INTERNATIONAL MARITIME ORGANIZATION

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MARINE ENVIRONMENT PROTECTION COMMITTEE
60th session
Agenda item 4

MEPC 60/4/18
15 January 2010
Original: ENGLISH

PREVENTION OF AIR POLLUTION FROM SHIPS

EEDI calculation method for LNG carriers with diesel-electric propulsion systems

Submitted by the Republic of Korea

SUMMARY

Executive summary:	This document proposes an EEDI calculation method for LNG carriers with diesel-electric propulsion systems, for which dual fuel diesel engines are installed
Strategic direction:	7.3
High-level action:	7.3.1
Planned output:	7.3.1.3
Action to be taken:	Paragraph 17
Related documents:	MEPC 59/24; MEPC.1/Circ.681; MEPC 59/4/22 and MEPC 59/WP.8

Introduction

1 The Marine Environment Protection Committee, at its fifty-ninth session (MEPC 59), agreed to circulate, by MEPC.1/Circ.681, the interim guidelines on the method of calculation of the Energy Efficiency Design Index for new ships (MEPC 59/24, paragraph 4.137.1).

2 MEPC 59, having considered the report of the Working Group on GHG emissions from ships, noted the debate on ships with non-conventional propulsion system, e.g., passenger ships with diesel-electric propulsion, and invited Member States and observers to submit their communications on this matter to the sixtieth session of the Committee (MEPC 59/24, paragraph 4.137.7).

3 The Committee invited Member Governments and observer organizations to use the interim guidelines for the purpose of test and trials on a voluntary basis (MEPC.1/Circ.681, paragraph 2):

.1 for ships with conventional propulsion systems (main engine mechanical drive); and

.2 to the extent possible, for ships with non-conventional propulsion systems (e.g., diesel-electric propulsion, turbine propulsion or hybrid propulsion systems).

4 Furthermore, the Committee invited Member Governments and observer organizations to provide the outcome and experiences in applying the interim guidelines to future sessions of the Committee for further improvement of the method of calculation of the EEDI for new ships (MEPC.1/Circ.681).

Objective

5 The current formulation of the EEDI formula, circulated by MEPC.1/Circ.681, is widely recognized as being appropriate for ships with "traditional" machinery layouts with one or two large diesel prime movers mechanically linked to the propeller(s) along with (a) much smaller engine(s) installed to provide auxiliary power.

6 Recently, there has been an increase in the number of ships with diesel-electric propulsion systems, especially in the case of LNG carriers.

7 To this end, the Republic of Korea has carried out an investigation to attain an EEDI calculation method which would be suitable for LNG carriers with diesel-electric propulsion systems. Furthermore, specific fuel oil consumption (SFC) of dual fuel diesel engine was also investigated in order to formulate a suitable EEDI calculation method for LNG carriers with dual fuel diesel engines using the actual NO_x technical file approved by a classification society on behalf of the Administration.

8 Based on the results of these investigations, this document proposes a suitable EEDI calculation method for LNG carriers with diesel-electric propulsion systems, for which dual fuel diesel engines are installed.

Calculation methods and discussions

9 To calculate the EEDI of LNG carriers with diesel-electric propulsion systems, the formula circulated by MEPC.1/Circ.681, with the omission of unnecessary factors, was used as follows:

$$\frac{\left(P_{AE} C_{FAE} SFC_{AE}\right) + \left(\sum_{i=1}^{nPTI} P_{PTI(i)} C_{FAE} SFC_{AE}\right)}{Capacity\ V_{ref}}$$

10 LNG carriers with diesel-electric propulsion systems do not have "traditional" machinery layouts. Instead, a number of auxiliary engines are installed on board to produce the electric power required for the propulsion and the normal maximum sea load (hereinafter refer to "NMSL"). Accordingly, it would be considered reasonable to calculate the amount of CO_2

emissions for the propulsion and NMSL using P_{PTI} and P_{AE}, respectively, in accordance with MEPC.1/Circ.681.

