Methanol: An Emerging Alternative Marine Fuel

Gregory Dolan, CEO – Methanol Institute
IMPCA European Mini-Conference – Como, Italy
15 June 2018
MI History

The Methanol Institute (MI) was established in 1989 to lobby the US Congress.

29 years later, MI is recognized as the trade association for the methanol industry, representing world’s leading methanol producers, distributors and technology companies.
<table>
<thead>
<tr>
<th>Company Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Methanex</td>
</tr>
<tr>
<td>Mitsubishi Gas Chemical America, Inc</td>
</tr>
<tr>
<td>MITSUI &amp; CO.</td>
</tr>
<tr>
<td>OCI</td>
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<tr>
<td>Oasis Methanol Company, LLC</td>
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<tr>
<td>PETRONAS</td>
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<td>QAFAC</td>
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<td>BP</td>
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<td>G2X Energy</td>
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<td>JM</td>
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<tr>
<td>Sipchem</td>
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<td>Ecofuel</td>
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<tr>
<td>Mitsubishi International Corporation</td>
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<td>META FRAX</td>
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<td>Mitsubishi O.S.K. Lines</td>
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<td>Southern Chemical Corporation</td>
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<td>Vitusa Products</td>
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<tr>
<td>NLJ Innovation Works</td>
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<td>Azelis</td>
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<tr>
<td>Nakhodka Fertilizer Plant</td>
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<tr>
<td>Tricon</td>
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<td>Enerkem</td>
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<td>Haldor Topsoe</td>
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<td>Coogee Energy</td>
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<tr>
<td>Clariant</td>
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<tr>
<td>Solvadis</td>
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<tr>
<td>Fuel Freedom Foundation</td>
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</tbody>
</table>
Strategic Partnerships

- American Chemistry Council
- Asian Clean Fuels Association
- China Ministry of Industry & Information Technology
- China Nitrogen Fertilizer Industry Association
- Chinese Association of Alcohol & Clean Ether Fuels & Automobiles
- Dangerous Goods Advisory Council
- European Chemical Industry Council (CEFIC)
- European Sustainable Shipping Forum (ESSF)
- Formacare
- Gasification & Syngas Technologies Council
- German Regenerative Methanol Network
- Gulf Petrochemicals and Chemicals Association
- International Bunker Industry Association
- International DME Association
- International Methanol Producers & Consumers Association
- Lloyd’s Register
- National Biodiesel Board
- National Institution for Transforming India (NITI Aayog)
- Oslo University Hospital
- Peking University Centre for Global New Energy Strategic Studies
- Solar Fuels Institute
Marine Fuel Drivers

✓ **Scale**: Marine sector consumes 370 million metric tonnes of bunker fuel per year.

✓ **Sustainability**: There needs to be a viable pathway to low- & no-carbon marine fuels.

✓ **Price**: Need to be price competitive with current bunker fuels and other alternatives such as LNG.

✓ **Supply**: Fuel needs to be available globally.

✓ **Safety**: Ship operators need to be assured of safe handling on-board vessel and for bunkering.
Broad feedstock range, many applications

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

- **Conversion**

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

- **Products**

- **Markets**
  - Appliances
  - Automotive
  - Construction
  - Electronics
  - Fuel
  - Paint
  - Pharma
  - And more...
Many different bio-methanol pathways

- Biomass: MSW, wood residues, etc.
- Biogas
- Renewable electricity
- Electrolyzer
- CO₂ capture
- Methanol production

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# Renewable methanol projects

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>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Bio-methanol</strong></td>
<td>• BioMCN (NL)</td>
<td>• Biogo (GER)</td>
<td>• BioMCN (glycerine) (NL)</td>
</tr>
<tr>
<td></td>
<td>• Enerkem (CAN)</td>
<td>• Enerkem (NL)</td>
<td>• Chemrec (SE)</td>
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<tr>
<td></td>
<td>• New Fuel (DEN)</td>
<td>• LowLands Methanol (NL)</td>
<td>• Range Fuels (USA)</td>
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<tr>
<td></td>
<td>• Oberon (USA)</td>
<td>• Södra (SE)</td>
<td>• Schwarze Pumpe (GER)</td>
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<tr>
<td><strong>Renewable methanol</strong></td>
<td>• CRI (IC)</td>
<td>• Blue Fuel Energy (CAN)</td>
<td>• Värmlands Metanol (SE)</td>
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<tr>
<td></td>
<td>• Innogy (GER)</td>
<td>• CRI (CN)</td>
<td>• Woodspirit (NL)</td>
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<td></td>
<td></td>
<td>• Infraserv (GER)</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>• Liquid Wind (SE)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Port of Antwerp (BE)</td>
<td></td>
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<td></td>
<td></td>
<td>• STEAG (GER)</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>• Swiss Liquid Future (CH)</td>
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<tr>
<td></td>
<td></td>
<td>• ZAST (GER)</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></td>
<td></td>
<td>• OPTIMEoH (GER)</td>
<td></td>
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<tr>
<td><strong>Low carbon methanol</strong></td>
<td>• GPIC (BAH)</td>
<td>• Carbon2Chem (GER)</td>
<td></td>
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<td></td>
<td>• Methanex (CAN)</td>
<td>• FRESME (SE)</td>
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<td></td>
<td>• QAFAC (QAT)</td>
<td>• NCF (CN)</td>
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<td></td>
<td>• SABIC (KSA)</td>
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</table>
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 has 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
- Industrial boilers
- Cook Stoves

