FCBI energy

METHANOL INSTITUTE

METHANOL AS A MARINE FUEL REPORT

In December 2015, FCBI Energy published a report titled Methanol as a Marine Fuel, authored by marine energy systems expert, Professor Karin Andersson of Chalmers University in Sweden. The aim of this report is to show how methanol is a strong contender as a future-proof marine fuel. The report was commissioned by the Methanol Institute (MI), which serves as the trade association for the global methanol industry. In providing this analysis, MI is looking to raise awareness of methanol as a marine fuel amongst policy-makers and industry leaders.

In recent years, governments and supranational organizations have introduced regulations to reduce harmful emissions from power generation and transportation; shipping is no exception. The International Maritime Organization (IMO) has introduced sulfur emission control areas (SECAs) with the objective of drastically reducing sulfur oxide (SOx) emissions. Current SECAs came into force in 2015 in two regions: North America and the Caribbean, and the North and Baltic Seas. Similar legislation mandating a reduction of nitrogen oxide (NOx) emissions was introduced in 2016 for all new build ships in North America and the Caribbean. The IMO is considering extending the reach of SECAs to other regions and introducing even more stringent standards.

> *"The potential of methanol as marine fuel remains largely unrecognized outside specialist circles. I believe this report can help raise awareness of this marine fuel and serve as an important source of facts to anyone looking for greener shipping fuels."*
>
> Carl-Johan Hagman
> CEO Stena Line

Given this pressure to reduce emissions in shipping, the industry has been forced to explore emissions reduction measures. Shipping companies have two options to remain compliant: either removing emissions from exhaust gases, through abatement technologies like scrubbers or catalytic converters; or changing from diesel to a low-emissions fuel such as methanol.

Methanol is a low-emissions fuel that has sometimes been overlooked in policy and industry discussions despite having many attributes that make it an attractive marine fuel. It is compliant with the strictest emissions standards, plentiful and available globally, could be manufactured from a wide variety of fossil and renewable feed-stocks, 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 similar to current marine fuels in that it is a liquid. This means that current marine fuel storage and fueling infrastructure would require only minor modification to handle methanol, necessitating relatively modest infrastructure investment costs compared with the sizeable investments required for the construction of liquefied natural gas (LNG) terminals.

SINGAPORE (HQ):
10 Anson Road, #32-10
International Plaza,
Singapore 079903
+65 6325 6300

WASHINGTON DC:
225 Reinekers Lane, Suite 205,
Alexandria, VA 22314 USA
+1 703 248 3636

BRUSSELS:
Avenue Jules Bordet, 142
1140 Brussels, Belgium
+32 276 116 59

BEIJING:
#511, Pacific Sci-Tech Development
Center, Peking University
No. 52 Hai Dian District,
Beijing 100871, China
+86 10 6275 5984

METHANOL.ORG

EXECUTIVE SUMMARY

METHANOL IS PLENTIFUL, AVAILABLE GLOBALLY AND COULD BE 100% RENEWABLE:

Methanol is readily available worldwide and every year over 70 million tons are produced globally. The main feed-stock in methanol production is natural gas. However, methanol could be 100% renewable, as it can be produced from a variety of renewable feed-stocks or as an electro-fuel. This makes it an ideal pathway fuel to a sustainable future in which shipping is powered by 100% renewable fuels.

METHANOL IS COMPLIANT WITH INCREASINGLY STRINGENT EMISSIONS REDUCTION REGULATIONS:

Marine methanol fuel produces no sulfur emissions and very low levels of nitrogen oxide emissons. It is therefore complaint with current emissions reduction measures such as emission control areas (ECAs). From the regulatory standpoint, marine methanol is a future-proof fuel that could comply with the most tightly specified emissions reduction currently being considered.

CURRENT BUNKERING INFRASTRUCTURE NEEDS ONLY MINOR MODIFICATIONS TO HANDLE METHANOL:

Methanol is very similar to marine fuels such as heavy fuel oil (HFO) because it is also a liquid. This means that existing storage, distribution, and bunkering infrastructure could handle methanol. Only minor modifications are required to allow for methanol being a low-flashpoint fuel.

