SKL DIESEL

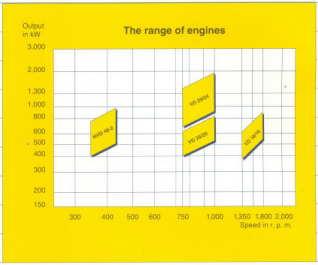
ENGINES MADE IN GERMANY

Diesel engine VDS 29/24 AL for marine propulsion or generator set

Main features:

- output range from 700 to 1,800 kW
- rated speeds of 750 to 1,000 r.p.m.
- fuel consumption 185 g/kWh
- operation on heavy oils up to 700 mm^2/s
- long service life

Innovative Engine Technology



SKL Diesel engines "Made in Magdeburg" have for decades been an established notability in the international top-class engine construction.

In over 50 countries and under most versatile conditions, SKL Diesel engines are operated as follows:

- Propulsion of ships of the most different designs
- Power supply on ships
- Diesel power stations
- Stand-by power generating sets on land

The development of SKL Diesel engines has been aimed at minimizing operating costs and environmental pollution while simultaneously maximizing the service value. For reaching this target, technical tasks such as

- the further reduction of fuel and lubricant consumption (e.g. by optimizing the part-load behaviour) and the use of moderate-cost, lower-grade heavy oils
- the maximum possible degree of heat recovery and conversion/further processing
- reduction of the maintenance requirements as well as increased component-part safety, automated monitoring of the operating functions and reduction of pollutant emissions

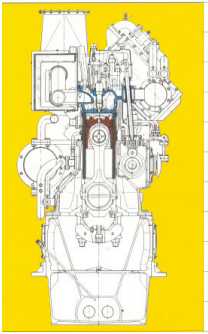
were solved by involving innovations in the engine design.

SKL's VDS 29/24 AL belongs to an engine series which furnishes a new definition of international standards in the output range from 700 to 1,800 kW and for speeds of 750 to 1,000 r.p.m.

Excellent heavy-oil suitability, low consumption of fuel and lubricating oil, compact construction and reliable operation with long maintenance intervals are further outstanding features.

Short description

Type of engine:	VDS 29/24 AL
Design:	Four-stroke Diesel engine with water cooling, direct injection of fuel, exhaust-gas turbo-charging with charging-air cooling
Number of cylinders:	6, 8 in-line
Cylinder diameter:	240 mm
Piston stroke:	290 mm
Cylinder output:	115 – 225 kW
Rated speed:	750 – 1,000 r.p.m.
Medium piston speed:	7.25 – 9.67 m/s
B.m.e.p.:	1.42 – 2.06 MPa
Heavy-oil suitability:	700 mm^2/s (50° C)
Specific fuel consumption:	185 g/kWh
Specific consumption of lubricating oil:	0.7 g/kWh



1. Housing

The rigid, laminar graphite, cast iron cylinder block houses the suspended crankshaft. Thanks to the special liner design, which incorporates a raised, rigid and separately cooled collar, the cylinder block remains free of cooling water. This feature not only protects it against corrosion and keeps it free from deposits, but also means that maintenance costs are significantly reduced. The cylinder liner is subject to all-round nitration, rendering it highly wear-resistant. Four cylinder-head screws with long anti-fatigue shafts transmit the forces via intermediate walls and ribs in the cylinder block and via the main-bearing screws to the main-bearing covers.

The camshaft is supported in the cylinder block and driven by the gearing at the opposite end to the coupling.

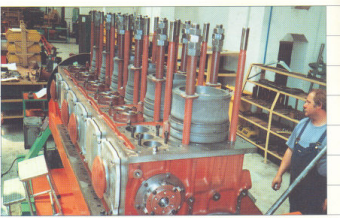
A deformation-resistant bedplate forms the bottom of the housing; this bedplate, in an appropriately extended form, can also serve as the mounting for the generator.

2. Crank gear

The hardened and tempered crankshaft, upset forged from C-steel, is supported by interchangeable, thin-walled, multi-layer slide bearings. At the free end of the shaft, a viscosity-type torsional vibration damper is arranged. The control gear and vibration damper flange are attached to the crankshaft by a cone interference fitting and hydraulically mounted. Up to 700 kW of the output can be taken off at the opposite end to the coupling.

The hardened and tempered connecting rod, forged from alloyed C-steel, is divided straightly at the large connecting-rod eye. The connecting rod also is supported in interchangeable, thin-walled, multi-layer slide bearings.

