LNG: natural gas quality

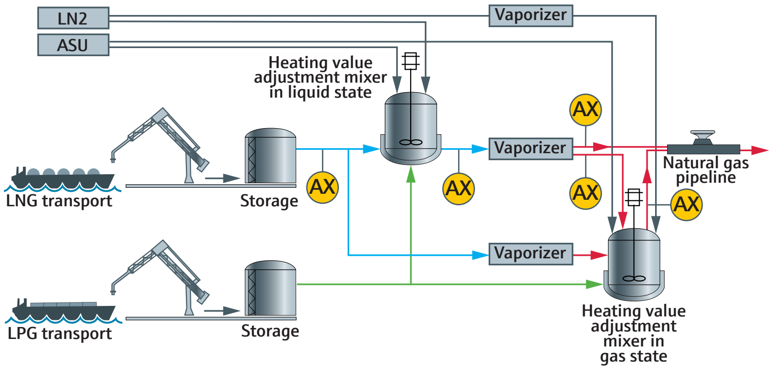

Figure 1: Example of heating value adjustment of NG at receiving terminals

Benefits at a glance

- Measure LNG quality before and after CV adjustment *in situ* in the cryogenic liquid phase or at the sample tap in the gas phase
- Measure LNG composition and the N_2, CO_2, LPG, or NGL's being added, not just the resulting WI or GCV
- Observe ballasting or CV boosting results in seconds
- Ensure that the delivered product meets both the pipeline WI specs and the N_2 (and O_2, if air is used) pipeline limits during ballasting
- Minimal maintenance requirements means lower OPEX

LNG that has been delivered to an import terminal may be too rich or too lean to meet local pipeline specifications of the downstream markets to which the gas will be delivered. There are several ways to modify the calorific value (CV) of the natural gas. The CV can be reduced by adding N_2 or CO_2, or by selectively removing C_3/C_4 components from the sample. The CV can be increased by mixing with liquefied petroleum gas (LPG) or natural gas liquids (NGL). And, in some cases, LNG with different CV's can be blended to achieve target quality. Measurement of the CV of the final mixture is essential to confirming that the product quality meets local regulations to avoid significant tariffs.

Measurement of LNG and nitrogen

The Wobbe index (WI), which is calculated from the gas composition, is the most widely accepted measure of gas quality and interchangeability. According to the United Nations Economic Commission for Europe[1], when NG quality modification equipment is installed, it is recommended to include additional control systems. Key requirements of this equipment are rapid measurement, sampling, and accuracy. Figure 2 shows monitoring of the WI of a natural gas sample during nitrogen ballasting. The Raman Rxn4 analyzer provides composition measurement of the LNG, WI, and simultaneously provides the concentration of nitrogen, which can be used to ensure that nitrogen levels do not exceed pipeline specifications.

Reliability issues with traditional methods

WI modification of natural gas at import terminals is often measured with a process gas chromatograph (GC). Prior to analysis, the LNG sample must be vaporized. Poor repeatability in vaporization leads to large variations in WI, adding uncertainty to the ballasting process. In addition, vaporization and sample transport lag time, coupled with typical process GC update times of 4-5 minutes, means that this approach provides only sporadic updates during ballasting, increasing the likelihood of overshooting the WI target, and incurring additional cost. Because the Raman Rxn4 analyzer for LNG is able to measure the sample in the cryogenic liquid, response times are much faster and repeatability is much higher than with legacy GC/vaporizer systems.

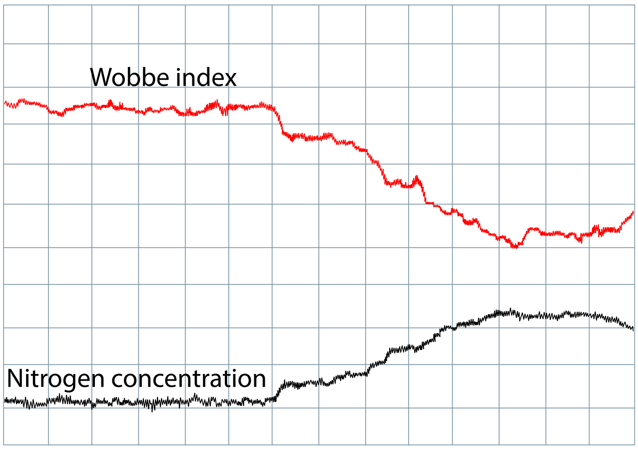

Figure 2: Real-time measurement of WI during nitrogen ballasting

Raman Rxn4 analyzer for LNG quality adjustment

The Raman Rxn4 analyzer for LNG coupled with the Rxn-41 probe for cryogenic service is capable of measuring the full composition of the LNG during natural gas quality adjustment processes, including LNG blending, extraction or injection of NGL and LPG, and injection of N_2 or other inerts, at cryogenic temperatures in the liquid phase and in the sample pipe, eliminating the need to vaporize the sample or transport it to the analyzer. With update times as short as 1 minute, and precision over 10 times better than a process GC/vaporizer solution, the Raman Rxn4 analyzer for LNG quality adjustment the ideal solution to ensure pipeline quality gas while minimizing overall cost.

The Raman Rxn4 Raman solution for LNG quality adjustment consists of the following:

- Raman Rxn4 analyzer base unit and internal calibration
- Rxn-41 fiber optic probe for cryogenic service
- Fiber optic cable (length from 15 to 500 meters, customized to your process plant requirements)
- Dedicated LNG quality adjustment method
- Optional probe version compatible with probe insertion hardware for continuous flowing streams

* Precision values are for liquid-phase measurements only. Gas phase precision will be lower. 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*

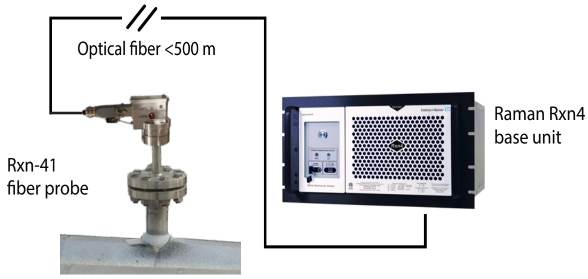

Figure 3: Recommended direct flange mounted installation

References

1. Study on Current Status and Perspectives for LNG in the UNECE Region", *United Nations, Geneva* **2013**

Endress+Hauser
People for Process Automation