LNG: truck loading

Figure 1: LNG truck loading at a peak shaving plant

Benefits at a glance

- No vaporizer - measures LNG *in situ* in the cryogenic liquid phase
- Simple analyzer installation in control room – no requirement for a dedicated analyzer room
- Low installation costs – no need for vacuum-jacketed tubing for sample transport
- Pilot-E probe (C1D1/Zone 0) installed up to 500 m from the analyzer
- No analysis delays due to sample transport or vaporization
- Virtually immune to LNG flow variations
- Lower OPEX – no moving parts or consumables
- Eliminates up to 2-hour temperature stabilization required by some vaporizers

The use of liquefied natural gas (LNG) as fuel is a key component of the decarbonization efforts worldwide. In many regions of the world, such as in Japan, the gas transport infrastructure is inadequate to transport natural gas from LNG import terminals to end users. Many of these regions have turned to transport of LNG by truck, and the establishment of satellite storage facilities to serve this customer base. Natural gas is transported using specialized trucks or ISO containers on flatbed trucks, then held in storage tanks at these facilities. Even in areas where the gas infrastructure is mature, satellite facilities can serve a 'peak shaving' role, storing LNG for injection into the local gas grid when demand spikes.

Measurement of Btu

LNG that is transported to a satellite storage facility involves a custody transfer to the receiving facility. As part of the transaction, the total energy transferred must be determined. Many truck facilities use scales to determine the mass of the LNG transferred, or can utilize mass flow meters, or volumetric flow meters coupled with a density measurement of the LNG. To determine the energy transferred, the quality, or calorific value of the LNG transferred must be measured as well. LNG quality can be determined either in the liquid phase using Raman spectroscopy, or in the gaseous phase using gas chromatography (GC), after sample vaporization.

Issues with traditional measurements

LNG composition at truck loading facilities has been traditionally measured using a gas chromatograph. Prior to injection into the GC for analysis, a representative sample of the LNG must be brought from its cryogenic liquid state to a room temperature gas using a vaporization process. Poor vaporization, usually due to partial and pre-vaporization of the LNG sample, is the dominant source of uncertainty in the measurement of LNG composition. When this occurs, the gas sample may not represent the composition of the LNG transacted, which translates to increased uncertainty in the energy content transferred.

Vaporization systems are sensitive to LNG flow rates, so any changes in stable flow during transfer may result in inaccurate energy calculations. In addition, with a typical transaction volume of only 60 m3, most truck loadings occur within thirty to sixty minutes, with hours or days between loadings. An LNG vaporizer can take two or more hours to stabilize while exposed to LNG before transfer can begin, adding unnecessary delays and cost to the transaction. By eliminating the vaporization step, a Raman measurement of the LNG in the cryogenic liquid state results in a significant improvement in efficiency and in the quality of the LNG.

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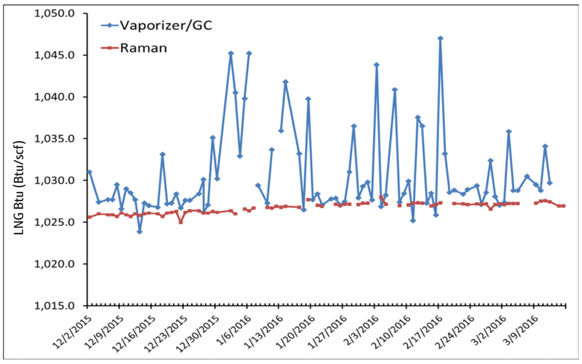

Figure 2: Comparison of Raman and GC/vaporizer measurements of multiple LNG truck loading events from one storage tank over a period of three months

Raman Rxn4 analyzer for LNG truck loading

The Raman Rxn4 analyzer for LNG with the Rxn-41 probe for cryogenic service provides accurate measurement of the composition and calorific value of LNG, with up to a 10 times lower uncertainty than GC-vaporizer system. As shown in Figure 2, the Raman measurement is not subject to vaporizing errors that caused this vaporizer/GC to report up to a 2% error in energy content. The stability of the Raman measurement assures both the buyer and seller of an accurate and precise measure of the entire LNG cargo during custody transfer. The rack-mounted Raman Rxn4 analyzer is easily installed in an existing control room, with fiber optic coupling to the Rxn-41 probe, mounted in the LNG pipe for *in situ* measurement in the liquid phase, eliminating sample conditioning or transport. No sample is lost or needs to be flared. With no moving parts or consumables, Raman analyzers have very low maintenance requirements. Virtually zero time eliminates up to two hours of cool down stabilization required by some vaporizers; measurement starts when the LNG flows.

The Raman Rxn4 analyzer for LNG truck loading consists of the following:

- Raman Rxn4 base unit with integrated and automated calibration
- Rxn-41 fiber optic probe for cryogenic service
- Fiber optic cable length from 15 to 500 meters, customized to your plant needs.
- Dedicated LNG custody transfer method valid over LNG temperature range of 93 K to 117 K*

*Requires manual entry for fixed temperature, or temperature input (±1 K) via Modbus for varying temperature

**Performance may vary for different cable lengths and analysis time.

LNG component ranges and performance

Component	Concentration (Mol %) Min	Concentration (Mol %) Max	Uncertainty (k=2)
Methane (CH_4)	87.000	98.170	< 0.46
Ethane (C_2H_6)	1.300	10.500	< 0.38
Propane (C_3H_8)	0.160	3.000	< 0.11
i-Butane (iC_4H_{10})	0.060	0.400	< 0.023
n-Butane (nC_4H_{10})	0.078	0.600	< 0.028
i-Pentane (iC_5H_{12})	0.005	0.120	< 0.031
n-Pentane (nC_5H_{12})	0.005	0.120	< 0.015
Nitrogen (N_2)	0.040	1.050	< 0.056

Table 1: Range of validated LNG with worst case uncertainty for fiber lengths < 500 m and measurement time of 300 seconds**

Component	Range Min – Max	Uncertainty (k=2)
Gross heating value (MJ/m^3)	38.4 - 42.2	< 0.16
Gross heating value (MJ/kg)	53.8 - 55.3	< 0.072

Table 2: Range of validated LNG heating values with worst case uncertainties for fiber lengths < 500 m and measurement time of 300 seconds**

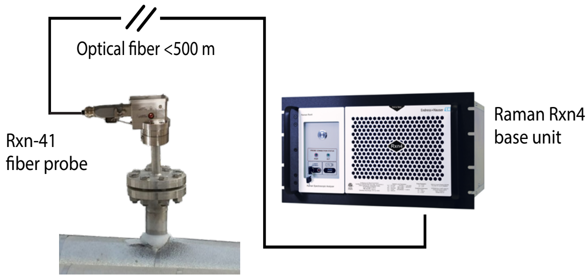

Figure 3: Recommended direct flange mounted installation

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