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ALTERNATIVE FUEL – PREDICTED ISSUES AND SOLUTIONS

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With changing times, Maritime industry also underwent modifications, and the process is still going on. This paper aims to bring out one such modification which is related to Fuel. The paper will focus on the GHG emissions by the Maritime sector with the current type of fuel i.e. HFO& MGO to run the ships. It will also bring out the possibilities of the types of alternatives which can be used and discuss in detail about their viability and environment-friendliness. The final opinion of the topic along with a scenario of future will be at the concluding part of this writing.

1. INTRODUCTION

We all have heard this famous adage "Without ships and the men manning those ships, half of the world would Freeze, and other half would starve". This clearly states that Maritime sector is the oldest and one of the most indispensable networks of this world. As we have stepped into 21stcentury, a century which is a victim to Global Warming, it is our utmost duty to upgrade our technologies and minimize the emission from our ships. As per the 4th GHG Report by IMO, the greenhouse gas emission from Maritime Industry rose about 10% from 2012 to 2018. The international consortium of research institutes that compiled IMO Report predicted that the emissions would increase up to 50% until 2050. The figures are alarming and Maritime sector will be and is also being presently targeted by International bodies who have adopted Paris Agreement under UNFCCC. IMO is under immense pressure to cut down GHG emissions to come in the bracket of Paris Climate Change Agreement. In January 2020, IMO has enacted regulations to lower the Sulphur content from 3.5% to 0.5%. These regulations require ship operators either to use high-cost low Sulphur HFO or look for alternatives. Hence, there is a dire need to reduce the carbon footprint, keeping in mind the cost effectiveness, availability, reliability and modifications to be done to adopt a different fuel for the ships.

Fig 1: Pollution by ships using HFO/MDO
Source – www.infineon.com

2. Brief Report on Possible Alternatives

A detailed study has been carried out regarding the viable alternatives and information has been compiled. The references for this study have been listed at the end of this paper.

2.1 LNG (Liquefied Natural Gas)

This fuel is produced by lowering the temperature of hydrocarbon to -160^0 Celsius. This liquefies the methane present in natural gas and makes it suitable for its application at atmospheric pressure. This fuel has clear cut advantage over HFO in terms of SO_X, NO_X emissions and particulate matter. The GHG Index of this fuel is also low as compared to the fuel used presently. However, the release of unburned methane could reduce the benefit of LNG as CH_4 has 25-30 times greenhouse effect than CO_2. As per IMO's 4th GHG report, methane emissions drastically increased to 151% over the period studied. The main reason for this was methane slip or unburned methane released through LNG powered ships. The ship makers are continuously devising methods to avoid methane slips and have got a little success in the field. The greatest resistance of LNG being adopted globally is cost of retrofitting and bunkering facilities. Also, ship owners felt that competitive prices in the market may not ensure its smooth sailing.

However, the fuel has gained popularity. The reason being EU announcing Sulphur **c**ap of 0.5% from 3.5% on MFOs and so an incentive to owners who are switching to LNG Powered ships. The Emission Control Areas (ECAs), namely Baltic Sea, North Sea, North American ECA and most of the American and Canadian Coast are also in favor of LNG as a less contaminant vehicle.

Hence, the demand for LNG-fueled ships is rising and below given figure shows the statistics of the same.

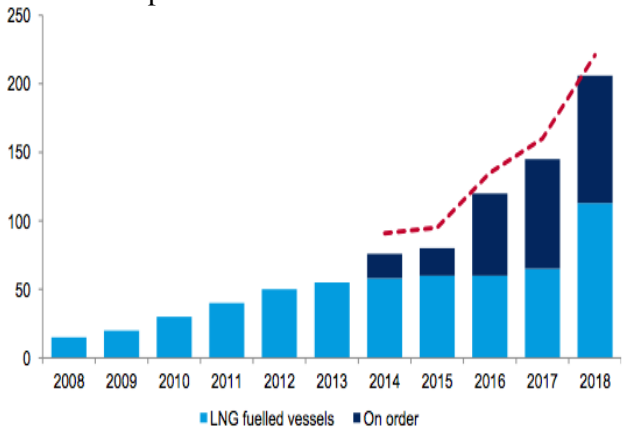

Fig2: Increase in LNG-Fueled Vessels
Source – www.globallnghub.com

2.2 Biofuels

This Fuel is derived from Biomass. Biomass can be used to produce to produce alcohol-based fuels such as Ethanol, Liquefied Biogas (LBG) or Biodiesel etc. This fuel is the most Technological – ready to be used by Shipping Industry as LNG requires costly retro-fitting and low Sulphur HFO is costly. But Biofuels have their issues too. As per the study by Forbes, the demand of biofuels will begin a debate to grow crops for food or fuel production and this will eventually lead to inflation in food prices. High water consumption and excessive use of fertilizers to grow crops will lead to excessive nitrogen as contaminant for environment. It is also estimated that this fuel will not be able to meet supply-demand cycle of this Industry.

However, if Biofuels are made flexible to mix with conventional fossil fuels and can be made to run combustion engines, the carbon footprint as well as cost can come down. The calculations show that Biofuels can only meet 20-30% of Shipping's requirement and hence to ensure that a functioning Bio economy emerges, coordination of entire shipping chain is needed.

