintenance skills that were passed back to manufacturers.

With the advent of microprocessors, ultrasonic technology moved into the level instrumentation mainstream where today it is one of the most common and favored techniques in use at wastewater treatment plants. Many of the characteristics unique to ultrasonics can be managed automatically by signal processing algorithms programmed into each instrument. Today's operators can take successful performance of an ultrasonic instrument for granted assuming the instrument is properly applied and installed.

The term "ultrasonic" is used because the frequencies of most instruments are above the audible range of the human ear — although you can also usually hear a lower frequency clicking from ultrasonic transducers. Operating frequencies range from about 12 to 90 KHz. Lower frequencies are used by sensors measuring the greatest ranges, while higher frequencies are best for short measurement ranges.

Ultrasonics level instruments all have a blind space immediately in front of the sensor. Manufacturers often describe it as a sensor "deadband" or "blanking zone". As a rule of thumb, the lower the frequency, the further this blind space will extend. Ultrasonic transducers generate sound when the ceramic crystal is energized by a pulse of electricity. The crystal vibrates and emits an acoustic pressure wave — much like a stereo speaker. But following the law of momentum, once set in motion the crystal continues vibrating for a brief period of time — milliseconds actually. Echoes received from targets too close to the transducer will return very quickly and arrive before the crystal stops vibrating from its transmit pulse. Hence the blind space or "deadband".

Ultrasonic sensors also have a "beam width" or "beam angle" which you will find listed in manufacturer's

specifications. This factor in ultrasonics is often misunderstood but is crucial for successful operation of ultrasonic instruments.

By convention, manufacturers specify a transducer's beam width angle at -3db (the point where sound intensity is half the maximum). But sound energy diffuses very easily. It fills the nearby space and is reflected off of all hard surfaces that it contacts. A good everyday example is that you can face the wall and speak in a closed room and anyone else in the room will have no difficulty hearing you.

So ultrasonic manufacturers design their transducers to focus as much energy as possible into a narrow cone emanating from the sensor. The width of this cone at half power is the "beam angle".

The instrument's signal processing software plays an equally important role in minimizing echoes from adjacent targets. Ricochet echoes are filtered out and various processing algorithms are applied to reject false echoes and lock onto the correct target. Each manufacturer has developed their own signal processing techniques which are often patented or closely held as trade secrets.

Ultrasonic technology is also used for point level control with "gap" type sensors, where the presence of a liquid in the gap between transmit and receive crystals can be detected. Applications in wastewater treatment are for high level alarms in chemical storage tanks. Similar gap-type ultrasonic sensors can also be used for sludge-blanket level measurement.

36.42 Differential Pressure Sensors

Common Level Applications

- Wet wells and sumps
- Chemical tank inventory

With access to the bottom of a tank, liquid levels are often measured with pressure sensors. They operate by measuring the weight or pressure exerted on the sensor diaphragm by the liquid above the sensor. Three types of pressure sensor are available:

Gage - where one side of the pressure diaphragm is open to atmosphere

Differential - where the open side of the diaphragm is connected to a pressure other than atmosphere

Absolute - where the open side is sealed off

"Gage" type pressure sensors are the most common in wastewater treatment applications for unpressurized tanks. The higher the liquid level, the greater the force exerted on the pressure sensor diaphragm. Typical accuracy is $\pm 0.25\%$ of full scale rating of the sensor.

Pressurized tanks can also be measured by connecting the vent side of the "differential" pressure sensor to the vapor space at the top of the tank.

Lighter weight fluids exert less pressure on the pressure sensor than heavy fluids, so specific gravity of the liquid must be known in order to calculate level properly. Liquids also expand and contract relative to temperature. Pressure sensors can not detect this change because the weight or pressure exerted on the sensor will not change.

Pressure sensors are typically 2-wire devices, transmitting a 4-20mA current output with 24VDC excitation. Some models include adjustment potentiometers allowing operators to trim output according to their application. Gage type pressure sensors can be either threaded into a port at the base of a tank, or "submersible" types can be suspended on a cable from the top of the tank. The cable is reinforced so that

there is no stretching and also contains a small air tube so that the sensor can reference the liquid pressure to atmospheric pressure.

