



## **New High Power, Large Bore Gas Engine from MAN Diesel**

11 June 2009

**MAN Diesel is using the 2009 staging of Power-Gen Europe to announce a further extension to its line-up of four-stroke gas engines.**

The new engine is the 51/60G, which like its 51/60DF dual fuel stable-mate is derived from MAN Diesel's robust, well-proven type 48/60 Diesel engine platform. The new engine uses a distillate fuel pilot injection system to achieve reliable, stable ignition of lean air-gas mixtures in a large bore, open combustion chamber. As a result, the new gas engine boasts one of the highest power densities in the four-stroke gas engine field as well as low emissions of oxides of nitrogen (NO<sub>x</sub>) and high fuel efficiency.

This choice of gas ignition technology also alleviates one of the main weaknesses of spark ignited gas engines, i.e. the relatively short exchange intervals of even the best spark plugs. By contrast, the liquid fuel pilot ignition system of the 51/60G gas engine exhibits the considerably longer service intervals typical of diesel engine fuel injection equipment. Other advantages include low gas admission pressures, high and stable ratings in hot and high power plant locations and excellent load imposition and load following characteristics.

"The 51/60G is now the largest, most powerful medium speed gas engine on the market," notes Dr. Stephan Mey, head of MAN Diesel's Augsburg based Power Plant business unit, "In particular, with the 51/60G we are aiming to bring the typical virtues of gas engines to power and cogeneration plants with electrical outputs in the range from 100 to 300 MW. These benefits include intrinsically clean combustion of gases containing methane combined with high fuel efficiencies and hence low emissions of carbon dioxide. Add the traditionally favourable price of natural gas, and we foresee the 51/60G becoming a popular choice in a full range of power and cogeneration plants."

### **Versions**

The 51/60G is offered in a 9-cylinder inline version and vee configuration versions with 12, 14, and 18 cylinders. Standard rated outputs are 1,000 kW per cylinder for 60 Hz power generation and 975 kW per cylinder for 50 Hz power generation. This overall power range from 8,775 kW to 18,000 kW mechanical equates to nominal generator set outputs from 8,538 kW to 17,514 kW electrical.

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### **Advanced Fuel and Ignition Control**

The 51/60G makes extensive use of microprocessor control technology to achieve its favourable economics and low emissions. Gas admission is precisely controlled via electronically controlled, electrically actuated valves in the 51/60G's inlet ports while pilot fuel injection is likewise via an electronically controlled, electrically actuated common rail system. Common rail injection technology allows flexible setting of the injection timing, duration and pressure for each cylinder. This capability ensures the reliable ignition of lean air-fuel mixtures, precise balancing of cylinder outputs and - essential for a lean burn gas engine - rapid response to combustion knock signals on a cylinder-by-cylinder basis. The pilot fuel quantity represents about 0.8% of the energy required to achieve the 51/60G engine's standard outputs, contributing to the engine's excellent NO<sub>x</sub> emissions.

### **Advanced Variable Turbocharging**

Further enhancing both control of the air-fuel ratio and the favourable efficiency of the 51/60G is the use of MAN Diesel's VTA Variable Turbine Area turbocharger technology. On the 51/60G, the VTA system replaces the traditional method of air-fuel ratio control based on charge air by-passing. Where a by-pass system dissipates energy by expelling excess charge air to the atmosphere, the VTA system uses variable nozzle rang vanes ahead of the turbocharger turbine to control the pressure of the gases impinging on the turbine and hence precisely match the charge air output of the compressor to the engine's demand for combustion air. As with gas admission and pilot fuel injection, the VTA system is electronically controlled by MAN Diesel's in-house developed SaCoS<sub>one</sub> microprocessor safety and control system. The "one" suffix denotes that the system is mounted largely on the engine.

