Methanol as Ship Fuel
Handling of Safety Matters

Lund
17th March 2015
Ulf T Freudendahl
Ship Fuel today – Flashpoint > 60 deg C

Small Molecules
- Low boiling point
- Light in colour
- Easy to light
- Runny

Large Molecules
- High boiling point
- Dark in colour
- Hard to light
- Thick

Crude Oil

Refining Column

Heating

Small Molecules
- Light in colour
- Easy to light
- Runny

Large Molecules
- Dark in colour
- Hard to light
- Thick

Heavy Fuel Oil – max 3.5% sulphur
Marine Gas Oil – max 0.1% sulphur
(Truck Diesel – max 0.001% sulphur)
- At least 2000 ships move in the Baltic at any moment.
- Around 20 Mill ton fuel per year is consumed.
- 20 Mill ton fuel containing 2.5% sulphur equals 500,000 ton.
• The North Sea is even more trafficated than the Baltic Sea
Max 0.1% sulphur in fuel 1\textsuperscript{st} Jan 2015

**MEPC 57 IMO Fuel-sulphur Content**
Equivalent methods may be used as alternative

- **Global**: 4.5 → 3.5 → 0.5
- **SECA**: 1.5 → 1.0 → 0.1

**IMO NOx Technical code**

<table>
<thead>
<tr>
<th>g NOx/kWh</th>
<th>NOx Tier II - 2011 (Global)</th>
<th>NOx Tier III - 2016 (NOx emission control areas)</th>
</tr>
</thead>
<tbody>
<tr>
<td>16</td>
<td></td>
<td></td>
</tr>
<tr>
<td>14</td>
<td></td>
<td></td>
</tr>
<tr>
<td>12</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Maps showing regions covered by NOx Tier II and NOx Tier III regulations.
Heavy Fuel Oil + Scrubber or Marine Gas Oil Oil max 0.1% Sulphur
Low flash point fuels - LNG & Methanol

- Liquefied Natural Gas –LNG-has potential to be an important energy source for marine propulsion
  - Flashpoint: -188 to -135 deg C
  - Boiling Point: -163 deg C

- Methanol is also an efficient energy carrier with high potential for marine propulsion and with possibilities to be renewable
  - Flashpoint: 11 deg C
  - Boiling point: 65 deg C
The world fleet

• Around 90,000 ships.
  Continuously improved safety records

• Around 400 LNG Carriers
  Excellent safety records

• 57 LNG Fuelled ships
  Excellent safety records
Methanol fuelled ships

- One very large Ro-Pax under conversion
- **STENA GERMANICA**
- Seven x 50,000 tdw on order
Rules and regulations for transportation of gases and low flashpoint liquids

- International Code for the Construction and Equipment of Ships Carrying Liquefied Gases in Bulk. **The IGC Code**

- International Code for the Construction and Equipment of Ships Carrying Dangerous Chemicals in Bulk. **The IBC Code**
Existing Rules & regulations for low flash point fuels.


- DNV. Gas Fuelled Ship Installations. Adresses natural gas as fuel and gives opening for other fuels after special consideration.

- Other Class Societies Rules.

Intended fuels:

- **Natural Gas (LNG)**   \( \text{CH}_4 \)   IGF Code Part A-1 Norway
- **Propane**            \( \text{C}_3\text{H}_8 \)
- **Butane (i and n)**   \( \text{C}_4\text{H}_{10} \)
- **Propane/Butane mixtures**
- **Ethyl alcohol**      \( \text{C}_2\text{H}_5\text{OH} \)   IGF Code Part A-2
- **Methyl alcohol**     \( \text{CH}_3\text{OH} \)   IGF Code Part A-2 Sweden
- **Hydrogen**           \( \text{H}_2 \)
- **Dimethyl-ether**     \( \text{CH}_3\text{OCH}_3 \)
## GAP Matrix LNG and Methanol

