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Well Pad Automation Improves Capital Efficiency and Reduces Fiscal Risk

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Abstract

Oil and gas operators in shale production face many challenges in developing well pad facilities. The rapid development and deployment of assets, accelerated production decline, and an evolving regulatory environment leave little margin for error and require effectively leveraging technology to achieve economically viable production and yield.

This paper examines best practices for implementing an automation strategy for well pad facilities in order to access insight into key variables that impact the health of the reservoir and optimize the custody transfer of oil and gas off the well pad. Field-proven solutions will be examined on how to fully utilize available measurement and control technologies to get beyond a "it works and is good enough" approach to effectively manage facilities. By utilizing innovative technology in a more systematic and cost-effective approach, operators can improve oil and gas process unit operations and reliability.

Introduction

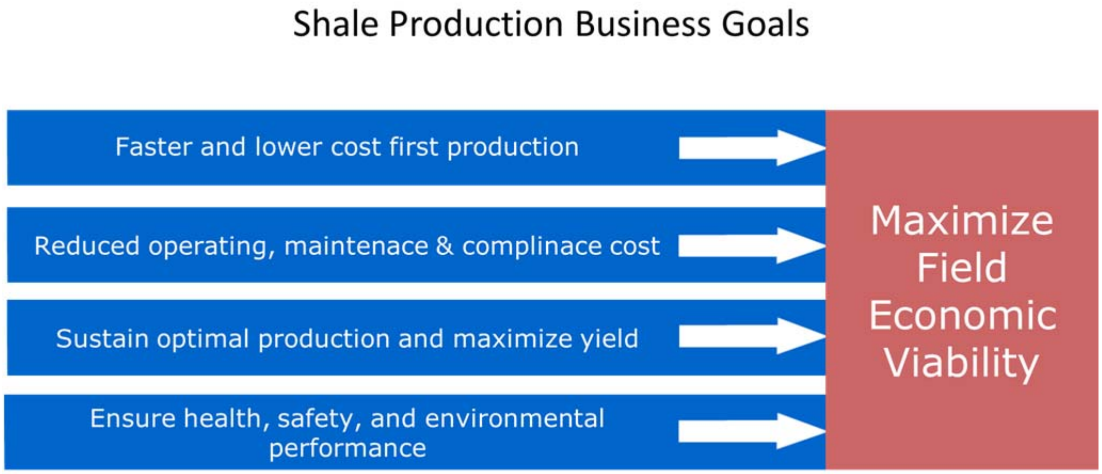
With the rapid development of new fields, the variety and availability of facility management data is dramatically increasing in quantity and complexity, yet finding the expertise to filter and interpret data in a timely manner is a challenge. The complexity of automation integration, combined with managing different service providers can put projects at risk. Oil and gas operators are looking to standardization and integration of systems and work practices that will improve capital efficiency, lower project risk, and meet challenging deadlines.

It is possible to use remote automation architecture and capability to transfer information from the field to the office providing the structure needed to readily access critical information regarding field equipment health, process unit diagnostics, optimization opportunities and resource utilization.

Many O&G operators are implementing a tiered strategy for automation:

1. **Surveillance** – obtaining real-time data to improve day to day asset management
2. **Analysis** – adding automatic data validation and analysis to migrate data to actionable information in real-time
3. **Optimization** – implementing intervention in real-time with automatic event detection and handling
4. **Transformation –** transforming operations with innovative business solutions

This automation strategy is being utilized to effectively solve key challenges in the oil and gas industry.



The Value of Real-Time Surveillance

In order to build a foundation for analysis, optimization, and transformation, access to real-time data is required to improve day-to-day asset management. This involves installing instrumentation and exploiting the breadth of technologies and telemetry in order to monitor key process variables in real time or near real time. As a best practice, technology selection should include devices that are designed to work together, offer a simple means of integration, and have diagnostic capability that will help to enable data validation and analysis. A flexible architecture that is scalable and considers wireless technologies will save cost and allow for the addition of instruments as the field changes and more advanced control algorithms are required such as artificial lift optimization. Preconfigured software and hardware will increase standardization and facilitate getting production online faster.

