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IIRE Journal of Maritime Research and Development

Maritime sector has always been influencing the global economy. Shipping facilitates the bulk transportation of raw material, oil and gas products, food and manufactured goods across international borders. Shipping is truly global in nature and it can easily be said that without shipping, the intercontinental trade of commodities would come to a standstill.

Recognizing the importance of research in various aspects of maritime and logistic sector, IIRE through its Journal of Maritime Research and Development (IJMRD) encourages research work and provides a platform for publication of articles, manuscripts, technical notes, papers, etc. on a wide range of relevant topics listed below:

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NAVIGATING TOWARDS SUSTAINABILITY: A COMPREHENSIVE REVIEW OF GREEN FUELS FOR SUSTAINABLE SHIPPING

Mr. Nagaraj Shenoy[1] & Ms. Yogyata Kapoor[2]

Abstract

The shipping industry, a cornerstone of global trade, is facing increasing pressure to reduce its environmental impact. The investigation of alternative fuels to replace conventional fossil fuels is one important area of research. An extensive analysis of sustainable shipping fuels, such as LNG, ammonia, and hydrogen, is given in this article. Every fuel type is examined for its advancements, benefits, drawbacks, and possible role in lowering emissions in the marine industry. Insights into the prospects and difficulties facing green fuels in transportation are provided in the article's conclusion.

Keywords: Green fuels, sustainable shipping, LNG, ammonia, hydrogen, decarbonization, maritime transport.

1. INTRODUCTION

A considerable amount of the world's air pollution and greenhouse gas emissions are caused by the shipping sector. The need to discover substitute fuels that can power commercial ships with little negative influence on the environment is becoming more pressing as the globe moves towards sustainability. Ammonia, hydrogen, LNG, biofuels, and mixed fuels are examples of green fuels that provide viable ways to lower emissions and advance environmentally friendly transportation methods. This article examines these green fuels' advancements, benefits, drawbacks, and possibilities within the framework of environmentally friendly shipping.

The marine sector is under pressure to decarbonise by the year 2050. The updated International Maritime Organisation (IMO) policy for cutting greenhouse gas (GHG) emissions has established a baseline, and new national regulations—especially those from the European Union—are

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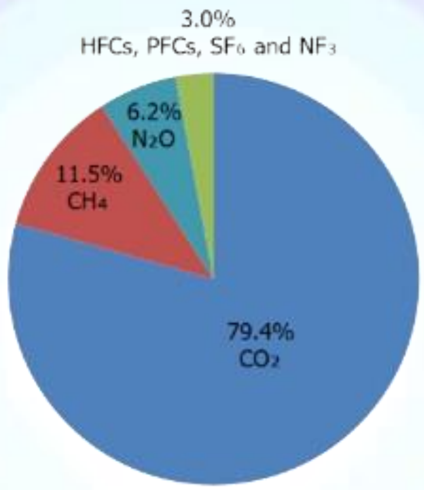
anticipated to drive additional reductions and expenses in emissions. Simultaneously, there is increasing public pressure on financial institutions, consumers, charterers, and other stakeholders to enhance sustainability. Switching to low- and zero-carbon fuels is the largest lever for reducing emissions in the maritime industry. However, the industry's fuel and technology landscape is complicated and becomes more so as numerous new possibilities emerge. A major competitive disadvantage might arise from choosing the incorrect fuel now because of client preferences and laws that are becoming more stringent tomorrow.

Figure 1 - Overview of Greenhouse Gas Emissions



Offshore vessels, due to slow steaming, causes a lot of emissions that needs to be tackled. Although a sizable portion of the fleet is now powered by heavy fuel oil/low sulphur fuel oil (HFO/LSFO), alternative fuels have recently been ordered for key newbuilding projects. To a great part, they are LNG, although methanol has also gained attention. Methanol-powered new structures have already been realised, and a sizable number of vessels are now being ordered. Ammonia is emerging as a third alternative, with initial projects being discussed. We consider the laws, engine and tank technology, bunkering infrastructure and operations, and the financial implications for both new construction and retrofits for each choice.

The transportation of goods by the marine industry has some of the lowest carbon emissions per tonne-kilometre (t.km) of any industry, accounting for only 2.9% of greenhouse gas emissions worldwide. However, as the world's commerce expands, marine shipping will be required to support other industries' low-carbon transitions, such as the transportation of lithium-ion batteries for electric vehicles and wind turbine blades. As a result, maritime emissions are predicted to rise.