**SEGMENTS**
- Road & non-road transportation
- Power & heat generation
- Marine
Methanol Fuel Examples Around the World

Canada – Waterfront Shipping Vessels
USA – methanol motorsport fuel
Iceland – M100 Trials
UK – EN228 low blend
Israel – Power generation & M15 Standard
Africa – cooking stoves
Sweden – methanol marine fuel
Denmark – methanol fuel cells for vehicles
Eni/FCA M15/E5
Egypt – M15 Trials
India – Methanol Economy Roadmap
Australia – GEM fuel
China – M15 to M100, Industrial Boilers
New Zealand – Introducing M3

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MI Focus: Methanol as a Marine Fuel

- Participate in formation of international regulations and safe handling guidelines for methanol as alternative fuel
- Work with engine OEMs on new build and conversion offerings across multiple scales
- Encourage and support pilot demonstrations of methanol marine fuels in multiple markets, to validate environmental, technical and economic merits
- Direct marketing campaign
The International Maritime Organization has adopted regulations for SOx and NOx that are transforming the shipping industry.

While 2020 global SOx reductions may be met with low sulfur fuels, the combination of SOx and NOx reductions driving shipboard solutions.

Recent IMO action on greenhouse gas emission reductions further narrow future options for shipping – at least 50% GHG reduction by 2050.
Options available to ship owners

- HFO + scrubbers
- MGO or HFO/MGO Hybrid
- LNG
- Methanol
Examples of vessels running on methanol

**DUAL FUEL**
- **7x**
  - chemical tankers
- **1x**
  - ROPAX ferry
- **1x**
  - Pilot boat
- **MOL, WL, Marininvest**
- **2 stroke MAN**
- **4 stroke Wärtsila**
- **new build**
- **retrofit**

**FUEL CELL**
- **1x**
  - Tourist boat
- **1x**
  - Ferry
- **Innogy**
- **Serenergy fuel cells**
- **retrofit**
- **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**
- **Port of Rotterdam Barge**
- **SI hybrid, dual fuel, etc.**
- **new build & retrofit**
Industry welcomes four new ocean-going vessels capable of running on methanol.

“...We are very happy to be working with Waterfront Shipping again on this innovative technology. With seven engines already in operation and proven in the field, this new order confirms the ME-LGI concept as a mature technology. Since this dual-fuel engine entered the market in 2016, its price has dropped considerably, which makes it an even more attractive propulsion option. Allied with its environmental credentials and convenience of use when employing methanol as a fuel, we are confident the ME-LGI will continue its promising progress,” states René Sejer Laursen, Promotion Manager, MAN Diesel & Turbo.
MAN Duel-Fuel Engine Configuration
- **Sustainable Marine Methanol (Sweden)**
  - MI 2015 support of USD$68,000
  - The research concluded that there are no obstacles to the efficient use of Methanol in a converted diesel engine and that smaller vessel conversion projects are feasible and cost-effective, with levels of safety that easily meet existing requirements
  - Road ferry with an engine capacity of about 350 kW
  - Potential for Biomethanol to be progressively blended into the mix as more becomes available
  - [http://summeth.marinemethanol.com/?page=reports](http://summeth.marinemethanol.com/?page=reports)
• **GreenPilot (Sweden)**

  - MI 2015 support of USD$112,000
  - Funding from Methanol Institute and Swedish Maritime Administration
  - WeiChai 6-cyl, 365kW, M100 converted NG engine provided by FiT, in high-speed, rescue/pilot vessel
  - Sea trials started on WeiChai engine in March, which concluded year end, 2017
  - WeiChai-powered vessel and converted Scania engine on stand, both exhibited at Nor-shipping on May 30th, 2017
  - Closing workshop was 3 May 2018 Gothenburg