Surveillance application examples:

- Wellhead integrity monitoring (casing, tubing pressure, temperature)
- Chemical injection monitoring
- Sand / corrosion monitoring
- Separator / Heater Treater production data gathering
- Tank volumes
- Fiscal measurement / LACT

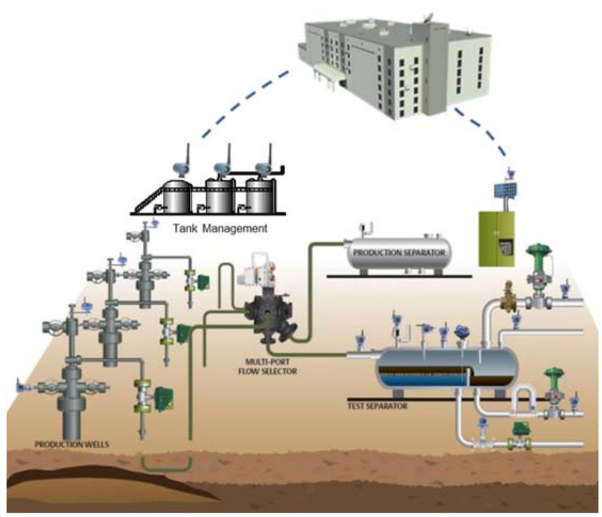


Figure 1: Typical well pad surveillance implementation

Well Pad Automation Best Practices

Wireless Surveillance

Being able to get online quickly is a key challenge in shale development due to the fast paced drilling schedules. Wireless technology is increasingly being adopted in the oil and gas industry to reduce start-up time, installation costs, provide a simple way to easily add monitoring points and access stranded data in remote fields. One such project consisted of:

- Four tank level measurement for inventory management
- Separator production measurements (pressure measurement, oil flowmeter, water flowmeter, gas flowmeter)
- Wellhead integrity monitoring (casing and tubing pressures)

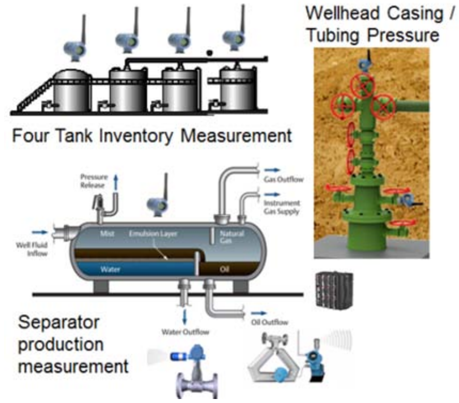


Figure 2: Wireless surveillance project

An economic analysis of the project concluded that by taking advantage of a wireless infrastructure vs. wired for this project resulted in a 66% cost savings and 80% reduction in start-up time.

Sand Monitoring

Sand production in shale plays is a challenge that can cause damage to downstream equipment and in extreme cases cause erosion that can compromise the pressure integrity of the wellhead and gathering pipelines. By taking advantage of non-intrusive wireless acoustic sand detection, proper choke settings were determined to minimize the production of sand and resulting equipment damage. Since the devices were non-intrusive and wireless they were rotated to different wellheads after the appropriate choke setting were determined minimizing capital costs.

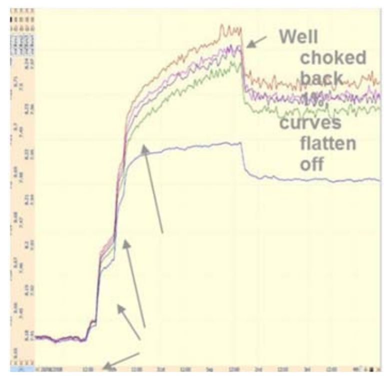
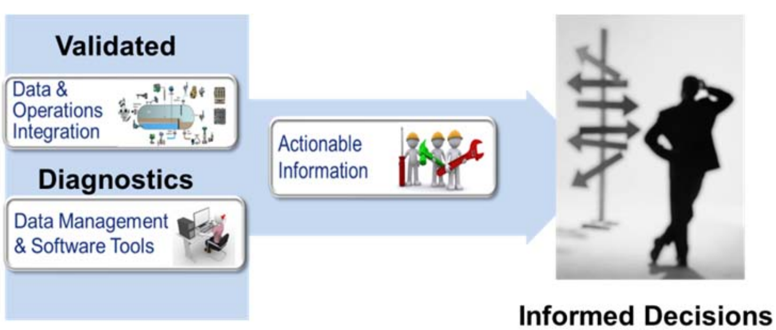


Figure 3: Sand Monitoring

The Value of Real-Time Analysis

By first establishing a surveillance foundation, the next step is to ensure data validity. As a best practice, consideration should be given to utilizing devices with diagnostics to confirm instrument health that provides a means to ensure measurement data integrity. Data management software tools allow easy visualization, trending and analysis to turn raw data into actionable information in order to improve production planning, schedule proactive maintenance operations, and provide a means for effective remote collaboration and problem solving in order to make informed decisions on field management.



