METHANOL: A FUEL WITH A FUTURE

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Methanol as a Marine Fuel Seminar
2018
Dubai
Contents

- About MI
- International Regulatory Framework
- (Renewable) Methanol’s Production
- Methanol’s History as a Fuel
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History

- The Methanol Institute (MI) was established in 1989
- 29 years later, MI recognized as the trade association for the global methanol industry
- Facilitating methanol’s expansion from our Singapore headquarters and regional offices in Washington DC, Brussels, and Beijing
MI STRATEGIC PARTNERS

- China Nitrogen Fertilizer Industry Association
- Asian Clean Fuels Association
- Chinese Association of Alcohol & Clean Ether Fuels & Automobiles (CAAEFA)
- Gulf Petrochemicals and Chemicals Association (GPCA)
- International DME Association (IDA)
- International Methanol Producers & Consumers Association (IMPCA)
- Peking University Center for New Global Energy Strategy Studies
- Lloyd's Register
- International Bunker Industry Association
- Dangerous Goods Advisory Council
- China Classification Society
02

International Regulatory Framework
Sulphur Cap

International Convention for the Prevention of Pollution from Ships (MARPOL)

Annex VI Prevention of Air Pollution from Ships entered into force

ECAs first introduced with sulphur content limit of 1 %

Global sulphur limit of 0.5%, effective January 2020

Sulphur content lowered to 0.1% in ECAS

Global Sulphur Cap (outside ECAs)

- 2005: 4.50%
- 2012: 3.50%
- 2020: 0.50%

1973

- 2005
- 2010
- 2015
- 2016
- >2020

- 2020
IMO Initial Strategy on the Reduction of GHG Emissions adopted at MEPC 72 (April 2018)

Level of ambition of Initial Strategy.

Carbon intensity of ships to decline through implementation of further phases of energy efficiency design index (EEDI) for new ships.

Reduce CO₂ emissions per transport work, as an average across international shipping by at least 40% by 2030, and 70% by 2050, compared to 2008.

Peak GHG emissions from international shipping ASAP, and reduce total annual GHG emissions by at least 50% by 2050 compared to 2008.
Road to 2050

MEPC 72 (April 2018)
- Initial Strategy adopted

MEPC 73 (October 2018)
- Approved the programme of follow-up actions up to 2023
  - 4th IMO GHG Study
  - 5th Inter-sessional working group
- To consider proposals on candidate short-term measures

MEPC 74 (May 2019)
- Consider candidate short-term measures; possible adoption and implementation?
- Procedure for assessing the impacts of candidate measures on States
- Candidate mid/long-term measures
IMO CONFIRMATION OF ETHYL/METHYL ALCOHOLS

CCC 1
• Establish CG to develop measures for:
  o Ethyl/methyl alcohol
  o Fuel cells
  o Low-flashpoint diesel

CCC 2
• Consider establishing WG to develop measures for:
  o Ethyl/methyl alcohol
  o Fuel cells
  o Low-flashpoint diesel
  • Consider re-establishing CG
  • Consider the need for other sub-committees to examine drafts or parts of them and, if so, make the necessary request to the relevant sub-committee(s)

CCC 3
• Consider establishing WG to finalize measures for:
  o Ethyl/methyl alcohol
  o Fuel cells
  o Low-flashpoint diesel

CCC 4
• Approval
• Consider establishing WG to finalize measures for:
  o Ethyl/methyl alcohol
  o Fuel cells
  o Low-flashpoint diesel
  • Not Approved

MSC 97
• Approval
• Not Approved

MSC 98
• Adoption, if required
• Not Adopted

CCC 5
• Approval
• Consider establishing WG to finalize measures for:
  o Ethyl/methyl alcohol
  o Fuel cells
  o Low-flashpoint diesel

MSC 99
• Approval
• Adoption, if required

MSC 100
• Endorse as urgent matter; refer safety topics to other sub-committees for input.

CCC 6
• Amendment for final approval

After Approval, IGF Codes may be implemented at flag state level with the understanding that additional amendments may be added, requiring compliance, before IGF Codes come into Force.
03

(Renewable) Methanol Production
**Broad Feedstock Range, Many Applications**

- **feedstock**
  - natural gas (~65%)
  - coal (~35%)
  - biomass & renewables (<1%)

- **methanol synthesis**

- **conversion**

- **derivatives**
  - other
  - solvents
  - chloromethanes
  - MTO
  - methylenamines
  - DME
  - biodiesel
  - gasoline blending
  - MTMA
  - MTBE
  - acetic acid
  - formaldehyde

- **products**

- **markets**
  - appliances
  - automotive
  - construction
  - electronics
  - fuel
  - paint
  - pharma
  - and more….

