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Reliability hangs on a cable
Hydrostatic level measurement with submersible pressure sensors

Extremely reliable, easy to install and suited for almost any liquid – the "popularity" of submersible pressure sensors for level measurement is not difficult to understand. This hydrostatic pressure-based measurement method is the ideal choice for a broad range of applications – and when it comes to measurements at great depths, there is no alternative.

The population of Germany consumes about 130 litres of drinking water per person and day. More than 70 percent of this need is pumped by utilities into their respective systems from groundwater arteries. These mighty reservoirs must never be allowed to run empty. The level in the arteries must be continuously monitored, so that water removal can be stopped in good time and there is always a sufficient flow.

This takes place at depths of up to 200 metres beneath the Earth's surface. That far down, hydrostatic level measurements are the only realistic option. The submersible pressure sensors developed specifically for this kind of measurement are lowered down to the bottom of the water arteries hanging by a connecting cable. The hydrostatic pressure recorded there by these sensors is the primary quantity for calculating the water level.

This method is suited for practically any liquid – whether in the settling pit of a waste water treatment plant or in the narrow shaft of a well. The amount of liquid involved and the geometry of the vessel or of an open reservoir such as a lake have no effect on hydrostatic pressure. This parameter is influenced solely by the height of the liquid column. For example, the pressure in a water tank increases by approximately 100 mbar for every metre below the surface.

Vessel geometry has no influence
Submersible pressure sensors transmit the pressure value which is measured to a downstream logic unit, which then calculates the actual filling height. Apart from pressure, this calculation also takes account of the density of the liquid concerned as well as gravity and acceleration due to gravity. In applications with high accuracy requirements and / or significant temperature fluctuations in the medium, the temperature change due to density must likewise be considered as the result will otherwise be distorted. In this case, submersible pressure sensors integrating a temperature probe are recommended, because this avoids the need to install an additional measuring point for temperature monitoring.

This independence from geometric constraints at the place of use is only one aspect which makes hydrostatic level measurement such a reliable alternative. Unlike other measurement methods, it is insensitive to many of a medium's physical properties like conductivity, the dielectric constant, foaming or viscosity. Moreover, submersible pressure sensors – the measuring instruments that accompany this method – are relatively straightforward to install and can be put into operation straight away without having to enter any parameters.

Beyond the measurement properties, it was these benefits which persuaded a major supplier of AdBlue®, the urea solution for diesel vehicles, to provide the tanks stationed at its customers with submersible pressure sensors. The level in the tanks is monitored based on a combination of these instruments and a telemetry unit. The telemetry unit transmits the level recorded to a central platform, so that necessary replenishments can be triggered in good time. The customers in this system are mainly freight forwarders, bus companies, large car fleet operators and farmers. Like the number of vehicles, the size and depth of the AdBlue® tanks vary from one customer to another. However, since the same sensor type is used for this measuring task regardless, the supplier merely needs to adapt the cable length and the measuring range.

Consumption change reading

Submersible pressure sensors inside a tank can measure more than just the filling height. The fact that they measure continuously means both the supplier and the customer can derive an accurate picture of any changes in consumption from the data history. Compared to other, technically more complex methods of continuous measurement such as radar or guided microwave, hydrostatic has clear economic benefits for AdBlue® tanks and similar applications.

As submersible pressure sensors can be operated permanently in the most diverse liquids – from urea solutions through water to alkalis and waste water – IP68 protection is essential. Their design must be optimised for the application in question in terms of media resistance and density. The compact housing, for instance, is generally made from 316L stainless steel in the case of non-critical media or from special alloys such as Hastelloy or titanium for aggressive liquids.

The best measurements are obtained if a submersible pressure sensor is integrated at the bottom end of the housing. Even in the most adverse conditions, the measuring cell must return robust, in-spec results. This accounts for the enormous choice of materials, from stainless steel to special anti-corrosion ceramic. The latter is particularly recommended for flush types because any adhesive residues can be removed without any problem.

Accuracy of up to 0.1%

Compared to long-term stability, accuracy tends to play only a minor role in the majority of applications. A value of 0.5% is the norm and as a rule perfectly adequate. Measuring tasks in the food and pharmaceutical sectors are an exception; accuracy of up to 0.1% is demanded there for process safety reasons or due to the economic value of the media.

The electronics are basically the same as with conventional pressure sensors. The pressure value is converted into a standard industrial signal, usually 4…20 mA. Versions with a low-power signal (0.1 to 2.5 V) are additionally available for battery powered measuring points in the field. Since submersible pressure sensors are used first and foremost outdoors, their electronics can be optionally protected against overvoltage due to lightning strikes.