Heater Treater Data Analysis

Many shale fields rely on production data measurements from the heater treater and have challenges ensuring accurate allocation accounting without the need to send someone to the field to validate the data. In many cases the heater treater downcomer level is not adequately controlled. This results in gas exiting the downcomer pipe with the oil. Many flowmeters on the market will experience an over registration of volumes measured due to gas which then must be reconciled with the tank volumes and can lead to royalty payment disputes. In addition to the measurement error, this gas is often lost to the tank and flare system if no vapor recovery unit is installed on site.

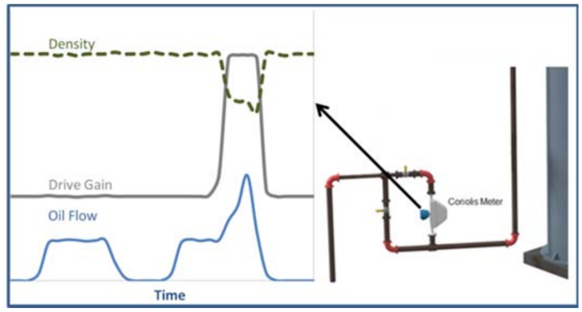


Figure 4: Heater Treater dump cycle analysis

By using diagnostic capabilities built into Coriolis technology, flow measurement data can be easily analyzed as shown in figure 4. A spike in oil production, combined with a drop in density and increase in drive gain indicates that gas is escaping with the oil during the dump cycle. One oil and gas operator estimated they could recover an additional $72,000/day in lost gas revenue on their field of 1200 wells by using flow data dump cycle analysis to minimize lost gas to flare.

Fiscal Measurement Assurance Data Analysis

Accurate flow measurement is very important as it is widely used for accounting purposes in fiscal and custody transfer applications. The meter is required to maintain a specified accuracy in order to be compliant with industry standards and regulations. Meter performance is ensured by periodic proving and calibration cycles. Modern flowmeters can be supplied with diagnostic tools that show deviations from baseline calibration values established at startup or at the calibration facility. In addition, alerts can be generated showing abnormal situations that will affect meter accuracy.

These analytical tools provide added assurance of meter performance between proving cycles. The fiscal risk of an additional 0.1% uncertainty on a metering system going undetected between proving cycles can cost $1000 per day which can be easily identified using analytical tools and meter diagnostics.

Figure 5. Diagnostics can be used to detect many upset conditions between proving cycles

The Value of Real-Time Optimization

With a surveillance system and data analysis and validation established, it is now possible to close the loop and control real-time in order to optimize processes and move to real-time intervention. Automation and integration of optimization software support closed loop control in order to optimize well production, reduce production measurement uncertainty and automatically optimize the field to ensure production targets are met and reservoir recovery is maintained.

Figure 6: Real-time optimization

Real-Time Separator Optimization

In order to meet production plans and maximize production and yield, reliable and efficient separator operations are required to provide accurate and timely production data. This requires reliable level measurement, dependable level control valve performance, accurate pressure control loops, and accurate flow measurement solutions with diagnostic insight to detect separator efficiency problems. All of these devices can then be integrated into a RTU (remote terminal unit) with software to perform and automate test sequencing, scheduling, and test validation that can be operated remotely.

An optimized separator solution allows for easy diagnosis of any separator problems per figure 7 below. Using these diagnostic tools, one oil and gas operator estimated they could recover 3.4% gas production by minimizing gas carry-under which would go to tanks and flare increasing gas sales by $3.3 million per year. In addition, production allocation errors are reduced and more accurate data is available to feed the reservoir model resulting in reduced reservoir characterization uncertainty.

