VEGA Journal

INTERVIEW: In any weather. **TECHNOLOGY:** Reliable measurement. **FIELD REPORT:** Clean measurement. ■ Water levels under control. ■ Radar delivers a clear picture. ■ Fresh water anyone? **LOOKING FORWARD:** Level measurement for weir control.

Issue 2/12

In Germany alone there are approximately 10,000 water treatment plants, where each year about 38 billion cubic meters of wastewater are cleaned. The data from numerous instruments form the basis for reliable processes.

Only the best is good enough

Radar sensors, designed for level measurement in water and wastewater applications, are technically and economically more than just an alternative to previously used techniques. They have demonstrated their capabilities over and over again in the field, and have proven to be the best solution for many applications in the area of water level and flow measurement. This has resulted in them being accepted as the "state of the art" technology for this sector.

State of the art – what is it really?

The term "state of the art" is used in many industries, and was so important to the European Standards Committee that it explicitly defined the term in DIN EN 45020 in 2004.
This shows that radar technology has been considered "state of the art" for some time already. Radar devices have been used for more than 20 years in the chemical and petrochemical industry and during this time have proven to be outstanding measuring instruments. Radar technology has also found

its way into the bulk solids industry and is established as a universal method for measuring a wide variety of bulk materials under all kinds of process conditions.

Until now, radar sensors were used in the water and wastewater sector only where the properties of microwave technology offered significant advantages in the application. In most cases ultrasonic sensors continued to be used for non-contact measurement of water levels or for flow measurement in open channels. Ultrasonic technology was the previous "state of the art" in this industry, because it offered adequate performance at a reasonable price. Many users were not even aware of the weaknesses of the ultrasonic measuring principle, or they just accepted certain compromises.

Radar technology optimised for wastewater

To allow the advantages of radar technology to be applied more widely in the water sector, the sensors were adapted to suit the required operating environment. This resulted in housings of highly durable plastic and factory sealed cables with a high protection category of IP 68 (2 bar). Process fittings of stainless steel were deliberately omitted in order to reduce weight and costs.

The result is a radar sensor that's a perfect fit for the water industry, both technically and commercially. VEGAPULS WL 61 from VEGA offers considerable advantages over the previously used ultrasonic sensors in all the typical applications of this industrial sector. The sensor measures the water level with great accuracy, regardless of the prevailing environmental conditions, such as temperature fluctuation, wind, intense sunlight, rain, snow or fog.

There are a range of installation options, such as wall fixing strap, bracket or collar flange. These allow the user to mount the sensor easily, without additional effort and expenditure. Integration into existing systems is easily accomplished with the 4 ... 20 mA current output (Profibus and FF are options too). Adjustment is carried out digitally via the superimposed HART signal or via fieldbus.

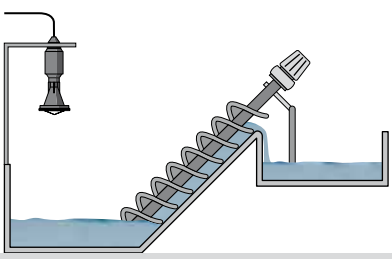
The radar sensor VEGAPULS WL 61 was developed from the very beginning in compliance with the new European standard EN 302729, "Level Probing Radar (LPR) equipment operating in the frequency ranges 6 GHz to 8.5 GHz, 24.05 GHz to 26.5 GHz, 57 GHz to 64 GHz and 75 GHz to 85 GHz", fulfilling the latest directives, which were not passed until last year.

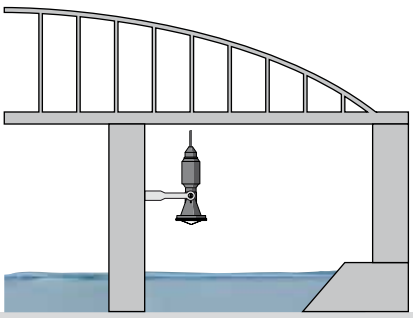
To protect against condensation and fouling, the entire antenna system is enclosed and sealed with a plastic disk.