  Converted WeiChai engine is planned to be used in a Singapore pilot project together with Nanyang Technological University, Q4 2018
METHASHIP: Cruise & Ropax

- **MethaShip (Germany)**
  - 2 designs – cruise and ropax, with Lloyds, Meyer Werft, HELM, Flensburger Schiffbau-Gesellschaft
  - MethaShip is a national research project funded by the BMWi (Federal Ministry for Economic Affairs and Energy)
  - 45-month project, closed on 28 May 2018
  - Recently completed successful truck-to-ship bunkering
  - Presented at IMO’s most recent CCC4
  - [https://www.vsm.de/de/presseinformation/7818](https://www.vsm.de/de/presseinformation/7818)
Other Pilot Projects

• Methanex
  • Tianjin University and ZiChai (engine OEM) as partners
  • Converted 1,100kW marine engine with DMCC technology for commercial fishing vessel applications (Tianjin University)

• Billion Miles (Singapore)
  • 4-cyl M100 prototype, skid-mounted, auxiliary power formally launched in 2018
  • Main propulsion unit coming later in 2018

• FiTech
  • Fujian (140kW), fishing vessel (still discussing)
  • MoA multi-vessel, LNG to methanol conversion (still discussing)

• PCG Product Supply Vessel Interest (still discussing)
  • Dual-fuel
  • Small product carrier (5,000 mt)

• NTU’s test bed facility (about to launch)
  • 1st Phase
    • Test bed emissions and fuel consumption analysis
    • Converted WeChai engine with FiT, ScandiNAOS, LR, IBIA, CCS, Keppel
    • No vessel yet, but targeting single-engine, shore-to-ship crew transport vessel

• Plus: EU inland waterways; India fishing boat/inland waterways; Celeste EU methanol fuel cell vessel
Emissions Reductions

*Methanol is among the lowest emission fuels for marine engines*

Source: Stena Lines -- Emission reductions when compared to alternative fuels currently available (fuel oil)
Fuel Comparison Model & Online Calculator

<table>
<thead>
<tr>
<th>Total Fuel CAPEX</th>
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<tbody>
<tr>
<td>Total CAPEX LNG</td>
<td>49,766 M USD</td>
</tr>
<tr>
<td>Total CAPEX HFO scrubbers</td>
<td>44,167 M USD</td>
</tr>
<tr>
<td>Total CAPEX Compliant fuel</td>
<td>42.3 M USD</td>
</tr>
<tr>
<td>Total CAPEX Methanol</td>
<td>44,913 M USD</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Price Differentials (USD/MT)</th>
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<tbody>
<tr>
<td><strong>Low</strong></td>
</tr>
<tr>
<td>LNG</td>
</tr>
<tr>
<td>HFO 3.5</td>
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<tr>
<td>Methanol</td>
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<table>
<thead>
<tr>
<th>Calorific Value</th>
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<tbody>
<tr>
<td><strong>Calorific Value LNG</strong></td>
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<tr>
<td><strong>Calorific Value HFO 3.5</strong></td>
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<tr>
<td><strong>Calorific Value Compliant fuel</strong></td>
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<tr>
<td><strong>Calorific Value Methanol</strong></td>
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<table>
<thead>
<tr>
<th>Fuel Costs</th>
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</thead>
<tbody>
<tr>
<td>LNG price</td>
</tr>
<tr>
<td>HFO 0.50 price</td>
</tr>
<tr>
<td>MGO 0.10 price</td>
</tr>
<tr>
<td>Methanol price</td>
</tr>
</tbody>
</table>

Check Fuel Prices
Available in many ports around the world

Methanol storage capacity estimates (thousand tons)
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
IMO IGF Code for Ethyl/Methyl Alcohols

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

CCC 2
- Consider establishing WG to develop measures for:
  - Ethyl/methyl alcohol
  - Fuel cells
  - Low-flashpoint diesel

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

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

CCC 5
- Approval
- Consider establishing WG to finalize measures for:
  - Ethyl/methyl alcohol
  - Fuel cells
  - Low-flashpoint diesel
- Not Approved

MSC 97
- Approval
- Not Approved

MSC 98
- Adoption, if required
- Not Adopted

MSC 99
- Approval
- Adoption, if required

MSC 100
- Approval
- Adoption, if required

- Not clear when IGF Codes will be Approved (ie; which future CCC X)
- Not clear after IGF Codes will be Approved, at which MSC they could be Adopted In Principle
- IMO has reserved 2024 by which IGF Codes must come into Force
- 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
Comparing apples to apples