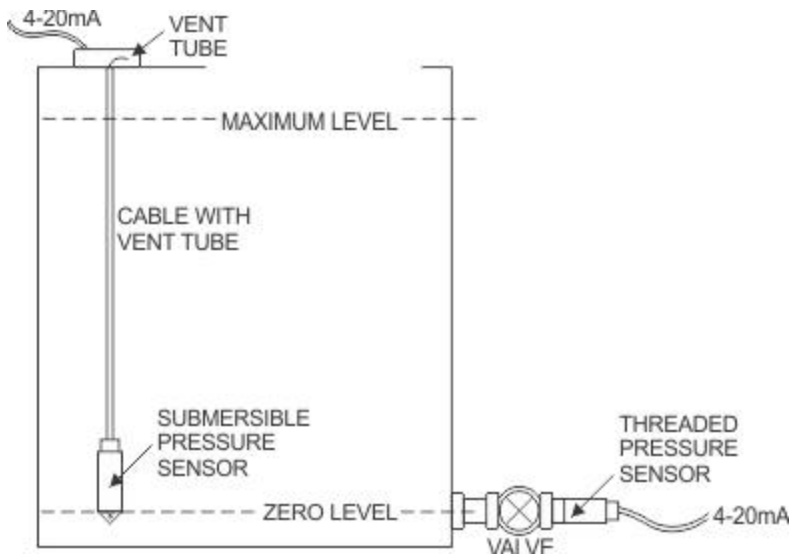


Figure 36.3 Gauge-type pressure transmitters

Pressure rating at 20mA output is configured by the manufacturer, so maximum pressure in your application must be defined before purchase. In most pressure sensor designs the face or sensor diaphragm will be directly exposed to the liquid being measured so chemical compatibility must also be considered. For hazardous rated locations, intrinsically safe and explosion-proof models are available from many manufacturers.

Solids buildup on or around the face of a pressure sensor will reduce its sensitivity and cause measurement errors. So pressure sensors are generally selected for relatively clean fluids. Some manufactures have developed designs with “flush-mount” and larger diameter diaphragms, or installation techniques that protect the sensor diaphragm from solids buildup. With this feature pressure sensors can be used in high-solids applications like sludge level.



Figure 36.4 Differential pressure transmitter for thermophilic aerobic sludge digesters at the Long Sault Sewage Treatment Plant, Long Sault, Ont.

Because pressure sensors rely on the physical deflection or strain of a material supporting the strain gauge, there may be some drift in readings over time. Most manufacturers include reference to this effect in their

product specifications. Typical “stability” for pressure sensors is $\pm 0.5\%$ of span over 6 months. Where accuracy is important, instrument technicians set up a maintenance schedule so that pressure sensors are calibrated periodically. Most operators report overall installed accuracy of $\pm 1\%$ of full scale.

36.4.3 Bubblers

Common Level Applications

- Wet wells and sumps
- Bar screen differential level

Bubblers measure the depth of a liquid by forcing air down a tube mounted in a tank or wet well. The air discharges or bubbles out of the tube at its opening near the bottom of the vessel. The pressure required to force air down the tube is proportional to the liquid level.

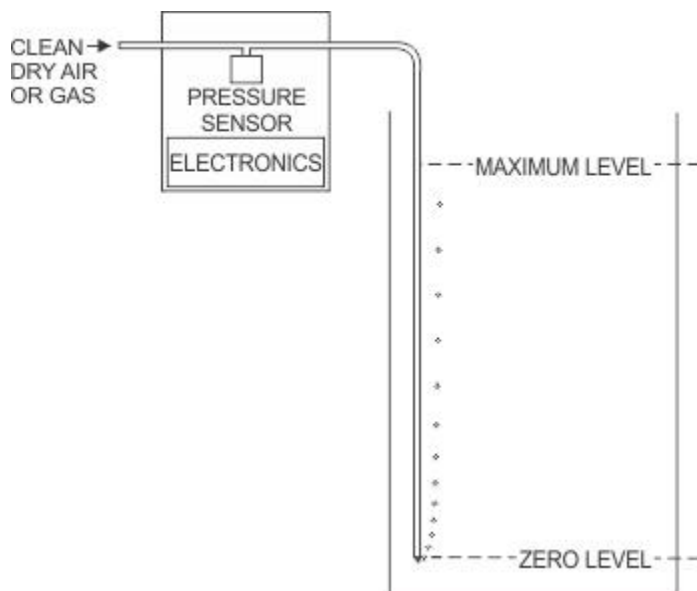


Figure 36.5 Bubbler Level Instruments

A typical Bubbler system consists of an air compressor or pressure source, a pressure sensor and control and calibration electronics, and a bubble tube made of rubber, plastic or stainless steel. A source of clean, dry gas is required. Accuracy is generally 0.5 to 1% of full scale.

