

Gas handling at LNG terminals – compressor technology and reliability



Compressors for a Lifetime

Across the LNG landscape, compressors play a crucial role in the efficient transport and storage of gas. Their continued reliability and efficiency are essential for effective operations in modern gas supply networks. Ageing assets can benefit from upgrades and overhauls that use the latest materials and reverse engineering techniques to update compressors and extend their service life. Even if different manufacturers supplied the original equipment, it is possible to find expertise and knowledge from a single source that can support a variety of machines and keep downtime to a minimum.

Rakesh Kulkarni, Engineering Sales Manager at Burckhardt Compression, looks at land-based compressors and how their performance can be improved.

Downstream applications in LNG terminals predominantly use oil-free reciprocating compressors. These avoid the need for lubrication systems and filter maintenance by making oil separation and gas filtration technologies unnecessary, thereby guaranteeing the cleanliness of the heat exchangers and high-pressure re-liquefaction system.



A typical terminal equipped with LNG compressors

Managing boil-off gas

Oil-free compressors are integral to the efficient and safe operation of LNG terminals. Their primary function is to manage boil-off gas (BOG) — the vaporized LNG that results from ambient heat absorption during storage and transportation. By compressing BOG, these compressors enable its re-liquefaction or use as fuel, minimizing product loss and reducing emissions.

Oil-free reciprocating compressors are favored for this role due to their ability to handle cryogenic temperatures, with inlet gas temperatures reaching as low as -170°C . They are designed with specific materials for wear components, such as piston rings and seals, to ensure reliability and minimize maintenance under these extreme conditions.

Common designs such as the Laby[®] and the Laby[®]-GI have been developed by Burckhardt Compression. These compressors are specifically designed for both land-based and marine LNG applications. They can compress gas to 300 bar without cylinder lubrication, making them suitable for both re-liquefaction processes and on-board vessels with dual-fuel engines.

Managing the local energy grid

Once BOG is reliquefied or used as fuel, the processed natural gas can be introduced into the distribution grid. This integration ensures a continuous supply of natural gas to meet consumer demand, enhancing the flexibility and reliability of the energy supply chain. Compressors are also used for transport over longer distances and at local storage and delivery stations to maintain gas pressure.

This entire infrastructure should be properly maintained to ensure safe and reliable operation, leading to decades of dependable service. However, ageing assets will eventually need more significant interventions if they are to continue working without being replaced.

Experienced service providers can provide comprehensive revamps, including reverse engineering parts and introducing upgraded materials.

Comprehensive assessments

The event that determines the need for an intervention can range from a change in local legislation, such as emissions regulations, to an unplanned outage that affects productivity immediately. Whatever the reason, the process to identify the best solution remains the same.



Accurate data collection is crucial for identifying maintenance issues

The first step in revitalizing a compressor is completing a comprehensive assessment to understand the condition of the equipment, the urgency of any repairs and potential benefits of this work. Obtaining sufficient information requires a structured assessment that uses advanced measurement techniques and data analysis to identify any issues.

Using data available from the operator's process, as well as any additional sensors that may be required for a comprehensive picture, in-depth analysis should identify any bad actors. The major issues can be categorized into three main groups: reliability, excessive energy consumption and gas emissions.

Each group has a direct effect on the business and should be addressed methodically to deliver data-driven insights and effective solutions.

Precision measurements

The monitoring and protection of reciprocating compressors is now covered by the 5th edition of API 670, released in November 2014. Plants operating these machines will often categorize them as critical equipment and therefore put in place sensors to collect important data.

Over time, continuous operation causes clearances to go out of tolerance, which will induce vibrations. Sensors can be installed in several locations as part of the machine build or portable equipment can be used to establish vibration levels periodically. Whichever option is chosen, this data is some of the most important information needed to determine any potential issues.

Velocity sensors can also be used to determine vibration in the frame, crosshead and cylinder. Their positioning is crucial in achieving accurate data that can be used to pinpoint issues. Working with the OEM or a maintenance provider experienced in this application should ensure that all sensors are correctly located and calibrated.

Problems with valves, such as sticking or lost springs, can be isolated if crank angle data is available. This should be complemented with accelerometers and velocity sensors, which can be used to measure vibration, gas leak malfunctions and overloading.