<table>
<thead>
<tr>
<th>Hazard pictograms (CPL)</th>
<th>METHANOL</th>
<th>DIESEL</th>
<th>GASOLINE</th>
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</thead>
<tbody>
<tr>
<td></td>
<td><img src="image" alt="Methanol Hazard Pictograms" /></td>
<td><img src="image" alt="Diesel Hazard Pictograms" /></td>
<td><img src="image" alt="Gasoline Hazard Pictograms" /></td>
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</table>

<table>
<thead>
<tr>
<th>Signal word: (CPL)</th>
<th>METHANOL</th>
<th>DIESEL</th>
<th>GASOLINE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Danger</td>
<td><img src="image" alt="Methanol Signal Word" /></td>
<td><img src="image" alt="Diesel Signal Word" /></td>
<td><img src="image" alt="Gasoline Signal Word" /></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Hazard statements (CPL)</th>
<th>METHANOL</th>
<th>DIESEL</th>
<th>GASOLINE</th>
</tr>
</thead>
<tbody>
<tr>
<td>H225: Highly flammable liquid and vapour.</td>
<td><img src="image" alt="Methanol Hazard Statements" /></td>
<td><img src="image" alt="Diesel Hazard Statements" /></td>
<td><img src="image" alt="Gasoline Hazard Statements" /></td>
</tr>
<tr>
<td>H303: Toxic if swallowed.</td>
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<tr>
<td>H315: Toxic if inhaled.</td>
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<tr>
<td>H280: May be fatal if swallowed and enters airways.</td>
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<tr>
<td>H319: Causes skin irritation.</td>
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<tr>
<td>H311: Toxic to aquatic life with long-lasting effects.</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Precautionary statements (CLP)</th>
<th>METHANOL</th>
<th>DIESEL</th>
<th>GASOLINE</th>
</tr>
</thead>
<tbody>
<tr>
<td>P203: Keep away from heat. Do not store in areas where temperatures exceed 50°C (122°F).</td>
<td><img src="image" alt="Methanol Precautionary Statements" /></td>
<td><img src="image" alt="Diesel Precautionary Statements" /></td>
<td><img src="image" alt="Gasoline Precautionary Statements" /></td>
</tr>
<tr>
<td>P210: Keep out of the reach of children.</td>
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<tr>
<td>P211: Keep away from flammable substances.</td>
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<tr>
<td>P220: Do not inhale.</td>
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<tr>
<td>P233: Avoid inhalation of dust or fumes.</td>
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<tr>
<td>P302/304: Wear eye/face protection, heavy 臺 clothing, and substantial gloves.</td>
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<tr>
<td>P313: Keep in a well ventilated area.</td>
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<tr>
<td>P403/2: Use respiratory equipment.</td>
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<tr>
<td>P405: Use self-contained breathing apparatus in emergency.</td>
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</tbody>
</table>

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Methanol Fuels and Fire Safety

Vehicle Fire Risk

In 1986, there were 500,000 vehicle fires and 1,400 vehicle fire fatalities in the United States. Gasoline was the first material to ignite in 180,000 of these fires and many of the other fires ultimately involved gasoline. Gasoline-ignited fires in 1986 involving cars, buses, or trucks resulted in 760 deaths, 4,100 serious injuries, and $215 million in property damage.

Projections indicate that casualties would drop dramatically if methanol were substituted for gasoline in the country’s primary automotive fuel. Looking just at vehicle fires in which gasoline is the first material to ignite, a switch to methanol could save an estimated 720 lives, prevent nearly 3,900 serious injuries, and eliminate property losses of millions of dollars a year.

Methanol’s fire safety advantage over gasoline stems from several physical and chemical properties (see figures on page 3):

- **LOWER VOLATILITY** (Figure 1)
  
  Methanol does not evaporate or form vapor as readily as gasoline does. Under the same conditions, exposed gasoline will emit two to four times more vapor than will exposed methanol.

- **HIGHER FLAMMABILITY REQUIREMENT** (Figure 2)
  
  Methanol vapor must be four times more concentrated in air than gasoline vapor for ignition to occur.

- **LOWER VAPOR DENSITY**
  
  Gasoline vapor is two to five times denser than air, so it tends to travel along the ground to ignition sources. Methanol vapor is only slightly denser than air and disperses more rapidly to non-combustible concentrations.

- **LOWER HEAT RELEASE RATE**
  
  Methanol burns 25 percent as fast as gasoline and methanol fires release heat at only one-eighth the rate of gasoline fires.