Bubblers are often used in wastewater treatment for basin and wet well level applications. They are ideal for deep wet wells, narrow vessels or tanks with a lot of obstructions. The bubble tube can be lowered and mechanically fastened to the sidewall. Most liquids, including sewage with high solids content, will form crystallized deposits at the discharge point of the bubble tube. A build-up of deposits will cause erratic readings and eventually block the bubble tube. Bubbler vendors can offer valuable advice on application of their systems in wastewater treatment.

Some Bubbler systems are designed so that the compressor runs in repeated cycles. Most models offer an adjustment for the time between cycles — anywhere from a few seconds to an hour. Between cycles static pressure in the bubble tube is measured. Other Bubbler designs use a regulator to adjust the compressor so that just enough pressure is applied to force a bubble from the tube. Minimizing the amount of air discharged from the bubble tube reduces the formation of deposits in the bubble tube. Typical accuracy is $\pm 0.5\%$ of full scale.

36.4.4 Capacitance

Common Level Applications

- Chemical tank inventory

Capacitive sensors are available for point level detection, or for continuous level measurement with a long probe immersed in a tank or silo. Capacitance sensors typically consist of insulated electrical conductors and use a radio frequency (RF) signal on the sensor. To calculate level they measure a change in electrical capacitance between the sensor and Ground — usually the tank wall. The change is relative to level or immersion depth of the sensor.

Within design ratings, capacitance sensors are not affected by pressure or temperature as they have no moving parts. Capacitance sensors can be used for liquids or solids level measurement but they must be selected and calibrated according to the dielectric constant of the material being measured.

Material build-up on capacitance sensors may be detected as false levels. So viscous liquids, or materials like wastewater scum or grease which coat the sensor may cause measurement errors. Manufacturers have various techniques to help compensate for the effects of build-up.

Modern RF Capacitance level instruments can be bench-calibrated by inputting calculated levels of capacitance, or after installation by physical measurements at two levels — normally a high and low point. Typical installed accuracy is $\pm 1\%$ of full scale.

36.4.5 Sight Glasses or Gauges

Common Level Applications

- Chemical tank inventory

Tank levels which are not automated or transmitted to the treatment plant control system, can be fitted with a simple, low-cost sight gauge. They are generally glass or transparent plastic pipes, $\frac{1}{2}$ or $\frac{3}{4}$ " diameter, mounted vertically on the outside wall of a tank with entry points near the top and bottom of the tank. Translucent, plastic tanks can have a staff gauge attached to or scribed directly on the tank wall. Operators can visually check level by looking at the sight gauge instead of climbing the tank.



Figure 36.6 Sight gage scribed on polyethylene chloring contact tank, Cornwall Sewage Treatment Plant, Cornwall, Ont.

External sight gauges are not recommended for hazardous liquids where a broken or ruptured gauge could result in a spill, or for tanks without spill containment. They are not suitable for highly viscous or solids bearing fluids where coating or blockage of the gauge would result in false readings. The sight gauge pipe is normally installed between valves so that it can be easily removed for cleaning or replacement.

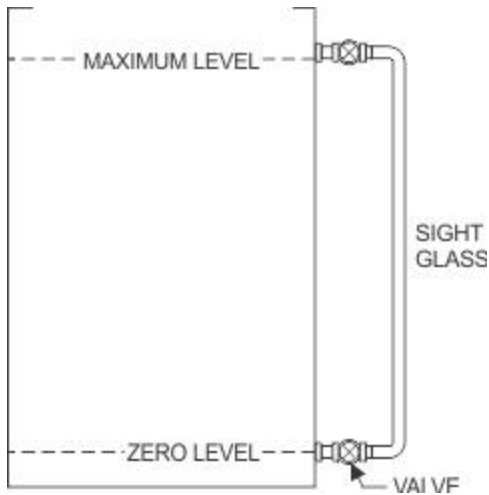


Figure 36.7 External sight glass

For high visibility, some manufacturers offer sight gauges with magnetically activated, colored flags. A floating magnet inside the sight gauge rises and falls with the fluid level. Flags below the magnet are rotated to show one color, while flags above the magnet are another color.

36.4.6 Infrared

Common Level Applications

- Sludge blanket level

Portable, battery-powered sludge blanket detectors often use infrared probes. The sensor contains an infrared light emitter or LED, and a photocell receiver. Light is transmitted across a gap to the receiver. As the sensor is lowered into the clarifier sludge blanket, the instrument will indicate a gradual decrease in opacity. Some models just detect the point where infrared light is not received by the photocell and provide indication to the operator. The cable suspending the infrared probe is normally marked off in feet or cm.

