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JOURNAL OF MARINE SCIENCE, TECHNOLOGY AND MANAGEMENT

Journal of Marine Science, Technology and Management (JMSTM) is primarily focused on research related to Marine Engineering and Nautical Science mainly, and other disciplines like Mechanical Engineering, Electrical and Electronics Engineering, Computer Science, Communication Skills and Management Science, etc. The scope of the journal covers theoretical, experimental and numerical research related to basics and applied problems, case studies and literature reviews from various disciplines mentioned above. We encourage contributions that will be helpful in solving real life problems that are complex in nature.

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Tolani Maritime Institute is one of the largest maritime educational centers offering Marine Engineering and Nautical Technology degree programs.

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Technical articles discussing various aspects of science and technology including innovations in the marine field, original research work, experimental investigations with results, industrial practices, case studies are invited for publication. The paper may be please be mailed to *jmstm@tmi.tolani.edu*.

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- Provide 4-6 keywords.
- Organize paper in smooth flow of title, subtitle and sub-sub title.
- Keep length of the paper to the limit of 12 pages approx.
- Provide 1 inch margin on all sides of the paper.
- Provide figures, drawings and graphs in black color on white back ground.
- Submit figures, drawings and graphs in JPEG format with 300 dpi minimum resolution.
- Number the figures and tables as per standard practice.
- Provide mathematical equations and functions in suitable equation editor.
- List the references at the end of the article with serial number.
- A declaration to the effect that – the work is original and has not copied or published earlier elsewhere – needs to be submitted along with the paper.
- On behalf of all the co-authors, the corresponding author shall bear the full responsibility for submission and shall provide his/her full address, contact number and email.
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Conclusion
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Editor-in Chief - Message

Journal of Marine Science, Technology, and Management (JMSTM) mainly focuses on research related to Marine Engineering and Nautical Science and other disciplines like Mechanical Engineering, Electrical and Electronics Engineering, Computer Sciences, Communication Sciences, and Management Sciences, etc. The scope of the journal covers theoretical, experimental, and numerical research related to basic and applied problems, case studies, and literature reviews from various disciplines mentioned above. We encourage contributions that will be helpful in solving real-life problems which are complex in nature.

JMSTM also provides a platform for exchanging information on various topics mentioned above. The journal's editorial board members strongly believe in the quality of the research articles, and hence the process of selection of the articles includes a science-driven approach and double-blind peer review process, which conforms to the strict international procedures and editorial standards expected by the scientific community.

I encourage engineering students, research scholars, academicians, industrialists, scientists to contribute their research through publication in JMSTM. All papers receiving a high degree of enthusiasm in the peer-review process will find a home in JMSTM. Therefore, we are committed to publishing all discoveries, methods, resources, and reviews that significantly advance the Marine Engineering and Nautical Sciences field.

On behalf of the JMSTM team, I would like to mention my sincere thanks to the authors, editors, reviewers, technical publication committee members, and bodies who have indirectly supported to achieve the required quality of the research articles and hence the journal. It is with profound pleasure, humility and anticipation that we celebrate the launch of the **Journal of Marine Science, Technology and Management (JMSTM)** with this inaugural issue.

At last, I welcome you to contribute to JMSTM. I see a bright future for JMSTM with the support of authors, reviewers, and editors. I ensure to serve science and the scientific community even better in the future. Ultimately, we will improve more lives and, consequently, our communities.

We would be delighted to hear about your suggestions for improving the quality of JMSTM on jmstm@tmi.tolani.edu.

Thank you. We hope you will find JMSTM informative and interesting.

Dr. Sanjeet Kanungo

Editor in Chief

Technical Publication Committee - Message

We are pleased to present the first issue of **Journal of Marine Science, Technology and Management (JMSTM).**

Tolani Maritime Institute (TMI) has been successful year after year in imparting Marine Education at pre-sea and post sea level because of its strength of faculty members, other resource persons in the organization and the facilities available for the research and industrial project work. TMI has created its benchmark in the Marine Education area.

Journal of Marine Science, Technology and Management provides the platform for the readers, students, academicians, research scholars, industrialists, scientists (authors) to take up the activity of writing and publishing scholarly articles in varied fields of Science, Technology and Management. The JMSTM Vol. 1, Issue 1 is dedicated to all those who have contributed directly/indirectly in keeping the light of knowledge on.

We are sure that the issue of the journal will keep interest alive of the readers and writers. Enjoy Reading and Writing!!

Technical Publication Committee

Tolani Maritime Institute, Pune

Student’s Committee - Message

It is a great honour and pleasure for us to bring the first issue of **Journal of Marine Science, Technology and Management (JMSTM)** to our esteemed readers.

The JMSTM is a compendium of various technical ideas by students and faculties. This issue captures every technical advancement of all industries and especially shipping by the cadets of TMI, students, faculties, research scholars, scientists, industrialists whose talents makes this journal a special one, highlighting the technical ideas on various technologies penned by them.

The magazine endeavours to reflect the values and aspects of the institution itself. Maintaining the respect or interest of values this magazine ensures an accord of technical skills and vision. Starting from day one we made a commitment of providing a balanced coverage of innovative ideas and publish a spectacular magazine that would tickle the grey matter of the readers.

It is the readers who complete this magazine as a whole and we cannot be more grateful to them. We are extremely grateful to our faculty, advisory and editorial team for having faith and providing us with this opportunity and their assistance. As a team we hope to build the creative ethos and an enthralling experience over this magazine.

I wish you all clear horizons, enjoy a roller coaster of an imaginative cum food for thoughts by authors. Hope you all like this issue. Suggestions and feedbacks are welcome as always.

Cheers!

Prathmesh Jadhav

Students Committee Representative

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A REVIEW PAPER ON THE USE OF METHANOL IN DUAL-FUEL MARINE DIESEL ENGINE TECHNOLOGY AND RECENT DEVELOPMENTS

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ABSTRACT:-
As global warming is increasing; International Maritime Organization and European and local governmental bodies are to implement stringent emission regulations. The research group Transport technology of Ghent University got involved in the Lean Ships project and demonstrated the potential of Methanol in decreasing the NO and soot emission on high-speed marine diesel engines. Fuel selection criteria such as sustainability, scalability, and storability, lead to the selection of Methanol as a viable alternative to fossil fuels. The results of dual fuel methanol/diesel operation on engine performance were recorded at different engine speeds and load points. The maximum obtained Methanol Energy Fraction (MEF) is 70%, and Diesel Substitution Ratio (DSR) is 67%. From this study, our main interest is to reduce emissions that can help ships meet environmental fuel regulations & improve air quality and related human health issues. Also, to seek out the importance of Methanol in duel–fuel propulsion engines and its recent developments.

Keywords—component, formatting, style, styling, insert

I. INTRODUCTION

The maritime industry faces challenges in adopting new technologies and operational practices to comply with increasingly strict international, national, and local regulations aimed at reducing Sulfur Oxides (SOx), Nitrogen Oxides (NOx), Particulate Matter (PM), Carbon, and Greenhouse Gas (GHG) emissions from ships. The regulations introduced by the International Maritime Organization (IMO), the European Union, the United States Environmental Protection Agency, the California Air Resources Board, and others are designed to reduce these emissions from ships. Many approaches are being considered to reduce carbon emissions in shipping [1]. Methanol is one of the top chemical commodities shipped around the world and is available in almost 90 of the top 100 ports worldwide. Unlike some alternative fuels, it is readily available through existing global terminal infrastructure and is well positioned to supply the global marine industry. Existing fuel storage tank and vessel designs can be used for Methanol with minor modifications without cryogenic or pressurized storage and supply equipment. Methanol has a higher energy content than alternate, low-emission fuels such as ammonia or hydrogen. As a result, it is better suited to a broader range of vessel types, longer voyages, and less frequent bunkering [2]. So far, methanol ships have been powered by diesel concept engines modified to run on Methanol and marine diesel. In both field and laboratory tests, converted methanol engines have performed at an equivalent or higher level than diesel engines. Methanol-optimized marine engines are under development and, once in service, are expected to perform better than retrofits. Methanol readily dissolves in water and is biodegraded rapidly, as most microorganisms can oxidize Methanol. In practice, this means that the environmental effects of a large spill would be much lower than those of an equivalent oil spill. It is compliant with the strictest emissions standards, plentiful and available globally, could be manufactured from a wide variety of fossil and renewable feedstocks, and its properties are well-known because it has been shipped globally, handled, and used for a wide variety of ends for more than 100 years. Moreover, it is like current marine fuels in that it is a liquid. This means that current marine fuel storage and fueling infrastructure would require only minor modifications to handle Methanol, necessitating relatively modest infrastructure investment costs compared with the sizeable investments needed for the construction of liquefied natural gas (LNG) terminals [3]. Dual-fuel engines can run on a combination of two different fuels. In dual-fuel engines, diesel and natural gas are frequently used together. Diesel fuel is frequently the only fuel that can be used in dual-fuel engines that mix natural gas and diesel. The difference in combustion mode between diesel-only (DO) operation and dual fuel diesel/methanol (DF) operation has an essential impact on engine parameters such as brake thermal efficiency and emissions.

Many Shipping Companies like Stena BULK, Stena LINES, MAERSK, WATERFRONT Shipping, etc., are currently implementing and adopting this trend. Methanol is cheap to produce relative to other alternative fuels. Methanol can be manufactured from various domestic carbon-based feedstocks, such as biomass, natural gas, and coal. The methanol vessel will be less expensive when comparing investment costs for a methanol-powered vessel and an LNG-powered vessel. This is because a methanol vessel does not need costly high-pressure fuel tanks and a very advanced fuel delivery system. From an environmental point of view, Methanol performs well. Methanol readily dissolves in water and is biodegraded rapidly, as most microorganisms can oxidize Methanol. In practice, this means that the environmental effects of a large spill would be much lower than those of an equivalent oil spill. There is little known about the long-term impact of methanol exposure, but they are believed to be similar to the short-term effects.

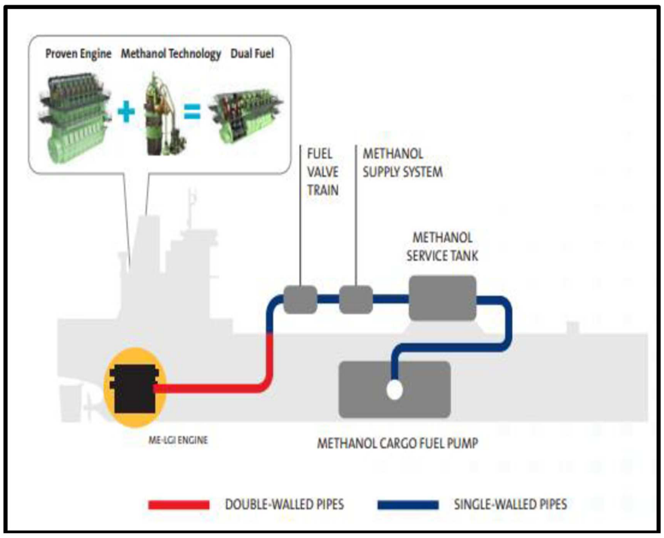

Fig.1. Methanol in DFDE

Methanol Supply System:

The engine uses temperature-conditioned Methanol at a fixed supply pressure and varying flow depending on the engine load. The low Methanol flashpoint fuel supply system (LFSS) will have to supply this fuel to the engine while complying with the requirements described regarding temperature, flow, pressure, and ramp-up capabilities. The fuel is taken from a service tank containing liquid fuel and boosted to a pressure close to the supply pressure, e.g., for Methanol approximately 8 bar. The circulation pump circulation pump then circulates the fuel, and the pressure is raised to the engine supply pressure, e.g., for Methanol approximately 10 bar. A typical circulation factor is 2-3 times the fuel consumption. To ensure the fuel delivery temperature, a heater/cooler is placed in the circulation circuit.

Methanol Valve Train:

The fuel valve train connects the LFSS with the engine through a master fuel valve (MFV) arranged in a double block and bleed configuration. From the valve train, the fuel is fed to the engine in a double-walled ventilated pipe through the engine room.

Purge Return System:

Because of the low flashpoint of Methanol, there are several operation scenarios where the fuel piping must be emptied and inserted. For the ME-LGI, the fuel piping on the engine and in the engine, room is arranged so that the liquid fuel can purge and thereby returned to the fuel service tank. After the methanol fuel has been returned to the service tank, full purging and inverting are conducted for the double-walled piping system.

Stop Gas Operation:

If the gas operation is expected to be stopped for a longer period, e.g., during short harbor stays, the procedure for switching to gas standby mode is used. However, the LFSS is switched off when the procedure finishes. The reason is that the supply lines in the engine room and on the engine are Methanol filled.

II. LITERATURE REVIEW

Jeroen Dierickx, Louis Sileghem, Sebastian Verhelst [4]. The results of the Lean Ships work measurement campaign on dual fuel methanol/diesel operation are presented in this paper. The results for four-engine performance parameters were presented after an explanation of the engine setup used for the measurements: the highest MEF, BTE, and particular no and soot emissions. Engine performance parameters like BTE, NO, and soot emissions are significantly impacted by the differences in combustion mode between DO and DF operation. The primary distinction between the two modes of operation is that in DF mode, more premixed fuel is burned. The maximum MEFs at the different engine speeds and loads vary between 25% and 70% and the maximum DSR is between 17% and 67%. For both high loads and low loads, the BTE in DF operation is higher and lower than in DO operation, consistent with research findings. In DF operation, the maximum relative increase in BTE is 12%. At high loads, there is a minimum at a certain MEF, after which the specific NO emissions increase again with increasing MEF. However, the specific NO emissions decrease with increasing MEF. DF operation results in a relative decrease of specific NO emissions of 61% on average. In DF operation, the average relative decrease in specific soot emissions is 77%.

Jeroen Dierickx, Jip Verbiest, Tom Janvier, Jens Peters, Louis Sileghem, Sebastian Verhelst [5]. This paper focused on the methanol injection position in engines since dual-fuel operation with methanol-diesel can be a significant factor in making vessels sustainable. because this position has a significant impact on the intake, engine performance, and overall cost of the retrofit. There are two feasible and tested injection places in the intake manifold: one where Methanol is injected at several points right before the inlet valves (MPI mode), and the other where Methanol is injected at a single point behind the turbo-compressor (SPI mode). To avoid condensation of Methanol in the IC, it was decided to remove the IC in SPI mode while setting up the measurements. As a result, MPI and SPI have differing intake charge temperatures. As a result, preignition is seen as an additional diesel replacement threshold for SPI as compared to MPI. However, testing MPI without an IC led to the conclusion that preignition was not dependent on the injection mode but rather was merely connected to the intake charge temperature. The MPI and SPI tests revealed five diesel substitution boundaries: incomplete burn, misfire, knock, excessive exhaust temperatures, and preignition. SPI had the highest MEF, which was 84% overall. The maximum MEF in MPI was 80%. With 44 of the 50 load points that were tested for MPI and SPI, NOx emissions with Methanol are lower than NOx emissions in DO. According to this study, SPI is preferred as a retrofit solution for marine vessel engines from a cost perspective (i.e., maximizing efficiency (and thereby minimizing fuel consumption) and minimizing the retrofit cost), but MPI is preferred from a sustainability perspective (i.e., maximizing the substitution of diesel by Methanol and decreasing NOx emissions).

Wang Pan, Chunde Yao, Guopeng Han, Hongyuan Wei, and Quangang Wang [6] On the impact of intake air temperature on performance and exhaust emissions of a diesel methanol dual fuel engine conducted a parametric study concerned with methanol mass fraction and intake air temperature from which they derived to show that there was a strong coupling between the intake air temperature and the methanol fraction to performance and emissions of the engine.

Martin Svanberg, Joanne Ellis, Joakim Lundgren, Ingvar Landälv [7] Using biomass to produce renewable Methanol for use in the shipping industry is a technically viable option to reduce environmental impacts from maritime transport. No significant technical challenges have been observed in production, distribution, or use on ships. Production of a “fuel quality” renewable methanol. A few studies showed that marine engines could use lower purity methanol than is currently produced and traded. One study on the production of Methanol from black liquor gasification provided an estimate of cost savings if less distilled Methanol is produced. Further work providing more details on the quality of Methanol that would be acceptable for a broader range of methanol engine concepts would be useful, as well as additional studies on the reductions of production costs and the environmental footprint for less distilled Methanol. Targets and strategies for emissions reduction from shipping were identified at the international, national, and corporate levels. Existing and expected future developments should be further investigated regarding economic implications for the adoption of renewable fuels and other emissions reduction alternatives.

Ming Liu, Chen Li, Eng Kiong Koh, Zhiqian Ang, and Jasmine Siu Lee Lam [8] Renewable methanol production is critical in determining if it is feasible as an alternative marine fuel in the future. Sunlight is the origin of renewable feedstocks such as plant biomass and electrons for renewable methanol production. Plants with high photosynthesis efficiency, i.e., high annual accumulation of biomass, are expected to have a higher potential. On the other hand, renewable electrons are a source of hydrogen to be combined with either carbonaceous biomass or carbon dioxide to produce Methanol. Direct air capture of carbon dioxide provides the ultimate carbon source for renewable methanol production, which relies on further cost reduction of the capturing technology and renewable electricity generation. It is anticipated that further enhancement in renewable methanol production technology is needed to enable the global adoption of Methanol as a marine fuel.

Nader R. Ammar [9] In this paper, the application of a methanol-diesel dual-fuel engine for a cellular container ship is investigated from an environmental and eco-friendly point of view. The annual NO_x, SO_x, CO, CO_2, and PM emissions will be reduced by 76.78%, 89%,55%, 18.13%, and 82.56%, respectively, after using the dual-fuel engine. In addition, a proposed solution for the increased dual-fuel costs compared to diesel fuel is proposed. The cost-effectiveness for each pollutant emissions reduction after using dual-fuel is assessed. The annual cost for recovering methanol dual-fuel engine conversion cost is 1.17 million $/year. The fuel and bunkering costs will be increased by 28.16% compared with the equivalent diesel engine costs at MCR and 2018 fuel prices. The annual SCR cost which will be after using a methanol-diesel dual-fuel engine, is 1.59 million $/year, at an annual interest rate of 10%. Using the same SCR costs, without reducing the ship’s profit, the cost of the engine conversion will be saved during the first 12 years of the dual-fuel engine operation.

Sebastian Verhelst, James WG Turner, Louis Sileghem, Jeroen Vancoillie [10] As explained in the introductory sections, Methanol is a compelling fuel for internal combustion engines. It has been investigated in the past, initially as a knock-resistant fuel, then as a fuel that could be produced from non-fossil-oil sources, and then – most extensively – as a fuel that substantially improved air quality. Assessment of the efficiency potential of a dedicated methanol engine, at peak and part load, exploiting state-of-the-art engine technology. Strategies for these engines to enable the use of gasoline (for a 'limp home mode'). Evaluation of the potential of onboard Methanol reforming using engine waste heat. Determination of the best strategy for using Methanol in CI engines, as this is a technology serving many applications. Another important way of introducing Methanol is its blending with gasoline; more data on water tolerance, phase separation, etc. of these blends are needed. Clarifying PN and aldehyde emissions from methanol-fueled operation (engine-out emissions and after-treatment efficiency). Completing the fundamental data, e.g., on burning velocities, ignition delay times spray. Improving simulation tools to capture better the effects of using methanol fuel. Investigating the cost-effectiveness of the different octane on-demand concepts possible with Methanol.

III. COMPARISON OF METHANOL WITH OTHER FUELS

Methanol has been the best and most efficient fuel as it is fulfilling the various parameters like cost- effective, less toxic and emission norms, thus compared with fuels like MDO, LNG, Bio-diesel, Ammonia, etc. Methanol can be used efficiently in marine dual fuel technology as it improves current technologies and also fulfills IMO requirements. The challenge in using Methanol compared to other fuels is the storage requirement as it consumes more area and requires treating Methanol through various chemical treatments to fulfill the desired chemical properties.

Table 1: fuel comparison on emission

	MDO	LNG	Methanol	Biofuel	Ammonia	Hydrogen	Battery
SOx, NOx, PM emissions	✗ (orange)	✓ (light green)	✓ (light green)	✗ (orange)	✓ (yellow)	✓ (green)	✓ (green)
Carbon (CO_2) emissions	✗ (red)	✗ (orange)	✓ (light green)	✓ (light green)	✓ (green)	✓ (green)	✓ (green)
Flammability	✓ (green)	✓ (green)	✓ (yellow)	✓ (green)	✓ (light green)	✗ (red)	-
Toxicity	✓ (green)	✓ (green)	✓ (yellow)	✓ (green)	✗ (red)	✓ (green)	-
Technological maturity	✓ (green)	✓ (green)	✓ (yellow)	✓ (light green)	✗ (orange)	✗ (orange)	✓ (light green)
Energy cost	✓ (light green)	✓ (green)	✓ (yellow)	✗ (orange)	✗ (red)	✗ (red)	✗ (red)
Bunkering availability	✓ (green)	✓ (yellow)	✗ (orange)	✗ (orange)	✗ (orange)	✗ (orange)	✓ (yellow)

IV. CONCLUSION

The review paper on the use of Methanol as a fuel in dual-fuel marine engines concludes that

- Using various techniques such as SCR,
- MCR, SPI, MPI, etc. in ME-LGI or dual fuel engines, we can reduce emissions that help ships meet environmental fuel regulations, control global warming by improving air quality, and fulfil the IMO requirements.
- The use of Methanol will reduce fuel costs and can be produced from biomass and feedstocks.

V. FUTURE SCOPE

- We can use a PID controller, which should be inter-connected to the injectors, which will control the output pressure of the Methanol sprayed into the engine and the temperature of air intake. Connecting the PID in the Main engine to the pressurized injector head to spray Methanol and also controlling the air valves to spray the right amount of air inside the ignition chamber.
- There is still a scope for research in methanol storage restrictions which reduces the area for the machinery space.

VI. ABREVIATIONS & ACRONYMS

MEF Methanol Energy Fraction
IMO International Maritime Organization
LNG Liquefied Natural Gas
MDO Marine Diesel Oil
NOx Nitrogen Oxides Emission
Sox Sulfur Oxides Emission
PM Particulate Matter Emission
GHG Greenhouse Gas Emission
DF Dual-Fuel
LFSS Low Flashpoint Fuel Supply System
MFV Master Fuel Valve
MELGI Marine Engine Liquid Gas Injection
BTE Brake Thermal Efficiency
DSR Diesel Substitution Ratio
SPI Single Point Injection
MPI Multi-Point Injection
IC Internal Combustion
PID Proportional Integral Derivative
CO2 Carbon Dioxide Emission
MCR Maximum Continuous Rating
SCR Selective Catalytic Reduction

VII. ACKNOWLEDGEMENT

We would like to express our special thanks to our mentor Mrs. Nilima Gujjalwar for the time and effort she provided in our project. Her useful advice and suggestions were helpful to us during the project's completion. In this aspect, we are eternally grateful to her.

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NAVIGATING TOWARD EFFICIENCY: STRATEGIES FOR ENHANCING MERCHANT VESSEL OPERATIONS

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ABSTRACT:-

The energy efficiency of merchant vessels can be increased through a variety of methods, including the optimization of vessel design, the implementation of advanced propulsion systems, and the implementation of energy management systems.

One approach to increasing energy efficiency is optimising the vessel's design, including the hull form and appendages, to reduce drag and improve hydrodynamic performance. Additionally, using advanced propulsion systems, such as hybrid propulsion, electric propulsion, and fuel cells, can also improve energy efficiency.

Another approach is to implement energy management systems, which can monitor and control the energy consumption of various ship systems, such as lighting, HVAC, and navigation. These systems can also provide real-time data on energy consumption, allowing for the identification and correction of inefficiencies. Furthermore, renewable energy sources, such as solar or wind power, can also be implemented to increase energy efficiency.

Finally, digitalization technologies and data analytics can also be applied to optimize vessel operation and reduce energy consumption. This includes using digital twins, real-time monitoring, and predictive analytics.

Keywords— Energy efficiency, Advanced Propulsion System, Energy Management System, Digital Technologies

I. INTRODUCTION

Energy efficiency has become a prime cause of concern across all industries in the world, and shipping is no exception. The terms 'sustainability' and 'green ships' are heard more and more frequently today, as the core principles of ship and boat building are being transformed due to these influences.

The concepts of energy efficiency and its need in everyday shipping have filtered down from the realm of the abstract to ground reality. They are making their presence felt in the day-to-day functioning of shipping organizations.

In general terms, the energy efficiency of boats and ships by design, as defined by the Energy Efficiency Design Index, is the ratio of carbon dioxide the ship would emit per ton-mile of the work done by the ship.

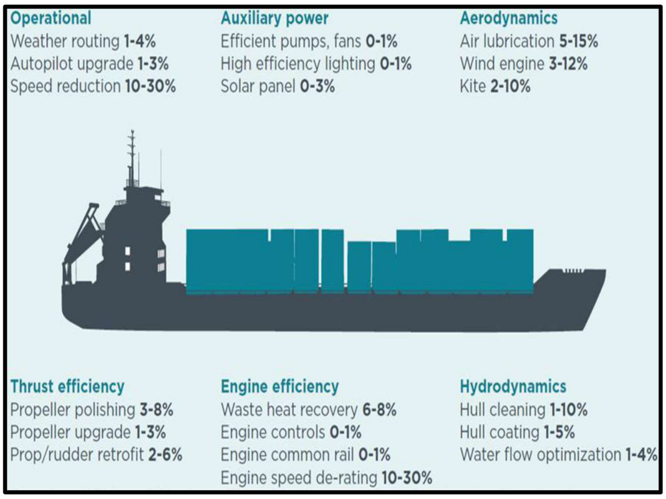

Fig. 1. Potential fuel use CO_2 reductions from various efficiency for ships

The best ways to optimize and maintain the energy efficiency of the ship are planned and implemented using the Ship Energy Efficiency Management Plan. SEEMP delineates all the best practices that need to be practiced on board and within the organization to ensure smooth sailing and maximum efficiency of the ship.

Finally, a critical analysis of whether these measures are useful, the return on investment they are offering, and the modifications required to make it better can be done using the Energy Efficiency Operation Index (EEOI). The main difference between the EEDI and the EEOI here is that the former measures how well a ship is built while the latter steps and how well it is operated.

There are several ways to increase the efficiency of merchant vessels:

- **Speed optimization**:
  By optimizing the speed of the vessel, fuel consumption can be reduced and therefore increase efficiency. This can be done using advanced navigation systems that can predict the best speed for a given voyage, considering weather conditions, sea state, and vessel characteristics. Additionally, vessels can reduce their speed when entering and exiting ports and when transiting through areas with high traffic density, which can help save fuel and reduce emissions.

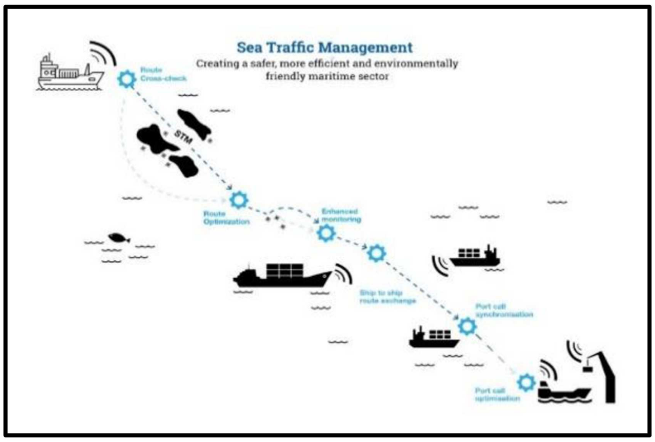

Fig. 2. Sea Traffic Management

- **Route optimization**:
  By optimizing the route of the vessel, fuel consumption can be reduced, and the voyage can be completed in a shorter time, increasing efficiency. This can be done by using advanced routing software that considers factors such as weather conditions, sea state, vessel characteristics, and the location of other vessels. Additionally, vessels can take advantage of favourable currents and winds to reduce their fuel consumption and speed up their voyage.

- **Hull optimization**:
  By optimizing the design of the hull, resistance to water can be reduced, reducing fuel consumption and increasing efficiency. This can be done by using advanced computational fluid dynamics (CFD) simulations to optimize the shape of the hull, and by incorporating features such as bulbous bows and stern flaps that can reduce resistance and improve propulsion efficiency.

- **Onboard systems optimization**:
  By optimizing the onboard systems, such as propulsion, electrical systems, and HVAC, energy efficiency can be increased. This can be done by using advanced control systems that can optimize the performance of these systems, and by incorporating energy-efficient technologies such as LED lighting, variable frequency drives, and heat exchangers.

- **Weather routing**:
  Advanced weather routing systems allow vessels to avoid adverse weather conditions and save fuel. These systems use real-time weather data to predict the best route for a given voyage, considering factors such as wind, waves, and currents. Additionally, vessels can reduce their speed when transiting through areas with high winds or heavy seas, which can help to save fuel and reduce emissions.

- **Crew training**:
  Training crew members on energy-efficient practices, such as reducing speed when entering and exiting ports, and turning off unnecessary equipment, can increase efficiency. This can be done by providing training programs that focus on energy-efficient practices, and by incorporating energy management systems that can monitor and control the energy consumption of the vessel.

- **Digitalization:**
  Using digital technologies such as IoT, AI, and big data analytics can help to improve vessel performance, reduce costs and increase efficiency. With the help of these technologies, real-time monitoring and analysis of various shipboard parameters such as fuel consumption, engine performance, weather conditions, and more can help to optimize vessel operation and reduce fuel consumption.

- **Maintenance:**
  Proper maintenance of the ship's systems and equipment can help ensure they are running optimally. This can be done by implementing a regular maintenance schedule and by conducting regular inspections of the vessel's systems and equipment. Additionally, by using condition-based monitoring systems, the ship operator can detect potential problems early and take action to prevent them.

- **Retrofitting:**
  Retrofitting older ships with new technologies and equipment can help to increase their efficiency and reduce their environmental impact. This can include retrofitting the ship with new propulsion systems, energy-efficient technologies, advanced navigation, and weather routing systems.

- **Compliance with regulations:**
  Complying with international and national regulations and best practices regarding energy efficiency can also help increase merchant vessels' efficiency. This can include compliance with regulations related to emissions, energy efficiency, and safety, as well as participation in voluntary programs such as the Ship Energy Efficiency Management Plan

Detailed Explanation of Point 1

Speed optimization:
By optimizing the speed of the vessel, fuel consumption can be reduced and therefore increase efficiency. This can be done using advanced navigation systems that can predict the best speed for a given voyage, considering weather conditions, sea state, and vessel characteristics.
One way to optimize speed is by using a Speed and Consumption Management (SCM) system. These systems use real-time data on weather conditions, vessel characteristics, and other factors to predict the most fuel-efficient speed for a given voyage. Adjusting the vessel's speed based on this information, can significantly reduce fuel consumption and improve efficiency.
Another way is by using voyage optimization software, which allows for calculating the optimal speed and consumption for a given voyage by considering a combination of factors such as fuel prices, weather forecasts, and vessel characteristics.
Additionally, vessels can reduce their speed when entering and exiting ports, and when transiting through areas with high traffic density, which can help to save fuel and reduce emissions. This is known as slow steaming. It can reduce the ship's speed to a more fuel-efficient level, reducing fuel consumption and emissions and reducing the risk of collisions with other vessels in congested areas.
It is also possible to use a combination of these methods to optimize speed and consumption, which can further increase efficiency.

Detailed Explanation of Point 2

Route optimization: By optimizing the route of the vessel, fuel consumption can be reduced, and the voyage can be completed in a shorter time, increasing efficiency. This can be done by using advanced routing software that considers factors such as weather conditions, sea state, vessel characteristics, and the location of other vessels.
One way to optimize routes is by using Electronic Chart Display and Information Systems (ECDIS), which allows for the use of digital charts and real-time weather data to plan and adjust routes. By using this technology, vessels can avoid areas of adverse weather or sea conditions, which can help to reduce fuel consumption and improve efficiency.
Another way is by using Advanced Routing and Optimization (ARO) software, which considers factors such as fuel prices, weather forecast, vessel characteristics and congestion in ports to calculate the most cost-efficient route for a given voyage.
Additionally, vessels can take advantage of favourable currents and winds to reduce fuel consumption and speed up their voyage. This is known as weather routing, which uses real-time weather data to predict the best route for a given voyage, considering factors such as wind, waves, and currents. By avoiding areas of adverse weather, vessels can reduce their fuel consumption and improve efficiency.
It is also possible to use a combination of these methods to optimize routes, which can further increase efficiency. [1]

Fig. 3. Route Optimization

Detailed Explanation of Point 3

Hull cleaning and coating:
The hull of a vessel is the most critical component in terms of its resistance to water, and its condition can significantly impact a vessel's efficiency. A dirty and fouled hull can increase drag and resistance, resulting in increased fuel consumption and decreased efficiency.
Hull cleaning is removing marine growth, dirt, and other debris from the hull of a vessel. This can be done using a variety of methods, such as pressure washing, scraping, and chemical cleaning. Regular hull cleaning can help reduce drag and resistance, improving efficiency and saving fuel.
Hull coating is the application of a specialized paint or coating to the hull of a vessel. This coating can help to reduce drag and resistance by creating a smooth surface that is less likely to accumulate marine growth and debris. Some advanced coatings can also prevent the growth of organisms on the surface, which can reduce cleaning and maintenance costs.
It is also important to note that, in addition to regular cleaning and coating, selecting the right type of coating for the specific vessel and its intended voyage is important. For

example, some coatings are better suited for cold water, while others are better for warm water. This can affect their performance in terms of resistance and fuel efficiency.
Overall, hull cleaning and coating can significantly increase merchant vessels' efficiency by reducing drag and resistance, leading to lower fuel consumption and improved performance. [4]

Detailed Explanation of Point 4

Ballast water treatment:
Ballast water is water that a vessel takes on board to provide stability and balance. It is commonly used during voyages to adjust a ship's weight and trim for different cargo loads and weather conditions. However, ballast water can also contain harmful organisms and pathogens, which can be introduced into new environments when the water is discharged.
Ballast water treatment systems are designed to remove or neutralize these harmful organisms and pathogens before the water is discharged. This can be done through various methods such as filtration, ultraviolet light, and chemical treatment.
Using ballast water treatment systems can not only help to protect the environment but also increase the efficiency of merchant vessels. When a vessel is not carrying cargo, it can take on ballast water to increase its draft (the depth of the vessel in the water) and improve its stability. However, when the vessel is loaded with cargo, the ballast water is discharged, which can cause a decrease in the draft, which can result in increased drag and resistance and, ultimately, increased fuel consumption.
By using ballast water treatment systems, the ship can maintain a consistent draft throughout the voyage, which can lead to lower fuel consumption, increased speed and better performance. [4]

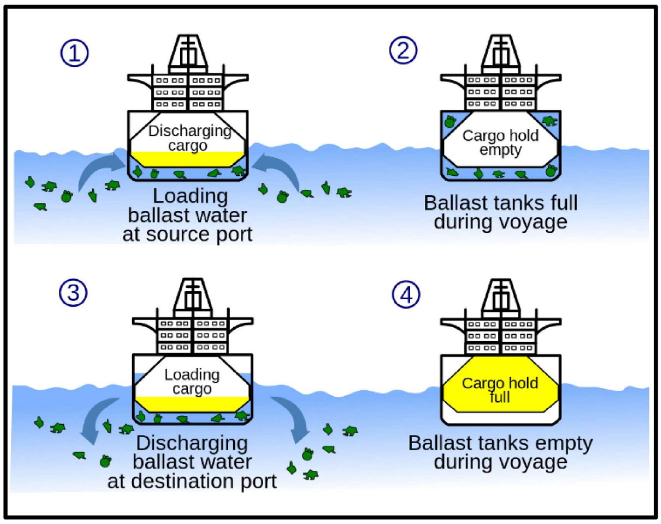

Fig. 4. Ballast Water Treatment

Detailed Explanation of Point 5

Energy-efficient technologies:
The use of energy-efficient technologies can also help to increase the efficiency of merchant vessels. These technologies can include things like:
LED lighting: Replacing traditional incandescent lights with LED lights can reduce energy consumption and lower costs.
Energy-efficient propulsion systems: Some newer vessels are equipped with propulsion systems that use less energy, such as hybrid or electric systems, which can improve efficiency and reduce emissions.
Variable speed drives: These devices can be used to control the speed of pumps, fans, and other equipment on board a vessel, which can reduce energy consumption and improve efficiency.
Waste heat recovery systems: Some systems can recover waste heat from engines and other equipment and use it to generate electricity, which can reduce the need for additional fuel consumption.
By using these energy-efficient technologies, vessels can reduce their overall energy consumption and improve efficiency. Additionally, using these technologies can help reduce the environmental impact of shipping by reducing emissions and conserving resources.
It is also important to note that, depending on the type of vessel and its intended voyage, some of these technologies may be more suitable than others. For example, a large container ship may be able to take advantage of energy-efficient propulsion systems, while a smaller fishing vessel may benefit more from LED lighting and variable speed drives. [1]

Detailed Explanation of Point 6

Optimized voyage planning:
Optimized voyage planning can also play a critical role in increasing the efficiency of merchant vessels. This includes things like:

Route optimization:
By selecting the most efficient routes, vessels can reduce fuel consumption and travel time. This can be done by taking into account factors such as weather conditions, sea state, currents, and the vessel's speed and capacity.

Speed optimization:
Adjusting the vessel's speed can optimise the fuel consumption for the specific voyage. For example, if the vessel is travelling through calm waters and there is no need to maintain a high speed, the speed can be reduced, which can reduce fuel consumption.

Load optimization:
Properly loading and stowing cargo can help to improve the vessel's stability and reduce drag and resistance. This can

be done by considering the weight and size of the cargo, as well as the vessel's capacity and stability.
By optimizing voyage planning, vessels can reduce fuel consumption and travel time, which can lead to increased efficiency and cost savings. Additionally, optimized voyage planning can also help to reduce the environmental impact of shipping by reducing emissions and conserving resources.
It is also important to note that voyage planning is a dynamic process that can change due to a variety of factors such as weather conditions, sea state, and cargo availability. Therefore, it is important to continuously monitor and adjust the voyage plan as needed to ensure the most efficient voyage possible. [2]

Detailed Explanation of Point 7

Crew training and best practices:
The crew plays a critical role in the operation and efficiency of a merchant vessel. Training the crew on best practices and procedures can help to increase efficiency and reduce costs. This can include things like:

Fuel-efficient navigation:
Training the crew on fuel-efficient navigation techniques can teach them how to optimize the vessel's speed and route to reduce fuel consumption.

Proper maintenance:
Training the crew on proper maintenance procedures can help ensure that the vessel's equipment and systems are operating at peak efficiency and reduce the risk of breakdowns or malfunctions.

Energy conservation:
By training the crew on energy conservation practices, they can learn how to reduce energy consumption and costs, such as turning off lights and equipment when not in use.
Additionally, by implementing best practices, the crew can improve the safety and environmental performance of the ship. For example, by following safety procedures, the crew can avoid accidents and injuries, and by following environmental regulations, the crew can reduce the negative impact of shipping on the environment.
It is also important to note that best practices and procedures will differ depending on the type of vessel and its intended voyage, as well as the company policies and regulations. Therefore, it is important to provide crew with the specific training and guidelines that apply to their vessel and voyage.
[6]

Detailed Explanation of Point 8

Fleet management and monitoring systems:
Fleet management and monitoring systems can also play an important role in increasing the efficiency of merchant vessels. These systems can include things like:

Fuel monitoring:
By monitoring and tracking fuel consumption, fleet managers can identify patterns and trends, and adjust and improve efficiency. This can include monitoring the vessel's speed, route, and cargo load, and identifying any issues with the vessel's equipment or systems.

Maintenance tracking:
By tracking and managing maintenance schedules, fleet managers can ensure that the vessel's equipment and systems are properly maintained and operating efficiently.
Real-time data collection and analysis: By collecting and analyzing data in real-time, fleet managers can make informed decisions to optimize the vessel's performance, reduce costs, and improve efficiency.
Fleet management and monitoring systems can also help to improve safety and environmental performance. For example, monitoring systems can alert the crew and fleet management of potential hazards or malfunctions. Real-time data collection and analysis can help identify opportunities for reducing emissions and conserving resources.
It is also important to note that different types of vessels will require different types of fleet management and monitoring systems, and some systems may be more suitable than others depending on the type of voyage, the size of the fleet, and the specific needs of the company. [7]

Fig. 5. Administration Level

Detailed Explanation of Point 9

Digitalization and Automation:
With the increasing availability of digital technologies, digitalization and automation can also play an important role in increasing the efficiency of merchant vessels. This can include things like:
Automated navigation and propulsion systems: Automated navigation and propulsion systems can help to optimize the

vessel's speed and route, reduce fuel consumption, and safety.