2.3 Ship Electrification and Hydrogen

Ship electrification is a fuel which can proudly give us zero emission. This alternative has showed promising results in shorter transits. We can add batteries almost everywhere on ships and they can reap us good benefits. But the issue concerning this is weighted batteries and lack of charging stations for longer transits.

Another opportunity to electrify ships is "Fuel Cells". They utilize liquefied hydrogen as fuel and through electro chemical process, produce electricity till the time fuel i.e. Hydrogen is available. They are better than simple batteries since the longer transits of ships are benefitted. Electric propulsion gives us more maneuverability and more power and efficiency to the engine.

But, on the other hand, there are limitations also. The first is that conventional lithium-ion batteries pose safety at risk as they use electrolytes. If the components degrade, they may heat up the battery leading to severe consequences. If we see Fuel cells, then as we all know, Hydrogen requires much more space, so we need tanks with large quantity. This will reduce the amount of cargo being loaded and eventually it is not beneficial for Ship owners. And costs are expected to rise as hydrogen is not readily available in the atmosphere.

2.4 Nuclear Propulsion

The most controversial alternative but its application cannot be questioned. Most of the people will argue about its misuse and the answer to it is low-enriched nuclear fuel which is not fit to make weapons. This fuel can be used for longer transits as massive amount of energy is generated. But, till date only four merchant cargo ships have been fueled by nuclear drive. The main reason is radiation accident due to which every port is apprehensive of calling them for cargo operations. But this fuel has proved its worth for Ice-breaker ships which refuel after years once they set their sail and engines are immensely powerful to finish their primary task.

Thus, operating this fuel in merchant fleet needs fool proof strategy as accidents such as general cargo ship Mutsu, now RV Mirai in which a lot of resistance was generated due to a possible leak of gamma rays and neutrons, still keeps this fuel distanced from Merchant fleet. But the technology is changing rapidly, and the figure may change after 2030 as Thorium reactors which are safer are being tested and they may bring a revolution in safety practices.

2.5 Renewable energy

The concept for green shipping is now becoming a concern for ship-owners and ship builders. There is always a possibility for application of Wind and Solar Energy as a fuel for ships. In 1970s and 80s, rigid sails on cargo ships proved to reduce fuel consumption. Also, wind turbines on ships can generate electrical power and propel the ships. Still, a lot of advancement related to expensive wind turbines, noise pollution created by them etc. This sum up to technological immaturity for this alternative.

One more discovery was of Application of Magnus Effect to propel the ships. The machinery used is known as ROTOR SAILS.

It is used to propel ship and is mounted with its axis vertical. When the wind blows, the Magnus effect creates a forward thrust, thus driving the vessel forward.

Fig 3 ROTOR Sails installed on Maersk Pelican (8.2% fuel savings were accounted)
Source- Google images for Maersk Pelican

Solar Energy has reduced fuel consumptions on ferries and small boats. But on merchant ships, the fuel saved through solar energy is very less and hence, it is not commercially viable to use solar power.

The hybrid engines which have both alternatives and also some fuel can be viable. In case of ROTOR sails, the engine can be throttled back when there is adequate wind speed and so fuel is saved.

3.6 Liquid and Gaseous Fuels

There are some fuels on which vessel cannot solely rely on but if hybridization capability is achieved, they are significant too. The fuels like LPG and DME can be used if initial ignition processes are carried out by primary fuel and then in the open ocean, they can play a role. LPG has a vast network, so refueling is not a tedious task, but it lowers the efficiency of engine. But work needs to be done to explore DME as a fuel due to its lower viscosity, combustion enthalpy and modulus of elasticity which leads to longer injection period, leakage in fuel pipes and greater compression pump respectively.

3. The Future Scenario

The alternative fuel is the need of hour and so we all should keep on striving until we achieve our aim i.e. to cut down GHG emissions and maintain efficiency as well as safety simultaneously. With regard to the alternatives listed above, I feel each of them have its pros and cons.

In today's times, LNG looks as the most viable replacement of HFO only if the problem of methane slip is resolved by making engines more environment efficient as CH_4 emissions are far more dangerous than CO_2. Nuclear propulsion is very far from being adopted and will continue to work for some icebreaker ships. The acceptance of Biofuels will be subject to their production and availability in coming years. Ship electrification will continue to be utilized for shorter voyages and Fuel cells (Hydrogen) requires more study. Renewable Energy, particularly wind and solar energy look as a more secure potential source which will be highlighted soon.

The crux of all these is Hybrid Engines. Even if Renewable energy comes into play, the ships will need a reserve of HFO and cannot fully depend on the ROTOR sails and same is the case with other alternative fuels. Also, International support is required in order to bring down the prices of expensive technologies such as dual-fuel engines, ROTOR sails etc.

4. CONCLUSION

The introduction of alternatives in any Industry takes time. The time taken is

accounted for research and exploring so as to develop the technology to extract the best out of it.

The majority of these alternatives will come into play in either region with excessive restriction on emissions or regions with a sufficient fuel supply along with developed infrastructure.

All the above written fuels have the potential but surely, introducing new technology will be viewed distantly from ship owner's view and hence, international and cohesive support is much needed to bring a change in this Industry.

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Note – Apart from this, knowledge of the Institute Faculty is also included.