Level Measurement in Water and Waste Water Lift Stations

Condensation, build up, obstructions and silt can cause difficulties in making reliable level measurements in lift station wet wells. New trends in low cost radar units solve these problems.

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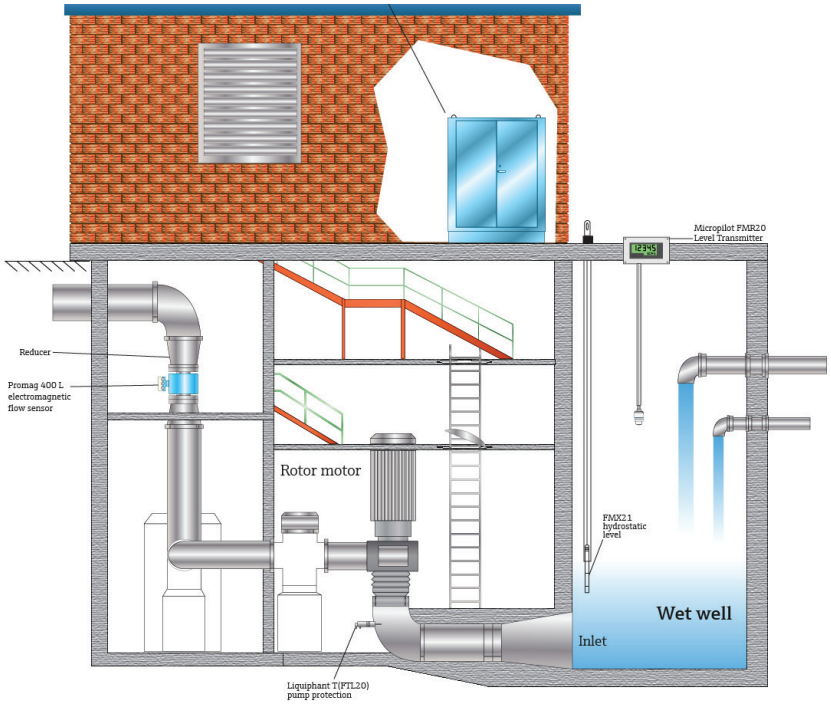

FIGURE 1. Typical lift station. Water enters the wet well from the right. A radar instrument monitors the level. When the level gets high, the controller starts the pump to lift liquid to a higher elevation and empty the wet well.

Lift stations pump water and waste water from a lower to higher elevation to compensate for topographical changes. Most processing facilities are fed by gravity flow of the water and waste water, so in locations where a change in elevation prevents gravity feed, lift stations pump the water to a higher elevation to increase the hydraulic head to provide reliable gravity flow into the facility.

Water level in the lift station wet well or reservoir needs to be monitored (Figure 1) to provide input to the pump, which pumps water out when it reaches a pre-determined level. The level measurement also turns off the pump at a minimum level to prevent run dry damage.

Wet wells can be a difficult environment for instrumentation with high humidity and condensation typically present. Heavy coatings and vapors can be found in sewage wet wells capable of coating or corroding mechanical level measurement devices leaving them inoperable. Technologies that do not contact the material being measured should be considered.

Historically, level measurement in lift station wet wells has used several technologies, including floats, submersible hydrostatic and non-contact ultrasonic instruments. These technologies can be effective when properly selected and maintained, so let's take a look at each and consider the positive and negative points.

Traditional Technologies

For decades, float switches have been used for wet well level measurement. The advantages of float switches are low cost and simple operation. Typically, two or more floats are used,

with one acting as a high level pump-on and another float acting as a low level pump-off indication. While floats have advantages in cost and simplicity they can fall short in several ways.

Depending on the type of float, the linkage or cable tether can foul or hang up. Floats can sometimes leak causing a loss of buoyancy. In waste water applications, coatings on the float can cause it to sink. When using floats for wet well applications, regular maintenance is extremely important to ensure proper operation.

Level switches are often used as a high-level back up for a continuous level transmitter to indicate if the level reaches a point where the well is close to overflowing. Since the high-level switch is only reached in "upset" conditions, floats work fairly well as a high level switch.

Submersible hydrostatic level transmitters operate on the head pressure of the water. A diaphragm in the transmitter is subjected to the water column on one side and referenced to atmosphere on the other side. Increases and decreases in level deform the diaphragm and cause changes in a capacitance bridge circuit which is then converted to an output.

Submersible transmitters have several advantages. They can be pre-selected for the applicable range of level measurement. For example, the transmitter may be ranged from 0 to 30 feet of water. Since they are pre-ranged, no calibration is required. Submersible transmitters also have no moving parts to hang up or wear out.

