Reduction of CO$_2$ emissions by diesel-electric propulsion system for an existing cargo vessel

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Cargo vessel “ENOK”
Test run I – before rebuilding*

Distance: Buelstringen – Rotterdam, December 2005
Cargo: 1 230 T wheat
Time: 7 days (67.25 hours)
Propulsion: 2 x 370 kW diesel engine and transmission
Power supply: 1 x 50 kVA generator
Consumption: 4 460 litres of diesel fuel

* Source: Log, Capt. Rudi Koopmans, „ENOK“
Cargo vessel “ENOK”
Test run II – after rebuilding*

Distance: Buelstringen – Wormerveer, September 2010
Cargo: 1 350 T wheat
Time: 7 days (69.5 hours)
Current: 1 - 3 230 kWe diesel-electric power trains
Propulsion: 2 x 2x 230 kWe electric torque propulsions
Power supply: 1 x 50 kVA converter
Consumption: 3 300 litres of diesel fuel

12 April 2011
* Source: Torque Marine GmbH IPS Innovative Propulsion Systeme GmbH & Co. KG, Hamburg
Considerable reduction in CO$_2$ emissions is possible!

Fuel saving: $1\ 160\ l = 26\ %$

CO$_2$ saving: $3\ 082\ kg$
Conventionally powered inland water vessels are overpowered

Design criteria for the propulsion system

Use of available power

<table>
<thead>
<tr>
<th>Power reserve</th>
<th>Additional power for the necessary torque at lowest propeller speed</th>
<th>Power for achieving the design speed with max. cargo capacity / draught</th>
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</thead>
<tbody>
<tr>
<td>100 %</td>
<td>80 % upstream, full power</td>
<td>50 % downstream, max.</td>
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<tr>
<td></td>
<td>80 %</td>
<td>33 % downstream, normal</td>
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<td>10 % canals</td>
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</tbody>
</table>

* Source: DST, Entwicklungszentrum für Schiffstechnik und Transportsysteme e.V., Duisburg
In inland water transportation, 55% of the available power is not used.

Design criteria for the propulsion system

- **Power reserve**: 100%
  - **Additional power** for the necessary torque at lowest propeller speed
  - **Power** for achieving the design speed with max. cargo capacity / draught

Use of available power

- 45% annual average

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* Source: DST, Entwicklungszentrum für Schiffstechnik und Transportsysteme e.V., Duisburg
Approach: the modular diesel-electric propulsion system

- 3 - 4 power trains deliver the propulsion power
- Dynamically switching the power trains on and off provides enhanced energy efficiency
- One power train (230 kWe) delivers the torque required for manoeuvring
The modular diesel-electric propulsion system of the cargo vessel “ENOK”
Innovative aspects and other benefits

Energy efficiency and environmental protection
- Dynamic delivery of the energy actually required
- Diesel generators always operate in their ideal performance range
  - low consumption and reduced exhaust emissions

Safety
- Redundant system components ensure reliability
- Switching power trains on without synchronisation of diesel generators
- Full torque in the respective drive / speed range facilitates safe manoeuvring, rerouting and stopping

Convenience
- Low vibration, quiet operation
- Thanks to water cooling and less waste heat, the engine room ventilation is reduced significantly
When used in new ships, propulsions can be smaller by up to 25%.

The modular system yields the ship design conditions necessary for optimal propeller inflow.
Modular diesel-electric propulsion system

Summary

- Fuel saving (test run: 1 160 l = 26 %)
- Reduction of CO$_2$ emissions (test run: 3 082 kg)
- High energy efficiency
- Direct drive without transmission
- Full torque from the first rotation

- And many other advantages