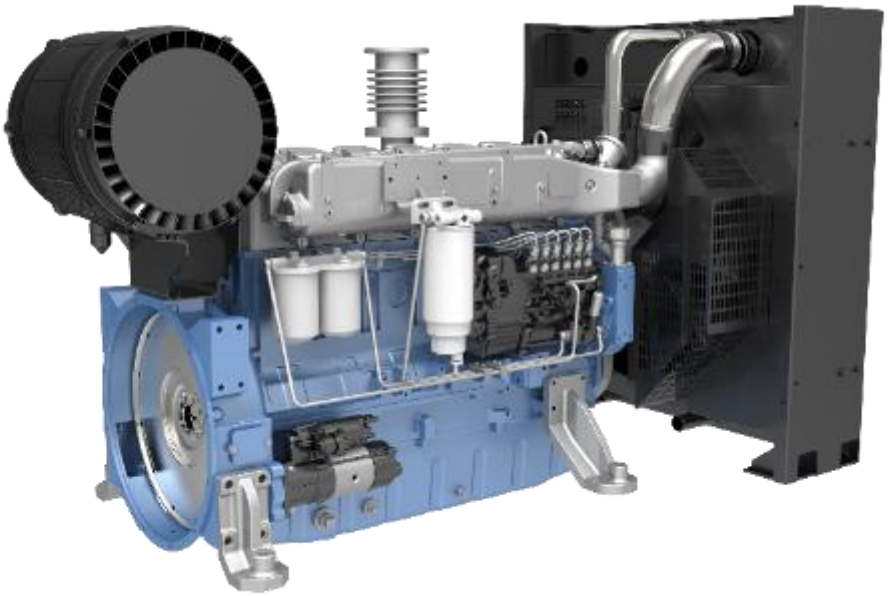
Operation and Maintenance Manual for PowerKit 6M16 Series



Dear Customer,

Thank you for choosing a Baudouin PowerKit engine!

This series has a compact structure, reliable operation, excellent performance, low fuel consumption and meets the requirements of international emission standards. The engine is quick to start, simple to operate and easy to maintain.

We are committed to launching new products and continuously improving our range. Therefore notification of changes will be made via our website; please visit Baudouin.com for the latest product information.

This manual covers the basic information for the use and maintenance of the engine. To gain optimal performance and to maintain the engine properly, please carefully read this operation and maintenance manual, and operate in strict accordance with the relevant provisions.

Notice

1. Before delivery, this series of diesel engines have already been tested, strictly following the test specification. Therefore, never dismantle the lead sealing on the throttle to raise its openness. Never dismantle or impact the rotor of turbocharger which belongs to the sophisticated parts; never loosen or remove the main bearings of diesel engine and bolts attached to connecting rod which have strict requirements for torque and angles.
2. As the bolts attached to connecting rod are disposable, never reuse them.
3. The operator of diesel engine should carefully read this Operation and Maintenance Manual, be familiar with the structure of the diesel engines and closely abide by the technical operation and maintenance procedures specified in this manual.
4. At any time of starting the diesel engine, please check whether the coolant and engine oil is filled up.
5. For the new diesel engine, 50h running-in is needed, with maximum load not more than 80% of the rated load and average load not more than 60%.
6. The starting time of the engine should not last for more than 30s. If the engine can’t be started within 30s, wait for 1-2min for startup again.
7. After the diesel engine is cold started, please slowly increase the rotating speed, do not make high-speed operation suddenly and never idle running for long time.
8. After engine running with heavy load, do not immediately stop it. It is necessary to idle running for 5-10 min at low speed.
9. After engine is stopped, if the ambient temperature is less than 0℃, moreover additive is not applied; please completely drain the water in radiator and diesel engine.
10. The diesel engine is prohibited to work without air filter which could prevent particulates from entering the cylinder Please select the specified fuel and oil grades which will be filled into the diesel engine (it is suggested to use the Baudouin special oil sold at all service stations of Baudouin when change the lubricating oil). Use the special clean container.
11. The fuel and oil should be filtrated through the strainer before added. Let the fuel precipitate for 72h or more.
12. Do not simultaneously use the diethyl-ether-assisted starting equipment and pre-heater or glow plug.
13. The inspection of electrical system should be done by the personnel mastering electrical knowledge.
14. The invalid duration of oil sealing of diesel engine is one year. If they expire, please take necessary supplement measures.
15. Our company perform the quality-trace filing for industrial power 6M16.

