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Examination of IMO's Regulations Regarding Combusted Sulphur and Its Effects on Shipping Lines

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ABSTRACT

Of the topics which have recently been taken into consideration are the environmental contamination and its fatal effects on earth. A considerable percentage of pollutant gases are made by the ships' diesel motors, so their manufacturers in adapting them have been impelled to take some implementations for decreasing these compositions. International maritime organization (IMO) has also put a serious stress on this matter. Sulphur is one of these greenhouse gases. More than 80 percent of SO diffusion rests on the fuels' combustion. The environmental regulations have strictly focused on minimizing these pollutants. This paper is aimed at examining Sulphur ingredients and its fatal effects, desulphurizing methods, IMO's related regulations, their effects on the ships and the ways of improving them. Some solutions have also been rendered to decrease the usage of Sulphur.

KEYWORDS: *Environmental Contamination, IMO's Regulations, Desulphurization, Combusted Sulphur*

1.0 INTRODUCTION

Researches demonstrate that marine transportation is one of the cleanest, safest and the most economical methods of transportation. Nonetheless the rate of combusted Sulphur in the sizeable oceangoing ships' fuel is 2000 times greater than that of trucks and motor cars [1]. The ships are one of the sources of the fatal environmental effects and by diffusing and leaking contaminant gases derived from combustion of fossiliferous fuels lead to the air contamination. The increasing consumption of fossiliferous fuels through diffusing a wide range of spherical contaminants such as CO_2, Sulphur and Nitrogen oxides and their environmental sub effects like producing greenhouse gases, earth warm up, acidic rainfall and creating a wide range of the environmental contaminants, have actuated the reactions of the worldwide nations. Since 1979, Canada, the U.S. and European nations have signed many agreements to decrease and control the Sulphur diffusion. These agreements are mostly aimed at transportation fuels because they are one of the most focal sources of the Sulphur diffusion [2]. IMO is one of the UN's agencies which are known as the regulatory institution of the activities related to marine transportation.

Earlier than 2008 there were no inclusive regulations to control diffusion of the ships' contaminants but in the same year IMO by reconsidering its regulations and to decrease diffusion of Nitrogen and Sulphur oxides tied the ships to control their own contaminants. The upcoming segments are set succinctly to examine the generality of these regulations and their effects.

2.0 CONTAMINATIONS MADE BY FOSSILIFEROUS FUELS

Today, the major divisions of the air contamination are made by combustion of fossiliferous fuels. The main contaminants are directly entered in the air through the motors' exhausts. Some of them as CO, Hydrocarbons and Carbon black are results of incomplete combustion, some others like Nitrogen oxides are created by unwanted secondary reactions and yet other ones such as Sulphur oxides are made by reaction of impurities existing in fossiliferous fuels. Fig. 1 is the indicator of these contaminants, their effects and importance. As it can be seen in this figure some of them consist of destructive ingredients and some others are involved in many processes [2].

Sun, Earth warm up, Ozone cut back, acidic rainfall, Smoke bulk, sight decrement, Suspended ingredients, the bulk of exhaust gases, combustion cavity.

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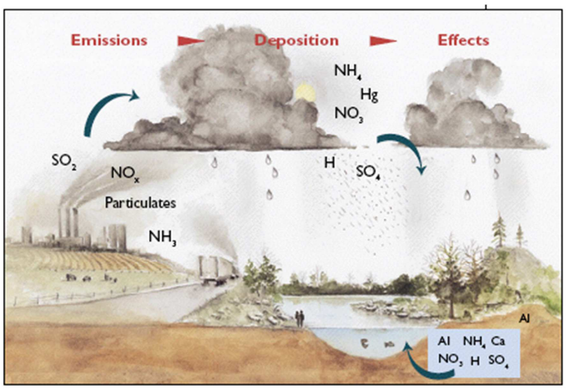

Figure.1: Diffusion of contaminants by IN-Combustion motors [2]

3.0 SULPHUR OXIDES AND DESULPHURIZATION

Recent studies have estimated the rate of diffusion of Sulphur oxides by oceangoing ships around 5 to 8 percent. Since the beginning of January 2015, the rate of Sulphur in the regions such as the North America, Baltic and North seas and Mansh channel which world widely control the level of Sulphur is to be decreased to 0.1 percent. For other places in the world, it amounts to 0.5 percent [3]. Generally saying for Sulphurized mineral compositions no any inclusive classification of desulphurization has yet been offered.