INFRASTRUCTRE COSTS ARE RELATIVELY MODEST COMPARED TO POTENTIAL ALTERNATIVE SOLUTIONS:

Because methanol remains in a liquid state, infrastructure investment costs are low relative to competing alternatives such as liquefied natural gas (LNG). Installation costs of a small methanol bunkering unit have been estimated at around €400,000 (Stefenson, 2015). A bunker vessel can be converted for approximately €1.5 million. In contrast, an LNG terminal costs approximately €50 million and an LNG bunker barge €30 million. Additionally, methanol allows for small incremental investments in infrastructure capacity as the number of users grows.

Bunkering of the Stena Germanica in Gothenburg

METHANOL PRICES SHOW REGIONAL VARIATION:

Over the past five years, methanol has usually been less expensive, on an energy equivalent basis, than competing fuels such as marine gas oil (MGO). In the lower oil price environment, both MGO and methanol prices have declined, and methanol remains competitive in many key shipping regions. Since methanol engines are dual fuel, a temporary change to marine diesel is always possible at points in time when methanol is more expensive.

CONVERSION COSTS TO DROP DRAMATICALLY AS EXPERIENCE MOUNTS:

The main reference point on vessel retrofit costs comes from the conversion of the 24 MW ro-pax ferry *Stena Germanica*. Conversion specific costs amounted to € 13 million and the total project cost was € 22 million, which includes a methanol storage tank onshore and the adaptation of a bunker barge. Being the first of its kind, the retrofit of the Stena Germanica and associated infrastructure entailed much design work on new technical solutions, safety assessments, and adaptation of rules and regulations (Ramne, 2015). It has been estimated that the cost of a second retrofit project would be much lower, at about 30% to 40% of the Stena Germanica Conversion (Stefenson, 2015).

METHANOL IS BIODEGRADABLE:

From an environment point of view, methanol performs well. Methanol readily dissolves in water and is biodegraded rapidly, as most micro-organisms have the ability to oxidize methanol. In practice, this means that the environmental effects of a large spill would be much lower than from an equivalent oil spill.

CURRENT ENGINES HAVE PERFORMED WELL AND UPCOMING TECHNOLOGIES WILL FURTHER IMPROVE ON THIS PERFORMANCE:

So far, methanol ships have been powered by diesel concept engines which have been modified to run on both methanol and marine diesel. In both field and laboratory tests, convered methanol engines have performed at equivalent or higher levels than diesel engines. Methanol-optimized marine engines are under development and once in service are expected to perform better than retrofits.

SHIPPING AND CHEMICAL INDUSTRIES HAVE A LONG HISTORY AND AMPLE EXPERIENCE IN HANDLING METHANOL SAFETY:

Methanol has been shipped globally, handled and used in a variety of applications for more than 100 years. Froma health and safety perspective, the chemical and shipping industries have developed procedures to handle methanol safely. There is ample experience in handling and transporting methanol as a chemical, both in tank trucks and bulk vessels.

> *"Traditionally one of the world's most widely shipped chemical commodities, methanol now has an historic opportunity to move from ship's cargo holds to their fuel bunkers. As this report documents, methanol's use as a marine fuel provides shippers and port facilities with an affordable option for compliance with tightening emission requirements. Produced from a wide range of feedstocks – including a variety of renewable pathways – methanol provides an ideal pathway to sustainable shipping."*
>
> Gregory Dolan
> CEO - Methanol Institute

METHANOL MARINE PROJECT

The types of diesel engine used in shipping are two-stroke or four-stroke engines. Nowadays it is possible to adapt both two- and four-stroke engines to use methanol in dual-fuel mode. In these adaptations, the engine's fuel-injection is modified to achieve higher injection pressure, which is required for igniting methanol.

EFFSHIP

The Effship project (2009-2013) evaluated different technical solutions and marine fuels available to fulfill SOx and NOx reductions regulations in the short term (2015-2016), GHG reduction targets in the medium term (2030) and long term. This project concluded that methanol was the best alternative fuel, taking into account prompt availability, use of existing infrastructure, price, and simplicity of engine design and ship technology with well-known land-based applications (Fagerlund and Ramne, 2013). This project was a Swedish initiative, co-funded by the Swedish Innovation Agency (Vinnova) and partners.

