

PA4 SM & SMDS

Diesel engines for submarines

Engineering the Future – since 1758.

MAN Diesel & Turbo

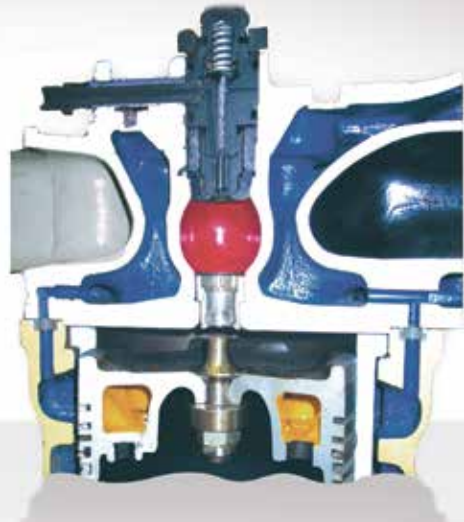


Technical Superiority

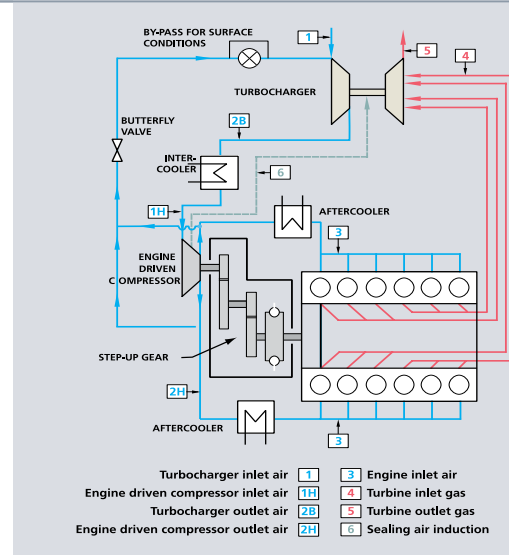
MAN Diesel & Turbo technology



Engine crankcase designed to be shock resistant



Variable geometry combustion chamber



Combined supercharging diagram of PA4 SMDS engine

Variable geometry combustion chamber

- Low mechanical stresses
- Lower noise
- Lower vibration emissions

Mechanically driven compressor

The safest solution in a submarine to produce energy with supercharged diesel engines is to use a suitably dimensioned mechanically driven compressor to adequately compensate back pressure.

Submarine engines supercharged by mechanically driven compressors bring the following advantages:

- Positive system for maintaining the air flow through the engine largely unaffected by the snorkelling conditions and for providing consistent performance over the whole output range.
- Easy adjustment of air flow.
- Good load acceptance under all conditions.
- Reduction of engine fouling.

Combination with a turbocharger

While retaining the compulsory mechanically driven compressor for its reliability and safety, MAN Diesel & Turbo developed a combination which places it in series with a turbocharger, in order to increase power. Each compressor is fitted with a charge air intercooler so that after compression the charged air can recover after its specific gravity to ensure good combustion chamber filling of the combustion chambers.

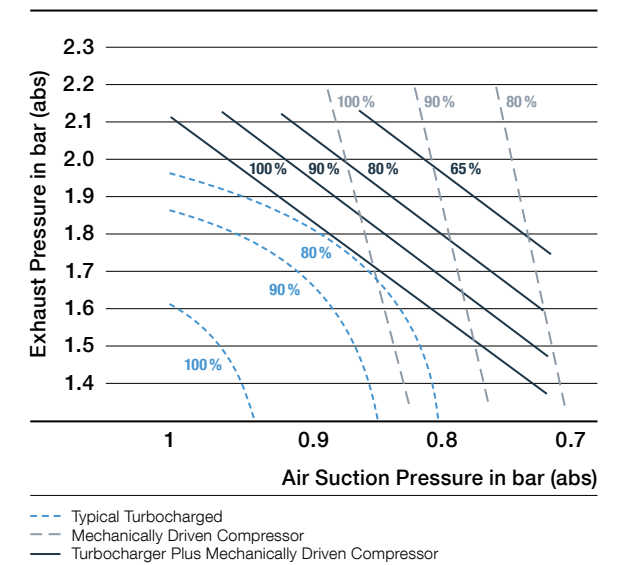
Total operational safety

The compressed air flow, necessary to build up a barrier against gases leakage inside the turbocharger, is delivered with the mechanically driven compressor at a suitable pressure level. For surface operation a butterfly valve opens a by-pass to discharge a part of the excess air flow from the mechanically driven compressor and returns it to the turbocharger air inlet to avoid the turbocharger compressor surge. Compared to an engine using only turbochargers, power drop-off due to suction

and exhaust pressures is still superior in real submarine snorkelling conditions. It has been demonstrated that no derating was required up to pressures of 1,800 mbar at the exhaust and 850 mbar at the inlet at an inlet air temperature of 50°C.

