PROCESS INSTRUMENTATION

In the oilfields, water matters – and so does your instrumentation

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With the rise of unconventional oil drilling practices, the demand for water has risen significantly over the past few years. Previously, the cost of water to drill a well was just a small part of the price of doing business, and the amount of water needed was not as high as it is today. But recently the paradigm has shifted from simply injecting produced water back into the ground to placing more value on water and finding new and creative ways to reuse or recycle it. The main drivers of this trend include water scarcity, costs and regulations. Processes and practices vary significantly by shale region due to geographical differences and the associated costs and limitations placed on underground water injection, transportation and storage capacity. Add to this the variability in oil prices and break-even points, and it quickly becomes apparent why there is increasing emphasis on more efficient water usage.

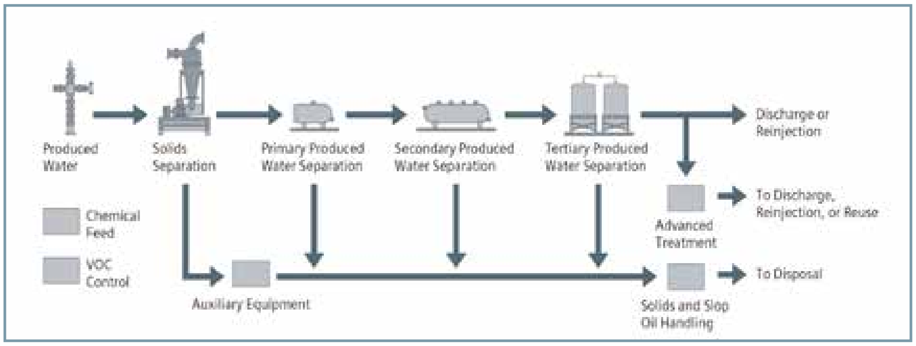
A new industry has emerged to better serve the water needs of the oil and gas sector. This has allowed drilling experts to focus on what they do best while the experts on water treatment and management find better ways to maximize the use of produced water, thereby reducing the need for fresh water. Water treatment in the industry is not new, but the former practice of treating around 40% of produced water has now skyrocketed to nearly 100% in some areas. As a result, many consider water "the new oil" and there is growing demand to invest in better water treatment processes. This opportunity will be better exploited not only by increasing capacity, but also by automating processes and reducing manual intervention – ultimately leading to lower operating costs, improved efficiency and safer environments.

Refining any process requires new thinking in order to implement improvements and stay ahead of the competition. Those who adopt automation stand to achieve higher efficiency, more competitive prices and a better profit margin that will keep them in business during economic downturns, which are common in the oil and gas industry. Automation also reduces the risk of accidents, making it easier to comply with new regulations and protect the environment.

Water treatment processes range from very simple to an impressively high level of complexity. However, one trait that nearly all share in common is a need for process instrumentation. Understanding where and how to use a specific level, flow, pressure or temperature measurement technology will support you in achieving your automation goals – from refining your processes to managing your inventory in real time and, ultimately, improving your bottom line.

What's driving the need for more water in oil drilling?

The quantity of water used in unconventional drilling has increased dramatically. The amount varies by region, but it has risen nearly everywhere due to deeper wells, longer laterals and the huge volume of proppant needed for each fracking project. Less than a decade ago, it took 100,000 barrels of water to frac a well, but now that number is 5 times higher and continues to increase. The issue goes beyond how much water is needed per well; it also extends to the amount of water produced and flowed back that needs to be treated or injected into the ground. It is estimated that 4 to 8 barrels of water is produced for every barrel of oil. Add to this the flowback water from injection, and we are dealing with billions of barrels annually. Some large producers have committed to reducing or eliminating the use of fresh water by substituting brackish water, which is also effective. But this practice does not significantly reduce the amount of water that will be required in the future – and without it, frac jobs can be delayed or halted. Thus, midstream water companies are now dealing with the logistics of rising water demand and must better support production with an increased focus on water handling, treatment reuse and disposal.



Although contacting technologies have evolved to handle buildup better than in the past, in certain areas buildup can still come a nuisance requiring more frequent maintenance to keep instruments operating correctly. Thus, it is best to limit the use of contacting devices to substances that will not coat sensors over time.

Understanding the application of process technology in water treatment and handling

Increasingly, the upstream oil and gas sector is employing measurement devices such as level instruments, flow meters, and pressure and temperature sensors in a variety of applications. Manual measurement can prove unsafe and inaccurate. Certain injection sites, for example, have signage indicating the possibility of H_2S gas being present. In other cases, produced water may be stored in holding tanks that also contain valuable crude oil that needs to be monitored and recovered. In either instance – and in many others -- process instrumentation would be favored over manual measurement.