Safety

CAREFULLY READ THIS MANUAL
BEFORE OPERATION

SAFETY WARNING

Failure to comply with the preventive measures and safety instructions included in this manual and with warnings indicated on the engine may lead to injury or even death.

This operation and maintenance manual must therefore be kept on board and must be easily accessible, ready to be consulted at any time.

Furthermore, this manual must stay with the engine if it is sold. The subsequent owner of the engine will also need the information it contains.

Symbols used in the operation and maintenance manual

Foreword

As you read this operation and maintenance manual, take note of the warnings indicating the precautions to be taken to avoid unsafe practices and conditions.

In this manual, the following symbols are used to highlight specific information.

Clearly these safety instructions alone are not sufficient to avoid danger. The only way to avoid accidents is to strictly comply with the specific instructions that apply to each operation and to use common sense.

Hazard warning

WARNING
AUTOMATIC OR
REMOTE START

This "Danger" symbol warns against the risk of automatic or remote start of the installation. The installation must be isolated prior to any intervention.

This warning sign is recognised across the world. In this guide, it is used to highlight the importance of the information that follows. Make sure that you understand the consequences of a dangerous situation and the ways in which to avoid danger. Failure to comply with warnings can result in material damage, injury or even death.

We often see an indication of danger as a general warning. In this Manual, there are different types of warning depending on the possible consequences of the danger (minor injury, serious injury, death).

⚠ WARNING	**This type of warning indicates a potentially dangerous situation, which if not avoided, MAY result in serious injury or even death, or considerable material damage.**
⚠ CAUTION	**This type of warning indicates a potentially dangerous situation, which if not avoided, may result in minor injury or material damage. It can also warn against dangerous practices.**

Before maintenance and repair, please notice that:

◆Avoid repeated exposure to used oil for a long time.

◆ If possible, wear protective clothing and waterproof gloves.

◆Do not keep oil-soaked rags in the pocket.

◆ Prevent oil from soaking the clothes, especially underwear.

◆ Wash the uniform frequently. Throw away the oil-soaked clothes and shoes that cannot be cleaned.

◆Use first aid immediately if there are any cuts or other injuries.

◆Apply protective cream before working so that the mineral oil is easier to get cleaned after getting on the skin.

◆Clean your hands with soap and hot water, or use the hand sanitizer and nail brush to remove all oil. If there's skin natural sebum loss during the wash, products containing lanolin can be used to help moisturize the skin.

◆Do not use gasoline, kerosene, fuel oil, thinner or other solvents to clean the skin.

◆ If you have a skin irritation, consult a doctor immediately.

◆ If possible, remove the oil/grease on the parts before handling them.

◆If there is possible danger to your eyes, use goggles or face shield. Eye wash solution must be available around the operating location.

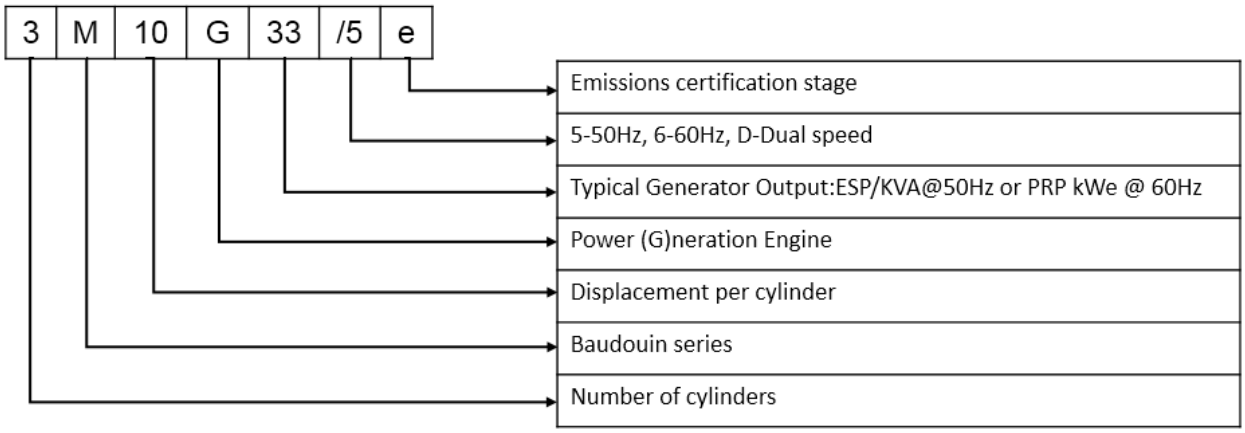
◆ When maintaining the engine, do not splash oil or other liquids onto the floor. If there's an accidental release of hydrocarbons or other liquids, take all necessary measures to isolate the leaking area to keep the environment clean and to protect personnel from injury.

