Measures for reducing emissions on Emma Maersk

Innovation Department
Technical Organisation
Anders Hultqvist, Ph.D.

22nd January 2008
Who we are

- The A.P. Moller - Maersk Group is a diversified conglomerate, founded in 1904 by Mr A.P. Møller
- 110,000 employees and operations in over 130 countries with own offices and employees
- Headquarters in Copenhagen, Denmark
Technical Organisation

Management of owned ships
- Crewing and training
- Daily management of vessel operations
- Health, safety and environment
- Engineering and projects
  - Newbuilding supervision
  - Expert engineering support
  - Regulations
  - R&D - Innovation
What we do

We serve customers worldwide in the shipping, energy, retail and industry sectors, operating in five business segments:

- Container and related activities
- Tankers, offshore and other shipping activities
- Oil and gas activities
- Retail activities
- Shipyards and other companies
Maersk Line

Creating opportunities in global commerce
- More than 500 container vessels
- Over 1.9 million containers, trucks and dedicated trains
- More than 30,000 employees in 130 countries
- Global network of routes
- Seamless door-to-door transport of all types of goods
Maersk Tankers

More than 150 owned, time-charter and pool vessels, including:
- Very Large Crude Carriers (VLCC)
- Product tankers
- Gas tankers
- Liquefied Natural Gas (LNG) carriers
- Pure Car/Truck Carriers (PCTC)
Environmental Goals

- We aim to ensure that all our global operations, at sea and on land, are managed responsibly with respect for the world around us.

- We are committed to the protection and conservation of the environment and place high priority on environmental considerations in managing our business.

- Our education and training courses include environmental sensitivity and awareness.
MARPOL Annex VI – revision NO\textsubscript{x} limits

3 tier approach has been proposed:

- Tier 1 in action
- Tier 2 (2010-11) will be in the range of 2-3.5 g/kWh below Tier 1 limits
- Tier 3 (2016) is still open for discussion
  - US proposing 80% below tier 1 – means after-treatment, in coastal zones
  - Norway proposing 40-50% below tier 1 – anticipating in-engine methods increasing the fuel oil consumption, globally
MARPOL Annex VI – revision SOx

- **Six different options for SOx regulation on the table**

1. No change
2. Keep global limit as is, strengthen SECA limit to 1%
3. Strengthen global limit to 3%, strengthen SECA limit to initial 1% and later to 0.5%
4. Keep global limit, introduce coastal zone concept with 0.1% distillate
5. Global ban of heavy fuel, 1% global distillate
6. Allow continued usage of HFO if abatement can produce emissions equivalent to 1% distillate
MARPOL Annex VI – revision – Particulate Matter (PM)

- Particle Matter is very closely linked to sulphur content
- As long as the sulphur content remains high it has no value to limit PM separately from limiting SO\textsubscript{x}

![Pie chart showing the composition of particulate matter with 83% Sulfate, 4% Carbon, 2% Ash, 8% SOF, and 4% Other.](chart.png)
Regional legislation - EU Sulphur directive

- Introduces stringent limits for Marine Gas oils (DMA & DMX)
- Mandatory use of 0.1% fuel alongside from 2010 in EU
- Introduces SECAs in Baltic and North Sea with different dates that MARPOL
- Sets stringent requirements for test of SO$_x$ abatement technologies

- Highlights the need for stringent IMO standards to avoid confusion
Regional legislation - California regulation

- Within 24 nm from shore mandatory use of DMA, or 0.5% DMB grade in Aux engines
- From 2010 mandatory use of DMA 0.1% in aux engines within the zone
- No operational waste discharges within 3 nm from coast
- No incinerator operation within 3 nm from coast

In the pipeline to:

- include main engines in the fuel switch requirement
- require shore side electricity or equivalent reductions
- require ships hulls to be cleaned regularly
## Emissions legislation

<table>
<thead>
<tr>
<th>Emission</th>
<th>Application</th>
<th>Pronosis 2010/11</th>
<th>Prognosis 2016</th>
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<tbody>
<tr>
<td>NOx</td>
<td>Global</td>
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<td>Locally</td>
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<td>SOx</td>
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<td>Alongside</td>
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<td>PM</td>
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Summary of Emission Topography

➢ Global & Local legislations
➢ Environmental pollutants - NOx, SOx, PM, VOC
➢ Green house gases

➢ Significant reductions are needed
Technical initiatives within Energy & Emissions

