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FAQs

CH_3OH

Methanol in the Shipping Sector

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FAQs:
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01. What is Methanol?

Methanol, a clean-burning and low-emission fuel, has long been utilised in the chemical industry and is now gaining traction as an alternative marine fuel to support the shipping sector's decarbonisation goals. Chemically simple, methanol (CH3OH) can be produced from various feedstocks, including natural gas, biomass, and renewable energy sources like green hydrogen combined with captured carbon dioxide. Sustainable methanol, such as green methanol and bio-methanol, is produced from renewable feedstock like agricultural and forestry residues, municipal solid waste, or industrial carbon capture. This makes green methanol a practical and scalable solution for reducing greenhouse gas emissions, especially when produced through low-carbon pathways.

References:

1. Methanol Institute. Marine Methanol: Future-Proof Shipping Fuel. 2023. https://www.methanol.org/wp-content/uploads/2023/05/Marine_Methanol_Report_Methanol_Institute_May_2023.pdf
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4. International Maritime Organization (IMO). Methanol as Marine Fuel – Environmental Benefits, Technology Readiness, and Economic Feasibility. 2021. https://futurefuels.imo.org/resources/marine-methanol-future-proof-shipping-fuel/

02. What Does Methanol Mean for the Marine Sector?

Methanol is emerging as a clean, versatile marine fuel that can be produced from both fossil with green hydrogen. When made sustainably, it's called green or bio-methanol and offers significant greenhouse gas reductions, supporting the shipping industry's decarbonisation goals.

Methanol burns cleanly, producing no sulfur oxides (SOx) and lower nitrogen oxides (NOx) and particulates than conventional marine fuels. Its compliance with IMO and EU regulations makes it a strong candidate for greener shipping.

Unlike LNG or ammonia, methanol is a liquid at ambient temperatures, which allows the use of existing storage and distribution infrastructure with relatively low modification costs. While retrofitting existing ships may require system modifications, methanol is easier to integrate into newbuilds. Methanol's ability to be blended with conventional fuels also provides a flexible pathway for gradual adoption.

Interest and investment in marine methanol are growing, with organisations like CIMAC, ISO, and IMO supporting its development and standardisation.

References:

1. Methanol Institute. Marine Methanol: Future-Proof Shipping Fuel. 2023. https://www.methanol.org/wp-content/uploads/2023/05/Marine_Methanol_Report_Methanol_Institute_May_2023.pdf
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03.
What Are the Safety Considerations for Methanol as a Marine Fuel?

Flammability: Methanol has a low flashpoint (12°C) and a wide flammable range (6–36.5%), increasing fire risk. Its flame is hard to detect in daylight and vapors may accumulate in enclosed spaces. Ships must have proper ventilation, leak detection, flame and heat detection systems, and fire suppression. Crew training is critical.

Toxicity: Methanol is toxic if ingested, inhaled in high doses, or absorbed through skin. It can cause blindness or death in severe cases. Safety systems are designed to prevent exposure, and the IGF Code outlines safety measures for methanol-fueled ships.

Environmental Effects: Methanol is biodegradable, water-soluble, and less toxic to marine life than fuels like HFO or ammonia. In case of a spill, it dilutes rapidly, minimising long-term harm. Still, preventive measures are essential for safe handling.

Recent updates under IMO's IGF Code and Circular MSC.1/Circ.1621 provide clear safety design and crew training protocols for methanol-fueled ships.

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1. Methanol Institute. Methanol Safe Handling Manual, 5th Edition. 2023. https://www.methanol.org/wp-content/uploads/2020/03/Safe-Handling-Manual_5th-Edition_Final.pdf
2. American Bureau of Shipping (ABS). Methanol Bunkering: Technical and Operational Considerations. 2022. https://ww2.eagle.org/content/dam/eagle/advisories-and-debriefs/methanol-bunkering-advisory.pdf
3. Oeko-Institut. Methanol as a Marine Fuel – Environmental and Economic Considerations. 2021. https://www.oeko.de/fileadmin/oekodoc/Methanol-as-a-marine-fuel.pdf
4. Bureau Veritas Marine & Offshore. An Inside Look at Methanol as Fuel. 2023. https://marine-offshore.bureauveritas.com/inside-look-methanol-fuel

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04.
What Are the Challenges of Using Methanol as a Marine Fuel?

