KOOIMAN MARINE B.V.
MEMBER OF

PETER VROLIJK
PROJECT MANAGER

4240 kW (5766 HP) LNG ‘DUAL’ FUELED IWW PUSH BOAT
VEERHAVEN X
“ORKA”

Sailing upstream with 6 loaded barges approx 16.800 Tonnes (coal and ore)
Service routes ThyssenKrupp Veerhaven BV
FUTURE PUSHER
DESIGN CHALLENGE

• Performance and functionality: Not to be less than existing vessels of the fleet.
• Overall fuel consumption: Less than existing vessels of the fleet.
• Range: 4 round trips (=one week 24/7 sailing).
• Bunker operations: Within 2 hours once a week.
• Environmental: Able to fulfill (at that time expected) requirements of CCR4.
• Redundancy: Independent of alternative fuel supply.
• Draught: Less than existing vessels of the fleet. Target draught: 1,60 m
Why ADN?
Time line

- 2011-2012  Future Pusher project
- May 2012  Start Concept Design LNG fueled push boat
- December 2012  Official presentation vertical tank concept to Lloyds R
- January 2013  Introduction LNG project to Ministry I&E in The Hague
- February 2013  Submission call for Ten T in LNG Master plan Rhine-Main-Danube
- March 2013  Hazid study Lloyds (TNO present at all meetings with Class)
- April-May 2013  Working at recommendations Hazid study
- June 2013  Presentation at CCR meeting in Brussels
- August 2013  Presentation at AND meeting in Genève
- July-Dec. 2013  Detailed design and submission plans and calculations to Lloyds Plan Approval
- January 2014  Start hull construction and Keel laying
- June 2015  Tests, trials and maiden voyage.
MAIN PARTICULARS LNG PUSH BOAT:

- LENGTH: 40 M
- BEAM: 18 M
- DRAUGHT (WITH 30% CONSUMABLES): 1.60 M
- PROPULSION: 4 X 1060 kW
- WÄRTSILÄ: 6L20 DF
- (1% DIESEL 99% LNG)
- BUNKER CAPACITY:
  - DIESEL: 80 M3
  - LNG: 160 M3
Propulsion concept
Tank position
Can we sail this LNG push boat under AND flag in 2015?

Thank you all for your interest in this presentation of our LNG push boat design.
Hierna hulpsheets voor evt uitleg
3 * 8L20 - Reference configuration
4 * 6L20DF – conventional configuration
4 * 6L20DF – hybrid configuration

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Operating Profile
## Operating profile: Rotterdam <-> Duisburg (Schwelgern)

<table>
<thead>
<tr>
<th>Operation</th>
<th>Time</th>
<th>Power</th>
</tr>
</thead>
<tbody>
<tr>
<td>Return trip</td>
<td>42 hours</td>
<td></td>
</tr>
<tr>
<td>Rotterdam harbor</td>
<td>1.5 hours</td>
<td>2 * 400 kW main propulsion</td>
</tr>
<tr>
<td></td>
<td></td>
<td>400 kW bowthruster ¼ of time</td>
</tr>
<tr>
<td>Rotterdam to Duisburg (loaded)</td>
<td>26 hours</td>
<td>3726 kW</td>
</tr>
<tr>
<td>Duisberg harbor</td>
<td>2.5 hours</td>
<td>2 * 400 kW main propulsion</td>
</tr>
<tr>
<td></td>
<td></td>
<td>400 kW bowthruster ¼ of time</td>
</tr>
<tr>
<td>Duisberg to Rotterdam (empty)</td>
<td>12 hours</td>
<td>1326 kW</td>
</tr>
<tr>
<td>Domestic consumption (all conditions)</td>
<td></td>
<td>120 kWe</td>
</tr>
</tbody>
</table>
Operating profile graph

Running hours

Operating mode

Rotterdam harbor  upstream  Schwelgern harbor  downstream

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Operating notes

- 7500 running hours per year on the main engines

- The minimum number of engines allowed are operating
  - Upstream all main engines are running
  - Downstream minimum 2
  - Harbor minimum 2
Relative emissions
PM values are very small and thus subject to measurement inaccuracy and rounding errors.

- Lub oil and pilot fuel quality of strong influence.
What do we save??

A sand truck can load 38.4 tons

- CO2: 2657 tonnes
- NOx: 123 tonnes
- SOx: 8 tonnes
- PM: 4 tonnes
What gas volume do we save annually??

A soccer field: 68 X 105 meters
What mass do we save??

A single barge can load 2840 tons at full draft

The annual CO2 savings nearly fill a barge
Annual PM emission savings

EU limits PM$_{10}$ to 40 [microgram/m$^3$] on average over the year.

Savings are up to 4 tons of PM annually. If all of this is PM$_{10}$, this translates to 100 billion m$^3$ of air at the 40 microgram/m$^3$ limit. This is equivalent to a slice of nearly 2.5 meters over all of the Netherlands that is saved.

This is equivalent to a savings of 2.25 centimeters over all of the EU.
Total Greenhouse Gases

Approx ~20% reduction

- CH₄ as CO₂ equivalent when CH₄ part of THC is max 90%
- CH₄ as CO₂ equivalent when CH₄ part of THC is max 60%
- CO₂

Based on the ISO defined operating profile
CH₄ in THC is 60-90% depending on gas composition

* Based on 32 / 34 bore comparison
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Methane slip

By using Wärtsilä DF 20 diesels the methane slip is reduced to less than 6 g/kWh

(Norwegian CO2 fee on petroleum products and measured as average in IMO / ISO test cycles)
Dual-fuel motor - principe

Gas mode:
- Otto principe
- Lage druk gas toevoer
- 1% Pilot diesel inspuiting

Intake of air and gas
Compression of air and gas
Ignition by pilot diesel fuel

Diesel mode:
- Diesel principe
- Diesel inspuiting

Intake of air
Compression of air
Injection of diesel fuel
Emissions

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