Methanol - An Ultra Clean Marine Fuel Solution

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Diego Jaramillo, Manager, Quality & Responsible Care, Waterfront Shipping
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Methanex Corporation
Methanex

The world’s largest producer and supplier of methanol to major international markets
About Methanol
Methanol

An essential ingredient of modern life

- Chemical market - essential ingredient used in countless industrial and consumer products (~55% demand)
- Fuels/oil substitution markets - represent the fastest growing demand segment for methanol (~45% demand)

Energy/Fuels Markets

Vehicle Fuel  Marine Fuel  Power Generation
Methanol Production

Methanol is typically made from natural gas

The methanol production process consists of four stages:

1. Desulphurization of natural gas
2. Reforming
3. Methanol Synthesis
4. Distillation

Liquid fuel at ambient temperature & pressure
Methanol Production

Methanol offers pathways to reduce CO₂ emissions

- Production from renewables and/or utilizing excess CO₂ streams
- Lower carbon content fuel for Energy Efficiency Design Index (EEDI) for new vessels

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Source: Methanol Institute
Methanol Marine Fuel
Methanol Marine Fuel

Methanol is an innovative alternative fuel solution with many benefits

- Low emissions
- Wide availability
- Innovative technology with low incremental cost
- Fuel flexibility
- Competitive fuel costs
- Safe, environmentally friendly
- Successfully in use today
- Commercialization activity expanding
IMO Sulphur Limits – Marpol Annex VI

IMO limits SOx content of fuel to 0.1% in ECAs. Global sulphur cap of 0.5% (from current 3.5%) to come into effect in 2020.

IMO Nitrogen Oxides Limits – Marpol Annex VI

Tier III NOx limits effective in North America in 2016 and North and Baltic effective 2021 (newbuilds only)

Source: IMO
Methanol is a clean-burning fuel that meets stringent environmental regulations

Emissions Reductions

Source: Stena Lines

Emission reductions when compared to heavy fuel oil
Emissions Reductions – Tier III NOx

- Methanol significantly reduces NOx compared to diesel with current engine technology, but not quite to Tier III levels
- Tier III NOx limits can potentially be met with water in methanol

1. EGR
2. SCR
3. Water + Methanol

- R&D work underway to meet Tier III NOx with a mixture of methanol & water
- Reduce additional capital and operational expenses related to SCR/EGR after treatment

Source: MAN
Wide Availability

Methanol infrastructure already in place and well positioned to reliably supply the global marine industry.

Methanol Global Terminal Locations

Methanol global terminal locations based on available information; not a complete list.

North America Methanol Market

Red flags/circles represent existing methanol supply locations; lines represent rail networks.

Source: Methanex
Innovative Technology

Methanol has minor modification requirements and modest incremental cost
Low-Cost Infrastructure and Capital Costs

- Methanol is a cost-effective, liquid marine fuel alternative
- Methanol offers fuel flexibility

Utilize existing supply chain/infrastructure

- Liquid fuel at ambient temperature & pressure
- Low cost infrastructure
- Compatible with diesel infrastructure

Modest incremental cost to convert or build new engines to operate on methanol

- Engine technology straightforward/minor modifications required
- Small amount of diesel used as pilot fuel
- Flex fuel (diesel or methanol) maintained mitigating commodity price & technology risks
Methanol is an economically viable alternative marine fuel over the cycle. Potential for short payback on investment based on historical fuel pricing.

**Marine Fuel Pricing**
Methanol adjusted to MGO Energy Equivalency

- Chart source: Platts and IHS Chemical
  - Methanol: USGC spot price adjusted to energy equivalent of MGO (2.16 factor)
  - MGO: West Coast Average: Vancouver, Seattle, San Francisco, LA; East Coast Average: New York, Philadelphia, Norfolk, Montreal, Charleston
Methanol - Environment, Health and Safety

*Methanol is a clear, colourless liquid that quickly and naturally biodegrades*

- More environmentally benign than conventional marine fuels (i.e. HFO and MGO)
- Long history of methanol safe handling
- International standard (IGF Code) under development for methanol as marine fuel
Methanol in Use Today: Stena Germanica Ferry

