The Potential Development of Energy Applications for Methanol

Gregory Dolan, CEO – Methanol Institute
IHS World Methanol Conference – Vienna, Austria
6 October 2018
US-China Tariffs

Methanol Institute Opposes Tariffs

- 23 August – MI Testified before U.S. Trade Representative
- Urged USTR to remove methanol from list of 6,000 products of Chinese goods for 25% tariff
- No methanol trade flow from China to U.S.
- U.S. becoming net methanol exporter and China the world’s largest market for methanol
- Tariffs threaten expansion of U.S. methanol production
- Reciprocal 10% tariffs on methanol now in effect, with US going to 25% tariff on Chinese methanol in January
- Hopeful U.S. and China can resolve differences
01 WHO WE ARE
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.
METHANOL PRODUCTION AND DEMAND
Broad feedstock range, many applications

Feedstock:
- Natural gas: ~65%
- Coal: ~35%
- Biomass & renewables: <1%

Conversion to methanol synthesis:

Derivatives:
- Formaldehyde: 27%
- Acetic acid: 9%
- MTBE: 8%
- MTMA: 2%
- Gasoline blending: 9%
- DME: 8%
- MTO: 18%
- Methanolamines: 3%
- Chloromethanes: 2%
- Other: 7%
- Solvents: 4%

Products:
- Fuel: 9%
- Biodiesel: 3%
- DME: 8%
- Methylamines: 3%
- Chloromethanes: 2%
- MTO: 18%
- Solvents: 4%
- Other: 7%

Markets:
- Appliances
- Automotive
- Construction
- Electronics
- Fuel
- Paint
- Pharma
- And more...

Source: IHS
Modern approach to biorefining

Sustainable biomass (residues, MSW, etc)

Fermentation

Biogas

Biomethane

Reformer

Syngas

Reactor & distillation

Bio-methanol

BioMCN, The Netherlands
Or gasification to syngas

Sustainable biomass (residues, MSW, etc)

Gasification

Syngas

Bio-methanol

Reactors & distillation

Enerkem, Canada

Courtesy QAFAQ
And from pulp mill processes

Sustainable biomass (residues, MSW, etc)

Kraft process

Reactor & distillation

Bio-methanol

Södra, Sweden

Courtesy QAFAQ

SÖDRA
E-methanol provides a whole different route

- Renewable electricity
- Electrolysis
- Carbon capture
- Carbon
- Syngas
- Reactor & distillation
- Renewable methanol

Courtesy QAFAQ

CRI, Iceland
## At different 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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<tr>
<td><strong>Bio-methanol</strong></td>
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<td>• BioMCN (glycerine) (NL)</td>
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<td>• Range Fuels (USA)</td>
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<td>• Heveskes Energy (NL)</td>
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<td>• Neo-H2 (USA)</td>
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<td><strong>Hybrid methanol</strong></td>
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<td>• Haldor Topsoe (DEN)</td>
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<td><strong>Low carbon methanol</strong></td>
<td>• GPIC (BAH)</td>
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<td>• Methanex (CAN)</td>
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<td>• Maverick Synfuels (USA)</td>
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Methanol is a versatile fuel source

Out of the ~75 million metric tons of methanol sold globally in 2017, energy and fuel uses represent 55% of total demand

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

**Global Methanol Fuel Examples**
03 ROAD TRANSPORT
Solutions for gasoline and diesel engines

- Low blends
- Mid level blends
- High blends
- FAME
- MD95
- DME
China methanol consumption in fuel products
thousand barrels per day

https://www.eia.gov/todayinenergy/detail.php?id=30072
Geely M100 Vehicles

• China’s Geely Automotive Holdings is global leader in the commercialization of M100 vehicles

• Geely has two methanol engine and five methanol vehicle manufacturing bases, with an annual methanol vehicle production capacity of 300,000 - 500,000 cars

• Now introduced M100 bus, long-haul truck and medium-duty truck
UK BioMethanol Blending

- UK Department of Transport: Renewable Transport Fuel Obligation Report – 1 February 2018
- Biomethanol 57 Million liters, or 4% of UK total renewable fuel use
- “The supply of biomethanol has been increasing in recent years to an all-time high in 2016/2017”

Green Methanol Infrastructure consortium opened the first methanol fuel pump in Europe.

Cars/vans use Serenergy RMFC technology as range extender and CRI methanol as fuel.

Increasing range of battery powered vehicles from 200 to 800 kilometers.