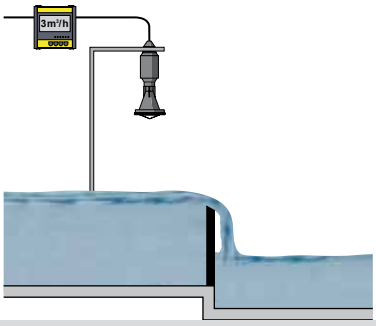
Thanks to this new development, radar technology is not just an alternative to ultrasonics: VEGAPULS WL 61 now defines the "state of the art" in the wastewater industry and sets new standards for the future.

On the following pages, you'll see typical applications in which VEGAPULS WL 61 has been deployed. For example: in stormwater overflow basins and canals, in the pump shafts of sewage treatment plants and in the wastewater treatment plant of a brewery.

From left to right:
Level measurement for pump control
Gauge measurement in open waters
Flow measurement in open channels







"In any weather – radar sensors for outdoor use."

Jürgen Skowaisa, product manager for ultrasonic and radar instrumentation.

VEGA Journal: *In the wastewater industry, we see primarily ultrasonic measuring devices and hydrostatic pressure transmitters being used. Why is radar measurement technology not as common in this industry?*
Skowaisa: The water sector hasn't had much experience with this technology yet. On the one hand, the cost of a radar instrument used to be significantly higher than that of an ultrasonic instrument, and on the other, many users still think this technology is used mainly for extremely difficult applications.

VEGA Journal: *Are these preconceptions still justifiable?*
Skowaisa: No, these assumptions are now completely outdated. Especially since radar is independent of external weather conditions such as rain, solar radiation, wind or fog, we believe that radar measurement is actually the more suitable alternative. Another consideration is that adjustment and operation of radar instruments has become very easy.

VEGA Journal: *The temperature dependence of ultrasonic instruments is compensated by a temperature sensor in the transducer, isn't that enough?*
Skowaisa: As long as it's cloudy, you get fairly accurate values. In bright sunshine, however, temperatures rise quickly in the mostly black ultrasonic transducers. If there is a large difference between the transducer and the ambient temperature this can cause significant measurement errors.

VEGA Journal: *What are the consequences of these measurement errors?*
Skowaisa: In flow measurement of open channels, the flow measurement error of ultrasonic sensors, due to temperature error, can amount to more than 20 %. Local authorities and individual companies will calculate their costs based on this of wastewater measurement data, so substantial differences can arise in their accounting.

VEGA Journal: *How do users benefit from radar technology?*
Skowaisa: The benefits for users include high accuracy, high reliability, ease of use and low costs. Previously, the price difference between radar and ultrasonic instrumentation was very high; today, the price of radar is comparable to that of ultrasonics.
There are even applications in which the price of radar instrumentation is actually lower, e.g. in extremely deep stormwater basins where a correspondingly large measuring range is required. Additionally, radar sensors can still continue to measure when water comes

very close to the antenna, and they can withstand complete immersion, thanks to their IP 68 protection category.

VEGA Journal: *Does radar technology require special approvals?*
Skowaisa: Radar sensors have to be approved for use in hazardous areas, of course. This is often necessary in the wastewater sector because many areas in the waste water, especially underground can have methane present.
VEGAPULS WL 61 is also the first radar sensor to be developed according to the new EU directive for the "Use of radar sensors outdoors." In DIN EN 302729. The frequency ranges and power levels of the devices have been re-defined – the new VEGA sensor complies with them in its entirety.

The shaft of the sewage pumping station is located in the middle of a flood-endangered area, so the radar gauges were designed with protection category IP 68.

Reliable measurement

In the course of modernisation of one of its stormwater basins, the wastewater treatment plant Waiblingen-Hegnach decided to implement radar measurement technology from VEGA. The basin, which is 5 kilometers away from the treatment plant, is monitored reliably by three radar sensors.

The employees of the sewage treatment plant Waiblingen-Hegnach certainly cannot be accused of not being close to nature. Yet they do have mixed feelings about spiderwebs! Spun beneath the ultrasonic sensors, spiderwebs used to cause measurement uncertainties again and again. But animals and insects were not the only culprits: foam and even sunlight also had adverse effects on the ultrasonic measurement. Indeed, the Waiblingen staff has really had enough of foam. Once, the wastewater discharge from a nearby shampoo manufacturer caused major problems for the ultrasonic measurement due to the huge amounts of foam generated.

