

Modern Concepts of 'GREEN SHIPS'

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Abstract

Recently, pollution has become one of our major concerns; the whole world is suffering from the consequences of the irresponsible polluting actions. Therefore, all institutes and individuals should take steps in the journey of a less-polluted planet.

All industries, countries and individuals are responsible for the current high rates of pollution, according to S. Seddieka and M. Elgoharya (2014), maritime industry is responsible for 2.7% of the global CO₂, 15% of all global NO_x emissions and 4-9% of global SO₂ emissions.

Therefore, IMO and other stakeholders are doing researches to contribute in decreasing the harmful impact marine vessels have on the environment.

This is done by working on enhancing the machine used in this industry. There are several technologies that can be applied on ships to make them more eco-friendly. Those technologies are divided into three categories: using renewable energy sources, reducing fuel consumption and reducing emissions. This paper discusses the procedures that recently been taken in terms of fuel efficiency and gas emission reduction to minimize the impact of marine pollution from ships through modern concept of "Green Ship".

1. Introduction

Shipping is one of the fast growing sources of air pollution causing health problem, acid rain and eutrophication. In 2000, rate of Sulphur dioxide (SO₂) emissions from international shipping in the seas surrounding Europe were estimated at 2.3 million tons a year, Nitrogen dioxide (NO_x) ones at 3.3 million tones. These emissions are expected to grow by 40 to 50% by 2020.

It is important to pay more attention to ship emissions to control this continuous growing. If things are left as they are, by 2020 shipping will be the biggest single emitter of air pollution. (**Transport & Environment, 2017**)

This paper discusses the environmental impacts of pollution from maritime industry. It also highlights the measures that can be taken to reduce SO_x and NO_x emissions from ships.

2. Eco-Friendly Technologies

Recently, many institutes have been concerned with the high pollution rates, including our university, which made us think more about this issue. We discovered that maritime industry is responsible for 2.7% of the global CO₂, 15% of all global NO_x emissions and 4-9% of global SO₂ emissions. These percentages were surprising but optimistic. It was surprising to discover that one industry can make that great contribution in global pollution and optimistic because that is our field of study, so doing some researches and exerting some effort can decrease them which means decreasing the global pollution rates, also maritime industry is one of the industries that are under good control, therefore; it will not be so difficult to apply some technologies to marine vessels that can help in reducing emissions and pollution and increase fuel efficiency, here we present some of these technologies.

2.1. Exhaust Gas Recirculation

One of the most recent important technologies is the Exhaust gas recirculation (EGR); it is a nitrogen oxide (NO_x) emissions reduction technique used in petrol/gasoline and diesel engines. EGR works by this technology mainly depends on reusing part of the exhaust gas by recirculating it back to the inlet manifold where it is blinded with fresh air. That means that there would be less amount of oxygen which is replaced by carbon dioxide, carbon dioxide has higher heat capacity than oxygen which will reduce the peak temperature inside the combustion chamber. Another advantage is that as the amount of oxygen is reduced that means reducing the speed of the combustion, that also will reduce the peak temperature. Reducing the peak temperature reduces the formation of NO_x. A valve is usually used to control the flow of gas, and the valve may be closed completely if required. (**Figure No. 1**).

The substitution of burnt gas (which takes no further part in combustion) for oxygen rich air reduces the proportion of the cylinder contents available for combustion. This causes a correspondingly lower heat release and peak cylinder temperature, and reduces the formation of NO_x. The presence of an inert gas in the cylinder further limits the peak temperature (more than throttling alone in a spark ignition engine)

The gas to be recirculated may also be passed through an EGR cooler, which is usually of the air/water type. This reduces the temperature of the gas, which reduces the cylinder charge temperature when EGR is employed. This has two benefits- the reduction of charge temperature results in lower peak temperature, and the greater density of cooled EGR gas allows a higher proportion of EGR to be used. On a diesel engine the recirculated fraction may be as high as 50% under some operating conditions. (Cambustion, 2017)

