High-performance measurement technology in the water industry

Sewage

Ensuring good water quality, monitoring and regulating water levels, checking pressure conditions in water pipelines, and measuring the fill levels in tanks – measurement technology plays a major role in the water industry. With its extensive expertise and many years of experience, KELLER AG für Druckmesstechnik is able to offer a wide range of pressure sensors for water-industry applications.

Nothing runs without water! After all, water isn't just one of the great elements; it's also vital for our survival. Water is both a foodstuff and a necessary part of the process for growing food and maintaining livestock. Water also keeps industry moving as a coolant, a means of transport and a component of power generation processes. In other words, without water, our economy would come to a virtual standstill.

Water should therefore be viewed as essential and irreplaceable. Water is not available in unlimited supply, which is why we are all obligated to use it efficiently and carefully – and not just because of economic interests. Reliable and accurate measurement technology is extremely important here, and KELLER AG für Druckmesstechnik has been doing its part by ensuring reliable pressure measurement in the water industry for more than 45 years now. This is accomplished by the use of level sensors, data loggers, remote transmitters and display units that monitor water supply systems, sewage systems, groundwater levels and surface water. This brochure offers an in-depth look at cost-effective solutions for water applications that are based on the extensive H2O expertise at KELLER and the knowledge accumulated by customers over many years.

Sewage

Challenges in the water industry

Water is the most common chemical compound on Earth, covering more than two-thirds of its surface. This is also why Earth is referred to as the blue planet. At the same time, most of this water cannot simply be used as desired, which is why the creation of a solid and reliable water supply also always requires efficient processing of wastewater, groundwater and surface water.

Despite its abundance, water is a finite resource and we need to be able to work with what we have of it, regardless of how many people there are on the planet. Approximately 2.1 billion people around the world still do not have access to safe drinking water, and more than 800 million don't even have a basic water supply system.[1] In addition, polluted and contaminated water continues to cause repeated outbreaks of epidemics, and the global ecosystem is increasingly coming under attack from water pollution. This means that it is of crucial importance to all of us to not only safeguard water supplies but also ensure the sustainable utilisation of this most valuable resource, regardless of the application in question.

Ensuring a reliable supply of drinking water and implementing effective environmental protection measures are not the only challenges associated with water management, as the illustration above shows. Indeed, if we don't come up with solutions to everyday problems, we'll hardly be able to address the major issues. Yet we must address all challenges large and small if we are to continue to benefit from water in every conceivable way. Efficient and effective water supply and monitoring solutions are needed everywhere around the world – and these solutions must be based on accurate and reliable measurement technology.

1: UNICEF/WHO: «Joint Monitoring Programme Report: Progress on Drinking Water, Sanitation and Hygiene 2017 Update and Sustainable Development Goal Baselines»

Sewage collects in the sewer system and, in Central Europe, almost invariably ends up in treatment plants. Sewage can contain all different types of pollutants and contaminants, everything from heavy metals and various chemicals to bacteria, fungi, viruses and nitrogen phosphorous compounds that can lead to excessive nutrients in stagnant water in particular. Such a variety of contaminants necessitates the use of a variety of purification and treatment processes. Initially, mechanical devices such as rakes, screens and filters of various sizes are used here. After that, pollutants are broken down into harmless components or components that are easier to remove from water. This is done using both microbiological and abiotic chemical processes. Any bacteria, fungi, viruses or other harmful organic compounds that remain can be destroyed with the help of chlorine, ozone or ultraviolet radiation. After that, the processed water flows into a natural body of water via a pre-flooder or is channelled into groundwater by means of a controlled trickling process.

Water treatment keeps our rivers, lakes, etc. from becoming contaminated. If, however, such a large amount of rain should fall that our sewers become unable to absorb it, the wastewater in the sewers will go its own way, so to speak. In the worst case, the increasing pressure can cause “fountains” of wastewater to shoot out of sewer openings and possibly even contaminate drinking water. That’s why spillover walls are installed in sewer systems. On the other side of these walls are rivers or canals. When necessary, the excess water flows over the wall and into the natural water. This setup is actually only an option for an extreme emergency, however, as it cannot prevent pollutants and contaminants from making their way into the environment. It’s therefore crucial to precisely determine where and in which amounts sewage runs off via this emergency spillover system. KELLER AG supplies the pressure measurement technology needed for this. Here, KELLER “Logger” software calculates the total spillover volume using data from the DCX-22 AA data logger, which measures water levels. Three trigger levels for the data logger can be set in the “Logger” software system in order to regulate the logging speed and the initiation of the flow calculation. The DCX-22 AA is installed in the sewer system with the level sensor placed as low as possible. The battery compartment is installed just below the manhole cover on the pavement or the street.

