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Specification of liquefied natural gas as a fuel for marine applications

Spécification du gaz naturel liquéfié comme carburant pour les applications marines

ICS: 75.160.30

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Foreword

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The committee responsible for this document is ISO/TC 28, *Petroleum and related products, fuels and lubricants from natural or synthetic sources*, SC 4, *Classifications and specifications.*

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

Due to numerous economic and environmental factors, the use of liquefied natural gas (LNG) as fuel for marine applications has increased. The 0,10% sulphur limit, in the sulphur emission controlled areas in Europe and the US, which entered into force the 1st of January 2015 has been one of the major driving forces for using LNG as fuel for marine applications. The decision for the 0,50% global sulphur limit by the International Maritime Organization (IMO) may further increase the interest in LNG. The International Code of Safety for Ships using Gases or other Low-flashpoint Fuels (IGF Code), entering into force on the 1st of January 2017 was a response to the need of guidance in this emerging market. Since LNG-fueled vessels are likely to bunker LNG in different parts of the world, a common specification is needed for ship owners, ship operators and LNG suppliers. It also helps engine manufacturers and ship designers and it is beneficial for the development of this new alternative marine fuel market.

In 2018, IMO adopted an initial strategy on reduction of greenhouse gas (GHG) emissions from ships. The strategy includes the objective to peak GHG emissions from international shipping as soon as possible, whilst pursuing efforts towards decarbonizing the sector as soon as possible in this century. It also includes the objectives to reduce the CO_2 emissions per transport work and total annual GHG emissions from international shipping by 2050, with an interim target in 2030.Thus, LNG produced from renewable sources as biomethane that can reduce CO_2 emissions when used as marine fuel is also addressed in this document.

LNG is produced in different locations in the world in liquefaction plants. Large scale production facilities are often dedicated to specific markets such as natural gas grids and large power plants that use their own standards. This document takes into consideration this major constraint for any adaptation to marine applications specificities/requirements.

Specification of liquefied natural gas as a fuel for marine applications

1 Scope

This document specifies the quality requirements for Liquefied Natural Gas (LNG) used as a fuel for marine applications. It defines the relevant parameters to be measured as well as the required values and the test reference methods for all those parameters.

This document applies to LNG from any source, e.g. gas from conventional reservoirs, shale gas, coalbed methane, biomethane, synthetic methane. LNG described in this document may come from synthesis process out of fossil fuels or renewable sources.

This document identifies the required specifications for fuels delivered at the time and place of custody transfer (at the delivery point).

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 6578, *Refrigerated hydrocarbon liquids — Static measurement — Calculation procedure*

ISO 6974 (all parts), *Natural gas -- Determination of composition and associated uncertainty by gas chromatography*

ISO 6976, *Natural gas — Calculation of calorific values, density, relative density and Wobbe indices from composition*

ISO 8943, *Refrigerated light hydrocarbon fluids — Sampling of liquefied natural gas — Continuous and intermittent methods*

ISO 13443:1996, *Natural gas — Standard reference conditions*

EN 16726, *Gas infrastructure - Quality of gas - Group H*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at http://www.iso.org/obp

— IEC Electropedia: available at http://www.electropedia.org/

3.1
biomethane
methane rich gas derived from biogas or from gasification of biomass by upgrading with the properties similar to natural gas

[SOURCE: ISO 14532:2014,[1] 2.1.1.15]

3.2
Liquefied Natural Gas
LNG
natural gas that has been liquefied after processing

[SOURCE: ISO 14532:2014, 2.1.1.12]

3.3
Methane Number
MN
rating indicating the knocking characteristics of a fuel gas

Note 1 to entry: It is comparable to the octane number for petrol. One expression of the methane number is the volume percentage of methane in a methane-hydrogen mixture, that in a test engine under standard conditions has the same tendency to knock as the fuel gas to be examined.

[SOURCE: ISO 14532:2014, 2.6.6.1]

3.4
natural gas
complex gaseous mixture of hydrocarbons, primarily methane, but generally includes ethane, propane and higher hydrocarbons, and some non-combustible gases such as nitrogen and carbon dioxide

Note 1 to entry: Natural gas can also contain components or contaminants such as sulfur compounds and/or other chemical species.

[SOURCE: ISO 14532:2014, 2.1.1.1]

3.5
Wobbe index
calorific value on a volumetric basis at specified reference conditions, divided by the square root of the relative density at the same specified metering reference conditions

[SOURCE: ISO 14532:2014, 2.6.4.3]

4 General requirements

4.1 The LNG at the delivery point shall comply with the characteristics and limits given in Table 1 when tested in accordance with the specified methods.

The components listed in Table 1 and Table 2 shall be measured to enable the calculation of the physical properties of the LNG at the delivery point.

4.2 The LNG delivered shall be free from any material at a concentration that causes the LNG to be unacceptable for use in accordance with Clause 1 (i.e. material not at a concentration that is harmful to personnel, jeopardizes the safety of the ship, or adversely affects the performance of the machinery).

