Commercial Green Initiatives
January 10th, 2012
Bob Bowers; Maersk Line, Limited; rbowers@mllnet.com
Contents

- Ship emissions and regulatory developments
- Energy efficiency, CO2 reduction
- Air emissions and abatement – NOx and SOx
- Operational measures, logistics
- Alternative fuels
Second IMO GHG Study 2009
Global CO2 emissions

- International shipping: 2.7% of global emissions; domestic/coastal shipping: 0.6%
- CO₂: main GHG ships
CARBON FOOTPRINT OF SHIPPING IS LESS THAN OTHER MODES OF TRANSPORT

80-90% of world’s goods transported by ship

Grams of CO₂ emitted by transporting 1 ton of goods 1 km

<table>
<thead>
<tr>
<th>Mode</th>
<th>CO₂ Emissions (g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Air (Boeing 747-400)</td>
<td>560</td>
</tr>
<tr>
<td>Truck (Global average)</td>
<td>47</td>
</tr>
<tr>
<td>Rail Diesel</td>
<td>21</td>
</tr>
<tr>
<td>Rail Electric (Global average)</td>
<td>18</td>
</tr>
<tr>
<td>Ocean (Avg. ML-owned vessels)</td>
<td>8</td>
</tr>
</tbody>
</table>

Source: Based on data from the Network for Transport and Environment, Sweden
1987
- Tracking DRC, Fuel consumption and Cylinder L/O consumption as independent metrics
- Safety tracked by claims
1998
- ISM drives process driven operations
2000 – 2001
- Bunkers and L/O costs mandate renewed emphasis on energy consumption; beginning of voyage optimization; focus on coatings, scamping
2004 - current
- Shipping KPI project
  - Little focus on energy costs
  - Benchmarking between competitors
2008 – Weak economy, over capacity, high energy costs, increased emissions focus (ECAs)
2012 – Lean operations, optimization of capital, alternative energy sources
Five elements essential for sustainability

**Marine Engineering**
- Basic load optimization
- Monitoring of hull & propeller conditions
- Propeller technology enhancements

**Innovation**
- Voyage planning and execution

**Vessel Performance**
- Main Engine efficiency
- Auxiliary Engine efficiency
- Monitoring of new paint technologies

**Regulatory**
- Cargo load optimization

**Business Case**
- Optimum trim guidance for all vessel classes
- Monitoring of new paint technologies
- Cylinder oil optimization

Other Initiatives
- Alternative fuel tests
- New propulsion technologies
- ISO 14001 certified
- Crew awareness/engagement
- SOx scrubber studies
- QUEST: Low energy chilled containers
- Modified bulbous bow
- Ballast water optimization and treatment systems

Waste heat recovery system
Slow steaming and super-slow steaming
Vessel Performance Management

Performance tool

- Vessel Performance Management Service (VPMS) provides
  - Key vessel performance monitoring
  - Decision support on vessel operation
- VPMS reports provide guidance and decision-support on
  - Hull and propeller performance and efficiency
  - Improving main and auxiliary engine performance
  - Optimal cylinder oil consumption
  - Drydocking, hull cleaning and propeller polishing intervals
  - Evaluation of anti-fouling paint type

Value Proposition

- Believe in the credo – “You can only improve what you measure”
- Promoting and reinforcing green image in the business
- This service has direct impact on optimising daily running cost
- Direct impact on improving fuel performance
- Provides continuous and close performance monitoring
- Ensures drydocking costs and off-hire are kept at minimum level
Innovation projects on the Maersk fleet

- **Maersk Attender**
  - Crane pendulation

- **Thurø Maersk**
  - BWTS testing

- **Maersk Kendal**
  - Ventilation optimization

- **Jeppesen Maersk**
  - Auto-tuning of main engine

- **Emma Maersk**
  - Aux. engine waste heat

- **Roy Maersk**
  - CLT Propeller

- **Maersk Kalmar**
  - Biofuel

- **Olivia Maersk**
  - Air lubrication

- **Alexander Maersk**
  - Exhaust gas recirculation

- **Gudrun Maersk**
  - Main eng. cooling systems

- **Clementine Maersk**
  - CRS autologging and performance prediction

- **Laura Maersk**
  - HT Pump optimization

- **Maersk Ohio**
  - Propeller boss cap fin

- **Maersk Belfast**
  - Water based hydraulics

- **Arthur Maersk**
  - Cylinder lube oil reduction
Example: CLT Propeller and Propeller Boss Cap Fin Projects

- CLT propulsion principle
  o Endplates fitted with minimum resistance
  o Higher efficiency (perhaps up to 5% fuel savings)
  o Lower vibration & noise level
- Main objective:
  o To confirm performance in full scale on a tanker

- PBCF principle
  o Fins to break up hub vortex, 1-5% fuel saving
  o Fit to series of tankers and container vessels
Regulatory scene


ECA

EU 0,1% S in port

CA 0,1% S 24nm off the coast

NOx Tier II

3,5% S

Use of low Sulphur fuels in ECA areas.

CA 50% NOx & PM reduction in port

NOx Tier III

0,1% S

Invest in NOx reducing initiatives. Required for CA port operation.

Global

NOx Tier III

0,5% S

Use of low Sulphur fuels globally.

General

CO2 reduction initiatives

Ballast water treatment, existing ships.

