Flowing
WITH THE TIMES

Yannick Harvey and Timothy Gabel, TETRA Technologies, USA, outline the benefits of automating water supply and treatment systems.

For producers of all sizes and in all basins, turning a profit today relies more and more on reducing overheads through operational efficiencies.

Making the workforce more efficient by using automation to monitor, control, and report on widely distributed operations of varying functions is at the top of the list of overhead-reducing options for most operators. With the expanding web of water handling systems for fresh and produced water, the automation of this sector is rapidly gaining momentum in every region.

The decision to automate pumps, tanks and other production operations has created workforce efficiencies on a significant scale by removing the need for field personnel to physically attend every site every day. Real time monitoring also alerts personnel to changes – and often impending problems – thereby increasing production by reducing downtime.

It is no surprise, then, that similar economies and efficiencies are to be had by automating water systems that grow in size and complexity every year. These systems collect and deliver

COVER STORY

Figure 1. *A web-based, real time monitoring and control technology provides the company's clients with 24/7 access to treatment and recycling operations. This provides a transparent, on-demand view of the chemistry used to treat the water and its effectiveness.*

Figure 2. *The TETRA frac water blending system includes an automated blending controller, coupled with a patented, on-the-fly blending manifold. The combination provides accurate parameter-based blending and consistent blend quality, whether directly filling frac tanks or transferring to another location.*

Figure 3. *The TETRA automated distribution manifold helps manage frac water buffer volumes safely and efficiently. The manifold provides real time computer-controlled management of tank level to ensure supply and prevent tank overflows.*

tens of thousands of barrels of fresh water and produced water daily, along with evaluating the produced water for the amount of mechanical and chemical treatment needed, blending water sources in the proper proportions, then storing and distributing back out to fracturing jobs or disposal wells.

Manually monitoring the dozens of critical points requires dozens of people, many of whom are required to simply stand by watching for pressure changes or tank levels, or awaiting instructions to change pump speeds or to make other fluid handling changes. Payroll for standbys becomes a huge liability, when those same employees could be doing something more productive elsewhere. Physically monitoring and controlling operations also increases the risk of human error.

Progress of field automation in the oil industry

Field automation on the production side came first, with sensors and programmable logic controllers (PLCs) tracking tank levels and pump statuses. However, in the beginning, this required personnel to go to the location, plug in a laptop, and download the data.

Next steps involved communication through satellite or other means to collect data and provide a more real time experience for supervisors, eliminating thousands of extra site trips. This greatly increased the productivity of field personnel.

Automating water transport and treatment

Applying automation options to water treatment came later because early water systems were mostly collect-and-inject modes. As hydraulic fracturing proliferated and the treatment and use of produced water for fracturing became economical, the benefit of automating those areas became more obvious.

How can automation help? Its three main functions – to monitor, control and report – can be considered as follows.

Monitor

Sensors collect data at points identified as vital by the operator or the water management company. They record tank or pond levels, water volume, pump speeds, and inlet/outlet pressures for each pump, in order to determine the water quality before and after treatment. They also monitor valves at decision points – does the water continue to a pond, a saltwater disposal well (SWD), to a fracturing site or back into the system for further treatment? Sensors also monitor the quality of produced water at the entry point and after most levels of treatment, whether chemical and/or mechanical.

Even without a consolidated monitoring system, some simple actions can be automated, such as shutting off a pump if its connected tank reaches a certain level, but that ignores the interconnection between other pumps upstream or downstream. Great amounts of human interaction would still be required.

Control

In the last two years more and more operators have become proactive at adopting automation for everything involving water systems, for treating produced water, and for transporting fresh or produced water from source to destination. At one time the idea of automating water systems was a hard sell – but this is no longer the case.

Today's multi-pad sites require millions of barrels of water for the fracturing process, and produce further millions of barrels of water (approximately 4:1 or 5:1 water-to-oil ratio). That produced water is collected and treated, then mixed with fresh water in carefully controlled ratios to be used in fracturing. With flow rates of 50 000 bpd or more travelling through a dozen or more points including ponds, tanks, valves, pumps, chemical and mechanical treatments, there are thousands of decisions to be made every day – decisions that require a computer control system for maximum efficiency.

It is important to note that there are two common types of treatment systems: portable and permanent. The vast majority are portable, spending a few days or weeks on a site while wells are drilled and completed on a pad, then moving on to the next pad location.

Temporary systems are usually focused on a few wells and spread out over a relatively small area. They must be carefully set up and calibrated on each location for maximum efficiency.

