RADAR LEVEL SENSORS IN PUMPING STATIONS

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ABSTRACT

The technologies used to measure the level in pumping stations (both potable water and sewage) have been traditionally hydrostatic pressure, ultrasonic, or simply switching (on/off) sensors. You may also add to these radar, which is fast becoming a preferred solution to many water and wastewater authorities. With the availability of these varied options how can installers and operators choose which one is best?

The selection of the level sensor for best performance is determined by many factors including; range, type of product to be measured, ambient and process conditions, plus mounting position. With the improved design and performance of modern loop-powered radars, the decision is becoming easier. Of course other technologies still also have features that will be suited (or may be not suited) to the final application.

Important level measurements don't stop at the pumping station so the same devices may also be utilised at treatment plants for easy and difficult applications.

Each application is different, so it is crucial to have an understanding of the principle of operation of all these styles of measurement in conjunction with good installation and commissioning by trained personnel. With all factors taken into consideration a reliable level sensor (or sensors) can be installed every time.

1.0 INTRODUCTION

In all level monitoring and control applications, but especially when using non-contact level sensor such as radars in pumping stations, there are three important factors to achieve a successful level measurement:

- Selection of the right technology for the application
- Correct mounting position
- Commissioning by trained persons

2.0 DISCUSSION

2.1 What Is A Sewage Pumping Station?

A sewage pumping station is an integral part of a sewage network. Its primary role is to collect wastewater and then pump it from one location to another. The site usually has one or more large, deep wells where wastewater can enter from an network of incoming pipes.

A radar level measuring sensor determines the height of wastewater in the well and sends a signal to a controlling system. The controlling system starts and stops large pumps which empty the well and transfer the wastewater on its journey towards a sewage treatment plant. Often a line of several sewage pumping stations are needed to transfer the wastewater from long distances away.

2.2 Why Control The Level?

It is important to accurately measure and control the level in SPS's primarily to ensure that the sewage does not get too high where spills will occur which can harm the environment. Conversely, the level cannot get to low as the pumps are usually designed to allow fluids only, and if too much air is injected then damage to the pumps can occur. Much care is taken in the selection of level sensors in SPS's to be accurate, reliable, and repeatable.

The control of the level is usually between about 15...30% to ensure there is enough capacity in the well in case of failure of the pumps.

As a backup to the primary radar level sensor there is usually high and low emergency switches which will take over if the level sensor reading is offline.

2.3 How Is The Level Controlled?

The level of wastewater in the wells is measured using a level transmitter. Several different types can used based upon available mounting locations, process conditions, or sometimes simply users preference. Non contact sensors like ultrasonic or radar transmitters can be mounted at the top of the pit. Hydrostatic pressure or conductive probes can be inserted into the medium.

A signal from the level transmitter goes to a controlling and monitoring system which is programmed to start and stop pumps when the level reaches critical points eg. start the pump at 30% full and stop the pump at 15% full.

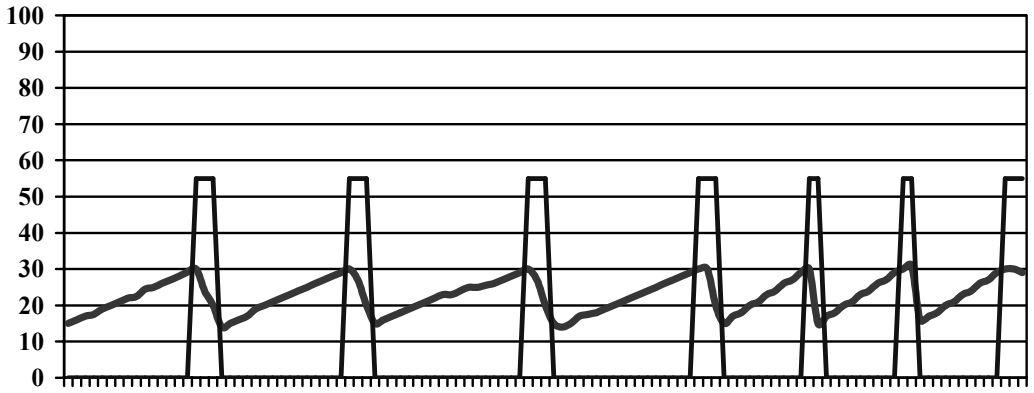

Figure 1: ***Trend showing level sensor output and pump on/off action***

2.4 Radar Level Transmitters

The idea of radio detection and ranging devices has been around for almost a century now. Microwaves are emitted towards an object; and the return signal produced by the targets ability to resist the transmitted microwave can be used to determine information about the target. This technology can be used to tell where aeroplanes are in the sky, how much rain is falling, or how fast you are driving.

As a level sensor, this type of technology uses the microwaves to measure the distance to a contained product. A system usually comprises a sensor which mounts at the top of the pumping station with an integral transmitter.

Figure 2: ***Typical radar level sensors***

There are two types of radar level sensor. FMCW (frequency modulated continuous wave) and pulse radar. In the pulse radar sensor the antenna of the instrument emits short radar pulses with a duration of approximately 1nS. The speed of the microwave pulses is about 300,000 km/sec. Similar to the widely known ultrasonic level sensor, these pulses are reflected by the product and received by the antenna as echoes. The running time of the microwave pulses from emission to reception is proportional to the distance travelled and hence the level. The determined level is converted into an appropriate output signal and transmitted as a measured value.

