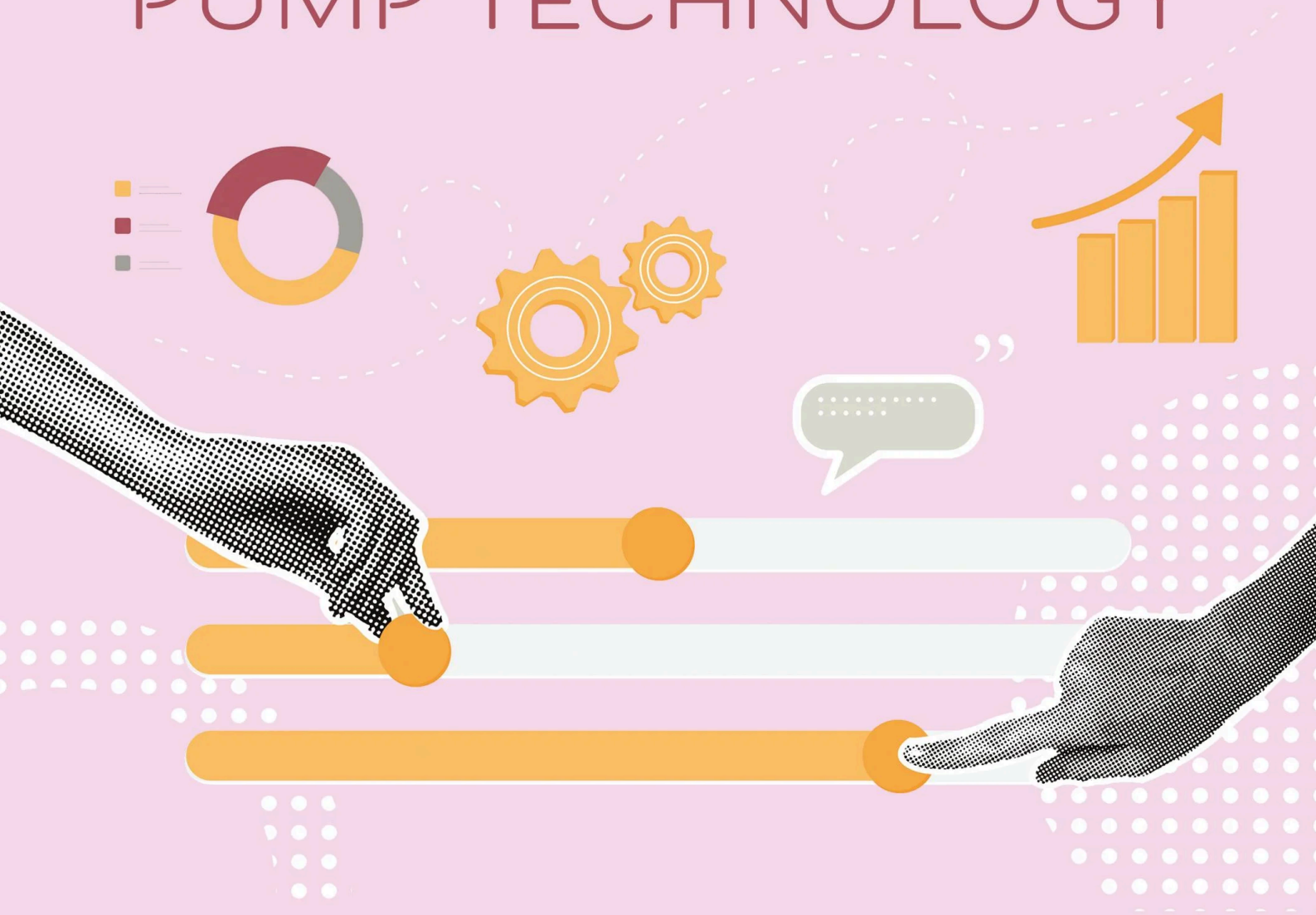
# ENHANCING LNG THROUGH PUMP TECHNOLOGY



**Thomas Damon and Blandine Billet, Optimex Pumps, France,** review how crucial cryogenic pumps are to the LNG industry and explore how advanced pump technology and maintenance can benefit production and transportation processes.

