INTERNATIONAL MARITIME ORGANIZATION

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MARINE ENVIRONMENT PROTECTION COMMITTEE
60th session
Agenda item 4

MEPC 60/4/44
22 January 2010
Original: ENGLISH

PREVENTION OF AIR POLLUTION FROM SHIPS

Results of data gathering exercise for the assessment of the Energy Efficiency Design Index (EEDI) for ships carrying liquefied gases in bulk

Submitted by the Society of International Gas Tanker and Terminal Operators (SIGTTO)

SUMMARY

Executive summary:	This document contains the results of a data gathering exercise to aid assessment of the application of the Energy Efficiency Design Index (EEDI) to ships carrying liquefied gases in bulk
Strategic direction:	7.3
High-level action:	7.3.1
Planned output:	7.3.1.3
Action to be taken:	Paragraph 12
Related documents:	MEPC 58/4/8, MEPC 59/4/15, MEPC 59/4/22, MEPC 59/WP.8, GHG-WG 2/2/7, GHG-WG 2/WP.1, MEPC 60/4/18, MEPC 60/4/33 and MEPC 60/4/34

Introduction

1 This document is submitted in accordance with paragraph 4.10.5 of the Guidelines on the organization and method of work of the Maritime Safety Committee and the Marine Environment Protection Committee and their subsidiary bodies (MSC-MEPC.1/Circ.2), and provides comments relating to documents MEPC 60/4/18 (Republic of Korea), MEPC 60/4/33 and MEPC 60/4/34 (IMarEST). Reference is also made to paragraph 3 of document MEPC 60/1/Add.1 concerning the deadline relaxation.

2 Following the deliberations at MEPC 59, a request was made to "Member Governments and observer organizations" to provide information and outcome of experiences in applying the Guidelines to future sessions of the Committee. SIGTTO has therefore polled its members who operate ships carrying liquefied gases in bulk to seek data from the design of vessels built since 1 January 2000 to assess the application of the Energy Efficiency Design Index (EEDI) to LNG and LPG vessels. This data therefore represents a retrospective view of ships already in service.

Types of vessel

3 The gas carrier fleet contains a number of different vessel types which have differing characteristics.

4 Liquefied Petroleum Gas (LPG)

.1 Pressurized LPG – small vessels which carry LPG at ambient temperature under pressure. No cargo reliquefaction equipment, and hence no additional fuel consumption for plant. The majority of these vessels fall in the size range from about 500 m^3 to 5,000 m^3 (450 to 4,800 dwt).

.2 Semi-pressurized LPG (also commonly referred to as "semi-refrigerated LPG") – vessels in a size range from about 4,000 m^3 to 30,000 m^3 (3,800 to 30,000 dwt). Pressure rating typically about six bar with reliquefaction plant. Some vessels are rated to carry liquefied ethylene at – 104°C and a few recent vessels rated down to LNG temperatures at – 160°C. The reliquefaction plant impacts the EEDI.

.3 Fully refrigerated LPG – vessels in the size range from 20,000 m^3 to 85,000 m^3 (18,000 to 54,000 dwt). These vessels primarily carry propane (about -40°C) or butane (about -5°C) at ambient pressure. They have large reliquefaction plants to handle boil-off from the cargo. The electrical load of these plants impacts the EEDI and is dependent on the cargo mix. Clearly, a full butane cargo needs much less energy to refrigerate than a full propane cargo.

5 Liquefied Natural Gas (LNG)

All LNG vessel types carry the cargo fully refrigerated at about -160°C. The size ranges from about 1,200 m^3 to 265,000 m^3 (800 to 150,000 dwt), although most vessels are in the range 125,000 to 170,000 m^3 (70,000 to 85,000 dwt). There are three distinct sub-types with differing characteristics.

.1 Steam driven vessels – typically designed to burn the "natural" boil-off from the cargo and supplement with heavy fuel oil (HFO), however, they may also supplement their fuel by means of force-vaporising some cargo liquid.

.2 Dual Fuel Diesel Electric – typically designed to use gas as the primary fuel. Diesel engines are inherently more efficient than steam turbines, however, losses through electrical drive system and fuel gas compressor system takes away some of the potential gains. Only one data point was received and it is not shown.