While planning the new instrumentation for the stormwater basin, plant manager Frank Sura knew exactly what he wanted. “As a matter of principle we use non-contact methods for wastewater wherever possible. Because of the oil, dirt and debris in the water, ultrasonic technology was often deployed, accompanied of course by the very well-known difficulties of using that method.” That is why, in the course

of modernization of the stormwater basin, radar level sensors of type VEGAPULS WL 61 from VEGA were used instead, at three different measuring points.
Since May 2011, the instruments from VEGA have been delivering reliable and stable readings. "It is certainly not a particularly difficult application, but it has to function reliably," explains the pragmatic Mr. Sura. "Beside their reliability, what really convinced us about radar instruments was their price, which was hardly different from that of ultrasonic devices." All plant components are connected via a control system, so the team working at the sewage treatment plant has access to all functions at all times. This is important because such mid-size treatment plants tend to be minimally staffed and many different areas have to be monitored. A remote control system provides security, setting off an alarm in case of damage or contamination by toxins or other hazardous substances.

Always a good overview

The stormwater basin, one of a total of 13, is 5 km away from the treatment plant and situated directly on the banks of the river Rems.

The radar sensor always has its eye on the level in the stormwater basin. A remote control system sends the measurement data to the control room via mobile phone network.

The measurement data is transmitted every half hour to the control system via a mobile phone network. The radar sensors are deployed at three measuring points. All units have Ex certification, a necessary precaution since fuels or solvents can also be present in the wastewater. Location Number 1 is directly in the open stormwater basin. There, the sensor monitors the level in the basin and, if necessary, puts the discharge pumps into operation.

In the nearby sewage pumping station, another radar sensor is installed in the pump shaft. Previously, this measurement was realized via a pressure measurement. The entire facility is located in a flood-prone area. "The Rems has a small channel, but a large drainage area. As a result, the water level can rise substantially within a few hours." That's why the measuring instruments have protection category IP 68, which allows them to be immersed in floodwaters.

The third instrument is located some distance away, hidden in the middle of a meadow. There, a vortex valve regulates discharge into the sewer line. Most of the water generally flows past the basin. Only when there is a heavy rain, for example, and the rainwater runoff increases to a multiple of the normal wastewater flow, do the stormwater basins come into play. They buffer the dirty water and take the load off the treatment plant. The tank contents stored during the heavy rain are forwarded to the sewage treatment plant little by little after the rain event. To ensure proper control of this process, the vortex valve has to work flawlessly.
"Very few people have an idea of what can be found in sewage. We've already had to remove boulders, two-by-fours and flashlights. A large tree branch can block the vortex valve very quickly," continues the plant manager.

In the past, someone from his team always had to go and check if there was really a blockage or if it was just another industrious spider that had built its web under the sonic transducer! This is no longer necessary, since a radar level gauge is keeping watch there now.

Further upgrades, including additional stormwater basins within the catchment area of the wastewater treatment plant, are planned for the future. "We'll build on radar measurement technology for this, too," says Mr. Sura in conclusion.

Info

The 30-year-old sewage treatment plant in Waiblingen-Hegnach is designed for a population of 25,000. 80 km of canals carry sewage and stormwater from surrounding villages to the treatment plant in lower Remstal. The wastewater treatment plant facilities include a biological phosphate removal system, digestion and a cogeneration plant that supplies about 50 % of required electricity (can also supply emergency power) as well as the total heating requirement.

Some of the 13 stormwater basins of the wastewater treatment plant are old Imhoff tanks, which were converted with minimal effort into stormwater basins during the process of centralization of all sewage works in the area around 30 years ago. These are now being gradually modernized and equipped with modern instrumentation.

Clean measurement in the sewage tunnel

The modern sewer network of the Greater Salzburg Conservation Association also serves as a rainwater storage system. In times of heavy rainfall, it ensures a constant flow of wastewater to the sewage treatment plant as well as efficient operation of the entire system. This optimal performance is achieved through a network of underground storm sewage overflow structures.