The LNG market requires highly specialised equipment for the safe and efficient transportation and storage of cryogenic liquids. Among these critical pieces of equipment, cryogenic pumps play a vital role in ensuring the safe and efficient handling of LNG, LPG, and other hydrocarbon fraction such as ethylene, propylene, propane, and butane. Since 1998, Optimex Pumps has emerged as an authority in designing, manufacturing, and maintaining seal-less pumps tailored for cryogenic applications.

## Challenges of cryogenic pumping in LNG operations

Pumping cryogenic fluids, such as hydrocarbon fraction fluids, LNG, and LPG, poses significant technical challenges. The extremely low temperatures involved can cause issues related to material performance, safety, and reliability. In addition to the basic need for pumps to handle low-viscosity fluids at such temperatures, the pumps must also be designed to prevent issues such as vaporisation and mechanical failure, all of which could lead to unsafe conditions or operational downtime.

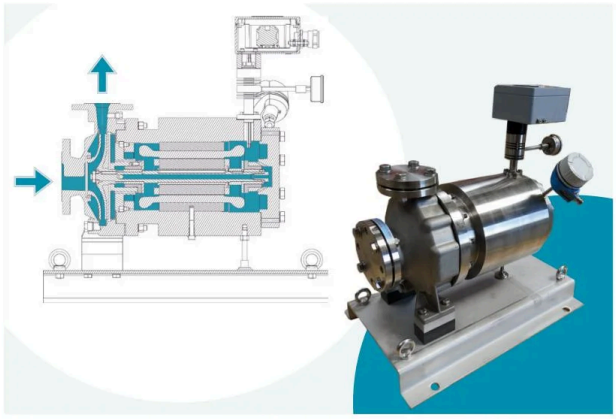


**Figure 1.** Horizontal pump application.

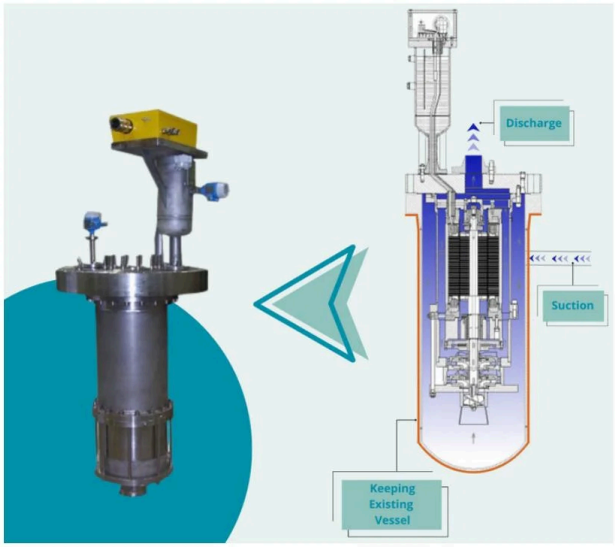



**Figure 2.** Retrofit solutions for offshore platform.

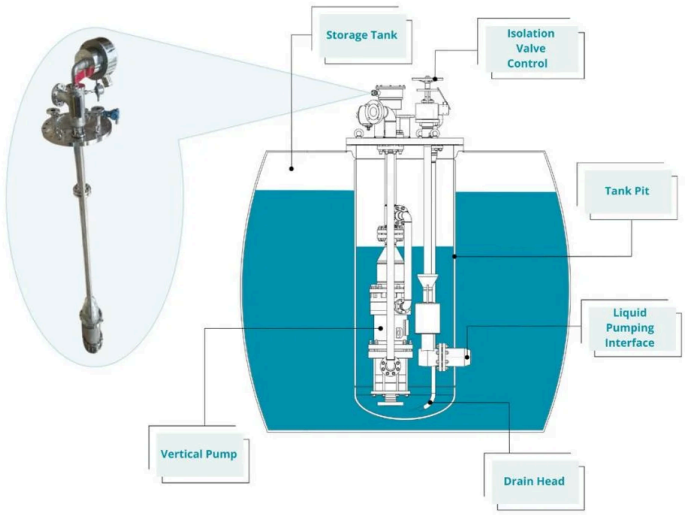



**Figure 3.** Vertical pumps for LNG storage tanks.

Hydrocarbon fraction fluids are inherently dangerous and explosive substances. Their handling and management require stringent safety measures to mitigate the risks associated with their volatile nature. One of the primary strategies for reducing the likelihood of accidents and explosions is to minimise emissions released into the atmosphere. Limiting these emissions not only protects the environment, but also significantly decreases the potential for hazardous vapour accumulations that could lead to ignition or detonation. Proper containment, monitoring, and adherence to safety protocols are essential to ensuring a safe and controlled environment in all operations involving these fluids.