◆The handling, storage and recycling of hydrocarbons, ethylene, glycol and petroleum must comply with safety and environmental standards of the country where the operation is done.

Contents

1.Structure and parameters of the diesel engine

1.1Model Meaning of the diesel engine



1.2 Main technical parameters of the engine

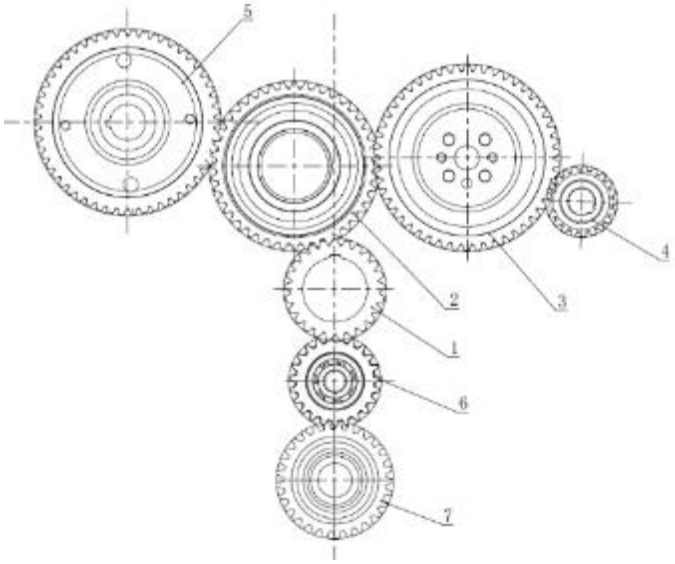
Items	Unit		Parameters
Engine type	—		In line, watercooled, 4-stroke, DI, turbocharged and intercooled
Number of cylinders	—		6
Bore/stroke	mm×mm		126×130
Displacement	L		9.726
Power	kW		320~360 (emergency standby power)
Oil/fuel consumption ratio	%		≤0.2
Emission level	--		China non-road Stage II
Crankshaft rotation direction	--		Clockwise (view from the free end)
Starting method	--		Electric started
Allowed longitudinal inclination (front side/rear side)	Long time	°	10/10
	Short time	°	30/30
Allowed transverse inclination (intake manifold side/exhaust manifold side)	Long time	°	45/15
	Short time	°	45/30

2. Brief introduction of main systems of the diesel engine

2.1 Gear train and valve mechanism

2.1.1 Sketch drawing of the gear train

6M16 series diesel engine adopts the front designed gear drive system (as shown in figure 2-1).



1-crankshaft timing gear; 2-intermediate gear; camshaft timing gear; 4-air compressor gear;

5-injection pump gear; 6-oil pump intermediate gear; 7-oil pump gear

Figure 2-1 Gear train transmission diagram

2.1.2 Adjustment of valve clearance

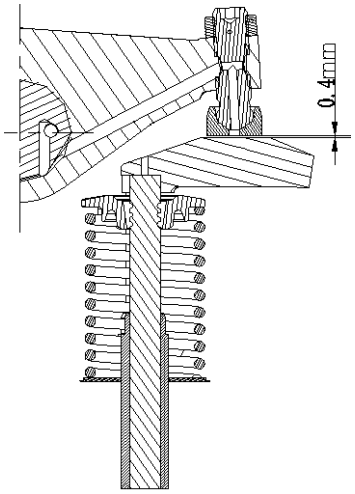


Figure 2-2 Inlet valve clearance (cold state)