While methanol offers clear environmental benefits, several challenges remain:

- **Lower Energy Density and Storage:** Methanol has about half the energy of HFO or MGO, requiring larger fuel tanks that can affect vessel design and cargo space.
- **Corrosiveness:** It is corrosive to some materials, requiring stainless steel or specially coated components, which increases costs.
- **Safety Risks:** Its low flashpoint and invisible flame pose fire hazards. Vapors can accumulate in confined spaces, and it is toxic if inhaled or absorbed, demanding strict safety systems and crew training.
- **Limited Availability:** Global methanol bunkering infrastructure is still developing, which may limit access for operators.
- **Cost of Green Methanol:** Renewable methanol remains costly due to current production methods, though prices are expected to drop as production scales.
- **Engine and System Compatibility:** Dedicated or retrofitted engines and fuel systems are needed to safely handle methanol's properties and prevent cross-contamination.
- **Certification:** Under the EU Renewable Energy Directive (RED III) and FuelEU Maritime, sustainability must be demonstrated through traceable feedstock certification systems, introducing a layer of administrative and logistical complexity

Addressing these challenges requires coordinated industry efforts in safety, infrastructure, and technology development.

Source: MAN

References:

1. Bureau Veritas Marine & Offshore. Methanol as Fuel. 2023. https://marine-offshore.bureauveritas.com/shipping-decarbonization/future-fuels/methanol
2. American Bureau of Shipping (ABS). Methanol as Marine Fuel – Sustainability Whitepaper. 2021. https://absinfo.eagle.org/acton/media/16130/sustainability-whitepaper-methanol-as-marine-fuel
3. NorthStandard. Methanol as a Marine Fuel. 2022. https://north-standard.com/insights-and-resources/resources/news/methanol-as-a-marine-fuel
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05. Shipowners'/Managers' Considerations

Shipowners must stay aligned with evolving IMO sustainability standards, including life cycle GHG assessments, the Carbon Intensity Indicator (CII), and FuelEU Maritime regulations. These will shape how methanol is adopted in the maritime sector.

A comprehensive risk assessment—done with class societies, flag states, and regulators—is essential to ensure compliance with safety, technical, and environmental standards during the transition to methanol.

As interest grows, industry stakeholders are working to scale up production, expand availability, and improve infrastructure, helping shipowners adopt methanol as a cleaner, sustainable marine fuel.

Owners may also benefit from national or EU-level incentives such as grants from the Innovation Fund, tax rebates, or FuelEU credit mechanisms that reduce the financial burden of switching to methanol. Pilot projects supported by ports like Rotterdam, Antwerp-Bruges, and Singapore offer technical and logistical insights for methanol adoption.

References:

1. International Organization for Standardization (ISO). ISO 6583:2024 – Methanol as a Fuel for Marine Applications. 2024. https://www.iso.org/standard/82340.html
2. MAN Energy Solutions. Methanol-Fueled Marine Engines. 2023. https://www.man-es.com/marine/strategic-expertise/future-fuels/methanol
3. American Bureau of Shipping (ABS). Methanol as Marine Fuel – Sustainability Whitepaper. 2022. https://absinfo.eagle.org/acton/media/16130/sustainability-whitepaper-methanol-as-marine-fuel
4. Methanol Institute. Marine Methanol: Future-Proof Shipping Fuel. 2023. https://www.methanol.org/wp-content/uploads/2023/05/Marine_Methanol_Report_Methanol_Institute_May_2023.pdf

06. What Is the Difference Between Bio-Methanol and E-Methanol?

The main difference between bio-methanol and e-methanol lies in their production processes and resource inputs. Both are classified as "green methanol" when produced sustainably.

Bio-methanol is made from organic materials like agricultural waste, forestry residues, biogas, or even municipal waste. It's a renewable fuel because it uses biomass, which naturally absorbs carbon dioxide as it grows. Producing bio-methanol helps reduce emissions by repurposing waste that would otherwise decompose and release harmful gases.