Permanent systems usually involve operators with extensive acreage and a large number of wells, with pipelines stretching 20 miles or more. These are the facilities that can handle 20 000 or more bpd on an ongoing basis. With automation, only two to three people are required onsite at any given time, as opposed to the dozens that would have been needed under manual operation.

From either type of installation sensor data is received by onsite PLCs. As the PLC analyses the data, its programme makes a series of decisions based on parameters determined by the producer and/or the water company. While the site can be monitored and adjusted remotely, through a PC or a mobile device, the TETRA control system is completely self-sustaining in the event of a loss of communication.

Here are some examples of the type of issues automated water systems can remediate through its internal logic.

- Pump speed adjustment: Should the PLC receive information from the manifold sensor indicating that the frac is pulling 93 bbl/min. of water, the unit sets the pumps to backfill at the same rate. Should the pull rate change for more than a set amount of time, the PLC will adjust pump speed accordingly.
- Retreatment decisions: Sensors can monitor treated water to determine whether it is within the desired specification for the fracturing operation. Should it not meet those standards, the system can reconfigure valve settings in order to return the unacceptable water to the inlet side for further treatment.
- Balancing produced and fresh water: Where there is a blender combining produced water with fresh water, flow rate is just one of the parameters in the mix. Frac water is expected to be within certain parameters of salinity, so sensors monitor the water exiting the blender for conductivity or total dissolved solids (TDS). Should the mix be detected as being outside specifications, the PLC adjusts the speed of either the fresh water pump or the treated water pump to return it to expected levels.
- Water treatment: Produced water's contaminants are animate (aerobic and anaerobic bacteria) and inanimate (iron sulfide, sulfur and other suspended or dissolved solids) so unique treatments are necessary for each component. All must be tightly monitored and regulated according to changes in flow rates (incoming and outgoing) and contamination levels.

In the absence of this type of automation, a reduction or cessation of incoming water would not be accompanied by an equal change in chemical injections. Continued injection of chemicals, at the least, would cost the producer money with no benefit, and, at worst, could lead to a chemical spill or worse.

Balancing pressures and pump speeds has had a surprising side benefit. TETRA technicians have observed a drop of 30 – 60% in use of the diesel fuel that powers the pumps. No human operator is individually deciding to run a single pump at a higher rate to see if it boosts throughput, causing the pump to work harder and burn more fuel to no effect. This reduction of fuel use also has the effect of cutting the number of resupply site trips by tanker trucks.

Figure 4. *Aerial shot of a TETRA produced water treatment and recycling operation.*

Report

In the process of recording per-minute inflow rates, pressures, chemical usage and outflow rates and destinations, (including SWDs), onsite systems accumulate a treasure trove of useful data. Tracking charges for chemical use and, when needed, SWD injections are just the start.

Supervisors can log in at any time to check systems on any level. Should onsite personnel need to consult on an issue, a supervisor can log in to see exactly the screen the field technician sees so they can fully collaborate on the decision.

Because the system tracks all alarms, it is easy to evaluate and act on the areas that have the most issues, whether through replacement of hardware or sensor or the cleaning of a filter or screen.

Conclusion

The best results are obtained when the water system and its automation are included in the planning stages for each location. Doing the hydraulic calculations up front, including flow rates, distance, and terrain elevation changes, ensures that the right pumps, tanks, and other equipment will be on hand when the first drop of water enters the system. This eliminates the non-productive time (NPT) involved in waiting for additional equipment or manpower to make the system work.

It also makes sure all components are correctly sized for the workflow; pumps, chemicals, flow processes, recycling ratios and everything else is optimised for that particular operation. Proper planning improves NPT and health, safety and environmental (HSE) issues as well.

As unconventional shale play production continues to grow, economical water systems become ever more vital to profitability, safety and environmental responsibility. To put this in perspective, TETRA has recycled a total of 15.26 million bbl of water in the Permian Basin alone over the last 12 months, equal to 128 000 truckloads that were kept off the roads.

Automation adoption in the oil patch has lagged behind other industries, but is now starting to catch up. Many experts have attributed this lag time to the boom-and-bust cycles – in boom times companies are too busy installing and learning new technology, and in bust times CAPEX money is too limited to invest in new systems.

This is changing now due to a variety of economic factors. As greater numbers of producers see the benefits in economics and in productivity, others are getting on board. This trend has the potential to make shale oil production profitable at increasingly lower commodity prices.