METHANOL AS A MARINE FUEL

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LNGgc ASIA

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NOVATEL, CLARKE QUAY, SINGAPORE
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DEVELOPING TRENDS FOR NEW CAPACITY
SUPPLY CAPACITY BY REGION

- Merchant projects are focused in USGC
- China future capacity additions may slow, with a focus on integrated facilities

Supply Capacity for Methanol by Region
2012–2022E

Source: MMSA
CHINA METHANOL DEMAND DRIVES WORLD MARKETS

Projected Methanol Demand Growth, by Product & Region
2017–2027E

Source: MMSA
WHERE IS METHANOL PRODUCED?

RENEWABLE PATHWAYS

Source: The Methanol Institute and Qafaq
AN EFFICIENT ENERGY CARRIER

LIQUID STORAGE MEDIUM FOR ELECTRICITY & HYDROGEN

CO₂ Capture → CO₂ → Synthesis → H₂ Generation

Reformer

Recycled through the atmosphere

Methanol for storing and distributing electricity and hydrogen.

H₂

Applications for pure CO₂

Emissions

Other Applications

Methanol CH₃OH has, on a volume basis, 40% more H₂ than liquid hydrogen at -253°C, and 140% more H₂ than compressed hydrogen at 700 bars.
## VARIOUS STAGES OF DEVELOPMENT

<table>
<thead>
<tr>
<th>Methanol category</th>
<th>Commercial</th>
<th>Feasibility and R&amp;D</th>
<th>Stopped or On-hold</th>
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GLOBAL METHANOL FUEL BLENDING
PRACTICAL LIQUID FUEL

- Dominant global transportation fuels, high energy density
- A Practical alternative
- Low energy density, high on board storage costs

Net gravimetric energy density / [MJ/kg]

- Batteries
- 700 bar H2
- 200 bar Methane
- L H2
- Methanol
- Ethanol
- E85
- M85
- Gasoline
- Diesel
Global Transportation Fuel Progress

Israel
- Cooperation with Italy Fiat to promote M15 Fiat 500 Car (Euro 6)
- Testing M70-85 in Flex fuel vehicles
- 2016 First M15 National Standard Released

Italy
- ENI and FCA cooperation to promote A20 fuel (M15+E5)
- Fiat 500 cars for car sharing service in 2018
- Compliance with Euro 6 standard and 3% tailpipe emission reduction

Denmark
- Methanol Fuel Cell for EV range extension
- Europe’s first methanol filling station in Aalborg, Denmark (Aug. 2015)
India: Roadmap to Methanol Economy

- September 2015, NITI Aayog formed the Methanol Economy Expert Group
- 2018 Methanol M15 Guidelines published
- 2018 IRClass published Guidelines for Methanol Fueled Vessels
- Launching Projects:
  - M15 fuel blending
  - methanol/DME buses and trucks
  - railway engines
  - inland waterways
  - cook stoves
  - industrial boilers

Union & Road Transport Minister Nitin Gadkari
METHANOL BOILERS

• Widely used for heating and industrial steam, new-builds and replacing coal and HFO-fired units

• Capacity range from: 1 - 20 steam tons/hour

• Standards developed together with MI and Methanex support

• Blends starting as low as 60% (M60)

• More than 1,000 registered units consuming over 2M mtpa of methanol

Source: Methanol New Energy Applications in China: Boilers and Cook Stoves
**METHANOL COOKSTOVES**

- Various applications:
  - Single burner heating
  - Stir frying
  - Steaming

- Widely used in restaurants and central kitchens:
  - Adoption mainly cost driven

- Simplified logistics, filling the deficit of NG pipeline/distribution capacity

- Fuel:
  - 100% methanol (M100)
  - 80% and higher blends (balance of fuel mix emulsified with water)

- **Consuming over 3M mtpa of methanol**
SMART SUPPLIERS – LAST MILE
METHANOL AS MARINE FUEL
Methanol can be a practical solution for dual fuel applications, to include other alternative fuels such as LPG and LNG.

- Multi – fuel engines will be the norm going forward.
- Methanol can be readily and safely applied in both new build and conversion.
Methanol (MeOH) achieves low emissions & acts as a bridge in lowering CO$_2$ in the future (renewable/bio methanol)
Approximately 25-40% water is added to the methanol to achieve a new, Tier III solution. NOx decreases almost linearly with water content, to approximately 2 g/kWh at 50% and 75% load. Similar system is being planned for fuel oil, so the Tier III compliant technology will be available as a dual fuel solution. R&D testing completed - service test is under preparation.

