The measurement of level and flow is crucial to effective and efficient waste water treatment. Ultrasonic technology promises that and some more.

It wasn’t so much about winning an order than about the opportunity to increase awareness about the benefits of ultrasonic technology in the water/wastewater treatment plants in this region,” said David A Hewitt, CoC Process Sensors Manager Middle East, Siemens Automation & Drives. Hewitt was referring to a six month trial deployment of Siemens’ ultrasonic level meters at the STP of a public works authority in the GCC.

The meters were used to control and monitor the operation of two pumps in a dry well, in order to prevent spillage of effluent, provide reliable information to the control room on the level status in the pumping station (interfacing with an existing Remote Terminal Unit – RTU), eliminate maintenance issues associated with contact measurement equipment and provide reliable, continuous measurement of level on a 24x7x365 basis.

Siemens installed and commissioned an Echomax Transducer (for monitoring the well) and a HydroRanger 200 level controller (to process the transducer signal and feed the 4-20 mA output to a central control room for continuous level reading) at the site. A third party data logger was installed to monitor and capture data in order to validate the performance of the level controller and enable a comparison with the RTU data. Hewitt said, “Following the installation, we visited the site three times. The unit performed successfully without any spillages and continuously updated the Authority’s central data storage with the level status of the station. Due to its non-contact nature, the unit did not require any maintenance.”

Hewitt believes when it comes to flow and level measurement in waste water treatment, ultrasonic is the way to go. The single phrase that sums up the benefits of ultrasonic is non-contact. “You have a choice in measuring...
sewage level, by being in contact with it or not being in contact,” he said.

Level devices can be continuous like ultrasonic and radar or point-level like floats and hydrostatic. Contact measurement devices like floats, bubbler and hydrostatic systems are vulnerable to clogging and other problems caused by suspended solids, harsh corrosives, grease and silt in the effluent, and need to be cleaned and replaced often. The higher maintenance costs and repairs associated with contacting devices can exceed any initial savings. Moreover, there is also a high element of risk to personnel going down into wet wells for maintenance of contact equipment.

Hewitt pointed out that ultrasonic meters are amenable to quicker installation and configuration, with three hours being the approximate time it took his team to get the trial site up and running. The unit was also configured on site. “The unit acts as an ultrasonic tape measure. Once the empty distance is programmed in, the unit will base all its calculation from this reference. The empty distance could be from the transducer face to the bottom of the well or wherever you want the end point to be. The unit can be commissioned, whether the well has sewage in or not,” said Hewitt.

He went on to sum up the key features of the trial unit: Two power supply choices 110/240 V AC and 12-30 V DC; a choice of two transducers - 0-8 metres and 0-15 metres; completely sealed (IP65) weather resistant housing for the unit; all the transducers are rated to IP 68 i.e. 100% submersible, should an overfill condition occur, Password protection to prevent of unauthorised programming; alphanumerical LCD display and bar graph to indicate the status of the pumping station well and which pump is running; two 4-20 mA output signals and up to six relays that can be programmed for pump sequences, such as duty standby, duty assist or percentage ratio.

Hewitt also used the opportunity to highlight the advantages of ultrasonic over hydrostatic. “Hydrostatic devices can give only 4-20 mA, a floating switch can give only on/off contact. For ultrasonic, it depends on what you want it to do. If you want it to give 4-20 mA, it will; if you only want it to give a contact closure, it will do that too. Moreover, ultrasonic can be configured on-site while hydrostatic
device have to be calibrated in the factory. So if you order them wrong, you are stuck.”

The numerous references to pumps brought the discussion to the core application of level measurement, which Hewitt noted, “is primarily a means to the end of efficiently controlling a process using pumps and valves.” And the best candidate for that is, of course, ultrasonic level meters because “they can provide the information you need to monitor and control pumps effectively.”