LNG facilities, where large quantities of cryogenic fluids are handled daily, rely heavily on pumps to ensure the continuity of process during LNG treatment. These pumps must function reliably under extreme conditions while remaining efficient, durable, and capable of operating with minimal downtime to mitigate costs. For safety, pumps must also be seal-proof on the outside in order to avoid leaks to the external environment. As the LNG sector continues to grow, the demands on pumping systems will only increase, making the role of advanced cryogenic pumps even more critical.

## Technical features for LNG applications

The company's cryogenic pumps are designed to address the specific demands of LNG applications, ensuring optimal performance, safety, and reliability under extreme conditions. Each feature reflects expertise in handling cryogenic fluids.

- Wet stator motor design: The pump's motor is submerged in the cryogenic fluid, providing an inherent safety feature that eliminates internal ignition risks. This design is crucial for handling cryogenic liquids which are gases in liquid form at extremely low temperatures – typically below -150°C. By keeping the motor submerged, the pump can operate reliably and safely without the threat of combustion or electrical hazards. The submerged wet stator motor also offers improved motor efficiency.
- Elimination of dynamic seals: Traditional pumps use dynamic seals which are vulnerable to wear and leakage in cryogenic applications. The Optimex cryogenic pumps eliminate this issue by using a design that does not rely on these seals, ensuring no fluid leakage and maintaining a secure and efficient transfer of cryogenic fluids.
- Inducer installation for net positive suction head (NPSH) enhancement: To ensure the pumps can operate effectively at extremely low liquid levels, Optimex has developed an inducer that can be fitted at the lowest point of the tank. This enhances the NPSH required for the pumps, enabling them to perform reliably even when the liquid levels in the tank are low. This feature is critical for LNG operations where low liquid levels are often encountered.

- Durability in low-viscosity fluids: Cryogenic fluids are known for their very low viscosity which can pose challenges for pumping systems. In light of this, the company has designed pumps which are able to handle these low-viscosity fluids efficiently, ensuring smooth and consistent operation regardless of the fluid's state. Several solutions for bearings and plain bearings are offered depending on the process characteristics.

- Compatibility with cryogenic temperatures: All components of the pumps, including power cables and slinging systems, are designed to be compatible with cryogenic temperatures, ensuring that the pumps can operate seamlessly in challenging LNG environments. The materials and design ensure that the pumps perform optimally even in the harshest conditions and, as cryogenic temperatures can significantly impact the materials and components used in the equipment, this compatibility is crucial for maintaining the integrity and performance of the pumps. By using materials that are able to withstand these extreme conditions, the pumps can remain reliable and efficient throughout their operational lifespan.

- Ensuring reliability through axial balancing: A key factor in ensuring the best reliability for a wet stator pump is to properly manage the axial balancing. Proper axial balancing is critical to prevent excessive wear and tear on the pump components, a complication that can lead to premature failure and increased maintenance costs. Verified during factory checks on each manufactured pump, each unit is tested to ensure it meets the highest standards of reliability and performance to minimise the risk of mechanical issues.

- Submersible configuration: These pumps are engineered for installation inside cryogenic fluid storage tanks. A submersible setup eliminates the need for bottom tank connections, reducing the risk of external leaks and providing a more efficient, safer design for LNG and other cryogenic fluid applications. A submerged design enhances safety by preventing external contamination and offering more reliable and efficient operation. The pump can be installed in deep tanks without impacting its performance and reliability.

- High pressure handling: Optimex can manage applications with high static pressure at the suction. To achieve this, the pressure vessel or vessels must be carefully calculated, dimensioned, and tested to ensure the integrity of the pump. Due to the company's monoblock design without dynamic sealing, these canned motor pumps can admit very high static suction pressures under exceptional operating conditions.

The company's range of high-pressure pumps covers applications up to 400 bar.

## Case studies: Optimising LNG pumping with cryogenic technology

Optimex provides three main types of pumps: horizontal pumps, vertical pumps, and vertical pumps installed within a storage tank. Each configuration is designed to address specific application needs, delivering optimal performance, reliability, and adaptability for handling cryogenic fluids.

