

1. Introduction

The international shipping industry is responsible for shipping about 90 % of world trade [1]. Since the early 1990s, the world fleet is constantly growing. This growth accelerated in 2005. As a result, in 2017, the world fleet reached 1.9 billion tons of deadweight, which is twice as much as 12 years ago [2]. It is necessary to pay attention to the UNCTAD data for the period from 2015–2017, the merchant fleet had an increase from 90,470 to 93,262 units, which is almost 1.5 % per year [3].

Based on the foregoing, it can be assumed that in the future the growth trend of the fleet will continue. The total fuel consumption also increased from 291 million tons to 298 million tons (+2.4 %) from 2013 to 2015 [4]. In 2015, the total emissions of the marine merchant fleet into the atmosphere amounted to 3 % of the global CO₂ emissions [5]. Currently, international merchant fleet emissions are 800 million tons of carbon dioxide (CO₂) per year. Despite all the steps taken by IMO to combat emissions of harmful substances into the atmosphere, according to experts, this figure could double by 2060 [6].

According to the authors, in order to more effectively control emissions of harmful substances into the atmosphere, it is necessary to pay more attention to innovative technologies, namely, autonomous ships, as well as the irrational use of energy resources in international shipping.

2. Methods

Analysis of the main methods of controlling emissions of harmful substances into the atmosphere, which are used in the modern merchant fleet, was carried out and the main ones can be identified:

- SLOW Steaming approach implies a ship's small stroke technology to reduce fuel consumption;

- Just in time is a more efficient management of the transport process;

- Energy efficiency design index (EEDI) is energy efficiency index of new ships aimed at creating more environmentally friendly engines and devices;

THE ROLE OF INNOVATIVE METHODS IN COMBATING EMISSIONS OF HARMFUL SUBSTANCES INTO THE ATMOSPHERE IN SHIPPING

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Abstract: The world merchant fleet covers about 90 % of all world trade. Over the past decades, there has been a growth trend and currently stands at 93,262 units, or 1.9 billion tons of deadweight. As the number of fleets grows, so does fuel consumption, which in turn increases emissions of harmful substances into the atmosphere. Currently, annual carbon dioxide emissions are about 800 million tons. According to experts, this figure may double by 2060. International organizations are taking steps to reduce emissions of harmful substances into the atmosphere. After analyzing the main methods of controlling emissions of harmful substances into the atmosphere from ships and the realities of the modern maritime transport market, it should be noted that more attention should be paid to the problem of inefficient use of energy resources, as well as the development and implementation of innovative technologies in shipping. The irrational use of energy resources is often due to inefficient feedback between the participants in the maritime transport. Creation and development of a program based on a conceptual scheme should reduce the irrational costs of energy resources, which in turn will lead to a decrease in emissions of harmful substances into the atmosphere in the industry of maritime transportation. The introduction of innovative technologies, and in particular, autonomous ships, needs more attention. Having considered such a project as YARA Birkeland, it should be noted that the development and development of ships with zero emissions should play a key role in solving the problem of emissions of harmful substances into the atmosphere. Even in the early stages of developing autonomous ships, it is becoming clear that autonomous ships in synergy with existing concepts such as Slow Steaming can lead to revolutionary changes in environmental issues.

Keywords: emissions of harmful substances, sea transportation, autonomous ships, conceptual scheme, reduction of emissions, environmental protection.

- Energy efficiency operational indicator (EEOI) is a tool for monitoring the performance of ships and fleets, allows operators to measure the fuel efficiency of an operating ship;

- Monitoring, Reporting, Verification (MRV) is monitoring, reporting and verification system that allows to track CO₂ emissions from ships.

3. Results

Today, environmental protection is an important issue not only for society, shipowners, but also international organizations.

After analyzing the modern methods of combating harmful substances into the atmosphere, it should be noted that little attention is paid to the issues of inefficient use of energy resources, as well as innovative technologies. The first tests of autonomous ships have already been completed [7] and some of the projects are scheduled to start in 2019. It should be clearly understood that, from a technical point of view, autonomous ships under the control of the operator from the shore can be used for commercial purposes in the foreseeable future. The main unresolved issue is the legal part; there is no clear understanding of how to interpret autonomous ships from a legal point of view and apply them to current international maritime legislation.

The ship "YARA Birkeland" may be the first automatic ship with zero emissions [8]. This is a very important step towards reducing global emissions. Automatic ships, primarily at the initial level of integration, will be environmentally attractive by reducing the working speed of the ship, which in turn will reduce fuel consumption and, as a result, emissions of harmful substances into the atmosphere will be reduced. Of course, a decrease in fuel consumption can be considered as economic attractiveness, but a decrease in environmental pollution is also a very important factor. By using the Slow Steaming technique on au-

tonomous ships, very high emission reductions can be achieved. As an example, the Port of Tubarao → Hamburg [9] transition was taken (Fig. 1). For various types of ships, the percentage

of fuel savings and reduction of CO₂ emissions will differ, but the trend and effectiveness of “Slow Steaming” is undeniable in situations where ship speed is not the main indicator. If to take into account the cost of the crew, the benefits of slow steaming will not be so high, but considering a ship without a crew, where there are no costs for the crew, the effectiveness of Slow Steaming on autonomous ships becomes much more, both in environmental and economic aspects. It should be understood that the deeper integration of autonomous ships will take some time and requires significant financial resources.

