Implementation of Ship Energy Efficiency requirements in offshore shipping industry

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Abstract. The International Maritime Organization (IMO), through its Maritime Environmental Protection Committee (MEPC), has been carrying out substantial work to provide the fundamental conditions for the reduction of greenhouse gas emissions from international shipping since 1997, following the adoption of the Kyoto Protocol and the 1997 MARPOL Conference. Many documents, issued in this respect, are dedicated to different types of vessels. More of the requirements and regulations for establishing of efficiency criteria are based on commercial activities of the vessels and respective fuel consumption. There is the big difference between offshore vessels and all other vessels. Offshore shipping industry has another criteria for effective fuel consumption. As longest as the job is with very high risk Safety is with high priority. The offshore industry try to find another way and means for implementation of MARPOL Annex VI requirements.

The article summarizes Classification Societies requirements regarding offshore vessels. The requirements are compare with IMO Resolutions in this field and conclusions are made. The authors has made proposals to education system which are related to STCW Convention Code, Part B..

Keywords. Offshore vessel, Ship Energy Efficiency Management Plan (SEEMP), Offshore Drilling expenses.

1. Introduction

Maritime transport retains its strategic importance as a major sector of world trade in goods and of passenger transport, despite the dynamics of the economic processes. The financial crisis at the end of the first decade of the 21st century delayed to a certain extend the development of shipping, changed a number of operational criteria such as "ship scrapping age", "ship green passport", "energy efficiency operational indicator", etc..

The United Nations data, published in the annual report of the Conference on Trade and Development titled "Review of maritime transport 2017", show a 2,8% increase in maritime trade in 2017 [1]. Along with the development of maritime trade, the UN reports also sustainability in the environmental protection. A number of IMO initiatives aim at encouraging further investment in installations which use ecological fuels,

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improving the structural and operational indicator of ships in service, etc [2]. Against the background of these activities one is puzzled by the general wording of the requirements of international institutions, the generalized formulae for calculating the ships' energy indicators, the lack of specific coefficients or multipliers which take into account the nature of the ship activities. An example in this respect are the offshore ships whose operational process is very different from that of traditional merchant and passenger ships. A series of publications of scientists and specialists go deeper into the IMO guidelines contained in MEPC circular letters and point at the versatility of the multipliers in the formula for calculating the operational energy efficiency indicator [3].

$$EEOI=\frac{FC_i.C_F}{m.D} \quad (1)$$

where:

FC_i – mass of fuel consumed by main and auxiliary engines during a single task performance[t],

C_F - conversion rate expressed as a relation of CO2 mass generated during used fuel combustion process [t CO2 / t fuel],

m – mass of freight onboard [t],

D – distance expressed in nautical miles that the vessel travelled during the performance of a specific task [Nm – nautical mile].

The Gaspar / Eriksted and Glowacki / Benkendt studies provide a good basis for presenting the specific activities of offshore ships and the differences from merchant ships in this respect [4,5].

Although Gaspar and Eriksted investigate the activities of offshore ships such as OSV and AHTS in the EEDI context, they ask important questions which refer to the operational activities in this sector of the maritime industry:

- How to calculate the work done by the aforementioned types of ship?
- How is the performance of the specific mission related to fuel consumption and to the emissions discharged into the atmosphere, from the point of view of the necessary power used?
- How can activities which are not part of the routine operational process such as fire extinguishing, rescue operations, oil spill clearance, etc., leading to non-production costs, be included in the calculations [4]?

In this vein, other question can also be formulated. For the purpose of the present study, the authors of the present article rely on their personal experience and accumulated statistics from the work of Bl. Belev as a DPA at the offshore company Bon Marine International AD and the above-cited publications.

2. The operation of off-shore ships presented as a system of operations

If the EEDI was incorporated during the building of a ship and its change during the service life of the vessel is a difficult process, then the EEOI allows enough freedom of choice of operational measures aimed at reducing fuel consumption and hence the emissions of green house gases. The authors cited in [4,5] make a profound analysis of the IMO guidelines in this respect. An ICCT study published on the Council's website also analyzes the abilities of the constructive index to enhance the energy efficiency of non-commercial vessels [6,7]. The authors of the present article, however, believe that additional possibilities should be sought in improving the operational indicator, despite the numerous constructive improvements on offshore industry ships. Their operational profile requires an in-depth and critical processing of statistic data in order to highlight the specific stages of each mission and to point out the possibilities for reducing energy costs.To make such an analysis, it is necessary to present the voyage or the mission as a system of operations. A similar approach was chosen by Gaspar / Eriksted and Glowacki / Benkendt in their publications. The understanding of the activity of offshore ships as a "mission" fully corresponds to their operation and formulates the distinction from merchant ships. This summarized characteristic also covers the non-productive activities defined in the third question above. A shortcoming of the cited analyzes is the lack of correlation of the missions with the meteorological situation, the training of the crews and the elements of the passage plan.

The specifics of the passage plan are well described by a number of authors. They adhere to the operation of merchant ships, which provides a summary of their conclusions on the nature of a voyage [8,9]. Another interesting and useful approach is represented by Fun-Sang and Caprace, who use a non-parametric model to describe the operation of ships during a routine voyage. The authors offer a data envelopment analysis method and a multicriteria decision analysis to describe ship operation [10]. Similar reasoning is presented by Behrandt, who analyzes the specifics of the operation of fishing vessels and the possibilities for reducing energy costs in their routine operation [11].