The built piston, with its steel crown and aluminium bottom section, is bolted from above and supplied with cooling oil through a longitudinal bore in the connecting rod. There are three chromium-plated compression rings in the top section of the piston. The chromium-plated oil scraper is placed in the bottom section of the piston.



3. Cylinder head and valve drive

The cylinder heads are secured to the cylinder block by means of four necked-down bolts tightened hydraulically. The cylinder heads are provided with two inlet and exhaust valves each. Where heavy oil is to be used, the exhaust valves are fitted additionally with valve turning devices. The hard-facing of the valve seat surfaces in combination with the cooling of the exhaust-valve seat rings, mounted in the cylinder head, result in long operational lives for the components. The injection valve is located in the centre of the cylinder head. The valve drive (lubricated by pressure oil and enclosed oil-tightly) is effected from the camshaft via roller tappets, push-rods and forked rockers.

4. Turbo-charging system

Turbo-charging is carried out by an exhaust turbo-charger (ETC) operating on the pulse system with a maximum efficiency ≥ 64 %. A compressor washing device and additionally, with heavy-oil operation, a turbine washing device is used for the maintenance-free operation of the turbo-charger.

The exhaust turbo-charger can be located either on the coupling end or on the opposite end.

DESIGN PRINCIPLES

Design Principles

5. High-pressure injection system

Fuel is injected by individual top-mounted pumps at maximum injection pressures ≤ 140 MPa (1,400 bar). In conjunction with a carefully adapted cam geometry this ensures a short combustion time.

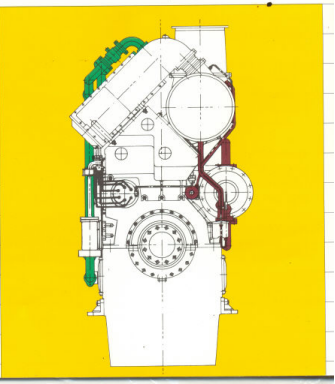
A perfect combustion process and minimum pollutant emissions have been achieved with the use of short injection pressure pipings and an optimum injection nozzle geometry. The injection pressure pipings are double-walled.

Where heavy oil is used, the fuel pipings sheathed with a heating piping are isolated.

The quantity of fuel injected is controlled by a mechanico-hydraulic speed governor via a compound-control-rod system.

6. Cooling system

The engine is cooled by means of two circuits: the cylinder liner, cylinder head and exhaust turbo-charger are cooled in the high-temperature circuit. The low-temperature circuit supplies the oil and charging-air cooler as well as the heat exchanger (water). Both circuits are designed for the direct fitting of centrifugal pumps.



7. Lubricating-oil system

The lubricating-oil system is designed as a pressure circulation system. The lubricating-oil pump, the self-cleaning lubricating-oil filter and the oil cooler are engine-mounted. The oil system supplies the piston (through the longitudinal bore of the connecting rod) with the cooling oil required.

8. Operation and monitoring

The start/stop functions and the manual speed control can also be adjusted mechanically at the operator's stand attached to the engine. For remote control or for automated operation, electrical controls are provided on the engine.

All important operating parameters are monitored by a warning/stopping system. In the case of inadmissible deviations of the operating parameters, visual and acoustic signals are released or the engine is stopped, respectively. An overspeed protection device acts directly on the regulating rod and stops the engine if the prescribed maximum engine speed is exceeded.

Monitoring by telemetering equipment is effected in conformity with the corresponding installation instructions and according to the order.

No. of cylinders	6	8
Operating data (at maximum output)		
Continuous output [1) 2)]	1,320 kW	1,800 kW
Rated speed	1,000 r.p.m.	1,000 r.p.m.
Excessive output [3)]	1,452 kW	1,980 kW
Overload speed to propeller curve	1,030 r.p.m.	1,030 r.p.m.
Starting speed	120 r.p.m.	120 r.p.m.
B.m.e.p.	2.01 MPa	2.06 MPa
Medium piston speed	9.67 m/s	9.67 m/s
Final compression pressure at Q % load and rated speed	3.5 MPa	3.5 MPa
Peak combustion pressure	16 MPa	16 MPa

(SI system 1 MPa = 10.0 bar = 10.2 kgf/cm²)