- Prime Mover performance
  - Waste Heat Recovery systems
  - Electronically controlled engines
  - Retrofitting electronically controlled cylinder lube
  - Auxiliary engines – Common rail
- Abatement initiatives
  - Fuel switch
  - SCR
  - Water injection
  - PM filter
- Propulsion Efficiency
  - Hull performance
  - Propeller design
  - Antifouling
- Vessel Performance Monitoring
  - World class vessel total performance feedback and database system
Emma Maersk –
A very large container ship

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Environment features on EMMA MÆRSK

- Biocide-free silicone based antifouling paint.
- Waste heat recovery system, and an electronically controlled engine
- Inboard protected fuel tanks

Transport efficiency:
- 66 kilometres using 1 kWh of energy per ton of cargo.
- A jumbo jet travels 0.5 kilometre using the same amount of energy per ton of cargo
Emma Mærsk
General Arrangement

Energy Efficiency in Shipping and Clean Air in Port Cities

LOA = 397.71 m
LPP = 376.00 m
B, mld = 56.40 m
D, mld = 30.20 m
11,000+ TEU

Main Engine:
MCR = 80 MW
Shaft motors= 2 x 9 MW

Class:
ABS +A1, E, Container Carrier
SH-DLA, SHCM,
SFA-25,+AMS,+ACCU

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Energy Efficiency in Shipping and Clean Air in Port Cities

Ship and Machinery
Energy Efficiency in Shipping and Clean Air in Port Cities

Propulsion and power installation

Total power installed on Emma Maersk:

Main engine: 80000 kW

Electric power: 29000 kW (Aux. Diesel Generators & Turbogenerator set)

Total: 109000 kW = approx. 150,000 Bhp
Propulsion and power installation
Wärtsilä 14 RT-flex96C

Energy Efficiency in Shipping and Clean Air in Port Cities
Machinery

Energy Efficiency in Shipping and Clean Air in Port Cities

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Casing
What is Waste Heat Recovery?

**Standard Engine**

- Shaft power: 49.3%
- Exhaust gas: 25.4%
- Scavenge air: 14.1%
- Jacket water: 6.3%
- Lubricating oil: 4.3%
- Radiation: 0.6%
- Fuel input: 100% (171 g/kWh)

**WHR Engine**

- Shaft power: 49.0%
- Exhaust gas: 12.9%
- Scavenge air: 12.9%
- Jacket water: 6.2%
- Lubricating oil: 4.2%
- Radiation: 0.6%
- Fuel input: 100% (172 g/kWh)
Waste Heat Recovery system overview

- Exh. gas boiler
- Steam for heating services
- Turbo-chargers
- Shaft motor/generator
- Exhaust gas receiver
- Main engine
- Superheated steam
- Generator, AC alternator
- Reduction gearbox
- Steam turbine
- Reduction gear with overspeed clutch
- Emergency generator
- Switchboard
- Diesel generators
Turbine Skid

Breadth: 3.5 meters
Weight: 58 tons without condenser
Weight: 75 tons with condenser
Waste Heat Recovery systems

Summary

- Recovering approx. 10% of engine output
- Reduction of all emissions by 10%!
- Total plant efficiency of 55%

An example:
- Yearly Total FO Consumption
  40,000mt/vessel
- Saved FO.. 10% ~ 4000mt
- ...or ~ 2.0 MUSD/year/vessel
Shafting system

Main data for the shafting system:

- Length: 120 meter
- Weight: 605 ton
- Propulsion add on power: 2 x Siemens 9 MW electric motors
- Propeller: MMG 6 bladed – weight 130 ton!
Emma Mærsk - Propeller

Energy Efficiency in Shipping and Clean Air in Port Cities

D = 9.6 m
Weight = 131.5 tons
Figure 4.5 Deformed Finite Element Model of Hold 5 for Load Case of L04.2 Heavy Full
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Lashing Bridges

Energy Efficiency in Shipping and Clean Air in Port Cities
OSS patented ergonomic and safe system with horizontal (inside) and inclined lashing (outside to bottom of 4th tier)
Energy Efficiency in Shipping and Clean Air in Port Cities

Ready for Sea-trial 16-08-2006
Energy Efficiency in Shipping and Clean Air in Port Cities

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G-type and E-type
WAY FORWARD

Energy Efficiency in Shipping and Clean Air in Port Cities

- Improve engine performance
- Further improve waste heat recovery systems
- Optimize hull-propulsion-rudder system
- Integrate abatement technology
  - NOx reduction – SCR, water injection, emulsion, ...
  - SOx reduction – scrubbing, other fuel, ...
  - PM reduction – filters, scrubbing, fuel, ...
- Lower resistance hulls
- Operational measures, design for operation

Close cooperation needed: shipowners, yards, engine designers, suppliers, R&D, class/regulators, universities
Comments and Questions?
Thank you for listening!