Fig. 6. Digitalisation and Automation

Remote monitoring and control:
Remote monitoring and control systems can allow fleet managers to monitor the vessel's performance and adjust remotely in real time, which can improve efficiency, reduce costs, and minimize downtime.
Digital documentation and communication systems: Digital documentation and communication systems can help to streamline processes, reduce errors, and improve communication between the vessel and shore-based operations.
Digitalization and automation can also help to improve safety and environmental performance. For example, automated navigation and propulsion systems can reduce the risk of human error, and remote monitoring and control systems can allow for real-time adjustments to reduce emissions and conserve resources.
It is also important to note that, digitalization and automation can be a complex process and requires a range of skills and expertise, from technology development to implementation and maintenance. It's important that companies invest in the necessary resources to develop and maintain the digitalization and automation systems for their fleet.

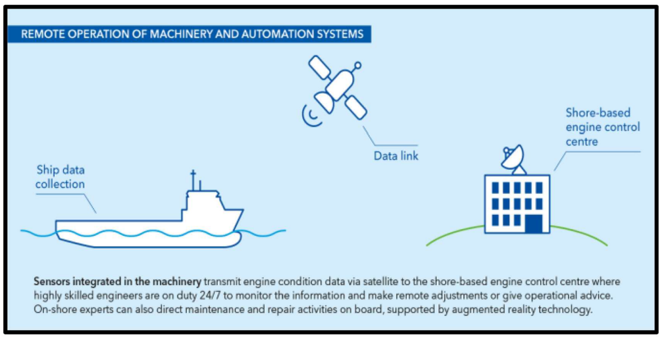

Fig. 7. Remote Operation of Machinery and Automation Systems

Detailed Explanation of Point: 10

Continuous improvement and innovation:
Finally, continuous improvement and innovation are key to increasing the efficiency of merchant vessels. This can include things like:
Regularly reviewing and analyzing performance data: By regularly reviewing and analyzing performance data, fleet managers can identify areas for improvement, and make adjustments to optimize the vessel's performance.
Investing in new technologies and equipment: By investing in new technologies and equipment, such as fuel-efficient engines or energy-saving systems, fleet managers can improve efficiency, reduce costs, and minimize environmental impact.
Collaborating with other industry players: By collaborating with other industry players, such as other shipping companies, suppliers, and research institutions, fleet managers can share best practices, identify new opportunities, and stay up-to-date on the latest developments in the industry.
Continuous improvement and innovation also help to improve safety and environmental performance. For example, by regularly reviewing and analyzing performance data, fleet managers can identify trends and patterns, and implement new processes and technologies to reduce the risk of accidents and injuries.
It is also important to note that, Continuous improvement and innovation is an ongoing process, and it is important that companies continuously strive to improve the performance, safety and environmental impact of their fleet. This can be done through regular reviews, evaluating new technologies and processes, and encouraging creativity and new ideas from the crew

II. CONCLUSIONS

In conclusion, there are several ways to increase the efficiency of merchant vessels, including improving vessel design, optimizing the vessel's speed and route, reducing fuel consumption, managing cargo loads, improving crew training and management, implementing fleet management and monitoring systems, digitalization and automation, continuous improvement, and innovation. By implementing a combination of these strategies, shipping companies can improve the performance, safety and environmental impact of their fleet, reduce costs, and stay competitive in the industry. However, it's important to note that these strategies require investment and commitment and that the specific needs and requirements of each company and fleet will vary. Additionally, it's essential to stay up-to-date with the latest developments in the industry and to continuously strive for improvement and innovation

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III. ACKNOWLEDGEMENT

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CARBON CAPTURE, UTILIZATION AND STORAGE (CCUS)

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ABSTRACT:-
Carbon capture, utilization, and storage (CCUS) is a technology that aims to capture carbon dioxide (CO2) emissions from industrial processes and power generation and either utilize it or store it underground. The captured CO2 can be used for various purposes, such as enhanced oil recovery, making chemicals, or carbonating beverages. The storage aspect involves injecting the captured CO2 into underground geological formations, such as depleted oil and gas reservoirs, deep saline aquifers, or unmineable coal seams, where it can be securely stored for hundreds to thousands of years. CCUS aims to reduce greenhouse gas emissions and mitigate climate change.

Keywords—Carbon Capture, Utilisation and Storage, CO2 transport

I. INTRODUCTION

CO2 capture, use and storage (CCUS) are recognized as a significant option in global efforts to control anthropogenic greenhouse gas emissions. Science since 2010 on the development and deployment of CO2 capture and storage (CCS) and its role in compliance with climate change targets. Significant progress has been made worldwide to advance the maturity of the various component technologies and their assembly in full-string proofs. However, there is still a gap in the path to widespread commercial deployment in many countries. In this contribution, we focus on the importance of business models adapted to the unique technical characteristic's socio-political drivers in different regions as a component of trade expansion and how the lessons could be shared across borders. We have a broad vision of this issue by proposing a framework that accounts for the different motivations and value propositions that exist through CCUS projects in different regions. Our argument is that CCUS is now developing due to three drivers, each with different short-term problems. These archetypal drivers: resources recovery, green growth and low carbon grid, offer a framing mechanism that can help translate the experience in all regions highlighting the most important technical aspects of policy issues and requirements to address and to carry out the projects[1-3].

II. TYPES OF CARBON CAPTURE

CO2 can be captured from large sources, such as power plants, natural gas processing facilities and some industrial processes. Capture from the open atmosphere is also possible. When fossil fuels are burned in power plants, there are three techniques to remove or "scrub" the CO2:

•Post-Combustion

• Pre-combustion

• oxy-fuel combustion

2.1. Post-combustion

In this process, the CO2 is removed after the combustion of the fossil fuel. The CO2 is captured ("scrubbed") from the exhaust gases (or "smokes"). This is the method that would be applied to most conventional power plants as it can be retrofitted. The technology is well understood and is currently being used in other industrial applications.

➢ Post-combustion capture is important because:
It is compatible with – and can be retrofitted to – the existing coal-fired power plant infrastructure without

requiring a substantial change in basic combustion Technology.

- It is the prime candidate for gas-fired power plants. Neither oxy-combustion nor are pre-combustion approaches well suited to the gasworks.

- It offers flexibility. If the capture plant shuts down, the plant can still function. The other two capture options are strongly integrated into the plant:

Thus, if the capture fails, the entire factory must shut down. In addition, it offers utilities (And the regulatory commissions) the possibility of authorizing increased capacity in temporarily shorten the capture process during periods of peak power demand.

2.2. Pre-combustion

As its name suggests, it involves the capture of CO_2 before combustion. This is not an option in pulverized coal (PC) power plants which account for most of the existing capacity. However, it is an option for coal gasification combined cycle (IGCC) power plants with CO_2 capture. In these plants, the coal is first converted into gaseous state to form syngas (syngas, a mixture whose main components are carbon monoxide and hydrogen). The syngas then undergoes the water-gas change, in which the CO reacts with the steam to form CO_2 and additional H_2. The CO_2 is then removed, and the hydrogen is diluted with nitrogen and introduced into a gas turbine combined cycle. The advantage of this approach is that it is much less expensive than the post-combustion capture process. The disadvantages are that there are only a few IGCC plants in the existing coal park, and IGCC plants are more expensive than PC plants when CO_2 capture costs are not included.

★ **IGCC plant without CO_2 capture:**

- Gasification - Technology based on GE Energy (GEE), operating in radiant cooling mode, with heat recovery from high-temperature syngas.
- Air Separation Unit (ASU) - Integrated into the powertrain extracting 16% of its air from the gas turbine compressor and producing a high-pressure nitrogen (N_2) stream for NOx control of the combustion chamber turbine combustion.
- Quench and Syngas Scrubbing – For additional cooling of syngas and removal of entrained fine particles and water-soluble contaminants (e.g., ammonia and chlorides) from quench gas synthesis.
- Gas cooling, boiler feed water heating (BFW) and quenching – Cools the syngas exiting COS hydrolysis before it is routed to Hg removal and 1 AGR unit by heat exchange with the boiler feed water. The water condensate produced is sent to the acid water treatment plant.
- Sour Water Extractor - Takes water/condensate produced from low- temperature cooling processes, including that of the scrubber, and removes gaseous contaminants such as H_2S, Ammonia (NH_3) and CO_2, etc., before the water can be sent to the plant's wastewater treatment plant.
- Mercury removal - via activated carbon bed.
- Selexol - A conventional Selexol unit is used for H_2S removal.
- Claus Plant and Hydrogenation Reactor and Gas Cooler - A conventional Claus process to recover sulphur from H_2S as a salable solid sulphur product, followed by hydrogenation of the Claus tail gas and recycling to the Selexol unit.
- High-Pressure Syngas Heater/Syngas Expander - Removes heat and expands clean high-pressure syngas to recover additional energy before sending it to the powertrain. Combined Cycle Powertrain - GE's advanced Class F gas turbine includes heat recovery steam generator (HRSG) and a steam turbine [2].

IGCC Plant with CO_2 Capture:

- Conversion reactors - A water-gas conversion reactor (WGS) is added to replace the COS hydrolysis plant. This was done to convert all the carbon monoxide (CO) in the syngas to CO_2 and H_2, so the CO_2 could be removed downstream in the AGR plant. Since the WGS catalyst also serves to hydrolyse COS, a separate COS installation is no longer necessary.
- Modify the conventional Selexol plant to allow selective removal of H_2S and CO_2. In principle, this involves the addition of an additional absorption column and flash balloons on the plant, whose technology supplier, UOP, would help with the detailed design once the gas flow rate and composition of synthesis, as well as CO_2 product specifications, are clearly defined.

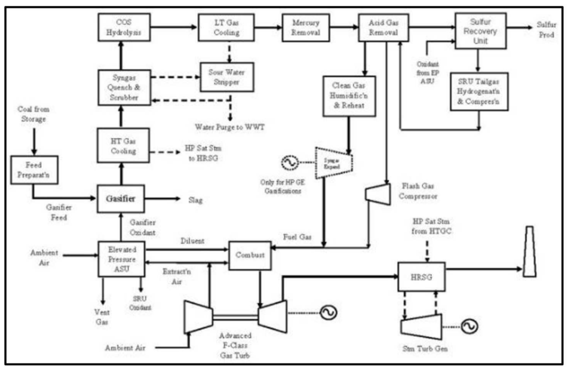

Fig. 1. IGCC Block Flow Diagram (Picture Credits : National Energy Technology Laboratory)

2.3 Oxy-Fuel Combustion

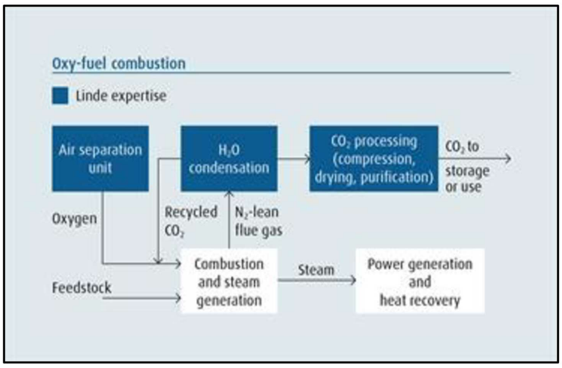

Fig. 2. Oxy-fuel Combustion (picture credit: Linde Engineering)

In oxyfuel combustion, the fossil fuel is burned in oxygen instead of air. The resulting flue gas consists mainly of CO2 and water vapour. The water condenses on cooling, and the result is almost pure CO2 which can be transported and stored. Power plant processes based on oxy-fuel combustion are sometimes referred to as "zero emissions" because almost all CO2 is captured. Some of the CO2 may dissolve in the condensed water, so the water may need to be further treated. Although this may be the most efficient method of the three, the initial process of burning oxygen is energy intensive.

2.4 Direct air capture:

It is possible to capture CO2 directly from the open atmosphere, but this is still being researched. The estimated energy required for airborne capture is only slightly higher than that required for capture from large emission sources. Costs may also be higher but may be feasible to deal with emissions from diffuse sources.

III. CARBON STORAGE

CO2 can be stored in two main ways:

- ***deep geological storage***
- ***storage of minerals***

Deep ocean storage will increase ocean acidification, a problem that stems from the excess CO2 already in the atmosphere and oceans.

Geological formations are currently considered the most promising storage sites. Areas such as the North Sea and the US Gulf Coast are thought to contain a large amount of geological storage space.

The Intergovernmental Panel on Climate Change (IPCC) says that for well-selected, well-designed and well-managed geological storage sites, CO2 could be sequestered for millions of years, retaining more than 99% of the CO2 injected over 1000 years.

Deep geological formations:

Storage in deep geological formations is also known as "geo-sequestration". In this technique, CO2 is converted into a liquid form at high pressure, known as "supercritical CO2". Supercritical CO2 behaves like a flowing liquid, much like WD40, and is injected directly into sedimentary rocks. The rocks can be found in old oil fields, gas fields, or saline formations - rocks with porous spaces filled with salt water. Unmineable coal seams and some volcanic rocks are also suggested storage sites.

Various physical structures prevent CO2 from escaping to the surface. These include impermeable "capacities" and geochemical trapping mechanisms.

3.1 Enhanced Oil Recovery (EOR):

This process is already understood and has been done for many years. In the United States, approximately 30 to 50 million tons of CO2 are injected into declining oil fields each year to increase oil production. This option is attractive for CO2 storage because the sale of the additional recovered oil can partially offset the injection costs. However, the subsequent combustion of the additional oil recovered by EOR will offset much or all of the reduction in CO2 emissions.

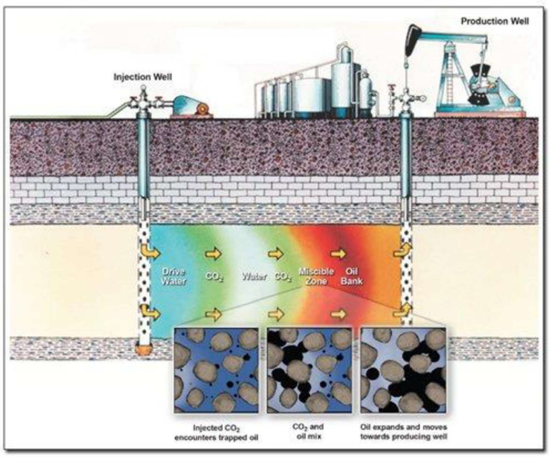

Fig. 5. Enhanced Oil Recovery [2]

3.2 "Unusable" Coal:

“Non-mineable” coal, i.e. coal that is too deep or difficult to extract can be used to store CO2. Coal absorbs CO2, provided the coal is permeable enough to allow CO2 to penetrate. During this process, the coal releases previously absorbed methane (CH4), which can then be recovered and used. This is called enhanced coalbed methane or ECBM.

The sale of CH4 can offset part of the cost of CO2 storage. However, as in EOR, combustion of the resulting CH4 would produce CO2, which would reduce some of the benefits of storing the original CO2.

3.3 Saline aquifers

Some deep rock formations contain highly concentrated brine (salt water). This is present in the pores of the rock and acts like a huge sponge. These are called "saline aquifers". The main advantage for CCS is their large storage potential and abundance. For example, large saline aquifers underlie much of the North Sea, continental Europe, and the Gulf Coast of Texas in the United States.

The main disadvantage of saline aquifers is that relatively little is known about them compared to oilfields. However, current research shows that several trapping mechanisms immobilize CO2 underground, reducing the risk of leakage. Unlike storage in oil fields or coal beds, there is no useful by-product to offset the cost of storage.

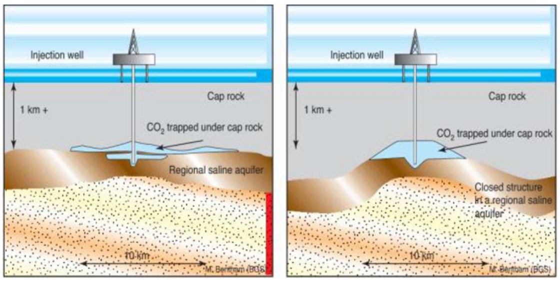

Fig. 6. Saline Aquifers [14]

3.4 Mineral storage:

In mineral storage, the captured CO2 reacts with the natural minerals iron (Fe), magnesium (Mg) and calcium (Ca). This is called "mineral carbonation" and occurs naturally as rock weathers over time. These minerals are very abundant and very stable. As a result, the re-emission of CO2 into the atmosphere does not occur.

However, these carbonation reactions are very slow under normal conditions and to speed them up would require energy to raise the temperature and pressure to ideal levels.

The IPCC estimates that a power plant equipped with CCS using ore storage will require 60-180% more energy than a plant without CCS.

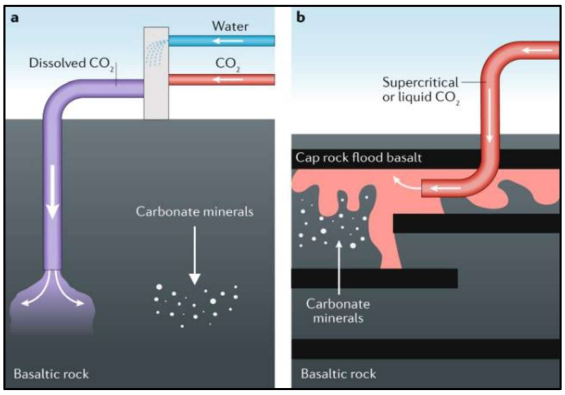

Fig. 7. Mineral Storage [15]

3.5 Forestation

Plants and trees store carbon in their biomass, including their leaves, stems, branches, and roots. As they photosynthesize, they take in carbon dioxide from the air and use it to build the glucose molecules that make up their tissues. In this way, they act as "carbon sinks," absorbing and storing carbon from the atmosphere. Forests are particularly effective carbon sinks because they are so large and contain so much biomass [9].

- **BENEFITS OF TREES: BEYOND CARBON OFFSETS**

Helping to reduce and offset carbon emissions is only one aspect of how trees help improve our lives. Some of the other benefits of trees are:

- Trees can absorb and retain water. As rainwater falls, much of it gets picked up by trees, preventing it from overwhelming storm drains. On average, a mature tree in a city can absorb up to 1,000 gallons of rainfall every year that would otherwise need to be pumped and filtered. In New York City, urban trees help retain nearly 900 million gallons of rainwater annually, saving the city more than $35 million dollars in stormwater management costs.
- Trees also provide social and economic benefits, such as creating jobs and helping raise people out of poverty and achieve sustainable development, ultimately improving our environment.
- Trees also provide health benefits, providing medicine and help clean the air.

- If you want to learn more about the benefits of trees, check out our Six Pillars on why trees are important.

- **Top 5 Oxygen Trees – Produce High Oxygen**

➢ **Bael Trees (Bel)**

Benefits of Bael Tree:

It has excellent benefits for various medicinal purposes. This medical tree has fragrant flowers to maintain a soothing aura around it. Bael tree has nutrients, vitamins, protein, and many more healthy qualities.

➢ **Arjuna Tree**

Benefits of Arjuna Tree:

It acts as an antioxidant, antimicrobial, anti-inflammatory. The tree reduces the risk of heart-related difficulties

➢ **Peepal Tree**

Benefits of Peepal Tree:

It is the best substitute for teeth cleaning and an Infallible medicine for toothache problems. It treats diseases such as constipation, asthma, blood-related issues, and diabetes. The leaves of the Peepal tree have asteroids, glucose, and phenolic. The bark of the tree has a high content of Vitamin K.

➢ **Neem Tree**

Benefits of Neem Tree

It treats leprosy, eye disorders, bloody nose, stomach bug, skin diseases, heart-related problems, and liver issues. The plant is versatile and enriches the air around it, giving a strong scent of purity to its surroundings. The neem tree is the highest oxygen-producing tree. It is considered a natural pesticide.

➢ **Banyan Tree (Bargad)**

Benefits of Banyan Tree

At night, oxygen trees produce a large amount of oxygen. It contains a huge amount of medicinal and herbal properties. Banyan trees ensure air purity and decrease the existence of CO2 in the environment. The oxygen plant tree protects from many diseases and infections.

4 List of CCUS projects across the world

While a limited number of large-scale capture facilities plan to send all the CO2 captured for use, several smaller-scale CCU facilities are also being developed that plan to source the CO2 from nearby industrial emitters:

➢ Announced in 2020, the North-C methanol project in Germany, part of the North CCU Hub, plans to use 65 000 t of industrial CO2 per year with electrolytical hydrogen to produce methanol.

➢ The US-based company Twelve uses electrochemical reduction to turn CO_2 into products ranging from plastics to aviation fuels.

➢ In Switzerland, Synhelion has developed a solar-based thermochemical conversion technology, with plans for the first plant to come online in 2023.

➢ Two North American companies, CarbonCure and Solidia Technologies, are leading the development and commercialization of CO_2 mineralisation in concrete, with 650 systems sold by CarbonCure to producers worldwide, the majority of them in the US. UK-based building material company Carbon8 deployed its first commercial CO2 container system in 2020 in France.

TABLE I: Advantages and Disadvantages Of CO2 Transportation

Advantages	**Disadvantages**
The transportation volume is large and the transportation cost is low.	The one-time investment of pipeline facilities are large.
Not affected by whether and traffic. Now special railway facilities need to be built.	The requirements for gas source and destination are high, and they need to be close to the railway.
Not limited by source and destination. There is no need to invest in the construction of transportation facilities.	Transportation cost are high. Vulnerable to weather and traffic conditions. Fuel and labour costs are high.
Good economy. Transportation technology is mature.	The temperature and pressure control requirements of the transport equipment are high.

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- *Policy incentives for low-carbon fuels and materials are supporting CCU development*
  - ➢ Public procurement rules in Canada and the Netherlands favour low-carbon material inputs for construction projects.
  - ➢ In the European Union, the Renewable Energy Directive (RED II) promotes the use of "recycled carbon fuels" as long as they generate emission savings of at least 70% relative to their fossil counterparts.
  - ➢ In 2022 government mandates in Norway, Sweden and France now require a 0.5%, 1%, and 1% blend of low-carbon fuels in aviation fuels, respectively, and the United Kingdom is currently consulting on a similar mandate.
  - ➢ In California, the Low Carbon Fuel Standard provides credits for fuels with a lower carbon intensity than the gasoline baseline, with credits currently trading at USD 90/ton of CO_2 avoided and as high as USD 200/ton of CO_2 avoided in the 2019-2021 period. This measure can be combined with the US 45Q tax credit, which has recently been increased through the Inflation Reduction Act to USD 60 per ton of CO_2 used, providing emission reductions are verified.

IV. CARBON TRANSPORT

After capture, the CO2 must be transported to suitable storage sites. Pipeline pumping is the cheapest means of transport and a well-known and reliable technology. There are 5800 km of CO2 pipelines in the United States carrying CO2 to oil-producing fields, where CO2 is injected to help produce more oil. This process is called enhanced oil recovery or EOR. However, increasing the number and carrying capacity of pipelines needed for a large-scale CCS industry will require additional pipeline safety studies, especially in heavily populated areas or areas of high seismic activity. Ships and tankers can also be used to transport CO2 for small-scale applications.

INVESTMENT

Over the past decade, global venture capital investments for CO_2 use start-ups has reached nearly USD 1 billion. Lanzatech, which uses the biological conversion of CO_2 into fuels, has raised over USD 500 million since its creation in 2005 and is now valued at USD 2.2 billion. In North America, the NRG COSIA Carbon XPrize, which supports the development of novel CO_2 use opportunities with a USD 20 million global competition, selected building materials companies Carbon Cure and Carbon Built to receive a USD 7.5 million prize. Governments have also allocated resources to deployment or have pledged to do so in the future. In 2021, the UK government announced a GBP 180 million funding package to support the design and building of sustainable aviation fuel plants in the UK. Governments in Canada, Japan, the United Kingdom and the United States, as well as the European Commission, are also providing significant RD&D support for CO_2 use. In the Netherlands, the sustainable energy transition subsidy scheme (SDE++) is being used to develop an advanced methanol plant in Amsterdam.

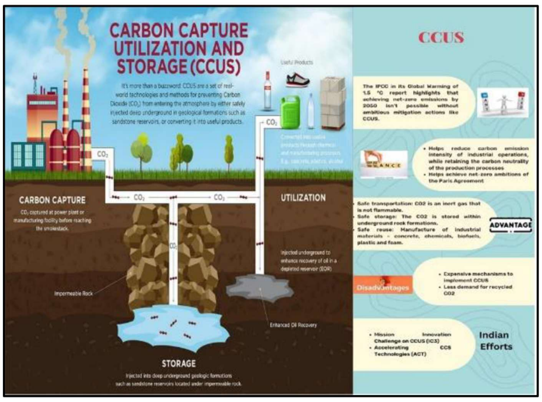

Fig. 8. Carbon Capture Utilisation and Storage (CCUS), picture credit: Insight on India [16]

V. CONCLUSION

Carbon Capture, Utilization, and Storage (CCUS) is a set of technologies and processes that aim to reduce carbon dioxide emissions from industrial and energy-related sources. Carbon Capture technologies include post-combustion capture, pre-combustion capture, and oxyfuel combustion. Carbon Utilization technologies include using CO2 as feedstock for producing chemicals, fuels, and other valuable products, and Enhanced Oil Recovery (EOR). Carbon Storage technologies include geologic storage, ocean storage, and terrestrial storage.

Geologic storage involves injecting CO_2 into deep, underground formations, ocean storage involves injecting CO_2 into the deep ocean, and terrestrial storage involves using CO_2 to enhance the growth of plants and trees. CCUS is considered an important strategy for reducing greenhouse gas emissions and mitigating the impacts of climate change. It is also important to note that the implementation of CCUS requires significant investment, technology innovation, and policy support.

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THE NUMERICAL ANALYSIS OF THE AUTOMATIC CENTRIFUGAL FILTER USED IN MERCHANT VESSELS

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ABSTRACT:-

Oils used for lubrication and fuel can be filtered to get rid of contaminants like cotton threads, paint chips, tiny pieces of metal, and other things that could damage engines and pumps. Even though filtration cannot distinguish between water and oils, water can be vaporized by adding heated lubricating oil to a vacuum chamber. Cartridges that separate the oil and water using water coalescing and water repellent filters. Automatic filters or auto-flushing filters contain permanent, metal-screen type filters that self-purge to maintain a clean screen for continued operation. The ANSIS 14.2 codes are used to analyse the flow of fluids through the nozzles, leading to reaction force to rotate the hollow rotor. Experimental data with validation of numerical study for fluid flow leads to getting optimum RPM of rotor. The k-ω fluid flow Navier Equation is used in the computations, which leads to the calculation of the optimum velocity of the fluid through the nozzles. The results of the parameter analysis of the automatic filter and the system data were also compared to corroborate the computational fluid dynamic findings. It was discovered that at 1430 rotor RPM, the nozzle achieves the maximum fluid velocity.

Keywords: Centrifugal filter, Engine lubrication oil system, Fluid velocity, Filter efficiency, Fluid model

I. INTRODUCTION

It is a common and well-known practice to purify fuel and lubricant oils on board ships. Typically, three techniques are used: centrifugal purification, filtration, and gravity. Settling tanks are used for the gravitation process, which is primarily used for oil fuels. Mediums with a relative density greater than the oil tends to the bottom of the tank when the oil is left to stand in peace, where they are regularly discharged through a manually controlled sludge cock. Heating the tank's contents can help, speed up the separation process there. Steam heating coils are typically employed when they can heat the contents, but it is important to take care not to overheat the oil.

The most basic sort of filter is the wire mesh type, which is fitted in pairs in the system. There are many different types of filters produced. The user of duplex filters can clean the inactive filter without switching off the oil system. Automatic centrifugal filters are completely maintenance-free and are cleaned as they filter. However, most auto-flushing filters have a limited filtering capability and cannot provide 5-micron particle control. In addition, each cleaning cycle produces sludge that must be handled and adequately discarded, and during the filtration of mildly incompatible fuel oils, the back-flushing frequency can be as many as 400 flushes per day, which produces a considerable volume of sludge refuse.

II. LITERATURE REVIEW

The ratio of processed foreign particle numbers to all particle numbers that pass through the filter determines the filtering efficiency. As a result, Equation (2) can be used to explain the filtration efficiency.

$$Filter\ Efficiency\ = \frac{Particles\ number\ filtered}{Total\ particles\ entery} x100$$

-----------(1)

Young-Seok Pyo et al. [1] shows the filtration efficiency according to the density and size of the particle. Under high density of particles, the filtration efficiency is higher and at low density, the filtration efficiency is limited. According to D. E. Smile [2], for materials whose permeability and effective stress are clearly defined functions of the water content, the early stages of automatic filtration are characterized by a differential equation non-linear Fokker-Planck equation cast in a fluid coordinate based on the distribution of the solid phase. The study predicts that during the "early phases" of the process, relatively non-uniform solid and liquid profiles are seen, and experiments using sodic bentonite have proven this. These profiles emerge in a manner that is essentially similar to that of constant system pressure filtering. According to Yong-Keun Kim et al., [3] as water and solid particles build up in oil used for cooling and lubrication in marine engines over time, it loses its ability to fulfil its initial function. As a result, techniques using the Bernoulli equation to remove water from oil were researched and suggested.

According to Jung, Ho-Yun, et. al., [4] a fluid model and the shear stress transport k- turbulence model was employed. The Moving view of rotor approaches has been developed to consider the rotational influence of the flows. The filtration efficiencies have been assessed under various conditions, including particle size, particle density, and rotating speed. It has been demonstrated that increasing the particle size, particle density, and cylindrical chamber rotation speed results in greater filtration efficiency.

This research aims to determine the ideal RPM for the automatic filter by numerically analyzing the fluid flowing through the nozzles of a centrifugal filter and system cleanliness.

III. EXPERIMENTAL SETUP

The experimental model is located at the Training Ship Prabhu-Vidys on the campus of the Tolani Maritime Institute at Induri, Pune, 410507. The Cummins KTA1150G power generator is the subject of the investigation shown in Figure 1. The Cummins generator is used in the current investigation to run on various grades of oil. Table 1 shows parameters on centrifugal filters, including rotor revolution per minute and filtered size particle. Table 1 and Figure 2 make it clear that when velocity rises, rotor RPM also rises, increasing the centrifugal force needed to remove foreign particles from the system fluid. In order to achieve the specified rotor RPM, the rotor nozzle diameter must be optimised to achieve maximum fluid flow through the nozzle.

The reaction turbine principle underlies how it works. The body and rotor of the centrifugal filter assembly have two opposing nozzles on them. By way of the engine lubricating oil pump, fluid is pumped into the automatic filter. The oil flow enters a hollow spindle before leaving through a cross-drilled hole in the filter rotor. The nozzles in the rotor base are used to release the pressurized oil that has filled the rotor and are radially positioned on a hollow shaft. Centrifugal force eliminates foreign particles from the lubricating oil as the velocity increases and the reaction force in the rotor causes the entire fluid inside the filter to revolve.

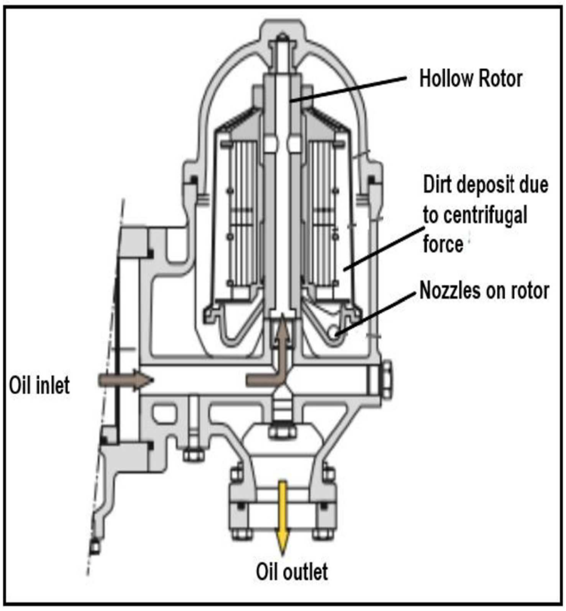

Fig. 1. Centrifugal automatic filter

Table 1: Parameter of centrifugal filter

RPM	Size µm
3250	100
1860	33
1350	25
1050	12
950	3.5
750	1

Table 2: Flow velocity vs nozzle diameter in mm

S. No.	nozzle radius mm	Flow velocity mm/s
1	12.55	119
2	15.5	94
3	19	76
4	28	53
5	34	45
6	38	38
7	63	23

3.1 CREATION OF REACTION FORCE

Assumptions: The fluid is non-Newtonian. The pressure is equal in the chamber.

Parameter of flow oil flow Q: 3000 ml/sec

The cross-section area of each nozzle: 15.90 mm2

The radius of hollow shaft nozzles: 150 mm

Streamline speed = $W_2 = \frac{Q}{2} * A_2$

$$= \frac{3000\text{ml/sec}}{2} * 15.90\text{mm}^2$$

W2 = 94.34 m/s

RPM of rotor = $\frac{\text{axial velocity}}{\text{radius}} = \frac{94.34\ m/s}{150mm}$

n= 0.62 rad/s

$$X = 2\pi n \frac{1}{60\ N}$$

--------(2)

$$N = \frac{60 * 94.25}{2\pi\ 0.62}$$

--------(3)

N = 1430 RPM

The rotor RPM 1430 is calculated for a 4.5 mm rotor nozzle diameter using equations (2) and (3) as per Tables 1 & 2. Refer to Figure 3 for the location and orientation of the centrifugal filter installed in the training ship's Cummins generator to continuously remove of small wear particles.

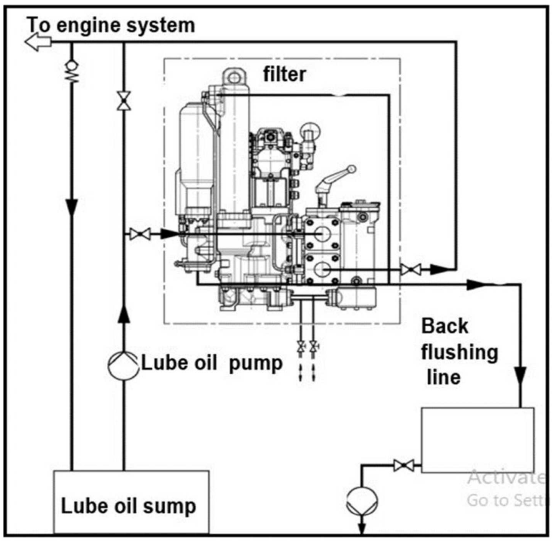

Fig. 2. Lubrication system line

3.2 Numerical analysis of Rotor

The automatic filter rotor with nozzle's numerical analysis is done using the ANSIS 14.2 code and the k- w turbulence model. The k-omega (k- w) fluid model is a two-differential equation flow model for the numerical analysis of centrifugal filter flow. The model attempts to forecast fluid flow using two partial differential equations for two variables, k and w. Where 'k' is the energy of turbulent flow and 'w' is the rate of the heat transfer function. This k- w turbulence model is selected in this study due to it performing well under unfavourable velocity gradients and in the presence of turbulence flow in the nozzle orifice. Referring to figures 3 and 4, the meshing of the nozzle is carried out with an 8 mm in rotor diameter and an orifice that is 4.5 mm in diameter.

IV. RESULTS AND DISCUSSION

Centrifugal experiments were carried out to identify the system's phenomena. This experiment revealed that the lubricating fluid velocity is higher

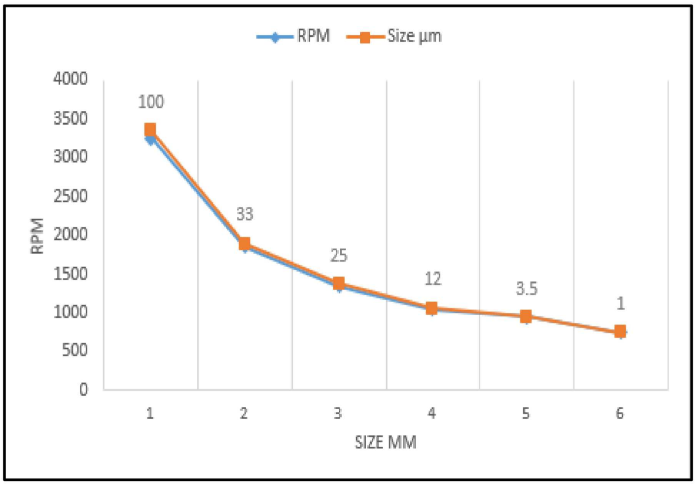

Fig. 4(a). Analysis of Rotor Parameters

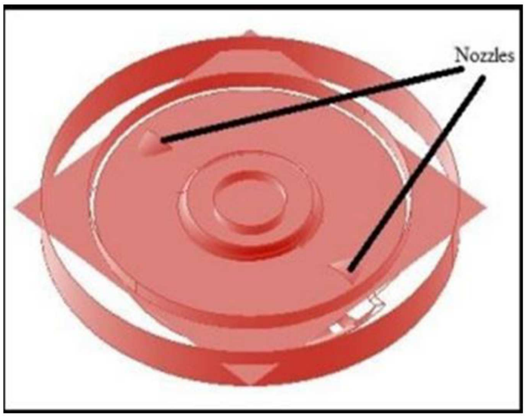

Fig. 4(b). Rotor of a centrifugal filter

at the nozzle exit, measuring 0.0037 m/s with a 2.25 mm nozzle radius as per Figure 4 and shown by Jitendra Singh Pal et. al [8]. Under pressure and flow, rotational energy is converted into speed up to 1430 RPM as the oil exits through the jets. Refer the Figures 5 to 9.

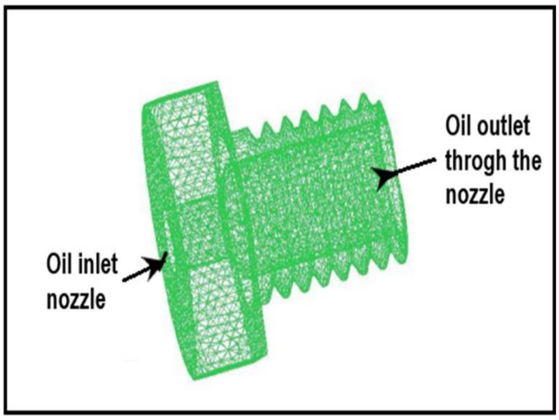

Fig. 5. Meshing of the nozzle of the rotor of the centrifugal filter

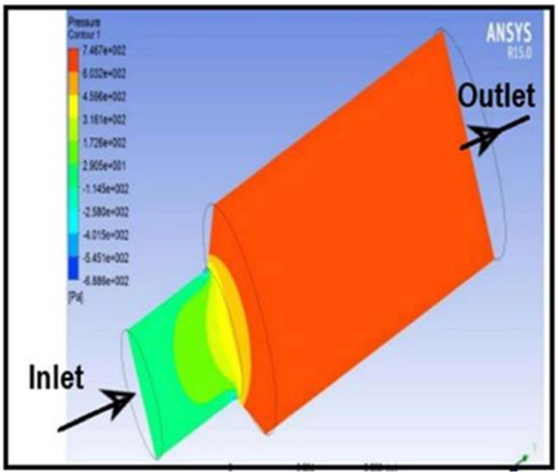

Fig. 6. Pressure contours of the nozzle

4.1 Significance of fluid flow analysis

Figure 6 and 7 shows the pressure contours of the nozzle. Pressure contours are used to illustrate the magnitude of a variable on the surfaces through the nozzle. Here we see the high and low-pressure areas in the inlet and outlet of the nozzle of rotor. Red colour shows the highest pressure and blue indicates the lowest pressure and a constant colour change represents the range in between. Figure 8 shows the velocity contour of lubricating oil passing through the nozzle. The flow direction and magnitude at each place in the mesh are shown by velocity vectors. The arrow points in the direction of the flow, while the length and colour indicate the size.