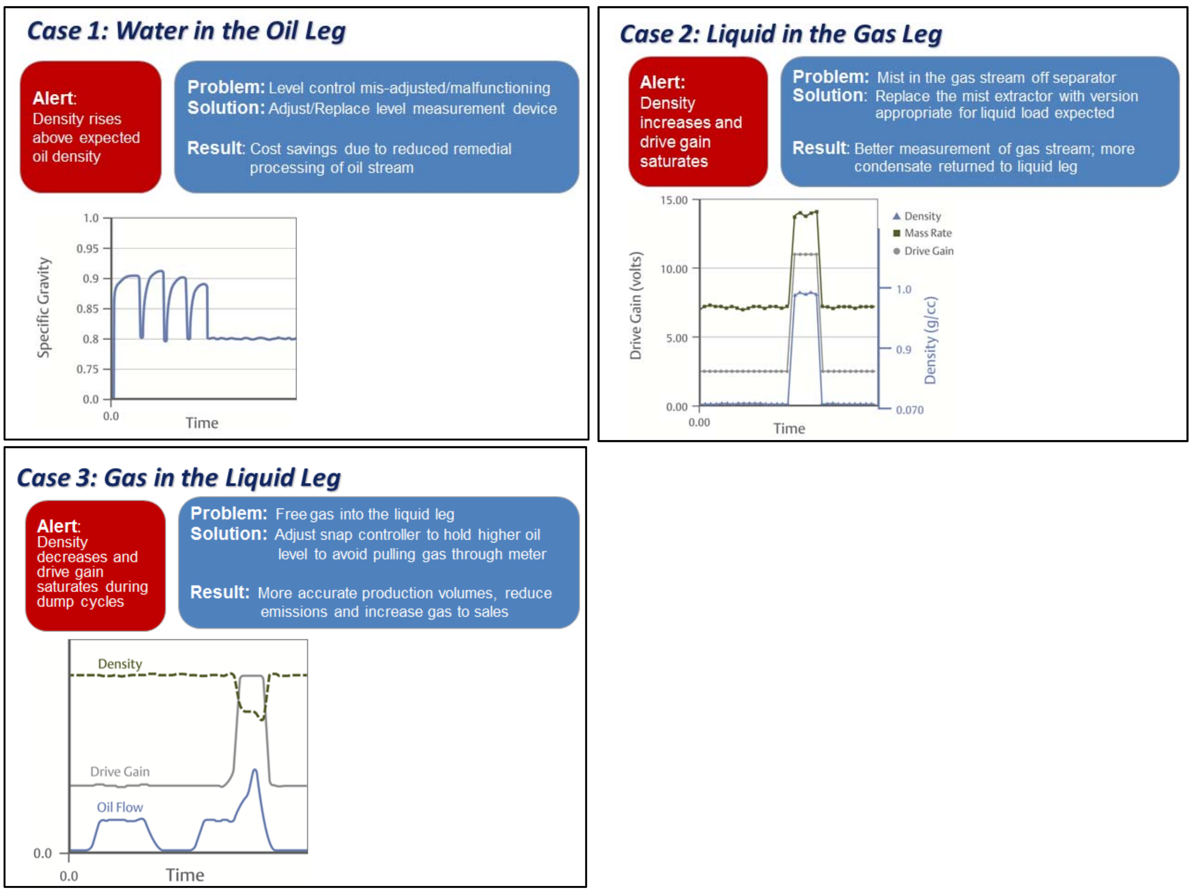


Figure 7: Real-time separator optimization case studies using measurement diagnostics

The Value of Transformation

With surveillance, analysis, and optimization implemented, the foundation is complete to transition to transformation or using innovative business solutions to change the way the field is managed and operated. It requires utilizing, people, processes, and technology in a collaborative and innovative way to solve complex business challenges. Oil and gas companies are increasing looking to iOps (integrated operations) centers to facilitate collaboration and the sharing of information per figure 8 and 9.