On the other hand, e-methanol is made synthetically using carbon dioxide that's captured from industrial emissions or the air, combined with hydrogen produced using renewable energy sources like wind or solar power. This makes e-methanol a cleaner option, as it recycles CO2 and uses green electricity, creating almost no net emissions if done correctly.

Source: IRENA

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1. International Renewable Energy Agency (IRENA). Innovation Outlook: Renewable Methanol. 2021. https://www.irena.org/publications/2021/Jan/Innovation-Outlook-Renewable-Methanol
2. Methanol Institute. Renewable Methanol. 2023. https://www.methanol.org/renewable/
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4. Idemitsu Kosan Co., Ltd. A One-Minute Guide to the Future Possibilities of "E-Methanol". 2023. https://www.idemitsu.com/en/business/oil/lowcarbon/e-methanol_future.html

07. Are There Provisions for Methanol in Marine Fuel Standards?

Yes. ISO 6583:2024 sets specifications for methanol used in marine diesel engines, fuel cells, and related systems—covering fuel quality, testing methods, and safe onboard handling. It builds on the long-established IMPCA chemical specification.

The IMO's Interim Guidelines (MSC.1/Circ.1621) also outline safety requirements for ships using methanol or ethanol as fuel, including containment, fire protection, and operational protocols.

Together, these standards provide a solid regulatory foundation for safe and effective methanol adoption in shipping.

References:

1. International Organization for Standardization (ISO). ISO 6583:2024 – Methanol as a Fuel for Marine Applications. 2024. https://www.iso.org/standard/82340.html
2. International Maritime Organization (IMO). MSC.1/Circ.1621 – Interim Guidelines for the Safety of Ships Using Methyl/Ethyl Alcohol as Fuel. 2020. https://www.register-iri.com/wp-content/uploads/MSC.1-Circ.1621.pdf
3. American Bureau of Shipping (ABS). Guide for Methanol and Ethanol Fueled Vessels. 2022. https://maritimecyprus.com/wp-content/uploads/2022/02/methanol-ethanol-fueled-vessel-guide-jan22.pdf

08. Which Regulatory Regimes Necessitate the Use of "Low-Carbon" Fuel Products Such as Methanol?

1. IMO Regulations

- CII (Carbon Intensity Indicator): Since Jan 2023, ships ≥5,000 GT must report annual emissions and receive A–E ratings. Poor ratings (D for 3 years or E once) require corrective action.
- Upcoming Measures: IMO is developing mid-term policies, including a marine fuel standard and GHG pricing, expected to be finalised by 2025 and enforced by 2027.

2. EU Regulations

emissions:

- 2025: 40% of 2024 emissions
- 2026: 70%
- 2027: 100%
- FuelEU Maritime: Enforces GHG intensity cuts starting at 2% in 2025, rising to 80% by 2050. Applies to ships ≥5,000 GT, regardless of flag.

These regulations are accelerating the shift toward low-carbon fuels like methanol in global shipping.

References:

1. International Maritime Organization (IMO). IMO's Work to Cut GHG Emissions from Ships. 2023. https://www.imo.org/en/MediaCentre/HotTopics/Pages/Cutting-GHG-emissions.aspx
2. DNV. IMO Regulations. 2023. https://www.dnv.com/maritime/hub/decarbonize-shipping/key-drivers/regulations/imo-regulations/
3. European Union. Renewable and Low-Carbon Fuels in Maritime Transport. 2023. https://eur-lex.europa.eu/legal-content/EN/LSU/?uri=CELEX%3A32023R1805
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08.
Which Regulatory Regimes Necessitate the Use of "Low-Carbon" Fuel Products Such as Methanol?

Main Takeaways from IMO's MEPC 83: "Methanol as a Marine Fuel as proposed for Acceptance at MEPC 84":

1. Regulatory Progress

- MEPC 83 noted the international standard for methanol as a fuel for marine applications (ISO 6583:2024)
- References in the final report of MEPC 83 to methanol is document MEPC 83/7/10 (Malaysia, Nigeria and Turkey) which referred to GESAMP-LCA WG with the sponsors requested to submit the proposed default emission factors to the Technical Secretary of GESAMP-LCA WG in digital form using the Excel tool for the standardised reporting of parameters.
- MEPC 83/7/10 (Malaysia et al.), evaluating the well-to-tank (WtT) and tank-to-wake (TtW) default emission factor and GHG intensity calculation for methanol fuel pathway "MeOH_fCO2_rH2_MS_gm" referencing appendix 1 of the 2024 LCA Guidelines; and seeking consensus that pre-combustion captured CO2 from point source fossil fuels be recognised as carbon neutral feedstock, and WtT and TtW default emission factors for the methanol fuel pathway, "MeOH_fCO2_rH2_MS_gm" accounts for eCCU parameters, and is proposed to be calculated with a SFCCU value of "1"