WWW.METHANOL.ORG
Renewable Methanol

CRI, Iceland

Renewable electricity
Electrolysis
Carbon capture

H₂

Syngas

Reactors & distillation

Renewable methanol

Courtesy QAFAQ

WWW.METHANOL.ORG
Renewable Methanol from Gasification

Sustainable biomass (residues, MSW, etc)

Gasification

Syngas

Bio-methanol

Reactor & distillation

Enerkem, Canada

 Courtesy QAFAQ

WWW.METHANOL.ORG
Renewable Methanol from Biorefining

Sustainable biomass (residues, MSW, etc)

Fermentation

Biogas

Biomethane

Reformer

Syngas

Reactor & distillation

Bio-methanol

BioMCN, The Netherlands

BioMCN

Courtesy QAFAQ
04 Methanol’s History as a Fuel
Methanol is a Versatile Fuel Source

- Out of the ~75 million metric tons of methanol sold globally in 2017, energy and fuel uses represent 40% of total demand.
- From 2009-2016, direct methanol fuel blending increased at an annual rate of nearly 23%.

**FUELS**
- Neat fuel
- Low blends
- High blends
- GEM
- MTBE
- Biodiesel
- DME & OME
- MTG

**TECHNOLOGIES**
- SI & CI engines
- Turbines
- Fuel cells

**SEGMENTS**
- Road & non-road transportation
- Power & heat generation
- Marine
Global Methanol Fuel Examples

- Canada – Waterfront vessels
- USA – motorsport fuel
- UK – EN228 low blend
- Iceland – M100 trials
- Denmark – fuel cells for vehicles
- Sweden – marine fuel
- China – M15 to M100, boilers, cook stoves
- Italy – Eni/FCA M15/E5
- Egypt – M15 trials
- New Zealand – M3
- Africa – cook stoves
- India – Methanol Economy roadmap
- Australia – GEM fuel
- UK – EN228 low blend
- USA – motorsport fuel
- Israel – M15, power generation
- Africa – cook stoves
- India – Methanol Economy roadmap
- Australia – GEM fuel
Global Transport 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

- Methanol production from coal and biomass, and utilize methanol and DME as transportation fuels

- September 2016, MI jointly organized a Methanol Economy International Seminar held in Delhi

- 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 t/h
- Standards with developed together with MI and Methanex support
- Blends starting as low as 60% (M60)
- Estimated more than 1,000 units currently, consuming over 2M mtpa of methanol

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

- **Different types of methanol cook stoves:**
  - Single burner heating
  - Stir frying
  - Steaming
- Widely used in restaurants, central kitchens: *mainly cost driven*
- Simple storage and transportation, filling the deficit of NG pipeline capacity
- Fuel:
  - 100% methanol (M100)
  - 80% and higher blends (emulsified with water)

- **Consuming over 3M mtpa of methanol**
05

*Methanol as a Marine Fuel*
Methanol achieves low emissions & acts as the bridge fuel of the future with the possibility of being produced renewably (offering an attractive life cycle analysis).
Approx. 25-40% water added to the methanol and then we have a new tier III solution with very low penalty in fuel consumption.

Similar is being planned for fuel oil, so the tier III solution will be available for dual fuel.

R&D test completed - service test is under preparation.

Source: MAN
Methasip

• Nationally-funded German research project
• Partners from shipbuilding, ship-safety, OEM manufacturers, methanol trading & production
• Study the use of methanol as a fuel for cruise ships and RoPax ferries
• Study concluded with the following findings:
  • Properties of methanol surpass other alternative fuels in shipping;
  • A major benefit includes storage at ambient temperature and pressure without loss;
  • Methanol offers compelling environmental properties and has the most promising lifecycle analysis when produced from renewable sources; and
  • Widespread availability.
Marine Experience

- **March 2015**: Stena Germanica – Wärtsilä methanol-fueled marine engine
- **Apr 2016**: Methanex’s Waterfront Shipping – dual-fuel MAN methanol/diesel engines
- **Lloyd’s Register MethaShip project**
- **LeanShips dual-fuel demo**
- **Oct 2015**: Billion Miles Singapore develops small-marine applications
- **Jun 2016**: ScandiNAOS Green Pilot Boat conversion
THE GERMANICA MODIFICATIONS

- Bunkering system + New bunkering facility on quay
- SOLAS alternative design with risk analyses by Lloyds
- Inert Gas System with two generators and nitrogen tank
- Upgrading of fire alarm system
- New high pressure common rail system
- Safety and fire education for safety crew