4.3 Physicochemical characteristics not requiring measurement are listed in Table 3.

It is not practical to require detailed chemical analysis for each delivery of fuels beyond the requirements listed in Table 1 or Table 2. Instead, a liquefaction plant, LNG terminal or any other supply facility, including supply barges and truck deliveries, should have in place adequate quality assurance and management of change procedures to ensure that the resultant LNG is compliant with the requirements of this document.

Examples of LNG compositions are given in Annex B.

Information on ageing of LNG can be found in Annex D and information on particles can be found in Annex E.

5 Sampling

Samples for quality verification, if any, may be taken at various locations as agreed among the parties concerned. Samples, if any, may also be taken at multiple moments in time, as LNG has distinct different ageing characteristics than traditional hydrocarbon maritime fuels (with regards to ageing reference is made to Annex D). In order to ensure a representative sample, it is essential that proper sampling procedures are followed.

When sampling of LNG for analysis is carried out, it shall be in accordance with the procedures provided in ISO 8943 or an equivalent national standard. Where specific sampling requirements are documented, the relevant parties should agree on the reference test methods. It is most imperative to ensure the LNG collected in liquid state is instantly conditioned to gaseous state without any partial vaporization or loss of molecular components to ensure a representative sample.

There are two methods of sampling LNG as defined in ISO 8943, continuous and intermittent. Both methods obtain LNG from the LNG cargo/bunker line and then it is gasified in a vaporizer. The continuous method collects the gasified LNG in a sample holder at a constant flow rate for offline analysis. The intermittent method collects gasified LNG and directs it to an on-line analyzer at predetermined intervals. Please refer to ISO 8943 for more details on these methods.

The requirements for sampling LNG for marine applications can vary throughout the industry depending on availability and equipment. Load port samples may be used for quality determination if the sampling equipment is not available and if it is agreed between the parties.

6 Requirements, limit values and related test methods

The components and physicochemical characteristics that shall be measured or calculated and the related test methods are given in Table 1 and Table 2.

Note Information can be found in ISO 6975 [2].

The reference conditions shall comply with ISO 13443:1996, Clause 3, which are 288,15 K, 101,325 kPa.

Information on MN and Wobbe index can be found in Annex C.

Table 1 — Physicochemical characteristics requiring measurement/calculation with limit values

Characteristic	Unit	Limit	Value	Test method
Net Calorific Value (NCV)	MJ/m^3 (s)	Min	33,6[a]	ISO 6976
Nitrogen	% (mol)	Max	1,0[b]	ISO 6974
Methane Number (MN)	no unit	Min	[c]	Annex A (PKI) or EN 16726[7]
[a] calculated for a theoretical mixture of 99% methane and 1% nitrogen in liquid phase				
[b] decided to limit the nitrogen concentration and pressure in the boil-off gas				
[c] both the method used for determining the MN and the minimum value shall be agreed between supplier and user				

The fuel supplier shall calculate the actual MN at the delivery point and provide this information to the user (see Clause 5 for sampling location). This information shall be given as $MN_{(PKI)}$ or MN (EN16726). For guidance on the MN applicability to a specific application, Original Equipment Manufacturer (OEM) specifications should be considered.

Table 2 — Physicochemical characteristics requiring measurement without limit values

Characteristic	Unit	Test method	Value
Density [a]	kg/m^3	ISO 6578	Report
Methane (CH_4)	% (mol)	ISO 6974	Report

Table 2 *(continued)*

Characteristic	Unit	Test method	Value
Ethane (C_2H_6)	% (mol)	ISO 6974	Report
Propane (C_3H_8)	% (mol)	ISO 6974	Report
n-Butane (C_4H_{10}) i-Butane	% (mol)	ISO 6974	Report
Pentane(C_5H_{12})	% (mol)	ISO 6974	Report

density at temperature of the liquid phase

7 Compounds removed by liquefaction process

Natural gas is liquid at around -160°C under atmospheric pressure and becomes Liquefied Natural Gas (LNG). To avoid freezing and plugging in the liquefaction plant's cryogenic heat exchangers, usual impurities or compounds that are present in the natural gas from various sources are removed upstream from the liquefaction process below their solubility level. Some LNG components (e.g. ethane, propane, butane and pentane) are possibly removed for commercial reasons or to achieve a targeted calorific value range.

LNG composition is therefore within more narrow limits compared to natural gas. The compounds which can be considered as harmful for marine applications are removed or reduced to very low levels (trace) so that they are no more a concern. They shall comply with Clause 4.2. The main compounds removed by liquefaction are listed in Table 3 and below for information and reference. The measurement of these species is not required. However, if the parties concerned agree to measure them, they should be measured according to the referenced methods listed in Table 3.

The reference conditions shall comply with ISO 13443:1996, Clause 3, which are 288,15 K, 101,325 kPa.

The melting and boiling points for a range of compounds, including those possibly present in biomethane, are available in Annex F, Table F.1.