Wastewater treatment plant

Installation of the DCX-22 AA unit in a sewer system

* The GSM-2 remote data transmission unit was refined and then replaced by the new ARC-1 unit: www.keller-druck.com/arc-1

Precise measurement of the spillover volume

Obviously, local governments have buffer systems that mitigate the effects of heavy rainfall. At the same time, heavy rain is expected to occur more often in future due to climate change, and even today municipalities increasingly face situations that conventional sewer systems are unable to cope with. When sewers become overrun, the sewer system is no longer able to take on the excess water and the overflow basins begin to fill up. As soon as the water level reaches the “Trigger ON” value, the DCX-22 AA unit engages and begins taking level measurements once every minute. When the water level exceeds the height of the dividing wall, the flow measurement is initiated and the data recorded until the water recedes. When the water returns to below the “Trigger OFF” value, the DCX-22 AA switches back to normal data logging with one measurement per hour.

The software reads the DCX-22 data storage device to calculate the flow. The GSM-2* transfers the data wirelessly to a computer – i.e. a technician does not need to be on-site to retrieve the data. A special conversion module calculates the flow and volume of the sewage water as follows: First the system subtracts the height of the dividing wall for each measurement of the water column. The remainder is then the water level on top of the sewer barrier. The system then calculates the average of all measured water levels and converts this into a flow rate (volume/time). The module now multiplies the average flow by the total time period of the overflow, which yields the total volume of overflow wastewater. Once this process has been completed, the KELLER software automatically generates an official report for each overflow location. The report lists the number of overflows and the amount of overflow wastewater in each case. Government agencies, such as “Waterschap” in Holland, can use this information to develop and implement additional measures. The reports also provide an overview of locations negatively affected by bottlenecks and insufficient capacity. Should overflows become more frequent, the Dutch government can instruct local governments to build additional wastewater buffers, for example.

Wastewater buffer tank

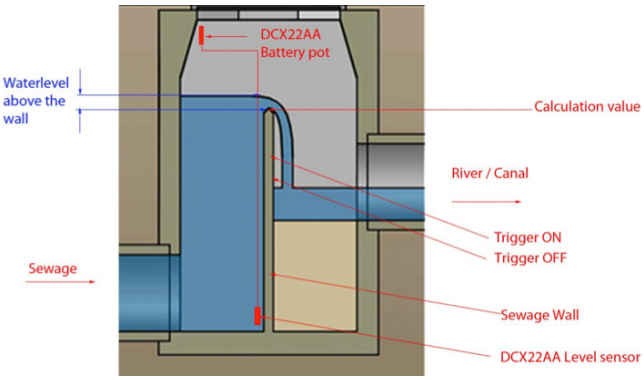

Diagram showing Trigger ON / Trigger OFF levels

The notorious Genoa low, also known as “the V(5)-track cyclone”, repeatedly brings catastrophic rainfall in its wake. The low pressure system extends across the Mediterranean region near the Gulf of Genoa. As it moves above the Mediterranean, it fills up with humid air and then strengthens as it heads in a northwesterly direction around the Eastern Alps. Depending on the path it takes, the front can cause extensive and long-lasting steady rain in eastern and southeastern Germany, Poland and the Czech Republic.

Nearly all of the major flooding disasters in recent years on the Oder, Elbe and Danube rivers can be attributed to the Genoa low. In 2010, for example, the Oder catchment area experienced the second-worst flooding disaster since the end of the 1940s. Between 15 May and 20 May 2017, a huge amount of rain fell in the Oder catchment area, with rainfall accumulation as high as 180mm/m². The second-highest rate of rainfall since weather services began recording such data – 2,100 cubic metres per second – was registered at the Czech-Polish border.[1] Poland, which has been among the hardest-hit countries in terms of flooding, has invested a substantial amount of money in flood protection measures over the last few years. Unfortunately, Poland still faces major challenges, as instances of heavy rainfall continue to increase due to climate change. The expansion and monitoring of sewer systems is crucial here – and since 2007, more than 5,000 KELLER Series 46 X transmitters have been installed for sewage applications in Poland. The transmitters are mostly used in newly built or upgraded lift stations, which pump wastewater in so-called backflow loops to a level higher than the downstream manholes in the sewer system. In heavy rainfall, a situation is thus prevented in which wastewater is pushed back into buildings and ends up flooding basements.

The pressure transmitters for level measuring serve as the main sensors for wastewater level monitoring, whereas the floating switches are used as a secondary control element. The main advantage of the 46 X is a chemically resistant AL2O3 membrane with a gold layer, which is also more resistant to mechanical damage than a steel membrane. Modern digital electronic systems enable free scaling of the 4-20-mA output, as well as the incorporation of the unit into a MODBUS communication network. In addition, the 46 X displays outstanding reliability in this extremely tough application.