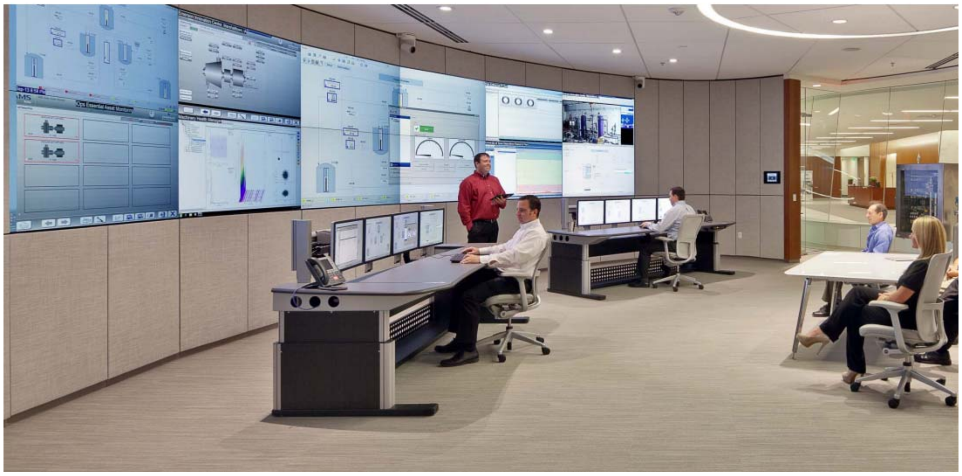


Figure 8: iOps Center

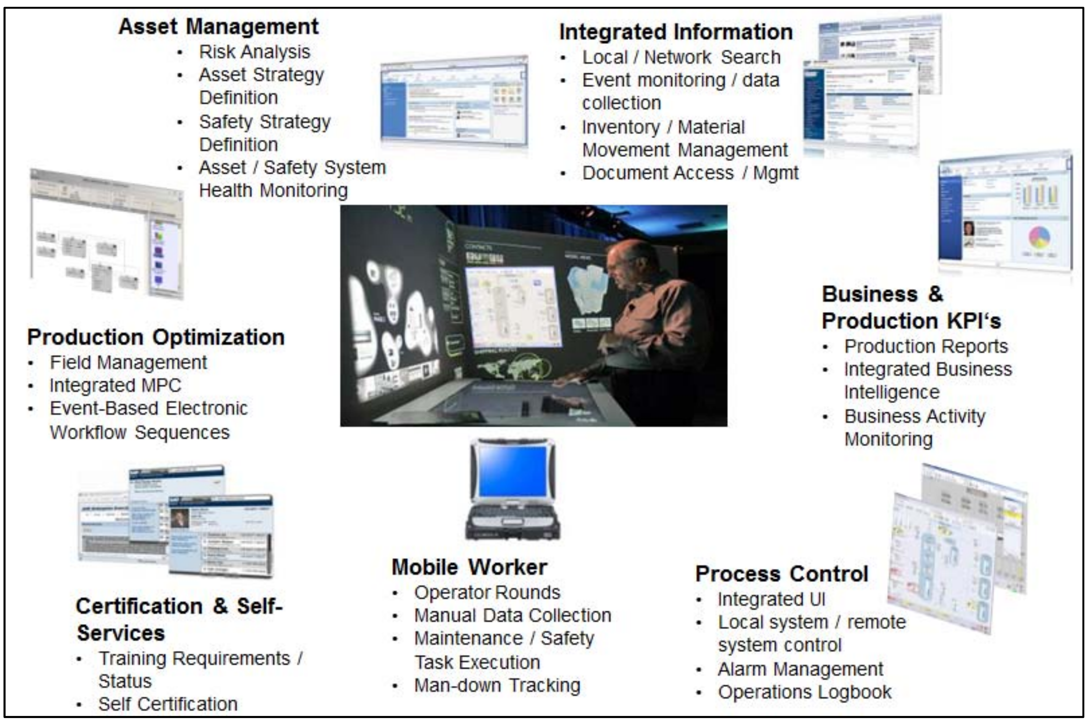


Figure 9: iOps Scope

Gas Lift Management Transformation

Gas lift optimization can pose significant challenges to ensure optimal hydrocarbon recovery. It is difficult to maintain an optimal gas injection rate based on the ratio of the volume of gas injection to the volume of oil produced. Over-injection reduces profitability due to the added cost of the gas and compression with a diminished incremental increase of oil. With a limited gas supply, over injection in one well potentially starves another well from needed gas resulting in diminished production. Under-injection simply increases the hydrostatic pressure which can reduce the BHP (bottom hole pressure) ability to push fluids to the top. With multiple wells and a limited gas supply it can is challenging to distribute gas to the most profitable wells and maximize recovery.