Analysts and researchers of the Energy Efficiency Operational Indicator draw their conclusions on the IMO formulae enclosed to the MEPC circular letters. This approach limits the possibilities to search for reserves in offshore ship operation due to the limited number of their mathematical multipliers. In the next part of the article we propose another approach to assessing the working environment.

3. Use of rectangular games for assessing the energy efficiency of offshore vessels

The rules of DNV Classification Society of July 2011 lay down the requirements for the construction, equipment and stability of all ships which are designed to perform offshore activities [12]. The summarized performance characteristics of these ships are:.

- The working environment - usually they operate in adverse weather conditions, heavy hydrodynamic loads on the ship's hull, machinery and auxiliary mechanisms;
- Experience of the crew to cope quickly with private and common tasks for each mission;
- Experience of ship masters to take quick decisions in non-standard situations;
- Flexibility of the ship's management by the mission leaders.

Ships in the offshore industry perform specific tasks, which can be described as permanent strategies. The practical approach requires systematic collection of information such as:

- The type of the mission;
- Meteorological conditions in the area of the ship's mission;
- Time required to perform the mission;

- Ability of the crew to perform the mission and necessity to attract additional members and specialists.

Based on the general description of the offshore mission, it can be stated that mission performance means solving a conflict situation. Typical for conflict situations is that each country in the conflict tries to gain maximum benefit regardless of the other party's counter action or of chance. The performance of an offshore ship mission can be presented as a conflict situation for which the Theory of Games is applicable

The conflict situation for each mission can be described as an counter action of the ship in pursuit of her specific tasks and against the nature, in compliance with IMO's requirements for safety at sea. Assuming that nature has only two strategies, unfavorable and favorable weather conditions, then each strategy of the ship depends on her mission. In this way, a graphical method is used to solve a rectangular game with a matrix of 2x m, where 2 are the above-mentioned states of nature, and m is the number of the ship's strategies:

$$U = \begin{cases} a_{1,1},\ a_{1,2},\ a_{1,3},\ \ldots a_{1,m} \\ a_{2,1},\ a_{2,2},\ a_{2,3},\ \ldots a_{2,m} \end{cases} \quad (2)$$

Let's assume that the mixed strategy of the ship is $X = (x, 1\text{-}x)$. Then for the pure nature strategy q_1 the following inequation will be fulfilled:

$$a_{1,1}.x+a_{2,1}.(1\text{-}x) \leq V \quad (3)$$

If the ship uses the second, third, etc. strategies, the inequations will form a system of the kind:

$$\begin{cases} a_{1,1}.x+a_{2,1}.(1\text{-}x) \\ \ldots\ldots\ldots\ldots\ldots\ldots\ldots \\ a_{1,m}.x+a_{2,m}.(1\text{-}x) \end{cases} \quad (4)$$

For the inequations (3), (4) and the limitations $x > 0$ and $x < 1$ the theory of linear programming is applied by which the solution of the inequation system can be represented graphically by figure 1. The straight lines drawn, m in number, determine the strategies of the ship in the present state of the meteorological conditions. Empirically, the fuel consumption can be determined for each strategy and then the optimal one corresponding to the lowest operational indicator can be selected

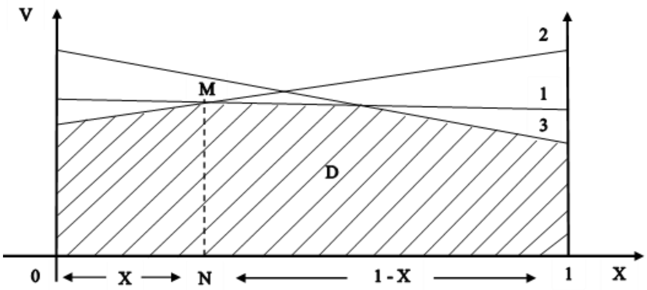

Figure 1. Representation of solution for system (4).

4. Conclusion

The proposed method for assessing energy efficiency requires preliminary preparation by the Company which manages according to the ISM Code. In order to introduce a rating system, a procedure must first be developed to form part of the company's SMS. This procedure would assist offshore ship crews in implementing the energy efficiency management plan and the choice of an optimal strategy even when performing an advanced mission.

Solving the problems of improving a ship's energy efficiency requires systematic training of ship crews. Here the training has very similar features to the risk assessment training adopted in 2010 when the ISM Code was amended. The international maritime community has become aware of the need for crew training and the results of various projects funded by European Commission programs illustrate it. The authors of the present article are participants in such a project titled "Diversification of the employability paths of seafarers through collaborative certification of the competences". Under this project Prof. Belev has developed a program and materials for a training course "Ship Energy Efficiency". Raising an awareness of the need to enhance the energy efficiency of ships has to be also part of the competences that the STCW Convention regulates. Thus the process will be completed and applied to all levels of responsibility of ship crews

The present article is the initial stage and the basis for experimental work on the implementation of different types of operational strategies in offshore ship operation. It can also serve for carrying out an empirical analysis of the SEEMP performance results of merchant ships

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