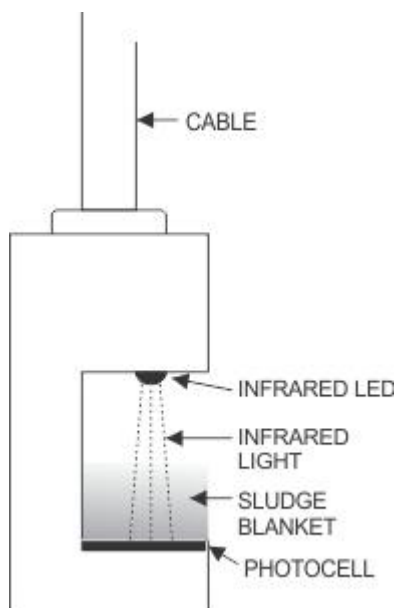


Figure 36.8 Infrared sludge blanket level detector

36.4.7 Microwave Radar

Common Level Applications

- Digester level

Radar tank gauges have been in use since the 1960's primarily for petroleum products. The Radar microwave signal is not affected by vapor or changes in the media you are measuring. Recent advances in design and lower costs are resulting in more widespread use of Radar in other applications. Although still very new in wastewater treatment, as prices continue to fall use of Radar may increase.

Modern Radar instruments consist of an antenna inside the tank and remote mounted electronics. They work by transmitting high-frequency microwave signals that reflect off of the liquid surface and are returned to a receiver. Much like ultrasonics which use sound echoes in a similar manner.

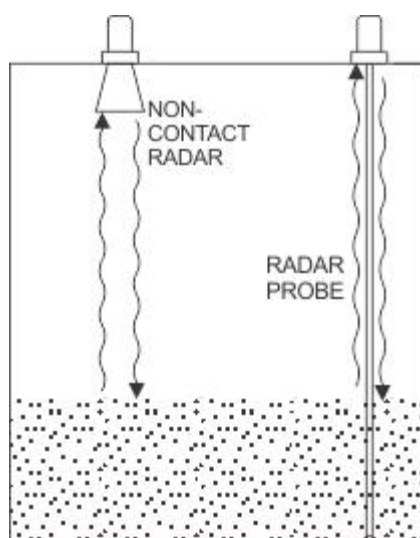


Figure 36.9 Microwave radar

Microwave Radar signals travel at the speed of light, so the reflected signal is returned in just nanoseconds from relatively nearby targets in a tank level application. The instrument's timing circuitry has to have very

high resolution to be able to measure level accurately.

Radar signals can also be transmitted through a probe or wire suspended in the tank. This technique permits measurement in confined spaces where non-contacting antenna-based systems might have their signals reflected off of obstructions like ladders, agitators or mixers.

36.4.8 Weight/Load Cells

Common Level Applications

- Chlorine cylinder level
- Chemical mixing or batching

Weight based level measurement offers high accuracy and high resolution. Weigh meters include one or more load cells that deliver an electrical output proportionate to the force or weight exerted on them. Weigh meters or scales are common in the Lab of any wastewater treatment plant, but are also used for chemical level measurement in the treatment process. Weight of the empty vessel must be deducted or “tared” from the final weight reading to determine the weight of the tank contents.

Installation of load cells requires raising the vessel, so is not practical for large tanks or wastewater process basins. Load cells and weigh meter systems are also relatively expensive so are normally limited to specific applications in wastewater treatment like chlorine cylinder level.

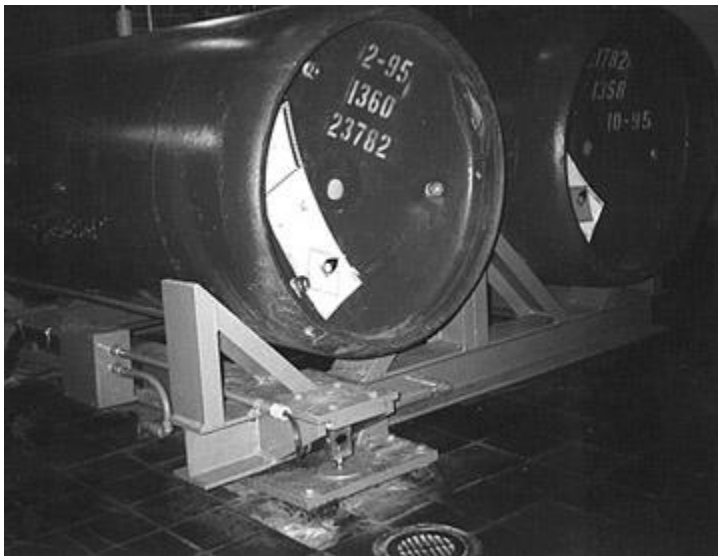


Figure 36.10 Chlorine gas cylinder on load cells, Cornwall Sewage Treatment Plant

