Methanol –
A Clean, Cost-Effective Marine Fuel Solution

MTCC Caribbean Regional Workshop
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Methanex Corporation
Agenda

- Methanex Corporation
- Methanol Marine Fuel
  - Attributes/Business Case
  - Commercial Developments
Methanex Corporation
Methanex

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

Headquartered in Vancouver, Canada, Methanex operates production sites in Canada, Chile, Egypt, New Zealand, the United States and Trinidad and Tobago. Our global operations are supported by an extensive global supply chain of terminals, storage facilities and the world’s largest dedicated fleet of methanol ocean tankers.
Waterfront Shipping

28 vessels, including 7 methanol dual-fuel vessels with 4 more on order

Medium Range Fleet
50,000 DWT
Methanol Dual Fuel
Engine Class

- Lindanger
- Taranaki Sun
- Mari Jone
- Leikanger
- Mari Boyle
- Manchac Sun
- Cajun Sun

Medium Range Fleet
45,000 - 50,000 DWT Class

- Cabo Negro II
- Caribbean Spirit
- Global Spirit
- Magellan Endeavour
- Patagonian Mystic
- Falkanger
- Finnanger

Handy Size Fleet
20,000 - 30,000 DWT Class

- Fjellanger
- Sabrewing
- Scarlet Ibis
- Tamiat Navigator
- World Navigator
- Taranger

Coastal Fleet
1,000 - 10,000 DWT Class

- Mariline
- Marinex
- Medalta Adventurer
- SCT Matterhorn
- Sakhara Lotus
- Marit

- Yelena
- Argo Chemist

Medalta Adventurer
SCT Matterhorn
Methanol Marine Fuel
Attributes/Business Case
Marine Fuel Emissions Regulations

Methanol & other clean burning marine fuels being phased in due to increasingly strict emissions regulations

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 for marine
Methanol is an innovative, economical alternative fuel solution with many benefits

Methanol marine fuel
- Low emissions
- Safe, environmentally friendly
- Wide availability
- Simple technology with low incremental cost
- Competitive fuel costs
- Fuel flexibility
- Successfully in use today & commercialization activity expanding

Diesel bunker fuel

Methanol
Emissions Reductions

Methanol is a clean-burning fuel that meets stringent emissions regulations

Tier III Compliant With Water Injection

Source: Stena Lines
Emission reductions when compared to heavy fuel oil
Methanol Reduces CO₂ emissions

- Methanol (typically produced from natural gas) is a lower carbon content fuel compared to HFO, resulting in ~13% CO₂ reduction (Energy Efficiency Design Index)
- Methanol production from renewables and/or utilizing excess CO₂ streams can reduce CO₂ significantly more
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 guidelines (IMO - IGF Code) for methanol as marine fuel being developed
Wide Availability
Methanol infrastructure already in place and well positioned to reliably supply the global marine industry

Methanol global terminal locations based on available information; not a complete list
Source: Methanex
Simple Technology

Methanol has minor modification requirements and modest incremental cost
Cost Competitive Fuel Cost vs. Marine Gas Oil (MGO)

- Methanol is an economically viable alternative marine fuel over the cycle
- Methanol technology offers fuel flexibility – operate on methanol or MGO

*Chart source: Platts and IHS Chemical

- Global 6% discount to MGO historically
- Discount expected to rise post 2020
- Economics vary by region

* Chart source: Platts and IHS Chemical
- Methanol: Average of North America / Europe / Asia published spot prices. Price adjusted to energy equivalent of MGO (2.16 factor)
- World MGO price based on Bunker Index all port benchmark
Low-Cost Infrastructure and Capital Costs

- Methanol: Competitive fuel costs, fuel flexibility & low incremental investment = potential for short payback

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

European Maritime Safety Agency Study – 2-3 year payback on methanol vessels – new or retrofit
Methanol Marine Fuel

Commercial Developments
Methanol in Use Today: Stena Germanica Ferry

The world’s first methanol-fueled 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
- Small efficiency improvements observed versus diesel
Methanol in Use Today: Waterfront Shipping Tankers

The world’s first methanol-fueled 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: ~54,000 operating hours. Modest efficiency improvement over MGO demonstrated
## Methanol Marine Fuel Projects

### Several Initiatives Supporting Commercialization of Methanol in Large & Small Engine Segments

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<td>China</td>
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<td>Fastwater</td>
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<td>Waterborne transport; four vessel types</td>
<td>Consortium of partners incl. Methanex &amp; Methanol Institute</td>
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Thank you!

www.methanex.com
linkedin.com/company/methanex-corporation
@Methanex
Summary
Methanol Marine Fuel Video
https://www.methanex.com/about-methanol/methanol-marine-fuel
ADDITIONAL SLIDES
Methanol significantly reduces NOx compared to diesel with current engine technology, but not quite to Tier III levels. Tier III NOx limits can be met with water + methanol (without need for EGR or SCR).

Emissions Reductions – Tier III NOx

1. EGR
2. SCR
3. Water + Methanol

- MAN has developed technology demonstrating Tier III NOx can be met with a mixture of methanol & water.
- Reduced additional capital and operational expenses related to SCR/EGR after treatment.

Source: MAN
Positive Reception on Methanol from Marine Industry

“We are very enthusiastic about methanol’s possibilities and it has the potential to be the maritime fuel of the future”

Carl-Johan Hagman
CEO
Stena Line

“We have found the technology for handling methanol is well developed and offers a safe dual-fuel solution for low-flashpoint liquid fuels”

Patrik Mossberg
Chairman
Marinvest/Skagerack Invest

“We investing in technology that encourages the use of a fuel like methanol that significantly reduces emissions is a step forward for both our company and the shipping industry”

Akio Mitsuta
Senior Managing Executive Officer
Mitsui O.S.K. Ltd

“We have found methanol to be one of the best alternative fuels due to its wide availability, the use of existing infrastructure, and the simplicity of the engine design and ship technology”

Rolf Westfal-Larsen Jr.
CEO
Westfal-Larsen Management
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 Marinvest, Westfal-Larsen and MOL on long term time charter with Waterfront Shipping owned by Methanex.
From Idea to Reality
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.
Safety features

✓ **Fail Safe System** – Immediate, 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
✓ **Fire fighting on deck & in engine room**
Recognitions and Milestones

Accolades from the marine industry for use of clean-burning methanol
Status

✓ 40% of fleet operating on Methanol by mid 2019
✓ ~54,000 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