The maritime industry must make progress towards decarbonisation in a variety of areas, including port building, the production and distribution of lower-carbon fuels, and the ships themselves, given their essential supply-chain position in relation to global commerce and other industries' net-zero ambitions (DNV, 2024).

Traditional fossil fuels now meet the maritime industry's energy needs satisfactorily. Nonetheless, the International Maritime Organisation (IMO) has imposed strict decarbonisation requirements and targets on the shipping sector as part of the worldwide effort to avert climate change. The shipping industry as a whole is concerned about achieving carbon-free operations nowadays. Alternative fuel solutions are among the newest and most promising possibilities available as a fuel and energy carrier. This article aims to give a useful overview of the current operational and technological information so that shipping industry players may more easily determine which alternative fuels they would like to pursue in the future (Jan Matthé, 2023).

2. AMMONIA: A POTENTIAL GREEN FUEL FOR SUSTAINABLE SHIPPING

Ammonia (NH_3), a colourless gas made of hydrogen and nitrogen, is becoming more and more of a viable substitute fuel for the marine industry. Because of its high energy density and carbon-free status when derived from renewable resources, it is especially well suited for long-distance travel. However, because of its intrinsic toxicity and the necessity for cautious handling, storage, and production procedures, ammonia poses special obstacles.

Ammonia is a widely available commodity due to its broad usage as an industrial chemical, fertiliser, and refrigerant. The Haber-Bosch process, which involves the reaction of hydrogen with atmospheric nitrogen, is the main source of its synthesis.

However, the bulk of ammonia produced today is "grey" or "brown" ammonia, which is made with hydrogen from steam methane reforming. This process contributes considerably to global emissions by releasing CO_2 into the atmosphere. When compared to conventional marine fuels, using brown or grey ammonia as fuel would actually result in higher well-to-wake CO_2 emissions.

True sustainability requires a change in emphasis to "blue" or "green" ammonia. Green ammonia uses hydrogen from water electrolysis, which is fuelled by renewable energy sources, whereas blue ammonia collects and stores the CO_2 emitted during steam-methane reforming.

Ammonia has a great deal of promise for use as a green fuel in transportation. It presents a chance to lower maritime activities' SOx and CO2 emissions. But ammonia burning results in the production of NOx and N2O pollutants, which need to be managed carefully.

Ammonia may be used in existing diesel-cycle two-stroke and Otto-cycle four-stroke engines, but due to its weak ignition characteristics, a pilot fuel—typically diesel or biodiesel—must be used. Moreover, ammonia may be cracked to create hydrogen for use in Proton-Exchange Membrane (PEM) fuel cells or utilised directly in Solid Oxide Fuel Cells (SOFC) (DNV, 2024).

2.1 Ammonia's Versatility and Potential as a Hydrogen Carrier

Ammonia (NH_3) is an important industrial product and a commonly traded commodity, typically transported in liquefied form at −33°C and atmospheric pressure. Primarily used to make fertilizers and pharmaceuticals or as a refrigerant, it is also considered a key future storage and long-distance transport medium for hydrogen.

While the liquefaction, storage and transport of pure hydrogen requires enormous energy input and is technically complex, handling ammonia is comparatively simple and established industrial practice. Furthermore, the energy density of liquefied ammonia is higher than that of liquefied hydrogen, making its transport more efficient.

2.2 Green Ammonia: Revolutionizing Decarbonization in Shipping

According to Benjamin Scholz, a DNV expert on alternative fuel systems, "green ammonia is a strong candidate as an alternative, climate-neutral fuel in the energy mix of a future decarbonised shipping fleet since ammonia combustion emits no carbon compounds."

"Green ammonia produced using hydrogen from seawater hydrolysis and renewable energy is expected to play a major role in decarbonising shipping once production capacities have been scaled up."

Diesel-cycle two-stroke engines and Otto-cycle four-stroke engines may both be powered by ammonia. Because ammonia is difficult to ignite, it needs a pilot fuel, usually biodiesel or diesel. Major ship engines manufacturers have recently announced or are developing ammonia-ready dual-fuel engines. Fuel cells can also employ ammonia. (DNV, 2024).

2.3 Engineering Challenges: Storage and Corrosion

Certain steel alloys are prone to stress corrosion cracking because ammonia is corrosive. It is consequently essential to choose the material for the equipment, pipe, and tank carefully. The available tank types differ in terms of design and manufacturing complexity, safety barriers, temperature and pressure tolerance, and space utilisation.

