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INNOVATION SOLUTION OPTIMIZES PRODUCED WATER DISPOSAL

Solar Power System Enables Remote Operation of Automated Valves on Water Gathering Pipelines

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ABSTRACT

Water is considered a byproduct of oil and gas production and must be carefully managed. This water, usually referred to as “produced water,” is the largest volume waste stream associated with upstream petroleum operations.

Most oil shale fields include pipeline infrastructure to gather produced water from wells. Pipelines transfer the water to temporary storage at either a disposal well location or at a central treatment facility.

Ferguson Industrial worked closely with its customer, a leading produced water management company, to develop solar-powered control stations for water-gathering pipelines located in the oilfields of West Texas and New Mexico. These innovative systems enabled remote operation of single-stage isolation and modulating valves to control the flow of produced water in the high-pressure pipeline network.

By partnering with a trusted automation equipment supplier like Ferguson Industrial, oilfield service companies can find new ways to improve the efficiency and reliability of their water disposal infrastructure while improving safety and reducing costs.

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BACKGROUND

A major oilfield services company within the US owns and operates an extensive network of water gathering pipelines and saltwater disposal wells focused on eliminating the problem of produced water for oil and gas producers. Its approach to produced water disposal minimizes environmental impact and improves health and safety, while reducing lease operating costs and improving reliability.

WATER DISPOSAL CHALLENGES

With a growing focus on corporate responsibility and sustainability, the proper handling and disposal of waste streams are critical to all oil- and gas-related businesses. Operators must ensure regulatory compliance while protecting assets, personnel and the environment.

Produced water from hydraulic fracturing contains chemicals that are potentially toxic and cannot be exposed to freshwater ponds or groundwater. Government and industry regulations require the water be disposed of in an approved and effective manner.

Deep well underground injection has become a popular method for the disposal of fracturing fluids and other substances from shale oil and gas extraction operations. The produced water is deposited into deep geologic structures, many of which have trapped brine for millions of years. These structures are often a mile or more below underground drinking water sources, separated by billions of tons of impenetrable rock.

NEED FOR RELIABLE AUTOMATION

As part of the water treatment operation, there is a need for automated valve technology to control the flow in high-pressure water-gathering pipelines. In many cases, however, these pipelines run for miles with no power to activate the valves. The customer wanted to optimize its water-gathering operations

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and had specific requirements for the valve application:

- Control system pressure to and from well sites
- Shut down lines in the event of a break or other failure
- Eliminate high-maintenance devices such as air compressors and other rotating equipment

The customer sought a reliable pipeline control solution, as valves and other equipment would be situated every five miles or so in areas that were “off the grid.” Without the availability of gas and electricity in these locations, the use of solar power for pipeline control stations seemed like a logical choice.

Solar power has had a significant role in oil and gas production for decades, largely due to the vastness of most producing fields. However, solar systems can be highly complex. Proper design is key, from the size of solar panels selected to the converters used. If there is a mismatch in load capacity at any point in the system, failures or accidents can occur. Therefore, it is best to have experts analyze load requirements and design an appropriate system for the application.

FINDING A TECHNOLOGY PARTNER

Starting in 2017, Ferguson Industrial partnered with its customer to develop a solution for its pipeline control application and was asked to provide a broad scope of supply for the customer’s produced water management operations, including piping, fittings, valves and controls. Chris Fadden, Director of Industrial, coordinated with specific Ferguson Industrial vendors in manufacturing pig launchers for use in cleaning and inspection of the pipelines.

Key to the water disposal operation was the utilization of automated valves on water-gathering supply lines. This proved to be a challenging application, since the installation environment did not have any type of gas for use in driving valve actuation, as well as a lack of local power to run the system. It was apparent that electricity would have to be generated at each control station installed along the water gathering pipelines.

Engineers addressed the project requirements by first calculating the annual number of cloudy and sunny days in the oilfields, and then determining how much power had to be generated to maintain a battery supply for electric valve actuators.