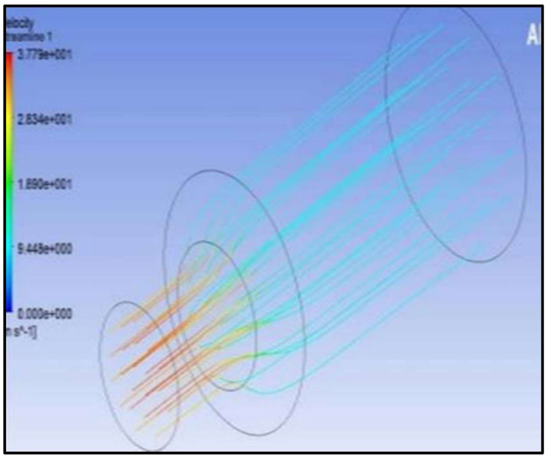

Fig. 7. Streamline the contour of the nozzle of the rotor

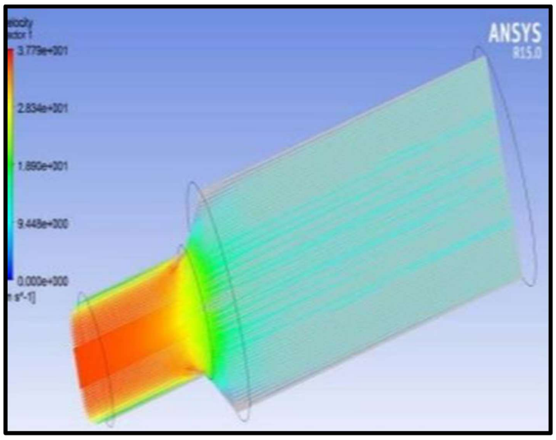

Fig. 8. Velocity contour of the nozzle

V. CONCLUSIONS

The automatic filter hollow rotor nozzle's flow velocity is at its peak at 4.5 mm in diameter when the rotor's RPM is 1430. The simulation (ANSIS 14.2) was run repeatedly with different nozzle diameters, and it was found that for a given flow rate and fluid boundary condition, a 4.5 mm diameter nozzle produces the best flow velocity. The resulting centrifugal force removes dirt and wears particles from the engine oil and deposits them in a dense cake form on the inner wall of the rotor. Clean oil is gravity-fed back into the engine oil sump. Five times in 24 hours, the full sump oil is cleaned by cleaning the 15% lubrication system oil. It produces the ideal lubricating oil balance and requires minimal engine maintenance.

VI. ACKNOWLEDGEMENTS

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THE ENERGY EFFICIENCY OF SHIPS USING SOLAR POWER

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ABSTRACT:-
Changes in climate, rising prices of bunker fuel, and superimposed international regulations on pollution and CO2 emissions are the three main issues the shipping sector must address. Reduced fuel use can address all of these problems. Compared to other forms of transportation, shipping already has very high energy efficiency, but it may and must be increased. To that degree, there are numerous technical and operational options. However, because ships are intricate systems, determining their real and long-term effects on fuel usage is far from simple. Using safe and renewable energy sources, such as solar energy, is suggested as a way to increase efficiency of the ship. Since most of a ship's top decks are highly exposed to the sun, especially in tropical areas, ships can profit from solar energy. The article provides a case study of how installing solar panels on cargo vessels can save electricity. The advantages and all the complications which come on the way while installing solar panels for the generation of auxiliary power on board a ship is covered in the research.

Keywords— environment, solar energy, container vessel emissions, energy efficiency

I. INTRODUCTION

The maritime industry releases approximately 1 billion tons of carbon dioxide each year, accounting for 2.5% of all fuel-related greenhouse gas pollution worldwide. Depending on future energy and economic changes, shipping emissions may rise by 50 to 250 per cent by 2050. Despite shipping's clear CO_2 efficiency in terms of grams of CO2 emitted per ton-km, the shipping industry is aware that these totals must be reduced. By implementing of emission control zones and requirements on freshly constructed marine diesel engines, recent law seeks to reduce these emissions. The price of gasoline has a big impact on the maritime sector. Also, remember that the vast bulk of ships uses fossil fuels for propulsion. This energy supply is finite, and its price has taken the lead among expenditures. Due to the historically nearly constant increases in fuel costs, the situation will not improve. In light of the need for energy efficiency and the need to stabilize or decrease emissions, and the shipping industry must find solutions. The use of renewable sources of energy (Wind, sun, etc.) was among the potential solutions when the IMO announced "Technical measures," "Operational measures," and "Economic instruments" in 2010 as measures to reduce CO_2 emission.

The primary goal of installing renewable energy systems on merchant vessels is to reduce fuel consumption, and there are a number of ways to achieve this goal, including the use of sails, kites, electricity from ports, bio-diesel in place of conventional wind turbines, diesel oil, hydrogen fuel cells, and photovoltaic panels.

We can claim that future ships will contribute way less to pollution by considering technological progress. However, it is clear that the only way to lessen the environmental impact of the shipping industry is to create hybrid systems based on various alternative energy sources, given the significant amount of energy a ship uses. However, the research on shipboard renewable energy infrastructures is still in its early stages due to the significant hurdles that this application still faces. Solar energy is one of the sustainable energy sources that can significantly contribute to meeting the rising energy demand and preserving the finite supply of fossil fuels. In order to decrease the consumption of fuel oil and greenhouse gas emissions, this paper seeks to investigate the viability and environmental impact of using solar energy as an additional power source on container ships trading in west Africa.

II. GENERATION OF SOLAR ENERGY

The development of photovoltaic systems results from energy generation using increasingly depleting conventional sources (SPV). The technical word for producing electricity from light is photovoltaic. It is quickly emerging as a crucial industrial product in the current environment of energy production.

An SPV produces electrical energy and, after storing it in a battery reserve, uses it to power various devices. Regardless of the system setup, the SPV panel is the essential part. The panel's building elements are solar cells. A complete system consists of various parts that are chosen while taking into account the requirements of the individual, the location of the site, the climate, and the expectations. Its functional, and operational needs to determine the components needed for the PV system.

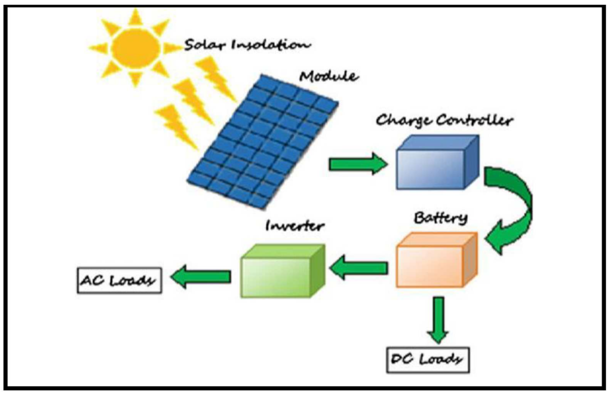

Fig. 1. SPV system equipment.

As seen in Figure 1, the main parts of a PV system include a DC-AC power converter, a battery, a system with a battery controller, auxiliary energy sources, and occasionally the designated electrical loads.

PV module: It transforms solar energy into DC electric power.

Inverter: It transforms DC electricity into usable standard AC power.

Battery: When there is an energy surplus, a battery holds it and releases it when there is a demand. Solar PV cells continually recharge batteries daily to keep them charged.

Auxiliary energy source: Utility power is provided automatically at night or in the daytime when the requirement exceeds solar electric power output.

Charge controller: It limits battery overcharging and extends battery life of the Solar system. Wiring, over-current surge protection and disconnect devices, as well as other power handling equipment, are additional components of the system hardware.

A variety of factors influences the use of solar PV systems for ships, but primarily by:

There must be enough deck space for the solar panels to be installed, there must be solar radiation available in the ship's operational regions, and the solar panel system must be technologically and economically efficient in terms of energy output, fuel costs, and investment costs.

III. SHIP ELECTRIC POWER LAYOUT

The standard electrical power distribution for container ships is shown in Figure 2, where there are typically two sets of or more diesel generators installed on board, one of which has enough capacity for the vessel to operate normally and the others are in reserve. Standby mode can be used to take over in the event that an operating generator breaks when additional intermittent power is required, such as during manoeuvring, crane operation, etc. A propulsion motor may run one generator. known as a "shaft generator"

The voltage is typically 440V, but in some big installations, it can be as high as 6.6KV. Bus bars are used to carry and transfer loads, and transformers provide the lower voltage needed for things like lighting, navigation equipment etc.

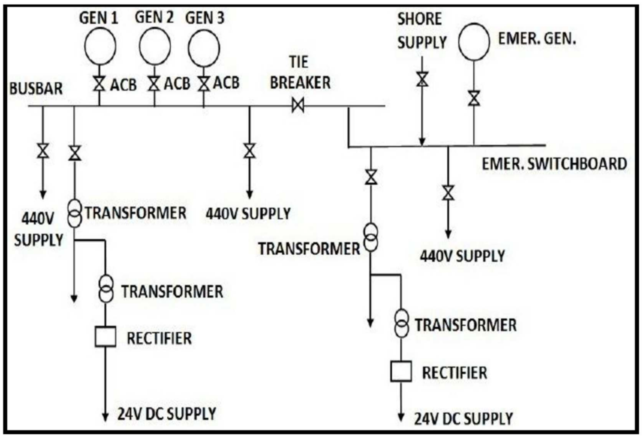

Fig 2. Ship's electrical power distribution

IV. CASE STUDY

We selected a container ship operating regularly between Indian and Gulf ports as our sample. Table 1 provides details of its features.

TABLE I. MAIN PARTICULARS OF THE VESSEL

Type	**Container vessel**
Length /Beam	158.7 / 24m
Net Tonnage	6478
Propulsion Engine	10010 KW
Diesel generators 3 sets:	930 KW each
Emergency generator	161 KW

Three diesel generator sets and an emergency diesel generator are installed on the ship. Table II compiles information from this ship's electric energy balance while at sea, in the harbour, and in an emergency. We can infer from Table II that, in the worst-case scenario, 30 KW will be required to furnish all necessary consumers for the vessel's safety (emergency lighting, Navigating lights, radio equipment and alarm systems).

A. Solar radiation in Ship's route

One of the factors to consider when determining whether solar energy can be used in a particular area is the quantity of solar radiation. Our ship carries containers on a regular route between ports in Gulf and India. There is excellent PV potential in these two areas.

The map in Figure 3 leads us to believe that the lowest annual average solar radiation is approx. 2000 KW/m2.

The general formula (1) to calculate the amount of electricity produced by a photovoltaic system is:

$$E = Apv \times \eta \times Ha \times Pr \quad \text{----- (1)}$$

Where E is the energy (kWh), Apv is the total area of solar panels (m2), and is the efficiency η (%). Pr is the performance ratio, a loss coefficient covering all losses (range between 0.5 and 0.9, default value = 0.75), and Ha is the annual average solar radiation on slanted panels (shadings not included).

TABLE II. VESSEL ENERGY BALANCE

			At Sea			Harbor			Emergency	
	Mode	Rated power	DF	CL	IL	DF	CL	IL	DF	CL
Inner lighting	C	22.7	80	18.6	0	80	18.16	0		
Outdoor Lighting	C	18.8					15			
Emerg. lighting	C	12.6	80	8.24		99	12.3		99	12.4
Radio & Navigate. Equip.	C	12	80		8.8	80			80	10.6
Battery charger	C	2.8	40		0.7	80		0.7	80	2.1
Navigate. & signal light	C	4.4	80	3.2		80	4.2		80	3.9
Total loads	C			29.74	11.1		34.96	0.7		29
Diversity factor of intermittent loads			0.3			0.3			1.0	
Total necessary electric power (kW) for safety and emergency use			11.74			16.8			30	
ABBREVIATION: For Working Mode (WM): "C" Means Continuous, "I" Means Intermittent, "L" Means Less Use; For each condition, "D.F." Means Demand Factor, "C.L." Means Continuous Load, "I.L." Means Intermittent load										

B. Free deck Space available on the ship

Figure 5 shows the deck space in parts, with the fore section covering the forecastle deck and the aft area surrounding the poop deck and the superstructure.

We can protect about 650-750 m^2 by installation of fixed panels above the superstructure, poop and forecastle deck, and floodable panels between the superstructure and No. 3 hatch.

C. Solar PV sizing

A variety of factors, including load consumption, solar radiation availability, battery and inverter efficiency, module performance, etc determines the size of PV modules.

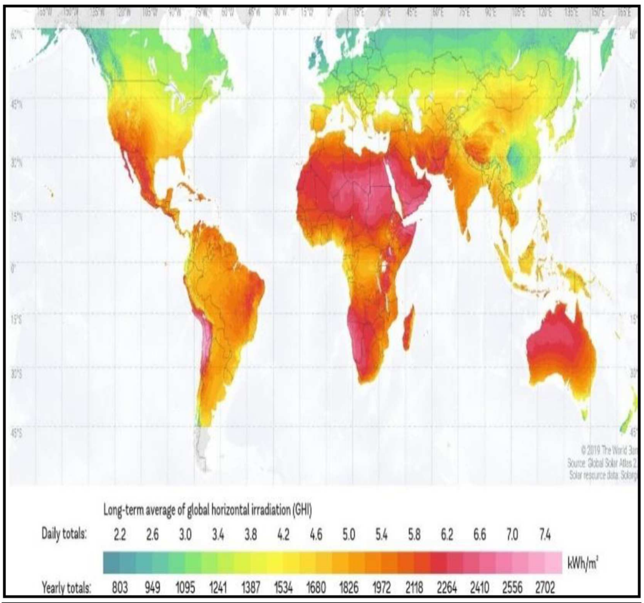

Fig. 3 Solar radiation map (Gulf - India).

a) Calculating the load demand:

We have already determined that the electrical power requested (Pt) for safety and emergencies is 30 KW based on the ship's energy balance (TABLE II).

So, the total load energy ($Et(KWh)$ per day is:

$$Et = 720 \text{ KWh} \quad (2)$$

The PV array should cover the average daily energy consumption with the nominal operating voltage.

Load demand (Io) in Ampere – hour is defined by formula (3)

$$Io = Et/\eta i.Vn.\ \mu b \quad (3)$$

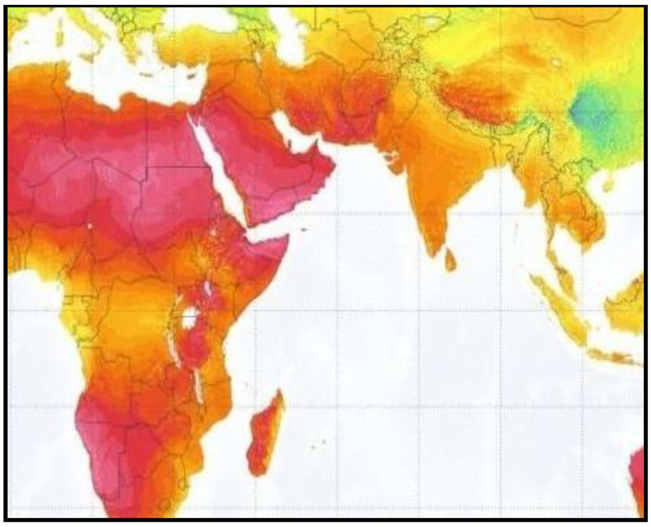

Fig. 4. Solar radiation map(Gulf-India)

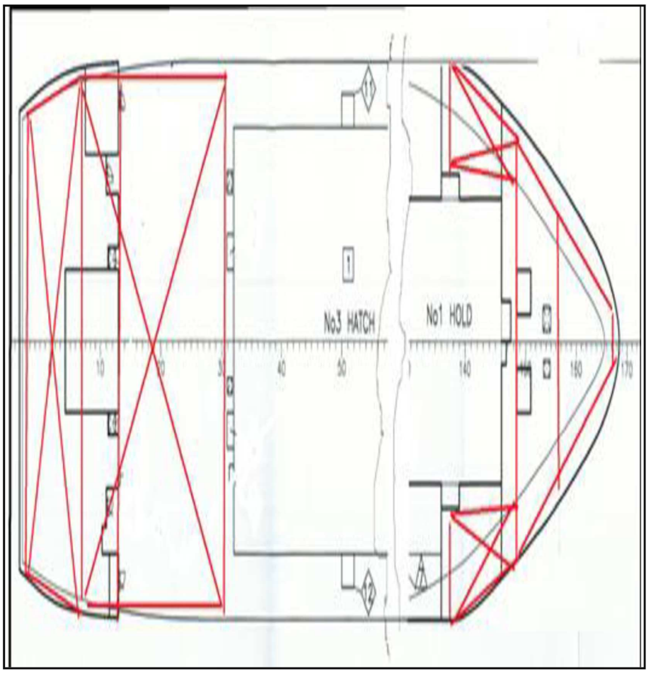

Fig. 5 Ship deck plan

With:

ηi: Inverter efficiency (0.9)

μb: Battery efficiency (0.8)

Vn: Nominal voltage (227V).

An example of solar PV panel specifications for industrial use is summarized in TABLE III.

b) Battery capacity:

The required battery capacity (Bc) can be calculated by formula (4):

Bc = Io. Td/DoDmax (4)

Td: Autonomous days.

$DoDmax$: Maximum depth of discharge of battery.

c) PV design current:

PV design load current (peak current) (Id) can be obtained from formula (5):

Id = Io/hs --- (5)

hs is the lowest daily sunshine.

Rated design current (Id) depends on the PV module global performance, formula (6).

Im = Id/µm --- (6)

$\boldsymbol{\mu m}$: PV module derate factor, coefficient for losses, it includes all losses.

a) Number of PV module in parallel (Np):

Np=Im/Ip --- (7)

Ip: Max peak current for selected solar PV panel.

b) Number of PV module in series (Ns):

Ns = Vn/Vp --- (8)

Vp: Max voltage of selected solar PV panel

TABLE III. DETAILS OF THE SELECTED PV MODULE

Type	PERC 350 Wp SPV
Nominal maximum power in watts (W)	350
Open Circuit Voltage (Voc) in Volts	46.4
Short Circuit Current (Isc) in Amps	9.80
Voltage at Maximum Power (Vp) in Volts	37.5
Current at Maximum Power (Ip) in Amps	9.35
Maximum System Voltage in Volts	1000
Module Efficiency (%)	18.5
Length x Width x Thickness (mm)	1960 90 x 40

IV. DISCUSSION

We can infer from TABLES III and IV that we should install 749 modules of SPV panels in order to deliver 30 KW of consumer power on board. Each has a surface area of 1.9× 0.9 m2. A minimum of 1280 m2 is needed to fit 749 panels.

The maximum amount of deck space in our sample ship is 720 m2, which will only cover power at half the required rate, or about 15 Kw (TABLE II), needed for emergency lighting, radio and navigational devices, and an alarm system.

TABLE IV: SUMMARY OF CALCULATIONS

Parameter	Formula		30KW	15KW	Unit
Total energy demand (EWh)	_		720	360	KWh
Load demand (Io)	(3)	ηi = 0.9; µb = 0.8; Vn =227V	4.405	2.202	KAh
Battery Capacity	(4)	Td = 1; DoDmax= 0.8	5.506	2.753	KAh
PV panel rated design current (Im)	(5)-(6)	hs= 6; µm=0.75	1000	500	KA
Number of panel in parallels (Np)	(7)	Ip= 9.35	107	54	_
Number of panel in series (Ns)	(8)	Vp= 37.5	7	7	_
Total number of panels	$Np \times Ns$	_	749	375	_

15 KW is equivalent to 0.2% to 0.3% of the overall electricity needed to power all ship electric equipment.

A. Environmental analysis

Diesel generators that burn fuel oil generate the electricity used on board. The four-stroke engine's specific fuel oil usage is approximately SFOC 210 g/Kwh.

IFO 180 and MGO are typically the marine fuel oils used for diesel engines. IFO has an emission ratio of approximately 3.15 kg CO2/kg FO.

Diesel generators need 2.4Kg of fuel oil per hour to produce 15KW. This is the same as saving 58 kg per day and 0.575 tons of CO2 by using solar electricity.

The fuel oil saved is insignificant when we compare it with the overall amount of fuel oil used by the ship's propulsion system and the creation of electricity (18 tons per day for the case study).

When considering the 300 days of solar radiation per year, fuel oil efficiency could amount to 17 tons of fuel oil and 172 tons of CO2.

In addition to the ecosystem, and based on typical market fuel oil prices: 991.5 USD was spent on a ton of gasoline.

$Fuel\ cost\ save\ per\ year = 17 \times 991.5 = 16855.5\ USD.$

B. Economic benefits

Numerous economic research studies showed that the entire investment in PV solar system will be repaid within approximately 10 years, considering that PV modules come with a guarantee for 25 years, batteries for 5 years, and other equipment like invertors for at least 10 years.

C. Safety aspects

In our study, solar energy is completely unrelated to the ship's mechanical systems, making it a viable substitute for the ship's emergency power source for emergency lighting, navigational equipment, communication equipment, and alarm systems.

VI. CONCLUSION

The current article explains that solar energy from PV can be used as an alternate or a backup source for auxiliary power on small container ships or just power equipment required for the ship's safety in case of any kind of mechanical failure. In a result, it will help us cut down on fuel oil use and greenhouse gas pollution. According to economic studies, energy payback estimated for marine PV systems are less than 10 years. However, the marine PV system's capacity is still quite less when compared to the total requirements of a ship, so its success in lowering fuel usage and pollutant emissions is not particularly noteworthy**.** The biggest obstacles to be overcome are: The ship's size and cargo requirements restrict the amount of deck space that can be exposed to the sun and the solar PV system's efficiency and capacity are still insufficient to meet ship requirements.

VII. ACKNOWLEDGEMENT

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REDUCING EXHAUST GAS EMISSIONS GHG, NOx, SOx, and PMs: A REVIEW

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ABSTRACT:-
By simultaneously considering climate, health, and environmental impacts and using solutions that fit into existing ship engines and infrastructure, you can maximize the impact of reducing ship emissions. Several available options allow you to choose the best solution for different ships, routes, and regions. Carbon-neutral fuels, including low-carbon and carbon-negative fuels, may resemble current marine fuels (diesel, methane, and methanol). Fuel carbon neutrality depends on well-to-wake (wet) emissions of greenhouse gases (GHG), including carbon dioxide (CO2), methane (CH4), and nitrogen oxide (N2O) emissions. Toxic substances such as NOX, SOX, CO2, and PM contained in exhaust gases are extremely harmful to the environment and human health. To combat the negative effects of ship emissions and increasingly stringent emission regulations by the IMO and governments, the shipping industry is adopting new clean energy and highly efficient exhaust gas cleaning technologies to reduce ship emissions. Exhaust gases that are harmful to health and the environment must be equally removed by exhaust gas cleaning using fuel, engine, or exhaust after-treatment technology. Particulate matter can contain polycyclic aromatic hydrocarbons (PAHs) and heavy metals that pose serious health problems. Carbon-neutral fuels typically do not contain Sulphur, so SOX emissions are negligible, and efficient exhaust after-treatment technologies such as particulate filtration can be used. The significant reduction in the external costs to society caused by ship emissions will justify the regulations, policies, and investments needed to support this development. For this purpose, specially designed water baths were used, equipped with perforated pipes submerged in water and providing water circulation to maintain water purity. Exhaust gases from the diesel engine were sent through perforated pipes to a water bath so that the exhaust gases were completely "cleaned" before being released into the atmosphere.

Keywords— EEDI, EEXI, Water Bath, IMO, EGR, etc.

I. INTRODUCTION

Ship emissions have a negative impact not only on the climate but also on-air quality, human health, and the environment. Air pollution alone is estimated to kill about 6.5 million people annually. Despite the 0.5% Sulphur limit in marine fuels in 2020, transportation is estimated to be responsible for about 250,000 premature deaths and 6.4 million childhood asthma annually. Previous assessments suggest shipping accounts for approximately 15% and 13% of global anthropogenic nitrogen oxide (NOx) and SOX emissions. Particulate matter (PM2.5) emissions from ships vary by region, with Africa accounting for 7% of the region's total 4% in Europe, 4.2% in North America, 3.4% in Southeast Asia, and 22% in Oceania.

The global fuel market is still adapting to the changes implemented by the IMO 2020. The difference in the Sulphur limits, reduced from 3.50% to 0.50%, has widespread effects on the global refining and shipping industries, disrupting the demands for specific bunker fuels. The demand for high-Sulphur fuel oil (HSFO) has dropped as shipowners must explore their ships' options. As a result of the shift from HSFO to very low Sulphur fuel oil (VLSFO), the fuel oil market is breaking down into three sectors. The market will consist of VLSFO, high Sulphur straight-run fuel oil (HSSR), which comes directly from a crude unit, and cracked HSFO (a by-product from sophisticated refining methods). Of GHG emissions, CO2 is the most critical contributor to global warming, while important gaseous contributors also include methane (CH4) and nitrous oxide (N2O) emissions, with 100-year global warming potentials (GWP100) of 28 and 265 times higher than that of CO2, respectively [8]. However, the second important anthropogenic species contributing to global warming after CO2 emission is non-gaseous black carbon (BC) emission with a GWP100 of 900 [9]. IMO regulates SOX and NOx emissions from ships and is a regional or global regulation where BC (PM and PN are indirectly linked) and CH4 emissions are expected. SOX emissions

are declining with the IMO global fuel Sulphur limit (or SOX scrubbers used) of 0.5% in 2020, already reduced from 4.5% to 3.5% in 2012. IMO also has regional emission control areas for SOX (SECA, 0.1% Sulphur limit in 2015) and NOx (NECA, effective from 2021 for new buildings). Ship emissions to the atmosphere are products of the complete combustion of fuel (such as CO2 and SOX) or oxidation of intake nitrogen (NOx), some of which are products of incomplete combustion of fuel. B. Hydrocarbons (HC, including CH4)., carbon monoxide (CO), formaldehyde, PM and its components (BC, polycyclic aromatic hydrocarbons (PAH)), particle number (PN) emissions. Exhaust after-treatment systems produce pollutants such as nitrogen dioxide (NO2), ammonia (NH3), and N2O. Heavy metal emissions can also come from fuel, lubricants, and engine wear SOX and NOx emissions impact terrestrial and aquatic ecosystems through the eutrophication of water bodies by acid rain and nitrogen nutrients. NOx emissions into the atmosphere combine with organic compounds to form ground-level ozone in the presence of heat and sunlight. In addition, NO emitted from the engine gradually oxidizes in the atmosphere to NO2, adversely affecting the respiratory tract and reacting with nitric acid (HNO3). Although the contribution of NO2 to engine emissions is low, increased NO2 production from oxidative after-treatment devices such as diesel particulate filters (DPFs) and catalytic converters is known and the use of these technologies on ships should be considered. Shipping is a significant contributor to overall NOx emissions, especially in ports, resulting in higher atmospheric concentrations of NOx near port communities and in urban centers ports. This overview-discusses ways to reduce ship's air emissions, focusing on
1)emissions that contribute to global warming and
2) air emissions that have a detrimental impact on human health and the environment consider Marine engines and CO2 neutral fuel and emission control options are presented, and emission factors for large engines above 40% engine load are presented. Some solutions are compatible with existing vessels and infrastructure, while others require new construction and are long-term options. This report focuses on technologies that may fit existing vessels (upgradeable). Carbon-neutral fuels here refer to a variety of fuels, from low-carbon to carbon-negative, that offset fuel pool emissions
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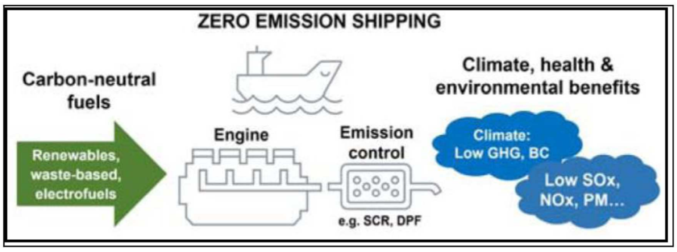

Fig.1. Zero Emission Shipping

II. METHODS TO REDUCE EXHAUST EMISSIONS FROM SHIPS

Alternative fuels

Maritime transportation moved from coal to diesel in the 1920s and to heavy oil (HFO) in the 1950s. Today, due to the changing regulations to mitigate the negative effects on human health and the environment, the shift towards alternative fuels becomes an important option for reducing emission rates and complying with rules issued in favour of the sustainability of maritime transport [1]. With regulatory changes to mitigate the negative impacts on human health and the environment, switching to alternative fuels will reduce emissions rates and support ocean sustainability. It is becoming an important option for complying with established regulations. In addition to low-Sulphur marine fuels, other fuels that can contribute to compliance include liquefied natural gas (LNG), liquefied petroleum gas (LPG), methanol, biofuels, and hydrogen [2]. HFO has a maximum Sulphur limit of 3.5% w/w, but refinery recovered MGO contains less than 0.1% w/w Sulphur when mixed with residual fuels. Low Sulphur blended fuels such as B. Fuels currently used in emission control areas will increase at high utilization rates. As a result, new types of low-Sulphur fuels are emerging that require vessels to be prepared for processes such as deployment, transport, and use.

LNG is the cleanest fossil fuel available today. Its main component is methane (CH4), the lowest carbon hydrocarbon fuel. This also makes it an alternative fuel with the highest potential to reduce CO2 emissions. LNG refining removes carbon dioxide and Sulphur during the manufacturing process. Therefore, no Sulphur oxides are emitted. In addition, nitrogen oxide emissions are lower than for the HFO and MGO and,
compared to the most widely used high-sulphur fuels, LNG has reduced CO2 emissions by about 25%, nitrogen oxides emissions by 85–90%, and sulphur oxides emissions close to
100% [3]. Since the boiling point of LNG is about –163°C at 1 bar absolute pressure, its storage must be in insulated tanks 2.5–3 times larger due to the smaller density and the

required thermal protection. The price level of LNG is currently competitive with MGO [4]. Furthermore, NOx emissions are lower than HFO and MGO, and

LNG reduces CO_2 emissions by approximately 25% and reduces NOx emissions by 85% to 85% compared to the most used high-Sulphur fuels. % reduction. 90% and 100% reduction in Sulphur oxide emissions. %. LNG price levels are currently competing with MGO. In addition to orders for LNG-powered vessels, significant development of infrastructure for bunkering and distribution of LNG-powered vessels is expected in the next few years.

LPG is a liquid propane and butane blend in various ratios to achieve desired saturation, pressure, and temperature characteristics.

Over the past decade, LPG production has increased by about 2% per year, and current distribution and storage facility distribution is one of the most important issues for LPG as an alternative fuel. The CO_2 emissions emitted when burning LPG are about 16% lower than HFO, but the GWP of the greenhouse gases propane and butane is 3-4 times that of CO_2.

At the same time, liquid gas significantly reduces Sulphur emissions and naturally prevents fine dust emissions.

Methanol (CH_3OH) has a low carbon content and a high hydrogen content due to its chemical structure. It exists as a liquid at atmospheric pressure between -93 °C and +65 °C. Its production is based on natural gas or coal CO_2 waste from pulp and paper mills, forest, or agricultural waste, and even power plants. Using methanol from natural gas significantly reduces emissions. At ambient conditions is a Sulphur-free, toxic, and corrosive liquid fuel under ambient conditions [5]. Due to its density and low calorific value (201 MJ/kg), a methanol fuel tank is about 2.5 times larger than a ship's fuel tank with the same amount of energy. It has a flash point of 11°C and can be converted to dimethyl ether (DME) which can be used as fuel in diesel engines. The use of methanol from natural gas results in

significantly lower exhaust emissions, it is without sulphur, toxic, corrosive, and liquid fuel under ambient conditions [5]. Due to its density and low heating value (20.1 MJ/kg),

methanol fuel tanks are approximately 2.5 times larger than marine fuel tanks for the same energy content. It has a flash point of 11°C and it is convertible into dimethyl-ether (DME), usable as fuel for diesel engines [6]. The world's first methanol-powered vessel, Stena Germanica, is fully compliant with Baltic Emission Control Area (ECA) regulations with 99% SOX emissions, 60% NOx, 95% particulate matter, and 99% CO_2. We are reducing. 25% discount. At sea, 11 ships have used methanol since 2019.

Biofuels from primary biomass residues are converted to liquid or gaseous fuels. The potential to reduce biofuel emissions is highly dependent on feedstock, biofuel production, engine type/model, and supply chain. The most promising biofuels for ships are biodiesels such as biomass-to-liquid (BTL), fatty acid methyl esters (FAME), and liquefied biogas (LBG). Biodiesel is the best substitute for MGO, and LBG HE is the best substitute for LNG and flat vegetable oil. The most promising biofuels for ships are biodiesel, such as biomass to liquid (BTL), fatty acid methyl ester (FAME) and liquefied biogas (LBG). Biodiesel is the most suitable option to replace MGO, and LBG is the best alternative to LNG and flat vegetable oil. Moreover, biofuels are applicable in diesel engines without any change,

as their combustion properties are almost identical to conventional diesel [7]. In addition, biofuels have combustion characteristics similar to conventional diesel, so they can be used directly in diesel engines. However, the use of biofuels is internationally restricted due to sustainability issues associated with large-scale production. In general, advanced biofuels have lower greenhouse gas emissions than conventional biofuels.

Hydrogen is a colorless, odourless, and non-toxic gas. It can be stored as a liquid, a compressed gas, or integrated into a chemical chain for onboard use. Due to its physical properties, it liquefies only at very low temperatures (below -253°C). Reduce temperature or increase pressure. However, since the critical maximum temperature for liquefaction is -239.96 °C, hydrogen liquefaction often requires cooling and additional compression of cryogenic hydrogen reservoirs. It has a specific energy per mass of ×119.9 MJ/kg, about three times that of HFO,

a bulk density of ×71 kg/m3, only 7% of HFO, and about five times its volume. intent. It comes from the energy stored in HFO.

Today, annual hydrogen production exceeds 50 million tons, almost entirely derived from natural gas, equivalent to the energy intensity of about 150 million tons of marine fuel. Additionally, hydrogen production by electrolysis is a method of storing and transporting surplus renewable energy, offsetting energy production from solar or wind turbines.

Treatment of exhaust gases technologies

To control emissions of NOx and SOX and particulate matter, selective catalytic reduction (SCR) systems and exhaust gas recirculation (EGR) systems, and exhaust gas cleaning systems

(EGCS), are available today.

Selective Catalytic Reduction (SCR)

Installation of an SCR system is one abatement technique for meeting International Maritime Organization (IMO) Tier III NOx emission limits. It reduces the level of NOx in the exhaust gas using urea as

the reducing agent and the vanadium pentoxide V2O5 supported on titanium dioxide (TiO2) as the dominant component of the catalysts [8]. The NOx content of the exhaust gas
is reduced using urea as a reducing agent and vanadium pentoxide V2O5 supported on titanium dioxide (TiO2) as the main component of the catalytic converter. The reduction reaction on the catalyst proceeds at a rate that depends on the NOx ratio. This reaction produces ammonia (NH3) and carbon dioxide (CO2). Nitrogen oxides (NOx) emitted from the exhaust gas react with ammonia (NH3) on the catalyst surface and are converted to nitrogen (N2) and water (H2O). The catalytic element is placed in the metal structure of the exhaust pipe. The efficiency of catalytic reduction depends on many factors, such as the dosage of a reductant, the number of catalytic elements, and the exhaust gas temperature. NOx emissions can typically be reduced by 90%.

Selective Catalytic Reduction (SCR) is a relatively mature NOx emission reduction technology, which has the advantages of a wide operating temperature range and high selectivity and can achieve over 90% conversion rate. As shown in SCR catalysts, metal oxides such as V2O5-WO3 and TiO2 are used as catalysts, and NH3 or urea (CO(NH2)2) are used as reductants eliminate NOX in the exhaust of marine engines reacts and converts to N2 and H2O.

SCR technology is mainly used in 4-stroke diesel engines with high exhaust gas temperatures. Exhaust gas temperatures in 2-stroke diesel engines are lower than the ideal operating temperature for SCR systems. Therefore, there are currently few SCR systems with 2-stroke diesel engines that reach reaction temperature by placing the catalyst behind the turbocharger.
The treatment of NOX in exhaust gases is affected by many conditions, such as; Temperature, fuel quality, SO2, etc.
NH3 in the reactor burns up and cannot participate in the reaction.
Additionally, high temperatures can thermally damage the catalyst. If the temperature is too low, the catalytic reaction rate will drop significantly

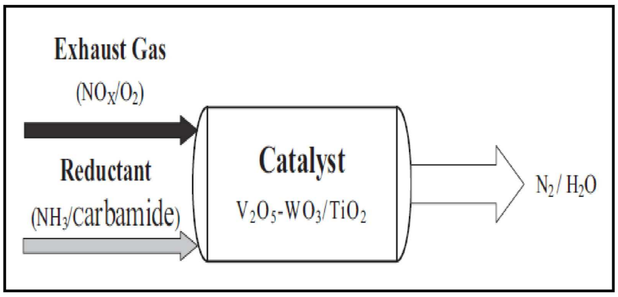

Fig .2. Process

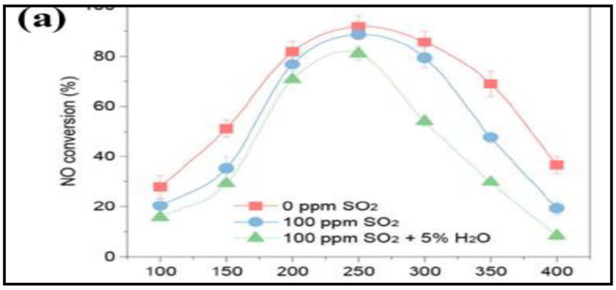

Fig. 3. Effect of SO2 and H2O on NH3-SCR Performance of CuMnFeO4

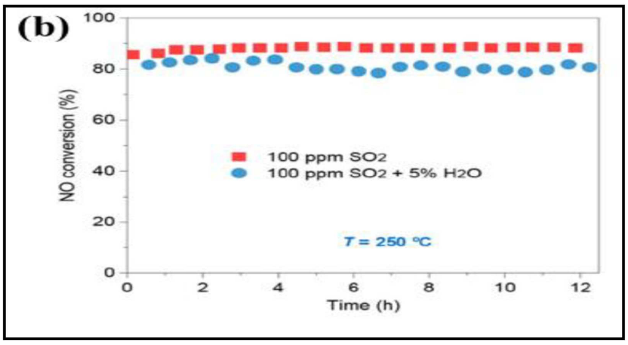

Fig. 4. Long-term stability of the CuMnFeO4 catalyst at 250 °C in the presence of SO2 and H2O

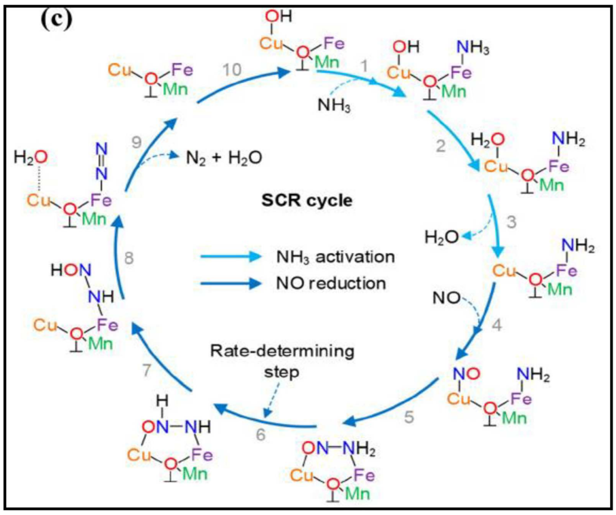

Fig.5. The NH3-SCR reaction scheme of NO reduction over CuMnFeO4 spinel proposed.

The SCR catalyst system has the advantage of high selective catalyst capacity and less modification of existing marine diesel engines that can meet IMO's Tier III emission standards but is suitable for large ocean-going vessels equipped with twins is difficult. Lift the diesel engine. In addition, the ship's SCR catalyst system still has some issues to be resolved, including B. Large footprint and high HC and CO emissions.

Exhaust Gas Recirculation

Exhaust Gas Recirculation (EGR) is an effective technology to reduce NOX emissions, which is mainly used in large two-stroke marine diesel engines. The device reduces the peak temperature of the gas in the cylinder by recycling the burned gas back into the cylinder, thereby reducing the formation of NOX.

The EGR system mainly comprises an exhaust gas wet scrubber, cooler, water mist catcher and high-pressure blower, etc. The functions of each part are as follows :

1) Exhaust gas wet scrubber: It is composed of a buffer tank with a freshwater supply, a sodium hydroxide quantitative unit, a circulating pump, and water treatment equipment with sludge collection, which is used to remove Sulphur oxides and particulate matter in the recycled exhaust gas, prevent corrosion and reduce fouling in system and engine

2) Cooler: further lowering the temperature of the recycled exhaust gas

3) Water mist catcher: Remove condensed and entrained water droplets from the purified exhaust gas

High-pressure blower: used to increase the pressure of recirculated exhaust gas before it is reintroduced into the engine cylinder.

