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CONSIDERATION OF CONCRETE PROPOSALS ON CANDIDATE SHORT-TERM MEASURES

Measures to address emissions of methane from gas fuelled ships

Submitted by SGMF

SUMMARY	
Executive summary:	This document discusses the GHG reductions achievable and proposed next steps to further reduce emissions from shipping using natural gas as fuel. SGMF also highlights the importance of developing robust guidelines on determining GHG life cycle emissions to ensure consistent evaluation of all fuels.
Strategic direction if applicable:	3
High-level action:	3.2
Action to be taken:	Paragraph 24
Related documents:	resolution MEPC.304(72); MEPC 73/19; MEPC 73/WP.5 and MEPC 71/INF.23

Introduction

1 MEPC 72 adopted resolution MEPC.304(72) *on Initial IMO Strategy on reduction of GHG emissions from ships* (the Initial Strategy). The Initial Strategy includes candidate short-term, mid-term and long-term measures.

2 A programme of follow-up actions was developed at ISWG-GHG4. MEPC 73 approved the report and in particular invited concrete proposals on candidate short-term measures to MEPC 74. Candidate short-term measures have been categorized into Groups A, B and C (MEPC 73/WP.5) where Group C is defined as short-term measures that are not work in progress and do not require data analysis.

3 Further to the decision of MEPC 73 to hold an intersessional meeting to consider concrete proposals for candidate measures, SGMF provides proposals for reducing GHG emissions from ships falling into Group C; this could in principle also apply to Group A.

4 These proposals are:

.1 development of measures to reduce methane slip; and

.2 development of robust life cycle GHG guidelines for all types of fuels.

Background

GHG emissions from LNG as a marine fuel

5 Liquefied natural gas (LNG) as a marine fuel alternative to fuel oil has significant environmental benefit with regard to air quality, as the combustion of LNG produces reduced formation of NO_X, SO_X and Particulate Matter including black carbon.

6 LNG mainly consists of methane with small percentages of heavier hydrocarbons such as ethane, propane and butane. The conversion factor to carbon on a weight basis known as the carbon factor (Cf) for different fuels has been laid down by MEPC.1/Circ.866 as 2.750 for LNG, 3.206 for marine diesel/gas oil (MDO/MGO) and 3.114 for heavy fuel oil (HFO). The energy content measured as lower heating value is variable, average values are 48 MJ/kg for LNG, 42.7 MJ/kg for MGO/MDO and 40.2 MJ/kg for HFO. The combination of a lower carbon factor and higher energy intensity per ton of fuel results in CO_2 emissions which on a chemical basis are for LNG up to 28% lower compared to HFO or 25% compared to HFO.

7 Emissions of unburned methane from engines, so-called "methane slip", can potentially reduce this benefit as methane has a global warming potential of 28 to 34 according to the Intergovernmental Panel on Climate Change (IPCC) Assessment Report 5 (AR5) over a 100-year time-horizon (GWP100). The amount of methane slip depends upon engine design, including power cycle (two-stroke, four-stroke engines of medium and high speed, or turbines), fuel (single or dual fuel), combustion cycle (Otto, Diesel or boiler) and operation (e.g. engine speed and load). Methane slip is therefore quite variable. Average values over a relevant test cycle range from 0.2% for modern slow speed two-stroke diesel engines to 2.6% for the latest four-stroke medium speed dual fuel engines.

8 Even though improvements have already been made to reduce methane slip during the combustion of LNG, substantial efforts are being taken to further reduce methane slip by means of engine design measures such as combustion chamber design and scavenging duration. High pressure and low-pressure fuel admission systems are both designed to ensure efficient combustion. To eliminate any unburned fuel post-combustion, treatment technologies are in early stages of development for certain engine types.

9 Fugitive emissions of methane during bunker operations and on board the ship, for example, losses from seals or flanges before repair, are further potential sources of ship associated methane emissions. In principle there is no deliberate venting of methane on board IGF Code ships at any time including bunkering unless there is an emergency situation that necessitates a controlled release. Document MEPC 71/INF.23 (Republic of Korea) provided research results for methane venting for LNG carriers to which the IGC Code applies. Further work, including measurement, may be required to assess these other onboard sources for LNG fuelled ships.

The importance of well-to-wake emissions

10 Consideration needs to be given to the life cycle emissions for all types of fuels to consistently assess their effectiveness to reduce GHG emissions, taking into account carbon dioxide, methane and other relevant GHG emissions over the fuel supply chain and fuel use.

Recent research estimated GHG reduction of up to 21% compared with current oil-based marine fuels over the entire life cycle from well to wake for current engine technologies using LNG as fuel. That same research illustrated a global average 15% reduction in GHG emissions if the world fleet were to completely switch to natural gas.

11 LNG derived from renewable sources (bio-LNG) can be produced from methane emitted from landfill or other waste. It has a lower total impact on climate change even though, from combustion perspective, the methane molecule is identical and the emissions benefits on a tank-to-wake basis are the same. This is because the methane used for this purpose would be captured and repurposed for fuel instead of being released into the atmosphere as fouling biomass.

