# Tunable T1000™

Natural Gas Analyzer – Boil-Off Gas Analysis

The global demand and use of liquefied natural gas (LNG) has been growing for decades, and the growth is foreseen to continue. The increased use and demand are also leading to increased transport of LNG on the world oceans.

LNG carriers utilize boil-off gas (BoG) from the cargo for propulsion. It is of key importance to understand and monitor the quality of BoG gas consumed by the engines.

This is because engine performance and fuel economy are heavily dependent on the gas quality, and live gas quality monitoring enables optimization of engine settings for maximized operational efficiency. Moreover, accurate knowledge of the consumed fuel can be of great economic importance when managing changing trade modes and contractual situations.

The T1000™ Natural Gas Analyzer is designed and developed to offer continuous monitoring of gas composition and quality in demanding maritime conditions. The analyzer is simple, easy to install and operate. It does not require regular maintenance. Real-time gas data is available on-line and the device can be monitored and serviced remotely.
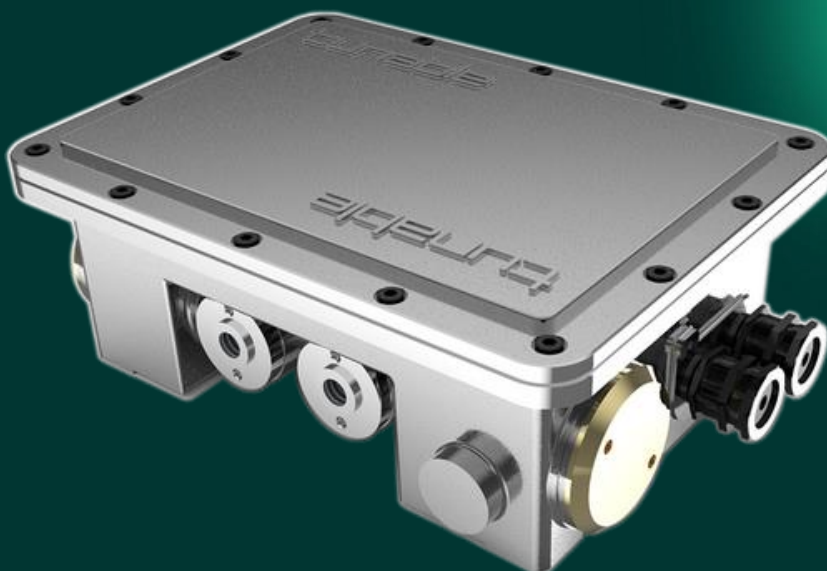
The Challenge

Liquefied natural gas (LNG) is transported around the world by LNG carriers. These are large vessels with insulated cargo tanks, containing liquid natural gas at a temperature below -160°C. Although these are temperatures where natural gas is in the liquid phase, part of the cargo will boil-off during a voyage. This is due to the fact that there is always some space in the LNG tank, limitations in insulation efficiency, and natural vessel movement causing sloshing.

Gas quality is typically given in terms of calorific value (CV) and methane number and provides a measure of the energy content per unit gas. The numbers vary during a voyage, changing as a function of tank content and weather and operating conditions. Moreover, they are a function of cargo LNG, which varies between the different production and processing facilities.

Being a product of LNG, boil-off gas (BoG) can naturally be utilized. Although the content of nitrogen in BoG is high compared to the cargo LNG, it can be used as fuel, both for propulsion and power generation. Excess BoG can also be returned to the cargo by reliquefication.

Accurate data on BoG quality is consequently of great interest. It translates to fuel efficiency and can be used in pricing, which is important when determining accurate energy usage and establishing freight terms and contracts.

A second point of interest in energy content of the BoG is related the Carbon Intensity Indicator (CII). This is because LNG carriers from 2023 will be subject to CII-rating. Knowing the correct nitrogen and hydro carbon composition of consumed BoG is then of essence. Wrongful estimation may severely impact the emission data and the resulting rating, placing a demand for reliable and real time measurement of the composition.

Our Tunable T1000™ Natural Gas Analyzer can answer to these needs. Through continuous real-time analysis, it provides BoG composition and enables calculation of calorific value, methane number, and other related parameters.

Boil-off Gas Analysis Improves Performance

Operating an LNG carrier is complex and challenging. Choosing the optimum operational profile requires comprehensive experience and data from multiple sections of the vessel. In this context, reliable real-time data on BoG composition is evidently central. It provides a direct measurement of the consumed fuel and enables cargo owners, charterers, ship operators and owners to agree on the correct pricing.

Firstly, BoG quality is used to determine and report on the overall fuel consumption. Wrong or inaccurate estimates of the BoG energy content will impact overall reported fuel consumption and may lead to breach of contract.

Secondly, real-time data on BoG composition in combination with advanced data processing is used to make decisions regarding dual fuel mode, cargo temperature control, boil-off rate control and environmental concerns. Moreover, data on BoG quality is used to predict engine derating and plan for maintenance intervals.

Real-time monitoring of changes in BoG composition is a great tool for maintaining optimum vessel performance. The data provided enables on-line analytics and system condition monitoring to provide actionable insight required to monitor consumption and actively control operational parameters.