Design data		
Cylinder diameter	240 mm	240 mm
Piston stroke	290 mm	290 mm
Piston displacement of one cylinder	13.12 dm³	13.12 dm³
Total piston displacement	78.72 dm³	104.96 dm³
Compression ratio	13	13
Control times		
Inlet valve opens – crank angle before t.d.c.	45°	45°
Inlet valve closes – crank angle after b.d.c.	25°	25°
Exhaust valve opens – crank angle before b.d.c.	55°	55°
Exhaust valve closes – crank angle after t.d.c.	45°	45°
Valve clearance (cold) for inlet	0.3 mm	0.3 mm
Valve clearance (cold) for exhaust	0.5 mm	0.5 mm
Firing order		
Clockwise rotation	1-5-3-6-2-4	1-3-2-5-8-6-7-4
Anti-clockwise rotation	1-4-2-6-3-5	1-4-7-6-8-5-2-3
Data on charging-air system		
Boost pressure ratio	3.25	3.25
Charging-air temperature – after the charger at 100 % load	180° C	180° C
Charging-air temperature – after the charging-air cooler at 100 % load	50° C	50° C
Intake air quantity	9,900 kg/h	13,200 kg/h
Data on exhaust-gas system		
Exhaust temperature after cylinder, full load	350° C	350° C
Exhaust temperature after cylinder, overload	375° C	375° C
Exhaust temperature after turbine, full load	330° C	330° C
Exhaust temperature after turbine, overload	350° C	350° C
Exhaust throughput	10,150 kg/h	13,530 kg/h
Exhaust turbidity at full load	≤ 10 %	≤ 10 %
Admissible difference between exhaust temperatures of cylinders	80 K	80 K
Admissible exhaust back-pressure	2 kPa	2 kPa

THE VDS 29/24 AL ENGINE IN FIGURES

No. of cylinders		6	8
Data on lubricating-oil system			
Consumption of lubricating oil		0.7 g/kWh	0.7 g/kWh
Pressure at control valve		0.40 MPa	0.40 MPa
Max. admissible temperature of lubricating oil at engine outlet (SAE 40)		83° C	83° C
Delivery rate of lubricating-oil pump		32 m³/h	44 m³/h
Oil content of bedplate	max.	850 dm³	1,000 dm³
	min.	600 dm³	700 dm³
Data on fuel system[a]			
Specific fuel consumption		185 g/kWh	185 g/kWh
Delivery rate of fuel pump		1.5 m³/h	1.5 m³/h
Data on cooling system			
Max. admissible cooling-water pressure			
– High-temperature circuit		0.4 MPa	0.4 MPa
– Low-temperature circuit		0.4 MPa	0.4 MPa
Max. admissible cooling-water temperature			
– High-temperature circuit	Inlet	82° C	82° C
	Outlet	88° C	88° C
– Low-temperature circuit	Inlet	38° C	38° C
	Outlet	53° C	53° C
Admissible cooling-water temperature at ETC outlet		90° C	90° C
Delivery rate of high-temperature water pump		35 m³/h	46 m³/h
Delivery rate of low-temperature water pump		35 m³/h	46 m³/h
Resistance level in the high-temperature circuit of the engine without water cooler		22 kPa	22 kPa
Water content of high-temperature circuit		95 dm³	125 dm³
Data on starting-air system			
Mean starting-air consumption per starting process		500 Ndm³	650 Ndm³
Starting-air pressure	max.	3.0 MPa	3.0 MPa
	min.	1.0 MPa	1.0 MPa
Nominal pressure of air bottle		3.0 MPa	3.0 MPa
Data on warning/stopping system			
Lubricating-oil pressure at engine inlet at rated speed	warning	0.35 MPa	0.35 MPa
	stopping	0.28 MPa	0.28 MPa
Cooling-water temperature at engine outlet	warning	90° C	90° C
	stopping	95° C	95° C
Fuel-leakage pressure	warning	0.04 MPa	0.04 MPa
Controller voltage		24 V	24 V

Marine Diesel Engine

If Diesel engine and gear are erected rigidly, both these units are connected with each other by a highly elastic clutch.

The Diesel engine can be erected elastically by using rubber anti-vibrators. The connection to the rigidly erected gear is established through a highly elastic clutch.

Marine Diesel engines (standard outputs)

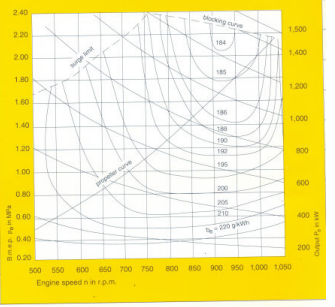
Output kW	Speed r.p.m.	No. of cyl.	p_e MPa
700	750	6	1.42
900	750	6	1.83
1,000	750	6	2.03
1,000	1,000	6	1.52
1,200	1,000	6	1.83
1,320	1,000	6	2.01
1,350	750	8	2.06
1,550	1,000	8	1.77
1,800	1,000	8	2.06