.3 LNG reliquefaction vessels. These vessels are similar in concept to the fully refrigerated LPG vessels with plants that reliquefies the natural boil-off and returns it to the cargo tanks. Propulsion is by way of conventional slow-speed diesel engines operating normally on HFO. The reliquefaction plant load is relatively high and this has an adverse affect on the EEDI.

Data gathering

6 The membership of SIGTTO was invited to submit data from the recorded results of sea trials to the SIGTTO Secretariat in a prescribed format for ships which entered service after 1 January 2000. Data for 145 ships were received, representing some 27% of the fleet less than 10 years old. In a few cases, not all fields were completed. Where possible, the SIGTTO Secretariat has made assessments based on public domain material to fill in some of the missing data.

Results

7 The EEDI was calculated from the results of the data gathering and is presented in two graphs. The first shows the consolidated results for all LPG ships. The second graph shows the results from all LNG ships. For the graphs, the EEDI was calculated as per MEPC.1/Circ.681, with adjustment to allow for the effect of liquefaction plants where appropriate.

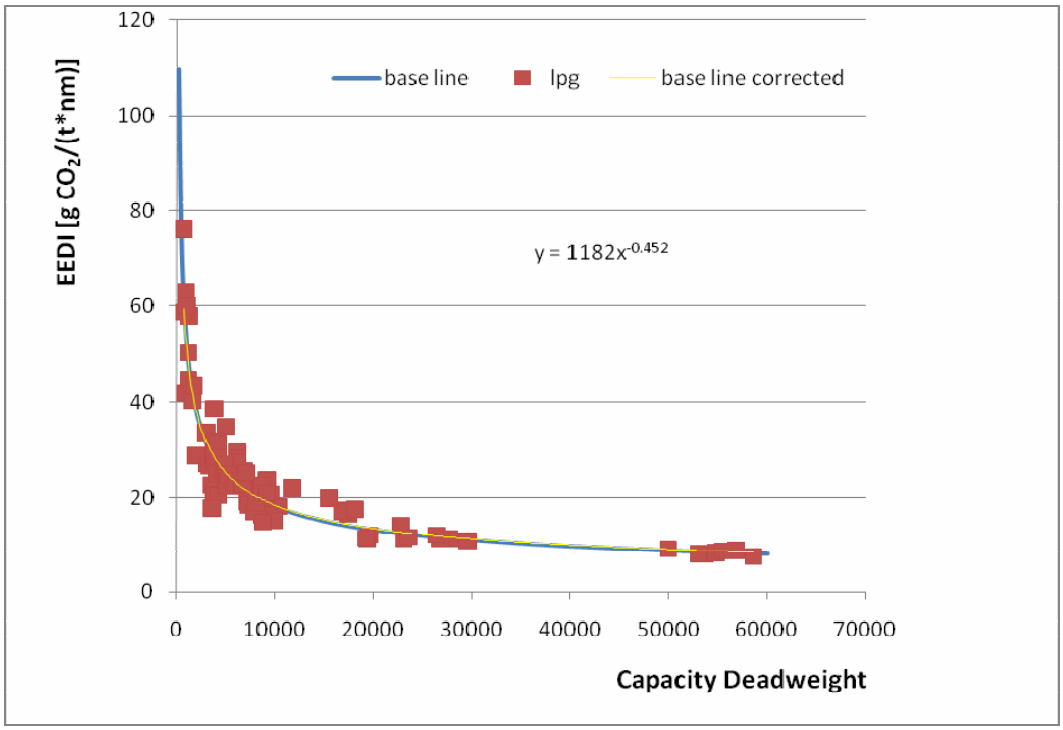

Figure 1 Calculation results for LPG ships

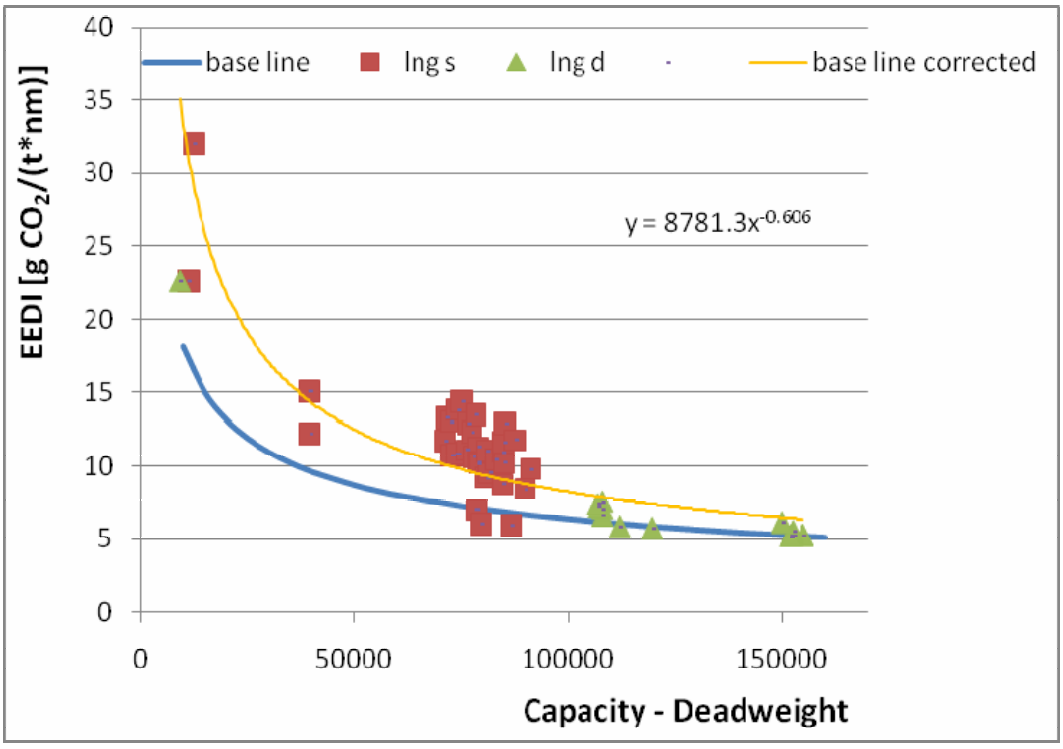

Figure 2 Calculation results for LNG ships

8 For the LPG ships, the correlation appears good, with the best curve fit closely following the benchmark line as per paragraph 11 below.

