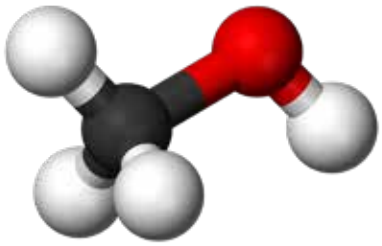
Methanol – a strong contender

By SHIPPING AUSTRALIA



Pictured: a ball-and-stick model of methanol. Four hydrogen atoms (white), one carbon atom (grey) and one oxygen atom (red). Graphic credit: Benjah Bmm27 via Wikipedia.

Methanol is a simple, clear and colourless, alcohol that is attracting huge interest as a potential marine fuel.

Maersk signed a contract for a 2,100 TEU methanol-powered container ship in July this year with the intent to launch in 2023. In March this year, Class NK issued an approval-in-principle to Sumitomo Heavy for its methanol dual-fuelled tanker design.

New large scale methanol-fuel testing began at Scandinavian industrial giant Alfa-Laval in earlier this year. In February this year, Italian class society, RINA, and the Shanghai Institute for Ship Design, formed a partnership to develop methanol-fuelled tankers. In November 2020, the IMO adopted interim guidelines on ethyl/methyl fuels.

There are, right now, 26 methanol-powered ships either in operation or on order, according to the "Alternative Fuel Insight" platform by class society DNV GL, that's 22 oil or chemical tankers, two gas tankers, one ro-pax and one tug.

Methanol's a potential fuel that's nearly ready for widespread use by the shipping industry.

So the whole sentence should read: "While there are a several technical and engineering issues to be resolved, class society DNV GL rates the technological maturity of methanol as a marine fuel as "commercially available, but not fully mature".

Globally used, traded worldwide

Methanol has many uses, including but not limited to, a feedstock for the creation of other chemicals, for synthetic fibres, pharmaceuticals, plastics, and plywood. It is an internationally transported commodity so there is a lot of handling experience. Although toxic and flammable, it is easily handled because it is a liquid between -93 Celsius and 65 Celsius at atmospheric pressure.

Because it's globally traded, logistics and storage infrastructure for methanol already exists. There are methanol terminals at Melbourne, Newcastle, and Taranaki (New Zealand), according to DNV GL. Methanol can even use the same type of storage as diesel, albeit with minor modifications to cope with the fact that methanol fuel has a low flash point, according to industry body the Methanol Institute.

Methanol is already produced in large volumes and there are about 90 methanol plants around the world with a combined production capacity of 110 million tonnes, according to industry body, the Methanol Institute.

Because it is widely traded, there's good pricing data. Methanex, the world's largest producer and supplier to global markets, recently posted per tonne prices of EUR 410 (US$483) for Europe; US$542 for North America and US$420 for Asia-Pacific. That's not a million miles away from existing bunker prices. At the time of writing, Singapore bunker prices per tonne were US$539 for Very Low Sulphur Fuel Oil (0.5%), US$538 for Marine Gas Oil and US$413.50 for Intermediate Fuel Oil.

Ignition and energy content

There are disadvantages to the use of methanol as a fuel. For instance, it currently needs help (usually from diesel) to ignite. That creates ship-design issues, which is a matter being investigated by Alfa-Laval.

"At present, combusting methanol requires a pilot ignition with fuel oil," said Lars Skytte Jørgensen, Vice President Technology Development, Alfa Laval Marine, in a public statement. "This necessitates two fuel lines and different types of fuel tanks on board. If methanol from renewable sources could be burned directly in standard compression engines, it would offer a shortcut to carbon-neutral shipping."

Methanol has a lower energy content than conventional fuels. Methanol has a net heating value of 16 gigajoules per cubic metre, Liquefied Natural Gas (LNG) has 22 GJ/m3 and diesel 35 GJ/m3. Lower energy density means that methanol-fuelled ship will either carry less fuel (giving it a smaller sailing distance, or requiring it to carry out more frequent bunkering) or it will have to carry bigger fuel tanks which will likely result in less cargo-carrying space.

Class society DNV GL estimates that methanol powered ships will need fuel tanks about 2.5 times bigger than vessels powered by marine gas oil (a distilled, diesel-like, fuel). DNV GL says that methanol tanks would need to be similar, or a bit smaller, in size than LNG tanks. Given that there are already 729 LNG-powered ships either in, or nearly-in, commercial service, according to DNV GL, the bigger tank size issue seems to be manageable.

Methanol's safety reputation

Methanol toxicity is very much dependent on species and size. Rabbits, rodents, and dogs might be able to recover from a dose that would seriously harm a person. Unfortunately, humans are particularly sensitive to methanol. Methanol poisoning can occur through ingestion, inhalation of vapours or through skin absorption. Symptoms include irritated eyes, skin and respiratory tract irritation, shortness of breath, nausea, headache, blindness, vomiting, diarrhea, and death.

Pictured: Methanex's methanol plant at Taranaki, New Zealand. Photo credit: Methanex.

Methanol does not appear to pose a severe risk to aquatic life. The toxic level in fish, according to the Methanol Institute, is 15,400 mg/litre, which compares extremely well to heavy fuel oil which has a toxicity to fish of 79 mg/litre. That said, methanol toxicity very much depends on the nature of the critter. About half of a sample population of small freshwater Japanese Rice Fish (*Oryzias latipes)* will die with an exposure of 7,900 micrograms / litre. However, it takes nearly twice as much methanol exposure, about 15,400 micrograms / litre, to kill half of a sample population of freshwater Bluegill *(Lepomis macrochirus).*

If there is a methanol spill, the alcohol evaporates quickly when exposed to air and it dissolves quickly when mixed with water. A methanol spill at sea would quickly disperse to non-toxic levels because of wind and wave action. Methanol is not persistent and industry body "Methanol Fuels", reports that methanol biodegrades within seven days or less, depending upon conditions. The alcohol also doesn't bioaccumulate in higher-level predatory animals.