SPIRETH

The SPIRETH project spun off from Effship and ran from 2011 until 2014 (Ellis et al, 2014). This project aims to demonstrate the feasibility of two fuel concepts by testing them in a laboratory setting:

1) Methanol used in a full-scale marine diesel engine.

2) Di-methyl ether (DME) produced by the conversion of methanol on board a ship and used in an adapted auxiliary diesel engine.

The SPIRETH project received funding from the Swedish Energy Agency, Nordic Energy Research, Nordic Investment Bank and the Danish Maritime Fund.

PILOT METHANOL

PILOT Methanol is a full-scale test of conversion and operation of the ro-pax ferry *Stena Germanica* to methanol fuel with support from the EU TEN-T program. The main objective of the project is to develop the fuel conversion expertise and infrastructure. It includes theconversion of engine and fuel supply system on board, bunkering facilities and permit/regulation development. The conversion was completed in April 2015 and tests are in progress (European Commission, 2015b).

SINGAPORE (HQ):
10 Anson Road, #32-10
International Plaza,
Singapore 079903
+65 6325 6300

WASHINGTON DC:
225 Reinekers Lane, Suite 205,
Alexandria, VA 22314 USA
+1 703 248 3636

BRUSSELS:
Avenue Jules Bordet, 142
1140 Brussels, Belgium
+32 276 116 59

BEIJING:
#511, Pacific Sci-Tech Development
Center, Peking University
No. 52 Hai Dian District,
Beijing 100871, China
+86 10 6275 5984

METHANOL.ORG

SINGAPORE (HQ):
10 Anson Road, #32-10
International Plaza,
Singapore 079903
+65 6325 6300

WASHINGTON DC:
225 Reinekers Lane, Suite 205,
Alexandria, VA 22314 USA
+1 703 248 3636

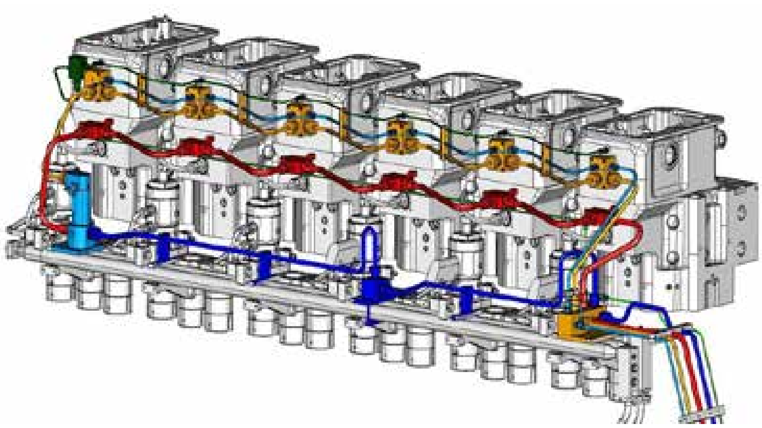
BRUSSELS:
Avenue Jules Bordet, 142
1140 Brussels, Belgium
+32 276 116 59

BEIJING:
#511, Pacific Sci-Tech Development
Center, Peking University
No. 52 Hai Dian District,
Beijing 100871, China
+86 10 6275 5984

METHANOL.ORG

WÄRTSILÄ -- *STENA GERMANICA*

Within SPIRETH there has been an evaluation of various combustion concepts and design solutions with the goal of obtaining low emissions, high efficiency, robust solutions and cost-effective conversion. The development builds on the experience of designing LNG/HFO dual-fuel engines with a low-pressure gas system. This concept has been tested for more than ten years. The low cetane number is a property that methanol shares with LNG and the engine will need a cetane enhancer in order to ignite. In the dual-fuel solution, Wärstilä developed a unique injection system using a small amount of diesel oil that is being used on *Stena Germanica.*