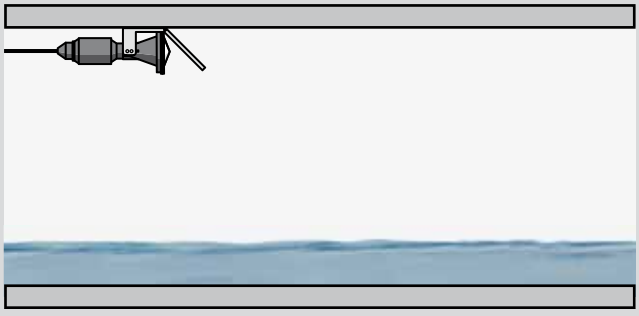
At the overflow station Düker-Salzach, they require reliable measurement of the overflow volume in the connecting pipe that runs under the Salzach River. This "hydraulic proof" was previously carried out via a combined height and flow velocity measurement with ultrasound. But sediments impaired the measurement on a regular basis and the ultrasonic sensor was also occasionally damaged by flooding or water-born rocks. All in all, this resulted in restricted function, uncertain measurement data as well as high maintenance costs.

Sensor under water – no problem!

In the search for cost-effective alternatives, the radar sensor VEGAPULS WL 61 was found to be the ideal solution. It measures the level in the given conditions with millimeter precision and provides an accurate documentation of overflow volume. What is more, its completely sealed construction makes it robust and maintenance free. Even after immersion in floodwaters it keeps on working – the high protection rating IP 68 (2 bar) makes it possible. The cable is factory fitted and sealed which saves time during installation. Another plus point: with radar sensors, measurement is possible right up to the antenna system. A minimum blocking distance, as required with ultrasonic sensors, does not have to be maintained. This means that the total channel capacity can be optimally measured and utilised for storage.

Into the signal conditioning instrument – and onto the information highway

But how do you get from level to flow volume? The connected VEGAMET 391 signal conditioning instrument is programmed with the cross section/height characteristic of the sewer pipe and converts the level into the corresponding flow volume. The output signal is used for direct control of an automatic slide valve. All the measurement data from the stations are transmitted to the control center quickly and reliably via fibre optic cable.
By the way, the measuring system processes flow rates of 200 ... 2500 l / sec. – so the next deluge of rain can come any time!



Measuring around the corner with VEGAPULS WL 61: a suitable holder with integrated deflection plate for fast, space-saving installation.

Info

The Greater Salzburg Conservation Association is one of the largest municipal wastewater associations in Austria. It operates a network of collection conduits about 540 kilometers long for the transport of wastewater from local sewerage systems as well as a biological sewage treatment plant with a capacity equivalent to 680,000 residents. To manage these complex systems, the association relies on the latest measurement, control and feedback control technology and network information systems.

Keeping the water level under control

Many regions in northern Germany are below sea level and have to be continuously drained. A long-established method of doing this are the pumping stations, which remove excess water and keep the level constant. Nowadays, state of the art measurement and communication technologies control these stations efficiently and reliably.

Drainage of the land is particularly important for its agricultural use. The Eider Treene Association in Pahlen operates 50 pumping stations, and is responsible for an area of approximately 1130 km^2.

The latest measurement technology for pumping stations

Most pumping stations are equipped with the latest measurement technology, some even run fully automatically. At one of the pumping stations, however, the pumps are still controlled by a classic float switch and the levels logged by a mechanical pen recorder. This necessitates the procurement of recorder paper and spare parts, which in the meantime has become quite a challenge, as well as cumbersome archiving.
Together with the West Coast University of Applied Sciences in Heide, the Association worked out a good solution. In a first step towards modernization, VEGAPULS WL 61 radar sensors were deployed for level measurement in eight of the pumping stations. A VEGAMET 391 signal conditioning instrument transmits the level data once a day via mobile network to headquarters, where they are stored in a simple and well-organized digital archive.