The world’s first methanol-fuelled ferry

- Stena Germanica ferry converted to run on methanol in 2015
- Gothenburg to Kiel
- Powered by four Wärtsilä 4-stroke engines (24 MW total)
- Straightforward fueling (liquid fuel)
- Fuel switching (Methanol or MGO) is fast, simple and reliable. No loss in engine speed or output
- Efficiency improvements (i.e. 1-2%) versus diesel
Methanol in Use Today: Waterfront Shipping Tankers

The world’s first methanol-fuelled tankers

- Commercial-ready technology
- In 2016, Waterfront Shipping launched 7 vessels with methanol dual-fuel MAN ME-LGI 2-stroke engines
  - 4 new methanol dual-fuel vessels on order for 2019 delivery
- Multiple ship owners
- Operating safely and reliably, across the globe: ~30,000 operating hours
# Methanol Marine Fuel Commercialization Activities - Small Engine Market

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<td>Swedish Maritime &amp; Transport, SSPA Sweden, ScandiNAOS, Methanol Institute</td>
<td>Consortium of partners (academia, technical, industry)</td>
<td>Ministry of Transport, Tianjin University, China Classification Society, Methanex</td>
<td>Billion Miles</td>
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Waterfront Shipping

Methanol dual fuel vessels – An operator’s experience
Waterfront Shipping
- 28 vessels, including 7 methanol dual-fuel vessels
- 4 new methanol dual-fuel vessels on order (2019)
Strong partnership between reliable stakeholders

Vessel concept developed together with MAN Diesel & Turbo, Alfa Laval, DNV-GL and the Norwegian Maritime Directorate.

Seven ships in total from Hyundai Mipo Dockyard and Minaminippon Shipbuilding for Marininvest, Westfal-Larsen and MOL on long term time charter with Waterfront Shipping owned by Methanex.
Design Philosophy: General design decision

Primary focus in the Dual fuel system concept has been personal and system safety. Secondly, sustain engine reliability.

Main design considerations

- A **Gas safe** engine room
- A **single failure** results in Second Fuel (SF, Methanol) shut down or SF stop
- The Methanol system **must not affect** the engine running on MGO/HFO
- The Methanol system is an “**Add-On**” to the ME engine
Methanol concept: Supply System (LFSS)
LFSS Unit (Liquid Fuel Supply System)
Safety features

- **Fail Safe System** - Auto change over from Secondary Fuel to Primary Fuel
- **Nitrogen** Purging
- **Double Walled** Piping and Components
- **Leakage Detection**
- **Continuous Ventilation**
- **Intrinsically safe** components
- **Fixed CO2 Extinguishing System**
- **CCTV Monitoring**
- **Alarms** with shutdown and purging
- **Immediate switch** to conventional fuel
- **Fire fighting on deck**
- **Fire fighting in Engine Room**
Main Engine - Overview
Main Engine - Overview

**ME-Engine** + **LGI Technology** = **ME-LGI-M**

- HFO/MGO
- Methanol
- Dual Fuelled
Novel ideas based on proven technology

Centered around the **MAN Ultra-long-stroke dual fuel engine** (6G50ME-B9.3-LGI), ensuring a **solid and reliable framework**.

Designed with instantaneous, **automatic fall-back to conventional fuel** in the unlikely event of a disruption of methanol supply.

Able to operate at **unrestricted power, equivalent efficiency, reduced emissions**, with 5% pilot fuel.

Fuel Booster Injection Valves with **integrated pressure booster allow for low pressure supply of methanol fuel**, through double wall pipes from the Liquid Fuel Supply System on main deck.
ME-LGI-M: Additional components compared to a standard engine

- FBIV-M
- Hyd pipe for FBIV-M
- Seal & purge pipe
- Control, LGI & purge block
- Sleeve
- Cyl cover
- Overview of main LGI Components on engine
- Supply & purge system
ME-LGI-M: 4 Fuel Valves per Cylinder
FBIV and conventional fuel injector slide valve
Fuel Booster Injection Valve (FBIV)

Sealing/
cooling /
hydraulic oil

Injection

Methanol

Booster
(injection pump)
Status

✓ Currently operating on Methanol.
✓ ~30,000 operating hours
✓ 3 fuel options (HFO, MGO, Methanol): flexibility in many price scenarios
✓ Cylinder chambers are much cleaner.
✓ Engineering crew transfer their knowledge from conventional engines.
✓ MAN provides LGI-M specific training to engineers
✓ Technical improvement and learnings continue
Thank you!

- For more information on methanol marine fuels & supply -

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