2. Inclusion Under FuelEU Maritime and IMO DCS

- Methanol, particularly sustainably produced (bio- or e-methanol), is considered compliant under emerging FuelEU Maritime regulations and IMO Data Collection System (DCS), as well as Carbon Intensity Indicator (CII) updates, provided certified GHG intensity thresholds are met.

3. Certification & Traceability

- Emphasis was placed on the need for robust certification schemes, such as ISCC or RFNBO-equivalent standards, to ensure traceable carbon intensity values. This emphasis is reflected as part of the IMO Net-Zero Framework with a mandatory requirement for these schemes to be recognised by IMO being set out in the approved regulation 34 of MARPOL Annex VI on "Sustainable fuels certification schemes".

Additional third-party verification mechanisms are still under consideration.

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Main Takeaways from IMO’s MEPC 83: “Methanol as a Marine Fuel as proposed for Acceptance at MEPC 84”:

4. NOx and Safety Considerations

- MSC 109 reiterated support for IGF Code amendments covering methyl/ethyl alcohol fuelled vessels and Tier III NOx compliance, referencing existing engine approvals. MEPC 83 adopted amendments to the NOx Technical Code 2008 concerning the certification of an engine subject to substantial modification or being certified to a tier to which the engine had not been certified at the time of its installation by resolution MEPC.398(83), which if accepted, would enter into force on 1 September 2026. “Substantial modification” is a defined term in the NTC. Primarily this would be where an installed marine diesel engine is intended to be altered outside the bounds of its current NOx certification or to have additional devices fitted or both. This may, for example, be due to the intent to use a different fuel type, re-rating of the engine or to reduce GHG or other emissions. The key point being that, in such instances, there is no available engine for test bed testing in accordance with the conventional application of the NTC chapter 5 requirements. Consequently, the required Parent Engine test must be undertaken on an installed engine and hence there will be all the real-world issues affecting the actual performance of that test on board a ship.
- No additional safety barriers identified for expanding methanol’s use.

MEPC 83 adopted resolution MEPC.402(83) on Guidelines for test-bed and onboard measurements of methane (CH_4) and/or nitrous oxide (N_2O) emissions from marine diesel engines. These guidelines refer to a protocol and the calculation of the emission mass flow rates for N_2O and CH_4 that include values for methanol.

5. Pending Formal Adoption at MEPC 84

- The final adoption of GHG intensity calculation guidelines for renewable methanol fuels (including pathway-specific default values) is expected at MEPC 84.

MEPC 84 is in Spring 2026 and for the default emission values for all non-conventional fuels very much depends on progress made by GESAMP-LCA WG between MEPC 83 and MEPC 84. Furthermore, the emphasis is on IMO Member States to submit proposals for the default emission factors following the procedure set out in MEPC.1/Circ.916 Methodology for submission, scientific review and recommendation of proposed default emission factors by GESAMP-LCA WG

- This would enable flag states and operators to claim GHG reductions when using certified bio-/e-methanol blends.

The IMO’s Life Cycle Assessment (LCA) Guidelines, in conjunction with the Fuel Lifecycle Label (FLL), provide a framework for assessing the greenhouse gas (GHG) emissions of marine fuels throughout their entire lifecycle, from “Well-to-Wake”. This includes assessing emissions from production, transport, and onboard use, including methanol as a potential marine fuel. The FLL is a tool for collecting and conveying relevant information for LCA, and the guidelines dually establish a methodology for determining default emission factors.

08.
Which Regulatory Regimes Necessitate the Use of “Low-Carbon” Fuel Products Such as Methanol?

Key components of the LCA Guidelines and FLL in the context of Methanol as a Marine Fuel include:

1. Well-to-Wake Assessment:

- The guidelines cover all stages of the fuel lifecycle, from production to use on board a ship.