Source: MAN
METHANOL IS ECONOMICALLY VIABLE

- MGO NA GC: Avg New orleans, Houston; MGO NA WC: Avg LA, San Francisco, Seattle, Vancouver; MGO Europe: Avg Rotterdam, Antwerp, Hamburg; MGO Asia: Avg Shanghai, Korea; MGO Middles East: Avg Fujairah, Kuwait, Khor Faakan

- Methanol: Avg USGC, China and Europe spot prices; adjusted to energy equivalent of MGO (2.16 factor)

Source: Platts and IHS Chemical
Pricing

Source: BunkerIndex
**Fuel Evaluator**


**Fuel Choice Calculator**

- **Vessel Type**: Bulk Carrier
- **Capacity**: 176506 DWT
- **Design Speed**: 11.7 Kts
- **Average loaded DWT**: 141204.8 tonnes
- **Annual Distance Travelled**: 56712 Nm
- **Methane Slip**: 3%
- **Time spent inside ECA**: 50%
- **Asset expected life**: 25 years
- **Annual fuel consumption conventional fuel**: 5756.213 mt/y

**Calculations**

- **All**
- **Fuel consumption & Costs**
- **NPV & Total Cost**
GLOBAL PORT TERMINAL AVAILABILITY (‘000 MT)

Source: IHS 2018
EXPERIENCE

DUAL FUEL
- 7x +4 chemical tankers
  - MOL, WL, Marinvest
  - 2 stroke MAN
- 1x ROPAX ferry
  - Stena Line
  - 4 stroke Wärtsila
- 1x Pilot boat
  - Swedish Maritime Admin
  - high speed Scania, Weichai, a.o.

FUEL CELL
- 1x Tourist boat
  - Innogy
  - Serenergy fuel cells propulsion
- 1x Ferry
  - Viking Line
  - hotel load

PROJECT and R&D
- Cruise ships, fishing boat, barge, dredge, a.o.
  - SUMMETH/MARTEC, Lean Ships, Methaship, Billion Miles, FiTech, India, PCG Product Vessel, NTU Test Bed
  - Green Maritime Methanol, FastWater SI hybrid, dual fuel, etc.
  - new build & retrofit
SAFER FOR THE ENVIRONMENT

LC50, LC = LETHAL CONCENTRATION
Concentration in water, at which half the marine population died within the specified test duration

Safer than Diesel by a factor of 240 times

Methanol\(^{[1]}\)
15,400 (mg/l)

Methane\(^{[5]}\)
49,9 (mg/l)

Heavy Fuel Oil\(^{[3]}\)
79 (mg/l)

Diesel\(^{[4]}\)
65 (mg/l)

Gasoline\(^{[2]}\)
8,2 (mg/l)

\(^{[1]}\) ECHA, European Chemicals Agency, registration dossier Methanol
\(^{[2]}\) Petrobras/Statoil ASA, Safety Data Sheet, ECHA registration dossier Gasoline
\(^{[3]}\) GKG/ A/S Dansk Shell, Safety Data Sheet
\(^{[4]}\) ECHA, European Chemicals Agency, registration dossier Diesel
\(^{[5]}\) ECHA, European Chemicals Agency, registration dossier Methane

Additional Source: Meyer-Werft
The draft interim guidelines contain a definition of such fuels as follows: “Fuel means methyl/ethyl alcohol fuels, containing allowable additives or impurities, suitable for the safe operation on board ships, complying with an international standard.”

Earlier 2018, MSC 99 mandated ISO to develop a fuel standard for methyl/ethyl alcohol fuels, which is ongoing.

After expected Approval by MSC 102 in May/June, 2020, Interim Guidelines may begin to be Adopted at the flag state level with the understanding that additional amendments will be added.
SUMMARY

• Cost effective and “future proof” fuel which can be produced from a variety of feedstocks – to include renewables

• One of the top 5 seaborne chemical commodities – safely handled for over 50 years

• Capital costs for converting to methanol are minimal – economically viable without subsidies

• Widely available and alleviates many infrastructure limitations both on land and at sea
THANK YOU