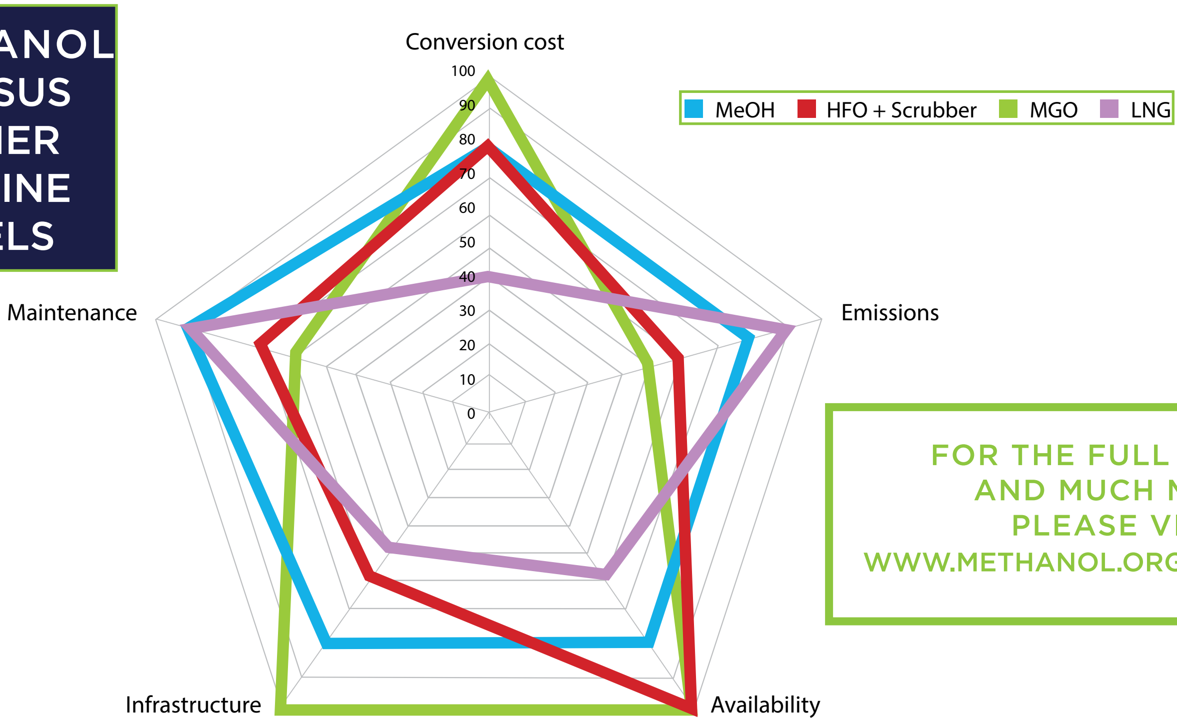


Wärstilä Engine with Additonal Piping for Methanol

MAN -- *WATERFRONT SHIPPING*

In 2016, Methanex's wholly owned subsidiary, Waterfront Shipping, will have seven of the world's first 2-stroke dual fuel vessels join its fleet, a revolutionary introduction to global marine transportation. These seven 50,000 dead weight tonne vessels are built with the first-of-its kind MAN ME-LGI 2-stroke dual fuel engines that can run on methanol, fuel oil, marine diesel oil, or gas oil. With the growing demand for cleaner marine fuel to meet environmental regulations, methanol is a promising alternative fuel that can meet the industry's increasingly stringent emissions regulations. These two-stroke 10 MW ME-LGI engines offer a dual-fuel solution for low-flashpoint liquid fuels. The cylinder covers are equipped with additional methanol booster injectors (MAN, 2015b), achieving a typical injection pressure of 10 bars.

METHANOL VERSUS OTHER MARINE FUELS



FOR THE FULL REPORT AND MUCH MORE, PLEASE VISIT WWW.METHANOL.ORG/MARINE.ASPX

SINGAPORE (HQ):

10 Anson Road, #32-10
International Plaza,
Singapore 079903
+65 6325 6300

WASHINGTON DC:

225 Reinekers Lane, Suite 205,
Alexandria, VA 22314 USA
+1 703 248 3636

BRUSSELS:

Avenue Jules Bordet, 142
1140 Brussels, Belgium
+32 276 116 59

BEIJING:

#511, Pacific Sci-Tech Development
Center, Peking University
No. 52 Hai Dian District,
Beijing 100871, China
+86 10 6275 5984