Application Note

Tank Level Measurement Capabilities

Viatran uses a variety of pressure measurement techniques to determine liquid levels in different tank setups and applications. By measuring the hydrostatic head pressure at the bottom of a tank and the specific gravity of the liquid, the level in the tank can be determined.

Hydrostatic head pressure at a certain point in a tank, is caused by the weight of the liquid above pushing down. Specific gravity is the ratio of the mass of the tank liquid to the mass of an equal volume of water at 4C. Viatran's pressure measurement instrumentation can be used to determine both of these quantities.

In order to understand how pressure is used to measure liquid level, consider the following equation:

$$H = \frac{P}{SG}$$

h – level of the liquid in a tank
P – hydrostatic head pressure at the bottom of the tank
SG – liquid's specific gravity

The specific gravity of the liquid in a tank is an important factor in the level measurement process. There are three basic situations where specific gravity factors into tank level measurement.

The simplest case is when a tank is used for water only. The specific gravity of water is 1.0, making the above equation elementary. No adjustments are necessary in order to compensate for specific gravity. Tank level is determined directly from the hydrostatic head pressure.

The second situation relates to a tank that contains a liquid other than water, but it always contains the same liquid. This situation is only slightly more complicated. The level measuring transmitter, or level indicator, must be scaled to compensate for the difference in specific gravity of the liquid. Once this step is complete, tank level can be determined directly from the hydrostatic head pressure measurement.

The third, and most complicated case, is when a single tank is used for more than one type of liquid. The measurement system must determine the specific gravity of the tank's liquid and the hydrostatic head pressure at the base of the tank simultaneously, in order to establish the level of liquid.

Viatran provides liquid level measurement for five basic tank setups: vented/open tanks; insulated vented/open tanks; sealed tanks; vented/open tanks with changing media; and sealed tanks with changing media. This technical note discusses how Viatran has successfully engineered systems that measure the liquid levels in all five of these setups.

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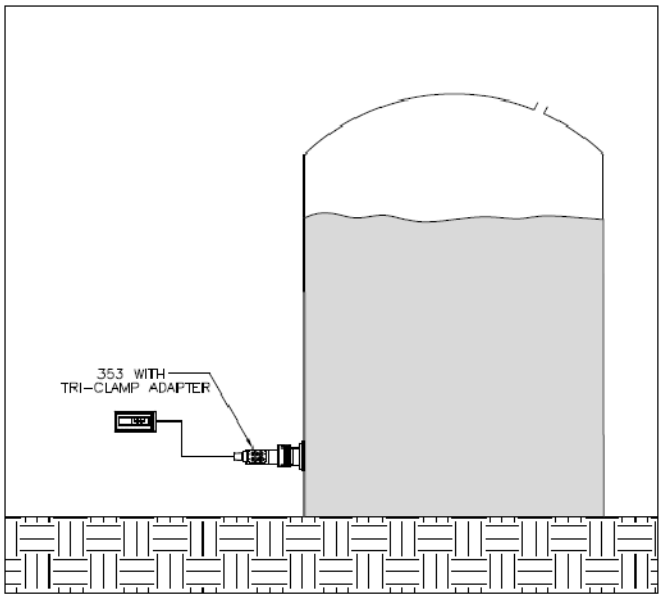
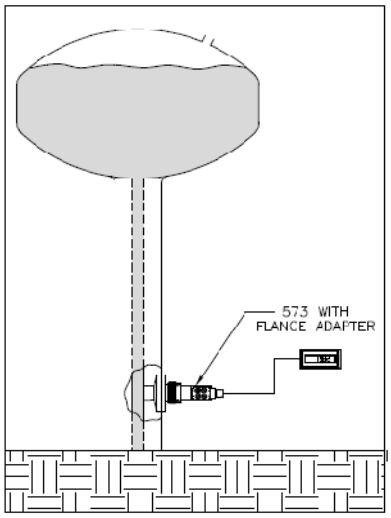
Vented/Open Tanks



These include elevated, above-ground, and in-ground tanks with exposed surfaces or vents that make the air above the liquid equal to local atmospheric pressure. These types of tanks are commonly used by municipalities for water storage, processing, and distribution. If the bottom of a tank can be tapped, Viatran's Models 353 or 573 pressure transmitters can measure its liquid level. Both units measure the hydrostatic head pressure at the bottom of the tank, which can be converted to a measure of liquid level. The 573 is ANSI flange-mounted, and can be used to measure liquid levels from 0 – 30 inches to 0 - 60 feet. Model 353 offers a tri-clamp fitting to mount to the tank, and provides accurate and reliable liquid level measurement in the same ranges as the 573.