36.4.9 Point Level – Floats

Common Level Applications

- Point level or Pump Control in wet wells and sumps
- High level alarms in all wastewater process basins
- Level controls in chemical storage tanks

Floats or ‘Displacers’ are the point level control of choice in most wastewater collection systems and treatment plants. From pump stations to process tanks, floats are widely used because of relative low cost and simplicity. Even tanks or wet wells with transmitting instruments often include a float as a back-up high or low level alarm.

There are many different configurations but all point level floats rely on the buoyancy of a non-corroding cylinder — usually plastic or porcelain — attached to a control relay. Designs vary, but action of the float will act on a mercury switch or a spring connected to a control relay.

Floats can also be used for continuous level measurement where the float is attached to a cable and pulley. As the float rises and falls with the liquid level, the pulley rotates proportionally and electronics convert the rotation into an analog signal.

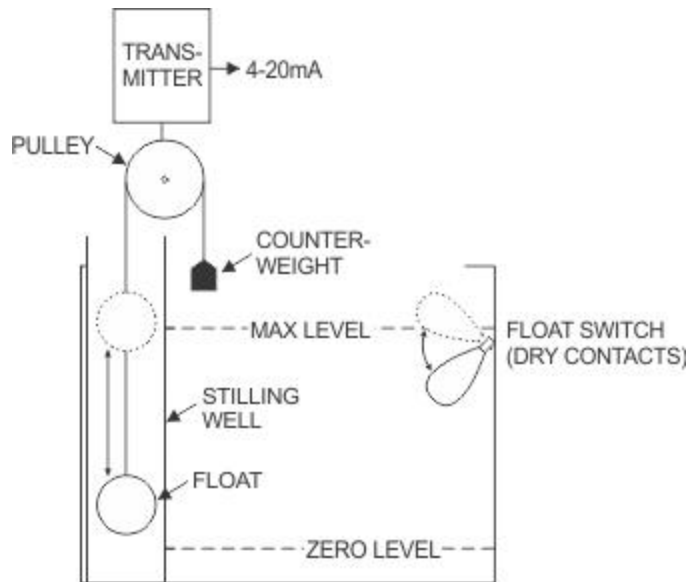


Figure 36.11 Float level controls

The obvious disadvantage of floats is the potential for build-up of solids or grease. Since the float must rise and fall freely to operate, deposits on the float or its linkage can cause a malfunction. Most plants develop a maintenance program where floats are washed with high-pressure spray periodically. Installations with a history of float failures are often retrofitted with a non-contacting sensor — like ultrasonics — to reduce maintenance.

36.4.10 Conductance

Common Level Applications

- Pump Control in wet wells and sumps
- High level alarms in process basins

Conductance sensors work by using water — or any conductive fluid — to transmit a low voltage electrical current from one probe to another, or to the steel wall of a tank. Most conductance sensors consist of two or more small diameter steel rods inserted into a tank at desired set points. When water or any conductive liquid contacts a transmitting probe, it completes the circuit by conducting the electrical current through the water back to a receiving probe or to the steel wall of the tank.

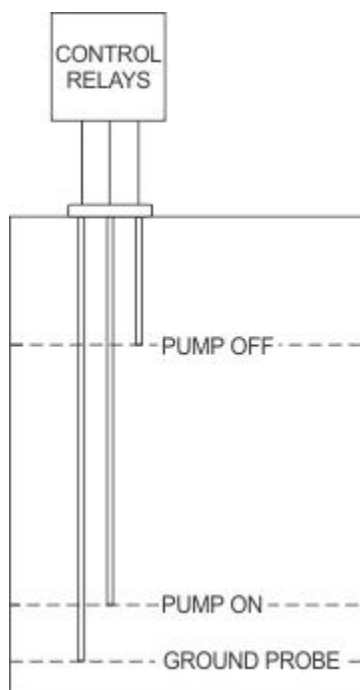


Figure 36.12 Conductance probes for pump control

Conductance sensors are simple and inexpensive, and are frequently included as level controls with equipment packages like UV disinfection systems or sump pump packages.