Underground lift station at a sewage plant

Above ground lift station at a sewage plant

1: Ministerium für Umwelt, Gesundheit und Verbraucherschutz des Landes Brandenburg; Fachbeiträge des LUGV, Heft 129: Das Sommerhochwasser der Oder 2010 (“Summer Flooding on the Oder in 2010”)

Inefficient wastewater level measurement system

In a wastewater level measurement system that was originally set up with float switches, the first switch initiates the filling of the tank when the level drops to a minimum. A second switch stops filling the tank when it reaches the maximum level, while switch number three acts as an alarm that also prevents the tank from being refilled.

There is a simpler method, however, which involves using KELLER 26 Y level transmitters instead of several floats. This electronic measurement technology offers clear advantages in sewage applications. For one thing, the piezoresistive level sensors do not detect foam as a level of liquid (as is the case with ultrasonic sensors), which ensures accurate level values. Because the system does not have mechanical components that can get jammed or blocked, it's also less likely to break down. In addition, measurements are taken continuously and current level values can be read off a display at any time. All in all, it's a highly reliable and simple solution.

Piezoresistive level transmitters

Series 26 Y pressure transmitters are used in level measurement applications that are price-sensitive but also require a high degree of accuracy.

These transmitters have a very low temperature error due to digital compensation of what is a purely analogue signal path. Here, amplification and the zero point can be influenced by digital-analogue converters.

The accuracy of the end product depends in large part on the sensitivity and linearity of the measuring cell and the compensation of disruptive influences. The silicon measuring cell in the 26 Y series is reliably protected from the measured medium by a stainless steel membrane. The latter, in turn, is protected against mechanical stress by a plastic cap, while its large diameter of 17 mm makes it especially accurate and stable.

Sewage pumping stations equipped with a continuous measuring system to control the level of wastewater capacity

A non-fouling solution to avoid pump failures resulting from grease accumulation

In wastewater measurement, accurate readings are essential to ensure proper pump operation. If such a measurement system fails, unhygienic wastewater can overflow and pollute the environment. The pump systems themselves can also suffer damage if operated incorrectly on the basis of erroneous measurement values. Among other things, wastewater contains organic compounds such as proteins, carbohydrates and fats (grease). The latter in particular have the unpleasant habit of clumping together and forming sediments that are difficult to dislodge.

False measurements due to the formation of sediments

Newport News, Virginia in the USA offers a good example of what can happen in such a situation. Newport News was founded in 1621. It is situated along the James River and its nearly 180,000 residents make it the fifth largest city in Virginia. Here, several restaurants were built in an area serviced by the same municipal wastewater lift station. The high grease content in the wastewater then polluted the existing level measurement equipment, ultimately leading it to break down completely.

Antiquated solutions

Prior to the development of the commercial district, the Newport News Waterworks and the Hampton Roads Sanitation District relied on a combination of mechanical floats and conventional submersible transmitters. Both measurement systems stopped working after the restaurants opened: Both the primary and redundant level measurement equipment failed to properly transmit level data to the pump controller.

The heightened grease content in the wastewater caused by the restaurants led clumps to form on the level transmitter membranes, which ultimately blocked the flow of water to the measuring membrane. On the redundant float switch, whose purpose was to trigger the pump in the event of a failed level transmitter, the accumulation of grease blocked the mechanical operation of the float ball. The failure of the level transmitter and the backup system led to the failure of the entire lift station because the pumps either operated constantly or not at all. If technicians hadn't acted quickly, the entire sewage system could have come to a complete standstill.

Large amounts of grease from restaurant chains put a strain on sewage systems (Barry Blackburn / Shutterstock.com)

Wastewater treatment plant in Newport News

Kynar® membrane offers better resistance

If a lift station is to function properly, grease must not be allowed to block the measuring devices. Various manufacturers offer non-fouling products that often present difficulties in other areas, however. The instruments usually employ a Teflon-coated elastomer membrane, which, while non-fouling, is also relatively weak and prone to puncture. The membrane is therefore equipped with a rather bulky protective shield that is mounted on bolts. Grease tends to accumulate in the gaps that result from this setup, however, which means the problem just moves to another location, as clumps of fibres, grease and sludge form the wastewater continue to impair correct measurements.

In the case of Newport News, city officials contacted KELLER AG für Druckmesstechnik, whose 36 XKY level transmitter, which is known in the USA as the LevelRat, enables a unique approach to wastewater level measurement.

The Kynar® membrane used in the 36 XKY is harder and offers superior abrasion and puncture resistance relative to other non-fouling solutions. Bulky shields are therefore no longer needed, which also enables a more compact design for the sensor. The 36 XKY can fully exploit the advantages offered by a non-fouling membrane without anyone having to worry about floating particles and small objects. Put simply, the level transmitter is perfect for this application. No incorrect measurements due to grease deposits have been recorded at Newport News Waterworks since the new transmitters went into operation: The LevelRat solved the problem.

36 XKY level transmitter with Kynar® membrane