Analyzing the options

Having established the areas of the compressor that require attention, the next step is defining the best course of action. There may be short- and long-term solutions and the operator needs to be aware of all the options. The OEM may not be able to deliver immediate support and replacement parts for older machines may have a long lead-time.

This is where an independent service provider with an OEM background could deliver alternative options. The ability to reverse engineer parts supported by all the required documentation is crucial to providing a fast response. Options can include upgrading the original material specifications as well as improving clearances and sealing solutions.

With many machines having completed decades of service, materials technologies have progressed significantly since their original design was conceived. In the intervening years, there have been many significant improvements in materials and machining technologies which can now be used to extend the service life of existing assets.

Extending piston life by 300%

The BOG compressors at an LNG terminal were suffering from reduced reliability – the 1st stage pistons needed to be replaced every four years. The operator had approached the OEM for a solution, but they did not respond with any support. This led to Burckhardt Compression being approached to investigate and resolve the problem.

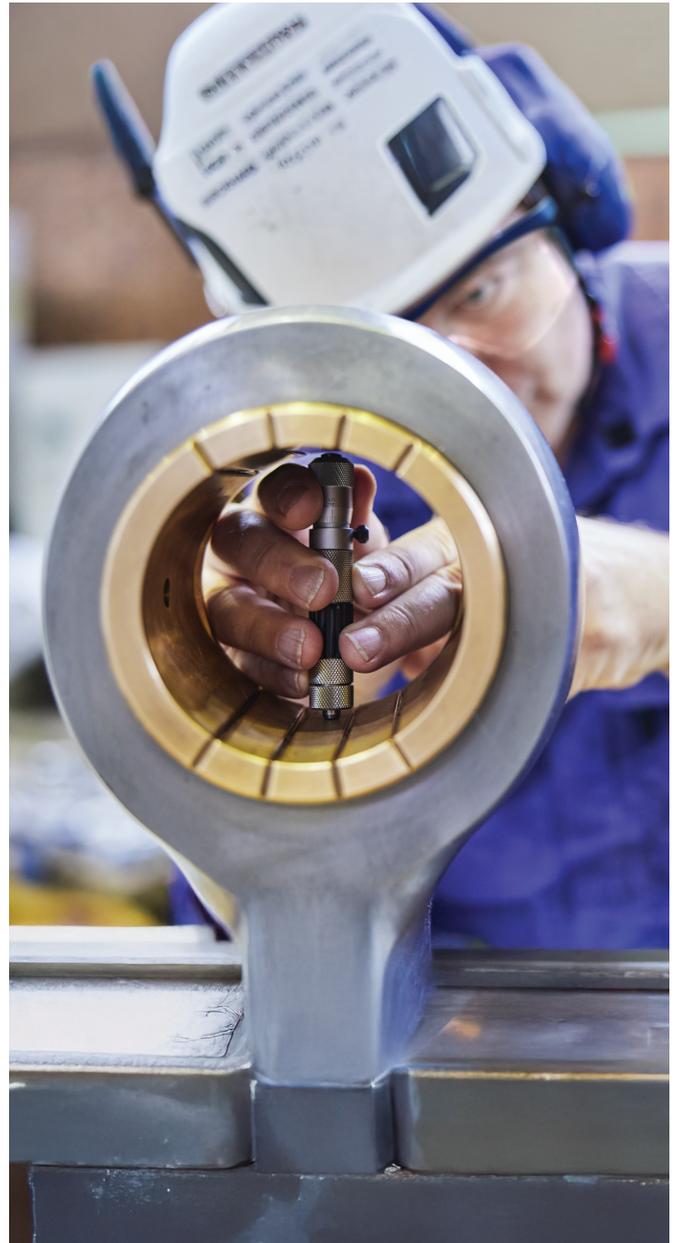
The LNG storage tanks used perlite for insulation and in the older tanks it had come away from the tank walls and was being carried through the pipework to the compressors. In the cylinders, it acted like a grinding paste, predominantly damaging the 1st stage piston, but some perlite carried through to the 2nd stage as well.