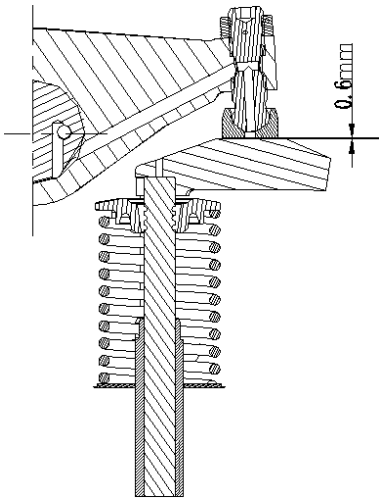


Figure 2-3 Exhaust valve clearance (cold state)

2.2 Lubrication system

The functions system include wear reduction, flushing, cooling and rust prevention, and the engine oil to be used should be selected according to the company's standards. And multi-grade oil is preferred because it is benefit for cold starting performance. Multi-grade oils for use all year around,

including 15W40, can be used within the specified temperature range. At occasional low temperature, the engine oil can be preheated by taking appropriate measures, or replace the engine oil suitable for the ambient temperature.

Time interval for replacement of engine oil is based on the requirements of maintenance and service.

a)The engine is generally not filled with lubricating oil in delivery, and lubricating oil must be filled prior to starting of diesel engine.

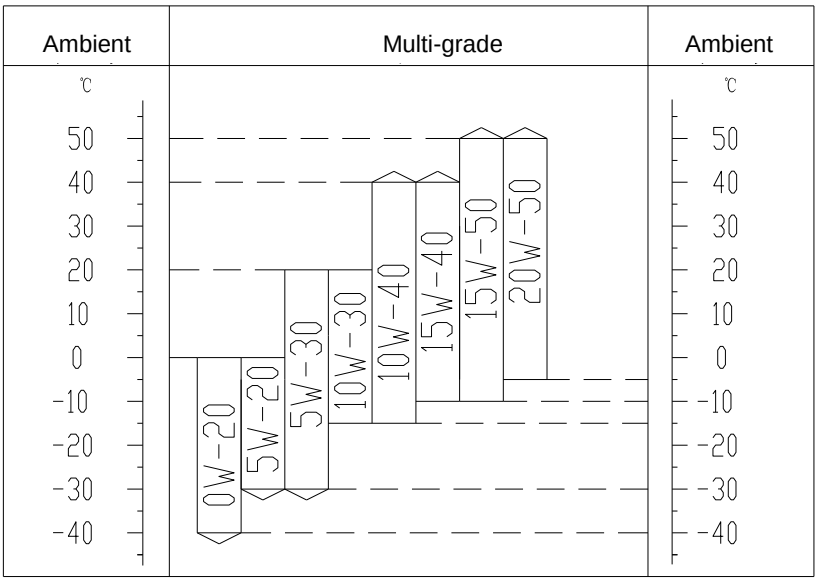
b) Please select the lubricating oil with appropriate viscosity grade based on the ambient temperature (see table 1), and only multi-grade oil can be used.

c) It is recommended to use Baudouin Power special lubricating oil.

d)When the engine is stopped and remains stationary, the oil level in the oil pan must be located in between the maximum and the minimum markings of the oil dipstick.

e)So far, the engine oil additives has not been found to bring any positive effect on operation of 6M16 series diesel engine, so the use of any engine oil additive is strictly forbidden.

Table 2-1 Selection of lubricating oil grade based on ambient temperature



Notice: The lubricating oil with grade CF-4 or above is used to 6M16 diesel engine forpower generation. Each time when replacing the lubricating oil, the oil filter element must be replaced!

Forced lubrication:

The engine oil from the oil pan passes through the oil strainer and then is pumped into the oil filter and oil cooler by the oil pump, and finally arrives at the positions need to be lubricated through the oil line system. Most of the oil will come to the main bearings and then to the connecting rod bearings via the oil hole of crankshaft. The lubrication of cylinder liner surface and piston pin is achieved through the lubricating oil injected by the piston cooling nozzle. The valve control system, turbocharger, oil pump and intermediate gear bearing are also provided with forced lubrication via the oil pipe and oil groove. The piston head is cooled through injecting lubricating oil to the inner chamber of piston by the piston cooling nozzle; and the lubricating oil is cooled by the cooling water in oil cooler. The pressure of lubricating oil in the circulation system is regulated by the pressure limiting valve in the oil pump body.