▲ Vented open tank for elevated storage

All of the exposed surfaces of the 353 and 573, including the flanges, are made of 316 stainless steel, making both products ideal in corrosive environments. Both transmitters also meet Factory Mutual (FM) intrinsically safe certifications.

Both units have magnetically coupled, hermetically sealed external controls, and internal field calibration for calibration without an external pressure source.

If a tank cannot be tapped at its bottom, Viatran's Model 516 submersible level transmitter can be used to measure liquid level. The 516 is lowered into the tank on a cable and provides level measurement by determining hydrostatic head pressure at the bottom of the tank. It can measure liquid level in ranges from 0 to 30".

The 516 uses a neoprene-jacketed cable that carries its signal and ensures water tightness, as well as a Kevlar™ fiber for support. A breather tube in the cable exposes the reference side of the sensor to the outside atmosphere, providing true gage pressure measurement. The 516's wetted parts are made from corrosion resistant 304 and 316 stainless steel. It also has an all-welded, "O"-Ring free sensor design.

Models 353, 516, and the 573 all provide a 4 to 20 milliamp output signal over the range of tank liquid level for feedback control or indication.

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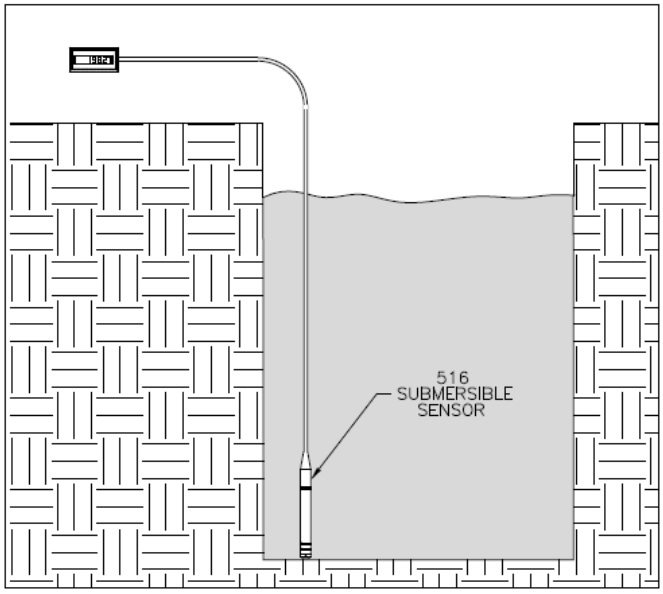
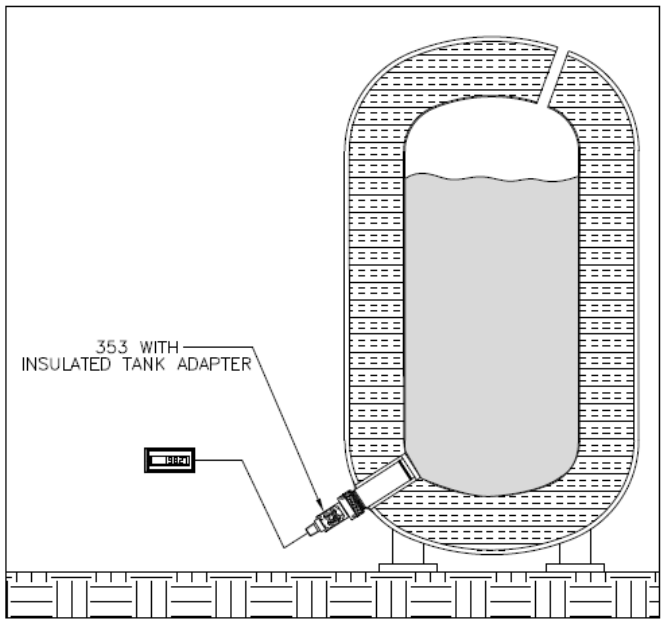
Insulated Vented/Open Tanks

