Operation of gas engines for marine

Kaj Portin, M/S Stavangerfjord 10-12.04.2018
CONTENT OF THE PRESENTATION

• Gas engines for marine
  • Drivers for using gas as fuel for the marine engines
  • Wärtsilä engine types for gas operation
Regulation drivers - Impact on the environment

- Acid rains
- Smog
- NO\textsubscript{x}
- Sulphur content in fuel
- SO\textsubscript{x}
- Direct impact on humans
- Locally regulated
- Particulate matter
- Greenhouse effect
- CO\textsubscript{2}
Driving trends: fuel price development

Fuel price [USD/MMBTU]

Source: bunkerworld.com; LNG OneWorld.com
Where to go?

- Bio fuels, Methanol, LPG
- LNG, gas
- HFO/MDO + aftertreatment
**Hydrocarbon variations in Wärtsilä ICE**

**SG = Spark Ignited**
- Otto process
- Fuel: gas
- Low pressure gas

**DF = Dual Fuel**
- Otto process + pilot
- Diesel process
- Fuel: gas + liquid fuels
- Low pressure gas

**GD = Gas Diesel**
- Diesel process + pilot
- Fuel: gas + liquid fuels
- High pressure gas
- Large fuel mixture ratio

**Diesel**
- Diesel process
- Fuel: MDO, HFO and Crude oil

### Fuel Types

- **Light Naphta**
- **Kerosene**
- **Inter Gas Oil**
- **Bitumen/Asphalt**
- **Pipe line gas**
- **LNG**
- **Gasoline**

### Hydrocarbon Variations

<table>
<thead>
<tr>
<th>C_1</th>
<th>C_2</th>
<th>C_3</th>
<th>C_4</th>
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<th>C_22</th>
<th>C_25</th>
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<th>C_70 +</th>
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<tbody>
<tr>
<td>LPG</td>
<td>Light Naphta</td>
<td>Heavy Naphta</td>
<td>LFO</td>
<td>HFO</td>
<td>Bitumen/Asphalt</td>
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**Low viscosity fuels**
Hydrocarbon variations in Wärtsilä ICE

**SG = Spark Ignited**
- Otto process
- Fuel: gas
- low pressure gas

**DF = Dual Fuel**
- Otto process + pilot
- Diesel process
- Fuel: gas + liquid fuels
- low pressure gas

**Diesel**
- Diesel process
- Fuel: MDO, HFO and Crude oil
Why lean burn gas engines ⇒ Low emissions

NOx (relative)

100%
10-15%

100%
~0%

Liquid fuel
Gas

SOx (relative)

100%

Liquid fuel
Gas

Particulates (relative)

100%
0-5%

100%
85-95%

Liquid fuel
Gas

GWP index as CO₂ equivalents

100%

Liquid fuel
Gas

GWP = Global Warming Potential
Why lean burn gas engines ⇒ High efficiency

Efficiency comparison between Wärtsilä engine operating on different fuel
> 1,870 DF engines, > 22,000,000 running hours

**MERCHANT**

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<thead>
<tr>
<th>Ship type</th>
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<tr>
<td>Tanker</td>
<td>29</td>
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<tr>
<td>Container Carrier</td>
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<tr>
<td>RoRo/ General Cargo</td>
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<tr>
<td>LPG Carrier</td>
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<tr>
<td>Bulk Carrier</td>
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<tr>
<td>Car Carrier</td>
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<td>Other</td>
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**CRUISE & FERRY**

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<td>Ferry</td>
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**SPECIALS**

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<tr>
<td>Cable Layer</td>
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**POWER PLANT**

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<th>Application</th>
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WÄRTSILÄ