- The first classification is based on the changes of Sulphur compositions throughout the process of desulphurization.
- The second classification is carried on the basis of Hydrogen's role in the process of desulphurization and this latter one is divided to two Hydro-desulphurization and non-hydro-desulphurization groups [4].
- The third classification based on physical and chemical features of the process is aimed at deletion of Sulphur compositions. Fig. 2 renders a schematic of this classification and some of the commonest methods of each group.

Most of desulphurization processes lead to formulation of products such as petrol, diesel and non-transportation fuels which constitute 75-80 percent of the sum production of a refinery. Decrement of Sulphur level in fuels is able of reducing destructive diffusion in three methods:

1. Direct decrement of Sulphur oxide and Sulphur ingredients
2. Through more efficient performance of diffusion control systems specially catalysts
3. Implementing modern techniques for reducing diffusion such as diesel ingredients filters, NOx absorbents and Sulphur decrement systems.

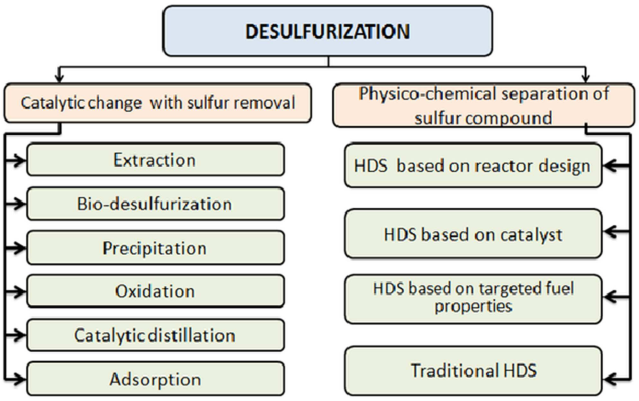

Figure.2: Classification of desulphurization processes based on physical and chemical features of the process [4]

Desulphurization, catalyst is process associated with Sulphur deletion, physical or chemical segregation of Sulphur compositions defined as follows:

- HDS Process, HDS process by the advanced catalysts,
- HDS Process with designation of the advanced reactors,
- HDS Process associated with the improvement of fuels' features
- Catalytic distillation process,
- Alkylation process,
- Extraction process,
- Oxidation process,
- Adsorption process,
- and Residual segregation process

At present the current fuel of the commercial ships are mainly HFO or MFO. The minor ships which are equipped to four term diesel motors associated with moderate velocity make use of marine diesel oil or gasoline fuels Fig. 3 shows distribution of the marine fuels consumption. MFO is the largest consumption in the marine diesel engines.

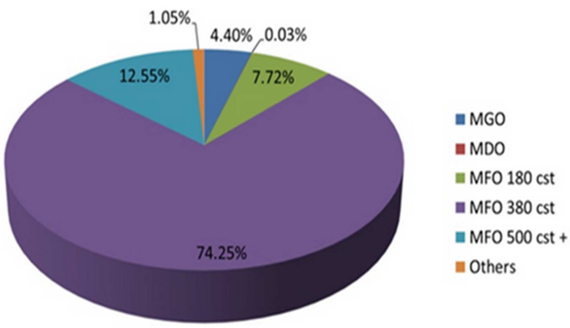

Figure.3: Distribution of marine fuels consumption [10]

All marine motors are designed to have maximum performance and this fact leads to production of contaminant gases such as CO_2, SO_2, Black Carbon and other types of contaminants in a lesser amount. Shipping industry at present experiences a transitory period of ratifying regulations related to contaminant

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gases and the worries which affect not only the owners but also fuel distributors, marine industry companies and refineries [5].