Serenergy fuel cells also in Gumpert RG Nathalie, a methanol fuel cell powered electric supercar with a 1,200 km (745 mile) range and a top speed of 300 km/h (186 mph).
Israel Methanol Fuels Demonstrations

- Prime Minister Netanyahu established Fuel Choices Initiative
- Driven 1,000,000 kms on M15 fuels with improved power and torque
- In 2016, Israel adopted national standard for M15 fuels
- Fiat marketing M15 car in Israel, and Dor Chemicals has introduced M15 retails pumps
Italy M15/E5 Blending

- 21 November 2017: With Italian Prime Minister, the CEOs of Eni and Fiat Chrysler Automobile sign MOU for joint development of technology reducing CO2 of road transport vehicles

- Eni had developed a 15% methanol and 5% bioethanol fuel blend

- New blend being demonstrated in 5 FCA Fiat 500 vehicles in Eni’s Enjoy car-sharing fleet

India: Roadmap to Methanol Economy

- September 2015, NITI Aayog formed Methanol Economy Expert Group
- September 2016, MI jointly organized Methanol Economy International Seminar held in Delhi
- Working towards standard for M15, M100 and MD95 fuel blending, demonstrations for cook stoves, marine fuels, railways, methanol production
04 MARINE FUELS
The International Maritime Organization has adopted emission regulations transforming the shipping industry.

In 2020, global SOx reductions take effect.

By 2050, greenhouse gas emissions must be cut in half.
Options available to ship owners

HFO + scrubbers
MGO or HFO/MGO Hybrid
LNG
Methanol

https://www.methanol.org/marine-fuel/
Examples of vessels running on methanol

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

**FUEL CELL**
- 2x
  - Tourist boat
  - Innogy HTWG Konstanz
  - Serenergy fuel cell stacks
- 1x
  - Ferry
  - Viking Line

**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
- Port of Rotterdam Barge
- SI hybrid, dual fuel, etc.
- new build & retrofit
MAN Duel-Fuel Engine – Waterfont Configuration

https://marine.man-es.com/two-stroke/2-stroke-engines/me-lgim
Available in many ports around the world

Methanol storage capacity estimates (thousand tons)

Source: IHS Markit
Methanol is widely available and easy to handle

- Liquid at atmospheric pressure
- Available in many ports around the world and along rivers
- Low infrastructure cost
- Flexible, modular system
- Environmentally friendly as it’s biodegradable
SAFER FOR THE ENVIRONMENT

**LC50, LC = LETHAL CONCENTRATION**

*Concentration in water, at which half the population died within specified test duration*

- **Safer than Diesel by a factor of 240 times**
  - Methane: 49.9 mg/l
  - Heavy Fuel Oil: 79 mg/l
  - Diesel: 65 mg/l
  - Gasoline: 8.2 mg/l

- **Safer than Gasoline by a factor of 1900 times**
  - Methanol: 15,400 mg/l

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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*
After Approval by MSC in December, 2018, Interim Guidelines may be implemented at flag state level with the understanding that additional amendments may be added, requiring compliance, before IGF Codes come into Force in 2024.
Methanol Industrial Boilers in China

- Industrial boilers are widely used for heating and industrial stream
- Many cities in China prohibiting use of coal and diesel fuels
- Capacity ranged from 1 to 20 t/h
- Methanol fuel is used neat or as blend with diesel fuel
- Standards developed with MI and Methanex support
- Estimated more than 1000 units, consuming over 2 MMTs methanol in 2016

https://www.methanol.org/energy/boiler-cookstoves/
Methanol Cook Stoves in China

- **Different types methanol cook stoves:** Single heating, stir fry, steaming
- Widely used in restaurants, central kitchens, mainly cost driven
- Simple Storage and transportation, filling the gap of pipeline NG supply
- Fuel: 100% methanol to methanol blends with usually with water
- **Market for Cooking Application estimated over 3 MMTs in China in 2016**
China also developing other new markets for the use of methanol:

- **Glass/ceramic kilns** – China produced 60% of world’s glass products; methanol uses less air intake and produces cleaner flue gas for superior finish
- **Tobacco drying** – One in every 3 cigarettes smoked in the world are smoked in China
Methanol a Hydrogen Carrier for Fuel Cells

- Horizon Energy Systems (Singapore)
- Oneberry (Singapore)
- Altergy (USA)
- Palcan (China)
- Serenegy (Denmark)
- SFC Energy (Germany)
- Toshiba (Japan)
- Ultracell (USA)
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