This tank design uses the same technology as the noninsulated vented or open tanks, but it requires a high degree of flexibility in mounting options. These tanks are commonly used in the dairy, food processing, pharmaceutical, biotech, and cosmetic industries.

Viatran's Model 353 transmitter is ideal for these applications. Viatran offers twenty-one adapters and receivers that fit nearly all of the wells or flange mounts already in use. Its flush diaphragm is ideal for clean-in-place systems.



▲ Submersible transmitter for inground tank



▲ Model 353 with adapter for insulated tank

Sealed Tanks

A sealed tank often has a higher-than-atmospheric pressure gas blanket on top of the liquid. This gas blanket pushes down, increasing the pressure on the liquid. This set-up offers a quick way to force the liquid out of the tank, in order to move it elsewhere and minimize evaporation. This kind of tank is often used in the petroleum and chemical processing industries.

It's not possible to obtain an accurate reading of level by simply measuring the pressure at the bottom of a sealed tank because the pressure of the gas blanket is included in the measurement. If you based the value of liquid level on that pressure, it would indicate a higher liquid level than was actually in the tank.

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Viatran has developed a way to measure liquid level in these situations with the Model 574 differential pressure transmitter. The Model 574's two pressure inputs are hooked to two taps in the tank—one at some point at the top within the gas blanket, and one at the bottom. The 574 measures the difference in pressure between the gas blanket and the bottom of the tank. The pressure at the bottom of the tank equals the sum of the gas blanket and hydrostatic head pressure of the liquid. The difference in pressure between the gas blanket and the base of the tank is the hydrostatic head pressure of the liquid, which can be converted to a measure of level.

Viatran's Model 574 measures levels that range from 0 - 5" to 0 - 230 feet of water column and it has all welded, corrosion resistant, 316 stainless steel construction. The 574 also has magnetically coupled, hermetically sealed external controls and internal field calibration. It has FM, Canadian Standards Association (CSA), and Cenelec (NEMKO) safety approval ratings.

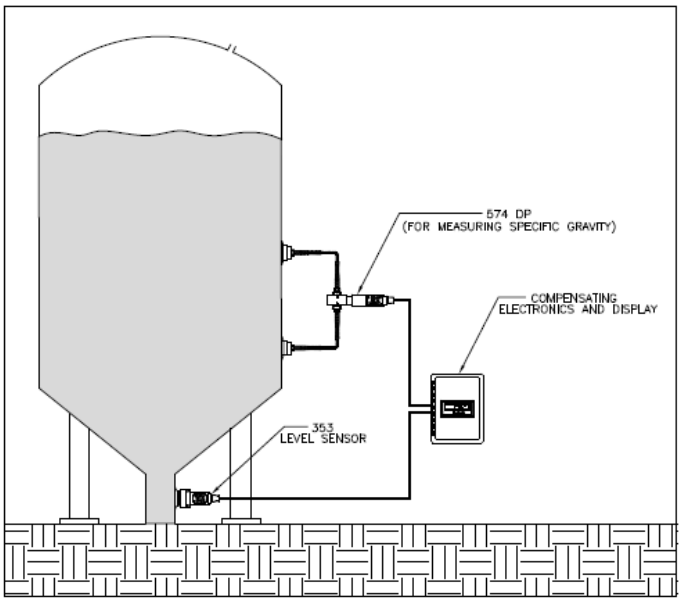
Like the other three models, Viatran's Model 574 provides a 4 to 20 milliamp output signal over the range of tank liquid level for feedback control or indication.