Hewitt noted that most ultrasonic meters including Siemens’ come equipped with relays for simple pump control that facilitate, for instance, economy pumping by scheduling pumping for off peak periods to save on energy costs; monitor pump performance people including pump status, efficiency and total pumped volume so that failing or under-performing pumps can be repaired, replaced or used less. “Where a plant has pumps of varying capacities, you can program the controller to turn the pumps on and off depending on flow. You want to engage the high capacity, high energy-consuming pumps only when needed,” said Hewitt. Advanced controllers offer a variety of pump control routines and subroutines such as fixed duty assist and fixed duty backup; alternate duty assist and alternate duty backup; service ratio duty assist and service ratio duty backup.

These routines manage pumps efficiently to save energy. This information enables plants to optimise operations with pump control by level rate of change, service ratios to balance pump run times, pump start delays to reduce power surges, pump run-on or valve flushing to clear sediments. The end result is a reduction in scum line build-up and more effective routine maintenance. “The range of control options is extensive with relays and current outputs as standard, but digital communications like Profibus is becoming also more common,” observed Hewitt. Advanced systems also enable monitoring of flow trends. By doing that across the entire network, plants can identify and address current and future problems. For example, one of the big challenges over time is that of specifications to meet future population demand. It is common for pumps to be under or over-specified. Trend flow monitoring identifies increases in demand for future planning and engineering.

So how should one go about selecting ultrasonic level measurement systems? Hewitt indicated that customers are concerned mainly about accuracy and reliability. However, accuracy and reliability are seen differently by different people. He continued, “If we take measurement accuracy, when customers state they want to stay within +/-6mm, they mean that irrespective of the time of the day or the season, irrespective of where the level is in their wet wells, they want to know it to within 6mm. For the product designers, it is about testing the product in the laboratory under ideal conditions and applying standard statistical methods to determine accuracy, repeatability, and linearity. We end up with a situation where all the products can ‘state’ that they meet the required accuracy over range.”

Similarly, reliability for the customer is often reliability of the measurement not the product, whereas the product designer takes that requirement at face value and builds in product reliability.

However, measurement devices today are more or less meeting the user expectations on accuracy and reliability fronts. They are expected to work first time out of the box and still be working a year later in the field. The twist in the tale is their perceived measurement reliability over time.

**MEASUREMENT RELIABILITY**

Hewitt pointed out that skilled technicians control and carry out tests in the laboratory under ideal conditions. Though the design
The process may have included extended site trials on carefully selected applications, again these would have been attended by skilled personnel who adjusted and fine tuned the product for best performance. The fact of the matter is that the world inside a wet well is anything but ideal with various influences that affect the return signal. There are internal structures such as pump cases, benching, guide rails, ladders, braces and struts. The process will have filling and emptying flows that obstruct parts of the well and cause turbulence or foam on the water surface. Ambient noise can be a negating influence and so can temperature. The challenge is to ensure reliable and accurate level measurement under such real life conditions.

An ideal situation would be one where the level measuring product can be mounted clear of all obstructions. However, this is often not possible, and even otherwise, the ideal state could be disturbed once the filling and agitation begins. Hewitt noted that when faced with site constraints and obstructions, the product with the narrowest beam angle has the least chance of accidentally hitting an obstruction and seeing a false echo. But if the beam angle is too narrow, agitation of the water can cause loss of echo at the receiver. “Our experience is that the optimum beam angle is between 6° and 10°,” said Hewitt.

While emphasising the importance of careful selection of mounting and optimised beam angle in getting reliable and accurate measurement, he cautioned that at times, even this could fall short, leading to false echoes and unreliable measurements. One solution would be to install products that can be taught the positions of obstructions giving rise to false echoes so that they can be ignored. But this often requires a reasonable degree of input from a skilled commissioning engineer, and once again, there is an assumption of constancy. “For example, a conventional system using false echo mapping may successfully be programmed to allow for a set of ladder rungs. However, what happens as product build up occurs on the rungs. The shape of the echoes in the pattern changes and so does their apparent position. Eventually, false echoes will again start to appear, and measurement becomes unreliable,” said Hewitt. A better alternative, he said, would be a system with built in signal-processing software, like Siemens’ Sonic Intelligence, that will not only automatically learn an installation but continue to adapt its internal map as things change. Sonic Intelligence is basically a set of algorithms that analyses echo profiles (a digital picture of the reflected echo) and learns to ignore obstructions and false echoes. “Sonic Intelligence distils down more than 20 years of accumulated data and experience with level applications,” claimed Hewitt, and went on to expand on its benefits, listed below:

A) Sonic Intelligence automatically optimises itself for both long and short range measurement by varying the ultrasonic pulses which are fired at the surface to be measured. At short range a narrow pulse is used to minimise blanking distance to within 300mm, at long range a wider pulse delivers more power right to the bottom of the well where it is needed maybe 15m away.
When selecting a transducer, the most important criteria are the application’s measuring range and environment. Very dusty or steamy conditions may reduce the effective standard range of a transducer so you may want to choose a higher range to compensate. Special models are available for long ranges, high temperature, dust and hazardous applications. Check the specifications carefully to ensure a transducer is suitable for the gases, conditions, temperatures and other conditions of your specific application. If the transducer could be submerged in its application, such as in a flooded wet well, for example, use a transducer with a submergence shield. The submergence shield will maintain an air pocket in front of the transducer. The transceiver recognises the unique echo created by the air pocket, and the transceiver outputs a high level reading. When installing a submergence shield, ensure it is properly seated and even across the transducer. Ensure there are no leaks by placing the assembled unit in a bucket of water and observe any bubbles leaking out. Leaks indicate the shield has not been pulled down far enough to properly seat the pressure clips.

When selecting a transceiver, make sure it is compatible with the transducer. In terms of transceiver features, there are many to choose from. You can select from rack, panel, or wall mount versions, depending on your plant configuration. Some transceivers offer pump control functions as well as level monitoring. Some models offer backlit displays for easy readability, advanced echo-processing technology, as well as data logging, remote monitoring and other advanced features that can improve plant efficiency. Consider your specific application needs against the many features that are available.

**LOCATION**

Choose a location that has no obstructions in the sound signal path or, at least, minimise any obstructions. To measure level, a transducer must be able to “see” the material being measured. A beam, pipe, or structural brace will block the view and affect the reading. For best performance, mount the transducer away from these obstructions and give the transducer a clear shot at the material to be measured.

The ultrasonic pulse radiates in a cone shape from the face of the transducer. It is important to keep objects out of this signal cone to reduce the chance of false echoes being recorded.

The transducer beam angle specifies the degree of the cone where the ultrasonic pulse’s power is reduced by 3 dB (decibels). In open vessels, locate the transducer as close as possible to the maximum height of the material being measured without infringing on the blanking distance (the distance required for the signal to be returned).

**Figure 1:** The submergence shield is designed for applications where flooding may submerge the transducer. The shield, which fits over the face of the transducer, creates an air pocket in front of the face which transceivers detect as a flood condition.

**Figure 2:** It is important to keep objects out of the ultrasonic signal cone to reduce the chance of false echoes being recorded.
b) In sump applications where submersion shield is a standard protection for the sensor face, Sonic Intelligence can look at the signature of the echo from the air within the shield. This information can be used to turn on additional high-high level alarms.

c) Turbulence or foam on the water surface can result in echoes being directed everywhere except back to the receiver. In such a situation, many level measuring products quickly revert to “lost echo mode” and fall back to various modes of ‘hold last’ reading or simple error output. Sonic Intelligence can determine if the surface is agitated or covered in foam by analysing the statistics of the fluctuating signals which manage to return. With the knowledge of how the level was moving before and also which pumps or valves are open, it can continue to track the level even with intermittent measurements.