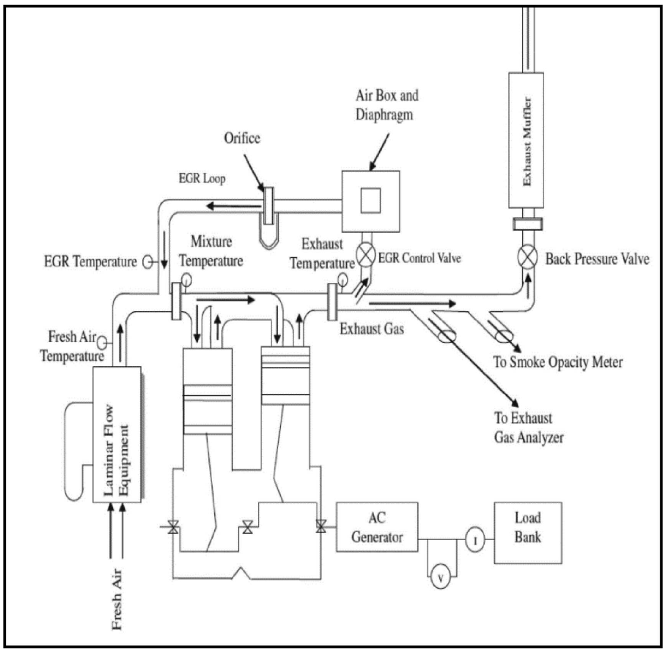

Fig.6. Exhaust Gas Recirculation

In recent years, researchers have studied the EGR technology of marine diesel engines. We studied the discharge performance of an LPG tanker using high-Sulphur fuel oil by combining low-pressure EGR and desulphurization by seawater washing. The results show that at EGR rates of 25-35%, the engine runs reliably and reduces NOX emissions by approximately 70% in line with Tier III standards. SOX emissions have been reduced by 98%. This is equivalent to using fuel emissions with a much lower Sulphur content of 0.04% (m/m) than ECA emission requirements. In addition, methane emissions have been reduced by more than 50%, and wastewater pH, turbidity and nitrate levels are well below IMO requirements. However, this device has drawbacks such as high CO and PM emissions and 2-3% additional fuel loss, requiring further research and optimization. Unlike the SCR, the EGR system is not limited by fuel Sulphur content and reaction temperature and can effectively reduce NOX emissions. However, after the combusted exhaust gas is recirculated to the cylinder, the total oxygen concentration in the combustion chamber is reduced, thus destabilizing the combustion process, and causing incomplete combustion of fuel, resulting in increased fuel consumption and smoke, CO, and particulate matter emissions.

There is a risk of accelerated engine wear and increased maintenance needs, so it must be combined with other technical improvements.

Scrubbing Tower

Seawater scrubbing desulphurization uses seawater as a cleaning agent and uses its natural alkaline content and SOX in ship exhaust gases to produce sulfates, which are discharged directly into the ocean.

Compared with other wet desulphurization methods, seawater scrubbing desulphurization has the following advantages:

(1) Simple process, mature and reliable technology.

(2) Conservation of freshwater resources.

(3) There shall be no contamination or clogging of pipes and equipment.

However, due to the low alkalinity of natural seawater and its limited acid-base buffering capacity, it is only suitable for low-Sulphur marine emissions. If the Sulphur content is high, the desulphurization efficiency is low, it is difficult to meet the existing emission standards, and the seawater needs to be continuously renewed to ensure desulphurization efficiency. In addition, the wash water is rich in sulphates and has a low pH value. Direct releases destroy the marine environment and affect marine life. In 2019, the China Maritime Safety Administration released the "Implementation Plan for the

2020 Global Marine Fuel Sulphur Limit Order", which states that from January 1, 2020, ships will no longer use cleaning water for open-loop waste gas cleaning systems in China's air pollution. It was stipulated that it was not allowed to be discharged. Ship control area.

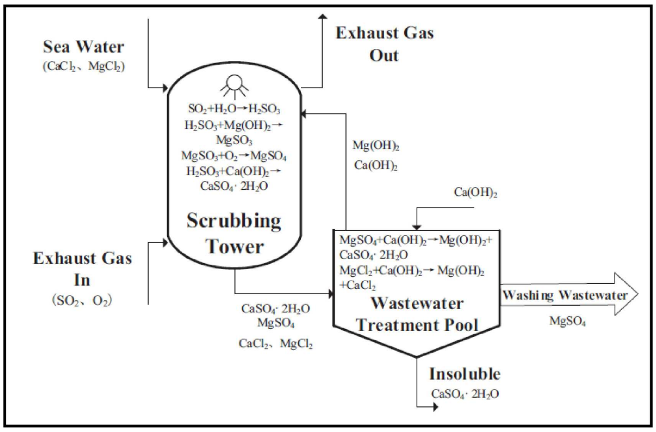

Fig.7. Desulphurization

Water Bath Method

The purpose of this work is to develop a simple, efficient and inexpensive diesel emissions control method that has the potential to be used to reduce emissions from diesel engines used for power generation in the private sector. A proposed emission control method involves placing the diesel engine exhaust in a water bath before it is released into the atmosphere.

To verify the feasibility of using this method to reduce diesel engine emissions, a specially designed water bath was developed and air-cooled with the necessary equipment to measure emissions. Tested on a single cylinder 4 stroke diesel engine. As NOx, unburned HC, CO and other parameters such as exhaust gas temperature and exhaust noise.

Experimental results show that using a water bath to control diesel engine emissions significantly reduces NOx,HC, CO, and exhaust gas temperature and reduces exhaust noise relatively slightly.

As shown in Figure 7, in the diesel engine power range (0.4 to 2 kW) examined in this study, using a water bath reduced NOx emissions by 62-73%. This ismuch better than the results of Raman et al. [18] He used Exhaust Gas Recirculation (EGR) to reduce his NOx content by 3.38-6.17% when the EGR ratio was 5-20%. Furthermore, the use of EGR increased HC emissions by 27.5-28.8% and CO emissions by 8.7-14.3%. Roy et al. reported

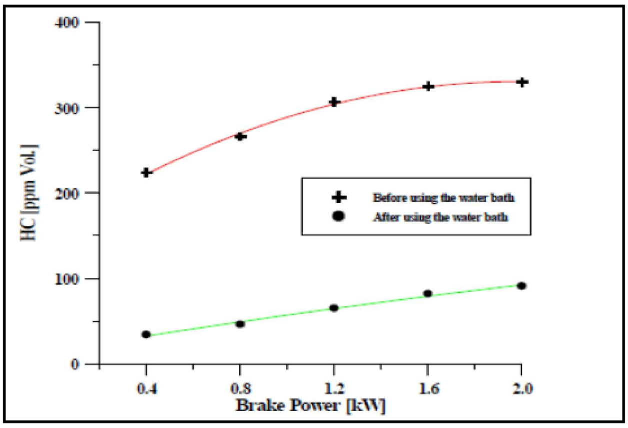

Fig. 8. Hydrocarbon

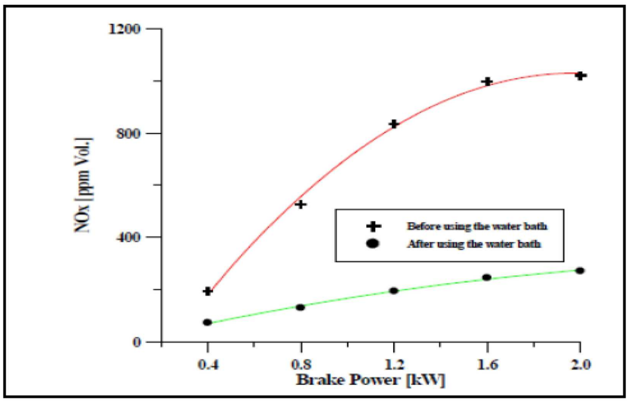

Fig. 9. Nitrogen Oxide

NOx reductions of 24%, 47% and 77% at his EGR ratios of 10%, 20% and 30%, respectively.

These results demonstrate that using a water bath can significantly reduce diesel engine emissions at minimal cost over methods commonly used. Furthermore, none of the methods used so far can completely reduce diesel engine emissions. On the contrary, as mentioned above, technology can reduce certain pollutants while increasing others. This has led to the simultaneous use of multiple technologies to overcome this limitation, increasing the cost of already expensive solutions. In addition, some of these technologies impact engine performance, such as engine thermal efficiency and fuel economy, as previously reported.

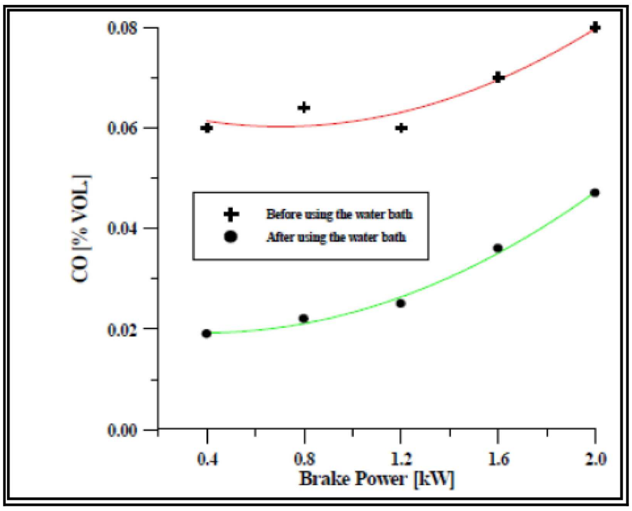

Fig.10. Carbon Monoxide

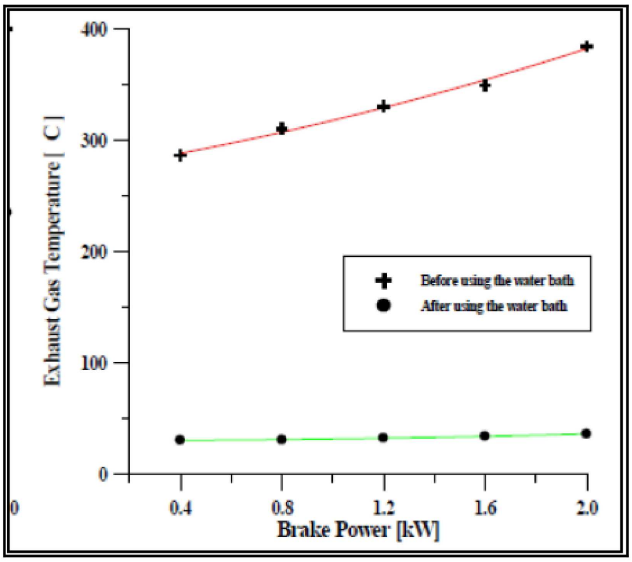

Fig. 11. Exhaust Gas Temperature

Varying Engine Loads

The load dependence of incomplete combustion and overall emissions are less pronounced in modern marine engines than in older engines. Fleet age affects emission levels and load dependence of emissions. The large ship fleet is younger than the medium and small ship fleet (24-28% built within 0-4 years and 16-22% aged 15+ years). About 61% of small boats are in service for 15 years or more. Non-optimized use of the engine is to be expected, along with energy efficiency targets, hybridization and controlled operation in port areas such as: B. California's "At-Berth Regulation" and the EU's proposed zero emissions at sea at berth will continue to decrease. Therefore, the literature considered here is limited to 40%.

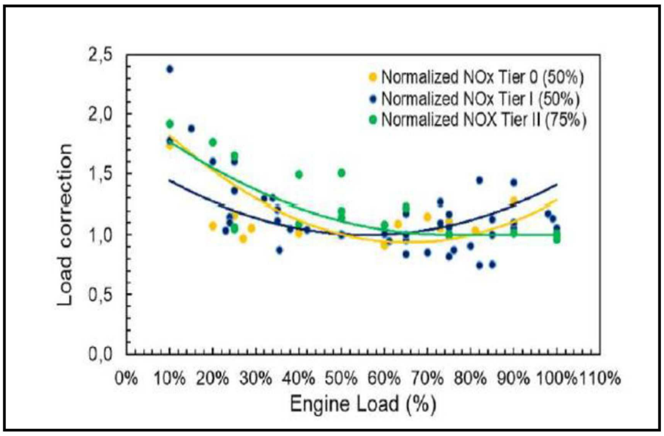

Fig. 12 Load Correction by Nitrogen Oxide

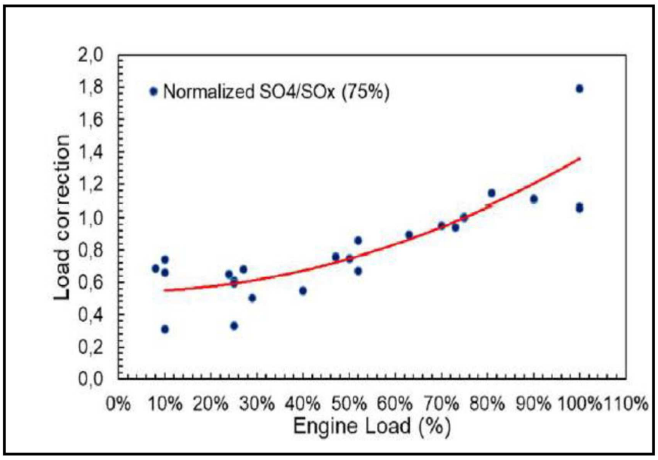

Fig. 13. Load Correction by Sulphur Oxide

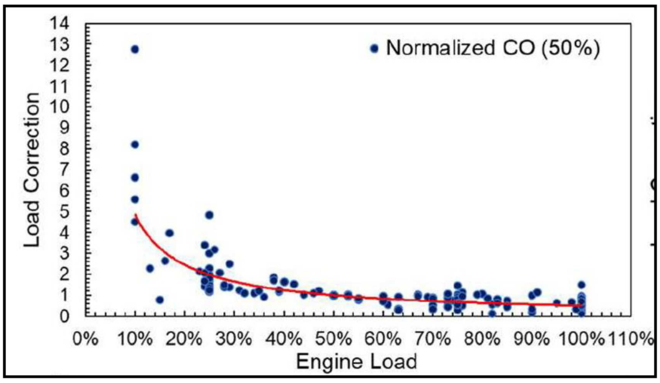

Fig. 14. Load Correction by Carbon Monoxide

Diesel Particulate Filter (DPF)

Exhaust gases from the engine's combustion chamber are channeled through a DPF that can be installed before or after the catalytic converter as required. Exhaust gases flow through the porous pores of the filter. Soot particles are larger than the porous holes in the filter. The treated exhaust gases are released into the atmosphere through the

DPF outlet. Soot particles slowly accumulate in the filter until the back pressure drops to a certain minimum. A differential pressure sensor then sends a signal to the electronic control unit (ECU). The ECU then sends a signal to the burner to carry out the regeneration process. During the regeneration process, accumulated soot is burned in one of the following ways: Active regeneration - Exhaust gas temperature rises above 600 degrees after particle accumulation reaches a certain level. Temperatures can be increased by engine derating, upstream burner use, and electrical regeneration.

• As the engine is throttled, the air/fuel mixture becomes leaner, increasing the amount of oxygen available for combustion. As a result, the temperature of the exhaust gases increases, allowing the accumulated soot to burn off.

• When signaled by the ECU, a burner can be deployed to burn off the soot built around the filter. •Electrical regeneration is particularly suitable for those involving the flow of metal fibers through filters. An electric current pass through the filter, heating and burning the unwanted soot. Passive Regeneration - These systems use a catalyst that reduces the total oxidation temperature of soot particles to the level of the exhaust gas temperature. By lowering the oxidation temperature, the soot can be easily regenerated at low temperatures Engine with DPF + EGR system. A DPF system was then installed to collect soot particles. The DPF is 0.30mm wall thickness and 200 CPSI construction. Installation of EGR and DPF systems ensures that no particulate matter is introduced into the combustion chamber during exhaust gas recirculation. Uses non-catalytic cordierite wall flow DPF.

This cordierite wall stream does not undergo chemical reactions. It just traps soot. Shows EGR and DPF schemes.

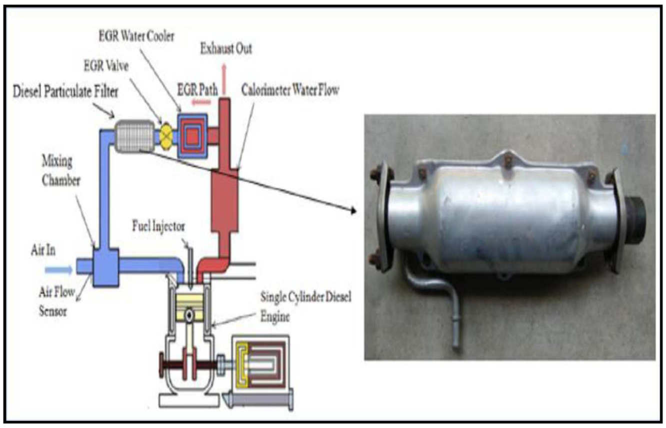

Fig.15. Diesel Particulate Filter

III.CONCLUSION

Ship exhaust fumes are increasingly harmful to the natural environment and human health and must be controlled. Since the IMO issued its MARPOL Annex VI in 1997, the emission limits set by governments and international environmental protection agencies have become increasingly stringent, and the technology used to reduce ship emissions has become a major concern. It brings big challenges. The clean energy and exhaust gas cleaning technologies introduced in this article can effectively reduce pollutant emissions from ships.

This study presented a comparative analysis of methodologies for systematically estimating merchant ship exhaust emissions and their environmental costs and emission reduction measures. This methodology was tested during her one-year operation on a bulk carrier vessel called Through cost-benefit analysis of alternative emission reduction scenarios.

New systems need to be integrated with technological developments to reduce ship-related emissions.

However, as mentioned earlier, using selected auxiliary systems or fuel type changes will reduce certain types of emissions, while implementing additional systems will result in a slight increase in fuel consumption and corresponding increase in fuel consumption. CO2 emissions. When installing scrubber systems, open circuit systems are preferred but are already controversial as many countries have banned the use of these systems because the wash water flows back into the sea.

Hybrid scrubber systems, on the other hand, are an effective but expensive solution. In addition, another handicap of scrubber systems is the inadequate knowledge and experience of personnel operating the system.

The use of VLSFO stands out as a significant disadvantage to shipowners, given the changing global fuel prices due to its high price.

When complying with the IMO 2020 sulfur regulation, the use of MGO is generally preferred due to the lower price of LNG is a tangible alternative to comply with emissions regulations for both existing vessels and her new buildings. The main advantage is near-zero SOx and PM emissions. This allows vessels to comply with the IMO Tier III limit for NOx emissions without the need for an emission control system.

The downside here is the expensive dual fuel engine and uneven distribution of gas stations.

From a pure cost perspective, the most suitable option among emission reduction methods is the use of MGO. MGO has no installation cost and offers additional advantages for vessels operating in ECA. VLSFOs, on the other hand, are vessels operating outside the ECA.

From a global perspective, investment PBP shows that in 2-3 years he recovery is possible, excluding the switch to dual-fuel engines Further development of research should begin with a focus on extending the test to a large number of vessels, varying in type, size, range, and age.

Additionally, reliable Energy Efficiency Design Index (EEDI) calculations must be addressed. This could provide additional benefits to using LNG and qualify the vessel's value when sold on the second-hand market, through margin recovery, especially at low freight rates and volatile fuel prices. In addition, customers, ship owners, and charterers are increasingly aware of the negative environmental impacts of shipping.

The use of the water bath resulted in significant reductions in NOx, unburned HC, CO, and exhaust gas temperatures, and a relatively small reduction in exhaust noise.
Unlike other methods of controlling diesel engine emissions that reduce some pollutants and increase others, water baths reduced all emissions considered in this work. The proposed method of using water baths to reduce emissions from diesel engines used for power generation in the private sector seems very promising given its ease of use and low cost.
In the future, renewable clean energy could power ships in large part, or even replace fossil fuels entirely. Improving production and synthesis processes, lowering fuel prices, and developing new advanced engines and fuel storage and delivery technologies are necessary to make the new energies practically beneficial to mankind.

III. ACKNOWLEDGMENT

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PROPULSION OF SHIPS ON ALTERNATIVE ENERGIES - A REVIEW

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ABSTRACT:-
Over the past decade, climate change has rapidly become the most pressing issue dominating global headlines. This is due to emissions from the shipping sector, which have historically increased at a rate similar to the global increase. The shipping industry uses fossil fuels that have a significant impact on the environment, and a shift to renewable fuels could be part of the solution to reduce emissions. This work aims to produce a synthesis of the literature outlining the manufacturing processes and possible applications of various renewable raw materials in maritime transport. The use of renewable resources is a technically viable option for reducing emissions from shipping, which has been shown to pose no major challenges to the potential production of biofuels. The minor challenges that exist today could potentially be overcome by tightening the environmental targets for shipments.

Keywords— Carbon footprint, Green Ammonia, Alternate fuel, Emission reduction, Bio-Fuels.

I. INTRODUCTION

Sea transport plays an important role in world trade. In 2015, ships worldwide used approximately 298 million tons of fuel, emitting CO2 and other greenhouse gases (GHGs), sulfur oxides (SOx), nitrogen oxides (NOx), and other particulate matter. Emitted pollutants, such as SOx emissions, are limited by International Maritime Organization (IMO) regulations that limit the sulfur content of fuels allowed worldwide and by Special SOx Emission Control Areas (SECAs) where lower sulfur levels apply is also displayed. This has led some ship operators to switch to low-sulfur fuel oil and, in some cases, to alternative fuels [25]. In this case, the alternative fuel must be made from renewable sources in order to be only and sustainable. The main renewable energy sources available are biomass, solar, wind, ammonia, methanol, and other technologies that use energy in running water.

IMO also introduced the Energy Efficiency Design Index (EEDI), which sets mandatory CO2 reduction targets for all new buildings built from 2013 onwards. Reduction targets will tighten every five years until 2030 to allow shipowners to order more efficient ships. This change also introduced the Ship Energy Efficiency Management Plan (SEEMP). This requires shipowners to have operational efficiency

Improvement plans onboard all ships [24]. This is necessary to reduce CO2 emissions by 2050 in a normal scenario. This overview describes the main primary energy sources that can be used to produce sustainable marine fuels. It also highlights various future fuels, challenges, and pathways for producing fuels such as ammonia, methane, methanol, wind power, and bio-factor. Final fuel comparison considerations are presented in this review paper.

1. Ammonia As a fuel

In recent years, ammonia has been discussed as a marine fuel. In principle, this is an additional way to store hydrogen in the form of NH3 molecules. At room temperature and atmospheric pressure, ammonia is a gas. For storage, it is cooled to a temperature below -33°C at atmospheric pressure or compressed to a pressure of 7.5 bar at room temperature. Ammonia has a higher energy density than compressed hydrogen and liquid hydrogen, so it can store more energy per unit volume.

Traditionally, ammonia is stored in insulated pressurized tanks, requiring more space on board than LNG and methanol. Today, ammonia is mainly used in agriculture for fertilizer production and to a lesser extent in various industrial applications and NOx control systems in the automotive industry. The main production route is the Haber-Bosch (HB) process, which combines hydrogen from the steam reforming of natural gas with nitrogen from the air.

Additional merits for using ammonia as a marine fuel

• It has a comparable energy density (of 22.5 MJ/kg) to some carbon-containing fuels such as methanol (22.7 MJ/kg), ethanol (29.7 kJ/kg), lignite coal (15 MJ/kg), anthracite coal (27 MJ/kg) but lower than other fuels such as natural gas (55 MJ/kg), diesel (45 MJ/kg), and hydrogen (142 MJ/kg).

• It can be readily liquefied by compressing it to 0.8 MPa at 20 degrees C or cooling it to -33 degrees C at atmospheric pressure.

• There is already an established and reliable infrastructure for ammonia production, storage, and distribution, with an annual global production of 150 million tonnes (in 2019).

• It has a narrow flammability range, and therefore, it can be stored onboard safely

• Because of its high-octane rating, ammonia (120 compared to gasoline which typically ranges from 86 to 93), it can be used in internal combustion engines with small modifications and can also be used directly in a fuel cell.

More than 95% of the world's hydrogen is produced by reforming fossil resources, and about half of this amount comes from reforming natural gas or shale gas. The simplified block diagram of the HB process uses methane (the main component of natural gas) as the feedstock. First, synthesis gas containing H_2, CO, and CO_2 as main components is produced through steam reforming (SMR) of methane. The water gas shift reaction (WGS) is used to enrich the H_2 content by reacting steam with CO to produce more H_2 and CO_2. CO_2 splitting is followed by methanation to hydrogenate traces of CO and CO_2 to methane (to avoid H-B catalyst poisoning). Nitrogen (from air separation) and hydrogen are compressed in the H-B reactor and react to form ammonia. Cooling and refrigerant condensation is used to separate and reuse unreacted H_2 and N_2 in the production of liquefied ammonia [1].

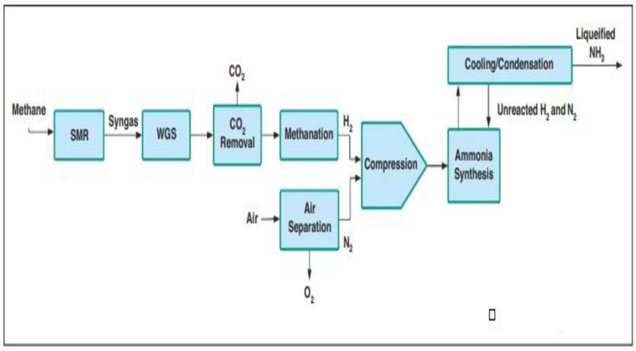

Fig. 1 A simplified block flow diagram of the H-B process [1].

Production of green Ammonia can be done through the:

• Electrolysis: Renewable energy (e.g., solar, wind, hydro) can be used to provide energy to produce hydrogen by splitting water in an electrolyzer such as an alkaline electrolyzer, a proton exchange electrolyzer (PEM) or a solid oxide electrolyzer

• Photocatalysis/photoelectrochemical conversion: Light irradiation (e.g., from a solar source) is used to produce hydrogen by splitting water through a semiconductor (e.g., TiO2)

• Thermochemical water splitting: high-temperature heat (e.g.: from a concentrated solar collector) is used to thermochemically split water in the temperature range of 500 to 2000 °C.

• Biomass conversion: Biomass can be converted into biogas through anaerobic digestion, which can then be converted into hydrogen and other components. Alternatively, biomass can be gasified to produce syngas, which contains hydrogen.

Green nitrogen can be generated on an industrial scale using three main methods: cryogenic distillation column, pressure swing adsorption, and membrane separation. Renewable energy can also be used to run an air separation unit (ASU) to produce green nitrogen. Some electrochemical processes have been proposed to directly convert water and nitrogen into ammonia, avoiding the intermediate step of hydrogen production [2,3].

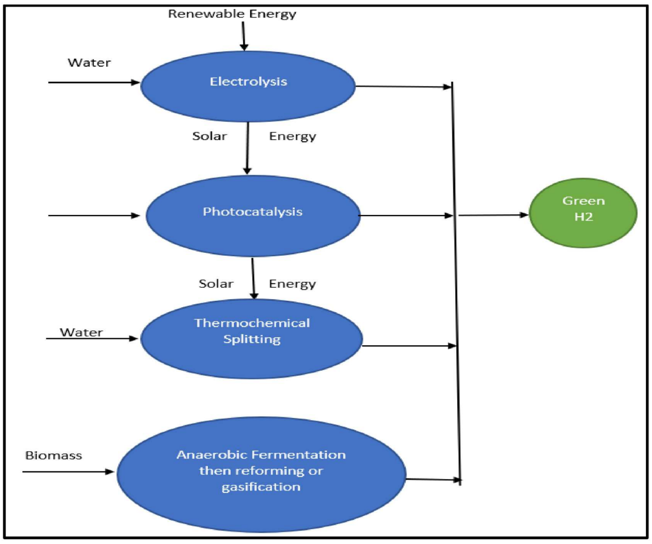

Fig. 2. Four pathways for the production of green hydrogen

The environmental analysis is based on a life cycle assessment (LCA) for the carbon footprint on two bases: well-to-tank (Watt) and tank-to-propeller (T-t-P).The formula for calculating total CO2 equivalent emissions is:

$$\mathrm{g\,CO_{2eq}} = \mathrm{g\,CO_2} + 25 \times \mathrm{g\,CH_4} + 298 \times \mathrm{g\,N_2O}$$

Some of the monitored references state emissions in terms of

CO2eq/kWh of engine power. These values were converted to the basis of delivered MJ of fuel by one of the following

$$\frac{g\,CO_{2eq}}{kWh\ engine\ output} \times Engine\ Efficiency \times \frac{1\ kWh\ delivered\ to\ engine}{3.6\ MJ} = \frac{g\,CO_{2eq}}{MJ}\ \frac{g\,CO_{2eq}}{kWh\ engine\ output} \times \frac{1\ kWh\ engine\ output}{g\,fuel} \times \frac{g\,fuel}{MJ} = \frac{g\,CO_{2eq}}{MJ}$$

.

As such, advances in electrolysis and renewable energy technologies can have a significant impact on reducing the cost of green ammonia. In addition, emerging technologies such as direct electrochemical ammonia synthesis and solid oxide electrolysis without needing H-B or air separation units can offer significant cost reductions for green ammonia production. Green ammonia power plants can be built in places where renewable electricity (e.g., solar, wind, hydropower) is abundant and competitive with local fossil fuel prices and create a combination of at least two energy sources to mitigate their irregularity. The possibility of using ammonia as a fuel requires fewer modifications to different engine technologies (e.g.; gasoline engine, diesel engine) compared to a fuel cell. This requires some design changes, material changes, or mixing with a secondary fuel source to start the combustion process.

Replacement of HFO and MGO/MDO with ammonia can be scaled with short-term strategies involving the use of grey ammonia, medium-term strategies involving the use of blue ammonia (with an increasing percentage of green hydrogen used in the H-B process), and long-term strategies. -term strategies involving the use of green ammonia [2,3,4,5].

II. METHANE

Methane is the main energy carrier in natural gas and biogas. For methane to become liquid, it must be cooled to about -162°C, which is done through several compression steps. Before 2000, LNG was only used as a fuel in marine transport, with LNG carriers using steam gas from LNG cargoes using steam turbines with boilers. Evaporations are vapors created when the surrounding environment heats cold liquefied gas. In Toe refrigerated, the liquefied gas must be stored in insulated tanks for cryogenic application. Cryogenic tanks are associated with high costs compared to conventional petroleum-based fuel storage and delivery systems [6]. But now it has spread all over the world. Compressed natural gas (CNG) may also be suitable for some ship segments. CNG has the advantage that less energy is needed for compression than for liquefaction. Both LNG and CNG face the challenge of being fossil fuels with limited potential to reduce the climate impact of shipping. However, it is possible to produce renewable methane from biomass or renewable electricity.

Renewable liquefied methane can be blended or used instead of LNG. There are several production routes for renewable methane. The most common is liquefied biogas (LBG), which is produced by the anaerobic digestion of biomass. LBG uses a combination of animal manure, organic waste from food processing, straw, or other energy crops fed into an anaerobic digester. Biogas plants process feedstock to produce methane-rich gas, which can be converted to methane by removing CO2 and other impurities. Raw biogas typically contains 50-75% methane. Renewable methane can also be produced by gasifying biomass (this fuel is usually called biomethane or similar, not biogas). Biomass gasification is combined with water gas reverse reaction or hydrogenation to achieve the correct H2/CO stoichiometry for the synthesis gas, which is subsequently processed in a methanation reactor to methane with a process efficiency of about 60% [7]. It is also possible to produce renewable liquefied methane via the electro fuel route by combining renewable CO2 with hydrogen produced by the electrolysis of water in a methanation reactor.

Different types of LNG engines used in marine transport have different emission profiles. High-pressure engines typically have higher NOx emissions and lower methane slippage, while lean-burning low-pressure engines have higher methane slippage and lower NOx emissions. Methane is the general name for unburned fuel released from gas engines. It's a problem because methane is a potent greenhouse gas and leaks reduce engine efficiency. Due to the lower ratio of carbon to hydrogen compared to diesel-type fuels, CO2 emissions are lower for the same energy produced [8]. The life-cycle performance of methane-based fuels will depend on the specific production route, whether it is from fossil or renewable sources, and what type of energy converter is used on board the ship.

III. METHANOL

Methanol, also known as methyl alcohol or wood alcohol, is a pure, simple alcohol. The main raw materials for methanol are natural gas and coal, but it is also produced from renewable raw materials. When used as a motor fuel, methanol results in low emissions and low environmental and health impacts. Methanol has recently shown promise as a fuel for marine transport.

Methanol is currently mainly produced by catalytic conversion of synthesis gas (CO and H2) from natural gas reforming or coal gasification. There are many production pathways where more sustainable feedstocks can be used to convert to syngas for further upgrading to methanol.

Sustainable methanol production routes **[9]**

- Gasification of wood chips or wood pellets in circulating fluidized bed (CFB) and bubbling

fluidized bed (BFB) gasifiers are feasible technologies.
• Tests were also carried out with wood powder in entrainment gasifiers. One of the advantages of this technology compared to fluidized beds is that a high purity synthesis gas is produced, which reduces the need for subsequent gas purification. The disadvantage is the associated high energy requirement for reducing the raw material to sufficiently small particles.
• Black liquor, a residue from pulp production and normally burned in a recovery boiler to produce process steam for the pulp mill is also an excellent feedstock for gasification.
• Methanol can also be produced by the thermochemical conversion of waste
• It uses its own developed technology in all process steps, and the gasifier is a bubble fluidized bed (BFB).
• The conversion of industrial sources such as steel coke oven gas to methanol contributes to a relatively large share of China's methanol production.

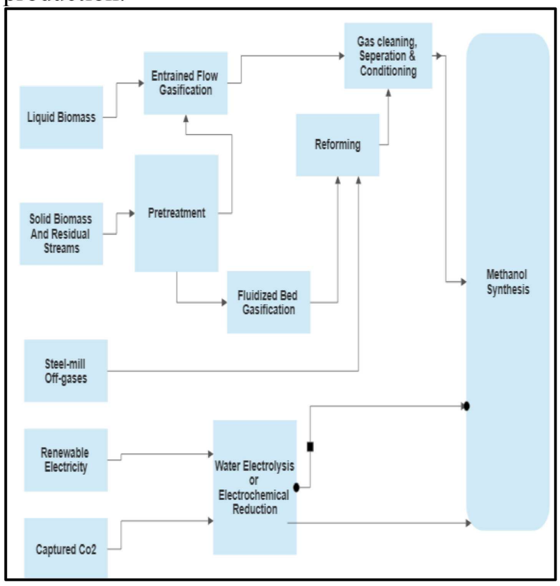

Fig. 3. various production routes for methanol [9]

Methanol with Engines

Methanol has been widely tested and used in petrol car engines where very little adaptation is required. For the type of compression engines used on most ships, where more customization is required due to the need for ignition assistance, testing has been limited.

Methanol tested in a pilot dual fuel ignition diesel engine obtained good engine performance and fuel economy and lower emissions of particulates and nitrogen oxides. Marine engine manufacturer Wartsila investigated several methanol combustion concepts for the conversion of engines on the ferry Stena Germanica and selected a concept where methanol is ignited with a small amount of pilot fuel (diesel) [10].
Engine manufacturer MAN also used the pilot fuel ignition concept to test methanol in its low-speed two-stroke LGI engines. The tests were considered very successful, and the engines were installed aboard seven new chemical tankers in 2016[11]. Methanol engines for smaller vessels such as pilot boats, ferries or road ferries are not currently commercially available but are under development.

Methanol has a lower flash point than that specified for marine fuels in the IMO Convention on the Safety of Life at Sea (SOLAS). This means that ships wishing to use it must go through a risk assessment process that demonstrates that the fire safety of the fuel solution is at least equivalent to that of a conventional fuel solution.

Regulations and rules for using methanol are under development by the International Maritime Administration and will form part of the International Safety Code for Ships Using Gases or Other Low Flash Point Fuels (IGF CODE).

The combustion of methanol in a marine engine, regardless of the feedstock used to produce the fuel, meets the most stringent sulfur emission requirements because methanol contains no sulfur. Burning pure methanol will not produce carbon-based soot, and soot emissions from dual-fuel engines using diesel pilot fuel will still be much lower than those from burning conventional fuel. Methanol combustion resulted in about 30% lower NOx emissions compared to diesel operation for the same dual-fuel low-speed engine [9].

If biofuels become cost-competitive by 2030 due to the existence of supportive policy measures, the share of biofuels in shipping should increase substantially. This suggests a good potential for renewable methanol as a marine fuel to meet the challenge of reducing carbon emissions from shipping.

The below image explains the main challenges and opportunities along the supply chain of renewable methanol as ship fuel:

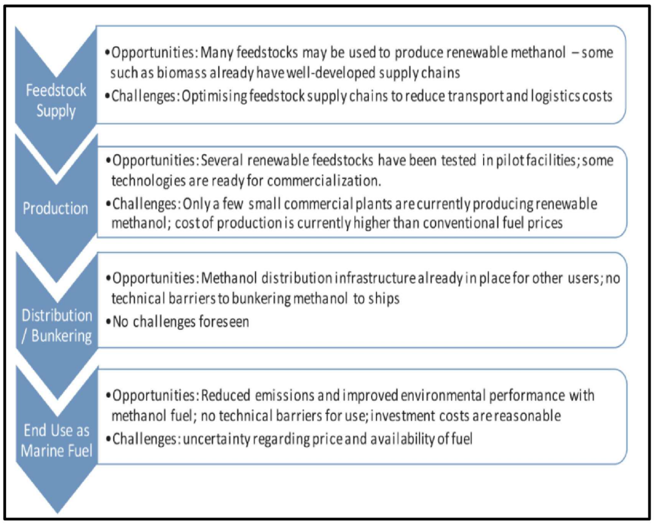

Fig. 4. Main challenges and opportunities along the supply chain of renewable methanol as ship fuel [9].

IV. HYDROGEN

Hydrogen was mentioned above mainly as a component in the production of electro fuel. Hydrogen in compressed or liquefied form can also be used in internal combustion engines and fuel cells. Hydrogen burns more easily in gasoline and other dual-fuel engines than in diesel engines. For example, a hydrogen engine for marine purposes is developed in the H2020 HyMethShip project [13]. Hydrogen combustion in gas turbines is also discussed in the aviation sector.

The challenge with hydrogen is the energy required for liquefaction (electricity consumption for liquefaction represents about 30% of the energy in the final fuel. Liquefaction is also associated with high investment costs. Liquefied hydrogen is stored in insulated cryogenic tanks. The development of cryogenic hydrogen tanks for ships is an example of a challenge needs to be solved for hydrogen to become the future marine fuel.

There are several types of fuel cells. A low-temperature proton exchange membrane fuel cell (LT PEMFC) operates at 65–85 °C and has an electrical efficiency of 50–60% with high power density [8]. On the other hand, the use of platinum is required to catalyze the reaction, and high-purity hydrogen is required due to the risk of cell poisoning, especially by impurities such as carbon monoxide or sulfur. High-temperature proton exchange membrane fuel cells (HT PEMFCs) have the advantage that their higher operating temperature (200 °C) enables heat recovery and its use in the ship's internal systems. The higher temperature further eliminates the need for expensive fuel reformers and reactor cleaning. However, HT PEMFC is a less advanced technology than LT PEMFC.

Solid oxide fuel cells (SOFCs) are also an option. SOFC operates at high temperatures between 600-700 °C and can be used with hydrogen, but it is also compatible with carbon or nitrogen-based fuels because the fuel reforming process takes place in the fuel cell [12].

Hydrogen is a carbon-free fuel, and therefore CO2 will not release CO2 during combustion or when used in a fuel cell, but CO2 may be released during hydrogen production. The life-cycle performance of hydrogen will depend primarily on the specific production route, whether it comes from fossil fuels or renewable sources, and the efficiency and emissions associated with the energy converter used on board the ship. When hydrogen is used in internal combustion engines, NOX and particulates are formed during combustion.

4.1 Hydrogen fuel cell

Hydrogen fuel cells are used especially in the first fuel cell vehicles, as a portable power supply and backup source. Fuel cells have significantly lower emissions at higher efficiency than internal combustion engines.

Hydrogen refueling is not a common application for commercial ships; by the way, it is very expensive. Therefore, onboard hydrogen production appears to be a strong option to address this problem, which increases capital costs. Hydrogen is the main fuel option for fuel cells and can be obtained from various sources such as diesel, natural gas, biomass or electrolysis. Hydrogen has a low storage density and this is a major disadvantage in terms of fuel logistics. stored in high-pressure tanks or cryogenically at -253 degrees Celsius [14]. Fuel cells also have other fuel alternatives other than hydrogen, such as natural gas and diesel.