The greatest advantage of this engine is its very low sensitivity to variation / deterioration in snorkelling conditions. With its mechanically driven compressor, the PA4 engine brings the utmost safety. This is the only supercharging system which minimises thermal stress on components when counter-pressure varies due to sea swell. This proven design is recognized worldwide as representing the most reliable technology for total operational safety.

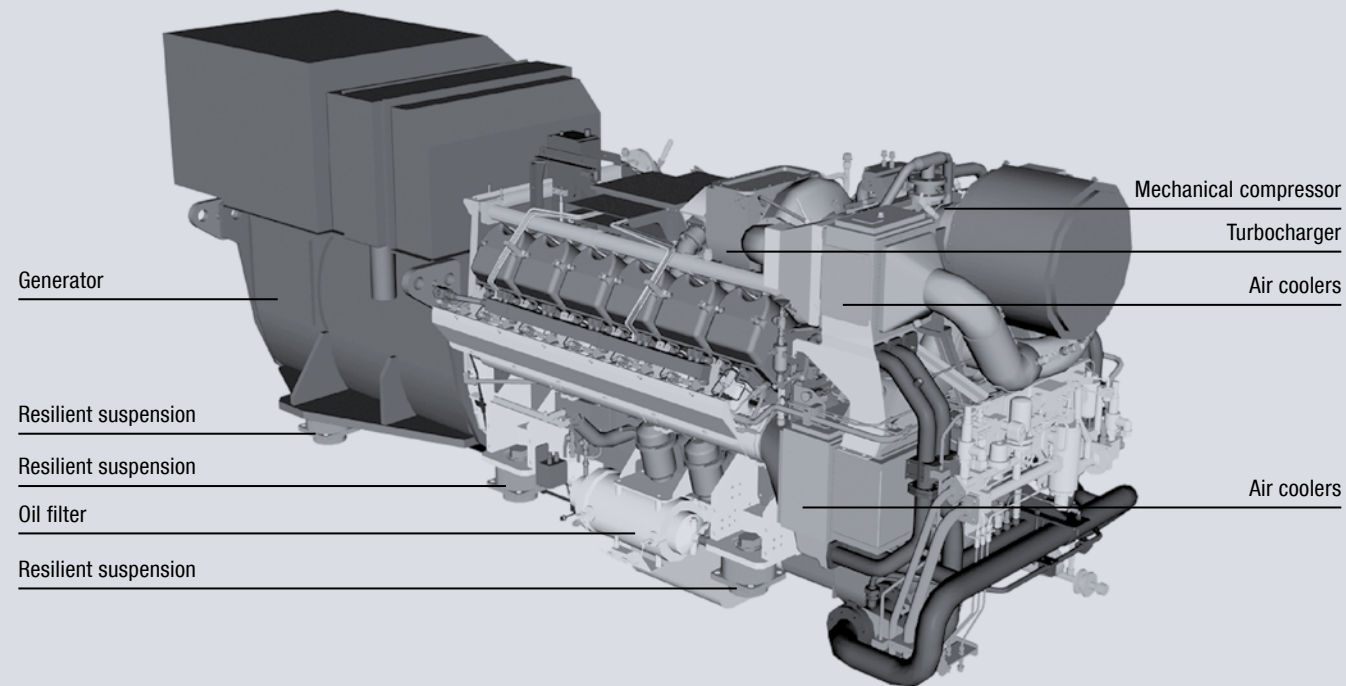
Power dropping versus suction and exhaust pressure (According to the supercharging process)



Technical Data

PA4 SM & SMDS

Diesel generating set of 1,250 kWe with diesel engine type 12 PA4 V 200 SMDS



Engine data for PA4

General

Working cycle: four-stroke
 Cylinder bore: 200 mm
 Piston stroke: 210 mm
 Swept volume: 6.6 liters/cyl.