But which instrument is the right choice? Two different shale regions may use the same process, but the composition or other characteristics of the fluids being monitored may require different devices. Since is not possible for one technology to serve every purpose, it pays to have a basic understanding of each technology's capabilities in order to choose the best fit for your application. Consider a tank with a material that has a tendency toward buildup. In this particular application, a level instrument using floats may not measure dependably since floats can stick.

As midstream water companies install additional facilities to treat produced and flowback water, reliable and efficient process instrumentation is becoming increasingly critical. Deciding which technology to use depends on a host of factors including production volumes, water quality requirements, size of operation, region and regulations.

Monitoring water levels

When flowback water resurfaces during a frac job, it must be contained in storage tanks or sent to a treatment facility via pipelines or trucks. Monitoring of the water level is always required, and there are several level technologies that can be used. One important factor to consider is whether you are dealing with primary, secondary or tertiary produced water separation stages. Since treatment and injection processes are not necessarily the same from one region to the next, having a general idea of what constitutes the media in a particular vessel can provide clues as to what should be used. The two most commonly used technologies for level measurement are contacting and non-contacting. Contacting technologies are those that come into contact with the media (water, oil, chemicals, etc.), including guided wave radar and float-based devices.

Non-contacting technology measures level using the time of flight principle, rendering buildup virtually nonexistent. Radar level transmitters are non-contacting devices that send a microwave signal through the air. When the microwave signal arrives at the surface of the media, it returns to the transmitter. This trip is used to determine the traveled distance, from which the level in the tank can then be derived. However, if there is excessive H_2S gas at a particular site, it can crystalize and build up inside a horn antenna. In such cases, horn antennas with a Teflon lens would be a better selection to prevent H_2S buildup. A hydrostatic pressure transmitter can also be used in this type of application.

One of the benefits of guided wave radar technology is that it can be used strictly for level measurements or for level and interface measurements, which comes in handy when there is a need to monitor the oil and water levels in a tank. A double-duty level and interface instrument is required in separation vessels as well as just prior to produced water injection, since any residual oil in holding tanks needs to be recovered for economic and environmental reasons before injection. Note that interface level measurement is not feasible for dissimilar substances such as resin and water or sediment and water. Interface and level measurement using guided wave radar requires that the upper layer is not conductive, as is the case with crude oil, and that the bottom layer is conductive, as is the case with water. For applications requiring only level measurement of produced water, treated water, chemicals or hydrocarbon, non-contacting radar is commonly preferred across all industries. Non-contacting technologies are practically maintenance free and there is no risk associated with hanging or swinging cables.

Preventing spills and protecting the environment

Point level technology is also applicable to water treatment. Capacitance point level switches, tuning forks or float switches can be used to ensure that tanks are not overfilled. All of these devices can be ordered with the desired length to detect product at a particular level point.

Of course, the potential for buildup and the chemical compatibility between the media being measured and the instrument being used should be considered to ensure long-lasting performance. For example, when measuring viscous media, floats may eventually stick and stop operating. In contrast, some tuning forks can monitor for buildup on their tines and indicate if maintenance is required. An even better choice would be digital capacitance level switches, which can be set up to work within the acceptable range. If buildup surpasses the set limit, a maintenance alarm will be triggered.

Keep in mind that an overfilled tank does not necessarily mean that product has spilled. "Overfilled" also refers to a condition in which the tank has reached a level beyond its 100% setpoint or where the level is higher than the maximum allowable level. This condition can render any primary continuous level devices unreliable. A material spill can occur if a truck delivers water or chemicals into a tank that is already filled beyond its maximum storage capacity. Both conditions should be avoided. Installing point level switches can help to ensure that operations continue without costly and dangerous process interruptions.

Accounting for what flows in and out

After the water is separated from the oil or gas, it must be processed for treatment, recycling or injection. Accountability is necessary not only for economic reasons, but also because government regulations mandate it; this can be achieved by using a flow meter to measure water as it is pumped into trucks or pipelines. The size of the flow meter is determined by the flow volume (typically 2" to 12", depending on flow rate). Two common technologies for measurement of this water are clamp-on ultrasonic flow and electromagnetic flow. However, choosing an ultrasonic meter vs. a mag meter meter is not simply a matter of preference.

A clamp-on ultrasonic flow meter offers the convenience of non-intrusive measurement. That is, the pipe does not need to be cut in order to be fitted with this type of technology. Also, since a clamp-on meter uses the transit-time principle, it does not matter whether the liquid is conductive. However, if there are too many suspended solids flowing through the pipe, meter performance will suffer or the meter may stop working entirely.