These properties together make methanol inherently more difficult to ignite than gasoline and less likely to cause deadly or damaging fires if it does ignite. Methanol is the fuel of choice for Indianapolis-type race cars, in part because of its superior fire safety characteristics.

Table adapted from Machiele, 1998; a 1-No concern. 2 to 3 = Low Level concern. 4 to 6 = moderate concern. 7 to 8 = high-level concern. 9 to 10 = extreme hazard. b Numbers in parenthesis reflect hazard reductions resulting from design changes. c Number in parenthesis incorporates the lowered likelihood of ingestion due to the presence of additives.

**TABLE 6-1 HAZARD SUMMARY**

<table>
<thead>
<tr>
<th></th>
<th>M100</th>
<th>Gasoline</th>
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</thead>
<tbody>
<tr>
<td>Flammability</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ease of Occurrence</td>
<td>4</td>
<td>9</td>
</tr>
<tr>
<td>Open &amp; Restricted Areas Enclosed Spaces</td>
<td>8 (2-4) b</td>
<td>2</td>
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<tr>
<td>Relative Hazard if Fire</td>
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<tr>
<td>Fire Severity</td>
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<td>10</td>
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<tr>
<td>Ease of Extinguishing</td>
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<td>10</td>
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<tr>
<td>Flame Visibility</td>
<td>8</td>
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<td>Toxicity</td>
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<td>Inhalation - Low Conc.</td>
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<td>Inhalation - High Conc.</td>
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<td>Skin Contact</td>
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<tr>
<td>Ease of Occurrence</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Ingestion</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Toxicity</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>Ease of Occurrence</td>
<td>8(2) c</td>
<td>3</td>
</tr>
</tbody>
</table>

Source: Malcolm Pirnie, Inc., Technical Memorandum
Methanol has lower fire risk

Methanol: evaporates slowly, needs lots of vapour to burn, confined fire zone; fires less likely

Gasoline: evaporates fast, needs little vapour to burn, broad fire zone; fires more likely
Putting things in perspective

LC50 - Lethal dose fish

Gasoline \(^1\)  
8.2 mg/l

Diesel \(^2\)  
65 mg/l

Methanol  
15,400 mg/l

Sources:
\(^1\) Petrobras/Statoil ASA, Safety Data Sheet, ECHA registration dossier Gasoline
\(^2\) ECHA, European Chemical Agency, registration dossier Diesel
\(^3\) ECHA, European Chemical Agency, registration dossier Methanol
## Methanol safer for marine environment

<table>
<thead>
<tr>
<th></th>
<th>Maritime accident</th>
<th>Maritime accident</th>
<th>Simulation</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Ship</strong></td>
<td>Erika</td>
<td>Tanio</td>
<td>-</td>
</tr>
<tr>
<td><strong>Fuel</strong></td>
<td>Heavy Fuel Oil</td>
<td>Heavy Fuel Oil</td>
<td>Methanol</td>
</tr>
<tr>
<td><strong>Released amount</strong></td>
<td>19 000 t</td>
<td>13 500 t</td>
<td>10 000 t</td>
</tr>
<tr>
<td><strong>Affected coastline</strong></td>
<td>400 km</td>
<td>200 km</td>
<td>0 km</td>
</tr>
<tr>
<td><strong>Total damage:</strong></td>
<td>$914M</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td><strong>Cleaning</strong></td>
<td>$100M</td>
<td>$50M</td>
<td>$0</td>
</tr>
<tr>
<td><strong>Fishing industry</strong></td>
<td>$98.3M</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td><strong>Tourist industry</strong></td>
<td>$400-500M</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td><strong>Claim for damages</strong></td>
<td>$120M</td>
<td>$17M</td>
<td>-</td>
</tr>
<tr>
<td><strong>Killed birds</strong></td>
<td>≈ 60,000</td>
<td>≈ 40,000</td>
<td>-&gt; 0</td>
</tr>
</tbody>
</table>

Source: MethaShip
MI marine fuel marketing campaign

- MI engaged Mariner Communications to promote methanol as a marine fuel
- News articles, op-eds, interviews
- Social media postings
- Web site content
- Webinars, workshops and conferences
Methanol...

- is plentiful, available globally
- can be made 100% renewable
- runs well in existing engine technology and has potential for further optimization
- complies with increasingly stringent emission reduction regulations
- requires only minor modifications to current bunkering infrastructure
- is biodegradable!
- safe handling can rely on long history and experience in shipping and industry
- shows slight regional price variation
- **NEEDED:** Vessels, guidelines, standards
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