Isolation valves are fairly simple devices—they energize over time, reach a set point and stop. The valves can remain inactive for days, weeks or even months before changing positions. As such, they have a minimal electricity requirement. All that’s needed is a power source for diagnostics, date stamp and time recording. Everything besides non-volatile memory that requires consistent power can utilize a battery source.

The project team decided to configure each pipeline control station with its own solar panels to generate the electricity needed for actuation of single-stage modulating and isolation valves and to run a programmable logic controller (PLC). They could have deployed electro-hydraulic actuators on the valves and eliminated the need for an actuator motor, but this approach would have impacted maintenance requirements and increased costs.

The solar systems had to be sized according to the number of actuator start/stop positions per day. For the isolation valves, this would be a complete slew from open to close, and for the control valve, it would be from a position-increased signal to a position-decreased signal.

One of the biggest challenges for the automation specialists was finding a way to maintain pressure within the dead band range of the control valves. Unlike a pneumatic valve, which moves a minimal amount of air to reach the desired position, electric actuators run until the control valve is within the dead band. Engineers had to determine the acceptable dead band range and calculate how many starts and stops would be performed with the actuator motor. This information would, in turn, help determine the amount of battery power needed for valve operation. The final calculation was used to identify the number of required solar panels based upon expected cloud cover in the oilfields.

IMPLEMENTING THE RIGHT SOLUTION

The produced water treatment company had trust in the engineering expertise and automation capabilities of Ferguson Industrial, which was chosen to design and construct self-contained solar systems to power the Allen Bradley MicroLogix™ PLCs used to run the automated valve equipment. Communication to the PLCs is provided via fiber optics.

The pipeline control stations include Warren 12 and 16-inch ball valves automated with Rotork IQ actuators, as well as a 24Vdc microcontroller. The 12-inch valves are sized using IQ 18 actuators with 48Vdc motors, whereas the 16-inch valves are sized using IQ 20 actuators with 120Vdc motors. Each valve is fitted with its own solar panel as well as a 24Vdc solar system for the PLC.

The Rotork actuators receive power from a self-contained solar-powered solution that is efficient, environmentally friendly and economical, saving the potentially significant environmental harm and cost of installing main power sources along the length of the pipelines.

Ferguson Industrial built a total of 22 solar systems based on the specified potential execution of open and closed positions, and well as positioning on the modulating valves. The solar systems are plug-and-play, and all configurations for control feedback and alarms were completed at a Ferguson Industrial automation shop. The

As part of the produced water treatment operation, there is a need for automated valve technology to control the flow in high-pressure water-gathering pipelines.

Ferguson Industrial was chosen to design and construct self-contained solar systems to power PLCs and automated valve equipment within pipeline control stations.

Figure 2: Pipeline control stations employ 12 and 16-inch ball valves automated with electric actuators. Each valve has its own solar panel.

systems were emulated and positioned so that testing and recording could be executed each day over a 30-day period.

The customer's engineering staff visited the Ferguson Industrial facility to witness the testing of all valve equipment, which included stroking the isolation valves open and closed. Test parameters included full open/full closed, position feedback, open/closing speed and voltage drop. Shutting the breaker off at the solar system simulated low-voltage alarms. A local control was utilized so that valves were not only stroked by Ferguson Industrial 24Vdc and 4-20 mA test controls, but also locally at the actuator. All valves passed the tests, including the open and closing speed requirements.

HOW THE SYSTEM OPERATES

Ferguson Industrial helped its customer harness and store the power of the sun with an automated valve solution that is highly reliable and efficient. The company provided solar-powered valve packages to meet specific application requirements.
The pipeline control stations consisted of:

1. Rotork IQ 20 actuator w/16-inch Warren ball valve (110Vdc solar system)

The system includes nine individual solar panels; voltage controllers to monitor the battery capacity and voltage, allowing the appropriate voltage to charge each battery; nine 12V batteries; temperature sensors; and complete fused system terminals with proper diodes.

2. Rotork IQ 18 actuator w/12-inch Warren ball valve (48Vdc solar system)

The system includes four solar panels; voltage controllers to monitor the battery capacity and voltage and allow the appropriate voltage to charge each battery; four 12V batteries; temperature sensors; and complete fused system terminals with proper diodes.