Compared to HFO and LNG, ammonia has a much shorter sailing range per unit of volume due to its lower energy density. Ammonia tanks can be up to four times bigger than tanks for an identical amount of HFO with the same energy content, depending on the fuel containment system selected. But ammonia doesn't need to be stored at cryogenic temperatures like LNG does. The additional room required for fuel storage may not be a major problem on bigger ship types.

Membrane tanks composed of appropriate materials and IMO Types A, B, and C may be utilised. The advice document on alternative fuels goes into detail on each tank type's benefits and drawbacks as well as the criteria for ship design.

2.4 Environmental and Safety Considerations

Ammonia is a dangerous gas that is colourless, corrosive, and extremely poisonous. Scholz notes that because it is flammable fuel, it must comply with the IGF Code and be equipped with special bunkering equipment to reduce ammonia leakage. It also has to be placed in specified safety zones and need additional crew training as outlined in the STCW Code (Seafarers' Training, Certification, and Watchkeeping). The placement of fuel tanks and pipelines must adhere to the rules of leak detection, double barriers, including thermal insulation, and segregation. Furthermore, boil-off gas control is necessary for liquid ammonia.

3. HYDROGEN: CHALLENGES AND OPPORTUNITIES FOR A GREENER MARITIME INDUSTRY

Another clean fuel being investigated for environmentally friendly transport is hydrogen. Its high energy content relative to weight and ability to burn solely create water vapour make it a desirable alternative for ships. However, the present energy-intensive nature of hydrogen generation limits

its environmental advantages as it frequently uses fossil fuels. The development of hydrogen fuel cells and storage options for marine applications is the main focus of research.

Importing and exporting hydrogen is a crucial component of the decarbonisation strategies that world leaders are formulating in the wake of the recent COP26. The World Energy Council states that the number of hydrogen partnerships worldwide is rising and is predicted to do so in the future; global commerce in hydrogen is anticipated to mirror existing trading in conventional fossil fuels. Due in large part to their availability to abundant renewable energy sources or substantial quantities of natural gas and oil, the Middle East, Africa, the United States, South America, and Australia have the greatest potential to become the world's top exporters (Høifødt, 2022).

Decarbonising hydrogen is a necessary step that will take all of our renewable energy resources together. Developing nations may meet this demand by exporting green hydrogen made from their abundant solar and wind energy. To support their decarbonisation plans, Northeast Asia—which includes South Korea, Japan, and Europe—will probably be the region that imports the greatest amounts of hydrogen.

International hydrogen commerce is made feasible in large part by the marine industry, but in order for hydrogen to be a practical substitute that speeds up the shift to clean energy, new ports, supporting infrastructure, and supply chains must be developed. Global hubs for the import and export of hydrogen are anticipated to emerge in areas where they may complement national decarbonisation policies and expand on current trade connections with port terminals (Jan Matthé, 2023).

3.1 Ports: A Catalyst for the Development of Hydrogen Hubs

There are multiple ways to use hydrogen power in shipping and the port industry. Ports can catalyse the development of hydrogen hubs by becoming international centres for hydrogen production, application, import and transport to other countries. Hydrogen hubs can be defined as an area where various users of hydrogen across industrial, transport and energy markets are co-located. Hubs help to minimize the cost of infrastructure and support economies of scale in producing and delivering hydrogen to customers as well as facilitating cross-sector opportunities for innovation and collaboration. The development of hydrogen hubs is gaining momentum worldwide, as indicated by recent collaborative efforts:

3.1.1. In Europe, the Port of Rotterdam plans to use hydrogen imported from places around the globe, such as Latin America, the Middle East, North Africa and Australia, to supply hydrogen to Europe. The Port of Rotterdam Authority and many port-based companies are preparing to build the infrastructure required for a complete system of local and international supply and demand, developing Rotterdam as one of Europe's hydrogen hubs. In neighbouring Belgium, the ports of Antwerp and Zeebrugge signed a Memorandum of Understanding (MoU) with the government of Chile to set up a corridor to speed up green hydrogen flows between South America and Western Europe. Other European ports, such as Hamburg and Valencia, are also forming alliances to promote the use of hydrogen in collaboration and with the support of the European Union.

3.1.2. In North America, Apex Clean Energy, Ares, EPIC Midstream, and PCCA (Port of Corpus Christi) will explore the development of green hydrogen production, including a new pipeline and a green fuels hub at the US Port of Corpus Christi in the state of Texas.