The emitted microwaves from a process pulse radar have an average power of only about 0.002mW, so are quite suitable for use around people and machines.

The use of modern radar sensors in applications such as pumping stations is becoming more common as the benefits of such a simple, and yet powerful device are becoming more accepted, affordable, and reliable.

2.5 Considerations

Installation Position

Careful consideration needs to be given to the location of a level sensor so a reliable measurement can be achieved The best location for a level measuring device will differ with the technology selected, fixed structures in the vessel, and accessibility.

As non-contact radar sensors are above the liquid, special care must be made to minimise collision between the emitted signal and any fixed structures in the vessel like the tops of pumps or float switches. Preferably a direct path for the signal to be transmitted is best although a false echo suppression function is available in both radar (and ultrasonic) sensors.

Foam?

Often in a sewage pumping station the surface of the liquid has a layer of foam. This can affect ultrasonic and sometimes even radar sensors.

With ultrasonic sensors the sound waves that are emitted towards the product can be absorbed by foam, which will reduce the magnitude of the echo that is reflected. Consider

the walls in a sound-proof room.
With radar sensors the microwaves that are emitted towards the product can be scattered by foam, which also reduces the magnitude of the echo that is reflected. Consider a disco ball with a light shining at it. With some low frequency radars the longer wavelength of the microwave is such that it can penetrate some layers of foam with little or no effect on the echo. High gain radar sensors can often overcome this by amplifying even the smallest signal that is produced from the liquid interface under the foam.

Condensation and vapours?
Non-contact level sensors such as radar transmitters are mounted at the top of pumping stations and therefore the microwave signal must travel through an air-gap before it can reach the product level. If this air-gap is highly humid then this can hinder the emitted signal of some sensors. Microwaves are generally not hindered by these events as they do not use the air particles as a transmission medium.

If the humidity in a closed vessel is extreme, then condensation on surfaces can occur. In the case of a non-contact level sensor this can happen on the transducer face or antenna thus blocking the emitted signal. Sometimes this can cause level sensors read full (or 100%). Modern radar sensor overcome this by special processing algorithms that can determine that a moving echo must be a product whereas a stationary echo must be from either a fixed item in the vessel or buildup caused by condensation.

Cleanliness?
Some common methods of level measurement in pumping station include contact sensors, or those which need to be in contact with the fluid to operate. These can create hazards when they need to be removed for routine maintenance or inspection.

Non-contact sensors such as radar transmitters overcome this by their ability to measure the level without needing to touch the fluid.

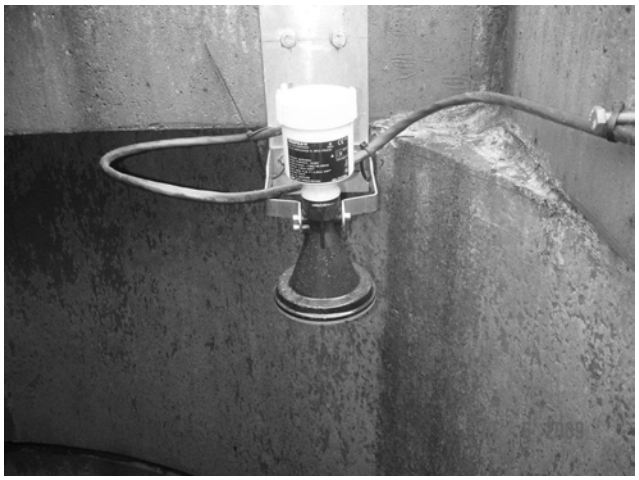

Figure 3: ***Installed radar sensor without touching the product***

2.6 Commissioning Level Sensors

On-site commissioning of level sensors is becoming more easy as technologies and industry tools improve. The traditional method of commissioning level sensors was the tedious process of emptying and filling the vessel several times to set and check the

adjustments.

In recent times the use of smart instruments and software can greatly assist in commissioning by offering fast set-ups without the need to empty and fill the vessel. A radar transmitter can be programmed after installation, by using known vessel dimensions. Potential "false echoes" that can occur with these technologies can easily be identified and suppressed using the software.

Generally speaking the most important functions to enter when programming are the minimum and maximum ranges.

2.7 Commissioning Tools

Most sensors and signal conditioning instruments use supplier specific software where a database of known sensors is stored in a technicians computer. These are polled to detect which unit/s are connected and specific parameters for that model will become available for adjustment or monitoring. These DTM's (device type managers) or EDD (extended device descriptors) are both highly informative and user friendly.

Figure 4: ***Notebook PC and HART communicator, typical programming tools***

An interface modem is usually required to connect the technicians computer to the instrument. Different connection methods can be utilised, HART or proprietary buses are often both available.

3.0 CONCLUSION

The three important factors when obtaining a successful level solution in a pumping station are always; correct selection of the sensor for the application, ideal mounting position, and commissioning by trained persons. With modern radar level sensors, the selection of the correct instrument at least has been made easier by improved signal processing, convenient mounting options, and easy programming.