THE MOST EFFICIENT ENGINE IN THE WORLD

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Wärtsilä Marine Solutions, Business Line Engines
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WHAT HAS BEEN THE DRIVERS FOR THIS ENGINE DEVELOPMENT

ENERGY EFFICIENCY & TOTAL COST OF OWNERSHIP

RELIABILITY

FUEL & OPERATIONAL FLEXIBILITY

EMISSION REDUCTION & LEGISLATION
**Main parameters**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Diesel</th>
<th>Dual Fuel (DF)</th>
<th>Spark ignited Gas (SG)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bore (mm)</td>
<td></td>
<td>310</td>
<td></td>
</tr>
<tr>
<td>Stroke (mm)</td>
<td></td>
<td>430</td>
<td></td>
</tr>
<tr>
<td>Nom. Speed (rpm)</td>
<td>720 / 750</td>
<td>720 / 750</td>
<td>720 / 750</td>
</tr>
<tr>
<td>Max. cyl. output (kW)</td>
<td>590 / 610</td>
<td>530 / 550</td>
<td>580 / 600</td>
</tr>
<tr>
<td>Cyl. configurations</td>
<td>8V31</td>
<td>10V31</td>
<td>12V31</td>
</tr>
<tr>
<td></td>
<td>14V31</td>
<td>16V31</td>
<td>20V31</td>
</tr>
<tr>
<td>Weight (tonnes)</td>
<td>56,7</td>
<td>62,0</td>
<td>73,0</td>
</tr>
<tr>
<td></td>
<td>81,0</td>
<td>89,0</td>
<td>110,5</td>
</tr>
<tr>
<td>Size L x W x H (m)</td>
<td>6.2 x 3.1 x 4.7</td>
<td>6.8 x 3.1 x 4.7</td>
<td>7.8 x 3.5 x 4.1</td>
</tr>
<tr>
<td></td>
<td>8.5 x 3.5 x 4.2</td>
<td>9.1 x 3.5 x 4.2</td>
<td>10.0 x 3.8 x 4.7</td>
</tr>
</tbody>
</table>

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PM Gen. as installed in lab
The Power-Pack

- “PowerPack” = cylinder head, liner, piston, exhaust pipe and connecting rod unit
- Cross-flow cylinder head, for stiffness and low stress concentration
- Same basic cylinder head for all fuels
- Semi-hydraulic valve system
- Drill cooled flame plate and cylinder liner
- Can be assembled or replaced as a unit
Engine Structure & Power Systems

Engine block

- The block has been given a stiff and durable design to absorb internal forces
- One piece nodular cast iron
- Including water and charge air channels and camshaft bearing housings
- Equipped with crankcase explosion relief valve with flame arrester
Crankshaft
• Constant main & big end bearing temperature monitoring
• Power take out from both ends

Connecting rod
• 3-piece design, for minimum dismantling height
• New designed connecting rod for low weight and increased stiffness
• Forged alloy steel, partially machined
• All studs are hydraulically tightened

Crankshaft bearings
• Tri-metal design with steel back, lead-bronze lining and a soft running layer
• Sn-flash for corrosion protection
• Excellent loading capacity
• Fully adjustable semi-hydraulic valve actuation
• Variable inlet valve closing enables right air-fuel ratio at any operating condition
• Variable exhaust valve closing enables lower component thermal load at any conditions
• No need to adjust valve clearance every 1000 hrs
VARIABLE VALVE TRAIN

Stepless VIC
- Fully adjustable inlet valve closing
-> Optimized performance at all loads!

VEC
- Variable scavenging

Validated in Valvetrain Rig
- 15 000 hours
- Components tested in extreme conditions.

• Valve spring validation
  • Additional to normal stress measurements high speed camera has been used.
• The new Wärtsilä 31 engine family represents the synthesis of all the previous experiences.

• The Wärtsilä 31 CR results in a unique package fitting a large spectrum of diesel and gas applications designed around the todays and future expected customer values.
• The current trend in fuel system development is to increase injection pressure.

• The fewer high pressure joints, the less the possibilities for fuel leakages. Clean and safe layout.

• A smart safety valve, the CUBE, with an additional function enabling pressure holding and control without automation.
COMMON RAIL 1 – Already good:

- Smoke and particulate emissions of the CR1 are low.
- Practically invisible smoke is achieved over load range 25-100%.

COMMON RAIL 2 - Even better thanks to:

- Nozzle design
- Higher injection pressure capability.

Smoke with different CR stages versus engine load

- CR1 is better than jerk pump at low loads.
- Jerk pump is better than CR1 at loads above 60%.
- CR2 brings a clear improvement in smoke over the whole load range.
GAS ADMISSION VALVE ON WÄRTSILÄ 31DF

- Easy & fast installation
- Easy to service
  - Service pack available
- Coated valve plates
  - Ensures expected life time with LNG
- Unchanged internal design
  - Vast experience from W32DF/W34DF

- Extensive CFD simulation:
  - Optimum gas flow to the gas admission valve
  - Balanced gas feed
  - Minimum losses
• 2-stage turbocharging enabler for high efficiency

• Serviceability and uptime improved by cartridge concept for compressor and turbine removal and overhaul

• 2nd generation two-stage turbocharging
  – Validated on 2-stage rig and engines – June 2017
Fast, Accurate, Reliable; Real time valve position feedback signal standard on W31 engines.

W31 engine is equipped with 2-3 control valves depending on application.
• Proper noise insulation on engine top part to reduce engine noise emission.

• Latest noise insulation reduced 10dB noise resulting sound pressure level at 1m distance from the engine top part to be ~105dB(A).
ENGINE AUTOMATION SYSTEM
FOR THE NEW AGE
High performance engines require high performance controls

- Air/fuel ratio control
- Thermal management
- Fuel & Gas injection control
- Self tuning
- Knock control
- Valve control
- Ignition control
- Start/stop management
- Redundancy (virtual sensors)
- Speed / load control
- Engine balancing
- Load sharing
- Prognostics/diagnostics
- Safety
- Plant/vessel communication
- Cylinder wise trip & transfer

INCREASED DATA MANAGEMENT & SYSTEM CAPABILITY IS A REALITY
Close to 50,000 h accumulated experience gathered by 2017 end
IN AVERAGE >9 G/KWH FUEL SAVING OVER THE WHOLE LOAD RANGE

SFOC Diesel-Electric constant speed 720 rpm

At ambient conditions according to ISO 15550. HFO as fuel. With engine driven pumps (two cooling water + one lubricating oil pump). Acc. to ISO 3046, IMO Tier II, without SCR.
Type: Icebreaker  
Owner: FSUE Atomflot  
Yard: Vyborg  
3 x W8V31

Type: RoPax  
Owner: MolsLinien  
Yard: RMC  
2 x W8V31

Type: Fishing vessel  
Owner: P. Hepsö Rederi  
Yard: Karstensen Shipyard  
1 x W8V31

Type: Fishing vessel  
Owner: -  
Yard: -  
1 x W10V31

Type: Fish processing vessel  
Owner: Hav Line  
Yard: Balenciaga  
1 x W10V31

Type: Fishing Vessel  
Owner: Strand Senior AS  
Yard: Karstensen Shipyard  
1 x W8V31

Type: Fishing Vessel  
Owner: Research Fishing  
Yard: Vard  
1 x W12V31

Type: Engine power plants  
Owner: -  
75MW (W20V31SG)
“Over 10 years ago the seeds of development were planted.

Now our customers can harvest the fruits of our work.”