11 In this regard, the calculation of P_{PTI} would be very simple. However, it is not clear as to which SFC_{AE} should be used – i.e. "at the engine(s) 50% of MCR power or torque rating" or "at 75% of MCR power or torque rating" – because the dual fuel diesel engines of LNG carriers with diesel-electric propulsion systems are used for both the propulsion and NMSL.

12 According to MEPC.1/Circ.681, SFC is the certified specific fuel consumption, measured in g/kWh, of the engines. The subscripts $_{ME(i)}$ and $_{AE(i)}$ refer to the main and auxiliary engine(s), respectively.

.1 For engines certified to the E2 or E3 duty cycles of the NO_x Technical Code 2008; the engine Specific Fuel Consumption ($SFC_{ME(i)}$) is that recorded in the EIAPP Certificate(s) at the engine(s) 75% of MCR power or torque rating.

.2 For engines certified to the D2 or C1 duty cycles of the NO_x Technical Code 2008; the engine Specific Fuel Consumption ($SFC_{AE(i)}$) is that recorded in the EIAPP Certificate(s) at the engine(s) 50% of MCR power or torque rating.

.3 For ships where the P_{AE} value calculated by paragraphs 2.5.6.1 and 2.5.6.2 of MEPC.1/Circ.681 is significantly different from the total power used at normal seagoing, e.g., conventional passenger ships; the Specific Fuel Consumption (SFC_{AE}) of the auxiliary generators is that recorded in the EIAPP Certificate(s) for the engine(s) at 75% of P_{AE} MCR power of its torque rating.

13 As well known, in the case where the dual fuel diesel engine is installed on board an LNG carrier with diesel-electric propulsion system, it is impossible to identify which engine is for the propulsion or for the NMSL. However, dual fuel diesel engines for LNG carriers with diesel-electric propulsion systems are tested in accordance with test cycle E2 which is for constant speed marine engines for ship main propulsion, including diesel electric drive or variable pitch propeller installations. Therefore, it would be more reasonable to use SFC_{AE} at 75% of MCR power or torque rating to calculate the amount of CO_2 emissions for the P_{PTI}.

14 Furthermore, for the calculation of P_{AE}, the empirical formula or electric power table may be used. However, in case where dual fuel diesel engines are installed on LNG carriers with diesel-electric propulsion systems, it is more reasonable to calculate the P_{AE} using the electric power table rather than the empirical formula. This is due to the fact that there is no propeller law operated main engine and that LNG carriers with diesel-electric propulsion systems have different machinery layouts in comparison with conventional diesel propulsion systems. In these cases; SFC_{AE} at 75% of P_{AE} MCR power of its torque rating should be used to calculate the P_{AE} in accordance with paragraph 2.5.5.7 of MEPC.1/Circ.681 as follows:

> "For ships where the PAE value calculated by 2.5.6.1 and 2.5.6.2 is significantly different from the total power used at normal seagoing, e.g., conventional passenger ships, the Specific Fuel Consumption (SFC_{AE}) of the auxiliary generators is that recorded in the EIAPP Certificate(s) for the engine(s) at 75% of P_{AE} MCR power of its torque rating."

15 In general, SFC of dual fuel diesel engine used for LNG carriers with diesel-electric propulsion systems has a tendency to decrease according to the increased load. Also, generally speaking, SFC of dual fuel diesel engines in the gas fuel operation mode is lower than in the liquid fuel operation mode.

Proposal

16 Based on the above, the Republic of Korea proposes the following:

.1 the amount of CO_2 emissions for the propulsion and NMSL should be calculated using P_{PTI} and P_{AE}, respectively;

.2 for the calculation of CO_2 emissions from the propulsion (P_{PTI}); SFC_{AE} at 75% of MCR power or torque rating should be used;

.3 for the calculation of CO_2 emissions from the NMSL (P_{AE}); P_{AE} should be determined using the electric power table rather than empirical formula;

.4 for the calculation of CO_2 emissions from the NMSL (P_{AE}); SFC_{AE} at 75% of MCR power or torque rating should be used; and

.5 the SFC of dual fuel diesel engine in liquid fuel operation mode should be used.

Action requested of the Committee

17 The Committee is invited to consider the proposed EEDI calculation method for LNG carriers with diesel-electric propulsion systems and take action as appropriate.