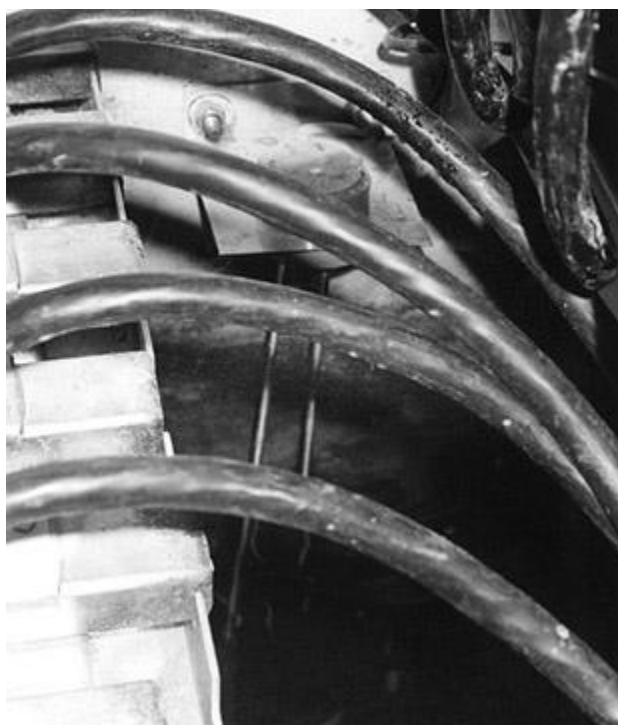


Figure 36.13 Conductance point level control in UV disinfection channel, Long Sault Sewage Treatment Plant, Long Sault, Ont.

36.5 LEVEL APPLICATIONS AND CHOICE OF INSTRUMENT TYPE

36.5.1 Wet Well and Sump Level Control

Ultrasonic instruments and Floats dominate this application. Ultrasonics are chosen for their non-contacting

feature and when a 4-20mA proportional signal is required for PLC's or Variable Speed Pumps. Most manufacturers offer intrinsically safe or explosion proof transducers for hazardous rated locations.

Ultrasonic transducers must be mounted in a position to receive an unobstructed echo from the wastewater level. Avoid locations where false echoes may be received from ladders, pipes or falling influent. Ultrasonic transducers are designed to withstand accidental submersion, so they should be mounted as low in the wet well as possible.



Figure 36.14 Ultrasonic sensor mounting in a sewage wet well, Iroquois Sewage Treatment Plant, Iroquois, Ont.

Bubblers or submersible pressure transducers are a good alternative to ultrasonics for narrow wet wells where obstructions limit the range of ultrasonics, and for wet wells where foam is constantly present.

Floats are selected for simple ON/OFF pump control applications and High or Low level alarms. It is not unusual to find Ultrasonic or Pressure instrument plus a high level Float installed in pump stations. The float provides added security in case of failure of the primary instrument.



Figure 36.15 Float level controls for seal water sump, Massena Wastewater Treatment Plant, Massena, NY

36.5.2 Plant Bypass Alarm/Control

Conductance, Capacitance or Floats are often installed at the plant headworks to activate an alarm at the high water or plant bypass level. The alarm may simply alert an operator, or activate bypass flowmeters and other instrumentation.

36.5.3 Chemical Storage Tank Inventory

Ultrasonics are a common choice for liquid chemical storage and mixing tanks. Models from most manufacturers offer local display for operators, 4-20mA output to the plant PLC or SCADA system, and control relays for pump or valve control and level alarms. Ultrasonics are ideal for viscous chemicals like polymer and alum, and sensor materials can be selected for compatibility with chemicals like potassium permanganate, ferric chloride and sodium hypochlorite.

With access to the bottom of the tank, gage type pressure transmitters with 4-20mA and optional displays are also popular.



Figure 36.16 Gage type level indicating pressure transmitter

36.5.4 Dry Solids Level Monitoring

Lime powder level at wastewater treatment plants is often monitored with point level controls including:

- Rotating paddle switches where contact with powder is sensed as a torque change
- Tuning forks where contact with the powder dampens the probe's vibration
- Diaphragm sensors where pressure of the solids activates a control switch
- Capacitance probes that are designed for non-conductive powders

Level or powder or dry solids can also be measured with continuous level instruments including:

- Mechanical cable sensors which raise and lower a probe continuously to track powder level

- Capacitance probes designed for non-conductive powders
- Radar transmitters with either contacting probes or non-contacting antennae
- Ultrasonics – select only models that are designed for dry solids measurement with dust-shedding sensors

Level instrumentation may also be installed in process equipment like gravity belt thickeners to monitor and control sludge level.