3.1.3. In Australia, the Port of Newcastle is partnering with Macquarie Group's Green Investment Group and the Commonwealth Government's Australian Renewable Energy Agency (ARENA) to support the development of a green hydrogen hub at the port.

3.1.4. In Japan, the Port of Kobe is exploring the potential of using hydrogen and ammonia under a government strategy to establish itself as a carbon-neutral port by 2050. The port is looking to develop hydrogen import, storage and supply infrastructure for a targeted 2030 start-up as part of efforts to assist the proposed fuel shift inside the port and adjacent areas. Kobe is already accommodating Japan's first hydrogen import terminal with the first international import of liquefied hydrogen occurring in 2021, with hydrogen from Australia being shipped to Kobe LH2 terminal.

Green hydrogen is one of the most promising and mature technologies that can be implemented at a sufficient scale globally and in a timely fashion to move society away from fossil fuels. The largest obstacle to implementation is not having the ability to transport green hydrogen from where it is produced to the end user at the required scale. Today, there is no ready-made solution to ship green hydrogen in the required quantities to where it is needed.

Hydrogen needs to be decarbonized, and this will require the full capacity of our worldwide renewable energy production. Developing countries could respond to this need by exporting green hydrogens produced by the wind and solar energy they possess in abundance. Worldwide maritime trade relationships between net exporters and net importers will need to be established to support this process.

The development of supply chain logistics, supporting infrastructure and new ports will be an essential link to support hydrogen trade. Ports have the opportunity to become the catalyst for the development of hydrogen hubs at both ends—export and import.Potential applications of hydrogen through hydrogen hubs extend across the transport, industrial and energy sectors.

Applications could include import and export of hydrogen and derivatives; storage and distribution through multimodal transport for delivery to customers; production of green hydrogen; hydrogen / ammonia bunkering for ships; implementation of hydrogen fuel cell technology for port vehicles and equipment; hydrogen refuelling stations for local transport, such as cars, trucks and buses; and support for various industries by generating heat, electricity or chemical feedstock (Jan Matthé, 2023).

4. THE ROLE OF LNG IN THE TRANSITION TO A DECARBONIZED MARITIME INDUSTRY

Some merchant ships are currently using LNG as fuel since it emits fewer emissions than conventional marine fuels. Because of its established infrastructure and supply chain, it is a practical solution for lowering air pollution in the maritime sector. Nevertheless, LNG does not completely remove greenhouse gas emissions because it is still a fossil fuel.

LNG has a chance to lower emissions of NOx, PM, and greenhouse gases (GHG). IMO NOx Tier III standards can be met with the use of Selective Catalytic Reactor (SCR) or Exhaust Gas Recirculation (EGR) systems, which can cut NOx emissions by up to 80%, depending on engine technology. Although they are not officially controlled, PM emissions have also significantly decreased. GHG emissions must take into account both CO_2 and CH_4 (methane), the latter of which is released as a result of incomplete combustion (methane slip). The whole fuel value chain, which includes the manufacture, transportation, and distribution of fuel, has methane leaks that add to the global greenhouse gas footprint. More information and thoughts on these topics are given in the paragraphs that follow.

4.1 100-year vs. 20-year Global Warming Potential

Global Warming Potential (GWP) variables are frequently calculated using two distinct methods when accounting for methane emissions from LNG engines: The usual metric is the 100-year GWP (GWP100). This indicates that methane has 28 times the potency of CO2 as a greenhouse gas. b) The 20-year Greenhouse Gas Potential (GWP20) indicates that methane has 84 times the potency of CO2 as a GHG. Put differently, methane degrades quickly—its estimated mean half-life is 9.1 years—but it has a significantly higher warming impact in the short term. The question of whether to use GWP100 or GWP20 to indicate the effectiveness of lowering GHG emissions is being debated in this context.

The Intergovernmental Panel on Climate Change (IPCC) developed the GWP and uses it to highlight the challenges of comparing components with different physical attributes with a single metric. The GWP100 is currently commonly used as the default measure after being endorsed by the Kyoto Protocol and the UN Framework Convention on Climate Change (UNFCCC). This is because, given the long-term nature of the issue, we ought to focus on finding solutions that will have the greatest overall long-term effects. When accounting for methane emissions, DNV employs the UNFCCC methodology and solely the GWP100 factor of 28 (DNV, 2024).