A key factor for proper operation of an electromagnetic flow meter is that the fluid flowing though it must be conductive, like water. This is generally not a problem; even if there is some residual oil mixed in with the water after separation, the amount is usually small enough not to disrupt the fluid's conductivity. Mag meters with Ebonite or EPDM liners are well suited for wastewater containing solids, and they are only minimally affected by variations in water composition

– making them a better choice than clamp-on meters for water flow measurement in the oil and gas industry. Furthermore, there are battery-operated models that offer an ideal solution for those areas where power is not readily available, e.g. in some impoundments where water is stored and flow measurement is required, but where power may be intermittent or not available at all.

Coriolis flowmeters eliminate waste

If accurate flow measurement is your top priority, then choosing a Coriolis mass flow meter is the sure path because its accuracy surpasses that of ultrasonic and mag meters. A Coriolis meter can simultaneously provide mass flow measurement and other important variables such as density, temperature and volumetric flow.

While a Coriolis mass flowmeter would be "overkill" for many water treatment applications in the oil and gas industry, this technology continues to gain in popularity. With the ever-increasing demand for water to complete drilling projects, there is a trend toward treating and recycling produced and flowback water instead of using fresh water. As previously discussed, the amount of produced and flowback water being treated has risen from 40% to nearly 100% in some areas. Naturally, the demand for chemicals to treat this water has also increased – along with their cost. Although small-size mag meters can be used for chemical dosing, Coriolis meters are a better choice for this task. If a mag meter being used for chemical dosing struggles with accuracy, the reason could be that the fluid does not meet minimum conductivity requirements for detection. In contrast, a Coriolis meter can measure both conductive and non-conductive fluids.

The cost of compact Coriolis flow meters has decreased over time, but in general, this type of technology remains higher-priced than mag meters of a similar size. Regardless, in some applications, the precise mass flow measurement offered by Coriolis meters ultimately results in significant cost savings. For example, precise chemical dosing is a critical part of water treatment in municipalities across the nation. Underdosing can mean that bacteria is not effectively eliminated and the water will not be not safe to drink. Overdosing, on the other hand, leads to wasted resources and inflated costs.

Although mag flow meters are more ubiquitous across the water handling process, there is certainly a place for Coriolis mass meters – where precise measurement is a must. As midstream water companies deal with increasing water demands, challenges and regulations, they will find that choosing the right flow measurement technology can make all the difference in the bottom line.

Smooth, well-controlled processes with differential pressure and temperature

As produced water begins its journey to the treatment process, solids must be removed. The filtering stages across the various phases in preparation for discharge, reinjection, reuse or disposal need to be monitored with differential pressure (DP) transmitters. Key considerations when choosing a DP transmitter are the wetted parts and the operating range. Stainless steel wetted parts are suitable for many applications, while those made of ceramic have a higher degree of chemical resistance. Ceramic parts are susceptible to temperature shock, but this is more likely to occur in other industries such as the chemical industry. Operating range is defined by the pressure drop across the filters, comparing normal operation to what would be a sign of contamination or clogging. Hydrostatic pressure transmitters can also be used for tank level measurement. This is a good alternative level technology in cases where the level of H_2S gas is leading to corrosion (e.g. a horn antenna). Hastelloy wetted parts are recommended for the diaphragm and threaded connections.

Temperature transmitters are important in areas where chemical reactions are required and to control bacteria growth in water treatment. Selecting the right transmitter often depends on the available process connection.

From the field to your fingertips

Manual tank monitoring is time-consuming, inefficient and unsafe. Traveling long distances between sites is a waste of time and money, while climbing tanks and opening hatches presents a safety hazard to operators. These issues can be addressed by a remote tank monitoring app like Siemens SITRANS store IQ, designed to collect data such as process values, device statuses and alarms from field devices and store it all in a cloud platform. This type of app puts real-time tank data directly into the hands of operators and management, and the web-based platform makes this data easily accessible from a mobile device or a computer in the central monitoring station. The result is enhanced asset management, reduced costs and improved safety.

Conclusion

A variety of process technologies can measure level, flow, pressure and temperature in water reclamation, treatment and disposal applications within the oil and gas industry. Given the restrictions imposed in some areas on injecting produced water into the ground and the decreasing availability of fresh water to complete drill projects, midstream water companies have found ways to treat water more effectively, thereby boosting recycling volumes to unprecedented levels – and ramping up the demand for high-quality, digitalization-ready process instruments.

Choosing the right device should not be a complex endeavor if you have a basic understanding of the benefits and limitations of each technology. In particular, knowing the characteristics of the media being measured (corrosive, prone to buildup, clean media or with lots of suspended solids) is a vital step in determining which technology fits best. And, of course, expert advice from reputable technology companies is always available to assist with those applications that require a closer evaluation regarding chemical compatibility, pressure, temperature, types of liners and even communication protocols.

When it comes to better water management in the oil and gas industry, process automation with the aid of the right instrumentation is the clear path to success.

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