36.5.5 Bar Screen Differential Control

The inlet side of a bar screen will normally have a high level alarm using a Conductance or Capacitance sensor. Inlet water level rises as debris builds up on the bar screen. The level switch activates an alarm to alert plant operators.

Automatic systems may include a Differential Level instrument where level is measured both up and downstream of the bar screen. The instrument monitors and calculates both levels and activates the screen trash rake at preset differential levels. Ultrasonic, Bubbler and Capacitance systems are generally selected.

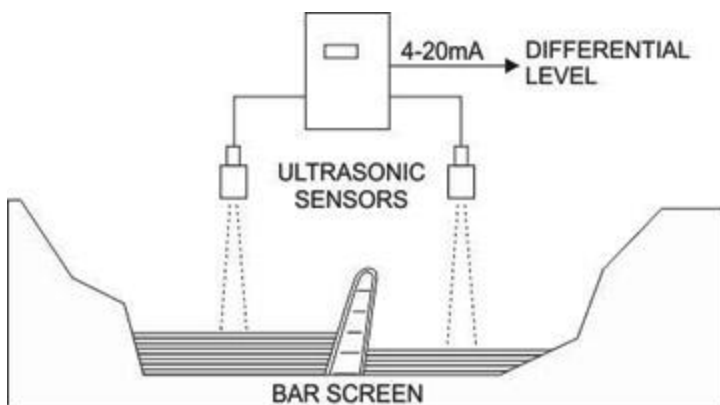


Figure 36.17 Bar screen differential level with ultrasonic transducers

36.5.6 Process Basins including Aeration, Chlorine contact, Skimmer tanks, Sedimentation and Flotation Thickeners

For continuous level measurement Ultrasonic and Pressure transmitters are common throughout the wastewater treatment process.



Figure 36.18 Ultrasonic transducer monitoring aeration tank level in the

Cardinal Sewage Treatment Plant's sequential batch reactor, Cardinal, Ont.

Floats or Conductance probes are also used for simple high level alarms and point level control.



Figure 36.19 Float level control for the effluent contact chamber, Ingleside Sewage Treatment Plant, Ingleside, Ont.

36.5.7 Sludge Blanket Level

Wastewater Treatment Plant operators must maintain the proper sludge concentration and level in clarifiers to optimize the activated sludge process. The interface between sludge and water can be gauged by hand-held tubes. A sample of the sludge layer is captured and raised for operator viewing. But this technique depends on the skill and judgement of the operator. Now plant operators have new choices in instrumentation to simplify and improve the accuracy of sludge blanket level measurement.

The simplest detectors use a sensor lowered on a cable by the operator. Sludge detectors can use ultrasonic sensors, where change in sound transmission from a transmitter crystal to a receiver is measured. Or they use an infrared light source and photocell receiver (Fig. 36.8). The operator lowers the sensor into the sludge blanket and the instrument indicates when the sensor falls to a preset sludge density. Normally there is an adjustment for sensitivity. This method can be quite accurate, but the sludge blanket can be easily disturbed or the sensors fouled.

Continuous sludge blanket level instruments are gaining acceptance in modern, automated wastewater treatment plants. They range from mechanically actuated systems that raise and lower an infrared or ultrasonic sensor, to continuous sonar-based ultrasonic systems that can profile the sludge blanket and provide operators with a detailed view of sludge density.

36.5.8 Sludge Holding Tanks

Ultrasonic instruments and flush-mount Pressure sensors are the common choices. Ultrasonics are ideal because the sensor mounts above the sludge and measures without contact. But splashing in tanks where sludge fills from the top, can coat ultrasonic transducers resulting in signal loss. Operators can choose flush-mount pressure sensors for sludge tanks where there is access to the bottom of the tank. The flush-mount sensor design helps reduce solids build-up or coating of the diaphragm.



Figure 36.20 Sludge holding tank with ultrasonic level transducer, Ingleside Sewage Treatment Plant

36.5.9 Anaerobic Digester Level

Scum, methane, steam and solids build-up make anaerobic digester level one of the most difficult applications in wastewater treatment. Differences in digester design mean that instruments that succeed in one plant, may fail in another. Many digesters displace supernatant from the top of the tank as sludge is pumped in from the clarifier. Often a simple high level alarm using a conductance or capacitance probe is sufficient.