4.2 Working of Fuel Cell [15]

A fuel cell is a lot like a battery. It has two electrodes where reactions take place and an electrolyte that transfers charged particles from one electrode to another. A fuel cell needs hydrogen (H_2) and oxygen (O_2) to function. Hydrogen enters the fuel cell at the anode. The chemical reaction strips hydrogen molecules of their electrons, and the atoms ionize to form H+. Electrons pass through the wires to provide current to do work. Oxygen enters the cathode, usually from the air. Oxygen captures electrons that have completed their circuit. The oxygen then combines with ionized hydrogen atoms (H+) to form water (H_2O) as a waste product that leaves the fuel cell.

The electrolyte also plays an important role. It only allows the passage of the relevant ions between the anode and the cathode. If other ions flowed between the anode and cathode, the chemical reactions inside the cell would be disrupted.

Table 1: Different types of fuel cells [14].

Fuel Cell Type	Fuel Options	Emissions	Efficiency	Operation Temperatures (degree Celsius)
Alkaline Fuel Cell (AFC)	Hydrogen	Water	50-60%	50-230
Phosphoric Acid Fuel Cell (PAFC)	Natural Gas, Diesel, Hydrogen	Water + CO2 if carbon included fuel is used.	40-50%	150-220
Molten Carbonate Fuel Cell (MCFC)	Natural Gas, Diesel, Hydrogen	Water + CO2 if carbon included fuel is used.	30-70%	600-700
Proton Exchange Membrane Fuel Cell (PEMFC)	Hydrogen	Water	40-60%	50-130
Solid Oxide Fuel Cell (SOFC)	Natural Gas, Diesel, Hydrogen	Water + CO2 if carbon included fuel is used.	40-70%	500-1000

The reaction in a single fuel cell typically produces only about 0.7 volts. Therefore, fuel cells are usually stacked or connected in some way to form a fuel cell system that can be used in automobiles, generators or other products that require energy.

The reactions involved in a fuel cell are as follows:

Anode side (an oxidation reaction): $2H_2 \Rightarrow 4H^+ + 4e^-$

Cathode side (a reduction reaction): $O_2 + 4H^+ + 4e^- \Rightarrow 2H_2O$

Net reaction (the "redox" reaction): $2H_2 + O_2 \Rightarrow 2H_2O$

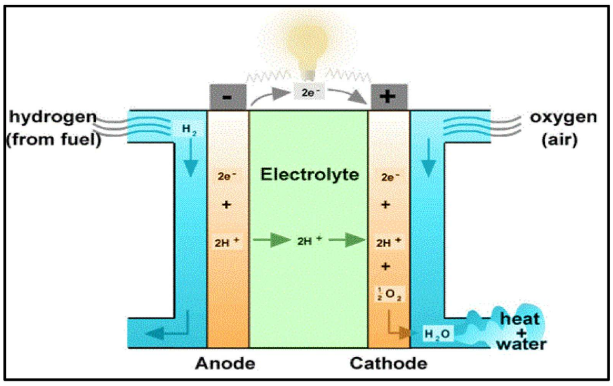

Fig. 5. Hydrogen Fuel Cell [15].

Fuel cells can be classified according to their electrolyte types, working temperatures used fuel types or working areas:

Fuel cells do not have a significant market share due to their high costs compared to diesel engines, but many companies see the potential to reduce costs. In this regard, the US Department of Energy predicts that the cost of direct hydrogen PEM fuel cells will decrease by almost \$45/kW by 2020 at 100,000 units per year production and \$45/kW at 500,000 units per year. and 2025.

Although the main fuel for fuel cells is hydrogen, as mentioned earlier, several types can use diesel and LNG. Therefore, all three types of fuel were investigated as a fuel options.

Table 2: Reported electrical efficiencies of fuel cells related to different fuel types [14]

Fuel Cell	Diesel Oil (%)	Natural Gas (%)	Hydrogen (%)
PEMFC	30-40	35-45	40-60
MCFC	29-54	40-55	-
SOFC	45-55	45-60	42-67

4.3 Power density of fuel cell.

The aim is to achieve a maximum value for both, which means that the fuel cell has relatively less weight with a small volume and maximum power. Fuel cells require auxiliary equipment such as pumps, blowers, power conditioning equipment, etc.; manufacturers call it a system. So, the calculations for the system will be more accurate in determining the correct specific power and power density for onboard applications [14].

Table 3: Power Density Comparison of fuel cells [14]

Fuel Cell Type	Relative Power Density (KW/m3)
PEMFC	Very High
SOFC	Low
MCFC	Medium
AFC	High
PAFC	Low

Safety-related to fuel cell-

The exhaust gas temperature is relatively higher than other types. During the discharge of exhaust gases from the fuel cell, the pipe must be double-layered and effectively insulated to prevent any leakage. In addition, internal equipment such as membranes, electrolytes, and electrodes must be maintained in good condition to achieve maximum efficiency and safer operation. In any case of leakage of electrolytes from the cell unit, it will be dangerous to human life. Second, as an additional precaution for clean hydrogen using fuel cell units, the storage tank and discharge piping must be insulated. Due to the properties of hydrogen, which are volatile and highly explosive, the transfer between the reservoir and the anode side of the fuel cell must comply with the double-barrier principle and is ensured by either ventilation or gas-tight packaging. In addition, safeguards are expected to prevent fuel spills, ensure adequate ventilation of required confined spaces, and screen confined spaces to ensure any fuel collection is identified.

Fuel cells can play a crucial role in reducing ship emissions and can be a solution to new emission regulations as they have fewer hazardous emissions compared to internal combustion engines. The dramatic decrease in regulated emissions such as NOx, PM, and Sox and the significant amount of CO2 highlights the importance of fuel cells for the marine industry. Fuel cells are still under investigation for large energy-intensive devices but have begun to find a place in the road transport sector. This new technology for the commercial marine sector is still in the investigation and demonstration phase.

V. BIO- FUELS

The term "biofuels" covers a wide range of options, the most important of which are fatty acid methyl esters (FAME), SVO, hydrogenated vegetable oil (HVO), Fischer-Tropsch (FT) diesel, bioethanol, bio-methanol, bio-DME, bio-LNG and bio-oil. [17]

After initial screening, several of these biofuel candidates were eliminated from further consideration for the reasons outlined below. The fuels that have been thus excluded are:

Fatty acid methyl esters (FAME): The use of biodiesel FAME is currently limited in ISO 8217 (2017) to 7% v/v in certain distillate fuels and to 0.5% in other distillates and residual marine fuels due to certain technical deficiencies. These include the tendency of biodiesel to act as a solvent and degrade certain rubber and elastomeric compounds; the tendency to oxidize during long-term storage (>2 months); hygroscopicity, and the risk of microbial growth.

Some biofuels include Straight Vegetable Oil (SVO), Hydrotreated Vegetable Oil (HVO), Fischer-Tropsch (FT) diesel, bioethanol, etc. Bioethanol is the most widely used biofuel in the world, but it is almost exclusively produced by the fermentation of food crops. Sugars and starches. Advanced ethanol processes that will produce ethanol from woody biomass and waste streams are under development and may be commercially available by 2030. However, even advanced ethanol processes are likely to have a lower potential to reduce greenhouse gas emissions than alternatives such as methanol and pyrolysis oil without accompanying CCS. Implementation. Currently, ethanol lags behind other biofuels in terms of evaluation as a marine fuel, as there appear to be no current projects testing ethanol, leaving its onboard storage, handling, and use unknown.

Bio methanol, bio-dimethyl ether, bio-LNG and bio-oil are the four fuels that have achieved reasonably good results in all criteria and will therefore be discussed in more detail in the following sections. The term "bio-oil" is used here to refer to crude oil produced from biomass, most commonly by pyrolysis, hydrothermal liquefaction (HTL), or solvolysis.

5.1 Bio – Methanol

Methanol is one of the most widely used organic chemicals, with a global production of around 92 million tons per year in 2016 [18]. Currently, however, almost all methanol produced worldwide comes from fossil fuels, with about two-thirds coming from natural gas and the rest from coal.

A significant number of projects have been carried out regarding the use of methanol as a marine fuel. These include the SPIRETH, and PILOT methanol projects. These showed that methanol could be used in gasoline and modified diesel engines. Methanol has a cetane number of 5 and an octane number of 113, which means that it is inherently more suitable for dual-fuel petrol engines. For use as diesel fuel, its corrosive nature and high auto-ignition temperature (464 C) require modifications to the engine, ignition and fuel storage systems. It should be noted that even in dual-fuel engines, a pilot fuel such as HFO or MGO (5%-10% of the energy base) must be used for ignition. Its growing commercial use has made methanol the fourth most-used marine fuel, with 160,000 tones consumed in 2018[16].

5.2 Bio-Dimethyl Ether

Dimethyl ether (DME), the simplest ether, is a clean, high-density fuel that can be used as a direct replacement for diesel fuel. It can be produced either by catalytic dehydration of methanol or by a one-step process that allows both the synthesis of methanol from synthesis gas and its dehydration in the same process unit. The two-stage process suffers from limited productivity in the methanol synthesis reactor due to equilibrium limitations, while the need for a second, separate

dehydration reactor also increases costs. Direct synthesis is thus thermodynamically more advantageous.
DME is a gas at ambient temperature and pressure but can be liquefied by pressurizing above 5 bar. Therefore, its behavior is similar to propane, so propane distribution and storage infrastructure can be used for DME distribution. DME has a volumetric calorific value (18.2 MJ/L) that is almost exactly half that of diesel, although its lower density (0.67 kg/L at 20 °C) means that its gravimetrically low calorific value (28.9 MJ /kg) is close to diesel. [24]. It is more compatible with diesel engines than methanol, requiring only minor modifications. The higher cetane number of DME (55-60) and the achieved very clean combustion are advantageous as a replacement for diesel, while the disadvantage is the low viscosity and lubricity.

5.3 Bio-LNG

Bio-LNG, also known as liquefied biomethane (LBM), can essentially be produced through three different routes: anaerobic digestion, catalytic upgrading of syngas, and the "Renewable Fuel of Non-Biological Origin" (RFNBO) route. Of these, the RFNBO route using CO2 from air capture and renewable hydrogen is technologically least developed and faces similar challenges to other RFNBO fuels [17]. Anaerobic digestion and synthesis gas routes are technologically more developed and therefore may have a greater impact in the near term.
Anaerobic digestion refers to the breakdown of organic matter by microorganisms in the absence of oxygen. Feedstocks such as manure, sewage sludge, and energy crops can be converted into a mixture of methane and CO2 called "biogas" in an anaerobic digester, and raw biogas can be converted into bio-LNG by removing the CO2 and traces.
The syngas pathway for bio-LNG production is analogous to that described for bio methanol. Syngas is produced by biomass gasification, the H2:CO ratio is adjusted to approximately three using a water gas conversion reaction, CO2 is removed from the syngas, and H2 and CO are converted to methane in a methanation reactor.
With marine emissions regulations tightening, LNG has been hailed as a potential "makeshift fuel" for the maritime sector. The IMO sulfur restriction, which came into effect in January 2020, has further increased the attractiveness of LNG, as it has been calculated that total Sox emissions from LNG can be up to a quarter of that of a low-Sulphur distillate (1000 ppm) at sea. Fuel as discussed in the Bio-LNG Current Status section, LNG is often available at prices below 5 V/GJ, making it extremely competitive with HFO and MGO. The growing attractiveness of LNG as a marine fuel is reflected in the increasing number of LNG-capable vessels
One of the problems with using LNG is "methane slip", where some of the methane escapes into the atmosphere. Although biogas synthesis has a relatively low GHG emission profile (20 g CO2eq/MJ), methane is a greenhouse gas with a 100-year global warming potential (GWP100) 28, and therefore, any leakage will have serious GHG life cycle consequences. Emissions for example, the Mari-Green project built a prototype catalyst to eliminate methane slippage from lean engines [16].

5.4 Bio-Oil as an alternative

The low moisture content, high calorific value, and high H: C ratio of HTL bio-oil have led to its being proposed as a backup fuel for heavy marine engines. The maritime industry is probably more favorable than the road and air transport industries in this regard, as marine engines are more tolerant of lower-quality fuel. A certain degree of modernization is, therefore, clearly necessary. Mild hydrodeoxygenation (HDO), in which the oxygen content is reduced rather than eliminated, may be sufficient for marine engines while limiting cost increases and the carbon footprint. Other schemes have also been proposed, such as combining esterification with azeotropic water removal to simultaneously reduce bio-oil acidity and moisture content to levels suitable for use in slow diesel engines.
The current state of technology: Different biofuels are currently at different stages of technological development. Due to the urgent need for decarbonization, more advanced biofuels will have an advantage over those that are unlikely to be commercially available for several years and will therefore receive a higher score [16].
The potential availability of biomass raw materials: Biomass is a heterogeneous resource that varies greatly in composition and spatial and temporal distribution. A biofuel that is more feedstock agnostic, or whose feedstock is available globally on a sustained, large scale without major competing uses, will be preferred over a fuel with a more limited feedstock base [16].
GHG Mitigation Potential: Although the main driver for replacing fossil fuels with biofuels is the reduction of GHG emissions, the actual reduction achieved depends on the composition of the fuel, the sustainability of the feedstock used, the fuel production process, the emissions arising from the transport of the feedstock and/or fuel, the efficiency of combustion and other factors. Biofuels, which can be evaluated as fuels with a higher potential for mitigating greenhouse gas emissions, therefore deserves a higher score [16].
Cost: As mentioned earlier, current marine fuels are very cheap, and the maritime sector is highly cost sensitive. Therefore, it follows that the estimated cost at which biofuel will be available is a crucial parameter.
Infrastructure Compatibility: The shipping industry has extensive fuel infrastructure in place, and the need to replace a significant portion of this infrastructure to accommodate biofuels will make their adoption much more difficult. This also applies to ships, where the ideal biofuel will require minimal fuel storage units and engine retrofit.
CCS is likely to play an important role in future efforts to mitigate greenhouse gas emissions. Although the storage aspect is independent of the fuel, the cost of CO2 capture depends on the fuel production process and thus needs to be kept in mind when determining fuel suitability for decarbonization efforts [16].

Table 4: Key Specification of the Four Biofuel Oils [16,17]

Property	Unit	Bio-Methanol	BIO-DME	Bio-LNG	Bio-Oil
Melting point	Degree Centigrade	-98	-141.5	NA	NA
Boiling point	Degree Centigrade	65	-24.8	-162	100-280
Relative density	Water= 1	0.79	0.61	1.8	1.1-1.3
Cetane no.		5	60	0	5-25
Octane no.		113	35	130	NA
Higher heating value (HHV)	MJ/Kg	22.9	31.7	51	17-34
Lower heating value (LHV)	MJ/Kg	20.1	28.9	46	13-18
Flash Point	Degree Centigrade	9.7-11	-41	-188	40-110

VI. POWER OPTIMIZATION THROUGH WIND AND SOLAR ENERGY

Wind and solar systems, of which wind is expected to offer the largest amount of renewable energy on board ships, at 10–60% [19]. They are easily available sources of energy and contribute to almost zero emissions. However, the availability of wind and solar energy depends on the ship's position and the local weather conditions in which it is sailing and therefore changes over time.

Flat rotors and hydrofoils are the most popular wind technologies. Flattening rotors offer high flexibility while, for example, having great potential for reducing fuel consumption. Two Norwegian-powered rotor sails 30 m high and 5 m in diameter together are expected to reduce average fuel consumption on a typical global shipping route by 7-10% [20]. Numerical simulations have also shown that the position of wind-driven devices, such as flat rotors, on the ship's deck, is because there are interactions between one rotor and the other. For larger vessels, fuel savings are high because they have a large deck area, which allows them to be equipped with taller turbines and operate in open waters exposed to more wind. Kites are commonly used in large ships, but their fuel-saving potential for large ships is very small. Ships equipped with sails are said to reduce fuel consumption by 10 to over 30% under favorable conditions.

Wind and solar systems, of which wind is expected to offer the largest amount of renewable energy on board ships, at 10-60%. They are easily available sources of energy and contribute to almost zero emissions. However, the availability of wind and solar energy depends on the position of the ship and the local weather conditions in which it is sailing and therefore changes over time.

Fig. 6. The Aquarius Eco Ship concept is based on the Energy Sail technology that uses solar panels embedded in rigid sails [22].

6.1 Study based on Hybrid Model (Wind and Solar) [19]

Two independent optimization models combined. The following figure shows the overall conceptualization of the step-by-step methodology developed in this research. The first model (Model 1) was used to optimize the sail stiff angle to maximize the average sail power output per sail area. A simulated experiment was conducted which was used to test all possible sail angles in full rotation for all wind conditions. The option providing the highest amount of forward propulsion was identified and selected. Subsequently, the amount of solar energy per solar cell area was calculated using the assumptions of average irradiance and solar cell efficiency. A second optimization model (Model 2) was then used to calculate the ideal ship deck area distribution between wind and solar energy. This second model used the results from the sail optimization model and the solar energy calculation as inputs. A full factorial design accounting for all possible levels of the factor in terms of the proportion of deck area allocated to wind or solar energy was calculated, and the option providing the highest amount of renewable energy produced was identified and selected. Assumptions had to be made about how the force of the sails per sail area is affected when a large portion of the deck area is used for the sails, as the interaction between the sails would be expected. Solar power was assumed to be unaffected by the size of the allocated deck area. Finally, the overall optimal performance was calculated, and then an EEDI calculation was performed to evaluate the amount of CO_2 emission reduction on transport work using onboard wind and solar energy.

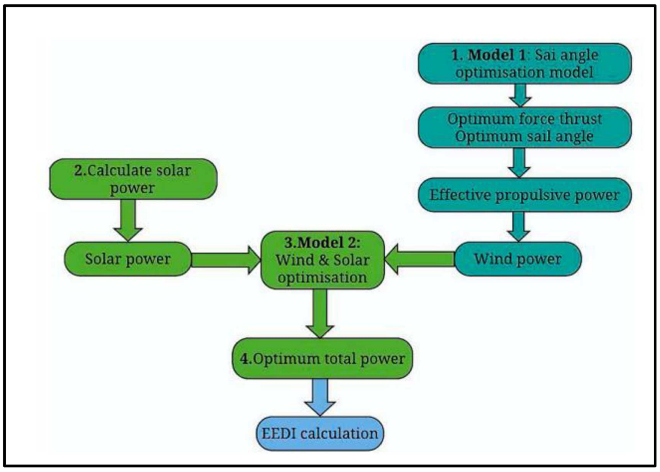

Fig. 7. The overall conceptuality of the developed methodology [23].

To determine CO2 reductions using the methodology used, a Handy-sized bulk carrier with IMO number 9798337, built in January 2017, was selected for the study, of the difference achieved by the EEDI (IMO, 2000). The achieved design energy efficiency index was calculated using the IMO EEDI formula.

The wind driving force produced by the rigid wing sail system was calculated for each sail angle position, and the sail angle was optimized to produce maximum forward thrust for the vessel. Using the IMO's Wind Probability Matrix, describing the probability of wind of a certain speed and direction relative to the ship's course was used to estimate the average wind performance for a bulk carrier along the global trade route. The optimal wind propulsion power was then integrated with the vessel's onboard solar power generation by optimizing the deck area distribution between wind and solar power applications to maximize the total average renewable energy capture for the ship. It was found that the use of these renewable energy technologies on board this ship reduced greenhouse gas emissions by 35.52%.

Comparison between different novel fuels, along with their pros and cons, are best explained in the following table

Table 4: Comparison of Novel Propulsion Options [16]

Technology	Pros	Cons
Nuclear Propulsion	Very high energy density Absence of CO2, CH4, NOx, Sox, particulate matter and other emissions	Public safety concerns Long-term storage of radioactive wastes
Fuel Cells	Zero emissions at the point of use if hydrogen used Suitable for large ships on longer missions	Production of renewable hydrogen and its secure onboard storage still in development Unsuitable for small vessels with high power requirements
Batteries	Clean and flexible operation Capitalize on global renewable electrification trends	Low energy density (<240 kWh/Kg, ~0.09 kWh/L) lead to volume and mass constraints Relatively high costs and short lifetimes
Ammonia	Well-developed global production and distribution infrastructure Non-carbonaceous fuel	Present production highly carbon intensive Highly toxic
Biofuels	More compatible with present shipping infrastructure than other options High level of GHG mitigation	Competition from road, aviation, and petrochemical sectors Fragmentation due to a wide range of feedstock and fuels

VII. CONCLUSION

The production and use of various alternative fuels in the shipping industry are a technically viable option to reduce the environmental impact of maritime transport. No major technical problems have been observed during production or use on ships. Likewise, there are no significant challenges within potential supply chains, and while there is currently an economic barrier, it does not appear to be insurmountable. The transition from fossil fuels to renewable fuels may be made easier shortly. In addition, both storage and transport infrastructure are already in place to some extent or can be easily adapted to existing ones.

Based on the review, it was found that the following work done above has enough potential to understand the use of various transition fuels in the shipping industry.

VIII. ACKNOWLEDGMENT

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HYDROGEN POWER

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ABSTRACT:-
Hydrogen-powered engines and hydrogen fuel cells are technologies that are being developed as alternative power sources to conventional fossil fuels. Both technologies use hydrogen as the primary fuel source but operate in different ways. Hydrogen-powered engines work by combusting hydrogen gas in an internal combustion engine (ICE) to generate power. The process is similar to the combustion of gasoline or diesel, but with the key difference that the only byproduct of the combustion of hydrogen is water vapor. Hydrogen-powered engines can be used in a range of vehicles, including cars, trucks, and buses. Hydrogen fuel cells, on the other hand, generate electricity through an electrochemical reaction between hydrogen and oxygen. The hydrogen is supplied to the anode side of the fuel cell and the oxygen is supplied to the cathode side. As the hydrogen passes through the anode, it is split into protons and electrons. The protons travel through the proton exchange membrane to the cathode, while the electrons flow through an external circuit, generating an electric current. The electrons and protons recombine at the cathode with oxygen to produce water vapor as the only byproduct. Hydrogen fuel cells can be used in a variety of applications, including vehicles, stationary power generation, and portable electronics. Both hydrogen-powered engines and hydrogen fuel cells have the potential to provide zero-emission power, as the only byproduct is water vapor. However, the technologies are still in the early stages of development and face several challenges, including the high cost of hydrogen production, limited infrastructure for hydrogen storage and refueling, and concerns about the safety of handling and storing hydrogen. Nonetheless, research and development efforts are ongoing to address these challenges and improve the viability of these technologies as a sustainable and clean energy source for the future.

Keywords - Hydrogen Fuel cells, electrochemical reactions, Power Generation, clean energy source.

I. INTRODUCTION

Hydrogen power refers to the use of hydrogen as a fuel source for generating electricity or powering vehicles. Hydrogen is a clean and abundant source of energy that can be produced through a variety of methods, including electrolysis of water, steam reformation of natural gas, and biomass gasification. In terms of electricity generation, hydrogen can be used in fuel cells to convert the chemical energy stored in hydrogen into electrical energy. This process produces no harmful emissions, and the only by-products are water and heat.

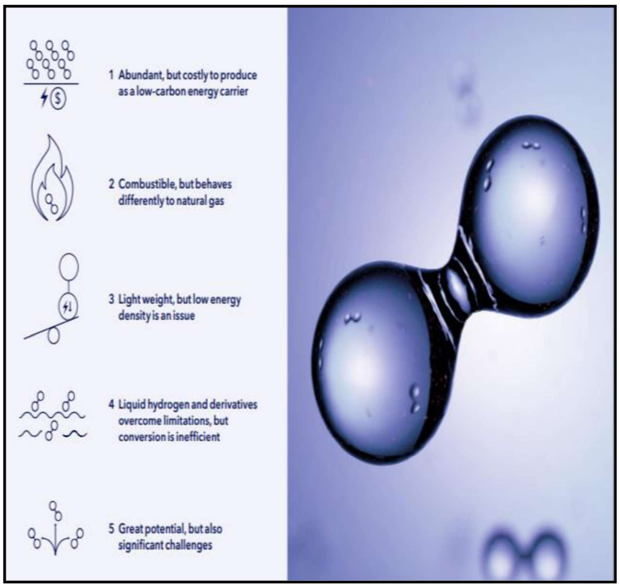

Fig. 1. Hydrogen is used for producing

Hydrogen can also be used as a fuel source for vehicles, either in the form of fuel cell vehicles or hydrogen combustion engines. Fuel cell vehicles use hydrogen and oxygen to produce electricity to power an electric motor, while hydrogen combustion engines burn hydrogen like a traditional gasoline engine. However, there are currently some challenges to the widespread adoption of hydrogen power, including the high cost of production and storage, the lack of infrastructure for distribution and refuelling, and safety concerns related to the storage and handling of hydrogen. Nonetheless, research and development in this area continue, and hydrogen power is considered a promising technology for a more sustainable energy future.

Hydrogen is used for producing:

1. Petroleum refining — Oil refineries are the largest consumer of hydrogen (around 37 Mt in 2020) using it to reduce the sulphur content of diesel oil

2. Ammonia — Around 33 Mt/yr. of hydrogen is used annually to produce ammonia (NH3)

3. Methanol — Around 13 Mt/yr. of hydrogen is used each year for methanol production

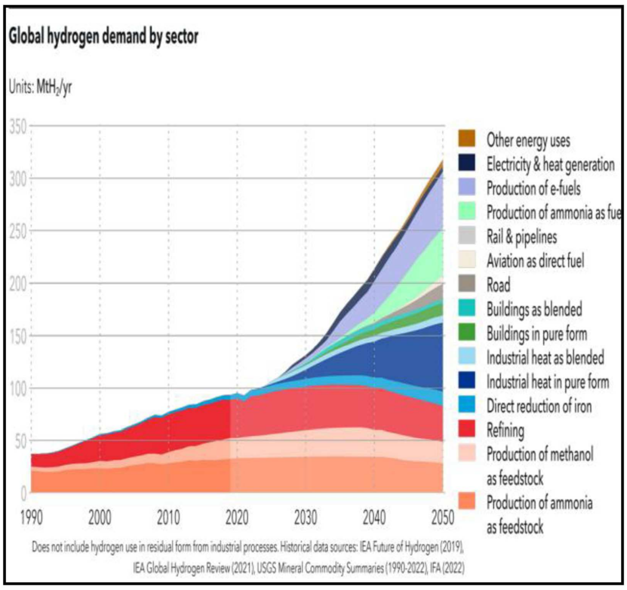

Fig. 2. Global Hydrogen demand by sectors

II. METHOD OF HYDROGEN PRODUCTION & USAGE

A. ELECTROLYSIS

Steps for producing hydrogen through electrolysis:

1. Set up an electrolysis cell: The cell consists of two electrodes, an anode, and a cathode, that is submerged in an electrolyte solution, typically water with an electrolyte like potassium hydroxide or sodium hydroxide added to increase its conductivity.

2. Apply an electrical current: A direct current (DC) is applied to the cell, which causes the water molecules to split into hydrogen and oxygen gas at the anode and cathode, respectively.

3. Collect the hydrogen gas: The hydrogen gas that is produced at the anode can be collected by attaching a tube or pipe to the anode outlet and directing the gas to a storage container.

4. Purify the hydrogen gas: Depending on the application, the hydrogen gas may need to be purified to remove any impurities before it can be used.

5. Store or use hydrogen gas: The hydrogen gas can be stored in tanks or used immediately for various

The colours of hydrogen and resulting GHG emissions

	Colour of hydrogen	Feedstock	Production technology	Direct GHG emissions[a] kg $CO_2e/kg\ H_2$	Indirect GHG emissions[b] kg $CO_2e/kg\ H_2$
Produced using electricity	Green	Renewable electricity, water and/or steam by thermolysis	Electrolysis	-	>0[c]
	Yellow	Grid electricity, water		-	<1 - 30 *Depends on the carbon intensity of the grid mix*
	Pink	Nuclear electricity, water		-	>0[c]
Produced using fossil fuels	Grey	Natural gas	Methane reforming	9 - 11	0.5 - 4
	Brown	Lignite	Gasification	18 - 20	1 - 7
	Black	Black coal	Gasification	18 - 20	1 - 7
	Blue	Natural gas or coal	Methane reforming with CCS Gasification with CCS	0.5 - 4	0.5 - 7
	Turquoise	Natural gas	Pyrolysis	Solid carbon (by-product)	0.5 - 5
	Green	Biogas or biomass	Reforming with or without CCS Gasification with or without CCS	Possibility of negative emissions with CCS	1 - 3
Other	Red	Nuclear heat, water	Thermolysis	-	>0[c]
	Purple	Nuclear electricity and heat, water	Thermolysis and electrolysis	-	>0[c]
	Orange	Solar irradiance, water	Photolysis	-	>0[c]
	Green	Waste wood, plastic, municipal solid waste	Thermochemical	Possibility of negative emissions with CCS	Not assessed as variabilities in the value chains are too great to accurately represent the GHG equivalent emissions

[a] Direct emissions account for the hydrogen production process emissions.
[b] Indirect emissions account for the feedstock supply-chain emissions as well as the energy generation supply-chain emissions. Other indirect emissions, such as capex-related emissions, are also important but are not included here.
[c] Comparable to renewable power production infrastructure (1-20 gCO_2/kWh). The emissions related to the hydrogen infrastructure and hydrogen leakage will also contribute to indirect GHG emissions, where the exact quantities have to be identified.

Fig. 3. Hydrogen and GHG Emissions

applications, such as fuel for fuel cells or industrial processes.

It's important to note that electrolysis is an energy-intensive process and the source of the electricity used to power the process can greatly impact the overall environmental impact of hydrogen production through electrolysis. So in order to reduce environmental impact we will be using green energy such as solar, wind, etc. for producing hydrogen. In terms of electricity generation, hydrogen can be used in fuel cells to convert the chemical energy stored in hydrogen into electrical energy. This process produces no harmful emissions, and the only byproducts are water and heat. The working procedure for a proton-exchange membrane fuel cell (PEMFC) can be summarized as follows:

A Proton Exchange Membrane Fuel Cell (PEMFC) is a type of fuel cell that converts the chemical energy of hydrogen and oxygen into electrical energy through an electrochemical reaction. The basic schematic of a PEMFC consists of the following components:

Hydrogen fuel supply: Hydrogen gas is supplied to the anode side of the fuel cell. The hydrogen can be stored in a tank or generated on-site through a reformer.

Oxygen supply: Oxygen gas is supplied to the cathode side of the fuel cell. The oxygen can be obtained from the air through a compressor or a blower.

Anode: The anode side of the fuel cell consists of a thin layer of platinum catalyst on a carbon support, which is coated on a proton exchange membrane. The hydrogen gas flows over the anode catalyst, and the hydrogen molecules are split into protons and electrons.

Cathode: The cathode side of the fuel cell also consists of a thin layer of platinum catalyst on a carbon support, which is coated on the other side of the proton exchange membrane. The oxygen gas flows over the cathode catalyst and reacts with the protons and electrons that have crossed the membrane from the anode side.

Proton exchange membrane: The proton exchange membrane is a thin, polymer electrolyte membrane that separates the anode and cathode sides of the fuel cell. It allows the protons to pass through it while blocking the electrons, creating an electrical potential between the two electrodes.

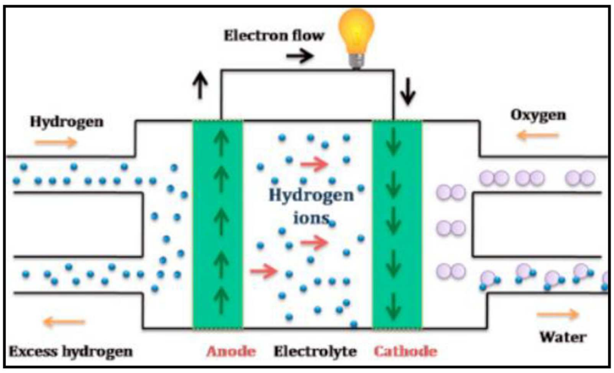

Fig. 4. Fuel cell

Electrical circuit: The electrons that are produced at the anode side of the fuel cell flow through an external circuit to the cathode side, where they combine with the protons and oxygen to produce water and heat. The electrical energy produced by the fuel cell can be used to power electrical devices, such as a motor or a light bulb.

PEMFC systems are required to operate in the range of approximately –40° to nearly 100 °C.

III. HYDROGEN COMBUSTION ENGINES

Hydrogen engines can work in two main ways: combustion or electrochemical reactions. In an internal combustion engine, hydrogen is injected into the engine's combustion chamber and ignited, creating energy that powers the engine. By-products of combustion are usually water vapor and small amounts of nitrogen oxides. In an electrochemical engine, hydrogen is used as fuel to generate electricity through a process called an electrochemical conversion. This can be achieved through a fuel cell that combines hydrogen and oxygen to produce electricity, water, and heat. Both internal combustion and electrochemical hydrogen engines have the potential to power vehicles and other machinery, with the latter offering the added benefit of zero emissions at the point of use.

Differences between a hydrogen ICE and a traditional gasoline engine include hardened valves and valve seats, thicker connecting rods, non-platinum spark plugs, higher voltage ignition coil, fuel injectors designed for gas instead of liquid, larger crankshaft damper, stronger head gasket material, modified intake manifold, overpressure compressor, and high-temperature engine oil. All modifications would be about one-fifth the current cost of a gasoline engine. These hydrogen engines burn fuel in the same way as gasoline engines.

The theoretical maximum output of a hydrogen engine depends on the air/fuel ratio and the fuel injection method used. The stoichiometric air/fuel ratio for hydrogen is 34:1. At this air/fuel ratio, hydrogen displaces 29% of the combustion chamber, leaving only 71% for air. As a result, the energy content of this mixture will be lower than it would be if the fuel were gasoline. Since both the carburettor and the port injection method mix the fuel and air before it enters the combustion chamber, these systems limit the maximum theoretical power achievable to about 85% of the power of gasoline engines. For direct injection systems, which mix fuel with air after the intake valve is closed (thus having a combustion chamber of 100% air), maximum engine power can be approximately 15% higher than gasoline engines.

Therefore, depending on how the fuel is dosed, the maximum output of a hydrogen engine can be 15% higher or 15% lower than that of gasoline if a stoichiometric air/fuel ratio is used. However, at a stoichiometric air/fuel ratio, the combustion temperature is very high, resulting in the formation of large amounts of nitrogen oxides (NOx), a critical pollutant. Because one of the reasons for using hydrogen is low exhaust emissions, hydrogen engines are not normally designed to operate at a stoichiometric air/fuel ratio.

Typically, hydrogen engines are designed to use about twice as much air as is theoretically needed for complete combustion. At this air/fuel ratio, NOx production is reduced to almost zero. Unfortunately, it also reduces power to about half that of a similarly sized gasoline engine. To compensate for the power loss, hydrogen engines are usually larger than gasoline engines and/or equipped with turbochargers or superchargers. A small amount of hydrogen can be burned outside the combustion chamber and enter the air/fuel mixture in the chamber to ignite the main combustion.

Limitations of hydrogen combustion engines:

1. Limited availability and infrastructure: Hydrogen is not widely available and infrastructure for hydrogen production, storage, transportation, and replenishment is limited.

2. Safety: Hydrogen is highly flammable and requires careful handling and storage to avoid accidents.

3. Lower energy density: Hydrogen has a lower energy density compared to traditional fuels such as gasoline and diesel, which means that a larger volume of hydrogen is required to produce the same amount of energy.

4. Higher costs: Hydrogen is currently more expensive to produce, store, and transport than traditional fossil fuels.

5. Nitrogen oxide emissions: Hydrogen combustion engines still produce nitrogen oxides, which are harmful pollutants.

These limitations prevent the widespread adoption of hydrogen combustion engines, and the technology is still in the early stages of development. However, research and development efforts are underway to address these challenges and improve the viability of hydrogen-powered engines.

Counter methods to reduce nitrogen oxide production in hydrogen combustion engines

1. Exhaust gas recirculation (EGR): EGR involves recirculating a portion of the exhaust gas back into the engine's combustion chamber, which reduces the concentration of oxygen in the combustion chamber and lowers the peak combustion temperature, resulting in lower NOx production.

2. Lean combustion: Running the engine with a lean air-to-fuel ratio can also reduce NOx production. This is because lean mixtures have lower flame temperatures, which results in lower NOx formation.

3. Water injection: Water can be injected into the combustion chamber, which cools the combustion temperature and reduces NOx production.

4. Selective catalytic reduction (SCR): SCR is a technology that involves injecting a urea solution into the exhaust stream, which reacts with NOx over a catalyst to form nitrogen and water.

5. Exhaust gas after treatment: After-treatment systems, such as diesel oxidation catalysts or diesel particulate filters, can also be used to reduce NOx emissions.

These methods can be used individually or in combination to reduce NOx production in hydrogen combustion engines.

IV. WAYS OF TRANSPORTING & STORING HYDROGEN

Hydrogen costs depend on developing infrastructure for low-cost distribution and delivery. Compared to other gases and liquids, hydrogen succumbs to low energy density and safety concerns. These properties pose specific cost and safety challenges at all stages of distribution, from production to end-use. Hhydrogen can be transported:

-either as pure compressed hydrogen or as liquid hydrogen

- Ammonia and Liquid Organic Hydrogen Carrier (LOHC)

Compressed Hydrogen

Pipeline transportation of compressed hydrogen gas is the most economical way to transport large quantities over long distances. It can be performed either pure or mixed with natural gas in a natural gas pipeline within the limits specified. Small quantities, such as those required by today's hydrogen filling stations, are usually most cost-effective to transport in bulk by truck.

Liquid hydrogen

Because liquid hydrogen has a higher energy density than compressed hydrogen, more energy is required to produce liquid hydrogen than to compress the hydrogen to its corresponding pressure. Also, liquid hydrogen has different safety characteristics than compressed hydrogen gas. For example, a leak into the open air from compressed hydrogen tanks will rise due to buoyancy and will generally dissipate quickly. In contrast, a leak of liquid hydrogen into open air will freeze the surrounding air, become a heavy gas, and may accumulate on the ground for some time. This is relevant when, for instance, transporting hydrogen either by ship or truck, or when storing it in tanks.

Ammonia and liquid organic hydrogen carrier (LOHC)

Ammonia has a higher energy density per volume than liquid hydrogen and can be transported and stored as a liquid at low pressures or in cryogenic tanks at around -33°C at 1 bar. This implies that ammonia can be transported at low cost by pipelines, ships, trucks, and other bulk modes.

The drawbacks are that the ammonia synthesis and its subsequent dehydrogenation to release hydrogen require significant energy and it is toxic if an accidental release occurs. Hydrogenation and dehydrogenation of LOHCs, such as toluene, requires less energy, but the gravimetric density of the hydrogen that can be extracted from the hydrogenated liquid (methylcyclohexane for the LOHC toluene) is 50%–70% lower than the gravimetric hydrogen density of ammonia1. These considerations show that the lowest cost or preferred value chain depends on the application and context.

Storage

The energy system must be designed and operated to ensure sufficient security of physical assets, diversity of energy supply, market control, and resilience to geopolitical events. Hydrogen can be stored in two ways — either as pure hydrogen or integrated into a carrier which makes it easier to transport and store. Hydrogen can be stored as a gas at high pressures or as a liquid at very low temperatures. When required, hydrogen can be withdrawn from the storage and the pressure or temperature carefully adjusted to suit end use without any further significant chemical processing. Liquid hydrogen carriers have significant hydrogen content, and are liquid at conditions close to ambient temperatures and pressures — this makes them easier for shipping or above-ground storage without specialist containment. There are several examples of organic molecules that are hydrogen-rich such as toluene and di-benzyl toluene — these are known as liquid organic hydrogen carriers (LOHC). The drawback of LOHCs is that there is an energy penalty in synthesizing them in the first place and in the subsequent regeneration of hydrogen at the point of use. There will also be a carbon penalty if the energy used in the hydrogen transfer process is not renewable. Ammonia has the formula NH3 and is a well-established hydrogen-carrying liquid, containing one nitrogen atom and three hydrogen atoms. In some cases, ammonia can be directly burned instead of breaking down to release hydrogen. Storing electrical energy in a battery is possible, but at a large scale and for long periods of time is problematic. Molecular energy storage as hydrogen is a stable and reliable form of energy storage, and hydrogen can be used directly or converted to electricity as needed.