Arrangement of cylinders: in Vee

Nominal speed: 1,300 rpm
 Mean piston speed at 1,300 rpm: 9.1 m/s

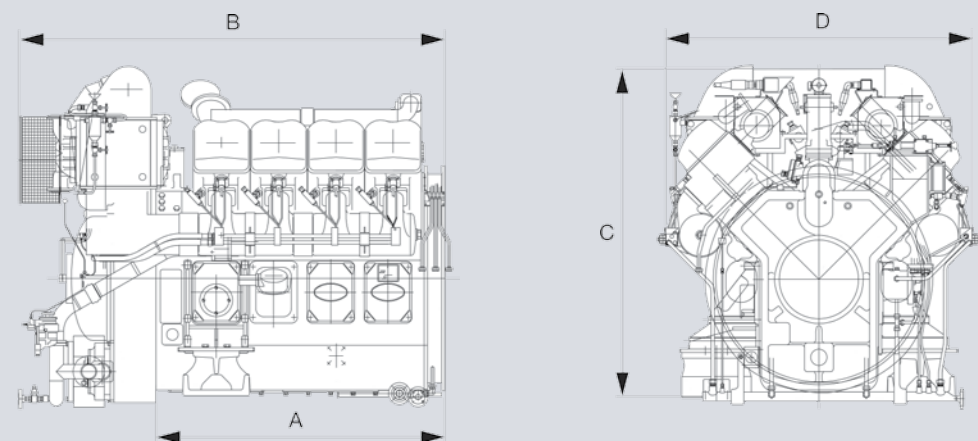
PA4 SM & SMDS engines are installed onboard nearly 100 submarines. The same main features have demonstrated perfect safety and very high reliability:

- Welded tunnel type frame
- 90° Vee configuration design.
- Single camshaft and monoblock injection pump
- Robust main bearing design and large shaft diameter
- "Variable Geometry" combustion system
- Piston with additional pintle for the "variable geometry" design

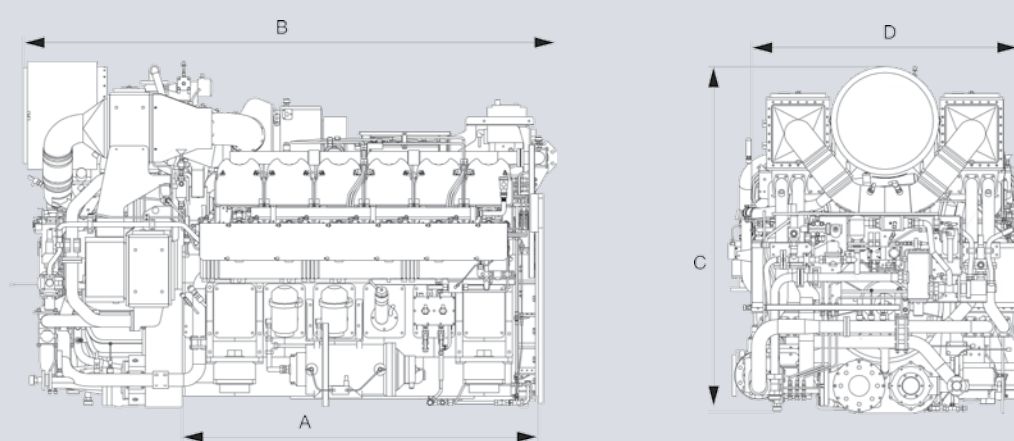
Dimensions and Weights

PA4 SM & SMDS

8 PA4 V 200 SM



12 PA4 V 200 SMDS



Cylinder Numbers & Output

Engine type	Cyl. No.	Mechanical output
8 PA4 V 200 SM	8	700 kW
12 PA4 V 200 SMDS	12	1,330 kW

Dimensions & Weights

Engine type	A in mm	B in mm	C in mm	D in mm	Wt. in t.
8 PA4 V 200 SM	1,515	2,320	1,785	1,470	5.5
12 PA4 V 200 SMDS	2,115	3,120	2,130	1,670	9.2

All dimensions and masses are approximate and subject to change without prior notice.

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