Increased clearances and wear to the piston ring grooves caused the sealing rings to become dislodged and trapped in the valve port, causing the rings to break. The material for the rider rings had been selected poorly and all stages were missing pressure release grooves. As a result, the original rings would be changed after 8'000 hours.

New materials

The engineering study determined that the best option for an improved design would be an aluminum, single-piece 1st stage piston, installed with new rider rings using a material optimized for dry-running, high speed and high load applications. These would be matched with a specialist coating applied to the piston rod and a new cylinder liner, designed by Burckhardt Compression. These improvements were projected to increase the mean time between overhaul (MTBO) from 8'000 hours to more than 24'000 hours.

Due to the perlite being carried over to the 2nd stage and on occasions to the 3rd stage, all the sealing rings were upgraded to the proprietary material from Burckhardt Compression. Since the upgrade was completed, the 1st stage rings have a minimum service life of 24'000 hours, while those in the 2nd and 3rd stages have been checked and reinstated, achieving over 72'000 hours of reliable service.



Expert on-site support is essential for fast turnarounds

Process modifications

In another example, an LNG terminal had a process that needed the compressors to start and stop frequently. While they were coming up to speed, the operation needed to flare the gas. This had both a financial cost as well as environmental implications and required regular dialogue with the local authorities.

Predominantly, the duty compressor would run at 50% capacity while the stand-by unit remained offline. Each month, the compressors would switch operations to rotate the duty cycle and share the running interval. Each time the duty compressor came online, the operator was flaring

the gas for up to an hour before the gas temperature was stable and low enough to prevent high-temperature trips.

The issue was process related, rather than a specific problem with the compressors' design. The terminal's engineering team called in Burckhardt Compression to investigate and recommend a solution that would improve the situation. After a detailed discussion about the existing process and the reasons for flaring the gas, it was possible to make some recommendations.

Eliminating the need to flare

The review found that the process had a desuperheater that was operating in bypass mode, so the first cooling step was not being used fully. This caused an extended cooling time, during which the gas had to be flared. By adopting a different procedure where the compressor runs in bypass mode and using the desuperheater, there would be no need to flare the gas.

In addition, Burckhardt Compression recommended modifying the start-up sequence when both compressors were needed to meet demand. As part of the comprehensive review, further suggestions were made to improve the packing to reduce leakages. Further recommendations on components that would improve reliability and ease of maintenance, such as valve covers with pressure bolts and improved bearing design for increased load bearing capacity were submitted.

This revised operating process could make a significant reduction, around 25 tonnes CO₂e per year, in the carbon footprint of the terminal and will also cut the financial losses of burning the gas. In addition, these changes would minimize the risk of environmental fines, at a time when local legislation was being tightened.

Trusting in decades of expertise

At a time when LNG operations are under increasing scrutiny from an environmental standpoint, a process review, even on a relatively new installation, can deliver improvements and cost reductions. For older installations, a review of legacy parts can reveal opportunities for improvements in terms of both materials and design.

Burckhardt Compression has developed its BC ACTIVATE assessment program, which analyzes and evaluates a

reciprocating compressor from any manufacturer and delivers a series of recommendations for improvements. Extensive data collection and analysis, coupled with decades of experience, result in a range of solutions that will improve performance, reliability and service life.

While operators of reciprocating compressors can call on this expertise as required, the most effective solution is to engage in a long-term service agreement (LTSA) which adds value to the business, with improved lifecycle costs, operational efficiency and accurate preventive maintenance. Together, this partnership ensures the compressors continue to deliver dependable service, with planned outages and revamps scheduled for optimum performance.

We love to provide services that matter. Hands-on.

Personal, passionate, powerful: this defines us. Meet technical experts with decades of engineering excellence and an outstanding customer-first mindset. Rooted in over 180 years of OEM expertise, we offer the full range of services for your compressors and auxiliaries throughout the entire lifecycle – regardless of brand or challenge.

We put safety first in all we do and support you with energy-efficient, sustainable solutions. With a strong local presence around the globe, we focus on building reliable and trusted partnerships that last, ensuring mutual success. At the forefront of digital innovation, we are constantly pushing boundaries to deliver faster, more efficient and advanced solutions that prioritize the highest safety standards and support your sustainability objectives. As a global leader in our field, we support you with unmatched engineering know-how.



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