4.0 IMO AND CONTAMINATION DIFFUSION CONTROLLING REGULATIONS

Of the sum of greenhouse gases, 2.7 to 3.3 percent is produced by marine transportation. This section examines the future and existing regulations related to decrement of these gases. The future and existing related proceedings have also been considered. Application of other types of fuel and newcomer run and the ships' body systems technologies are among these proceedings [2]. IMO is an organization which internationally ordains and pursuit's inclusive regulations and frameworks for the ships and marine fleet. In 1973 and in order to prevent the contamination created by the ships, this organization ratified 'Marpel'73/78 convention. Aimed at minimizing marine contamination, this convention is one of the most important international marine ecology conventions. First announced in 1997 Marpol's sixth amendment restricted diffusion of the ships' main contaminants specially Nitrogen and Sulphur oxides and prohibited the intentional diffusion of the ingredients which lead the Ozone's cut back. This amendment was enforceable since 2005 and based on that the ships made in 2000 and onward, in the case of installing new 130 kw and higher diesel motors, were tied to apply the motors with the standard certification 'Tir 1.' After 3 years of sequential examination, Marine Ecology Protection Committee (belongs to IMO) in 2008 through its fifty eighth session ratified the sixth reconsidered version of Marpol convention which was enforceable since June 2010 [7]. Whether regulations related to decrement of greenhouse gases should be considered as a legal obligatory document or a merely advisory and non-obligatory one was subject to a vast body of extended challenges in this session. Based on the ratified regulation in this convention and protocol, governments facing with greenhouse gases are subjected to the common and yet distinctive liabilities. Therefore the names of developed countries which have the most portions in this contamination are mentioned in the second amendment. On the other side developed countries leading by the U.S., Germany, Britain and Sweden, arguing that unequal execution of regulations toward the ships regardless of their flags will leave unmet the expectations of the plan of greenhouse gases decrement, were after equal execution of regulations toward all ships because more than 3/4 of international ships were under ownership of developing countries. Eventually this matter led to definition of diffusion control regions and determination of separate borders to these and other international regions [3]. This amendment defines some restrictions to the ships' exhaust gases including NOX, SO2, unstable mineral compositions and other wastages which lead to Ozone cut back.

Here, a comparison of the different ship types is presented in Fig. 4. The blue bar shows the percentage of ships in each type. The black, yellow and green bars show the relative emissions of NOx, SOx and CO2, respectively. The columns describing the SOx and CO2 emissions are not in all cases equal. This is caused by the fact that some ships voluntarily use fuel, which contains less sulphur than what is dictated by the SECA regulations. According to the existing SECA rules, the maximum value for fuel sulphur content is 1.5 percent on a mass basis [5].

While RoRo/Passenger ships (RoPax) represent less than 5% of all ships, their emission was over 25% of the total NOx, SOx and CO_2 in 2007. Emissions of container ships (8%) are larger than their share of total number of ships (4%). Container ships and RoRo cargo/RoPax ships usually have large engines, and work to a tight schedule. Pushing engines to their limits rapidly increases the fuel consumption and exhaust emissions.

Additionally, based on IMO's ratifications (MEPC in 2008, Oct.) the ships have to control the air contamination on the basis of the following three temporal ranges and adapt themselves to the related mentioned regulations [8].

Region or regulation/ Sulphur rate general state European ports amongst others the following factors are remarkable in prompting the ships' owners for making use of new and clean fuels: ecological changes and diffusion decrement of greenhouse gases, new strict regulations in confronting watery contamination, application of low Sulphur fuels in gas diffusion protected regions and their accessibility, price changes of fossiliferous fuels and lastly marine motors' energy consumption productivity index. Table 1 presents Sulphur emission in EU and ECA. It is predicted to diminish the emission of the Suphuor in 2025 in less than 0.1% in the ECA and 0.5% in EU.