<table>
<thead>
<tr>
<th>A</th>
<th>A</th>
<th>A</th>
<th>A</th>
<th>A-1</th>
<th>A-1</th>
<th>A-1</th>
<th>A-1</th>
<th>A-1</th>
<th>A-1</th>
<th>A-1</th>
<th>A-1</th>
<th>B</th>
<th>B</th>
<th>B</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Preamble</strong></td>
<td><strong>General &amp; Def.</strong></td>
<td><strong>Goal &amp; funct. req.</strong></td>
<td><strong>General requir.</strong></td>
<td><strong>Ship design and arr.</strong></td>
<td><strong>Fuel containment syst.</strong></td>
<td><strong>Fuel supply to consumers</strong></td>
<td><strong>Power generation</strong></td>
<td><strong>Fire safety</strong></td>
<td><strong>Explosion protection</strong></td>
<td><strong>Ventilation</strong></td>
<td><strong>Electrical installation</strong></td>
<td><strong>Control, monitoring &amp; safety syst.</strong></td>
<td><strong>Alternative design</strong></td>
<td><strong>Manufacture, workmanship &amp; test</strong></td>
</tr>
<tr>
<td>5</td>
<td>6</td>
<td>7</td>
<td>8</td>
<td>9</td>
<td>10</td>
<td>11</td>
<td>12</td>
<td>13</td>
<td>14</td>
<td>15</td>
<td>16</td>
<td>17</td>
<td>18</td>
<td>19</td>
</tr>
<tr>
<td>5.1</td>
<td>6.1</td>
<td>7.1</td>
<td>8.1</td>
<td>9.1</td>
<td>10.1</td>
<td>11.1</td>
<td>12.1</td>
<td>13.1</td>
<td>14.1</td>
<td>15.1</td>
<td>16.1</td>
<td>17.1</td>
<td>18.1</td>
<td>19.1</td>
</tr>
<tr>
<td>5.2</td>
<td>6.2</td>
<td>7.2</td>
<td>8.2</td>
<td>9.2</td>
<td>10.2</td>
<td>11.2</td>
<td>12.2</td>
<td>13.2</td>
<td>14.2</td>
<td>15.2</td>
<td>16.2</td>
<td>17.2</td>
<td>18.2</td>
<td>19.2</td>
</tr>
<tr>
<td>5.3</td>
<td>6.3</td>
<td>7.3</td>
<td>8.3</td>
<td>9.3</td>
<td>11.3</td>
<td>12.3</td>
<td>13.3</td>
<td>14.3</td>
<td>15.3</td>
<td>16.3</td>
<td>17.3</td>
<td>18.3</td>
<td>19.3</td>
<td></td>
</tr>
<tr>
<td>5.4</td>
<td>6.4</td>
<td>7.4</td>
<td>8.4</td>
<td>9.4</td>
<td>11.4</td>
<td>12.4</td>
<td>13.4</td>
<td>15.4</td>
<td>16.4</td>
<td>17.4</td>
<td>18.4</td>
<td>19.4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5.5</td>
<td>6.5</td>
<td>7.5</td>
<td>8.5</td>
<td>9.5</td>
<td>11.5</td>
<td>12.5</td>
<td>13.5</td>
<td>15.5</td>
<td>16.5</td>
<td>17.5</td>
<td>18.5</td>
<td>19.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5.6</td>
<td>6.6</td>
<td>7.6</td>
<td>8.6</td>
<td>9.6</td>
<td>11.6</td>
<td>13.6</td>
<td>15.6</td>
<td>17.6</td>
<td>18.6</td>
<td>19.6</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5.7</td>
<td>6.7</td>
<td>7.7</td>
<td>8.7</td>
<td>9.7</td>
<td>11.7</td>
<td>13.7</td>
<td>15.7</td>
<td>17.7</td>
<td>18.7</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5.8</td>
<td>6.8</td>
<td>7.8</td>
<td>8.8</td>
<td>9.8</td>
<td>11.8</td>
<td>13.8</td>
<td>15.8</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5.9</td>
<td>6.9</td>
<td>7.9</td>
<td>8.9</td>
<td>9.9</td>
<td>11.9</td>
<td>13.9</td>
<td>15.9</td>
<td>15.10</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5.10</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5.11</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5.12</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5.13</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- **Valid for LNG as well as methanol**
- **Partly valid for methanol or valid after interpretation**
- **Not valid for methanol**
- **Additional requirements for Methanol**
Classification Societies Rules for Methanol fuelled Ships
Threat to Safety - Fire

- A considerable part of all total losses start with fire in the engine room.
- 80% of all fires in the engine room start with fuel coming in contact with hot surface. Usually the fuel comes from damaged fuel pipes.
- The figures come from oil fuelled ships with fuels having a flashpoint above 60 degrees C.
- So far the low flash point fuelled (LNG) ships have an extremely good fire safety record.
80% of all engine room fires...
Double walled pipes

- Ventilated annular space.
- 30 air changes per hour.
- Gas and liquid detection in the annular space.
- Alarm and automatic shut down of fuel system.
Fire fighting onboard

- CO₂
- Water mist
- Alcohol resistant foam
Methanol tank at Perstorp
100,000 ton per year
Ships – other than chemical carriers - transporting methanol

- DNV Pt 5 Sec 8 B 102. Where not bound by bottom shell plating or pump room, the tanks shall be surrounded by cofferdams.
Ballast tank converted to methanol fuel tank

Transfer pump room

High pressure pump room

Double walled High pressure fuel pipes

Ballast tank converted to methanol fuel tank

Transfer pump room
Where not bound by bottom shell plating or pumproom, the tanks shall be surrounded by cofferdams
Threat to safety - Explosions
Explosion ranges

- Methanol  6.7 – 36 %
- Methane  5.0 - 15 %
- Petrol  1.4 - 7.6 %
Methyl alcohol tanks shall be inert. Nitrogene is preferred.

Nitrogen Generator

Nitrogen Bottles
Fuel storage onboard

• Methyl alcohol is relatively simple to store onboard.
• We can use double bottom tanks which cannot be used for anything else than water ballast.
• Methyl alcohol is totally diluteable in water and biodegradeable.
Summary

• Methanol is a clean low flash point fuel fulfilling upcoming requirements.
• The methanol fuel containment system onbord and the infrastructure ashore are considerably less expensive than for LNG.
• Rules and regulations exist to a large extent and are under further development. In many parts similar requirements as for LNG.
• There is no doubt we can handle safety issues re methanol onbord used for fuel.
• The existing methanol industry can coop with an increase in demand of 20 mill ton.
Georg A. Olah
Nobel Price Chemistry 1994
Thank you for listening.