2. Fuel Lifecycle Label (FLL):

- The FLL is a technical tool for documenting and sharing information about the fuel, including its GHG intensity.

3. Sustainability Themes:

- The guidelines incorporate sustainability themes to assess fuels, including those like bio- and e-methanol, which take into account locality, feedstock, process technology.

4. Methanol as a Potential Marine Fuel:

- Methanol is considered a potential low-carbon marine fuel, and the LCA framework helps assess its environmental impact.

5. Verification and Certification:

- The guidelines allow for the use of actual emission factors, subject to verification and certification by a third party, to validate their specific sustainability features (CO2eq emissions).

MEPC 83 recognised that work on the guidelines to support implementation of the IMO-Net Zero Framework is urgent and an Intersessional Meeting is expected to take place in the week following MEPC/ES.2 in October to prepare drafts. 10 sets of new guidelines have been identified as needing to be developed with four sets, including the 2024 LCA Guidelines, needing to be amended.

An informal group that IBIA is participating in and that had developed regulation 34 of MARPOL Annex VI on “Sustainable fuels certification schemes” has started work on developing the “Guidelines on requirements and procedures for recognition of certification schemes/standards and reporting of certification activities to the Organization”. This informal group has also recognised a need to possibly amend the FLL to adjust the FLL structure (compared to what is currently included in the LCA Guidelines) so that it includes all the necessary information to “accompany the bunker delivery note”.

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09. Are the EU and IMO Regulatory Regimes the Same?

No, the EU and IMO CII share the goal of reducing GHG emissions in shipping but differ in scope and approach. The EU focuses on ships ≥5,000 GT operating in or calling at EU ports, using a Well-to-Wake (WtW) method and strict sustainability standards under RED III. Its EU ETS and FuelEU Maritime regulations progressively tighten emission limits from 2024 to 2050.

The IMO, on the other hand, applies globally and currently uses a Tank-to-Wake (TtW) approach, focusing on onboard emissions. However, it is moving toward lifecycle assessments, as shown in its recent LCA guidelines. While the IMO's standards are less strict than the EU's, both frameworks support the use of low-carbon fuels like green methanol.

Source: DNV

References:

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2. European Commission. Reducing Emissions from the Shipping Sector. 2023. https://climate.ec.europa.eu/eu-action/transport/reducing-emissions-shipping-sector_en
3. Maersk. Navigating the EU ETS and FuelEU Maritime Regulations. 2024. https://www.maersk.com/insights/sustainability/2024/10/10/what-you-need-to-know-for-2025
4. DNV. FuelEU Maritime. 2023. https://www.dnv.com/maritime/insights/topics/fueleu-maritime/

10. What is a Renewable Feedstock?

Renewable feedstock is a resource that can naturally replenish itself or be restored over time, making it a sustainable choice for fuel production. In the context of methanol, renewable feedstocks are essential for producing e-methanol or bio-methanol, which serve as low-carbon alternatives to traditional fossil-based fuels.

Key renewable feedstocks for methanol production include:

- **Biomass:** Organic materials such as agricultural residues, forestry waste, municipal solid waste, and other biodegradable materials can be converted into methanol through sustainable processes.
- **Captured Carbon Dioxide (CO2):** CO2 is captured from industrial emissions or directly from the atmosphere and combined with green hydrogen to synthesise methanol, reducing the carbon footprint of the fuel.
- **Green Hydrogen:** Hydrogen produced via electrolysis using renewable energy sources like wind, solar, or hydropower is a vital component for creating sustainable methanol.

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1. International Renewable Energy Agency (IRENA). Innovation Outlook: Renewable Methanol. 2021. https://www.irena.org/publications/2021/Jan/Innovation-Outlook-Renewable-Methanol
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4. Methanex Corporation. How Methanol is Produced. 2023 https://www.methanex.com/about-methanol/overview/

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11. Why Are Renewable Feedstocks Important?