Hydrogen is a stable and reliable form of energy storage; it can either be used directly or converted to electricity as required. Understanding storage needs and options It is likely that a mix of hydrogen storage options will be needed, and projects centred on industrial clusters will be important to understand storage needs and timings. hydrogen storage may need to be more distributed than that natural gas as there will be fewer line packs in gas pipelines. We must also not forget that hydrogen has a much lower volumetric energy density than natural gas (3 to 4 times less dense) which increases the complexity of the solution. Where hydrogen is to be used for transport applications it is about 2,700 times less dense than gasoline which means that it needs to be compressed, liquefied, or chemically combined before storage. An overall framework for comparing hydrogen storage options is likely to be necessary and assessments for each region or country should include:

- Capacity
- Deliverability
- Injectability
- Discharge duration
- Response time
- Energy intensity
- Cost per unit stored
- Safety
- Location
- Time to market

A mix of storage options is likely to include:

- Long discharge duration storage for gas networks
- Salt caverns that can manage multiple fill/discharge

cycles and that can deliver and inject very quickly.

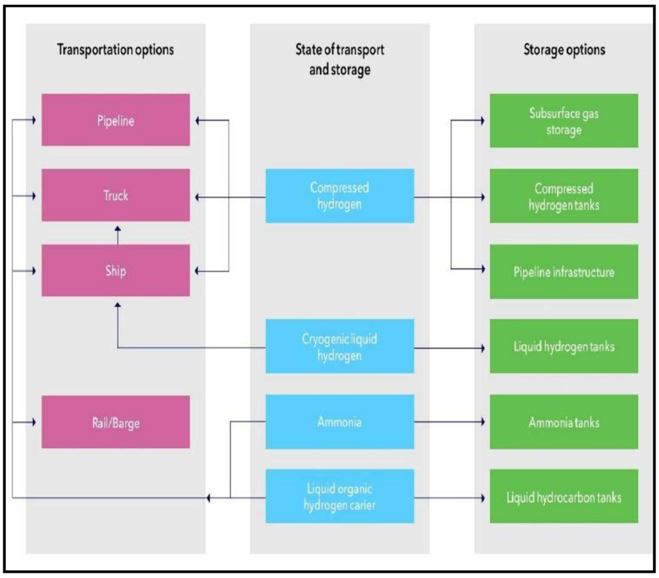

Fig. 5. Layout

V. HYDROGEN V/S OTHER FUELS

Like gasoline or natural gas, hydrogen is a fuel that must be handled properly. With proper guidelines, it can be used like other fuels. Hydrogen is colorless, odorless, tasteless, non-toxic, and non-poisonous. It’s also non-corrosive and is a gas under atmospheric conditions and it is the lightest element.

Gaseous hydrogen has several properties that make it different from other fuels, including:

Energy content: Gaseous hydrogen has a high energy content per unit of weight compared to many other fuels. In fact, it has the highest energy content of any fuel on a weight basis. This means that less hydrogen is needed to produce the same amount of energy as other fuels.

Emissions: Burning hydrogen in the air produces only water vapor as a byproduct, making it a zero-emission fuel. This is in contrast to fossil fuels such as gasoline and diesel, which produce carbon dioxide and other pollutants when burned.

Safety: Gaseous hydrogen has a wide flammability range, meaning it can ignite easily in the presence of air or oxygen. It is also highly combustible and can pose a safety risk if not handled properly.

Storage: Storing gaseous hydrogen can be challenging due to its low density and the need for high-pressure containers. This can make it more difficult and expensive to transport and store compared to other fuels.

Availability: Hydrogen is the most abundant element in the universe, but it is typically found bonded to other elements such as oxygen in water or carbon in fossil fuels. Extracting hydrogen from these sources can be energy-intensive and costly, which can limit its availability as a fuel.

Overall, gaseous hydrogen offers many potential benefits as a fuel but also poses some unique challenges that must be overcome

It will rise and disperse rapidly when it is released in an open environment as it is about 57 times lighter than gasoline vapor and 14 times lighter than air.

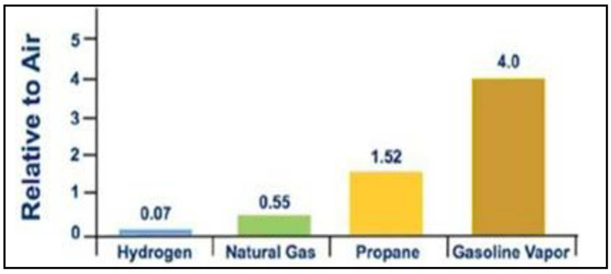

Fig. 6. Relative Vapor Density

The auto-ignition temperature of hydrogen is the temperature at which hydrogen gas will spontaneously ignite without an external spark or flame. The auto-ignition temperature of hydrogen is approximately 500°C (932°F) in the air at standard pressure (1 atm or 101.3 kPa). This means that if hydrogen gas is released into the air and the temperature of the surrounding environment reaches or exceeds 500°C, the hydrogen gas will spontaneously ignite and burn.

It is important to note that the auto-ignition temperature of hydrogen can vary depending on the pressure, oxygen concentration, and other factors present in the environment. For example, the auto-ignition temperature of hydrogen is lower in the presence of pure oxygen or higher pressures.

Because of its low auto-ignition temperature and wide flammability range, hydrogen gas must be handled with care and stored in specialized containers designed to prevent leaks and minimize the risk of ignition. Proper safety measures and training are critical when working with hydrogen gas to ensure that the risk of fire or explosion is minimized.

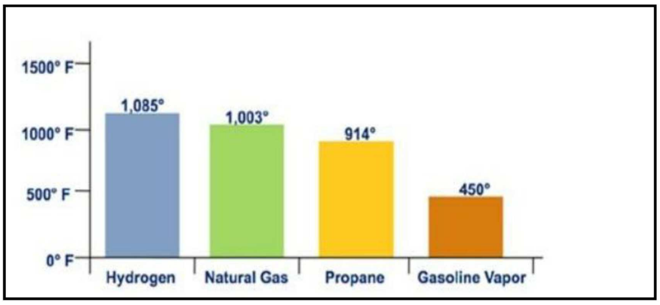

Fig. 7. Auto Ignition Temperature

The flammability range of hydrogen is generally wider compared to many other fuels, meaning that it can ignite and burn at a wider range of concentrations in the air. For example, the flammability range of gasoline is typically between 1.4% and 7.6% by volume in air, which is much narrower than the flammability range of hydrogen. The flammability range of natural gas, which is mostly composed of methane, is also narrower than hydrogen, typically between 5% and 15% by volume in air.

However, some fuels such as propane and butane have wider flammability ranges than gasoline or natural gas, which are more comparable to the flammability range of hydrogen. For example, the flammability range of propane is typically between 2.1% and 9.5% by volume in air, while the flammability range of butane is typically between 1.8% and 8.4% by volume in air.

It is important to note that the flammability range of fuel can vary depending on the specific composition of the fuel, as well as other factors such as pressure, temperature, and humidity. Proper handling and storage of all fuels, including hydrogen, is essential to minimize the risk of fire or explosion.

Hydrogen fuel is a promising alternative fuel for shipping that is being explored as a potential replacement for conventional fossil fuels. Compared to other fuels used in shipping, such as diesel and heavy fuel oil, hydrogen has some advantages and disadvantages.

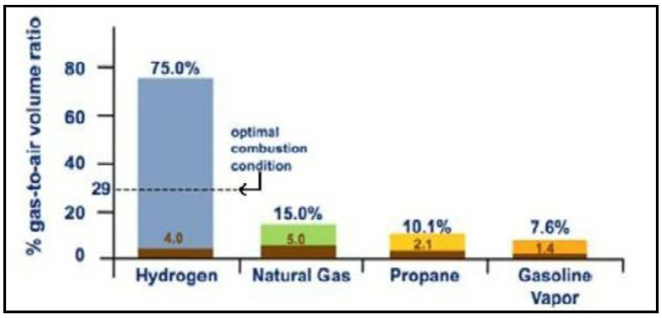

Fig. 8. Flammability Range

Advantages of Hydrogen Fuel in Shipping:

1. Zero Emissions: One of the key advantages of hydrogen fuel is that it produces zero emissions when burned, which means it can help reduce greenhouse gas emissions and air pollution in the shipping industry.

2. Abundant Supply: Hydrogen can be produced using renewable energy sources such as solar and wind, which means it has the potential to be a sustainable and abundant fuel source for shipping.

3. High Energy Density: Hydrogen has a high energy density, which means it can provide a lot of energy per unit of weight or volume. This can be particularly useful for long-range shipping where weight and volume are important factors.

Disadvantages of Hydrogen Fuel in Shipping:

1. Limited Infrastructure: One of the main challenges of using hydrogen fuel in shipping is that there is currently limited infrastructure for producing, storing, and transporting hydrogen. This would require significant investment in infrastructure to make it viable on a large scale.

2. Safety Concerns: Hydrogen is highly flammable and requires careful handling to prevent accidents. Safety concerns would need to be carefully addressed to ensure the safe use of hydrogen in shipping.

3. Energy-Intensive Production: Hydrogen production can be energy-intensive, especially if it is produced from non-renewable sources. This means that the overall emissions reduction benefits of hydrogen fuel in shipping can be limited if the production process is not fully sustainable.

Compared to diesel and heavy fuel oil, hydrogen fuel has the advantage of producing zero emissions when burned. Diesel and heavy fuel oil are major sources of air pollution and greenhouse gas emissions in the shipping industry. However, diesel and heavy fuel oil have a well-established infrastructure and are currently more widely used in the shipping industry. They also have higher energy densities, which can make them more practical for certain types of shipping operations.

In conclusion, hydrogen fuel has both advantages and disadvantages compared to other fuels used in shipping. While it has the potential to reduce greenhouse gas emissions and air pollution in the shipping industry, its widespread adoption would require significant investment in infrastructure and careful attention to safety and sustainability issues.

VI. EXAMPLES OF HYDROGEN POWER IN SHIPPING

A. *INDIA'S PROJECT*

Mministry of Ports, Shipping and Waterways unveiled the Government's plan for building India's first Hydrogen-fuelled electric vessel at Cochin Shipyard Limited (CSL). The Hydrogen fuel cell is based on Low-Temperature Proton Exchange Membrane Technology (LT-PEM) called Fuel Cell Electric Vessel. The technology is estimated to cost around 17.5 Cr, 75% of which will be funded by the centre.

The project is expected to elevate India's efforts in becoming carbon neutral by 2070 as a target set by the Prime Minister as well as complying with the regulations set by the International Maritime Organization (IMO).file.

B. *CARGO VESSEL*

A French company is developing the world's first hydrogen-powered cargo transport vessel, which is scheduled to debut sometime later this year.

Built by Compagnie Fluvial de Transport (CFT), the ship is to be deployed on the River Seine in Paris and will use compressed hydrogen produced by electrolysis as its sole source of energy. The vessel is intended for inland waterways only and is not intended for ocean voyages. The flagship project received just under $6 million in funding in 2018 from the European Union's Horizon 2020 research and innovation program, which aims to further research into hydrogen-fuelled freight transport. One hydrogen-powered concept ship is already sailing in Paris, while two other vessels are currently under construction.

Converting much larger ocean freighters to hydrogen power could present a substantial logistical challenge. Fossil fuels are much more energy dense and take up less space on ships. Refuelling stops could also significantly increase the cost of running a cargo ship - but the vessel is an interesting concept nonetheless.

C. *HYDROGEN-POWERED TUG*

The world's first hydrogen tugboat arrived in Belgium on October 27 after construction in Spain. Installation of the vessel's hydrogen system is expected to be completed at the port of Ostend, and tugboat testing will also be completed ahead of the expected delivery date later this year. The goal is to have Hydro tug 1 fully operational in the port of Antwerp in the first quarter of 2023.

The tugboat was built at the Armón shipyard in Navia, Spain, and launched on May 16th. It is being developed as part of a pilot project in collaboration with CMB technology and the port of Antwerp-Bruges. CMB. Tech is taking a leading role in converting ships to sustainable fuels and says the tugboat is the latest in a series of unique projects demonstrating hydrogen propulsion. Earlier this year, the company also launched the Hydrocat 48, a hydrogen-powered crew transport vessel. The Hydro tug 1 is powered by two Be Hydro V12 dual-fuel medium-speed engines that can run on either hydrogen or normal fuel.

The tugboat is the only one of its kind and the world's first to be equipped with an internal combustion engine that runs on hydrogen combined with diesel fuel. Its power is 5500 horsepower. Port officials reported that the Hydrotug-1 can store 415 kg of compressed hydrogen in six racks installed on board. They estimate that this will eliminate the equivalent of 350 cars in emissions. Additionally, every time Hydro tug 1 is filled with hydrogen, the total emissions from one vehicle are reduced by one year.

Ostend was chosen as the site for final fitting and testing because Tug could use a Hydrocat 48 CMB.TECH hydrogen rig operating in the port.

D. *WORLD'S FIRST HYDROGEN TANKER*

The world's first liquid hydrogen carrier has arrived in Victoria as part of a project to test the viability of a hydrogen export market between Australia and Japan. The HESC pilot project is testing the feasibility of producing hydrogen using coal from the Loi Yang lignite mine in the Latrobe Valley and transporting it to Japan for consumption. The mine produced hydrogen for the first time last year.

The project is being developed by a consortium of Japanese and Australian companies including Kawasaki Heavy Industries, Japanese energy giant J-Power, and AGL, which owns Loy Yang.

At Loi Yang, hydrogen is transported in gaseous form and is liquefied before export. The 8,000-ton gross tonnage Suiso Frontier heads to Kobe, Japan, on a two-week liquefied hydrogen voyage. The features a 1250 cubic meter storage tank capable of holding 0.125% of the original volume of liquid hydrogen in its gaseous state. The project has received $100 million from the Victorian and Commonwealth governments.

E. *HYDROGEN-POWERED PUSH BOAT*

Elektra is the world's first hydrogen pusher named in Berlin. The christening of Elektra, the world's first hydrogen pusher (tugboat), was held in Berlin. It took shipbuilder Hermann Barthel and his partners two years to build this landmark vessel.

The boat is designed to make full use of the energy available on board. In addition to power plants, hydrogen power plants provide cabin and wheelhouse heating. Waste heat from the fuel cell is used for continuous water cooling and the cabin is heated by a heat pump. The pusher tug, loaded with 750 kg of high-pressure compressed hydrogen and approximately 2,500 kilowatt-hours of battery capacity, had a range of approximately 215 nautical miles and pushed a fellow barge, the Ursus.

Together with other charging stations, this is enough to transport the Elektra along the regional waterways to the Ruhr, Hamburg, and Stettin.

The Department of Marine Systems Engineering and Operations at the Technical University of Berlin served as project leader with support from Berliner Hafen- und Lagerhausgesellschaft (BEHALA), the Hermann Barthel shipyard, and fuel cell manufacturer Ballard Power Systems. At Berlin's Westhaven, Berlin Mayor Franziska Giffee presided over the ship's naming ceremony. In 2023, the first hydrogen tank replacement stations and electric charging stations will begin to operate at the ports of Westhaven Berlin and Luneburg.

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DESIGN A SMART DASHBOARD CONSOLE FOR ELECTRIC TWO-WHEELER WITH ENHANCED FEATURES

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***ABSTRACT*:-**
Electric Two-wheeler business in India is coming up with an attractive Dashboard console. For smart and safe Two-wheeler, the integrated dashboard becomes a necessary product. The proposed system can not only represent the conventional dashboard in a digital form but also endow the system with intelligent guidance. Various research work has been carried out to design & developing a Dashboard for EV (Electric Vehicle) with an optical bonded 7inch touchscreen Thin film transistor (TFT) display with features like a Mobile phone app with Android & IOS, Navigation, Roadside assistance, Service book, Alert tap, Incognito mode, List of documents, charging status, ODO meter, Trip, Time, Avg. speed, State of charge(SOC), Economy(ECO) mode, Screen brightness, Notifications, Motor RPM, Homologation tell tales, activation of TCS Park assistance enhance the rider's safety & ease of driving. The EV and the dashboard console are linked using microcontrollers (MCU) and have a wireless architecture with a Control area network (CAN) base. Then the operation procedure can be simplified, and hence driver can concentrate more on steering. Designing such a dashboard console for cost competitive domestic market based on complex technical requirements, additional features, environmentally friendly design, and safe vehicle ride are goals of this study.

Keywords— *CAN, EV, IOS, SOC, TFT, MCU, Navigation, etc.*

I. INTRODUCTION

A Dashboard Console is a product that is used to display all the information of the EV, which can either be criticalor not. The information is usually displayed on to LCD/TFT screen, which is easily visible. The Smart Dashboard Console forms a critical part as it is the face of the EV wheeler that reflects the current real-time state of the vehicle. Apart from that, it can also provide crucial indications of electrical component malfunctions.

The information is gathered from various sensors of the Electric Two-wheeler, and this information is received by ECU (Electronic Control Unit). The control unit prioritizes the data gathered by all the sensors and displays it to the driver [2],

- The sensors should send signals to the ECU & prioritize which information must be displayed to the driver.
- Recently all Electric Two-wheeler are using CAN protocol, the information sent to the ECU is prioritized through the unique 'Identifier' (ID) bit of the CAN Protocol
- The ECU uses the identifier bit and displays the data which has a high priority to the driver; for example, if the speed is high then the HMI speedo screen displays with red or some indications.

Fig. 1: Smart Dashboard Image with Location in EV

The above images show the Dash's HMI and Dash viewing angle. Normally, the viewing angle is kept around the 38-to-48-degree range to have overall visibility after seating at a different level. The eye point of the driver is normally kept at 90 deg. or 8/9 deg. w.r.t Dash's Glass.

Also, sunlight reflection on the Dash should not affect the rider's visibility.

Need to design properly so that the Ghost image should not be visible to the consumer eye point.

A. *Types of the Instrument cluster in Two-wheeler :*

- Mechanical /Analog Instrument Cluster
- Semi digital - Cross coil type cluster
- Electronics cluster -
  - Pointer with stepper motor
  - Fully digital with LCD
    - Positive Display
    - Negative Display
    - ASTN/ STN (Hybrid LCD) Positive & Negative
    - DSTN Negative
    - IBN/EBN/TBN
  - Dashboard - TFT 5 "or 7" display (mostly suitable for EV)

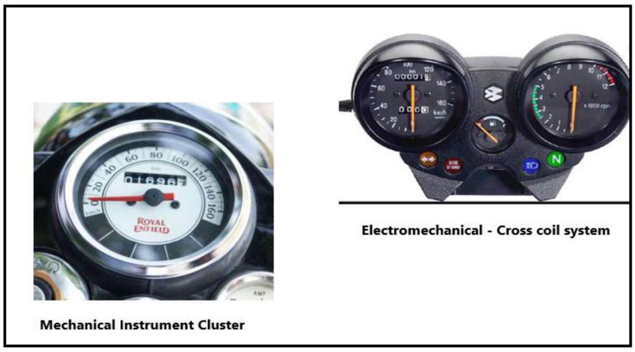

Fig.2. Mechanical/Analog Instrument cluster Image

The above images show the Mechanical /Analog instrument cluster where Speed input from the speedo cable. Speedo movement is present inside the cluster, which is a Gear mechanism that shows the speed output onto the Dial. And for the fuel level resistance type, gauges are there to show the fuel level taking input from the tank unit.

Semi Digital, Full Digital & TFT Dash are all digital instrument clusters. Technology updates from Semi Digital, Full Digital & then TFT Dash, which will be followed to connected clusters. It makes it possible to present a wide variety of information to the driver that is adapted dynamically to suit the current driving situation.

Fig. 3. Semi-Digital & Full Digital Electronics Instrument Cluster Image

Fig. 4: 5 "/ 7" TFT dashboard Image

The digital cluster is ideal for a wide range of possible application scenarios, including conventional tachometer displays, function displays, route planning graphics, or displaying video from a rear-view camera. The driver is always shown exactly the right information when needed. That ensures less distraction and helps reduce the accident risk. The information is very easy to read in all situations, thanks to the display's outstanding resolution. The user interface (HMI) can be personalized and easily adapted to different vehicle models and markets due to its versatile core design.

Fig. 5. Construction of Smart Dashboard console in Electric Two-wheeler

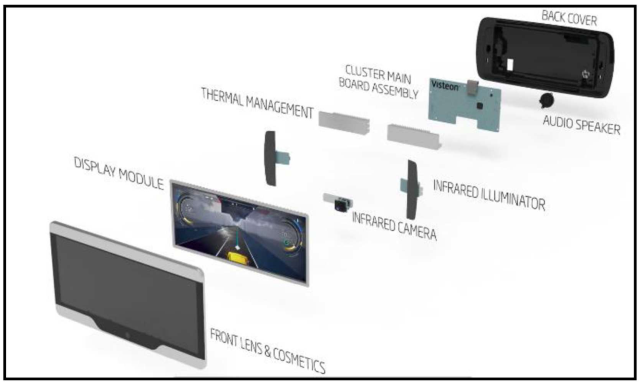

Fig. 6. Exploded view of Smart Dashboard Image

The smart Dash consists mainly of the front lens, which is optically bonded glass with CTP or without CTP fixed with a TFT module. Then the TFT module is the product's heart, including the backlight module. Then as per requirement infrared camera, Ambient light, and temp sensors are located. Below the TFT module, there are thermal pads for temp. Management of the product. The main PCB assy. This included all E-component as pert schematic followed by the back cover, which completes the product assembly.

Packing compliance IP 67/68 requirement of the industry.

B. *Existing Design of Dashboard console for Two-wheeler :*

Currently, many Two wheelers are using Mechanical, Semi digital & digital gauges and an LCD screen to display the information to the driver. In Semi digital, the LCD screen becomes small due to the bigger dial plate of both speed and RPM gauges. It will display less information, such as odometer readings, fuel levels, and time. The vital information such as oil levels, engine errors, ABS, Traction Control, side stand, service reminder, etc., lights up as tiny symbols. These tiny static symbols only light up if there is an error. To appreciate the benefits and the challenges of the instrument cluster, we first need to examine what they have evolved from Mechanical/analog clusters.

A typical Electro-mechanical cluster (cross coil type) includes the following components:

- Stepper motors:

Long gone are the days when a speedometer cable reached from the wheel/Engine to directly transmit the speed; modern clusters use a stepper motor to control the needles. The speed sensors send pulsed to MCU & it drives the motors.

- Controller (MCU): A semi-digital cluster typically uses an 8- or 16-bit MCU that has onboard analog-to-digital converters, general-purpose I/O (GPIO) pins, and other peripherals. Because the MCU needs only small signals to take decisions & activate required functionality. Nowadays, many MCU have the capacity to drive the CAN signals, so we can avoid the wiring complexity and many warning indicators, we can turn ON /OFF by reading the CAN message.
- Analogue-to-digital converters (ADCs): Analog to Digital converter converts the analog signal into digital form. This is required to process the signal to MCU having information in form of various Voltage levels which can finally be calibrated as per the customer specifications & displayed.

These measure fuel level, battery charge, and other information by directly sampling the voltage level. They can also detect failure conditions (for instance, the voltage drop on a backup battery) and detect when a single wire carries multiple signals (for instance, a resistive ladder on a steering wheel button). The ADCs may reside on the system-on-chip or a discrete chip.

- LED/LCD drivers: A mechanical/analog cluster has many indicator lights, including turn signals, low fuel, low battery, low oil pressure, and a service reminder. The MCU or another module may drive some of these indicators directly, but in most cases, the MCU intercepts a CAN message and sends a signal through a GPIO to turn the indicator ON or OFF. Some clusters use a segment display for the speedometer or the odometer/trip meter.

C. *New Design Concept for Smart Dashboard console :*

Smart Dashboard can acquire Two-wheeler data over simple mechanisms such as encoders as well as through complex interfaces such as CAN [1].

Smart Dashboard Console design for electric Two wheelers may have less system complexity, but they must be more user-friendly, less power consumption. Careful design and cluster component choice are necessary to meet the stringent compliance requirements. It is always recommended to use AEC's Q components for better reliability.

Ultra-low power microcontroller (MCU) enables customers to build compact, energy-efficient Smart Dashboard Consoles for a wide range of two-wheeler. It offers highly suitable peripheral interfaces such as Timer/captures for Speed /RPM signal processing, a built LCD controller, Multiple IOs, etc.

In this blog, we will discuss in detail the various features of a Smart Dashboard Console and how MCU will help simplify the design.

[12] By using the CAN Bus, it is possible to send the data from all the sensors to the central control unit or the ECU through a single bus, and then from the central control unit or the ECU, the data such as speed, RPM, fuel level, etc., are

displayed to the driver. For CAN protocol to be implemented and communication in the network, each node requires a microcontroller, CAN controller, and CAN transmitter.

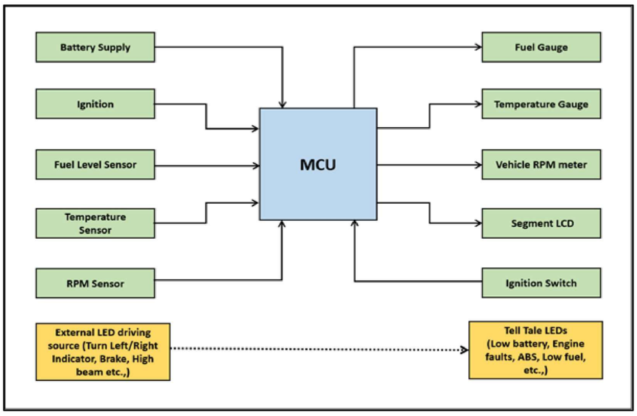

Fig.7. Hardware interface model

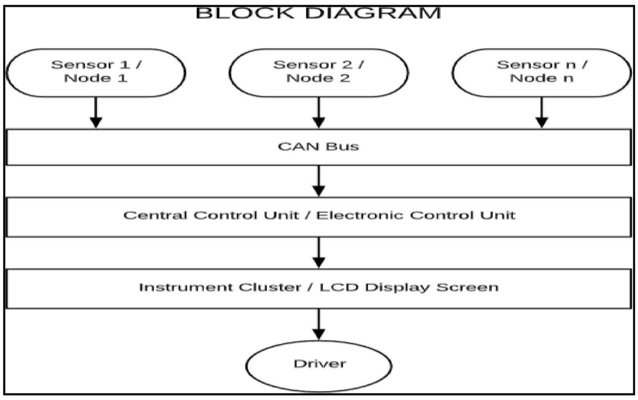

Fig. 8. Block diagram of CAN model

[7] Why, then, are automakers adopting Digital Smart Dashboard Consoles? Here are some of the reasons:

Reusable: With a digital cluster, automakers can simply deploy the same hardware across multiple EV Two-wheeler lines by changing the software.

Dynamic: Digital clusters use MCU and alloys to process the signal fast and accurately. Nowadays, 32-bit MCU also uses two providing very fast response for EV two-wheeler.

Simple: Digital clusters support reducing driver distraction by displaying only the accurate and real-time information that the driver currently requires.

The software behind a semi-digital cluster is fairly simple. It'd need an operating system (OS) since all tasks can be executed within a fixed duration in a small, tight loop. To develop the software, engineers need traditional embedded skills: setting and reading bits for GPIOs, debouncing switches, reading ADCs, receiving and sending CAN messages, and performing other direct-to-hardware tasks.

II. LITERATURE REVIEW

According to Y. Tao et.al. [7], automobiles have had a good demand in the market over a period due to the increased features of the Two wheelers. EV Two-wheelers nowadays follow almost every safety regulation, due to which the highest possible occupant safety could be achieved. For this smart and safe EV Two-wheeler concept, the integrated smart dashboard becomes a necessary product. The proposed system with intelligent guidance for safety.

According to Rakesh Ranjan et.al. [2], to implement a safer, more efficient, and reliable automated system for vehicles with decreased complexity and reduced wiring. In this paper, the implemented system uses many sensors for data acquisition, and the CAN bus is the communication medium for data transmission.

III. DASHBOARD SYSTEM DESIGN

Automotive displays generally fall under the parameters of ASIL B. Specifically, within the Smart Dashboard Console display few blocks should meet ASIL B criteria.

[6] In electric Two-wheeler Battery State-of-Charge is the most important feature to be displayed, it shows the battery pack voltage as an indication of remaining battery capacity, usually read when the Two-wheeler is at rest. The remaining capacity to the battery's full capacity. Voltage alone does not give a comprehensive indication of battery charge. Additionally, the relationship is not linear, with voltage remaining relatively constant during a large proportion of the battery discharge. The graph of battery voltage (V) versus battery capacity (in Amp-hours) should be understood. SOC % and SOH % are shown in the Smart dashboard for EV two-wheeler.LED Telltales or Telltales inside the TFT-

We need to drive LEDs. It is a waste of port pins if we drive the LEDs directly through the microcontroller. Furthermore, the microcontroller may not have the required current capacity. Instead, we can use an LED driver for the same purpose. LED drivers that connect directly to the microcontroller through SPI/I^2 C are available.

5 "or 7 "TFT Display for EV –

It consists of different HMI as per customer inputs.

[3] Serial or CAN Communication Module –

We first need to identify the type of Two-wheeler communication are going to use. The latest microcontrollers have in-built communication modules, supporting protocols such as SAE J1850, CAN, and KW2000. Another alternative is to have an external chip that connects directly to the bus accessed by the microcontroller using SPI/I^2 C.

III.A.1 Microcontroller –
The microcontroller selection is one of the most critical parts of the system design. You have many software and hardware considerations in selecting the ideal microcontroller. The following are the minimum requirements for our processor.

- 30 I/O lines that are pin addressable
- ADC module with five A/D channels/pins
- An SPI/I^2 C module capable of driving five devices
- External/Internal Interrupt capability
- Two to four general-purpose timers.

[2] Other than these functions, you may also consider other built-in functions for the microcontroller, such as a built-in Two-wheeler communication module, stepper driver, or LCD driver. The complete processor software will average occupy 70 to 90 Kbytes of ROM, 3 to 4 Kbytes of RAM, and 1K to 2K bytes of EEPROM. The microcontroller we select must have enough on-chip memory. You use the EEPROM for data backup, so keeping it outside the processor is best. EEPROM chips with 256 bytes, accessible through SPI/I^2 C, are available.

We next need to choose the processor type and clock frequency. Depending on the complexity, the system can use an 8, 16, or 32-bit processor. We may have a tradeoff between bits and clock frequency. The optimum clock frequency to use is around 4 MHz to 32 MHz

Separate pins are used to enable the peripherals. The built-in ADC senses all the analog inputs. Separate port pins are used to give pulses to the corresponding stepper motors. Write software such that with one direction pin, you can independently control the direction of all the stepper motors. EV Two-wheeler speed pulse train is given to the Capture interrupt/Timer pin so that no pulses are missed. A wakeup interrupt pin is provided for waking up the controller from sleep mode. Two PWM pins are provided to control the backlighting of the LCD/TFT. In EV, all electronic components go to deep sleep mode, so that minimum battery capacity will reduce, less power consumption.

III.A.2 Signal Conditioning:
The signal conditioning section deals with the conversion of various signals to signals compatible with the microcontroller. Ignition and battery voltages are scaled down to a 5V range. A 2.5V reference voltage is generated from regulated 5V DC. The regulator supplies power for all the peripheral ICs and circuits. The microcontroller can switch off the regulator using PWR_EN. The processor will go into sleep mode when the ignition switch is off, and there is no activity on the communication bus. The processor is awakened by the WAKE_UP signal, generated by OR-ing Bus status, and ignition switch.

IV. PROPOSED ADVANCED FEATURES IN THE DASHBOARD

Below all features are not available in any smart Dashboard in the Indian market. So, our research work and data can be helpful who are designing these kinds of devices.

Existing features in Dashborad from market	
Contents	**Graphical presentation Ref.**
Speed	198 km/h
Tachometer	
ODO	ODO 13614.3 km
TRIP	TRIP A 12.2 km
Average Speed	AVG SPEED 58 km/h
Range	RANGE 56 km
Clock	9:15 AM
Battery Persentage	80%
Battery Status	60%
Throttle failure	
Motor failure	M

Fig. 9.(a) Existing Features of Dashboard in Market

Riding mode	ECO POWER
SOC (State Of Charge)	
Service Reminder	Service due in 500 km
Side Stand	
Forward / Reverse Mode	FORWARD 2 kmph REVERSE
Bluetooth	
Music	Play music Coming soon!
Call	
Message	
Ambient Air Temperature	20°C
Battery Temperature	
Mobile Battery status	
Network Signal	
Turn by Turn Navigation	930 meters
Notification Display	99+ New Messages; Incoming... Sanket Koktk...
Cruise Control	
Diagnostic indicator	
Lap disatance	LAP 32.0 KM
Lap timer	MIN SEC MILLI 18 : 78 : 05
Park Assitance mode	PARKING MODE

Fig. 9.(b) Existing Features of Dashboard in Market

Gear Indication	N GEAR
Distance to Discharge	DTD 58 km/h
Settings	Time & Date; Units; Language; Automatic Update; 250
Top speed	TOP SPEED 58 km/h

Fig.9.(c) Existing Features of Dashboard in Market

New features can be added in Smart Dashboard	
Ice Warning	22°c
Tyre Pressure Status	2.4 bar 2.8 bar
Leaning Angle	00° 40° MAX 36°
Helmet	
Traction control	TC

Fig. 10. New Features added in Smart Dashboard

V. CASE STUDY - DESIGNING A VEHICLE INSTRUMENT PANEL

In modern vehicles, software-controlled electronics play a significant role in the functioning of the vehicle's subsystems. In a medium-sophistication vehicle, 8 to 10 intelligent electronic modules will perform functions such as engine control, transmission, brakes, steering, navigation, HVAC, safety, security, audio, driver information, and others. Though each of them works on its own, the modules will be connected using some in-vehicle network. Communication protocols such as SAE J1850, CAN, and KW2000 are commonly used for automobile inter-module

The Instrument Panel Cluster (IPC), or Vehicle Dashboard, is one of the few devices with which the vehicle communicates with the driver. Devices such as a driver information Centre and heads-up display are considered subsystems or add-on devices to the IPC. Even though from technology and complexity perspectives, the IPC is simpler than other modules, it is important to the driver since it is one of the few modules the driver sees.

System Design

- Analogue speedometer display
- Analogue tachometer display
- Analogue fuel display
- Analogue engine coolant temperature display
- LCD single-line season/trip odometer
- Nine discrete LED or bi-pin lamp telltales

VI. Results and Discussion

A Smart Dashboard Console, which is accurate, fast, and easy to understand and uses CAN protocol, has the following features,

- By displaying messages instead of warning

lights, the driver can quickly understand the issue.

- Reduced wiring costs due to CAN bus.
- Easily add and remove sensors.
- Easier to understand which component malfunctioned.
- Display critical information first.
- Reusable, scalable product, error-free product

By displaying error messages in the Smart Dashboard Console and the component symbol lighting up, which indicates that a component has malfunctioned, the driver can easily understand the issue in the automobile. Quick and accurate passing of data from the sensors to the ECU or the central control unit is achieved by using the CAN protocol. Also, OEMs need to add relevant features considering the safety aspects during driving.

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CYBER-SECURITY- REGULATORY ASPECTS AND DATA THEFT IN MARITIME INDUSTRY

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ABSTRACT
We know that 'maritime shipping' has a great impact on the world economy. Almost 90% of international trade is carried by maritime transportation. The maritime field is now adopting various methods as per the need of time. But this adaptation has led to many thefts in the maritime industry. To run with the need of time, making automized and future realistic ships maritime industry is using IT, both in port and at sea. AI techniques are used for various purposes like navigation and cargo management etc. The thefts in the maritime industry are not only causing casualties but also causing a great loss to the companies. The maritime industry and other industries are also affected by cyber-related thefts. As the international maritime organization has noticed the cyber security threat and hence come up with a Cybersafe law by IMO Resolution MSC.428 (98) – adopted June 16, 2017. This paper proposes case studies, reasons, and solutions regarding improvement in cyber security awareness in the maritime field.

Keywords--Cyber security, cyber-physical system, attacks, protection measures, cyber theft, case study

I.INTRODUCTION

Cyber security is a method of preventing hackers from gaining access to systems and information. It also addresses the system maintenance, integrity, confidentiality of data, and availability of information and systems, ensuring business continuity and the continuing utility of cyber assets. We must consider how to protect systems from physical attacks, force majeure events, etc when designing port systems or supporting operational processes. Personnel security is also essential as the insider threat from staff or contractors who decide to behave carelessly or maliciously cannot be ignored.

Most of the maritime equipment on deck, as well as the engine, is mostly computerized. All the types of machinery are interconnected through satellite internet, and this is the main reason for cyber-attacks in the maritime sector if a ship is near the harbour or port the attacks can turn into a serious problem throughout the area, the well-known cyber-attack on the A. P. Moller (Maersk). A.P. Moller (Maersk) reported a malware attack in June 2017. This incident cost 200-300 million losses in company. In other cyber-attacks, malware affects port assets and operations, and there has been unintentional jamming or interference with wireless networks. If the port systems were to fail, malfunction, or were misused, would this result in economic, operational, physical, or reputational loss or damage, or disrupt the operation, own an information asset that includes information about your strategy or commercial operations, either the construction or the operation of your port or port facility, including any port systems If this information asset were compromised, could this result in economic, operational, physical or reputational loss or damage.

II.WHAT IS CYBER SECURITY?

A. We can define it as "The collection of security concepts, safeguards, risk management and techniques to avoid these threats."
B. Network security is the method of securing a computer network from targeted attackers or opportunistic malware.
C. Application security focuses on keeping software and devices free of threats.
D. Information security protects the privacy of data, both in storage and in transit.

E. Operational security includes the processes and decisions for handling and protecting data assets.

F. End-user education addresses the most unpredictable cyber-security factor: people. Anyone can accidentally introduce a virus to an otherwise secure system by failing to follow good security practices. Teaching users to delete spam email attachments, not plug in unidentified USB drives, and various other important lessons are vital for the security of any organization.

III.REASONS FOR CYBER ATTACKS IN MARITIME FIELD

A. Lack of Encryption:

We believe that the lack of any inbuilt encryption or authentication code in navigation systems is an issue. Due to the lack of encryption, it becomes easy for hackers to hack the data, so it's our fault we provide them with a chance to hack our system. Cyber hackers can take advantage of this open system by creating a condition of a non-existent vessel and assigning it static information such as name, identifiers, flag, ship type, speed, and direction.

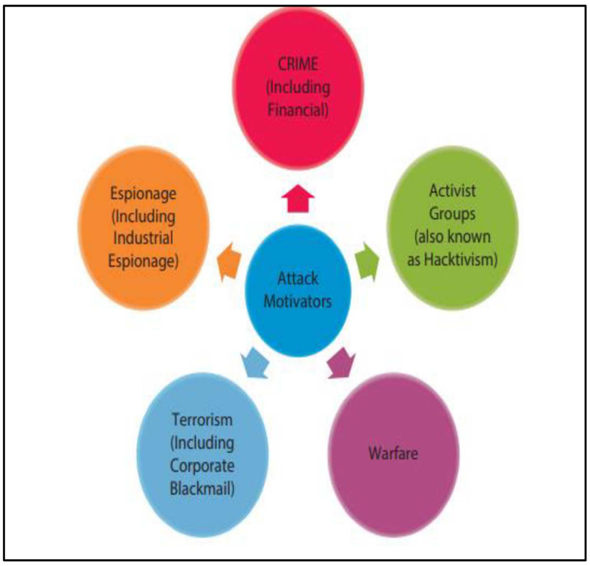

Fig 1: Aim of cyber attackers.

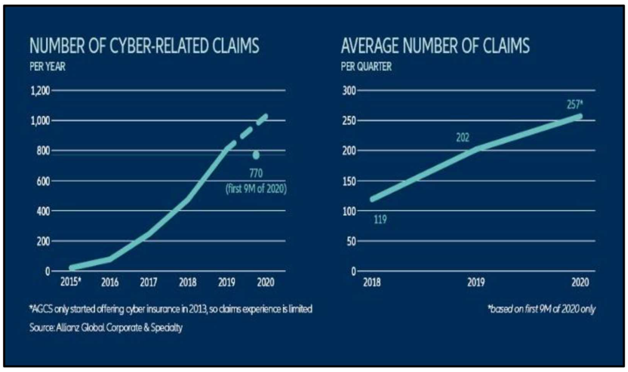

Fig 2: - Increasing numbers of cyber-attacks in the world

B. Increased use of computer services:

If we observe now, not only the maritime sector but all sectors are relying more heavily on computerized systems, which mainly turns out as the main reason for the threat. Ships and offshore systems are performing various operations with coordination and connection and are using more and more computer programs that connect to the internet, which is not a good choice. We are not against adopting new technology but it should be used at a certain limit. The systems are like an open door waiting for hackers to walk through.

C. Crew is not aware or trained in cyber security:

Companies believe that cyber security preventative measures are expensive but instead of thinking in this manner, they should think of the loss they will come across when the hackers will attack them. However, getting stuck in a cyber-attack is much more expensive and causes severe damage to reputation. There is the perception that getting hit by an attack is very unlikely, and therefore spending the money to safeguard oneself is not always worth it. There are some examples made public of maritime cyber.

