COLDSTREAM ENERGY®

Best Practices for Optimizing Compressor Station Performance

MAY 2025 WHITE PAPER

Best Practices for Optimizing Compressor Station Performance

Overview

Compressor stations play a critical role in the natural gas infrastructure by ensuring efficient transportation through pipelines from wellhead to burner tip. Optimizing their performance is crucial for reliability, cost-efficiency, and regulatory compliance.

The demand for natural gas projects is set to increase in the coming years, given anticipated changes in energy policy that will likely encourage the further development of oil and natural gas resources. Coal-to-gas switching in the power generation sector, rising potential for LNG exportation projects in the U.S., and increasingly stringent emissions regulations are likely to drive an increase in natural gas consumption in the years ahead.

But development of affordable and reliable oil and gas energy resources can't happen without compressor stations driving projects forward. From small gathering systems to large interstate pipelines, compressor stations are essential for the movement of natural gas, making operational efficiency, profitability, and emissions performance top priorities for operators.

The primary function of compressor stations is to move natural gas through a pipeline (e.g., a gathering system or transmission line) by boosting pressure and keeping the gas moving through the network. Compressor stations commonly use reciprocating compressors, often fueled by the gas they are compressing. Although this makes compressor stations extremely self-reliant, it does make them vulnerable to less than ideal fuel gas quality and the inherent inefficiencies and reliability related issues of higher knock and increased VOC emissions.

In this paper, we cover the objectives of compressor station optimization, the factors that operators can consider, and recommendations. Central focus is on the impact of fuel gas quality, which is one of the most significant factors for achieving maximum operational, financial, and emissions performance.

Objectives of Compressor Station Optimization

Operators of compressor stations, whether a midstream company or a large integrated E&P, typically focus on the following objectives when it comes to optimizing efficiency and performance:

1 **Keeping Gas in The Pipe.** Fugitive emissions of gas to the atmosphere are expensive. Not only do leaks result in lost revenue but they can also result in expensive fines and regulatory actions, especially if they result in a Super Emitter Event (a leak of 100 kg/hour or more).

2 **Maximizing Pipeline Efficiency.** The primary function of a compression facility is to elevate gas pressure for efficient pipeline transportation. Minimizing the horsepower needed for compression enhances profitability. By reducing fuel consumption along with reduced maintenance costs, compression facilities can achieve significant savings. Additionally, improving efficiency and engine performance allows for greater gas throughput with the same horsepower, thereby increasing potential revenues.

3 **Improving Equipment Reliability.** The value of a compressor station is a function of its reliability. Improving reliability is a function of several factors, including fuel quality, operating practices, preventive maintenance regimens, and consistently monitoring engine performance.

4 **Boosting Revenue Producing Capability.** Efficient compressor station performance is a key factor in maximizing throughput of natural gas, recovery of valuable heavy hydrocarbons, and maximizing fee- based revenue.

5 **Maximizing the Value of People.** Long-term efficiency and cost-effectiveness hinge directly on the expertise, skills, and capabilities of local operating and maintenance personnel. Well-trained personnel working in an environment that prioritizes long-term efficiency and uptime are better positioned to identify and resolve issues before they become problems, continuously improve operational practices, and create a sense of pride in their facility.

Factors Impacting Compressor Station Performance

Several factors impact compressor station efficiency and performance, including:

MECHANICAL FACTORS

Reliability and efficiency depend in great part on the smooth mechanical functioning of compressor engines.

- **Equipment Reliability and Maintenance:** Ensuring regular maintenance and reliability testing of compressors and gas-fired engines.
- **Efficiency of Compressors and Gas-Fired Engines:** Utilizing efficient equipment to minimize energy consumption.
- **Control Systems and Instrumentation:** Implementing advanced control systems for better operational oversight and identifying potential issues before they become problems and/or cause unexpected downtime.

OPERATIONAL FACTORS

Operational factors, often beyond the control of the compressor station operating personnel, also materially impact facility performance.

- **Gas Composition:** Managing gas quality variations including high liquids content and swings in BTU content is important, as lower quality fuel gas generates higher emissions and can cause horsepower derating.

Factors Impacting Compressor Station Performance (cont.)

- **Temperature and Environmental Conditions:** Adapting operations to varying environmental conditions is critical, as ambient temperatures and inclement weather can impact compressor engine performance.
- **Load Variability and Demand Patterns:** Optimizing operations to meet fluctuating demand efficiently helps ensure compressor engines are functioning within their ideal operating parameters.

ECONOMIC FACTORS

Compressor station facilities must contribute to the economic performance of the entire system and not serve as a drag on financial results to ensure long-term economic sustainability.

- **Operational Costs:** Controlling operational expenses through efficient practices is ideally an ongoing process for continuous improvement.
- **Return on Investment (ROI) Considerations:** Balancing capital expenditures with long-term savings is critical for effective capital allocation and ensuring adequate economic returns.