Ballast water treatment, newbuildings
Sulphur challenge: feasible solutions for 2015 and beyond

- **Existing fleet:**
  - Burn *low sulphur fuel*
    - ✔️ Availability from refineries?
    - ✔️ Increase overall CO2
    - ✔️ High cost
  - Retrofit **SOx scrubbers**
  - Use **Biofuel** on certain trades as supplement or alternative to low sulphur fuel

- **Newbuildings:**
  - Burn *low sulphur fuel*
  - Install **SOx scrubbers**

- **Longer term possibilities**
  - Switch to **LNG**
  - Biofuel in large quantities
  - Nuclear power
Examples of Scrubber Designs
More than 90% reduction of Sulphur and Particulate matter

Two most common scrubber types (both open and closed loop):
- Straight through flow
- Venturi type
Example of full installation on a bulk carrier 10MW (Clean Marine scrubber system)
Example of Main Engine scrubber installation on Ro-Ro TOR FICARIA
Exhaust Gas Recirculation project

Objective:
- Reduce NOx emissions by at least 50%

Status:
- System has been installed on board Alexander Maersk (1000 TEU, 10 MW)
- Cooperation with MAN Diesel and ABB, EU FP7 project HERCULES B
- Tests and evaluation of the concept to be documented throughout 2011.

Source: MAN Diesel
Machinery optimization for energy efficiency

- Retrofit of systems aimed at minimizing energy consumption
- Ventilation; SW and LT cooling systems
- Potential: 1% CO₂ global reduction for a container ship
Slow steaming: extensive investigations have led to new industry standard on super slow steaming: BIG savings, less CO2

Container vessel

Optimum ship speed

Optimum engine load
EEE Dimensions

- Length: 400 m
- Beam: 59 m
- Height: 73 m
- Capacity: 18,000 TEU
LNG for Fuel

LNG: reduce impact on environment
- 20% less CO2
- 100% reductions of SOx and PM
- NOx reductions

Key challenges for shipping are
- Substantial investments for Shipowners, Oil Majors and key suppliers
- Issues related to Bunkering (terminals, bunker boats, procedures, etc.)
- Uncertainty regarding the future LNG bunker price

![Graph showing comparison between Crude oil and Natural gas prices from 1990 to 2035.](image)
Small scale LNG in Norway is a reality
Many LNG shipping projects in the pipeline

DNV’s Quantum Project:
Biofuels

- 1st generation: fuel derived directly from plant seed or animal fat.
- 2nd generation: derived from non-food crops or from agricultural waste products, i.e. not competing with food. Sources can be straw, jathropha, lignin, waste from paper mills, etc.
- 3rd generation: new technologies such as algae -- not considered cost-competitive in the short to medium term.

➢ Large-scale biofuel is expected to be derived from sustainable 2nd generation biofuel in the medium to long term
➢ Reduce carbon footprint / approx. CO2 neutral
Eco-efficient ships: consider all relevant technologies. Maximum benefit for business and environment

Example

- Ex: Contrarotating Propeller
- Ex: Waste heat r.
- Ex: Derated ME
- Ex: Hull shape

A ‘standard’ ship — A ‘green’ ship
Eco-efficient ship: choose level of fuel efficiency for max business value subject to limits of investment
Conclusions

- Shipping is a very efficient mode of transportation
- Shipping industry can achieve ambitious emission reduction goals
- Solutions exist or will be available to reduce emissions and comply with future regulations
  - Technologies are of a complex nature and typically not mature yet
- Long time horizon is needed for R&D, testing and implementation
  - Technical, operational and commercial challenges
- Life cycle approach required for making investment decisions
- Emission regulations: must be goal based, encourage innovative solutions with level playing field
Impact on fuel consumption and CO2 when installing BWTS

- Impact on daily fuel consumption when installing BWTS, 500 USD/T HFO assumed:

<table>
<thead>
<tr>
<th></th>
<th>Daily fuel consumption, USD</th>
<th>BWTS daily fuel consumption, USD</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>7500 TEU</td>
<td>33,600</td>
<td>150</td>
<td>0.5</td>
</tr>
<tr>
<td>4500 TEU</td>
<td>15,600</td>
<td>70</td>
<td>0.5</td>
</tr>
<tr>
<td>VLCC</td>
<td>24,600</td>
<td>300</td>
<td>1.2</td>
</tr>
</tbody>
</table>

Total impact on Maersk Line CO2 emission:

- 2009 fuel consumption: ~10 MTONS -> 0.5% increase due to BWTS: 50,000 tonnes fuel
- For Maersk Line alone the introduction of fleetwide ballast water treatment will lead to an increase in CO2 emissions of ~160,000 tonnes per year.
- This corresponds to the CO2 emission from ~25,000 average UK households in one year
Questions & Answers
Efficiency: engine auto-tuning

- Automatic adjustment of engine settings to obtain optimum maximum combustion pressure
- Retrofit/upgrade potential for larger MAN B&W ME engines
- Field test proved concept on vessel in service
- Fuel/CO2 savings: approx. 0.3 - 2%
- Retrofit and newbuilding applications
Can we make the overall supply chain greener?

→ Can consumer drive major changes?
→ Structural changes: For instance Carbon War Room
→ Benchmarking: For instance BSR: Clean Cargo Working Group