Methanol's green benefits

Nitrous oxides, sulphur oxides and particulate matter emitted during the combustion of fossil fuels are highly adverse to human, plant, and animal health. They're also terrible for the general environment too. Acid rain, for instance, is caused by atmospheric sulphur oxide.

So the less, the better.

Methanol combustion results in far lower levels of these toxic nasties compared to heavy fuel oil combustion. According to the International Transport Forum's 2018 "Decarbonising Maritime Transport" paper, methanol combustion offers emissions reductions of 99% for sulphur oxides, 60% for nitrous oxides and 95% for particulate matter when compared with heavy fuel oil. Nitrous oxide emissions can also be further reduced with emissions control technologies.

Methanol can also be made with clean, renewable, energy, which is a further point in its favour.

Methanol's two weak points

Methanol has two weak points: carbon emissions during production and during combustion.

The chemical formula of methanol, CH_3OH, shows that the alcohol is comprised of six atoms: one carbon, one oxygen and four hydrogen. Even one carbon atom means methanol is not a zero-carbon fuel. However, it contains less carbon than fossil fuels. Methanol's carbon content is 37.5% by weight while, in comparison, Liquefied Natural Gas has 75.0% carbon by weight and diesel has 86.9%, according to analyst FCBI Energy.

Methanol is commonly made from natural gas. Industry body, Methanol Fuels, reports that, formerly, a "typical methanol manufacturing plant would emit about 0.9 – 1.0 metric tonnes of carbon dioxide for every ton of methanol produced". The body adds that, as the methanol industry has replaced its heavy industrial plant over time, carbon dioxide emissions have declined by up to 40%.

However, emissions science is not favourable to natural gas-produced methanol. Brynholf et al in "Environmental assessment of marine fuels" (2014) conclusively demonstrated on a full life cycle basis (including production, transport, and usage) that methanol fuel made from natural gas is a bit worse than heavy fuel oil from a global warming perspective.

But methanol can also be made from renewable feedstocks, such as biomass. This includes biomass from the paper industry, the sugar industry (bagasse, molasses, cane leaves), other agricultural industries and forestry. Biomass production massively reduces the greenhouse gas effect of methanol. Brynholf et al demonstrated that life-cycle emissions from forestry-sourced methanol have about five times less global warming potential than heavy fuel oil.

"The shipping industry needs to reduce its emissions of greenhouse gases significantly in the future in order to bear its share of the burden. This study highlights that LNG and methanol produced from natural gas will not reduce the global warming potential in the life cycle. However… methanol produced from biomass is one possible pathway to reducing shipping greenhouse gas emissions," Brynholf et al wrote.

It is also possible to make methanol directly from carbon dioxide and hydrogen.

For maximum environmental benefit, C02 could be supplied by carbon capture. Capture can come in several forms, two of which are relevant here: capture from industrial facilities or capture directly from the air. In both cases, carbon capture technology exists but economic viability has not been demonstrated. That may change with new technology or the introduction of carbon pricing.

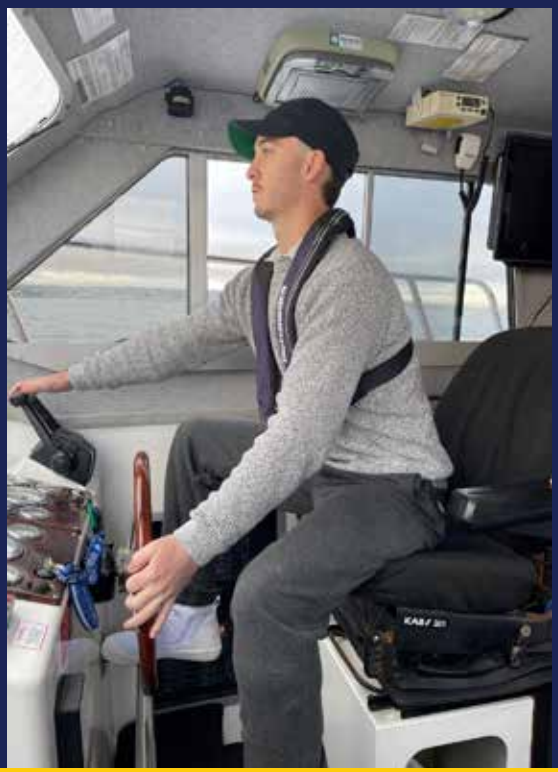
Carbon capture from industrial plant would prevent emissions being vented to the atmosphere. Meanwhile, production of methanol using direct air capture of carbon would greatly reduce emissions and possibly even reduce atmospheric carbon, provided the necessary hydrogen was also produced in a green manner.

It may be possible to use carbon offsets by, for instance, buying credits to fund the restoration of mangrove swamps, or re-planting rainforests. That could potentially lead to a net-neutral position.

Methanol's here, it's manageable, mostly green and its carbon problems can be overcome. It's a contender.

"Since completing my radio operator, Elements of Shipboard Safety and Coxswain training at the Academy my commercial diving career has taken off. I believe the training has helped to open up to more opportunities"
Damian Sturm

Photo: student doing Coxswain boat practical June 2021



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