9 For the LNG ships, the results are not so good. For the diesel powered vessels (data plots "lng d") with reliquefaction plants, the results are concentrated in two clusters, around 110,000 dwt and 150,000 dwt. Whilst there are 35 vessels in this range (about 17.5 % of the LNG vessels less than 10 years old), there is only one data point for a smaller diesel powered vessel, so no conclusions can be drawn about suitability for smaller vessels. For steam driven ships (data plots "lng s") the results are poor. There is a distinct cluster around 70,000 to 90,000 dwt, with a few smaller vessels. Part of this may be explained by the fact that the performance criteria in the shipbuilding contract is typically based on HFO use only, whereas, in service they burn a mixture of HFO and boil-off gas (BOG). In other words, for these ships the design conditions bear little relationship to the actual operating conditions. The data gathered was for the HFO only consumption, but to try to give an indication nearer to the normal operational pattern, SIGTTO has assessed the EEDI assuming 50% HFO and 50% BOG. It should be noted that most of these vessels have, or potentially have, the ability to derive all the fuel requirement from BOG supplemented with vaporised LNG. This would alone, significantly reduce an EEOI value.

10 Further analysis is necessary to try to understand why, particularly at the smaller sizes, there is such a scatter of data. It is noted that this scatter is a feature of many such studies. Further study is necessary for the LNG ships.

11 The base line on all the graphs has been calculated using the coefficients of a = 1252.6 and c = 0.4597 as per documents MEPC 58/4/8, GHG-WG 2/2/7 and GHG-WG 2/WP.1.

$$\text{Baseline} = a * \text{Deadweight}^{-c}$$

Action requested of the Committee

12 The Committee is invited to consider the information presented in this document and take action as appropriate.