As the interview drew to a close, the discussion veered around to how ultrasonic technology faring in the Middle East? Hewitt replied that the ratio is 10:1 in favour of hydrostatic. Why so? Tenders continue to specify hydrostatic devices, and engineers prefer to stick with that because going back to the consultant to change the specs to ultrasonic would lead to time delays in closing the bids. Pump suppliers like KSB and Grundfos use hydrostatic over ultrasonic only because the end-user has specified so. Hewitt ascribes this preference to the hydrostatic mindset of the engineers. “It is more than a job for us to change. We have to slowly put something in for evaluation, make sure it proves itself before we are able to get ourselves in,” he said. However, the earlier STP story ended on a successful and pleasant note: At the end of the six month trial, Hewitt and his team discovered that the STP had 24 Siemens ultrasonic units fitted on its treatment works. “This technology is not entirely unknown in this region, having made its way here through overseas contractors. But for it to become more widely prevalent, a mindset change is needed,” he noted. Hewitt hopes to build ultrasonic’s case in general and his company’s strength in particular on the back of the million units installed by Siemens globally.

Aim the target
For best results in liquid level measurement, the transducer must be perpendicular to the material

Provide a secure platform
Attach the transducer to a stable, secure platform. You may use mounting platforms you have designed in-house or, in many cases, it may be easier and more cost-effective to use ready-made mounting brackets from the transducer supplier. Eliminate welds and seams as they have the same effect as build-up. Stilling wells (essentially an extended standpipe) may be used for turbulent liquid applications.

Use proper cabling
Cable selection is a very important aspect of ensuring proper functioning of the transducer. Installation should only be performed by qualified personnel and in accordance with local governing regulations.

In general, transducer cable runs should be in grounded metal conduit to protect it from ambient electrical noise. Do not run cables near high voltage or current runs, contractors or SCR control drives. Seal all thread connections to prevent the ingress of moisture. For extended runs beyond the transducer’s integral cable always check the product manual for recommended cable type.

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Close proximity reduces the target size for more precise sensing. The blanking distance varies among models, so you should check the product manual for blanking distance instructions related to your transducer. In open channel applications, place the transducer away from channel feeding points where the water velocity or turbulence may reduce measurement precision. Consult the transducer manual which should provide location instructions related to various types of flumes and weirs.

Ultrasonics level controllers are available in panel mount versions allowing installation directly into existing panels.

Conditions in wetwells are challenging - debris clings to all surfaces and there are many obstructions. Self-cleaning transducers are available too tackle this issue while built-in signal processing software processes the echoes, thereby ignoring the debris and obstructions and providing reliable and accurate level readings.

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In solids applications, the transducer should be perpendicular to the angle of repose of the material, which usually means mounting it to one side and at an angle. For cone bottom tanks, aim the transducer at the draw point at the centre of the cone. Aim the transducer away from seams, structures and irregularities in the bin wall. Locate the transducer away from the material inflow. On fluid-like solids, aim the transducer perpendicular to the material surface. On dual discharge bins, aim the transducer at the draw or discharge point to ensure accurate readings on emptying.

**MATCH ENVIRONMENT TEMPERATURE**
If a transducer becomes significantly warmer or cooler than the average air temperature in the application environment, it can affect accuracy because the speed of sound changes with temperature. It’s always best to mount a transducer where it will share the same air temperature as the rest of the application environment.

If there’s a significant temperature difference between the medium and the sensor surface, you can obtain the highest level of accuracy by installing an external temperature sensor connected to the transceiver to do the proper calculations for you.

**MAINTENANCE IS EASY**
If significant performance changes are observed, shut down the level measurement system and inspect it, starting with the transducer. Ensure the transducer is still firmly mounted, wipe the face if it has become soiled, and check the wiring conduit to ensure it is all sound. Generally, low maintenance is a key advantage of ultrasonic transducers. The powerful pulsing action makes the face self-cleaning. Because they use non-contacting technology, they are not subject to material build-up. This avoids the nuisance, danger and expense involved in cleaning, adjusting and repairing contacting devices.