Example: - Such as AP molar Maersk so each company must conduct various sessions to keep aware of cyber-attacks. They can appoint a cyber security expert on each ship, which will increase employment and drastically reduce cyber-attack.

B. IV. TYPES AND STAGES OF CYBER ATTACK IN SHIPPING INDUSTRY

Cyberattacks can be of two types active or passive, which mainly include both targeted and untargeted. Targeted attacks are cyber-attacks on specific corporate Internet networks and network components with a specific purpose of penetration - access to confidential information and obstruction of the normal functioning of ship systems. Untargeted attacks are carried out using an Internet environment and software tools to detect unprotected communication components.

A. *Types of Untargeted Attacks:*

The most popular untargeted cyber-attacks are the following:

1) *Malware* – aimed to access or damage a computer from the network of the ship or shipping company. It includes Trojans, spyware, ransomware, viruses, and worms.
2) *Ransomware* – This is a cyberattack with software that encrypts data files on individual workstations or databases, which the user does not have access to until the ransom is paid.
3) *Phishing* – This is an attack with emails to multiple users' addresses to access personal and/or confidential information, request to visit a fake website and other fraudulent activities.

B. Types of Targeted Attacks:

Targeted attacks are carried out with software tools and techniques specifically designed to affect ships and shipping companies. Tools and techniques for targeted attacks include:

1) *Social engineering* - This is a non-technical approach to cyber-attacks used to manipulate and force personnel to violate security requirements, usually, but not exclusively, through interaction through social media.
2) *Brute force* – this is a cyber-attack through repeated attempts to decipher the password of the network or network device.
3) *Denial of service (DoS)* – this is a classic cyber-attack to prevent authorized users from accessing information, usually by flooding network devices (computers and servers) with data.
4) *Man-in-the-middle* – a form of active eavesdropping attack in which the attacker intercepts to read or modify data communications to masquerade as one or more of the ship's entities are involved.
5) *Spoofing* – a false signal is broadcasted with the intent to mislead the victim receiver, such as a Global Positioning System or email user.

V. HOW CYBER SECURITY POLICIES ARE IMPLEMENTED IN TODAY'S MARITIME FIELD?

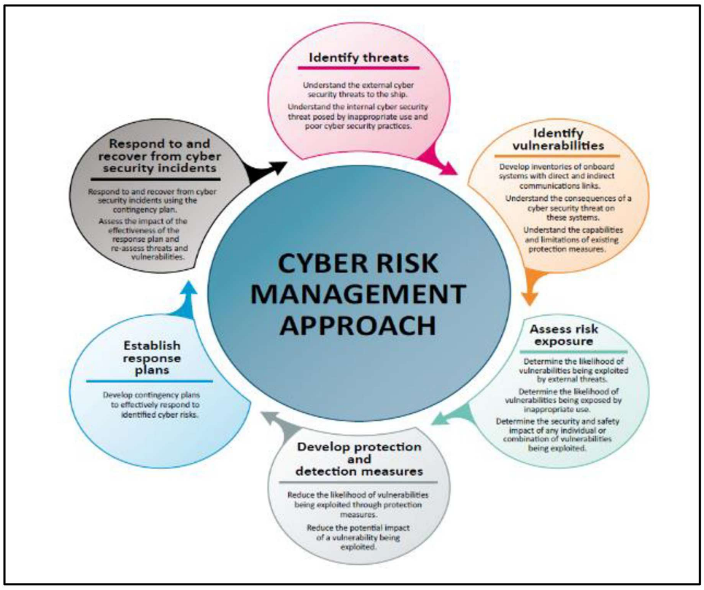

Fig.3. Cyber Risk Management Approach

Recognizing the need to respond to cyber threats on a digitalized ship, the IMO has been conducting discussions on maritime cybersecurity, ultimately adopting a resolution on maritime cyber risk management at the 98th MSC on June 16, 2017. This IMO adopted Resolution MSC.428(98) "encourages administrations to ensure that cyber risks are appropriately addressed in existing safety management systems (as defined in the ISM Code). Under this resolution, the IMO recommends that each flag state should integrate matters concerning cyber risk management regulations into the ship safety management system (SMS) before the first annual verification of the company's Document of Compliance (DoC), which occurs after January 1, 2021. The IMO guidelines include functional elements to support cyber risk management and provide appropriate integration into the risk management framework (the United States National Institute of Standards and Technology's Framework for Improving Critical Infrastructure Cybersecurity: NIST's Risk Management Framework).

IMO Resolution MSC.428(98) identifies an urgent need to raise awareness of cyber risk threats and vulnerabilities to support safe and secure shipping, which is operationally resilient to cyber risks. Thus, all maritime owners and stakeholders should work towards safeguarding shipping from current and emerging cyber threats and vulnerabilities. The resolution also states the importance of the SMS code should consider cyber risk management under the objectives and functional requirements of the ISM Code.

VI. RECOMMENDATION TO REDUCE CYBER-ATTACKS IN THE MARITIME FIELD

A. Protection measures may also be procedural and should be covered by company policies, safety management procedures, security procedures, and access controls. As with all other control and countermeasures, only procedural controls that are practical and cost-effective should be implemented.
Procedural controls are focused on how personnel uses the onboard systems. Plans and procedures that contain sensitive information and strategy should be kept confidential and handled according to company policies.

B. Training and awareness- As we know, human is the weakest link to security. Training and awareness are the key supporting elements to the best approach to cyber risk management or counter cyber-attacks against the transfer of malware. The employees are not aware of different types of cyber threats that can get into their system and create huge problems like not keeping good passwords, sharing passwords, using professional systems for surfing, downloading, or accessing any site without checking and a lot more that's why the cyber awareness among the whole people is important.
Training and awareness should be tailored to all levels, whatever may be the basic job of the employee for onboard personnel, including the Master, officers, and crew shoreside personnel, and port authorities, who support the management, loading, stowage, and operation of the ship, etc.

C. *Remote access.*
Every organization must have a remote monitor system to analyze or keep track of all the instructions or activities going on in the systems for analysis and development purposes. Clear guidelines should establish who has permission to access, just like higher officials, when they can access, and what they can access as per the guidelines. Any procedures for remote access should include close coordination with the ship's Master and another technical superintendent.

D. All remote access occurrences should be recorded for review in case of an IT or OT system is disrupted. Systems, which require remote access, should be clearly defined, monitored, and reviewed periodically.

E. *Multi/factor authentication (MFA) and passwords*
The MFA should be developed to protect the system and confidential data from any unauthorized access by any third person. This system can be used at every system and every level to protect from brute force attacks, and every company must have strict strong policies about passwords.

F. The crew members and company Ensure system security and hardening of connections (Removable devices, malicious code, backup & recovery).

G. Anti-virus and anti-malware tool management. Scanning software tools like anti-virus and firewalls used to detect and deal with malware and different types of cyber thefts need to be kept up to date and managed

VII. DEVELOP DETECTION MEASURES

A. Detection, Blocking, and Alerts
Detecting intrusions, infections, and thefts is the most critical part of cyber risk management. A baseline of network operations and expected data flows for users and systems should be established and managed to establish cyber incident alert thresholds. Key to this will be the definition of roles and responsibilities for detection to help ensure accountability.
B. Malware Detection
Scanning software that can automatically detect and address the presence of malware or any other cyber theft in systems onboard should be kept up to date and managed. As a general guideline, computers on board should be protected to the same level as office computers ashore. Anti-virus and anti-malware software should be installed, maintained, and updated on all personal as well as work-related computers and all IT systems onboard. This will reduce the risk of these computers acting as attack vectors toward servers and other computers on the ship's network. How regularly the scanning software will be updated must be taken into consideration when deciding whether to rely on these defense methods.

VIII. CASE STUDY

A. In June 2017, A.P. Moller Maersk fell victim to a major cyber-attack caused by the NotPetya malware. As a result, Maersk's operations in transport and logistics businesses were disrupted, leading to an unwarranted impact.

1) The attack reportedly created considerable problems for the world's biggest carrier of seaborne freight, which transports about 15 percent of global trade by containers. In particular, Maersk's container ships stood still at sea, and its 76 port terminals around the world ground to a halt. The recovery was fast, but within a brief period, the organization suffered financial losses of up to USD300m.

2) It all began when an employee in Ukraine responded to an email featuring the NotPetya Malware. The system was affected, and therefore operations practically had to be on hold until the system's restoration.

3) Although the incident was serious, the organization responded rapidly, under the supervision of the CEO and top management team. A team of IT experts (including internal and external partners) mobilized to track, identify and remove malware from affected systems

B. Lessons Learned

1) No matter the preparation, there is a high possibility for a cyber threat to find the "way in". Therefore, each organization should be prepared to respond and recover by building cyber resilience.
2) Guidance and decisions taken by top management at the operational level and media handling are vital to business continuity.
3) Employees at all levels (low-medium-top) should be aware of possible cyber threats and response plans to mitigate damage.
4) Response and Recovery plans should be tested and updated frequently to include new mitigation actions for possible cyber threats.
5) Being proactive is a must; therefore, an investment in an organization's protection and employees' awareness is proven to be more affordable than the subsequent financial loss due to a cyber-attack.

IX. CONCLUSION

As part of its aim of strengthening cybersecurity systems in the maritime sector, the IMO published the "Guidelines on Maritime Cyber Risk Management" in 2017, adding to the ISO international standard, the U.S. National Institute of Standards and Technology's standards, and industry guidelines for shipowners' organizations. Under the IMO's guidelines, each flag state is to integrate and manage matters concerning cyber risk in the ship SMS of the ISM Code before the first annual audit due on or after January 1, 2021. This paper, to derive cybersecurity improvement plan priorities in consideration of digitalized ships, and cybersecurity vulnerability items in the maritime sector. Considering that most international trade is conducted via maritime transportation, maritime shipping trade has a significant impact on the global economy. There is a saying that transport is meat and drink to cyber criminals. That means it is very vulnerable to cyber-attack. Seafarers cannot fathom the extent of damage a cyber security attack can cause to a ship. This paper described essential cyber security measures that should be undertaken on a ship. It explored how a ship navigation facility interconnects and, as an example of a cyber threat, how hackers hack. In addition, in this paper, we have explained a case study of a very famous cyber-attack in our maritime field: A.P. Moller Maersk, a malware attack.

X. ACKNOWLEDGEMENT

We would like to thank for providing us the platform to present a technical paper on such a diverse topic that is of great importance and is still scarcely trod upon. We are glad to be able to grab this opportunity and take full advantage of it.

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DEVELOPMENT OF AN AGRICULTURE MULTI-NOZZLE SPRAY

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ABSTRACT

The foundation of the Indian economy is agriculture.

The livelihood of 70% of Indians depends on agricultural output.

Due to the distribution of farms among families due to population growth, farmers are divided into three categories: small, middle, and wealthy farmers. Due to their limited resources, small-scale farmers are drawn to manually handled knapsack backpack sprayers. However, this sprayer has certain drawbacks, such as the inability to maintain continuous pressure requirements and back or shoulder pain issues. However, this technology can also result in incorrect chemical application, inefficient pest control, and pesticide loss during application. This may contribute to ecosystem imbalance and environmental contamination. This essay suggests a battery-operated, multi-nozzle pesticide sprayer device. An electric motor and a 12-volt battery are used to power this. It can help back pain issues and execute spraying at optimum efficiency in the shortest period, which should be quicker than the conventional way of spraying.

Keywords **- Multi-Nozzles, Pesticides, Pump, Sprayer.**

I. INTRODUCTION

In India's economy, agriculture is extremely important. Agriculture supports over 65% of the state's population. Although it now makes up only a sixth of the GDP, it employs 56% of the Indian labor force. In 1960–1961 there were around 81% marginal and small farmers and 44% land operators. In the Indian scenario, more than 75% of farmers are involved in small- and marginal-land farming, and cotton is the only crop that employs roughly 80% of the Indian labor force. Therefore, every development in productivity-related tasks helps raise the status and economy of Indian farmers. The present backpack sprayer is somewhat limited and uses much energy to run. In 1960–1961, the percentage distribution of agricultural holding land was as follows: 39.1% for marginal farmers, 22.6 for small farmers, 61.7 for small and marginal farmers, 19.8% for semi–medium farmers, 14 for medium farmers, and 4.5 for large farmers. Explain in detail how a large percentage of the farm's distribution fell into the tiny and marginal group.

The project is an automatic pesticide/fertilizer sprayer that is powered by a motor or battery and put on a cart or trolley. The primary reason for creating such a design is to avoid the three main problems with the pump now in use. The farmer must, first, carry the entire weight of the pesticide spraying pump (around 20+ kg) on his shoulder; second, he must continually pump with one hand while using the handle, and third, the spraying period must be shortened. Along with being affordable, light in weight, and strong, this project has taken into account all these criteria.

II. PROBLEM SUMMARY

The farmer who employs a backpack sprayer deals with a variety of issues, including fatigue and pain in the muscles and spinal cord. Utilizing this automatic pump type may lead to the following issues.

COMMON PROBLEMS:

- Operator fatigue brought on by hefty weight
- The operator becomes extremely fatigued and exhausted during spraying because of the hefty weight, which lowers efficiency
- The risks to the environment and human health from using this outdated technology in farming are intolerable.

III. LITERATURE REVIEW

- 1. R.D. Dhete has worked on “Agricultural fertilizer & pesticides sprayers”. In his work, he emphasizes a different method of spraying devices
- India's population is growing daily, making agricultural modernization crucial to meet the country's growing food needs. The fertility of the soil is declining as a result of chemical fertilizers. As a result, farmers are drawn to organic farming. Fertilizers and pesticides are delivered evenly over the farm thanks to mechanization in spraying

systems, which also reduces waste generation and prevents losses and input wastage.

- The cost of production will go down. The cost of production will go down. Mechanization increases output while requiring less input.
- Farmers continue to apply pesticides and fertilizers using the same conventional techniques. The equipment is also unchanged over time. In India, the industrial sectors have developed far more rapidly than the agrarian ones Designed and built in New Zealand by Metal form Dannevirke. However, there is a correlation between rising fertilizer use and declining water quality. Although research on the consequences of nitrogen leaching and the most effective strategies to limit fertilizer use is ongoing, it is obvious that control over the application will become increasingly crucial. Metal form Dannevirke is a New Zealand-based company that designs and manufactures the Tow and Fert line of fertilizer machinery.

Numerous fertilizers, both soluble and non-soluble, can be sprayed using the Tow and Fert line of products. With a ratio of up to three parts fine particle fertilizer to one part water, the Tow and Fert can spray fertilizer slurries that are exceptional. The usage of a recirculating system allows for this. The flow rate of the machines is currently almost completely uncontrolled, and the operator's speed determines the application rate. For the Tow and Fert product line, a flow control system is being designed, built, and tested as part of this thesis's investigation of the impact of adjusting flow rate on spray characteristics.

Numerous difficulties arise from the capacity to spray such a diverse spectrum of fluids with radically differing characteristics.

Numerous flow meters were considered, including installing and investigating a low-cost ultrasonic sensor (TUF2000M). A straightforward turbine flowmeter was added after the ultrasonic sensor had only moderate success. The development and tuning of a flow controller. The controller maintained a flow rate of between 10 L/min and 25 L/min depending on the installed nozzle using a PID control loop.

2. Pavan B. Wayzode, Sagar r. Umale, Rajat R.Nikam, Amol D.Khadke, and Hemant carried out their work in the “design fabrication of agricultural sprayers, weed with cutter

Chemicals are widely used for controlling disease, insects, and weeds in crops. They can save a crop from pest attack only when applied in time. The chemicals are costly. Therefore, equipment for uniform and Effective application is essential. Dusters and sprayers are generally used for applying chemicals. Dusting, the simpler method of applying chemicals, is best suited to portable machinery and usually requires simple equipment. But it is less efficient Than spraying, because of the low retention of dust.

They have suggested a portable, fuel-free wheel and pedal sprayer that is simple to transport and spray the pesticide by turning the wheel and pedaling the apparatus. This equipment is described in work as being wheel and pedal driven. This apparatus uses a reciprocating pump, and an accumulator for continuous liquid flows to generate the pressure required for the spraying operation. This wheel-operated pesticide spraying apparatus saves time and prevents pesticides from coming out of the nozzles in front of the user of the pesticide spraying apparatus. One of the laborious tasks in crop production is weed control. Weeding is not advantageous due to labor expenses, time, and complete physical labor. As a result, efforts are undertaken to design and create effective farm equipment that can accomplish weddings without the use of electricity.

3. Sandeep H. Poratkar and Dhanraj R. Rout carried out their work in the “Development of a Multinozzle Pesticides Sprayer Pump” "
India is a land of agriculture that comprises small, marginal, medium, and rich farmers. Small-scale farmers Are very interested in manual lever-operated knapsack sprayers because of their versatility, cost, and design. But This sprayer has certain limitations like it cannot maintain the required pressure; which leads to the problem of back pain. However, this equipment can also lead to the misapplication of chemicals and ineffective control of target pests Which leads to the loss of pesticides due to dribbling or drift during application.
This phenomenon not only adds to the cost of production but also causes environmental pollution and imbalance in the Natural echo system. This paper suggests a model of a manually operated multi-nozzle pesticides sprayer pump That will perform spraying at a maximum rate in minimum time. Constant flow valves can be applied at the nozzle To have uniform nozzle pressure.

IV. OBJECTIVES

- The aim of this project is that the farmer need not carry the entire pesticide sprayer pump on his shoulders but just pull/push the mechanism mounted on the trolley to operate the pump and spray the pests. This makes the farmer feel comfortable, relaxed, and less tiresome.
- To reduce human efforts due to the constant pumping action for creating pressure inside the pesticide and thereby provide a suitable environment for the user reducing the fatigue load acting on the Body. As discussed previously, the farmer has to continuously keep on pumping using one of his hands and spray

the pests on the crops using the other hand. This in the long run is a tiresome and cumbersome Job and the farmer slowly loses interest in it.

- This project focuses on the problem of health-related issues of the farmer (operator). The majority of them Don't use precautions like face masks and hand- gloves against hazardous chemicals and work in direct contact with them. Consequently, this harms the farmer as the spray in the conventional method directly hits the face. Multi-nozzle is used hence the larger area of the field can be sprayed at a faster rate.

V. METHODOLOGY

- The motor and pump are used so that the water is pressurized and the water gets a higher flow rate and velocity. The connection of the motor and pump is given to the water tank. And the output is connected to the nozzle and valve of a water tank.

- When we switch it on / off, the motor and pump will suck the water from the water tank, and the water flows through the pipe and then it goes into the nozzle.
- The nozzle is fitted on an adjustable stripas you can increase or decrease the height of the nozzles according to the crops.
- This is a simple mechanism. It is very useful for small framers farmers and its cost is also low. There will be more and faster work in less time

VI. DESIGN & CALCULATIONS

1. Frame

Length of frame = Tank Width + Wheel Diameter + Excess = 300 + 500 + 300
= 1100 mm

Width Of Frame = 300 mm

2. Selection of Wheel

Distance between two plants 20inches=508mm.

Let, in one rotation wheel covered 4 plants

4 x 508 = 2032 mm (c =2032 mm)

To find the

Diameter of Wheel

$C = 2\pi r$

$2032 = 2\pi r$

$r = 323.40$

mmd = 646.8mm

d = 650mm

We choose the diameter of the wheel = 650 mm

3.Nozzle Strip

Height = Height of plants – (Wheel radius + height offrame +excess)

= 1500 – (325 + 130 + 50)

= 996.5 mm

= 1000 mm

Width = 30 mm

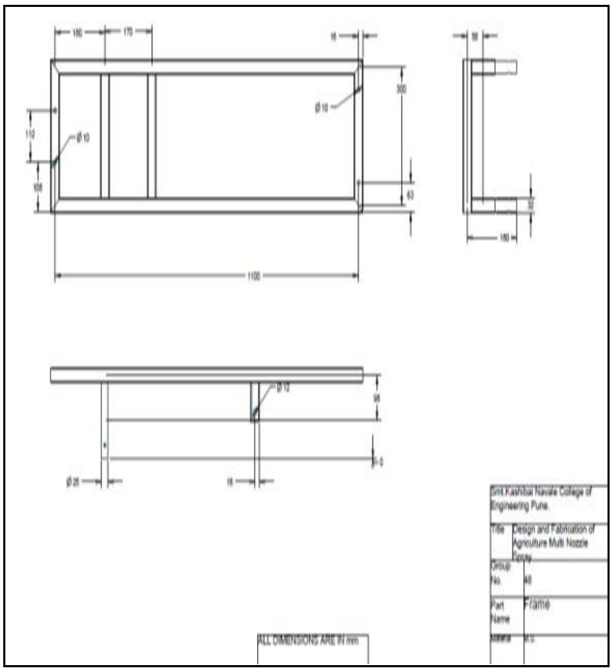

Fig. 1. Frame

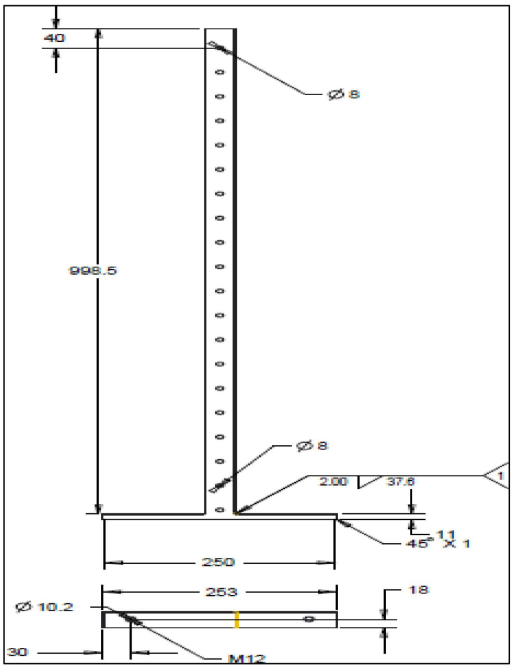

Fig. 2 Nozzle Strip

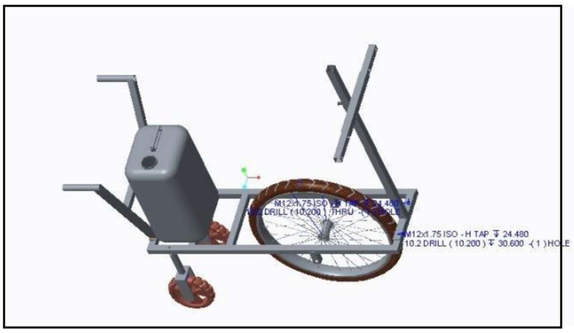

Fig.3. Assembly view

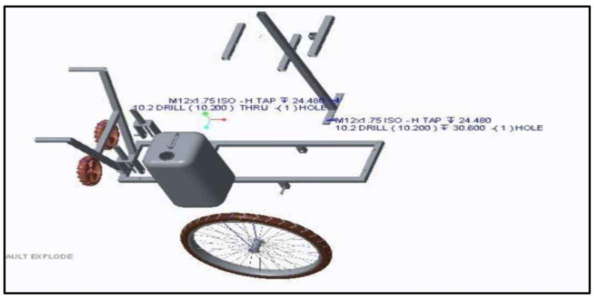

Fig.4. Exploded View

4. Storage Tank

Storage Tanks are generally used to store chemical pesticides. Storage tank capacity is 25 litres and these tanks are made up of plastic.

Fig.5. Storage Tank

5. Pump

A pump is a device that is used to lift, transfer, orincrease the pressure of a fluid

Volt – 12V, Pressure – 130psi

6. Battery

A Battery is an equipment that is mainly used for several applications. For the battery here, we choose a 12v battery.

VII. CONCLUSION

- This model removed the problem of back pain since there is no need to carry the tank on the shoulder.
- Muscular problem is removed due to no need tooperate the lever.
- This pump is suitable for different types ofcrops.

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A BRIEF REVIEW ON FINS

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ABSTRACT:-
Fin clusters on horizontal and vertical surfaces are utilized in a variety of design applications to dissipate warmth to the environmental factors. Studies of a warmth transfer and a liquid flow related to such clusters are in this manner of impressive design importance. The principle controlling variables generally available to the designer is the direction and the calculation of the fin exhibits. If there should be an occurrence of short horizontal exhibits, it is seen that the air entering evenly from both the closures gets warmed as it moves towards the trot of the fin channel, just as it ascends because of a reduction in thickness. Along these lines, the focal bit of the fin becomes inadequate in light of the fact that the hot air stream ignores that part, and subsequently it doesn't achieve the huge warmth transfer.

Keywords—Free Convection Heat Transfer, Notched Fin Array

I. INTRODUCTION

From the early research work and literature survey (1-15) plainly, there is establishment of single chimney design. Figure 1 shows the stream design for longwise short blade clusters. It is framed by the cold air entering from the two closures of the cluster, voyaging the long way and combining at the focal point of the exhibit. An upward part of speed is created bringing about exit of the air the vertical way in the central portion of the cluster.

Such a blade exhibits the central portion of the balance level and doesn't contribute a lot to warm exchange as effectively warmed air comes over that portion. Along these lines, if a portion of the material from that central portion is taken out, and is added at where more prominent natural air comes in the contact of the balance surface, it would build in general warmth move coefficient 'h'. In present examination the blade pads are altered by eliminating the central balance portion

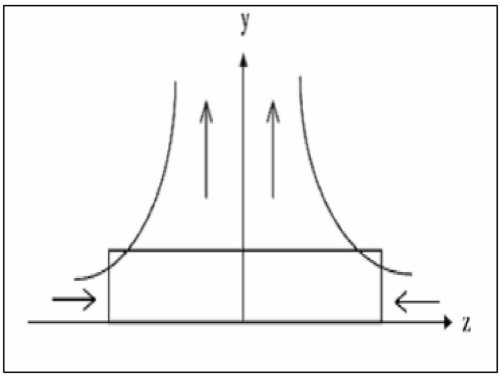

Fig. 1. Single Chimney Flow Pattern

Coming up next are the region where the rectangular balance is utilized generally and they are,

• Motor, transformers, microcontroller information, simple framework and CPU circuit sheets.

• Around the bike and engine cycle motor chambers, rectangular or three-sided profile balances are generally utilized.

•Refrigerating frameworks of evaporators and condensers.

• Car radiator and cooling of fuel warmers normally has rectangular balances.

Indent idea in fin array comes for lengthwise short fin array. In lengthwise short fin array single chimney stack stream design is available. Bottom central portion of the fin level becomes less successful because of the presence of effectively warmed air coming in its contact. In this sort of fin array the air enters from the two sides and gets warmed as it moves inwards. Temperature of the air increases and the thickness of the air rises upwards. Consequently, just less portion of air comes in contact with the central bottom portion of the fin channel. Because of this, the stagnation zone happens close to the central bottom portion of the fin channel as displayed in Fig.No.1. To conquer this intricacy some portion of fin is taken out close to the stagnation zone (score), to build the HTC.

II. NEED OF PERFORATION

The electronic systems during their operation generate heat which continuously increases the temperature of electronic components and causes their failure at high temperature. This generated heat needs to be dissipated quickly to surround the atmosphere to keep the working temperature of electronic devices at a protected and portable level. A heat sink is a passive device that dissipates heat to surrounding air using extended surfaces such as fins. Perforation means a circular hole is provided on the pin fin. Perforation on pins dissipates the heat rapidly to surrounding fluid because it disturbs fluid. Perforation on the pin also helps to reduce the overall size, weight and cost of the heatsink.

III. LITERATURE SURVEY

The problem of rectangular fins exhibiting horizontal bases has been studied both scientifically and tentatively. The scientific examination incorporates both two-dimensional and three-dimensional models. A portion of the test examinations join stream perception considers utilizing straightforward as a smoke method, Schlieren shadowgraph strategy and Mach-Zehnder interferometric procedure.

R. Sam Sukumar et al. [1] studied warmth move qualities of warmth sink with nonstop and interrupted.

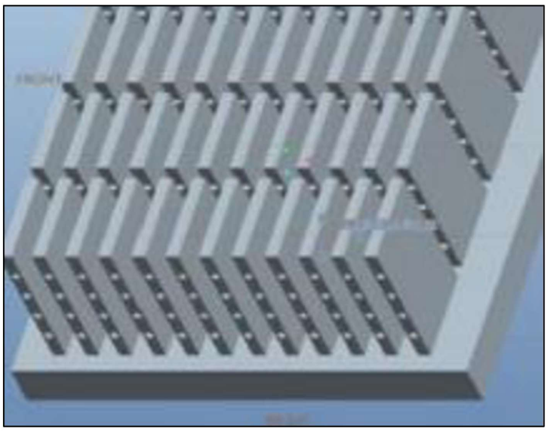

Fig. 2. Interrupted rectangular fins with through holes.[1]

rectangular fins. Further they give through holes on both rectangular fins and saw that an interrupted fin with through holes gives preferred execution over interrupted rectangular fins of warmth sinks. Raaid R. Jassem [2] studied the effect of perforation on heat transfer rate. They have taken five fins and give distinctive states of perforation on fins like circle, square, triangle, and hexagon. They found that the temperature drop is higher for perforated fins than that of strong fins and fins with three-sided perforation give higher warmth transfer.

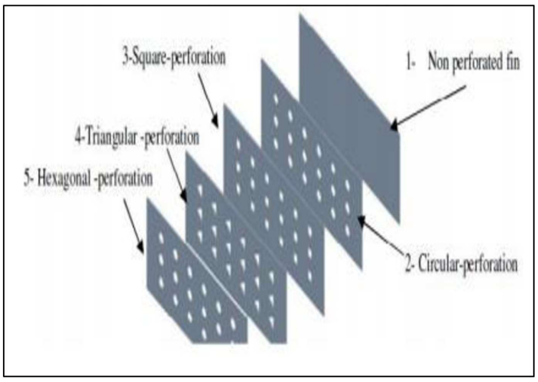

Fig. 3. Plate fins with different shape of perforation. [3]

Kavita H. Dhanawade et al. [3] studied the square and circular perforated fin arrays in constrained convection. They changed size of perforation as 6mm, 8mm and 10mm and scope of Reynolds number from 21 x10^4 to 8.7 x10^4.They saw that square perforated fin array gives more warmth transfer at low Reynolds number and the circular perforated fin array performs better at high Reynolds number.

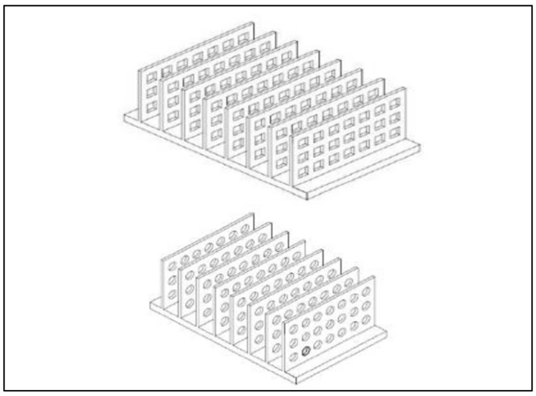

Fig-4: Square and circular perforated fin array respectively.[3]

Starner and McManus [4], who estimated the average warmth transfer coefficient in horizontal as well as in 45o and vertical base positions, have played out the primary work on horizontal rectangular fin exhibits. Flow representation tests were led utilizing smoke procedure. The previously mentioned flow patterns, for horizontal clusters a single chimney flow pattern was seen when the finishes were kept open and down and up flow pattern when the closures were shut.

Harahap and McManus [5] broadened craft by Starner and McManus [4] with a goal of all the more completely exploring the horizontal fin exhibits. Flow patterns were pictured.

Jones and Smith [6] attempted their examination with the great goal of building up the ideal separating of fins for most extreme warmth transfer from a given base surface. The average heat transfer coefficient (ha) increases with dissipation and moves asymptotically towards the flat plate to encourage mass redistribution.

Mannan [7] contemplated the impact of practically all appropriate mathematical boundaries of the fin cluster on its exhibition. His work covered a wide scope of length: 12.7 cm < L < 50.8 cm, Height 2.54 cm < H < 10.16 cm and dividing 0.48 cm < S < 2.86 cm, with (ΔT) differing from 39° C to 156° C.

Sane and Sukhatme [8] examined the issue of horizontal fin clusters. They tackled the administering conditions disregarding the speed segment typical to the fin pads on account of single chimney flow issue and utilizing vorticity – stream work detailing. Past specific upsides of S/H on the lower side, the single chimney flow pattern stops to exist because of gagging impact on the entering side flow.

Vollaro et al. [10] and Anand et al. [9] have reported a basic model to figure the warmth transfer of vertical finned surfaces in natural convection. The impacts of the warm conductivity (k), emissivity (ε) of the fins material and warmth traded by the un-finned part of the base plate on the ideal execution of the framework have been assessed.

Sobhan et al. [11], [12] explored experimentally free convection heat transfer from fins and fin exhibits joined to a warmed horizontal base. The significant contrast between the single fin case and the exhibit case is experienced close to the fin tip. The fin cluster shows a sudden expansion in the qualities around here. It was conceived by Gawali et al. [13] that a cross fin, whenever added at the focal point of a horizontal cluster, may improve the flow in a single chimney and may bring about better execution.

Shalaby [14] researched laminar natural convection from vertical and horizontal fin exhibits. He tackled the issue without disregarding the speed segments opposite to the fin pads. This includes the full arrangement of Navier-Stokes conditions, administering the three segments of speed, pressing factor and temperature each being a component of three space coordinates.

Baskaya et al. [15] completed parametric study of natural convection heat transfer from the horizontal rectangular fin exhibits. An infinite number of fins with immaterial thickness were expected. The fin surfaces and fin cluster base were thought to be at a uniform temperature. Radiation heat transfer was ignored. They noticed the single chimney type flow pattern in which the chimney is just a small part of the width of the fin cluster. The ha esteems expanded with expansion in the fin structure. A little drop with expansion in the fin stature was noticed for the littlest fin separating. In any case, no reasonable ends were attracted because of the different boundaries included.

Yuncu and Anbar [16] reported an experimental study of free convection heat transfer from rectangular fin-clusters on a horizontal base. The analyses were led in order to obviously distinguish the different jobs of H, S and base-to-surrounding temperature distinction (ΔT).

Suryawanshi and Sane [17] have ended up being fruitful holding a single chimney along with the expulsion of incapable fin level segments from ordinary fin exhibits. It was tracked down that the average warmth transfer coefficient for altered score fin clusters is almost 30 to 40 % higher as contrasted and typical exhibit.

Dayan et al. [18] led a consolidated scientific, mathematical and experimental study to research the issue of natural convection under a horizontal rectangular plate fin cluster. The insightful arrangement obviously uncovers the reliance of N_u on the R_a, P_r and the fin's stature to separate proportion. Ideal examinations were led to decide the base fin stature that gives the vital cooling ability of a predetermined exhibit base region. These findings have significant mechanical application since they sway both the expense and size of cooling finned surfaces.

IV. CONCLUSION

1. Nusselt number value upsurges with increasing number of holes on rectangular fin array.

2. The perforated fins have higher heat transfer coefficient than strong fins.

3. The perforated fin is light in weight, saves material and concentrates heat rapidly from the warmed surface contrasted with a strong fin.

4. Heat transfer upgrades rely upon number of holes, size and state of hole, thickness of perforated fin and thermal conductivity of fin material.

V. ACKNOWLEDGEMENTS

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A REVIEW OF AMMONIA USED AS A SUSTAINABLE FUEL OPTION ON SHIPS.

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ABSTRACT

Ammonia is an important that is widely available except having high electricity density in keeping with dollars as a fuel for gasline cells ,prodution techniques for ammonia are properly installed on this evaluation , one of a kind production technques for ammonia, mechanisms at the back of the operation of various ammonia fuel cells , one-of- a-kind catalystts used for various forms of fuel cells and their design limitations are reviewed . We`ve reviewed 10 extraordinary ressearch papers and based on that we`ve got made an evaluation on Ammonia as sustainable fuel on deliver.

Keywords— **Maritime sector Ammonia Power-to-ammonia Emission reduction Alternative fuels 0**

I. INTRODUCTION

Worries about environmental change are driving extremist changes in business behavior. Since the Nineteen Seventies, various arrangement data had been given with the aid of the United Nations (UN), the European Union (european), the Intergovernmental Panel on climate change (IPCC), the international Maritime organization (IMO), and numerous different institutions centered on diminishing the unfavorable effect of human beings on environments. The IPCC record of 2019 expressed that the worldwide imply Sea degree (GMSL) in the following 30 years may want to increment basically. This become assessed in view of the representative concentration Pathway (RCP), which units out diverse radiative compelling qualities within the yr. 2100 depending upon the concentration of GHG in the weather. via 2050 GMSL will increment through roughly 24 cm for the RCP2.6 (2.6 W m− 2) situation and via more or less 32 cm for RCP8.five (8.5 W m− 2). adjustments impact industries like strength introduction and transportation. within the strength region, there's a perceptible enlargement inside the usage of environmentally pleasant electricity assets (RES) and the intrinsic introduction of synthetic gases. Sea shipping is hoping to exchange to elective, artificially introduced gases. Ammonia is being mentioned as a gas representing things to return. The oceanic and ammonia union industry together are answerable for approx. five% of all out anthropogenic CO2 discharges (ammonia enterprise normally up to two%, [1]oceanic industry normally 3%). energy from RES will be blended with ammonia production as a characteristic of profoundly gifted and low-discharge gasoline transformation frameworks. sturdy oxide the advent of engineered hydrogen - that's expected to combination ammonia - and supply energy on board delivers. This audit examines ongoing turns of activities and the present status of mechanical headway in those advances. It proposes logical, modern, lawful suggestions, and monetary issues. It reasons to be aware the bearing of logical exploration and alludes to plausible exploration areas that could speed up the execution of ammonia inside the sea vicinity. This technique investigates the usage of ammonia as a gas in robust oxide power devices (SOFC) in an industry that is questioning beforehand. As humankind ships something like eleven billion tons of merchandise all over the planet consistently, converting to a incredible substance delivered the world over from RES bears the sign of a prominently sustainable marine gasoline arrangement. Over the maximum recent 5 years, many audit reports and hypothetical breaks down were created at the usage of ammonia inside the power business, specifically in controlling boats. among others, McFarlane et al. performed a manual to the ammonia economic system. within the review, the challenge of the oceanic commercial enterprise and power devices (robust oxide and direct ammonia gas cells) points were referenced hoarsely. The creators zeroed in at the ammonia advent and usage of ammonia delivered in unique generation a long time. The creators proposed that the third era which not functions the Haber-Bosh method however depends at the electro discount of NH3 may be normally charming for the oceanic enterprise as a gas. A comparable record become disbursed in 2021 by Hasan et al. with a piece greater information base. In 2018 Siddiqui and Dincer gathered a deal with direct ammonia strong oxide power gadgets in a single article. [2]The creators targeted on the correlation among the presentation of SOFC-O and SOFC- H fabricated with various electrolytes and terminals. A comparable file changed into performed by Rathore et al. in 2021. also, of their paintings, the creators amassed facts on the models that empower direct ammonia robust oxide power modules exam. In articles the writers portrayed specialised problems, ecological value determinations, or policies for destiny fills e.g., LNG and ammonia in an effort to be applied inside the sea business. Contrasted with the above paintings, our survey extensively covers the existence sample of inexperienced ammonia added and used in strong oxide cells. beginning from the worldwide family members of advent what is greater, the usage of ammonia, the continuing possibilities of the oceanic industry inside the car of ammonia are delivered. The audit centers additionally on unambiguous mechanical preparations empowering the utilization of ammonia. In light of the writing, the effectiveness and electricity usage of the now not set in stone. What takes into attention the assessment of the benefits coming about due to the development of proper cycles within the ammonia lifestyles chain I. Emission control and changes in the power industry

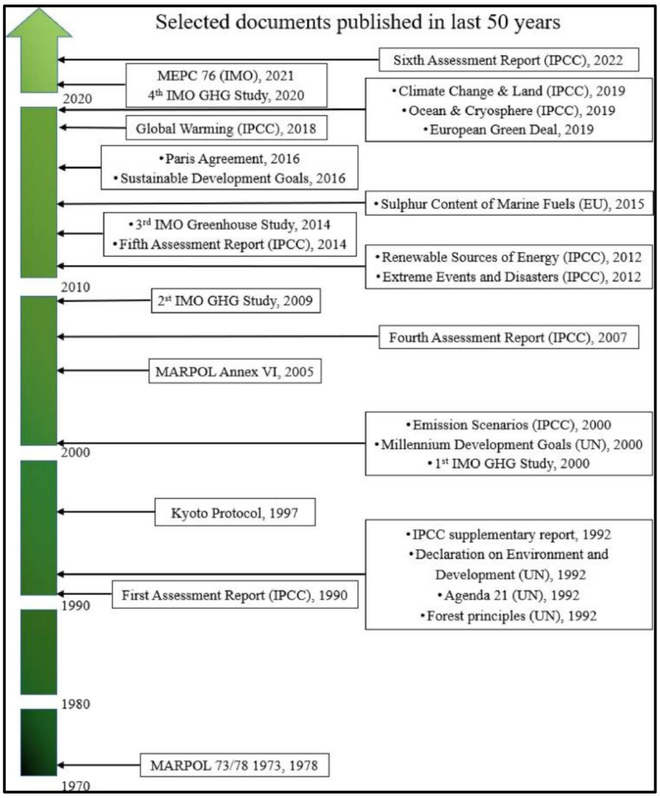

Fig. 1. A timetable of selected files and sports relating to environmental protection within the ultimate 50 years.