Table 1: Sulphur emission in the EU, ECA and Global

Year	ECA	EU	Global
Prior to 2010	1.5%	4.5%	4.5%
2010	1.0%		
2012		3.5%	3.5%
2015			
2020	0.1%	0.5%	0.5%
2025			Potential Postponed

Replacement of the ships' heavy fuels like crude oil with clear ones is a reliable solution. Needless to refine the exhaust gases driven by combustion, DME and Methanol are among the fuels that adapt the ships to the new regulations of gas diffusion protected regions.

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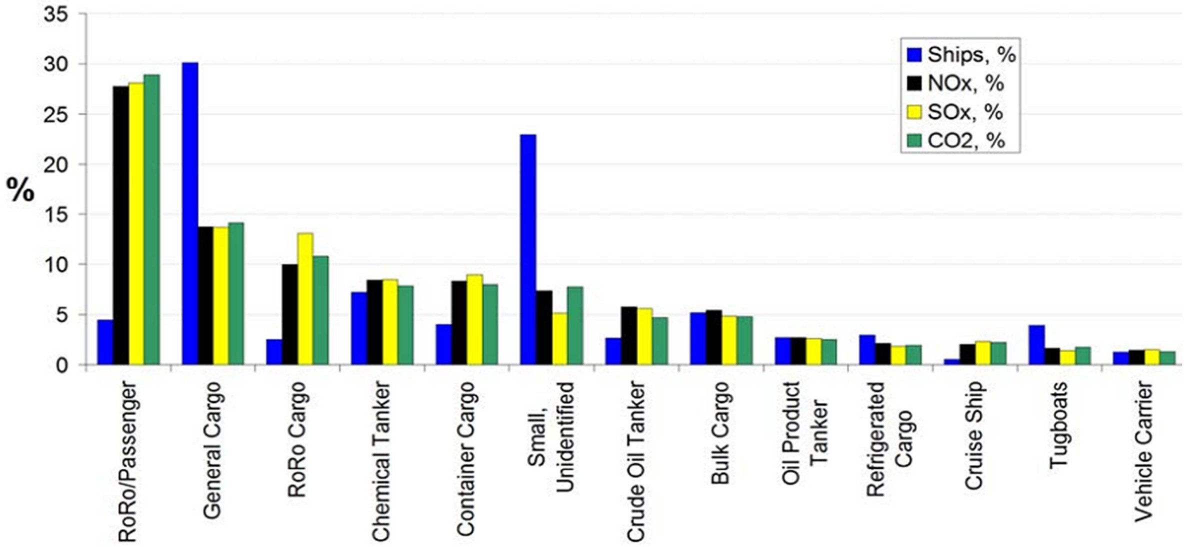

Figure.4: Relative proportions of ship types and their emissions. Only ship types responsible for over 1% of NOx emissions are shown. These 13 types are responsible for >96 % of the total NOx generated by Baltic Sea shipping during 2007. The blue bar shows the proportion of ships in each category, black, yellow and green bars the proportion of NOx, SOx and CO2 produced by each of the ship types [5].

In the near future these fuels will have the capability of being used as green fuels. Natural gas and Propane as gas fuels can also be used in shipping industries. Although Propane has been introduced as the main candidate and reliable replacement of marine fuels, but world widely it seems that this gas is a valuable product which has a higher price than other replaceable fuels. Today, liquid natural gas has been hold forth as a reliable fuel in shipping industries. Nonetheless its low freezing point requires taking some safety points such as duplex pipes and installation of detection and alarm systems in powerhouse [4]. However in recent years a great deal of endeavors has been done to designate an international inclusive plan which their reconsideration under the effect of the sixth amendment of Marpel convention has led to a more serious and stricter form. So in order to decrease diffusion of contaminants, manufacturers of these motors and generators have intended to apply new technologies.

5.0 MODERN TECHNOLOGIES AND SOLUTIONS AND DECREMENT OF FUEL CONSUMPTION

Using liquid gas, dual consumption motors and implementing changes on the ships' construct are overall aimed at lowering the ships' operational costs and manufacturing the ships that are more adaptable to the environment. In this segment common techniques and new technologies of shipping industry are under consideration [9].