Vented/Open Tanks with Changing Media

Many manufacturers use a single tank to process more than one type of liquid. This is typical in the food processing industry, where a single tank may be used for several different types of juice or sauce. This presents a problem when trying to calculate liquid level, because different liquids have varying physical properties such as density and specific gravity. A system that uses hydrostatic head pressure to measure liquid level in this kind of a tank must be able to compensate for these differences.

Viatran has solved this problem by using a combination of our Models 353 and 574 transmitters. The 353 is mounted as close to the bottom of the tank as possible, to measure the hydrostatic head pressure. The 574 is mounted to the side of the tank to determine the specific gravity of the liquid in the tank.

The 574 measures the difference in hydrostatic head pressure between two points of liquid elevation in the tank. For example, Viatran can tap the tank at two fixed levels, 10 inches apart. For a particular liquid, the 574 might measure a hydrostatic pressure difference between those fixed points that corresponds to a separation distance of 12 inches of water. This would mean that the liquid in the tank is 20% heavier than water, and has a specific gravity of 1.2.



▲ Tank level system for vented tank

By dividing the output signal from the 353 by the output signal from the 574, the user obtains a compensated reading for the actual level in the tank. This calculation corrects the liquid level measurement for the change in density of the tank media.

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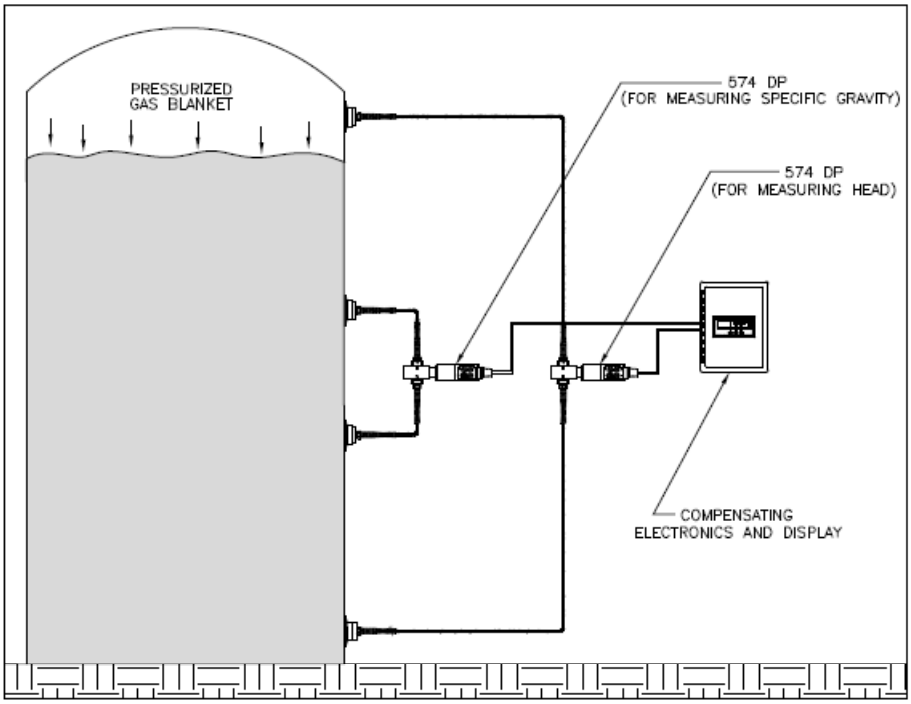
Sealed Tanks with Changing Media

Municipal waste water treatment facilities have a common problem where the consistency of waste water ranges from a mostly liquid state to a sludge-like substance.
Measuring the level of liquid in this dramatically variable state requires a combination of two of the above methods. It's critical to compensate for the gas blanket above the surface of the liquid and for changing specific gravities of different liquids.

Viatran solves this problem by using a system with two Model 574 differential pressure transmitters. One unit determines the hydrostatic head pressure at the bottom of the tank in the manner described previously for sealed tanks. The other 574 determines the specific gravity for the particular liquid in the tank in the manner previously described for vented/open tanks with changing media. The output signal from the transmitter that measures head is divided by the output signal from the unit that measures specific gravity, in order to determine the level of liquid in the tank.



▲ Tank level system for sealed tank

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