12 As an example, Hydrogen is a zero-carbon fuel, so it does not generate CO_2 emissions on board the ship. Today, Hydrogen is primarily produced by steam reforming of natural gas which can emit significant amounts of CO_2; production via water electrolysis using renewable power would remove those emissions. Other alternative fuels present similar challenges where the contribution of well-to-tank emissions to the overall life cycle emissions vary significantly.

13 Refined fossil fuels can be characterized by a wide range of feedstocks, processing and blending. A refinery produces many products and the allocation of GHG emission to specific products is very challenging and different approaches have been used. Combustion of the fuel, however, is the largest component of the well-to-wake emissions, typically accounting for 83% of the GHG emissions from using MGO/HFO in two-stroke engines for example.

14 MDO/MGO and HFO combine high energy density on a volume and weight basis with good performance on handling and safety, and are used in highly efficient engines. Many alternative fuels have a lower volumetric energy density and for carriage efficiency they need to be pressurised or liquified. Additional storage and equipment can reduce the cargo capacity (potentially by weight and/or volume) of a ship and may be associated with increased energy use for managing the fuel or a lower conversion efficiency. As a result, the operational energy efficiency of a ship using alternative fuels may be reduced, which will partially offset some advantages of a lower carbon fuel.

Discussion

15 IMO has agreed the Initial Strategy to reduce GHG emissions from shipping. To maximize the impact of the GHG reduction from ships, the overall life cycle emissions associated with different fuels also need to be considered to ensure consistent evaluation and treatment of all options, to avoid unintended consequences. Recent research confirms up to 21% CO_2 reduction when using LNG as a marine fuel, well-to-wake.

16 MARPOL Annex VI focuses on emissions originating from the ship, Ozone Depleting Substances, shipboard incineration and VOCs from tankers. Mandatory technical and operational efficiency measures (EEDI and SEEMP) were adopted in 2011. The EEDI is based on CO_2 only, which may provide an advantage to LNG under those regulations as methane emissions are not accounted for. Local emissions are reduced using LNG as fuel, NO_X by 98%, SO_X by 99.98% and Particulate Matter is negligible. The EEDI is expressed in grams of CO_2 per ship's capacity mile; this may provide an advantage to LNG as methane emissions are neglected in this approach, i.e. the EEDI would be higher if a CO_2 equivalent value was used in the calculation of the EEDI.

17 Engine suppliers have recognized the challenge of reducing GHG emissions from LNG-fuelled ships and are working on minimizing methane emissions, as well as optimizing

fuel consumption and minimizing other emissions such as NO_X. It is not feasible to minimize all emissions simultaneously for a given power output and trade-offs are consequently needed.

18 One approach to address GHG emissions could be to set limits for the engine, similar to the existing NOx regulations; all emissions need to be considered and CO_2 equivalence assists in this evaluation. Further work would be required to define engine categories, as well as to measure and develop engine emission factors to establish a baseline per category. Reduction targets could then be set to progressively reduce emissions in line with advances in technology.

19 An alternative approach could be to address the concern that neglecting methane emissions gives LNG inconsistent consideration under the existing regulations when only CO_2 is considered, by taking a more holistic approach. This would drive optimization of both fuel consumption (CO_2) and methane slip to reduce total GHG emissions, and could also be applied to the next phases of EEDI without the need to change the reference lines.

20 Any measures to drive the reduction of methane emissions should be balanced with the contribution LNG makes to reduce GHG emissions, and improve local air quality, be technology neutral, and utilize a goal-based approach whilst also provide due consideration to existing ships using LNG as a fuel, including LNG carriers.

21 To enable consistent evaluation of low and zero carbon fuels, criteria need to be set regarding the well-to-wake emissions for a specific fuel to be accepted as low- or zero-carbon. Carbon forcing factors need to be based upon reliable data. As a first step, an overview of CO_2 and GHG emissions of fuels with potential for use in shipping is needed to provide a starting point for discussion. This should also include the provision of any shore-based power for onboard auxiliary requirements, cold ironing or charging of batteries. This database should reflect the variability of different supply chains and should include the conversion to propulsive power. There is an urgent need to implement a research and development programme for propulsion and fuel technologies to facilitate alternative fuel technologies for the maritime sector.

22 SGMF has commissioned an independently reviewed study of the GHG for LNG as a marine fuel on a well-to-wake basis. This report using data provided by the gas fuelled shipping industry is publicly available from April 2019.

Proposals

23 SGMF proposes that:

.1 a baseline for the contribution of methane emissions on a tank-to-wake basis for GHG emissions for different engine technologies should be developed. This would greatly inform the selection of measures that both reduce methane emissions and effectively reduce overall GHG emissions; and

.2 a database of well-to-wake emissions for different fuel options and their production/end-use pathways should be developed.

Action requested by the Working Group

24 The Group is invited to consider the comments and proposals contained in this document and to take action as appropriate.

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