A. mission and environmental protection regulations

Diverse giant principles and guidelines had been supplied at the general public, provincial, and international ranges to decrease ecological contamination and discharges of perilous substances and boost sustainable development. The essential milestone document turned into the Kyoto conference, encouraged at the United Nations climate exchange convention in 1997. The approving countries tried to lower emissions of carbon dioxide, methane, nitrogen oxide, alkyl halides, consistent with fluorocarbons, and sulfur hexafluoride with the aid of five% by way of 2012 in view of 1990 ranges. The conference became recommended via 192 countries. The Paris agreement as a continuation of the Kyoto convention was endorsed at some stage in the twenty first United international locations gathering on Environmental exchange. It meant to keep the expansion in ordinary temperature underneath 2 ◦C and to try to limit the temperature increment to at least one.5 ◦C, among others by means of reducing discharges of GHG. The nations that authorized the knowledge undertook to introduce their arrangements like clockwork, as well as to reply to one-of-a-kind gatherings and people in widespread on how they're being executed. severely, greater created international locations likewise consented to co-finance projects by non-business international locations in quest for those targets. As of June 2021, the arrangement turned into sanctioned by way of 191 nations and marked however no longer accredited with the aid of six unique nations. Ammonia non-compulsory powers ought to activate an international lower in CO2 outflows. One gas of interest is unadulterated hydrogen, yet due to value and issues connected with potential and strength hobby for stress/liquefaction, it isn't yet obtrusive whether or not it's going to turn out to be being the main power transporter in the transport vicinity. optionally available gas is ammonia, which is an remarkable hydrogen transporter and is leaned in the direction of by using the oceanic vicinity. The international Maritime business enterprise (IMO) has set competitive objectives for decreases in GHG outflows. All out GHG emissions need to fall through someplace around half of and CO2 outflows should fall via no less than 70% underneath the 2008 figures by using 2050 [69,70]. thus, DNV proposed that through 2050 no much less than 15% of sizable distance boats have to be energized by ammonia or Fig. 2. a) price conveyance of introduced restriction in sustainable strength assets in

2020, b) expansion in delivered restrict in wind and sun powered power 2013-2020. k. Machaj et al. power technique Audits 44 (2022) 1009266 hydrogen. organizations have all started to perform RES to supply hydrogen by way of electrolysis, prompting the mixture of NH3 for use in change what's greater, transport. as an example, a five GW hydrogen/ammonia ranch is being installation in Saudi Arabia therefore. Ammonia is an inorganic artificial constructed from nitrogen and hydrogen. It carries 17.6 wt% hydrogen. it's far additionally one of the most usually created inorganic artificial materials and data for around 1.five% of worldwide human CO2 emissions in 2016. that's what measurements show ammonia introduction has accelerated in sync with the growing populace because the 1900s. In 2019, round 240 million lots of ammonia were created (Fig. 3) and it's far predicted that during 2030 production will increment to round three hundred million tons. A huge portion of it's far delivered in 4 nations: China, India, Russia, and the usa, yet is exchanged usual. Of which China and India, no longer withstanding tremendous, creation are likewise driving merchants of ammonia, as opposed to Russia, which basically trades NH3. round 70% of ammonia (approx. a hundred and seventy million lots) is deliberate for exchange. Ammonia is imported and traded to nations on all primary lands (Fig. three) what is greater, as examined within the following segment, a massive variety of those countries likewise play a activity in shipbuilding. on the off danger that ammonia is taken up as a fuel, this can set off enhancement of the introduction procedure[3], [4]. Ammonia is applied principally within the agribusiness region (eighty%), and the improvement of plastics, drugs, and explosives. As a without carbon hydrogen transporter, ammonia could enhance the tempo of worldwide advancement of the hydrogen financial system. Ammonia introduction, transport, and capacity advances are as of now superior inferable from the modern, a way achieving makes use of ammonia. it is positioned away in fluid shape at exceptional tensions and temperatures. The ammonia liquefaction manner is obvious and modest contrasted with hydrogen. For substantial limits, low- temperature capacity is all the more monetarily feasible and may be very almost more than one instances less luxurious than hydrogen capacity, that's in truth checking out and consumes a variety of energy. it's far reasonably simple to set hydrogen loose from ammonia in the sight of an impetus or at an accurately excessive temperature.

B. Ammonia Synthesis

As ammonia advent is a costly a part of the inexperienced ammonia economy, some new cycles are proper now under development to help effectiveness and reduce prices. green ammonia creation is definitely now not a singular idea. Norsk Hydro brought ammonia for the extensive majority of the 20th hundred years with the HaberBosch manner, utilizing fundamental electrolysis and an air department unit (ASU) fueled through hydropower. As of late, inexperienced ammonia has grown to be considerable around the sector, specifically for shipping purposes in Norway, Australia, China, Germany, Israel, and Japan. Likewise, the first commercial enterprise inexperienced ammonia introduction tasks are in progress, supported by way of companies like A.P. Møller - Mærsk A/S, Air objects and synthetic materials, and Thyssenkrupp.[4], [5]

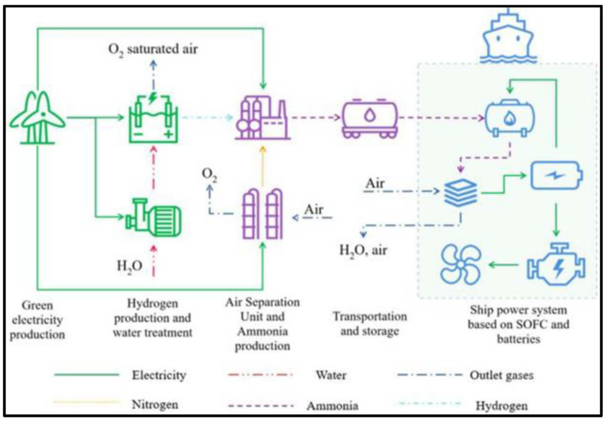

Fig. 2 Chart of processes of NH3 production and usage in a ship with energy fully provided by renewable sources.

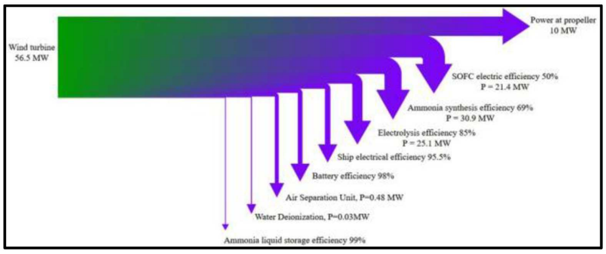

Fig. 3. Sankey diagram of ammonia use as a fuel.

C. Maritime industry- Emission reduction implication

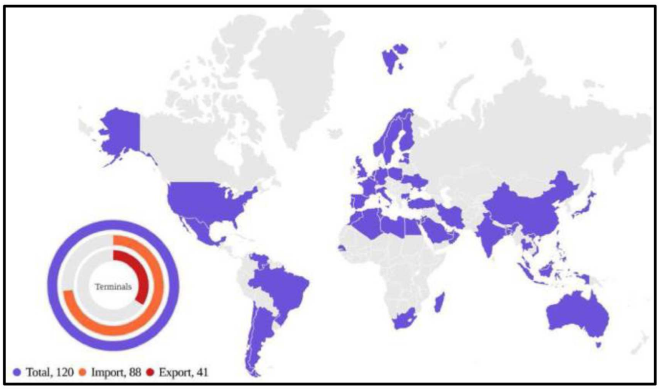

Fig. 4. Countries with ammonia terminals.

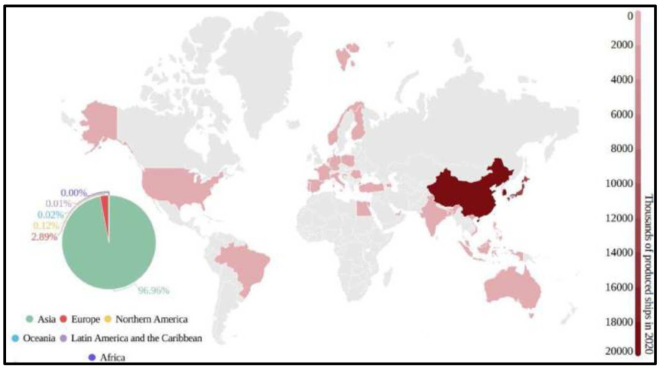

Fig. 5. Countries with the highest ship production representing each continent.

Seaborne vehicle regulations the worldwide alternate marketplace as the maximum practical and power-effective form of mass freight transport. because the 1970s how a good deal merchandise moved via ships improved from 2.6 to eleven billion lots every yr. As of now, ships are for the maximum element powered by non- renewable electricity sources, and IMO in fourth Ozone depleting substance look at (2020) assessed that during 2018 they represented 2.8% of worldwide CO2 outflows. The all-out world armada numbers are just shy of a hundred,000 freight ships moreover, in 2020 a 3% growth in the number of boats turned into recorded. but this is only a little piece of boat advent. complete boat creation is displayed at the guide in Fig. 6. In China by myself, in extra of 23 million burden lots have been added in 2020. Asia is turning in 97% of all boats. each yr in extra of 50 million burden lots depart shipyards, and most of the people of them will uphold GHG outflows (see Fig. 7)[6]. Lessening these emanations will drastically affect limiting global anthropogenic GHG discharges and the projected worldwide temperature increment. Likewise, the 1/3 IMO GHG have a look at (2014) DNV and UMAS expect that ammonia may be one of the predominant marine powers from right here on out, with wherever among 15% or even 95% of boats being energized with NH3. As a be counted of reality, just 0.2% of the boats at present on request could be powered by ammonia. thinking about global patterns, the decrease of GHG discharges have to be executed no longer simply from the CO2 viewpoint but similarly regarding nitrogen oxides, sulfur oxides, additionally, particulates. searching at Figs. three, 5 and 6 you may see that few shipbuilding countries moreover produce and import/trade ammonia. they're to be had around the sector (e.g., Africa - Egypt; North America - US; Europe - Germany, Poland; Asia - China, Japan, India; Oceania – Australia)

D. Maritime fuel economy

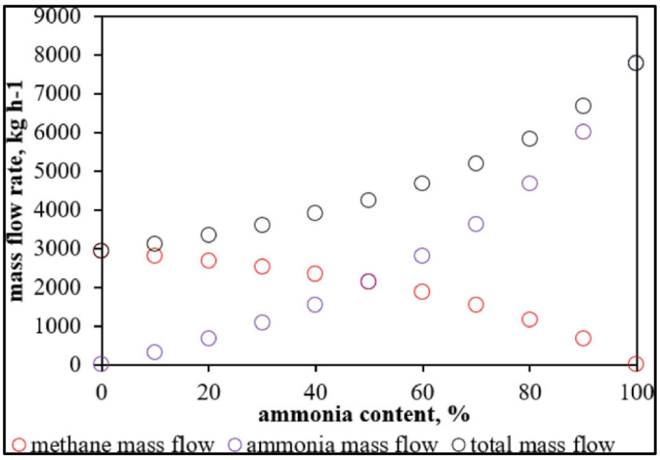

Fig. 6. Energy demand for the assumed project: pure LNG, dual fuel with different ammonia

There are two major ways of accomplishing the outflow decrease targets: (I)more gifted strength transformation gadgets, and (ii) gas trade. both troubles are complicated and managed exhaustively in surveys from 2021. Al-Enazi et al.gift a extensive primarily based correlation of fills yet do exclude an outline of gasoline use innovation. Malluoppas and Yfantis center round energizes yet additionally contain a valuable define of boat strength frameworks. nonetheless, there may be minimum profound research for one precise solution for riding boats e.g., sturdy oxide power devices. . In 2019, F. Baldi et al. brought a techno-monetary point of view of ammonia usage consisting of delivery, stockpiling, and power transformation. The results show that ammonia is much less costly and extra powerful to apply than fluid hydrogen. however, M. AlBreiki and Y. Bicer did complicated research that considers no much less than seven variables. The results showed that ammonia is an incredibly luxurious gasoline contrasted with LNG and DME or methanol. at the same time as ammonia itself would not incorporate CO2, the ammonia advent technique is electricity concentrated - electricity basically modified over from petroleum derivatives - which is additionally sizeable in any kind of thorough investigation. In 2020 Hansson et al. allotted every other complex evaluate with multi-regulations preference exam and electricity fee showing. They show that the case for ammonia as a marine gasoline is incredibly indistinct: its actual potential is excessive but expenses might vary because of many troubles, and primary, complete changes are predicted inside the entire chain of manufacturing and use. as the cost of CO2 discharge is increasing, inside the long term it is able to change into a large calculate making the practical price of ammonia in ships decrease than LNG or methanol. obviously, the researchers conflict. They get numerous outcomes relying upon the elements they contain. anyhow, it's miles vital that to accomplish a full CO2 divestment, except the truth that a fuel exchange is essential yet so is the kind of advent. In combination, ammonia and methanol look like the best marine powers representing things to come back[7], [8].

E. Fuel hazards

Substance fills present wellness and ecological risks. Ammonia, no matter being harmful to people, isn't any more regrettable in such manner than different Fig. 6. international locations with the maximum noteworthy boat introduction addressing each mainland. Fig. 7. strength interest for the expected challenge: unadulterated LNG, double fuel with various ammonia content material, unadulterated ammonia. k. Machaj et al. electricity method Audits 44 (2022) 10092610 tested here fills. it's far fairly rotten and can be identified by way of people in incredibly low fixations (17 ppm). it's far likewise a profoundly responsive yet regardless constant substance; solvent in water emitting warmth. Ammonia inside the sight of nitric corrosive and ammonia nitrate can spark off the formation of volatile strong particles at the nanometric scale. However this trouble is by using all money owed extra dangerous for the city agglomeration with excessive infection than for the seaward preparations. In contrast with LNG and methanol its combustibility is a lot of decrease, and to mild ought to be preheated. In some other modern-day record the creators noticed that ammonia is a refrigerant (put away at − 33 ◦C) not a cryogenic substance, so provides much less gamble of cryogenic consumes than LNG or fluid hydrogen. table 2 suggests the risks of four chose energizes in view of the NFPA704. notwithstanding diverse aftereffects, ammonia was grouped within the identical amassing as LNG: 3 (can purpose extreme or extraordinarily durable harm). Ayvali et al. likewise alluded to the risks of ammonia in water, as it tends to be dangerous to fauna and verdure in precise situations[9]. The real influences of ammonia spillage at the water are tough to foresee due to some variable.

Table 1: evaluation of fuel dangerous (primarily based on NFPA 704).

Criteria	Ammonia	Methanol	LNG	Hydrogen
Health	3 Can cause serious or permanent injury.	1 Can cause significant irritation.	3 Can cause serious or permanent injury.	0 No hazard beyond that of ordinary combustible material.
Flammability	1 Must be preheated before ignition can occur.	3 Can be ignited under almost all ambient temperature conditions.	4 Burns readily. Rapidly or completely vaporizes at atmospheric pressure and normal ambient temperature.	4 Burns readily. Rapidly or completely vaporizes at atmospheric pressure and normal ambient temperature.
Instability	0 Normally stable, even in fire condition	0 Normally stable, even in fire condition	0 Normally stable, even in fire condition	0 Normally stable, even in fire condition

F. Fuel consumption

In view of the Remontowa LNG Frameworks Ltd Rumia compartment shipping venture - which utilized a Wartsila 9L34DF motor (determinations in desk 7) - gas hobby for ammonia and methane changed into assessed. The outcomes are displayed in Fig. 6 above. The boat was meant to run on methane, with 2930 kg h− 1 LNG request. The impact is 2.0159 MJ (fuel)MJ (engine)− 1 of force usage, conducting forty-eight.7% talent (LHV basis). In exquisite instances, the motor would possibly paintings under over-burden and yield each available ounce of attempt of finest energy (all matters considered four.95 MW). This empowers a extra noteworthy scope of labor. For a boat running on an inward burning motor, fuel mass flow increments 1.45 times after the trade from methane to ammonia, owing essentially to various fuel energy densities[10]. The exchange to ammonia may reason designing issues related with the fuel conveyance framework. Double gas preparations may additionally likewise spark off troubles with estimations and responsibilities. The electricity thickness of 5 unique Wartsila an oceanic car was assessed and long past from 32to 50 kW m− 3. To similarly develop effectiveness, SOFC frameworks are likewise proposed as hotspots for energy transformation on ships. In 2007 an reachable SOFC-based totally framework achieved electricity thickness more than 19 kW m− three, but innovation connecting with strength thickness has progressed from that point forward. The performance of SOFC surpass half. Diesel cars are a run of the mill electricity supply within the oceanic area. they may be adaptable and can be utilized with unique powers. The fundamental problem is with the exhaust gases they produce CO2 and NOX among others. Diesel automobiles adapt severely to ammonia as a fuel; despite the fact that CO2 emissions are lower, extra NOX are created at some point of burning and a further decrease impetus is needed. one of a kind elements that necessitate configuration changes within the diesel motor are the excessive begin temperature (round 650 ◦C), low fire temperature and coffee stoichiometric hearth speed. subsequently, ammonia cannot be applied in contemporary, unmodified boat vehicles, sturdy oxide power gadgets are a promising generation as wellsprings of depth and electric electricity supply within the sea place, as they can work with a large wide variety of powers. the following part audits and thinks about SOFCs and diesel motor.

II. CASE STUDY- LNG VS AMMONIA

LNG is proper now the principle optionally available marine gas in like manner use. The number one LNG supply framework devoted to visitor ships within the ecu was created in Poland and started out conveying vacationers in 2015. LNG gas is placed away in cryogenic occasions. The fluid level inside the vessel is based upon strain, with LNG kept at a temperature beneath − one hundred twenty ◦C (at 10 bar). Then it goes via a re- gasifier and exchanger vaporizer to reach at room temperature. In 2021 0.5% of boats in dramation were managed by means of optionally available energizes (counting batteries) and 0.19% with the aid of LNG[11], [12]. similarly, 12% of boats on request could be controlled by means of optionally available powers and 6.1% via LNG. The competitive GHG outflow targets set by means of IMO will probably be neglected attributable to the lazy enlargement in the quantity of boats during recent years, which has differed somewhere inside the variety of 3% and 5% in keeping with annum blended with the slow velocity of imparting new LNG- controlled gadgets and the shortfall of different typically applied elective energizes. LNG for fuel frameworks may be placed away in numerous sorts of tanks: A, B, and C. The preliminary two are restricted to zero.7 bar considering they are adjusted to the state of the structure. They want an extra fuel stress framework

in the back of the tank. [2]by means of and massive, they have big capacities and they're utilized inside the far off ocean area. A fundamental gauge changed into finished of the maintaining time for a cryogenic tank supposed for LNG but loaded up with NH3. retaining times have been decided in light of the mathematical estimations of the nice and cozy misfortunes and the most important regulation of thermodynamics. CoolPack programming was applied to assess am Monia's thermodynamic residences. desk 4 gives the holding season of an eighty m3 LNG tank for the ocean area deliberate at the Wroclaw university of science and Innovation in Poland. The results show that for comparable tank the ammonia keeping time is a significant degree bigger. The high preserving time for ammonia receives for the most component from the greater modest temperature distinction and better electricity limit of the sub role. On different hand, it's miles rage to specify that ammonia has a comparative thickness and limit at environmental stress to LPG (melted oil gas). The substance of LPG can vary, and in table 3 houses of ammonia are contrasted with the houses of fluid propane (CoolPack) The stop may be drawn that LNG stockpiling tanks are 'large than ordinary' from a stance of view related with the thermodynamic barriers they need to be effortlessly adjusted to address ammonia. A simple gauge was completed of the preserving time for a cryogenic tank intended for LNG but loaded up with NH3[5]. preserving instances were determined in view of the mathematical estimations of the nice and cozy misfortunes and the essential regulation of thermodynamics. CoolPack programming turned into applied to appraise ammonia' thermodynamic residences. table 4 offers the preserving season of a eighty m3 LNG tank for the ocean place planned on the Wroclaw college of science and Innovation in Poland. The effects display that for comparable tank the ammonia conserving time is a full-size degree larger. The excessive holding time for ammonia receives generally from the more modest temperature difference and better electricity limit of the sub function. On other hand, it's miles rage to make connection with that ammonia has a comparative thickness and restriction at air pressure to LPG (melted oil gasoline). The substance of LPG can exchange, and in table three residences of ammonia are contrasted with the residences of fluid propane (CoolPack) The cease can be drawn that LNG stockpiling tanks are 'interestingly massive' from an outlook of view connected with the thermodynamic obstacles they must be efficaciously adjusted to cope with ammonia. additionally, in study from 2019 it turned into performed out that suggest strength intake of compartment transport is round 42%. In view of these records, it has a tendency to be assessed that the ammonia would be sufficient for something like 94 days, or 1/four of the day trip assuming freight boat might be completely crammed. This indicates that the oceanic commercial enterprise is to some diploma prepared to give ammonia as a gas. (17. five Mt -section three.) approximately 4500 holder boats might be fueled. moreover, in study from 2019 it changed into played out that imply power intake of holder transport is round 42%. In mild of those records, it has a tendency to be assessed that the ammonia might be enough for about 94 days, or 1⁄four of the excursions within the occasion that freight boat might be completely crammed. This indicates that the ocean industry is to some degree prepared to present ammonia as a gas[13].

III. CONCLUSION

The above paper demonstrates the way that ammonia may be applied as a gasoline without a carbon affect and might likely be a totally climate properly disposed arrangement assuming that a complete method is taken to the economy all in all. The intricacy of the most not unusual way of converting electricity from RES over completely to ammonia requires collaboration among numerous areas of industry. in any case, this may be extraordinarily tough, in light of the truth that environmentally friendly power ought to be applied to pressure unique cycles to get inexperienced ammonia. This calls for enormous adjustments within the economic system. The exam distinctive in this paper suggests that the effectiveness of the complete cycle - from RES strength via to driving a boat related to ammonia as a hydrogen transporter - is classed at round 18%. Ammonia may be utilized to drive ships and the advances required are actually complete grown. similarly, ammonia has been shipped all over the planet through freight ships for pretty a long term. moreover, advances for its managing are like those utilized for LPG that can make bigger boat's fuel adaptability. some simple issues need to be thought approximately even as searching at ammonia and LNG as gasoline. to begin with, ammonia desires around 1.five instances greater room than LNG. this may altogether reduce freight space and increment shipping charges. second, there aren't any specialised contraindications to regarding ammonia as a marine gasoline. Ammonia is not any greater risky than LNG regarding the burning houses and protection limits[14]. At remaining, a critical boundary to the utilization of ammonia as a gasoline would possibly come from valid suggestions within the oceanic location that may be constituted of now on. some inquiries stay unanswered consistent with a strength age perspective. Hypothetically, ammonia can be scorched in diesel motors in unmarried or double gasoline mode. experience received from the improvement of LPG stockpiling frameworks is adaptable to dealing with ammonia, especially fluid ammonia. a few innovations, which includes capability tanks, may be utilized with the two fills. notwithstanding, diesel motors could want to be overhauled - due to the distinctions in thermophysical properties amongst ammonia and specific powers - and further arrangements acquainted with prevent NOX discharges. alternatively, hydrogen placed away in ammonia can be modified over with the aid of SOFCs straightforwardly to power. It isn't always yet clear which method is better - either direct ammonia transformation or use of extra ammonia saltines before SOFC stack. the 2 preparations experience benefits and burdens, but the primary viewpoint right here is to restrict the corruption tempo of SOFCs and further develop the intensity integration of the framework. these troubles need to be tested through strong lengthy haul exams mimicking the real burden adjustments on ships. any other problem is the concepts for energy module strength introduction on board the boat. they may be still work underway and there aren't any authorities sanctioned checks for energy additives as energy frameworks[15]. notwithstanding, rules for ships are being controlled with batteries because the main wellspring of energy, which may be vast in a consolidated framework and could deliver a faster implementation of power additives equipped. consequently, for progressed execution and treasured lifetime, the SOFC may be joined with batteries to drive the boat. This association increases, thusly, specific problems linked with space and weight the board of one of these frameworks. The SOFC framework with a comparable energy is, as normally assessed through the creators, extra than 1.five instances extra and heavier than a diesel motor. within the occasion that the SOFC is an electricity converter however batteries are the essential electricity source, then excessive overcapacity have to be thought of. some inquiries connected with the relevance of SOFC energized by using ammonia stay open anyway there's no doubt that each the increasing cost of CO2 emanations and modern expenses of ammonia direct the awareness to non-compulsory impetus frameworks. The calculation of the Levelized price of oceanic frameworks wishes to include each the capital and operating consumptions. whilst the earlier stay higher for an energy component-based framework, the ultimate option can be extensively decrease.

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A STUDY ON INFLUENCE OF SOCIAL MEDIA ADVERTISING ON CONSUMER BUYING BEHAVIOUR

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ABSTRACT:-
Social media is dynamic ancient selling communication. Shoppers are more and more mistreatment social media to look for info and rejection from ancient media like T.V, magazines, radio. Companies, therefore, have to produce effective online advertising ways to maximize current market section by incorporating effective options in online advertising, particularly in social media. This study offers theoretical contributions and abstract model to existing analysis on Social Media Ads and Consumer's purchase Intention.
This study highlights the characteristics of online ads and their influence on the intention to get. Whereas previous studies have investigated completely different options of online ads towards angle and shopper is shopping for behaviour, this study provides a brand-new set of consumer's responses towards Social Media ads with relation to Purchase Intention.

Keywords - Advertisements (Ads), Consumers, Purchase Intention, social media

I. INTRODUCTION

Social Media Reviews are one among the key areas that have emerged from social media. Client reviews are widely accessible for product and services, generating nice worth for each shopper and corporations. In fact, Corporations to rate and review product and services online actively inspire shoppers. These activities turn out the electronic word of mouth. This word of mouth, created through social media, helps shoppers in their buying choices. The analysis shows that client reviews have adult quickly on the web. On-line advertising is one quite digital promotional material that has become a good suggests that of selling communication because of net access is widespread. It's the latest and quickest growing thanks to advertising. The web currently provides everything from links on sites, to banner ads on sites, to tiny ads on sites, to pay per click advertising. Net advertisements are distinctive within the means that buyers visit the advertisements, in comparison to ancient Print and television media, wherever advertisements are placed before the viewers. On-line advertisements embody banner ads, opening ads, text ads, pop-up ads and HTML ads and are found to be a dominant media wherever corporations use to plug their product and services through the net. Differing kinds of measures like hits, click-through, and the frequency of visits to websites Associate in nursing time spent at websites predict shopper behaviour in an interactive setting.

II. LITERATURE REVIEW

According to *Rowley (2001),* internet's high speed, user-friendliness, low value and wide accessibility have contributed to its exploitation within the variety of on-line marketing–a new platform for generating attention and awareness among shoppers through on-line advertising.
Jang (1998) expressed that the characteristics of web advertising embrace constant availableness, low cost, fun, property, internationalisation, interaction and two-way communication. On-line Advertisements are often classified in step with seven characteristics: Unlimited Open-endedness of your time and area, two-way communication, attainable linkage with databases, free support and varied varieties of advertising. Therefore, internet advertisements should be visually charming, share fascinating content and be simple to navigate *British, 1993)*. Majority of studies are restricted to the impact of on-line advertising characteristics i.e., format, design, content and frequency on purchase behaviour **(***Campbell and Wright, 2008: Coyle and Thorson, 2001; Moe and Fader, 2004; Stevenson et al., 2000; Johnson et al., 2006)***.**
According to Khan (2006) all people area unit shoppers, we have a tendency to consume daily relating to our wants, preferences, and shopping for power, that opens the door for too several questions on what to buy? However, we have a tendency to buy? Wherever and once, we buy. Additionally, when we have a tendency to after we say client, we talk over with two kinds of overwhelming unites, first one is that the structure shoppers like business organizations, government agencies, or non-profit organizations, other the ultimate shoppers like people, families, or households *(Al-Jeraisy, 2008, P43)*. Evidently, inside this project, we have a tendency to area unit reaching to concentrate on the second

kind that represents the ultimate shoppers because the field we have a tendency to apply in is that the fashion retail business.

Fashion retail business has deep roots and one among the foremost vital kinds of retail business, like most alternative, quickly started mistreatment the web to achieve enhancements within the potency and effectiveness of operations and promoting. Withal, shoppers' area unit more and more mistreatment web to form in depth quantity of analysis on product and fashion trends before getting through and media, additionally creating a lot of and a lot of on-line purchase (*Tuhnainen, Rossi, 2012).*

Regarding *L.Tuten (2008, P3-5)* their area unit several variations between ancient advertising and social media advertising. First distinction is that the variety of media, whereas ancient advertising tied with the "mass media" embrace TV, radio, print, or outdoor, advertising by social media would possibly mean each matched advertising through permission-based, and targeted messages, or it can be mass coverage employing a show ad, once shaping advertising for on-line media, the scale of the audience mustn't be used as a shaping issue of advertising.

III. THEORETICAL ISSUES OF CONSUMER BUYING BEHAVIOUR

A. Purchase Intention

Purchase intentions are outlined as associate degree individuals aware arrange to build a trial to buy a whole. Purchase intention is a very important index for analysis of shopper behaviour. It represents the degree of risk the buyer would be willing to buy. Purchase intention will live the likelihood of a shopper to shop for a product, and the higher the acquisition intention, the upper a consumer's disposition to shop for a product. Customers are a lot of seemingly to own a stronger intention to buy a product once they react favourably to a billboard this product *(Haley and Baldinger, 2000: Mackenzie and Lutz, 1989).* Purchase intention indicates the marketers what shopper would get. The intention is that the Geter's forecast for that product they are going to buy. Raney et al., 2003 and Brown and dessert apple, 1992 delineated Purchase Intentions as a key indicator of the success of online advertisements. Whereas it indicates that this angle relates completely to buy intentions, the factors that mediate the connection between attitudes and intentions are unclear. Several types of research thought of the angle toward the advertising had numerous impacts on consumer's purchase intention.

B. Theoretical Framework

An empirical investigation will be done by reviewing this model to quantify the link between Social Media Ads and Consumer's Purchase Intention mediate by Informative, Interactivity, entertainment and believability.

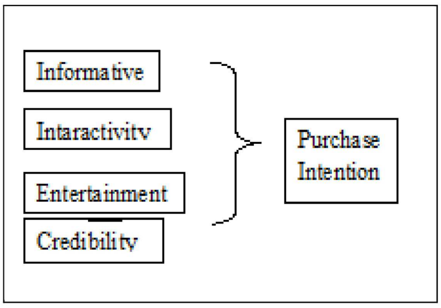


Fig.1. Influences of Purchase Intention

C. Implication

Results showed that these responses play a necessary role however Associate in Nursing uneven influence on shopper behaviour towards on-line ads. However, this study might function inspiration for future studies on options of Social Media Ads that influence Consumer's Purchase Intention. Promoting managers ought to think about the importance of quality and amount of knowledge, larger interactivity on on-line sites whereas planning their websites for advertising. This additional implies that advertisers will show intelligence use these options to extend sales.

IV. OBJECTIVES OF THE STUDY

1. To study the influence of Social Media Advertisements on Consumer's Purchase Intention.
2. To develop a conceptual model on feature of social media advertisements and purchase intention.

V. RESEARCH METHODOLOGY

A. Research Design

The research study is based on the descriptive research design. The purpose of this study is to describe the influence on social media advertising on consumer buying behaviour in the Anantapur Town.

B. Data collection

I have considered both the data is useful to my research work. So primary data and secondary data used to my research work.

1) Primary data collection

Primary data was collected through well-structured questionnaire. Questionnaire was sent through different electronic methods.

2) Secondary data

Secondary data was collected through Journals, Textbooks, Newspapers and Magazines etc.

C. Population

The research study is based upon the people living in the Anantapur Town, researcher wanted to measure the impact of globalization on their purchasing behaviour.

D. Sample Technique

In this research study, non-probability convenient based sampling has been adopted. As researcher, have little resources like time and financials. Therefore, they select the areas in the city and respondents on their convenient basis.

E. Sample Size

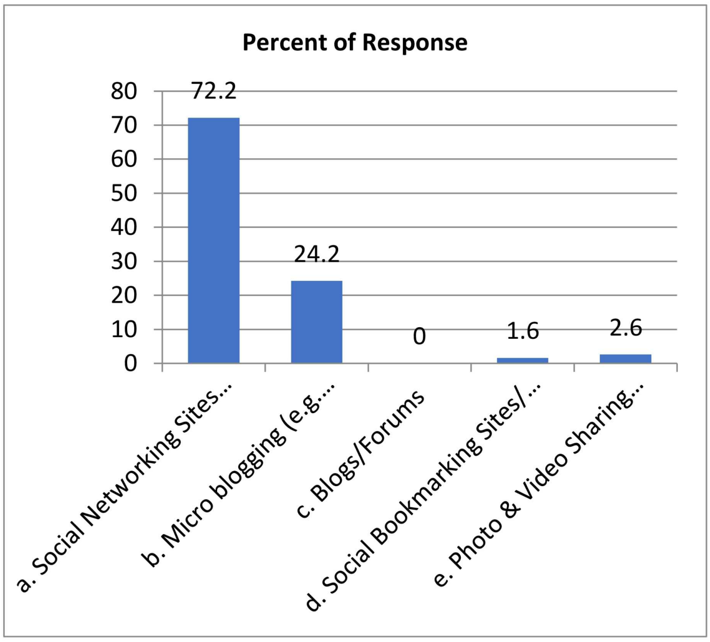
The researcher used in his study 130 as sample, in that they received only 123 returns out of which again 20 response sheets are incomplete, they have not considered this for their study. Finally, the 103 responses sheets with full information. This 103 is the sample size.

F. Type of the Study

My study is analytical because, my aim is to measure the influence on social media advertising on consumer buying behaviour in the people who are staying in the Anantapur Town. Therefore, it is simple measure the cause-and-effect relationship because the globalization will have significant impact on the consumer behaviour.

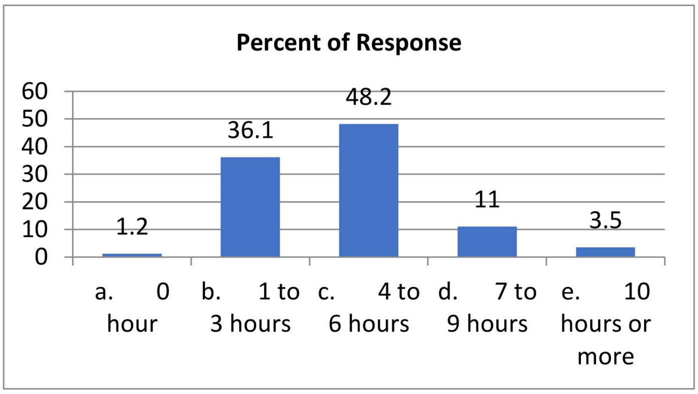
VI. DATA ANALYSIS AND INTERPRETATION

GRAPH I. SOCIAL MEDIA USAGE



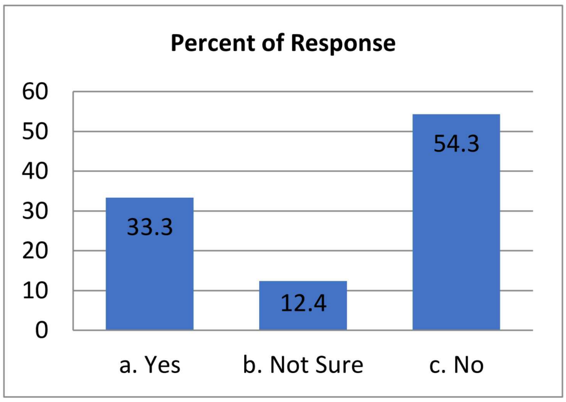
Inference*:* As per the table, showing overbilling number of respondents is using social networking sites like face-book.

GRAPH II. HOURS SPENDING ON SOCIAL MEDIA



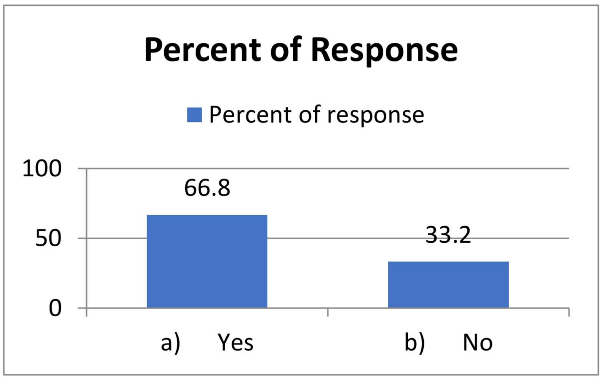
Inference: According to the given response the highest numbers of people are using social media every day that is 4 to 6 hours

Graph III. PURCHASING PRIORITY OF PRODUCT/SERVICE USING SOCIAL MEDIA



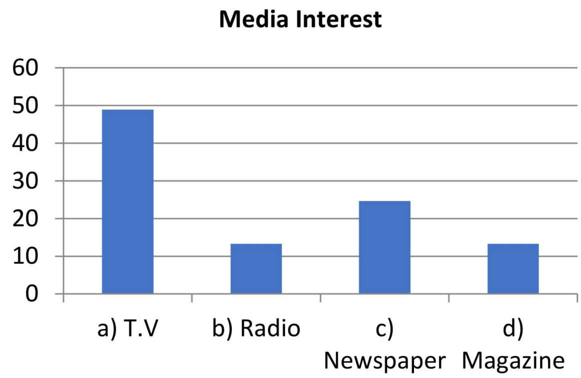
Inference: As per the above table, most of respondents are not using social media for purchasing of their products and services.

GRAPH IV. RESPONSE ON MASS MEDIA (TV, RADIO, NEWSPAPER) INTEREST



Inference: As the above table response, highest **numbers of respondents are accepting still mass** media (T.V., Radio, and Newspapers) is the best way for get attracted by the advertisement.

GRAPH IV. RESPONSE ON MASS MEDIA



Inference: *As per the above table, the highest numbers of respondents are accepting T.V is the best alternative for promotions*

VII. FINDINGS

- Most number of respondents are male members than female.
- Most number of respondents are belonging to the age of 18-25.
- Most number of respondents are students and followed by employees too.
- Highest number of respondents is using social media.
- Most number of respondents is using social networking sites like face book.
- Most number of people are using social media every day which is 4-6 hours.
- Most of respondents are not using social media for purchasing of their products and services.
- Highest numbers of respondents are accepting still mass media is the best way for get attracted by the advertisement.

VIII. SUGGESTIONS

- Social media is the best weapon for promoting products but it is not particularly for marketing.
- Most of the respondents are using social media for enhancing their network and communication only.
- For advertising social media is comfortable. But it is not such effective for motivating the customers to purchase the product and services.
- Social media is having the power of influencing the buyer but it is not such effective platform for gathering more information about product/services.

IX. CONCLUSION

Participation to the social media promoting platforms in Republic of India has not an extended history. However, over the second half decade, it's been quickly increasing. The findings of this analysis are barely restricted to the context of Republic of India, wherever cultural dimensions haven't been captured, if any. Recommendations for the long run analysis are supported the findings and limitations of this research. Initial of all, because the result indicates, there are a lot of variables left that ought to be thought-about during this model to analyse the impact of social media promoting on on-line buyers' whole loyalty. Besides, evidences of the inclusion of variables within the model that don't have explaining power were conjointly found. Additionally, thanks to time constraints, the sample size thought-about here isn't enough to possess a decent image of the difficulty, this study deals with. Future analysis ought to be done by avoiding the failings of this study contain in choosing freelance variables for the model, and diversifying the sample by as well as on-line client in metropolis city from many areas with excitations varieties in terms of culture, technology, economic standing etc.

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