Route	Port of Tubarao -> Hamburg		Changes at "slow steaming"
Distance (nm)	5446		
Speed (kn)	16	11	-31 %
Time (d)	14.2	20.6	45 %
Fuel (t)	624	288.8	-54 %
CO ₂ (t)	1 948	915.5	-54 %

Fig. 1. Calculation of the transition by the “Slow steaming” method and without

Autonomous ships are the inevitable future of the entire maritime transport industry and their development, and promotion needs and needs to be given more attention today. The integration of autonomous ships is a long-term project, and the problem of the irrational use of energy resources must be solved today.

According to the authors, one of the main reasons for the inefficient use of energy resources in shipping is the ineffective feedback between the participants in the process of sea transportation. Due to the use of irrelevant, incorrect information or due to its complete absence, inefficient fuel costs in the field of shipping are increasing every day.

It is necessary to create a work program, the content of which will be the information provided by all participants in the sea transportation. The conceptual scheme proposed by the authors should be the basis of the work program. Each of the participants in the process, namely the ship, port and charter must provide actual and relevant information concerning the scope of their activities. For example, a ship should provide timely and realistic information about its arrival time, weather conditions, location and so on. Charter should provide full and timely information about

the upcoming voyage, the required time of arrival at the next port, the amount of cargo, etc. Port services need to promptly and realistically indicate the prospects for mooring to the berth, the estimated time of the end of cargo operations and the departure of the ship. All this information should be regularly updated and stored in a single database that all process participants should have access to. Based on this information, it will be possible to improve the efficiency and quality of the shipping process and reduce the waste of fuel, as well as reduce emissions of harmful substances into the atmosphere.

4. Discussion of results

Based on the analysis, it should be noted that the “Slow Steaming” concept may have a positive effect on reducing energy costs and reducing emissions of harmful substances from ships into the atmosphere, but is not always applicable in real conditions of sea freight. Given the recent developments, it can be expected that the bulk carrier should become one of the first autonomous ships. The specificity of these ships involves the transportation of one type of cargo from one port of loading to one port of discharge. This is an important factor in the initial stages of introducing automation into the industry. By applying the “Slow Steaming” approach to autonomous ships, maximum efficiency can be achieved. EEDI is an effective tool to reduce emissions [10], but given the trend of the market of modern maritime transport can be noted an increase in the average speed of ships, which reduces its effectiveness. Although the newly built ships have more environmentally friendly power plants, but taking into account the above factors, it may not always have the expected effect.

The MRV system has a fairly good potential [11], but its full implementation and application in Europe is expected only by 2020 (Fig. 2) and there are no prerequisites for its global integration and use.

To improve the EEOI performance, and in particular, to reduce wasteful fuel consumption and reduce emissions of harmful substances into the atmosphere, the authors propose a conceptual feedback scheme. It should be the basis of the work program, which will contribute to reducing energy costs through more timely exchange of real information between the participants in the process of sea transportation. To begin with, this scheme should pass the test at a smaller cargo terminal with smaller cargo traffic and demonstrate its attractiveness not only for the ship and the charter, but also for the port itself.

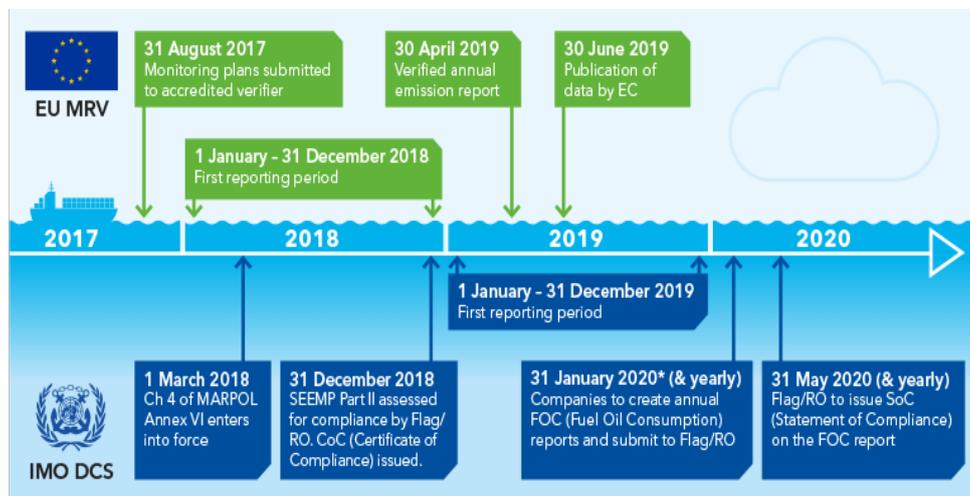


Fig. 2. Plan to put the MRV system into action

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