Renewable feedstocks are essential for ensuring the sustainability and environmental credibility of methanol as a marine fuel. Regulatory frameworks, such as the EU Renewable Energy Directive (RED III) and IMO guidelines, rigorously scrutinise feedstocks to verify their compliance with sustainability criteria. To be considered sustainable, renewable feedstocks must:

- Avoid competing with the food chain by not using crops primarily grown for food.
- Prevent direct or indirect land-use changes that could lead to deforestation or increased greenhouse gas (GHG) emissions.
- Meet strict lifecycle carbon intensity targets, ensuring that emissions reductions are genuine, measurable, and calculated on a Well-to-Wake (WtW) basis.

Sustainability verification is conducted via mass balance or book-and-claim chain-of-custody systems under certification schemes like ISCC, RSB, or Bonsucro. These systems ensure compliance with RED III criteria, including land-use change avoidance, GHG reduction thresholds, and traceability audits.

The use of renewable feedstocks is pivotal in achieving the carbon neutrality of methanol. By utilising feedstocks like biomass, captured CO2, and green hydrogen, methanol producers and ship operators can align with global and regional decarbonisation goals, contributing to the transition toward a greener and low-carbon shipping industry.

References:

1. European Commission. Voluntary Schemes under the Renewable Energy Directive. 2023. https://energy.ec.europa.eu/topics/renewable-energy/bioenergy/voluntary-schemes_en
2. International Maritime Organization (IMO). Resolution MEPC.391(81) – 2024 Guidelines on Life Cycle GHG Intensity of Marine Fuels. 2024. https://wwwcdn.imo.org/localresources/en/KnowledgeCentre/IndexofIMOResolutions/MEPC-Documents/MEPC.391(81).pdf
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5. Transport & Environment. RED III Implementation Briefing. 2023. https://www.transportenvironment.org/uploads/files/REDIII_implementation_briefing.pdf

12. Are Any Specific Tests or Trials Required Before Methanol Use in Relation to MARPOL Annex VI Regulations on NOx and SOx Emissions?

Methanol use in marine engines is regulated under MARPOL Annex VI, with specific provisions addressing sulfur oxides (SOx) and nitrogen oxides (NOx) emissions:

- SOx (Sulfur Oxides): Methanol inherently complies with Regulation 14 of MARPOL Annex VI as it contains no sulfur, eliminating SOx emissions entirely. This makes methanol an ideal choice for meeting the global sulfur cap of 0.50% and the stricter 0.10% limit in Emission Control Areas (ECAs) without requiring exhaust gas cleaning systems or additional fuel treatment.
- NOx (Nitrogen Oxides): Methanol's use in marine engines is regulated under Regulation 18 of MARPOL Annex VI, which outlines compliance requirements for non-petroleum fuels:
- If a marine engine operates on methanol without requiring changes to NOx-critical components, settings, or operating parameters (as specified in the engine's approved Technical File), no additional tests or trials are required under Regulation 18.3.2.2.
- For engines that do require modifications to NOx-critical components, additional assessments may be necessary to confirm compliance with the applicable NOx Tier limits.

References:

1. International Maritime Organization (IMO). Nitrogen Oxides (NOx) – Regulation 13. 2023. https://www.imo.org/en/OurWork/Environment/Pages/Nitrogen-oxides-(NOx)-Regulation-13.aspx
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13. How available is methanol as a marine fuel, and what is its future production outlook?

Methanol is increasingly recognised as a viable marine fuel, with existing infrastructure supporting its adoption. It is currently produced at scale, with an annual global production capacity of nearly 100 million tons, primarily for the chemical and energy industries. While methanol is widely available in the global market, its availability as a marine fuel is still developing, with several key ports offering methanol bunkering services. Methanol is accessible at a limited number of ports worldwide for marine fuel use, with 120 ports reflecting general methanol availability rather than specific bunkering infrastructure.

Currently, most methanol is produced from natural gas, known as "gray methanol." Efforts are underway to reduce the carbon footprint of methanol production through methods such as CO_2 recirculation and the incorporation of green hydrogen, leading to "blue methanol."

By 2050, e-methanol and bio-methanol (green methanol) are projected to make up 80% of global methanol production, reaching up to 500 million tons annually. However, this output will also serve other sectors, including chemical, energy, and manufacturing industries. Methanol's adoption in maritime transport will rely on scaling production, infrastructure development, and policy support to meet decarbonisation goals.