Early warning system for water influx

Another project focuses attention on the surrounding tributaries leading to the pumping stations. In the future, the huge amounts of water that flow to the pumping stations during heavy rainfall will be detected earlier, allowing the pumps to start up ahead of time. To this end, self-sufficient level measuring systems are being installed on the various tributaries. Each measuring point consists of a VEGAPULS WL 61 radar sensor, a VEGAMET 391 signal conditioning instrument and a radio transmitter. Solar panels provide the measuring stations with energy.
The signal conditioning instrument monitors the water level or change of the water level and sends a message via mobile network to the pumping station. There, a switching command is triggered to start the pump. The processing unit at the measuring station stores the signal level of the radar sensor minute by minute and radios the recorded level trend curves once a week.
First experiences with the system have been promising. In the long run, collecting data on inflow quantities for pump control will contribute significantly to higher operating and planning reliability .

The pumping station at Tielenau is used to drain the middle reaches of the river Eider. The total capacity of the pumps is 6 m^3/s.

Info

Water lifting stations are the oldest man-made technical installations. They are used for draining the marshes and lowlands of agricultural land on the coast or in river landscapes. In pumping stations the water is raised high enough so that it can then flow out, e.g. via channels, with a natural downhill gradient. In areas where the fields are higher than the groundwater level they are used the other way around, namely for irrigation.

The Eider Treene Deich- und Hauptsielverband, based in Pahlen in Schleswig-Holstein, has 34 member organizations. Its functions are inland flood protection, operation of water pumping stations as well as maintenance and development of inshore waters.

The West Coast University of Applied Sciences in Heide (Schleswig-Holstein) teaches special fields of technology and business. In the course “Electrical Engineering and Information Technology”, numerous projects and bachelor theses on measurement data acquisition and processing have already been carried out.

Radar delivers a clear picture – waste-water management in the brewery

The long established Karlsberg Brewery has had its headquarters in the city of Homberg, in Saarland, near the French border, since the late 19th Century. This is where the art of brewing is practiced for classic pilsner varieties as well as popular mixed drinks – all with state of the art technology.

Large quantities of fresh water enter the brewing process from four privately owned wells each day. Whether for grinding, mashing, fermenting, rinsing or cleaning – each stage of the brewing process has a great demand for water. In spite of optimised process steps and recycling, up to 250 m^3 of wastewater are produced per hour at peak times. It is collected in two large subterranean wells and pumped into a highly efficient wastewater treatment plant.

View of the Karlsberg Brewery from the city park in Homburg.

The right measure – in spite of steam and foam

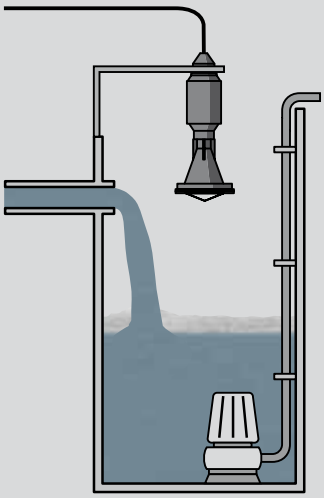
Wastewater levels in the wells must be reliably determined and processed by the control system. The measurements are used to control powerful pumps by means of frequency inverters. Throughout the process, measuring conditions in the wells are a real challenge: extreme moisture, agitated surfaces and clouds of steam. In addition, foam is created through the action of sterile water and detergents.

Previously employed capacitive cable probes did not fully meet the requirements. Buildup had to be cleaned off regularly; the stay wires made the removal of the probes difficult. This was clearly a case for VEGAPULS WL 61 radar: the instrument is non-contacting and therefore wear free. As a cost-efficient "water radar", it is totally encapsulated and complies with protection class IP 68 (2 bar). Its connection cable in two-wire technology is permanently attached and only needs to be connected to an intelligent terminal on site. From there, the measurement signals are routed to the control system via Profibus DP.

Radar thus delivers a clear picture for wastewater management, and keeps the beer and shandy brewing processes running smoothly.

Karlsberg

Tradition and innovation have shaped the history of the brewery founded by Christian Weber in 1878. With a reliable instinct for trends the company has progressed to an innovative array of brands. Karlsberg pioneered shandy (a beer and lemonade mixed drink), and with its fashionable alcho-pop MiXery it is still Germany's unchallenged market leader in this area today.