EMISSIONS PERFORMANCE

Minimizing emissions from compression facilities plays a critical role in meeting both regulatory compliance and voluntary emissions reduction initiatives. Maintaining a low emissions profile can help avert expensive permitting requirements, enhance your reputation with the investment community, and of course avoid fines or regulatory actions.

- **Regulatory Considerations:** The Gathering and Boosting segment, which includes onshore and offshore compressor stations, is subject to new emissions regulations put in place by the EPA in 2024.
- **Title V Operating Permits:** Maintaining emissions levels below Major Source thresholds can help avoid the burden of obtaining an expensive and time-consuming Title V operating permit and its ongoing compliance requirements.
- **Voluntary Emissions Reduction Initiatives:** Addressing climate risks and enhancing corporate reputation. Many operators have signed on to voluntary emissions reduction groups, such as the Oil and Gas Methane Partnership (OGMP 2.0), including 140 operators of gathering systems and pipelines such as Devon, ConocoPhillips, BP, Chevron, EOG Resources, EQT, ExxonMobil, Diamondback Energy, Williams, and others.

Options for Optimizing Performance

Operators have several key focus areas for improving the overall performance, efficiency, and profitability of compressors stations.

EQUIPMENT INVESTMENT

Adding more horsepower allows more gas to be compressed and transported through the pipeline, enhancing overall throughput and improving throughput per horsepower.

- **Pros:** Relatively easy to implement, good equipment availability in most cases, usually no retraining needed.
- **Cons:** May require significant capital investment, can take time to permit and install, increases operating expense.
- **Verdict:** You are anticipating a significant increase in long-term gas volumes system wide from ongoing development drilling projects.

PREDICTIVE MAINTENANCE

Implementing proactive maintenance strategies is crucial for enhancing equipment reliability and operational efficiency. By adopting proactive measures, organizations can preemptively address potential issues before they escalate, thereby minimizing downtime and optimizing productivity.

- **Pros:** Can increase the longevity and reliability of engines and overall performance with relatively low implementation cost.

- **Cons:** Unlikely to deliver significant gains in throughput or efficiency, may not have the technical/analytical expertise to implement adequately. Minimal impact on emissions reduction.
- **Verdict:** You expect the same or declining volumes and seek to maximize the value of existing assets and avoid major capital outlays.

Options for Optimizing Performance (cont.)

J-T SKID

Commonly employed on well sites or production pads due to their simplicity and compact size. Operating on the principle of the Joule-Thomson (JT) Effect, these units utilize a JT Valve to reduce pressure without mechanical force. As gas experiences a rapid pressure drop, it cools, causing heavier Natural Gas Liquids (NGLs) to condense out, resulting in a leaner gas stream with higher methane content.

- **Pros:** Simple operation, widely available technology, small operational footprint, some incremental NGL revenue, relatively low maintenance (no reciprocating parts), and marginally better engine performance from burning a leaner fuel gas.
- **Cons:** Imprecise NGL recovery, can be prone to freeze-ups causing unexpected system downtime, may require additional investment in dehydrators, methanol injection systems, and/or compression capacity. The reliability of methane injection systems can be a single point of failure, for example if a methane pump goes down, then so does the compressor station. Produces only a marginal improvement of fuel quality that may meet the minimum specification, but not good enough to avoid an engine derate and still generates high relative emissions. Performance is dependent on ambient temperatures and available pressure drop and can only be used in high pressure systems (>1,000 psi).
- **Verdict:** Best to use in remote locations for treating lower gas volumes in areas where electric power is unavailable and/or NGL content is lower.

Options for Optimizing Performance (cont.)

RESIDUE LINE FUEL

Implementing residue line connections for improved fuel quality and reduced emissions. A residue gas line run from a gas processing plant to a compression facility is a method for delivering lean, pipeline quality fuel gas to compressor engines.

- **Pros:** Access to lean, pipeline quality fuel gas that burns cleaner producing fewer emissions and maximizing engine performance.
- **Cons:** Can be time-consuming and expensive to install, additional capital outlays may reduce overall ROI, potential variability in gas quality and consistency, ongoing costs for maintenance and repair, potential for creating fugitive emissions. Cannot be moved when decommissioning a station. In some cases may result in additional costs if the gas gathering contract does not include a fuel allowance.
- **Verdict:** Often considered the "gold standard" of optimization but can be expensive and time-consuming to implement. Best used when your compressor station is located near processing facilities where residue gas is readily available, facilitating easier logistics and integration into existing infrastructure. Generally, it is not feasible for remote locations.

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Technology-Based Solution: MaCH4™ NGL Recovery System

MaCH4™
NGL Recovery Solution

The ***MaCH4*** **NGL Recovery Solution** from Coldstream Energy is a technology-driven solution for generating residue line quality gas without the time and expense of a residue line.

The ***MaCH4*** uses patented, proven Pressure Swing Adsorption (PSA) technology that allows you to recover NGL's instead of burning them for increasing revenue and reducing emissions.