- Upgraded engine control system and eight dual diesel/methanol injectors per engine (Wärtsilä development)
- Flame and gas detectors in engine room
- Separate ventilation system in pump room with airlock. New sensors for leakage
- New double walled piping between pump room and engine (60 m)
- Ballast tank in double bottom converted to 500 cbm zink coated methanol fuel tank with IGS

Source: Stena
GERMANICA – BEFORE & AFTER (COMMON RAIL)

Source: Stena
BUNKERING THE GERMANICA

- Self-contained eye/body wash station
- Gas leak detection
- Flame detection
- Foam fire extinguishing system
- Coffer dam
- Secure, no-drip connections

Sources: Haan Paa, Stena
BUNKERING THE GERMANICA – COFFER DAMS

Sources: Haan Paa, Stena
BUNKERING THE GERMANICA – FIRE FIGHTING

Sources: Haan Paa, Stena
BUNKERING THE GERMANICA – FIRE FIGHTING

Sources: Haan Paa, Stena
BUNKERING THE GERMANICA – NO SPILL / BREAKERS

Sources: Haan Paa, Stena
BUNKERING THE GERMANICA – PUMP ROOM

Sources: Haan Paa, Stena
BUNKERING THE GERMANICA – SHIP SIDE

Sources: Haan Paa, Stena
**MAN’s Experience with Dual-Fuel Engines**

**Service status:**
- 4 vessels from HHI in service
- 3 vessels from MES in service
- Currently more than 38,000 service hours are obtained
- First start up of MeOH operation was carried out by the crew alone

**Challenges:**
- Broken springs in fuel diesel fuel valves
- Broken cut-off shafts in Fuel Booster Injector Valves
- Micro cracks observed in FBIV atomizers
- Damage of sealing rings in FBIV suction valves
- Unstable hydrocarbon sensors
- Several software bugs

**MAN Energy Solutions**
**MAN’s Experience with Dual-Fuel Engines**

**Benefits:**
- Diesel cycle high fuel efficiency - 50%; much higher for other engine types
- High fuel flexibility
- No derating because of knocking danger
- Negligible fuel slip; no formaldehyde in the exhaust gas
- Robust Gas combustion - unchanged load responses; unaffected by ambient conditions

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**MAN Energy Solutions**
Global Port Terminal Availability

Source: IHS 2017
## Takeaways:
- Not more toxic than gasoline or diesel
- Methanol poisoning is treated simply and is not carcinogenic
- No GHG potential (methane)
- Miscible in water – a large concentration spill will rapidly decrease with only short term effects
- Far less hazardous to the environment

### Economic Impact - HFO vs Methanol:

<table>
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<th>Maritime accident</th>
<th>Maritime accident</th>
<th>Simulation</th>
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<tbody>
<tr>
<td>Ship</td>
<td>Erika</td>
<td>Tania</td>
<td>-</td>
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<tr>
<td>Fuel</td>
<td>Heavy Fuel Oil</td>
<td>Heavy Fuel Oil</td>
<td>Methanol</td>
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<tr>
<td>Released amount</td>
<td>19 000 t</td>
<td>13 500 t</td>
<td>10 000 t</td>
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<td>Total damage</td>
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<tr>
<td>Cleaning</td>
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<td>Fishing industry</td>
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<td>Claim for damages</td>
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<td>$17M</td>
<td>-</td>
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<tr>
<td>Killed birds</td>
<td>60,000</td>
<td>40,000</td>
<td>-&gt; 0</td>
</tr>
</tbody>
</table>

Sources: Economic, Social & Environmental Effects of the “Prestige” Oil Spill, Meyer-Werft
Safer for the Environment

(LC50, LC=Lethal Concentration):
Concentration in water, at which half the population died within a specified test duration.

Methanol\(^1\)
15400 (mg/l)

Methane\(^5\)
49.5 (mg/l)

Heavy Fuel Oil\(^3\)
79 (mg/l)

Diesel\(^4\)
65 (mg/l)

Gasoline\(^2\)
8.2 (mg/l)

**Methanol** better than
- **Diesel** by factor 240
- **Gasoline** by factor 1900

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

Additional Source: Meyer-Werft
SUMMARY

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

- Methanol is one of the top 5 seaborne chemical commodities and has been safely handled for over 50 years

- Capital costs for ship conversions are less than LNG and after treatment technologies

- New Build dual fuel tankers are only marginally more expensive than conventionally-fueled vessels

- Widely available and alleviates many infrastructure limitations on land and at sea
Contacts
THANK YOU