Silver Stream Tech (SST) Company installed an air flux system named Silver Stream on the ships of a Norwegian shipping line. It was the first implementation of this system in an industrial scale and was aimed at increasing the ships' operational productivity, decrement of spherical contaminants, lowering the ships' fuel fees and at the same time improving their efficiency in contesting with other rivalries. By producing micro bubbles and creating an airflow strand under the ships' body, produced systems of this company lead to decrease hulk remittances, lowering fuel consumption and eventually reducing diffusion and production of spherical contaminants and improvement of the ships' operational productivity. This SST can be integrated into the new ship manufacturing plans and is applicable to the older ships [10].

6.0 INSERTION OF AN ADDITIONAL PART TO THE PROPELLER FOR DECREASING ENERGY CONSUMPTION

To decrease fuel consumption in the ships, Hyundai Company made use of an instrument named High Fin. Inserted to the roundish end of propeller, this part unlike the propeller's whirling motions creates some rotational circuits which results in improving the performance of propeller, the propellant system and decrement of fuel consumption. This technology is applicable to liquid gas ships and other ones such as super tankers and container ships.

7.0 HYBRID TECHNOLOGY

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Through implementing varied energy sources and inductors (battery), this system leads the initial propellant system to work in its ideal state. Key feature here is reducing the motors' transitional power which leads to fuel consumption decrement and eventually contaminants diffusion decrement. This system is connected to a converter unit and at the same time to a common system of energy management system. In addition to power increment, this system makes the possibility for the motor to be designed in the optimal state and to have the highest productivity and least rate of contaminants diffusion. Low costs of reparation, maintenance and high productivity of this system derived from inductors' fast reaction are among the merits of the system.

8.0 CHANGES IN THE SHIPS' CUTWATER DESIGNATION

Implementing changes in the shape and designation of the ships' cutwater is one of the efficient methods in reducing fuel consumption. Performing these changes during Dry Dock reparations, field calculations showed a fuel decrement for the ships around 1000 tons per year.

9.0 FUEL EMULSION TECHNOLOGY

Through adding fuel supplements, this method leads to more efficient combustion and decrement of fuel consumption in comparison with the fuels which are avoided of these supplements. Diffusion of spherical contaminants will be decreased and owning to lower combustion point, the ship's motor works in a lower temperature which results in lower costs of reparation and maintenance. This technique besides than decrement of fuel consumption and contaminant production offers a considerable financial saving to the owners.

10.0 WIND AND SOLAR ENERGY

Wind energy seems to be the most reliable helpmate energy in running the ships. Numerous studies have been carried about the optimal usage of the wind energy. Marine examinations on the propellant system driven merely by a mini generator showed 2.5 percent energy saving. Helpmate sails is another applicable technology. In this system two 35 mts elevated sails are installed on the deck and each of them is connected to 3 aerodynamic baleens. These sails are able of automatic rotating in the case of changes in the wind's velocity and direction and leads to the optimal utilization.

Through producing more energy, this technology causes the motor to work with lower rev and pressure. Despite the ship's proper speed, a considerable rate of fuel saving is occurred. Similar to wind energy, solar energy can also be considered as one of the auxiliary or helpmate energies [11].

11.0 CONCLUSIONS

In addition to the mentioned cases, researches have also carried about anti-duckweed colors and economical marine motors. Here the most deployed methods in marine industry are discussed. The most portion of Sulphur existing in fossiliferous fuels can easily be decomposed. Unremitting and ceaseless international endeavors to decrease Sulphur level are because of the need to more clear combustive fuels. Today, as the industries are pushed forward by technology, to have a more efficient and environment adapted shipping line it is hoped that correspondent energy saving methods be also designated. Generality of IMO's regulations related to the fuels' Sulphur and its effects were discussed in this paper. Additionally, regarding new regulations an increasing demand for low Sulphur fuels will occurred and it is expected that implemented changes in reconsidered amendment to have tangible and positive effects on the environment and human health specially those who reside in ports and coastal regions.

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