POSITION-PAPER

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BY THE CIMAC WORKING GROUP 'GAS ENGINES'

INFORMATION ABOUT THE USE OF LNG AS ENGINE FUEL

1. General comments about LNG as engine fuel

LNG, liquefied natural gas, is natural gas cooled down to about –161 °C at atmospheric pressure and transported as a liquid. It is now rapidly becoming a widely used engine fuel in association with its growing popularity as an energy source world-wide.

LNG is normally traded by its energy content HHV or by the Wobbe index with otherwise little information about its actual composition although normally this includes some heavier hydrocarbons and some nitrogen as well. The result may be some spread in the knocking resistance of the gas ("methane number", MN) even though the LNG might be within the specifications, and this is further depending on the way the gas is extracted from the LNG tanks.

CIMAC therefore provides some information about what quality differences may be encountered when using LNG as an engine fuel and what could be done in the future to try to limit the effects of these variations in order to ensure steady engine operation.

2. How do the LNG quality differences show up in the engine operation?

There are two distinct types of gas made from LNG depending on how it is extracted:

- "natural boil-off gas" which is taken off the top of the LNG tanks above the liquid will have a high methane content and some nitrogen and thus have a high knocking resistance. Analysis show values typically around MN 100 and LCV between 33 – 35MJ/nm3. (Initial gas extraction after up-loading may have reduced calorific value because of the high nitrogen content at the top of the tanks).
  This is a somewhat special application typical for fuelling of LNG tanker propulsion plants

- "forced boil-off gas" i.e. LNG extracted from down in the tanks and evaporated separately. This gas will contain a mixture of all hydrocarbons in the liquid and its resistance to knocking may differ from origin to origin and even from load to load, with the MN typically in the range between 70 and 80. The calorific value will be higher than natural boil-off gas and quite stable at around 38 – 39 MJ/nm3.
  This gas type is now becoming very popular as fuel for general shipping.

3. Some reasons why the LNG composition may differ

Per definition LNG is natural gas which has been cooled down so much that it is made into a liquid. As is well known the base natural gas from which it is made not only contains methane - although this is by far the main component, but also ethane, propane and even some butane, so during the condensation process these other components and a certain amount of nitrogen will be present as well.

Because methane requires the lowest temperature for liquefaction (after nitrogen), the other hydrocarbons which may be present in the natural gas will all become liquids before the methane during the cooling-down process. Therefore it is normal to take out most of these in a process called "fractioning" and which can be explained by the boiling temperatures and liquid densities:

	Boiling temperature at atmospheric pressure	Liquid density
(Nitrogen	- 195.8 ºC	0.810 kg/ dm3)
Methane	- 161.5	0.421
Ethane	- 88.6 "	0.546 "
Propane	- 42.0 "	0.585 "
N – Butane	- 0.5 "	0.600 "

Depending on the liquefaction process, storage capacity and other practical and economical considerations at the terminal, there might be an incentive to keep some of the higher hydrocarbons in the LNG. This will increase the energy content per shipload of LNG and as such have its clear economic attractions for the trader.

From what is becoming known about the LNG trade, a limited amount of heavy hydrocarbons will always be present in the LNG, but as explained above the actual content may depend on its origin. This also means that there will be a certain spread in the knocking resistance of gas made from LNG depending on its origin.

4. CIMAC position on LNG quality variations when used as engine fuel

Currently, the CIMAC Working Group 17 "Gas Engines" is addressing the issue of fuel gas quality identification and quantification in general and including that of LNG quality. Our information to date gives some practical advice to the use of LNG as an engine fuel until improved quality standards may become available. Some of these are:

- "Natural boil off gas" from the top of the tanks as readily available in LNG tankers for propulsion is very high in methane and has good knocking

stability. It is therefore particularly well suited as an engine fuel. However, when a propulsion system is laid out for the use of this, it is important to ensure that there is always enough natural boil-off gas with sufficiently high methane content available, so that any need for mixing in “forced boil-off gas” from the bottom of the tanks in order to maintain the power is limited. If this is nevertheless required, the operator must be aware that the knocking stability of the gas then will be reduced and that appropriate precautions concerning engine power or ignition timing will have to be taken in order to avoid knocking.
Engine installations specifically designed to be fuelled by LNG should preferably be of the type “forced boil off” with the LNG taken from deep down in the tanks and well mixed before extraction into the evaporator. This will ensure good homogeneity of the LNG taken out and hence constant gas quality. One must be aware that this type of LNG-based fuel gas will be different from the “natural boil off gas” from a tank top and the rating of the engine will have to be based on a somewhat lower MN in this case, in order to ensure knocking-free operation. Evaporator sizing must be sufficiently large in order to ensure that no gas droplets are entering the engine even under severe transient operation.

- when evaporated LNG is injected into a gas grid differences in power and performance is to be expected compared to using pure grid gas, even if the Wobbe index remains within the specifications.

The CIMAC WG 17 will continue to follow up on the use of LNG as a fuel and inform about further developments in handling any variations in the engines as well on progress made in the standardisation process of future LNG-based fuels and the required system solutions.