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14. Will There Be Enough e and bio–Methanol Available for Bunkering When Emission Regulations Tighten?

As emission regulations grow stricter, methanol—especially green methanol and bio-methanol—is poised to play a significant role in decarbonising the shipping industry. However, the availability of sustainable methanol remains a concern due to the need for substantial investment in production capacity and infrastructure. Currently, most methanol is fossil-based, and scaling up green and bio-methanol production requires renewable energy for green hydrogen, carbon capture technologies for CO2 utilisation, and reliable biomass supply chains. Industry estimates, including those from DNV, highlight the challenge of meeting shipping's long-term demand while competing with other sectors like aviation and industry.

To address these challenges, a diversified approach will be essential. While bio-methanol is a contender for clean marine fuel, the maritime sector must also invest in synthetic fuels such as synthetic ammonia, synthetic hydrogen, and synthetic-LNG options to ensure sufficient supply. Expanding production capacity of bio and synthetic feedstock, building bunkering infrastructure, and improving energy efficiency will be critical for meeting decarbonisation targets without over-relying on a single fuel source. Collaboration across industries and stakeholders will be key to ensuring methanol's availability at scale.

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15. What are the Energy Density Characteristics of Methanol and Their Implications for Shipping?

Methanol is a stable liquid at ambient conditions, offering simpler and cheaper storage and bunkering than cryogenic fuels like LNG, hydrogen or ammonia. However, its energy density is much lower—around 15.8 GJ/m^3 compared to Marine Gas Oil's 36.6 GJ/m^3—meaning ships need about 2.4 times more tank space to achieve the same range. Despite this, methanol's compatibility with conventional fuel tanks and even coated ballast tanks (i.e., as on the Stena Germannica) eliminates the need for cryogenic systems, making it practical for mid- and long-range shipping (deep sea shipping). This as enough energy can be brought on board efficiently to compensate for methanol's lower energy density. The adoption of ISO 6583:2024 and growing investments over recent years highlight methanol's potential as a viable decarbonisation fuel for container ships, tankers, and cruise vessels.

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16. What do the OEMs say?

Leading OEMs such as Everllence E&S (formerly MAN Energy Solutions), WindGD and now offer dual-fuel two-stroke engines (e.g., MAN B&W ME-LGIM) as well as four-stroke methanol-compatible solutions by Wärtsilä, have developed extensive guidance based on their experience with methanol-fueled engines. Key considerations highlighted by OEMs include:

- **Material Compatibility:** Methanol's corrosive and water-soluble nature requires the use of compatible materials for injectors, tanks, seals, pipes, and pumps to avoid leaks and degradation.
- **Fuel System Design:** Due to methanol's low viscosity and energy density, OEMs recommend customised injection systems and engine adaptations to ensure efficient combustion.
- **Operational Guidelines:** OEMs stress the importance of leak detection, combustion monitoring, and preventive maintenance to ensure safety and optimal performance.

Following OEM technical updates and service letters is essential for safe, efficient, and compliant methanol engine operation.

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17.
Are Methanol Fuels Priced Differently Than Conventional Fuels?

Methanol is typically priced in US dollars per metric tonne ($/mt), similar to conventional fuels like HSFO, VLSFO, and LSMGO. However, its pricing dynamics—especially for synthetic methanol and bio-methanol—are influenced by unique market factors related to its production processes and reliance on renewable energy sources. Fossil-based methanol prices are closely tied to natural gas markets, often benchmarked against indexes like the Methanex Methanol Price Index. In contrast, sustainable methanol pricing reflects the costs of renewable feedstock, advanced production technologies, and growing demand across various sectors, including shipping, chemicals, and aviation.

In major methanol bunkering hubs such as Singapore and Rotterdam, pricing structures often include premiums over conventional fuel benchmarks like Platts VLSFO or Low Sulfur Gasoil. Suppliers may also use methanol-specific benchmarks to account for regional supply-demand factors and production costs. The variability of renewable feedstock costs makes methanol pricing more complex, requiring shipowners and fuel buyers to adopt tailored strategies for managing price risks. While methanol fuels may carry higher premiums, their role in meeting regulatory and decarbonisation goals makes them an essential investment for the maritime industry's clean energy transition.

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