Still, it is important to make sure the diaphragm does not become clogged with silt or other solids as clogging will affect accuracy. A heavy build up can prevent the diaphragm from reacting to changes in water level. When using submersible transmitters in applications where silt or solids are present, choose a transmitter able to tolerate these applications. A transmitter designed for water with solids will have a cover over the diaphragm that allows for easy cleaning, but it is important not to damage the diaphragm when cleaning.

Ultrasonic instruments are another common technology used to measure wet well water level. Ultrasonic instruments operate based on the time of flight (ToF) principle. An acoustic pulse is sent to the surface of the water being measured which is reflected back. The time it takes to reach the water and return provides the distance to the water, which is then converted into a level signal. One of the big advantages of ultrasonic level devices is that they are "non-contact." That is, the transducer sending the acoustic pulse does not come in contact with the water, providing a cleaner application for sewage wet wells.

However, ultrasonic instruments are not immune to problems. The humid conditions in a wet well can cause condensation to form on the face of the transducer which can attenuate the acoustic energy, limiting the range. In some cases it can even cause a near-field fault. Confusing acoustic reflections caused by structures in the wet well such as ladders, pump columns, cables, etc., must be taken into consideration and avoided or mapped out if the ultrasonic device being used offers this feature.

Another concern is splashing on the transducer which can leave residue able to attenuate the acoustic energy, requiring cleaning. In sewage wet wells, where methane can be present, ultrasonic instruments experience another problem. The speed of sound is faster in methane than it is in air. This will cause errors in the level measurement, resulting in the level appearing higher than it actually is.

Radar Level Measurements

A recent trend in level measurement for lift station wet wells is radar technology. In the past, radar transmitters were considered too expensive for use in wet wells but recent developments in electronics have allowed for new offerings in the sub $1,000 range. Radar transmitters offer a number of advantages over traditional wet well level technologies.

First, like the ultrasonic instrument, radar is a non-contact technology using the time of flight measurement principle. With radar, an electromagnetic pulse is directed to the surface of the material being measured. The energy is reflected by the dielectric property of the water. Similar to ultrasonic, the time taken to reach the water surface and the reflection to return are measured, providing a distance to the surface of the water which is then used to calculate the level.

Along with the advantages of non-contact measurement, the transmission of electromagnetic energy is not affected by vapors or steam in the air space above the water, which is a decided advantage over ultrasonic level technology.

New radar antenna designs provide wetted parts of all Teflon with a concave surface. These concave antennas are designed to shed condensation buildup on the antenna face, preventing attenuation of the electromagnetic signal. In sewage wet well applications, the Teflon helps to prevent coatings from adhering to the antenna when water splashes solids.

When selecting a radar unit for mounting inside a wet well vault it is important to remember the transmitter may experience submersion in extreme conditions. For this reason, selecting an encapsulated transmitter that meets IP68 (protected against temporary immersion) is recommended.

FIGURE 2. With Bluetooth, modern radar level transmitters can be commissioned from a tablet (pictured) or a smart phone.

Mapping it out

One of the great advances in new radar units is the simplicity of commissioning and mapping. Accessing the setup program can be made via Bluetooth® and executed on a smart phone or tablet (Figure 2). This is a great advantage over older units that required commissioning through a push button HMI interface or opening the housing and connecting a cable to a laptop with a modem.

In many cases the radar transmitter may be located in an installation that is difficult to access. This is particularly true of water and sewage wet wells where the radar may be inside a concrete vault. Trying to reach these units for access to the HMI or to connect a cable to a modem may require a confined space permit. With Bluetooth it is a simple matter of opening the manway in most cases.

New radar technology offers sophisticated mapping programs that allow the transmitter to ignore internal obstructions such as ladders, pump columns, cables and baffles. While these mapping programs are sophisticated, they are much easier to implement than previous mapping programs from even a few years ago. If the wet well is empty or the level is at its lowest point, simply executing the mapping routine is all that is required. The radar transmitter does all the work. In situations where the tank is not empty, you need to determine where the level is and then map to a few inches above the actual level.

Summary

There are a number of ways to measure the water level in lift station wet wells. Selecting the technology able to provide the most reliable level measurement with the least maintenance should be the goal. While traditional technologies, such as submersible hydrostatic and ultrasonic instruments, can provide a reliable measurement, the new lower-cost radar transmitters now available in the market should be considered for these applications. The advantages gained in performance and reliability along with the ease of commissioning are significant.

About the author

Bill Sholette is the Northeast Region level product manager for Endress+Hauser. He is responsible for technology application and development of level products, and has published a number of white papers and articles pertaining to level instrumentation. Sholette received his certification in management and marketing at Villanova University.

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