All of the control valves are controlled and monitored with a signal coming from the PLC. The isolation valves are set up in two strategies: The IQ actuator is internally-wired where valves require a 24Vdc signal to open and 24Vdc signal to close, whereas some valves have only one 24Vdc signal. When the voltage is present, the valve will override the internal wiring from interlock closed to the open position, and when the 24 VDC is de-energized, it will travel to the closed position. The valves also have limit switch feedback for fully open and fully closed positions. An alarm provides diagnostics should there be a failure of the power source from the solar system to the valve actuator. The control station battery systems are sized with sufficient capacity to power the actuator for five strokes per day—over a five-day period—with little or no sunlight. Calculations assumed a minimum average daily temperature 30°F (-1.11°C). All systems are designed to discharge their batteries to 40 percent of full capacity. This means the batteries do not deep discharge, which significantly extends their service life. In extreme circumstances, the batteries can supply more than five strokes per day but would discharge more than the intended rate.

The solar panels are sized according to the lowest level of sunlight during the winter months. They should replace daily power consumption in less than one day in sunny weather with five strokes per day of the actuator. With the 24Vdc system, the solar panel sizing is based on the PLC consuming .21 amps continuously all day.

SUCCESSFUL PROJECT RESULTS

The use of solar power in industrial valve automation goes back several decades. However, technological advances in efficiency and storage mean the technology has become a practical, dependable alternative for many isolated locations.

The customer is now utilizing a robust solar system providing power to operate PLCs and electric valve actuators for pipelines transporting contaminants from fracturing sites to water gathering and disposal facilities.

The innovative solar power solution provides the proper voltage to operate automated modulating and isolation valves with a tremendous safety factor. The electric actuators incorporate an internal battery system that also provides position feedback and diagnostics. A feature programmed in the system provides a low-voltage alarm to notify pipeline operators if the power from the solar system has dropped below the level required for valve operation.

In addition, the solar system includes a control panel that utilizes a series of voltage regulators to monitor the battery voltage. The system only provides charging when the voltage drops below specified levels. This prevents overcharging the battery and possible degradation.

Testing of the solar-powered valve packages provided valuable insights on system wiring. A default 24Vdc signal had been used to open the valve, and when de-energized, it would close. Upon loss of signal power, the valve would again close. This function was set up in the actuator's two-wire priority to close on loss of signal. It was subsequently requested that the valve fail in place with one 24Vdc signal to open and another to close. All of the units were reconfigured and successfully retested.

The project team also learned the pipelines would be hydro-tested after the valves were installed. Instead of shipping the devices in the closed position, it was decided that they should remain open. This way, the hydro-tests could proceed even if the solar system was not yet connected to the valves.

Finally, the project team realized that it is impossible to predict the weather. Upon completion of assembly, there was a good balance of sunny, cloudy and rainy days, and engineers were

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Figure 3: Testing at the Ferguson Industrial facility demonstrated the effectiveness of the solar power solution.

NOTE: Jack DiFranco and Ferguson Industrial would like to recognize automation technician Josh Hasty for his assistance and contribution to the complete assembly and testing of the automated solar system.

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Figure 4: A rigorous evaluation of the solar-powered valve packages validated the expected performance signatures.

able to fully test the valves and confirm they would stroke with no sunlight for at least two days. However, just before the viewing of the testing procedures, there was complete sunlight and a proper test could not be emulated. This required the placement of covers over the solar panels. The valves were stroked fully open and fully closed five times off battery power each day over a three-day period. Upon removal of the covers, the batteries immediately started charging and were fully charged in two to three hours depending on the solar system.

CONCLUSION

Oilfield service companies seek to optimize their network of produced water pipelines and underground injection wells, which are designed to gather and dispose of saltwater for the shale oil industry. By partnering with a trusted automation equipment supplier like Ferguson Industrial, they can find ways to improve the efficiency and reliability of their water disposal infrastructure while improving safety and reducing costs.

FOR MORE INFORMATION

To learn more about Ferguson Industrial, visit **fergusonindustrial.com** or contact your account manager.

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