### Horizontal and vertical pumps for external installation

Cryogenic pumps that can be installed either outside or inside storage tanks are within Optimex's range. For low-power applications, the company has implemented external pumps for cryogenic uses, including LNG and propane. The insulation of the motor pump assembly is a critical design consideration, responsible for ensuring the effective cooling of the motor in extreme conditions.

To meet operational requirements, the company provides single-stage or multi-stage hydraulics, selected based on the required flow rate and head. During an installation, the pump orientation, whether horizontal or vertical, is determined by process parameters and power consumption.

### Retrofit solutions for ageing infrastructure

When it comes to retrofitting solutions, Optimex is capable of replacing obsolete or failing pumps, enhancing the reliability of industrial operations. By leveraging design expertise, the company is able to deliver tailored solutions without modifying existing installations, a technique which minimises the costs of site changes.

An example of this technique in action can be found in Optimex's work on an offshore platform in Africa. Since 1998, the company has replaced several pumps on the platform, significantly decreasing the mean time between failures and ensuring continuous production. This project highlights the company's ability to deliver robust retrofit solutions that meet stringent industry demands. The company's pumps hydrocarbons at -61°C and at 160 $m^3$/h at 81 m.

A key challenge in this project was designing a mounting plate and motor-pump assembly in keeping with the existing vessel and preserving the same dimensions of vessel infrastructure.

### Vertical pumps for LNG storage tanks

For pumps installed inside LNG storage tanks, a typical setup involves a motor-pump assembly housed within an insultation pit inside the storage tank. This configuration includes a bottom valve at the surface, allowing the pump to be isolated from the complete tank to carry out maintenance operations. The advantage in this process is that only the pit needs to be emptied during maintenance, preserving the tank's contents.

In a notable case, Optimex provided a cryogenic pump for a petrochemical plant, installed 10 m deep within an LNG storage tank. The pump featured a multi-stage hydraulic design to handle a small flow rate and high head efficiently, pumping ethylene at -101°C, at 63 $m^3$/h.

## Maintenance and repair: Ensuring reliability and longevity of cryogenic pumps

Regular maintenance is essential for the optimal performance and extended lifespan of cryogenic pumps since they play such a critical role in LNG operations. The company offers maintenance and repair services to ensure reliability, minimise downtime, and support efficient LNG processes. This structured approach ensures cryogenic pumps maintain reliable performance in demanding cryogenic environments. Addressing potential issues early and implementing customised solutions can help to extend the operational lifespan of pumps and optimise LNG distribution processes.

The maintenance process for cryogenic pumps is structured into several key steps:

- Reception and diagnosis: The pumps are received, disassembled, and thoroughly inspected. This includes electrical checks of the motor, analysis of mechanical clearances (bearings, impellers, shaft), and run-out measurements to identify malfunctions.
- Operational data analysis: Data from the pump's operation is analysed to uncover the causes of failures and to refine the diagnostic process.
- Tailored solutions: Based on the findings, customised solutions, such as replacing worn components or modifying the original design to improve reliability, including adjustments to the axial thrust balancing system, are proposed.
- Reassembly and testing: After repairs, the pump is reassembled and undergoes comprehensive testing, including leak tests and electrical checks before a detailed report is relayed back to the client.

## Conclusion

The LNG industry is constantly evolving and requires advanced technology to meet its unique challenges. Cryogenic pumps play an indispensable role in ensuring the safe, reliable, and efficient handling of cryogenic fluids. Optimex's offering of specialised cryogenic pumps positions the company as a key player in this market. Through tailored solutions, the company is able to propose different solutions to different needs of LNG and LPG operations, from submersible pumps for storage tanks to horizontal or vertical configurations.

Additionally, it is important that each pump is managed like a single manufacturing process where every pump undergoes rigorous testing to ensure reliability and performance under extreme conditions.

Comprehensive maintenance and repair services, including detailed diagnostics, customised upgrades, and rigorous reassembly testing, help ensure extended pump lifespans and consistent operational excellence. These services are vital for minimising downtime, optimising LNG distribution processes, and maintaining the highest safety and performance standards. By leveraging research, development, and maintenance expertise, companies such as Optimex can aid the technological advancements that are ensuring reliability, safety, and continuous innovation for LNG operators worldwide. LNG