




Measures for the reduction of fuel consumption and CO₂ emissions in inland navigation

| | | TORQUE Marine IPS (Innovative Propulsion System GmbH + Co- KG) |
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| 1. | Keywords | <ul style="list-style-type: none"> Energy efficiency, Fuel saving, Reduction of CO₂ emissions Gearless direct drive, Full torque from the first revolution. |
| 2. | Short description | <p>The required driving power is distributed between 3 – 4 units, gearless drive with full torque. This allows simultaneous operation of 2 or more propulsion drives, i.e. fixed-pitch, steerable or Voith-Schneider propellers.</p> <p>This was implemented on the 85 m motor freighter “ENOK” in 2010</p> <p style="text-align: center;">Innovative Propulsion System Aktueller Status</p> <p>➤ <i>Überblick am Beispiel ENOK</i></p> |

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| | | <p>Re. 2.</p> <p>Rear engine room 2 x 2 x 230 KWe TORQUE drive + 2 x 230 KWe units</p>  |
| 3. | Objective & target | Provide propulsion in all operating profiles at the required torque, as necessary for safe operation of the ship in the current operating profile. |
| 4. | Key success factors | <p>Since the annual mean utilisation of the total installed capacity (in inland navigation) is < 45%, the main objective is to reduce the current consumption of fossil fuels, while simultaneously and consequently reducing NOx and CO2 emissions.</p> <p>Typical load on the installed capacity = 100%:</p> <p>80% required during upstream passage at full power</p> <p>50% required during downstream passage (max.)</p> <p>33% required during downstream passage (normal)</p> <p>10% required during canal passage</p> |
| 5. | Innovative aspects | <p>A modular system allows distributed location of the units, e.g. in the forecastle or midships between the cargo holds. This permits more efficient vessel hulls, due to the optimisation of the incident flow at the propeller, making it possible to use drives that are up to 25% smaller.</p> <p>(Draft 2130 of a 110m inland navigation vessel with special shallow water properties)</p> <p>All of the electrical power components such as the permanent magnet generators, inverters for the DC link and inverters for the TORQUE drive motors are water cooled as standard.</p> <p>Due to the high efficiencies:</p> <ul style="list-style-type: none"> • Torque generator 97% • Torque motor 97% • Torque inverter 98.5% <p>this is possible at relatively modest pump powers. This significantly reduces the amount of engine room ventilation required.</p> |

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| 6. | Benefits for users | <ul style="list-style-type: none"> ➤ A modular propulsion system allows new shipbuilding concepts ➤ Reduced energy costs due to the efficient use of diesel fuel in the ideal power range. ➤ The units can be switched on without the need for synchronisation with the diesel generators. ➤ Full torque in the current speed range allows safe manoeuvring, reversing and stopping of the ship |
| 7. | Geographic area | <ul style="list-style-type: none"> • All inland waterways that are navigable by motor freighters. |
| 8. | Status | <ul style="list-style-type: none"> ❖ GMS ENOK, an 85 m motor freighter, owned by TORQUE Marine IPS, has been navigating the European waterway network as an innovation carrier since August 2010. It is freighted by IMPERIAL Duisburg |
| 9. | Difficulties met | <ul style="list-style-type: none"> ❖ The diesel engines needed to be retrofitted with lubricating oil separators due to the high soot levels in the lubricant. ❖ This is/was the result of measures taken by the engine manufacturer inside the engine in order to meet the requirements of Stage II of the Central Commission for the Navigation of the Rhine and in accordance with Directive 2004/26/EC of the European Parliament and of the Council of 21 April 2004. |
| 10. | Year(s) | <p>2006 > Research, development & planning started</p> <p>2008 > ENOK purchased as an innovation carrier</p> <p>2009 > Planning & production of the world's first TORQUE drive for an inland navigation vessel</p> <p>2009 > Factory acceptance test and ZSUK approval for 2 shaft drive systems.</p> <p>2009 > Order placed for conversion of the machinery at the Friedrichs shipyard in Kiel</p> <p>2010 > July 1st test voyage with the new propulsion system</p> <p>2010 > 18th August Official presentation of the ENOK at the jetties in Hamburg.</p> <p>Since the end of August it has made its first journeys as a motor freighter navigating the German & European waterway network.</p> |
| 11. | Users, stakeholders | <p>TORQUE Marine IPS GmbH + Co KG</p> <p>Georgswerder Bogen 7</p> <p>21109 Hamburg</p> <p>Germany</p> |
| 12. | Contact person | Claus D. Christophel GF TORQUE Marine IPS |
| 13. | Costs & financing | <p>approx. €4,000,000 incl. purchase of the GMS ENOK as an innovation carrier</p> <p>by the shareholders of TORQUE Marine</p> |
| 14. | Website / links | <p>Antriebssystem der ENOK im Betrieb – Fahrt auf der Elbe von Scharnebeck bis Hamburg</p> <p>(Propulsion system of the ENOK in operation – Sailing on the river Elbe from</p> |

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| | | Scharnebeck to Hamburg) Innovatives Binnenschiff 2130 ausgerüstet mit einem Torque-System (Innovative inland navigation vessel 2130 fitted with a torque system) | | | | | | | | |
| 15. | Available data, publications | <p>® European patent applications</p> <table border="0"> <tr> <td>i. E 243 1 0109</td> <td>Redundant system</td> </tr> <tr> <td>ii. E 243 1 0209</td> <td>Modular system</td> </tr> <tr> <td>iii. E 243 1 0309</td> <td>Electronic control</td> </tr> <tr> <td>iv. E 243 1 0409</td> <td>Zero emission system</td> </tr> </table> | i. E 243 1 0109 | Redundant system | ii. E 243 1 0209 | Modular system | iii. E 243 1 0309 | Electronic control | iv. E 243 1 0409 | Zero emission system |
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| 16. | Added value: possibility for application elsewhere | <p>All use cases in which less than 60% of the max. installed capacity is used.</p> <p>All use cases in which the best possible emission and energy efficiency are called for.</p> <p>All use cases in which the propeller speeds of as low as approx. 20 rpm. with short stopping/reversing times of the fixed pitch propeller are beneficial.</p> <p>All use cases in which the highest possible level of redundancy and availability are beneficial.</p> | | | | | | | | |
| 17. | Further information | <p>1. NEWS</p> <p>Torque Marine: Start-up-Unternehmen mit neuem Schiffsantrieb auf Kurs (Torque Marine: Start-up company sets sail with a new ship propulsion system)</p> <p>Ein voller Erfolg: Mit Torque-Antrieb von Kiel nach Glückstadt (A Resounding Success: From Kiel to Glückstadt by Torque Drive)</p> <p>Mit der GMS Enok auf Testfahrt (Taking a Test Voyage Aboard the GMS Enok)</p> | | | | | | | | |
| 18. | Filled in by | Claus D. Christophel | | | | | | | | |
| 19. | Date | 1 st April 2011 | | | | | | | | |