The VEGAPULS WL 61 is perfect for measurement in wastewater environments: simple mounting, encapsulated construction and high protection rating.

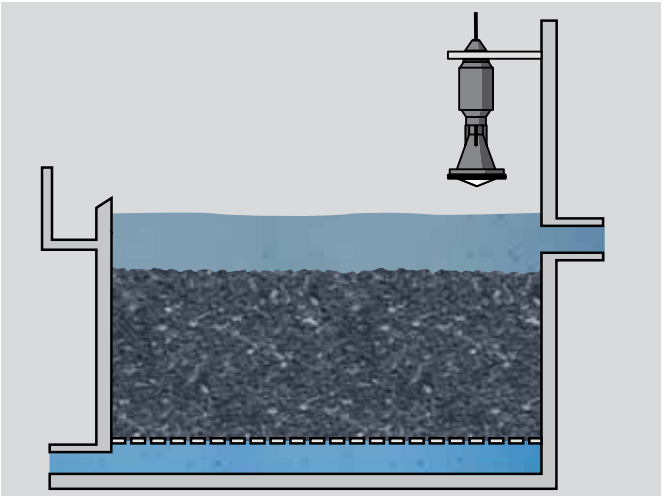
A drink of fresh water anyone?

In the Waternet drinking water purification facility in the Netherlands, water is cleaned in several stages. After a sand filter, which serves as a pre-filter, fine dirt particles are retained in a three-stage activated carbon filter. The level of contamination of the individual filter stages is detected by radar sensors via the water level in the basin.

The water at Waternet is pre-cleaned through a sand filter, softened, and disinfected with ozone before being fed into the multistage activated carbon filter. Here, mainly organic substances are filtered out in the different sized pores of the carbon particles. As the activated carbon gets increasingly clogged up with foreign material, its permeability decreases, which in turn makes the water level in the filter basin rise. So the degree of filter congestion can be continuously monitored by simply measuring the water level in the basin. When a certain level is reached, the filter bed is rinsed with a countercurrent, which flushes the deposited organic matter out of the carbon.

Waternet

The dike and polder committee "Waterschap Amstel, Gooi en Vecht" and the city of Amsterdam constitute together the Waternet water board. It handles the entire water cycle for 1.2 million people in Amsterdam and surrounding towns – from drinking water purification and supply to wastewater treatment and care of the dikes. Waternet also regulates the water level in the idyllic canals of Amsterdam.



To prevent the dirt and contaminants held back by the filter from depositing on the sensor, the water level is measured contactlessly.

VEGAPULS WL 61 radar sensors are used to monitor the water levels in the 40 carbon filter pools of Waternet. Mounted directly on the basin wall, they detect the level continuously without touching the medium – fouling of the sensors is impossible. Also, any contaminants on the surface of the water or foam generation during the flushing process don't affect the measurement.

The radar sensors provide high accuracy and operate completely maintenance free. Since they do not need a minimum distance to the medium, they can be installed closer to the water surface at maximum level. The mounting bracket from VEGA allows simple, fast installation of the instruments.

Level measurement for weir control

When the main switch of VEGA's own hydroelectric power station is in the "ON" position, there is no escape for the river Kinzig, which flows behind the Black Forest factory and headquarters of VEGA. The river water rushes through the valves to the turbine, where clean, sustainable energy is produced.

A 250 kW generator in VEGA's hydropower plant in Schiltach has been providing electrical energy for the company since 1997. It generates up to 50 % of the annual electricity requirement.

VEGA also uses the hydropower plant to test its own level and pressure measuring instruments under realistic conditions as well as demonstrate their practical application to visitors. The water level upstream and downstream of the turbine, the flow rate and the velocity are measured by a variety of VEGA sensors. The system also includes an automatic screen cleaning system, which is set in motion when too much flotsam has accumulated.

Just recently, wireless data transmission has found its way into the scheme of things here. A VEGAPULS 61 radar sensor measures the water level at the weir, and a PLICSMOBILE radio unit supplies the sensor with power and transmits the measured values via mobile network to the control center of the hydroelectric facility. To keep this measuring station operating independently throughout the year, an ordinary solar module continuously recharges the internal battery.

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