Operating time and repair intervals
at rated speed of 1,000 r.p.m. and heavy-oil operation

Operating time between general overhauls:	50,000 h
Repair intervals for	
■ injection valve	3,000 h *
■ cylinder head	6,000 h *
■ exhaust turbo-charger (bearings)	12,000 h *
■ piston rings	12,000 h **
■ main/big-end bearings	24,000 h **
■ piston	50,000 h **
■ cylinder liner	50,000 h **

* check ** exchange

Characteristics of 6VDS 29/24 AL engine
b_e measured without oil and water pumps
fitted and at a net calorific value of 42,700 kJ/ kg



The Diesel engine and the brushless three-phase constant-voltage generator are mounted on one common, flexurally rigid base frame. Anti-vibrators fitted to the base frame facilitate an elastic erection on a ship's or concrete foundation.

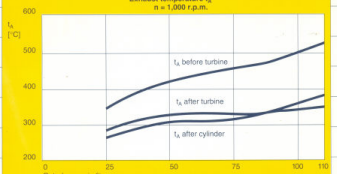
DIESEL-GENERATING SET

Diesel-generating sets (continuous power)

Power kVA	Frequency Hz	No. of cyl.	Speed r.p.m.
1,050	50	6	1,000
1,300/1,150	50/60	6	1,000/900
1,450/1,300	50/60	6	1,000/900
1,550/1,400	50/60	6	1,000/900
1,700/1,550	50/60	8	1,000/900
1,900/1,700	50/60	8	1,000/900
2,100/1,900	50/60	8	1,000/900

Characteristics of 6 VDS 29/24 AL-2 at generator operation

Exhaust temperature t_a
n = 1,000 r.p.m.

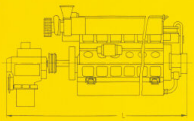


Specific fuel consumption b_e
(net calorific value = 42,700 kJ/kg, without fitted pumps)

Weight data		
No. of cylinders	**6**	**8**
Engine without flywheel	12,100 kg	15,500 kg
Flywheel	820 kg	880 kg
Cylinder block, complete	2,200 kg	2,800 kg
Crankshaft	1,850 kg	2,400 kg
Torsional vibration damper	200 kg	420 kg
Cylinder liner	140 kg	140 kg
Piston with connecting rod	90 kg	90 kg
Cylinder head	120 kg	120 kg
Injection pump	20 kg	20 kg
Combined oil and water cooler	360 kg	380 kg
Exhaust turbo-charger	260 kg	260 kg
Charging-air cooler	150 kg	160 kg
Self-cleaning lubricating-oil filter	140 kg	160 kg

Dimensions And Weights

Diesel-gear set



Power kW	Speed r.p.m.	Length mm	Width mm	Height 1 mm	Height 2 mm	Weigh kg
700	750	5,585	1,510	2,760	2,420	15,690
900	750	5,685	1,520	3,030	2,525	16,740
1,000	750	5,685	1,520	3,030	2,525	16,740
1,000	1,000	5,500	1,510	2,910	2,465	16,240
1,200	1,000	5,685	1,520	3,030	2,525	16,740
1,320	1,000	5,685	1,520	3,030	2,525	16,740
1,350	750	6,920	1,680	3,170	2,620	21,940
1,550	1,000	6,780	1,620	3,080	2,565	20,940
1,800	1,000	6,920	1,680	3,070	2,620	21,940

Diesel-generating set

Power kVA	Speed r.p.m.	Freq. Hz	Length mm	Width mm	Height 1 mm	Height 2 mm	Weigh kg
1,050	1,000	50	5,530	1,500	2,840	2,550	18,000
1,300	1,000	50	5,715	1,500	2,840	2,550	19,000
1,450	1,000	50	5,715	1,500	2,840	2,550	19,000
1,550	1,000	50	5,715	1,500	2,840	2,550	19,000
1,700	1,000	50	6,600	1,500	2,840	2,550	24,000
1,900	1,000	50	6,805	1,500	2,840	2,550	25,500
2,100	1,000	50	6,805	1,500	2,840	2,550	25,500
1,150	900	60	5,530	1,500	2,840	2,550	18,000
1,300	900	60	5,715	1,500	2,840	2,550	19,000
1,400	900	60	5,715	1,500	2,840	2,550	19,000
1,550	900	60	6,600	1,500	2,840	2,550	24,000
1,700	900	60	6,805	1,500	2,840	2,550	25,500
1,900	900	60	6,805	1,500	2,840	2,550	25,500

a) stationary design
b) marine design

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