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Economic policies to reduce CO_2 emissions in maritime transport

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Abstract. The international shipping industry contributes with 2.7% to the global emissions of CO_2. In light of the projected growth of world trade by 2050 and the demand for maritime transport, it is necessary to identify and implement additional measures compared to the existing measures to reduce CO_2 emissions. A category of measures with the potential for implementation is Market-Based Mechanisms (MBM). The paper presented a synthesis of the types of market-based mechanisms proposed to be implemented in maritime transport. Also, in the situation of implementing the market mechanism based on the introduction of the tax depending on the quantity of CO_2 emitted by the ship, there is presented a calculation program for determining the amount of CO_2 emitted during a voyage.

Keywords: shipping, CO2 emissions, environmental policy, Market-Based Mechanisms

1. Introduction:

Currently, international shipping contributed with 2.7% of the global emissions of CO_2 and this contribution is expected to increase in the future as a result of the projected growth in world trade by 2050 and demand for shipping [1].

The current policies in the GHG emission reduction transport sector (EEDI, SEEMP) have a modest impact in relation to the increasingly restrictive global emission reduction requirements.

Therefore, it is necessary to identify and implement more efficient policies both at the operational level (speed limitation, fuel standards), but also at the economic level, by introducing market-based mechanisms [2].

Since 2010, IMO within the MEPC 60 committee has been debating and analysing the identification of a package of economic measures called market based measures (MBM). [3]

The main purpose of these measures is to economically support the maritime industry in implementing efficient GHG emission reduction technologies on board. Also, the funds obtained by implementing these measures could also be used to adapt and transfer technology in the maritime sector.

Currently, a package of market-based measures to reduce GHG emissions is not implemented at the IMO level, which remains at the discretion of each country or region. Thus, starting in 2010, the U.E. has legislated that maritime transport will be introduced in the European Union Emissions Trading System (EU-ETS) until 2023 if IMO does not implement policies to that effect [4].

2. Potential market-based mechanisms

At the IMO level, there are debates on the MBM proposals coming from the states regarding the advantages and disadvantages of these proposals. The MEC 63/2012 agreed on the need to carry out an impact assessment of the MBM proposals. The proposed MBM studies should address the following criteria [5]:

- Efficiency from an environmental point of view;
- Profitability and potential impact on trade and sustainable development;
- The potential to provide incentives for technological change and innovation;
- The practical feasibility of the MBM implementation;
- The need for technology transfer and capacity building in developing countries.

The proposed economic policy options can be divided into three broad categories:

a. Emissions price controls;
b. Emissions quality controls:
c. Subsidies.

a. Emissions price controls

There are several approaches to introduce this category of taxes, namely:

- the fee to be paid for each ton of bunker purchased;

- the fee to be paid to each port based on the amount of fuel consumed by the ship in the journey to this port;

- the fee to be paid to each port based on the amount of CO_2 emitted by the ship during the journey to this port.

- the tax should be paid in proportion to the contribution of international transport to global CO_2 emissions.

b. Emissions quality controls:

A number of proposals to reduce GHG emissions were aimed at acquiring/ trading the amount of emissions through credits/certificates (ship emission units). Thus, ships that do not meet an emission ceiling to be set internationally will purchase credits/emission certificates through different methods: trading program, global emissions trading system (ETS), international GHG emission fund, etc.

Another proposal is to allocate emission quotas at the national level and not through global bidding. These emission allowances may then be traded between countries. [2, 3, 4]

c. Subsidies:

Subsidies can be granted to provide financial support directly to industry sectors, either from the government or in the case of shipping, from the maritime authorities. The grant mechanisms may be: low-interest loans, favourable tax treatment, auction systems and other financial assistance for CO_2 emission reduction technologies.

So far, no proposals have been approved at the IMO level, as each category of proposals has certain disadvantages.

A summary analysis of the advantages and disadvantages of these categories of economic policies is presented in table 1. [2]

3. Ship CO_2 emissions determination during a voyage

In the situation of Market-Based Mechanisms obligation for ships that do not meet the requirements of energy efficiency, it is necessary to identify the amount of CO_2 emitted by them. To support the determination of the amount of CO_2 emissions during the course of a voyage, a calculation program has been developed that can be used when the data on the ship, travel, type, and power of the on-board engines are known.

Table 1: The analysis of different shipping decarbonisation policy options

MBM category	Advantages	Disadvantages
Emissions price controls	• Economic efficiency • Environmental efficiency	• Carbon leakage; • Cap on development; • Displacement to air or road
Emissions quality controls	• Flexibility • Economic efficiency	• Transaction costs; • Burden of additional costs on developing Countries
Subsidies	• Can be targeted	• Requires careful implementation and oversight • Need for revision when conditions change

By using the calculation program, the amount of CO_2 emitted by the ship is obtained during the actual voyage, during the execution of the entry and exit manoeuvres from the port, as well as during the stationing on the radar.

The required input data and the obtained results are identified using the program interface shown in figure 1.

Type of ship	Cargo			
Age of ship	Before of 1983			
Ship speed	15			
Type of propulsion engine	Slow speed engine			
Number of propulsion engines	1			
Power propulsion engine [kW]	4500			
Type of fuel propulsion engine	IFO 180			
Type of auxiliary engine	medium speed engine			
Number of auxiliary engines	3			
Power auxiliary engine [kW]	287			
Type of fuel auxiliary engine	MGO			
Days of ship travel	20			
Days of maneuvering out	0.5			
Days of entry maneuver	0.5			
Days of stay	4			
RESULT	Amount of CO_2 (t)	CO_2 (t) maneuver	CO_2 (t) in stationary waiting	CO_2 (t) voyage
Cargo	1,165.590	19,471	12,283	1197,34

Figure 1: Computer program interface

In the calculation program, for the determination of the of the CO_2 mass flow rate emitted by the ship, the formula [6] was used:

$$M_{CO2\,ship} = 3{,}666 \cdot c_i \cdot \sum_{ikm} FOC_{ikm} \cdot p_{ikm} \cdot t_{km} + 3{,}666 \cdot c_j \cdot \sum_{jkm} FOC_{jkm} \cdot p_{jkm} \cdot t_{km}$$ [CO_2 tons/ underway]

where

$FOC_{ikm} = SFOC_i \cdot P_i \cdot 24 \cdot 10^{-6}$ [fuel tones / day] - hourly consumption of propulsion engines;

$FOC_{jkm} = SFOC_j \cdot P_j \cdot 24 \cdot 10^{-6}$ [fuel tones / day] - hourly consumption of auxiliary engines;

P_i – propulsion engine power [kW];

P_j – auxiliary motor power [kW]; [kW];

c_i – Carbon concentration of the propulsion engine fuel supplying [%];

c_j – Carbon concentration of the auxiliary engine fuel supplying [%];

p_{ikm} – the fraction of the maximum fuel consumption of the propulsion engine in the "m" underway mode [%];
p_{jkm} – the fraction of the maximum fuel consumption of the auxiliary engine in the "m" underway mode [%];
t_{km} – the time taken by the ship for the "m" underway mode [days].

The necessary data on the specific consumption of the engines, the average speeds of the ship, the loading factors for the auxiliary engines, by types of ships and speeds were entered in the calculation program on a statistical basis. [6]

4. Conclusions:

Due to the absence of effective methods of reducing CO2 emissions from ships, it is necessary to add to these methods and economic policies based on the market mechanisms.

Regardless of which MBM will be chosen, it is important that it be implemented worldwide and its implementation must be done by the IMO, which must also be the initiator of these policies.

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