Gas lift management requires integration of multiple variables across the field and is a key example of where people, process, and technology can come together to provide an innovative solution. In order to maximize efficiency you must:

1. Optimize gas lift injection flow rates to each well automatically
2. Prioritize gas lift supply to the wells with the highest profitability
3. Protect your compressor from common failures and trips that threaten gas lift supply

Figure 10 shows ideal gas lift architecture in order to accomplish these goals.

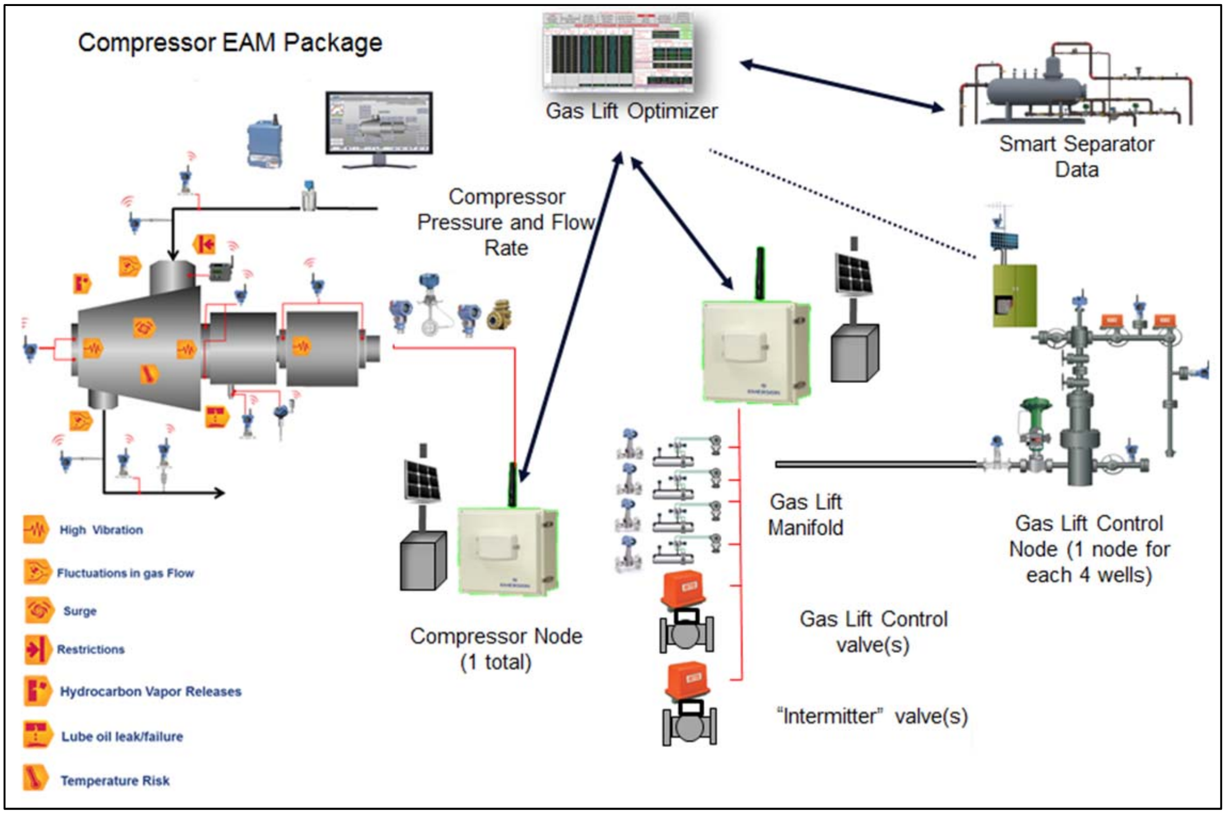


Figure 10: Gas lift optimization

Using this architecture, specialized gas lift optimization software gathers real-time data from the field and tests the various combinations of lift gas rates against operating constraints. The software then converges on an optimum set point and sends new lift gas rates to the automation system either as an advisory or as a new set point automatically making the most of available gas and allocating gas to wells where it makes the most money. One oil and gas operator experienced a 16% increase in oil production using this solution.

Conclusion

Unconventional shale production has many challenges and an automation strategy based on surveillance, analysis, optimization, and transformation provides a unique opportunity to reduce time to first production, lower operating and maintenance costs, improve HSE performance, and increase production and yield in order to maximize the economic viability of the field.