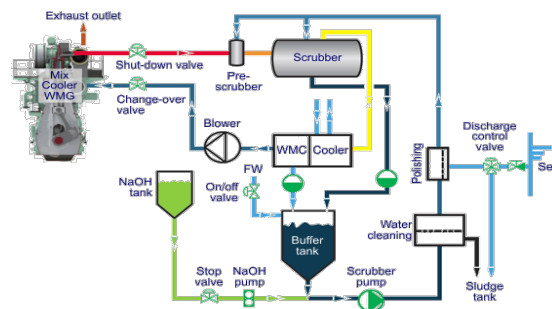


Figure No 1

EGR system for a low-speed two-stroke marine application

Source: MAN Diesel & Turbo (Jääskeläinen, 2012)

2.2.Hull Paint

Hull condition for merchant ship is a key factor in deciding the fuel efficiency of the ship. The application of protective coating of anti-fouling paints results in a smooth hull devoid of any marine fouling, which decreases the frictional resistance caused by the water flow. The anti-fouling paints (Anti fouling is the process of removing or preventing the accumulation of marine organisms from the surface of hull and the paint used for this application is called anti fouling paint) decrease the load on the engine and increase fuel efficiency.

With time, marine fouling and sea condition roughens the hull surface of the ship. As the frictional resistance caused by the water flow over the hull increases, the engine has to consume more fuel to overcome this resistance which adds on to the normal fuel consumption of the ship so applying correct paint at correct hull area can reduce the frictional resistance of the ship resulting in 3-8% of fuel savings. (Chopra, 2017)

2.3.Improved Pump and Cooling System

An optimized cooling water system of pipes, coolers and pumps can result in decreased resistance to the flow. This will lead to savings of up to 20% of electric power of the ship and fuel consumption up to 1.5 %.

2.4. Sandwich Plate System

Sandwich plate system is a process of compositing two metals plates by bonding it with polyurethane elastomeric core. This avoids usage of steel which requires additional stiffening hence makes the structure light weight and less prone to corrosion. This technology can definitely play a good role in green ship recycling process as SPS feature includes superior in service performance and reduced through life maintenance.

2.5. Sulphur Scrubber System

A scrubber system is one such technology which is used on ships to reduce the pollutants from the ship's emissions. The system operates in an open loop utilizing seawater to remove SO_x from the exhaust. Exhaust gas enters the scrubber and is sprayed with seawater in three different stages. The sulphur oxide in the exhaust reacts with water and forms sulphuric acid. Chemicals are not required since the natural alkalinity of seawater neutralizes the acid. Wash water from the scrubber is treated and monitored at the inlet and outlet to ensure that it conforms with the MEPC 184(59) discharge criteria. It can then be discharged into the sea with no risk of harm to the environment. Figure No 2

(Kaushik, 2017)

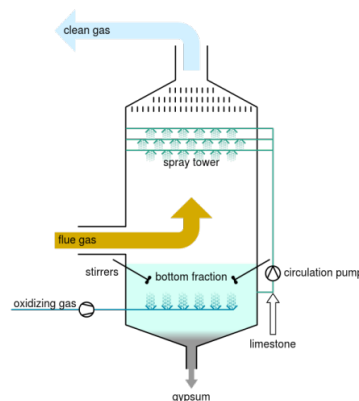


Figure No. 2

Sulphur Scrubber System

Source: Wikiwand "Flue-gas desulfurization"

2.6. Liquefied Natural Gas

The use of Liquefied natural gas as Fuel: More attention has been paid to the use of liquefied natural gas as fuel for ships in Europe, Asia and the United States. There are three factors that can make the use of LNG as fuel one of the most effective technologies to reduce pollution.

- Sulphur oxide emissions (SO_x) can be reduced by 90 - 95% by using liquefied natural gas as fuel.
- Another point is the cost of LNG; LNG is much less expensive than marine gas oil. Even while being not widely common, the LNG prices compared to heavy fuel oil concerning the energy content is reasonable.

