LNG Quality and Quantity Measurement

Dr. Thomas Wu
National Metrology Centre

Email: thomas_wu@nmn.a-star.edu.sg

LNG Measurements Roundtable, WMD 2017 Conference, Singapore
19 May 2017

Copyright © 2017 All rights reserved
National Metrology Centre
LNG custody transfer

➢ The annual capacity of LNG production grew to 308 million tonnes and total LNG trade reached 245.2 million tonnes in 2015 according to GIIGNL annual report.

➢ An expanded uncertainty of 0.74% in transferred energy in LNG bunkering is equivalent to a financial risk of 711.8 million US dollars per year during LNG trading (assuming an average LNG price at US$7.8/mmBtu and a LNG energy value of 51 mmBtu per tonne).

➢ Accurate measurement of LNG energy in custody transfer is important to minimize the financial risk in trading.
LNG custody transfer

- LNG quantity measurement
  - Weighbridges
  - Mass Flow Meters (MFM)

- LNG quality measurement
  - LNG calorific value (CV) and density are calculated from its composition

- LNG custody transfer energy content (E) is calculated from mass of the transferred LNG (M) and the calorific value (CV)

\[ E = M \times CV \]
LNG quantity measurement

Using weighbridge

• Net mass of LNG delivered obtained by taking the difference of two gross mass measurements (before and after delivery)
• Weighbridge should be calibrated annually according to OIML R76
• Maximum Permissible Error (MPE) for weighbridge is given in OIML R76
LNG quantity measurement

Using Coriolis Mass Flow Meter (MFM)

- According to OIML R117-1, Maximum Permissible Error (MPE) is 1% for quantity measurement of LNG using MFM

- Prior to installation, Coriolis MFM shall be calibrated to ensure that MPE for measurement of LNG falls within 1%
LNG quality measurement

- LNG quality measurement is needed to obtain the LNG composition, which is used to calculate the calorific value.

- The lower and higher calorific value (LCV, HCV) can be determined by computation on the basis of molar fraction of component $X_i$, molecular mass of component ($M_i$) and the mass calorific value of component ($LCV_i$, $HCV_i$).

$$LCV = \frac{\sum X_i M_i LCV_i}{\sum X_i M_i}$$

$$HCV = \frac{\sum X_i M_i HCV_i}{\sum X_i M_i}$$

- Two ways to measure LNG quality:
  - LNG is sampled and vaporised to gaseous phase for analysis by Gas Chromatography (GC).
  - LNG is sampled and analysed directly in liquid phase by Raman analyser.
LNG quality measurement: sampling & vaporisation

- LNG is sampled and vaporised to obtain sample in gaseous phase for composition analysis
- LNG sampler and vaporiser may cause some changes in the LNG composition
- LNG should be sampled during a stable flow of LNG.
  - *Install the sampling point as close as possible to the custody transfer point*
LNG quality measurement by GC

- Re-gasified LNG sample is analysed by gas chromatography (GC) to determine its composition.

- Calibration of LNG quality measurement equipment is required using certified reference gas mixtures (CRMs), which are traceable to primary gas mixture standard prepared by a national metrology institute.
LNG quality measurement by Raman analyser

- LNG can also be sampled and analysed directly in liquid phase using Raman analyser (without vaporisation step)
  - Incorrect operation of LNG vaporisers can lead to poor precision and accuracy, thus elimination of vaporisation step offers a significant improvement in the analysis of LNG quality.
  - LNG composition can be measured in liquid phase by Raman analyser through a probe. The applicable concentration range is 200 ppm to 100 % (according to ASTM D7940).
Summary

- Accurate LNG quantity & quality measurements ensure consistency and reliability in transferred energy value for LNG bunkering.
- Calibration of LNG quantity & quality measurement equipments should be traceable to SI units through national primary standards maintained at a national metrology institute (NMI).
Thanks for your attention.

Q & A