For continuous level measurement in Digesters the choice of instruments ranges from simple, mechanical level gauges for floating roofs, to pressure transmitters with an intrinsically safe or explosion-proof sensor.

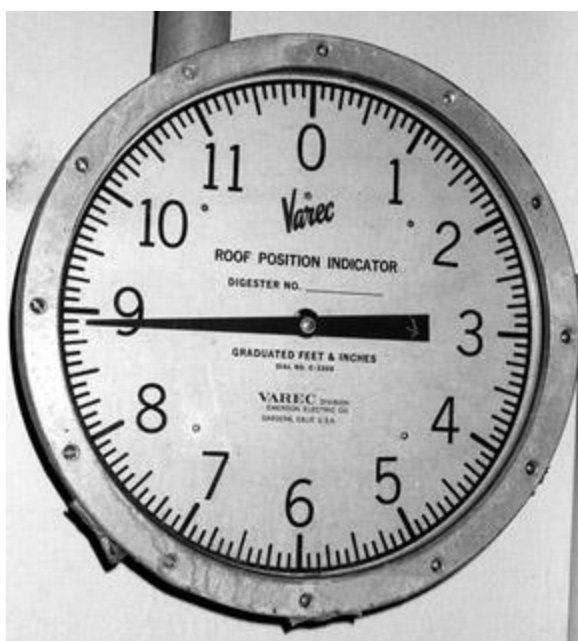


Figure 36.21 Digerster roof position indicator, Massena Sewage Treatment Plant, Massena, NY

Flush-mount Differential pressure sensor designs are normally preferred to minimize sludge build-up at the sensor. Because of methane pressure, the atmospheric side of the sensor's diaphragm must be referenced to the vapor layer at the top of the tank. So a tube or pipe is connected from the top of the digester down to the pressure sensor.

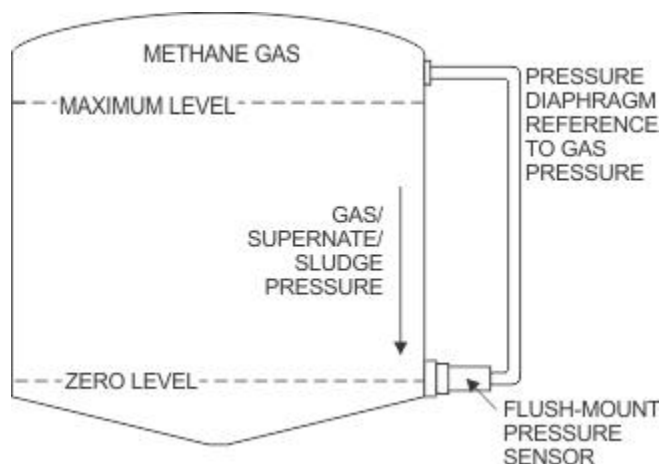


Figure 36.22 Differential pressure level monitoring in an anaerobic digester

Floating Digester roofs can be fitted with a mechanical roof position indicator, or with a non-contacting ultrasonic instrument. Ultrasonic sensors require a flat reflective surface so domed digester roofs should be fitted with a flat “target” to reflect the ultrasonic signal.

Ultrasonics are rarely selected for mounting inside a digester. Speed of sound in methane varies according to the gas concentration and pressure, so ultrasonics are not repeatable. Where non-contacting level measurement is necessary, some digesters have been fitted with stilling wells for ultrasonic sensor mounting. The well is ventilated, so that the space above the supernate level is filled with outside air rather than digester gas. Regular cleaning of the stilling well is necessary to prevent false readings from solids build-up or from solidified scum.



Figure 36.23 Anaerobic digester with ventilated stilling well and ultrasonic transducer, Cornwall Sewage Treatment Plant

Non-contacting Radar level instruments offer a new choice in instrumentation for digester level measurement. The radar signal is unaffected by methane gas concentration. As the price of radar instruments continues to fall this technique may become more common.

36.5.10 Lagoons and Settling Ponds

Ultrasonic transmitters are the first choice for many treatment plant operators. Most ultrasonic instruments provide a local digital display, 4-20mA analog signal and control relays. They are selected for the benefit of a non-contacting sensor and simple installation.



Figure 36.24 Ultrasonic level indicating transmitter on aeration lagoon at the EMOS Wastewater Treatment Plant, Santiago, Chile

Submersible pressure sensors are also popular for sewage lagoons. Pressure sensors normally transmit a 4-20mA analog signal to a PLC or SCADA system, but can also be equipped with displays and control relays.