The cable entry into the housing is another sensitive point. More often than not, the cavity there is potted. This filling can become brittle after a while and break off. However, in applications involving non-critical media and typical immersion depths it is generally sufficient. A mechanical solution with a long-term effect has been developed by WIKA for applications where the risk of "vulnerabilities" at such points must be reduced to a minimum. The LF-1 submersible pressure sensor for high measurement requirements features a form spring, which presses a special seal against the socket at 1000 N.

Swelling nonwoven prevents cable leakage

The principal task of the connecting cable which is used to lower a submersible pressure sensor down to the measuring point is to ensure secure signal transmission. Its sheath must reliably withstand constant exposure to the medium and to the – at times considerable – hydrostatic pressure, so that no liquid can leak inside the cable and provoke a sensor failure. To more or less rule out the possibility of any such damage, WIKA's submersible pressure sensors can be fitted with a special type of cable. If a micro-crack forms in the cable sheath and moisture gets inside, the nonwoven fabric around it swells up and seals against leakage.

Apart from the signal line, the connecting cable of a submersible pressure sensor also contains a vent capillary. This is because the instrument is designed for use in open vessels and reservoirs (lakes, rivers, pits) and measures hydrostatic pressure relative to ambient pressure. If submersible pressure sensors are also intended to perform level measurements in a closed system, an ordinary pressure sensor must additionally be installed in the vessel's side wall. This second sensor records the pressure in the gas zone above the liquid; the measured hydrostatic pressure is then compensated by this value.

Without this, significant measurement errors would be likely because the submersible pressure sensor transmits a total pressure here made up of the liquid's hydrostatic pressure and the gas pressure. In other words, the level which is calculated is higher than the actual level.

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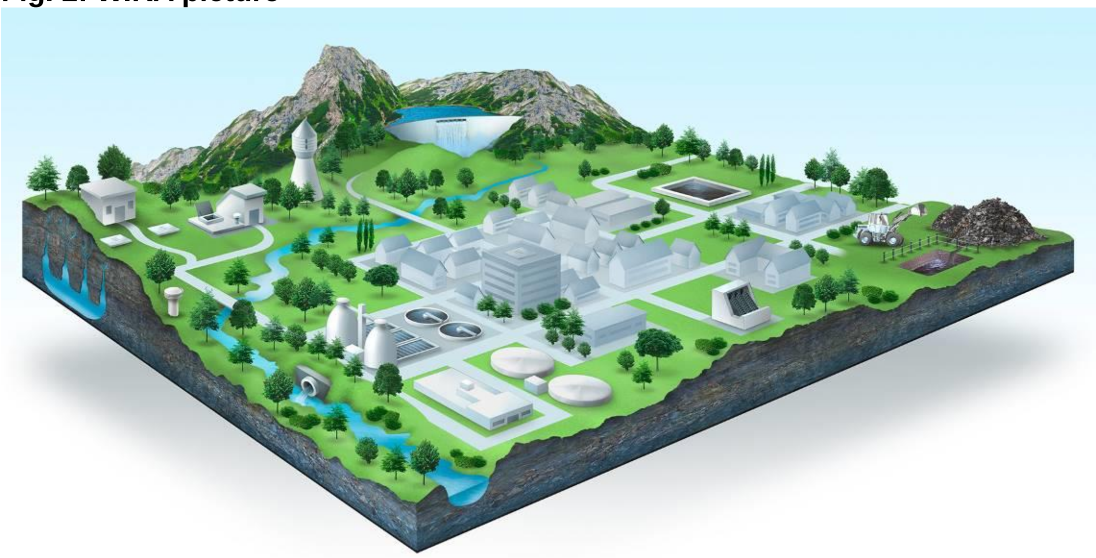
Conclusion: Hydrostatic level measurement with submersible pressure sensors is a realistic option for the vast majority of liquids. These sensors determine the liquid level based on hydrostatic pressure and are insensitive to the vessel geometry and many of the medium’s physical properties. Submersible pressure sensors and their connecting cables are easy to install and the ideal choice for a broad range of applications, even if the liquid column is 200 metres high. However, users should bear in mind that the housings, cables and cable entries are always optimised for a specific measuring task.

Characters: 8672

Fig. 1: WIKA picture

Description: Model LF-1

Fig. 2: WIKA picture



Description: WIKA illustration of water / waste water

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Fig. 3: WIKA picture

Description: Schematic diagram of level measurement with a submersible pressure sensor in a vented tank

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