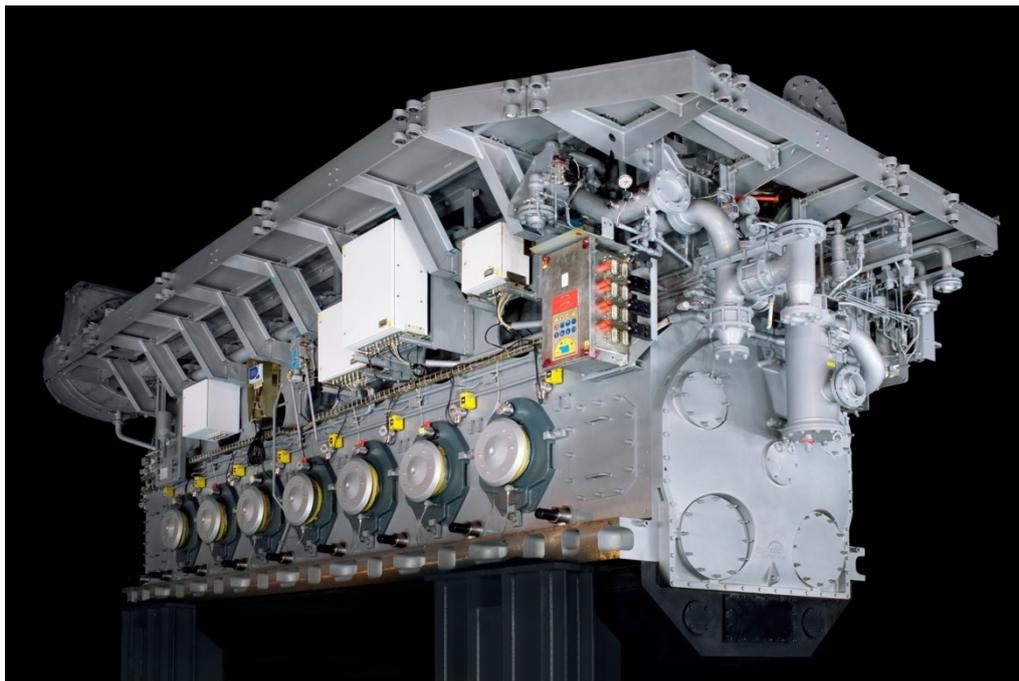
### **Fuel Consumption and Emissions**

On the fuel efficiency side, the overall effect of these measures is specific consumption for natural gas plus the liquid fuel pilot of 7,708 kJ/kWh<sub>e</sub> (7,500 kJ/kWh<sub>m</sub>) for generator sets powered by the 51/60G in NO<sub>x</sub> optimised applications, and 7,430 kJ/kWh<sub>e</sub> (7,230 kJ/kWh<sub>m</sub>) in efficiency optimised applications. With NO<sub>x</sub> emissions levels below 500 mg /m<sup>3</sup> at 5% O<sub>2</sub>, the 51/60G both readily achieves compliance with the limits prescribed in Germany's TA luft clean air code and undercuts the limits currently required by the World Bank by a wide margin.

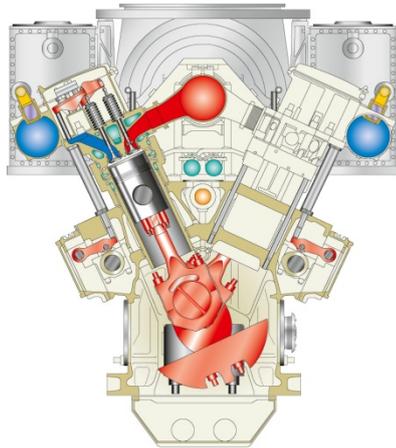


### **Energy Recovery**

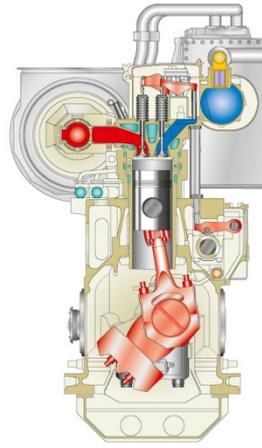
“Naturally, we expect the 51/60G to be popular in co-generation and trigeneration applications.” Mey notes. “In these plants, thermal energy recovered from engine sources is used for heating, cooling or generating process steam, resulting in energy utilisation levels as high as 95%. As with our large diesel engines, a further energy recovery option on offer from MAN Diesel with the 51/60G is a combined cycle set-up in which the exhaust heat of the 51/60G engine is used to produce steam to drive a steam turbine generator. In this way, the overall electrical output and efficiency of the power plant can be increased by 10% to 15% without additional fuel costs.”



*The MAN Diesel 51/60G gas engine offers market leading power density and efficiency.*



Four-stroke engine V51/60G



Four-stroke engine L51/60G

**GenSet output \* (kW<sub>e</sub>)**

		500 1/min, 50 Hz kW <sub>e</sub>	514 1/min, 60 Hz kW <sub>e</sub>
9L51/60G	9 cyl.	8,538	8,757
12V51/60G	12 cyl.	11,384	11,676
14V51/60G	14 cyl.	13,282	13,622
18V51/60G	18 cyl.	17,076	17,514
Mean piston speed		10.0 m/s	10.3 m/s
Mean effective pressure		19.1 bar	19.1 bar

\*Alternator Efficiency: 97.3%

*Electrical power quoted depends on alternator make.  
 Power and consumption may vary according to set-up conditions.  
 Engines comply with the TA Luft guidelines for thermal power plants.  
 The stated consumption figures refer to the above mentioned ISO  
 reference conditions. The heat rate for gas operation  
 refers to a LHV of 28 MJ/Nm<sup>3</sup>.*

*Ratings are given with a tolerance of +5% and without engine-driven  
 pumps. Figures for gas engines refer to natural gas with a methane  
 number higher than 80.*

*The specific lube oil consumption is specified at MCR with a toler-  
 ance of 20%.*

**Technical Data of the MAN Diesel 51/60G gas engine.**

**About MAN Diesel**

MAN Diesel is the world's leading provider of large bore diesel engines for marine and power plant applications. The company designs two-stroke and four-stroke engines, generating sets, turbochargers, CP propellers and complete propulsion packages that are manufactured both by MAN Diesel and its licensees. The engines have power outputs ranging from 450 to 97,300 kW. MAN Diesel employs approx. 8,000 staff, primarily in Germany, Denmark, France, the Czech Republic, India and China. The global after-sales organisation, MAN Diesel PrimeServ, comprises a network of the company's own service centres, supported by authorised partners. MAN Diesel is a company of MAN SE, which is listed on the DAX share index of the 30 leading companies in Germany.

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