Effective Use of Energy

The modern LNG carrier industry is going through rapid and substantial change. Demand for LNG is increasing as it has the potential to reduce our climate footprint by replacing older fossil fuel technology. Moreover, established truths are challenged due to changes in trade patterns, emission requirements, and extended use of short term and spot contracts.

These changes have propelled advances in insulation and reliquefication technology, ship and cargo volume size and propulsion systems. However, regardless of these advances, BoG from a refrigerated and insulated tank cannot be fully eliminated. Utilizing this gas for propulsion and power generation is pertinent with respect to efficient energy use. Optimal use does however require accurate live data on the gas quality.

Estimating the real BoG quality during a voyage from cargo data alone is challenging. To obtain a correct and true value, the composition needs to be measured as it streams into the generators. This is of special importance for LNG with a high nitrogen content. The volatile properties of nitrogen at the cryogenic temperature makes the BoG especially sensitive to nitrogen content of the cargo. The amount of nitrogen in the BoG will fluctuate with varying operational and weather conditions. This can have an especially large impact on longer journeys. In this case, an underestimated nitrogen content will lead to significant overreporting of the fuel consumption.

The true energy consumption and amount of BoG utilized or lost can only be quantified by continuous monitoring of the gas composition and energy content.

Operational Excellence

The T1000™ analyzer is based on a novel Micro Electro-Mechanical System (MEMS) and utilizes a detection principle based on infrared optical spectroscopy. Compared to alternative solutions, the MEMS-technology enables robustness and a compact form. Solutions based on optical spectroscopy is in general known for stability, high sensitivity, and long lifetimes and maintenance intervals. In addition to fulfilling these general advantages of optical spectroscopy, we employ a tunable optical filter that allows for continuous scanning over a wide band of frequencies, providing fast and accurate analysis for all gases of interest. Finally, a fast response time, renders the analyzer feasible for real-time process optimization.

In relation to transport of LNG, the T1000™ analyzer can be utilized to provide data on the BoG composition and quality, delivered reliably, continuously and in real-time throughout a voyage. Moreover, the instrument can be monitored remotely via a data link, either from the ship bridge, control room or from shore.

Compared to alternative technologies like gas chromatography, the T1000™ analyzer has some distinct advantages:

- It is considerably faster, as it does not require time for separating gas components. This enables the BoG quality to be reported more frequently leading to significantly improved models and fuel consumption reporting.

- It does not require calibration or carrier gases. Running costs associated with purchase and logistics of such gas bottles are eliminated.

- Frequent maintenance is eliminated while still maintaining close to 100 % up-time. The robust construction and measurement principle of the T1000™ analyzer is proven to provide stable operation, whereas gas chromatographs often require manual handling and service for stable operation.

- Service and upgrades can be done via remote link.

The T1000™ gives operators actionable insights to maintain optimum performance and fuel economy. Other clear benefits are equipment health monitoring, lower overall maintenance costs and increased operational efficiency.

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A Unique Technology

The T1000™ Natural Gas Analyzer is powered by a unique, patented technology to continuously monitor all key natural gas components. The instrument is fast, reliable, and accurate, designed to simplify gas analysis.

The combination of a reliable long life infrared source, our proprietary tunable filter, and no moving parts, ensures a robust solution with a minimum level of required maintenance. The result is low operational costs and exceptional stability. The instrument is suitable for both new installations and retrofits.

Other Applications

The T1000™ is not only applicable in the marine sector. It can be used for process monitoring in general, where real-time monitoring of all species of the typical natural gas composition is of essence for operators to determine key indicators, such as calorific value and methane number. Our fast response times enables optimization where timing is key, e.g. for performance optimization of engines and process equipment.

Typical Performance Ratings

Component	T1000–10™ LNG Analyzer Range % vol	T1000–10™ LNG Analyzer Accuracy % Vol	T1000–20™ Natural Gas Analyzer Range % vol	T1000–20™ Natural Gas Analyzer Accuracy % Vol
Methane	0 - 100 %	0.5 %	0 – 100 %	0.5 %
Ethane	0 - 20 %	0.5 %	0 – 20 %	0.5 %
Propane	0 - 20 %	0.5 %	0 – 20 %	0.5 %
Iso-Butane	0 - 5 %	0.2 %	0 - 5 %	0.2 %
N-Butane	0 - 5 %	0.2 %	0 - 5 %	0.2 %
C5-total	0 - 2 %	0.2 %	0 - 2 %	0.2 %
Carbon dioxide			0 – 20 %	1 %
Nitrogen	0 - 100 %	Balance	0 – 100 %	Balance

Calorific Value (CV)	Accuracy 0.5 %, according to ISO 6976:2016
Methane number (MN)	Tailored to customer specification
Response time (T90)	15 - 150 sec (tailored to application need)

About Tunable

Tunable was founded in 2015 in Norway to build the world's most versatile gas analyzer.

The core technology is based on a patented tunable optical filter.

Tunable's gas analyzers offer market leading performance and unprecedented size. Our instruments rely on state-of-the-art nano- and MEMS- technology. The core technology enables continuous analysis operation and exceptional selectivity. All the components in the gas mixture are precisely determined and operation is supported by auto-calibration and rugged design.

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