- A 20-25% reduction in carbon dioxide emissions (CO₂) due to the low carbon content of the liquefied natural gas; however; any slip in the methane while using it may waste that advantage. (Man Group)

2.7. DynaRigs

Recently, due to the stringent regulations and the increasing costs of fuel, companies and organizations are exerting more efforts to find alternatives for traditional fuel. In this system of propulsion, sails are used to provide the cargo ship with a considerable amount of energy needed for propulsion. This system is still under research for quite some time now but some researchers have shown that it can provide cargo ships with 60% of the amount of power needed. That means that there would be about 60% reduction in the amount of fuel used. (RINA, 2017)

2.8. Sail-Kite System

This system consists of a kite, a towing rope and a control system to steer the kite, a telescopic mast is used to launch and recover the kite. It depends on using the wind energy to provide the ship with the needed amount of power. The kite flies at an altitude of 100-500 meters, it flies in a shape of number 8 producing a towing force of 325 kilo Newton, which reduces the amount of fuel used and the CO₂ emissions by 10-35%. 90% of the world trade takes place by sea, so shipping contributes with 3% of the world CO₂ emissions, therefore; applying the sail kite technology can have a great effect on cutting down the CO₂ emissions. Figure No 3 (Watt Now, 2012)

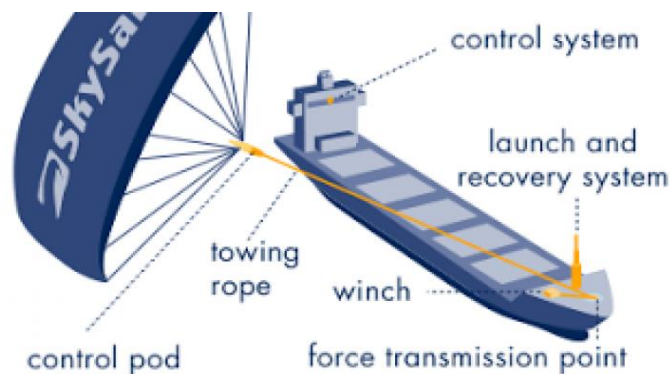


Figure No 3

Sail-Kite System

Source: Next big future

2.9. Solar Cell Propulsion

Solar panels are used as sails along with their primary use, so it uses both solar and wind energy. Solar panels alone are unable to provide the ship with the required amount of power; therefore, it is used as an alternative for onboard electrical systems. It can be also used with other renewable energy sources, such as wind energy where solar panels can be used as sails that use the wind energy to provide the ship with adequate propulsion.

2.10. Water in Fuel

Making low-emission diesel engine has been recently more required due to the strict regulations and the increasing use of diesel engines. The NO_x and particular matters are the diesel engines only problems that have not been solved yet. The formation of NO_x and PM highly depends on temperature inside the combustion chamber and trying to reduce one of them will increase the other one.

NO_x and PM can be reduced by injecting water into combustion chamber. NO_x emissions can be reduced by decreasing the combustion products temperature that can take place due to liquid water vaporization. However, the PM emissions can be reduced by adding water while formation of soot or amorphous carbon since the high concentration of oxidation components as OH helps the carbon unburnt remains to burn completely.

Theoretical and experimental studies have been done by Nicolas et al; their theoretical studies have mainly depended on the chemical equilibrium calculations. The water has been injected in suction, compression and power processes, theoretical results have matched the experimental ones which indicated a 90% reduction in NO_x.

Injecting water in fuel has several ways; emulsion, fumigation and direct water injection.

The fumigation way depends on injecting the water in a liquid state to the inlet manifold during suction stroke. The emulsion style depends on mixing water with the fuel on surfactants to form emulsion, this emulsion is a fuel alternative. Finally, the system of direct injection of water a dual injection nozzle with an identical water supply system. All these styles of water in fuel technology have a noticeable effect on reduction of NO_x and PM. **(Kantharia, 2017)**

3. Conclusion

There are 10 technologies; all of them aim at reducing pollution caused by marine vessel. Those technologies works on slowing down the increasing pollution rates and this happens by reducing emissions from marine vessels such as; CO₂ emissions, NO_x emissions and SO_x emissions, particular matters and by reducing fuel consumption. DynaRigs technology can save up to 60% of fuel used but it is still under research. Also Sail Kite technology reduces CO₂ emissions by 10-35%. Another technology that has a great impact on the environment through reducing emissions is Water in Fuel, since it reduces the NO_x emissions by 90%. Another technology that would help our environment is using the proper hull paint since it reduces the fuel consumption by 3-8%. Therefore, using some of those technologies on marine vessels can greatly help us cut down the pollution rates and save the environment for the coming generations.

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