4.2 Fuel systems and engines

Certain factors are taken into account while bunkering and storing LNG on board as an ultra-cooled liquid, in contrast to standard fuel oil propulsion systems, where LNG is burnt as a gas in the engine. Natural gas has a low flashpoint (below 60°C), which raises a number of safety-related issues and regulations. The International Code of Safety for Ships using Gases or other Low-flashpoint Fuels (IGF Code), which covers regulations for ships utilising low-flashpoint fuel generally, lays out the particular criteria. The laws that cover the functional criteria related to petrol fuel (LNG) are the main emphasis of its present form. The particular functional criteria outlined in Section 3 of the IGF Code may be used to establish the fundamental safety rules that govern the various sections and elements of a gas infrastructure.

Since LNG has a much lower energy density than HFO, a lot more room is needed to carry the requisite amount of fuel on board. This extra volume lowers the amount of cargo space that is accessible. The tank types listed below are designed to transport cryogenic liquid gases and can also be used to fuel petrol:

- Type A
- Type B
- Type C
- Membrane

At the moment, Type B prismatic tanks, Type C tanks, and membrane tanks are the tank types used for LNG fuel. The standard cargo tank designs need to be adjusted for fuel tanks in order to meet the requirements of the IGF Code and take different filling levels into account. The next subsections address the advantages and disadvantages. The advantages of Type B and Type C tanks are combined in new hybrid designs that are becoming close to market ready, such the lattice tank and the Bi-Nut tank. These designs include:

- The good space utilization of prismatic tanks
- The safety concept and higher design pressure of Type C tanks.

Special consideration needs to be given to the different gas fuel tank filling levels. The fill level decreases from the highest (95%) to the least (10%) throughout a cruise. Tank loads are largely affected by the intermediate levels. Particularly when building LNG fuel tanks, sloshing loads must be taken into account as they are highly dependent on the actual fill level.

5. CONCLUSION

The shipping industry is at crossroads, facing the urgent challenge of transitioning from a reliance on fossil fuels to sustainable energy solutions. This comprehensive review has explored the potential of three leading green fuels: ammonia, hydrogen, and LNG, offering a nuanced analysis of their strengths, limitations, and future prospects.

Ammonia presents a compelling case for decarbonization, particularly green ammonia produced using renewable energy. Its high energy density and carbon-free combustion make it well-suited for long-distance shipping, although challenges related to its corrosive nature, toxicity, and established infrastructure require careful consideration.

Hydrogen, while boasting a high energy content and clean combustion, faces significant hurdles in its production and distribution. However, as technologies advance and renewable energy sources become more widely available, green hydrogen could play a crucial role in achieving a decarbonized maritime sector. LNG, already adopted by a growing number of vessels, offers an immediate solution for reducing emissions compared to traditional fuels. However, its reliance on natural gas, a fossil fuel, means it is not a long-term solution for achieving net-zero emissions.

The success of these green fuel hinges on several key factors. Strong policy frameworks, including regulations, incentives, and financial support, are crucial to encourage the adoption of green fuels and create a level playing field for their deployment. Governments and international organizations must prioritize investment in research, development, and infrastructure to pave the way for a widespread shift to sustainable fuels. Continued technological advancements are critical for improving the efficiency, safety, and cost-effectiveness of green fuel production, storage, and utilization. Collaboration between industry players, researchers, and policymakers is essential to address the challenges and capitalize on the opportunities presented by each green fuel.

The transition to a decarbonized maritime sector will not be linear. It will require a concerted effort, a long-term commitment, and a willingness to adapt as technology evolves and new challenges emerge. However, the potential of green fuels to reduce emissions and promote sustainable shipping practices is undeniable. By embracing innovation, fostering collaboration, and implementing sound policies, the maritime industry can navigate a path towards a cleaner, more sustainable future.

REFERENCES

DNV. (2024). *Alternative Fuels for Containerships - LNG, methanol extended, ammonia.*

DNV. (2024, January 11). *New ammonia chapter for technical and operational decision support*. Retrieved from Maritime Impact: https://www.dnv.com/expert-story/maritime-impact/new-ammonia-chapter-for-technical-and-operational-decision-support

Høifødt, F. A. (2022). Hydrogen as marine fuel source and energy carrier for ships power production and propulsion. *USN Open Archive*.

Jan Matthé, P. J. (2023). Hydrogen in Maritime: Opportunities and Challenges. *WSP*.

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