WHAT THE *MaCH4* DOES

The ***MaCH4*** NGL Recovery Solution captures NGLs instead of burning them and simultaneously delivers lean, dry fuel gas to your natural gas fired engines and equipment at compressor stations. Using reliable PSA technology, the ***MaCH4*** delivers these benefits:

- **Maximized NGL Value.** Cryogenic level NGL recoveries capturing 60% of C2 and 95% C3+, keeping NGL's in gaseous form for downstream monetization.
- **VOC emissions reduction.** The highly effective NGL recovery produces a consistent stream of residue line quality, lean fuel gas that can reduce up to 75% of VOC emissions, and 8% CO2 emissions upstream of engine catalyst.
- **Increase station throughput.** Using lean, residue quality fuel gas minimizes engine derating (up to 9%) to maximize gathering station throughput and fee-based revenue.

CASE STUDY

Iron Horse Midstream

The ***MaCH4*** proved its value proposition in a rigorous pilot project with Iron Horse Midstream that will be converted into a permanent installation in Q1 2025.

A ***MaCH4*** unit has been fueling an Iron Horse compressor station with lean gas since commissioning of the Pilot in December of 2023. The ***MaCH4*** solution has posted an enviable track record of more than 99% mechanical availability since commissioning and has been remotely monitored and operated since May 2024.

In the Pilot the ***MaCH4*** was benchmarked against a J-T skid. The Pilot employed a 4-bed PSA system with a compressor package delivering high-pressure feed gas to the ***MaCH4*** unit. The ***MaCH4*** generated a lean fuel gas stream for the compressor station engines and recovered heavy hydrocarbons remaining in a gaseous state for later processing at a gas processing plant.

MaCH4 **Pilot Results:**

- Reduced raw gas from 1,305 BTU/scf (HHV) to less than 1,070 BTU/scf (HHV) consistently over the pilot (methane number of 78 for the LP product versus 59 for raw gas)
- Recovered NGLs (HP product) remain in gas phase, over 99% of the C4+ and over 85% of the C3 is returned to the suction header for monetization downstream
- Pipeline quality fuel gas without liquid dropout, freeze issues, or constant methanol consumption

Based on a field gas BTU value approximately 1,305 BTU/scf at the Pilot site, the total annual NGL value recovered would be greater than $1.2MM for a 7,500 HP Compressor Station.

Read more: ***MaCH4*** White Paper (PDF Download) ▶

Summary

One of the most significant improvements operators of natural gas-powered compressor stations can make for optimizing operational, financial, and emissions performance is to use the highest quality fuel gas. Although residue line gas is considered the "gold standard" of quality fuel gas, it is typically time consuming and expensive to install, the line is a permanent fixture that cannot be moved when a station is decommissioned, and in many areas of new development a residue line is simply unavailable.

The *MaCH4* NGL Recovery Solution uses patented, proven Pressure Swing Adsorption (PSA) technology that delivers cryogenic-like NGL recovery along with a lean, high-quality fuel gas without the expense of a residue line. This groundbreaking application of PSA technology has proven itself in a long-term field trial with Iron Horse Midstream, a leading midstream operator.

In summary, the ***MaCH4*** increases NGL revenue, reduces VOC emissions, and improves engine efficiency and station throughput.

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Contact us today to learn more about the ***MaCH4*** and how it can optimize your compressor station efficiency, profitability, and emissions performance.

About Coldstream Energy

ColdStream Energy, based in Houston, Texas, is a leader in innovative natural gas conditioning and separation technology to maximize profits and minimize emissions for upstream and midstream operators.

At Coldstream Energy, we are passionate about our commitment to improving air quality and reducing waste of the Earth's valuable resources. A sustainable oil and gas industry is the foundation of the modern global economy, providing affordable and reliable energy. At this pivotal time, our technology provides a tremendous opportunity to capture valuable resources that otherwise would be wasted by combusting NGLs in compressor engines or flaring natural gas. Not only is converting "field gas" into valuable products good for the environment, but it is also just good business.

Our solutions are engineered to recover Natural Gas Liquids (NGLs) efficiently and effectively for maximizing the value of natural gas production streams. We use proven technologies for recovering heavy hydrocarbons (C3+) from produced gas and tank vapors, generating incremental revenue, boosting operational efficiency, and improving environmental performance.

Our flagship ***MaCH4*** NGL Recovery Solution is a breakthrough application of proven Pressure Swing Adsorption (PSA) technology for use in the oil and gas industry and is the simplest and fastest way to achieve cryogenic-quality NGL recovery and lean compressor engine fuel gas.

CONTACT
Matt Thompson
SVP Sales & Marketing
ColdStream Energy, LLC
mthompson@coldstreamenergy.com

LEADER IN INNOVATIVE NATURAL GAS CONDITIONING AND SEPARATION TECHNOLOGY

COLDSTREAM ENERGY®

info@coldstreamenergy.com
www.coldstreamenergy.com

ColdStream Energy
1801 Main Street, Suite 1300
Houston, Texas 77002