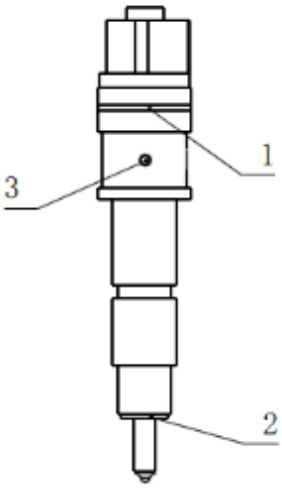
When starting the diesel engine, with low oil temperature and high viscosity, the oil pressure will be higher, but as water temperature of the diesel engine increases, the oil temperature will increase and the oil pressure will gradually drop to the normal range of 350kPa~580kPa.

2.3 Fuel system

Since the fuel system is of critical part of the diesel engine, the manufacturing and installation of fuel tank and fuel pipe and quality of the fuel used can influence the performance and reliability of the diesel engine. The fuel tank prepared by the user must be clean and free of rust and corrosion, and it must be made of materials which do not react with diesel fuel to avoid production of foreign matters. The fuel tank must be provided with fuel drain device to drain the water and foreign matters in the fuel. It is recommended that a valve should be designed on the outlet pipe of the fuel tank to facilitate maintenance of the pipeline.

2.3.1 Fuel returning

When installing, the fuel return pipe shall not contact with hot parts (e.g. exhaust manifold, turbocharger, and exhaust gas recirculation pipe) of the diesel engine. There should be no throttling area in the fuel return pipe. The fuel return pipe cannot touch any sharp edge, be folded to form sharp corners or even be twisted. Incorrect installation of fuel return pipe will cause fuel leakage.



1. O-ring; 2. Gasket; 3. Fuel return hole of injector

Figure 2-4 Fuel return method

Internal fuel return through the cylinder head is adopted for6M16 four-valve diesel engine for power generation (figure 2-4). In this manner, the injector mounting hole is located in the cylinder head, so it should be ensured that fuel return is completely free of leakage.

2.3.2 Internal high-pressure connection

The high-pressure fuel comes to the injector via the fuel inlet joint inside the cylinder head. For the high-pressure sealing of standard fuel inlet joint, the pre-tightening force should be at least 12kN, and it should not exceed 22kN. Excessive pressure will result in leakage due to overload of the fuel inlet joint.

When installing the fuel inlet joint, apply some oil to the O-ring and thread pairs. The screw threads and shaft shoulder must also be oiled. The mineral oil is recommended. The oil to be used must be suitable tothe materials of O-ring. For the O-ring and threads with the surfaces being lubricated already, no oil is needed to apply.

Due to the lateral sealing force of fuel inlet joint, improper mounting of the joint will cause inappropriate stress on the injector (the lateral force resulting from fuel inlet joint may cause bend of the injector). The 5-step tightening method from previous practices is most suitable to minimize the force deformation of injector.

Recommended 5-step method for tightening the fuel inlet joint:

1) Insert the injector into cylinder head. Ensure that the injector is correctly placed and contacts with the seal ring correctly, and then tighten the clamping bolt of injector to 3Nm.

2) Loosen the clamping bolt to make the axial force acting on the injector equaling to zero, and ensure that the injector is located correctly in the cylinder head.

3) Pre-tighten the high-pressure fuel inlet joint (nut) to the torque of (15~20) Nm. This torque is essential for rotating the injector to align with the fuel hole.

4) Tighten the injector clamping bolt to the torque of 8Nm, and then turn an angle of 90°.

5) Tighten the high-pressure fuel inlet joint (nut) to the torque of (50~55) Nm.

Notice: High-pressure fuel inlet joint, O-ring and seal gasket can be used only once.

2.4 Cooling system

The function of cooling system is to ensure that the diesel engine can operate continuously at the suitable temperature. The forced circulating cooling provides the best guarantee for achieving the operating temperature promptly. The circulation of cooling system is as shown in figure 2-5. The cooling system mainly consist of water pump, intercooler, cooling water chamber of diesel engine, oil cooler, thermostat, water pipe and fittings. The circulating water is used mainly for cooling engine oil and the diesel engine, and to ensure continuous operation of the diesel engine at appropriate temperature, the water circulation is divided into long circulation and short circulation. When the water in the diesel engine is at low temperature, the thermostat is closed, and cooling water enters the water pump of the diesel engine through the thermostat to increase the water temperature rapidly. When the water temperature reaches to 76°C, the thermostat opens and the cooling water enters the radiator for cooling.

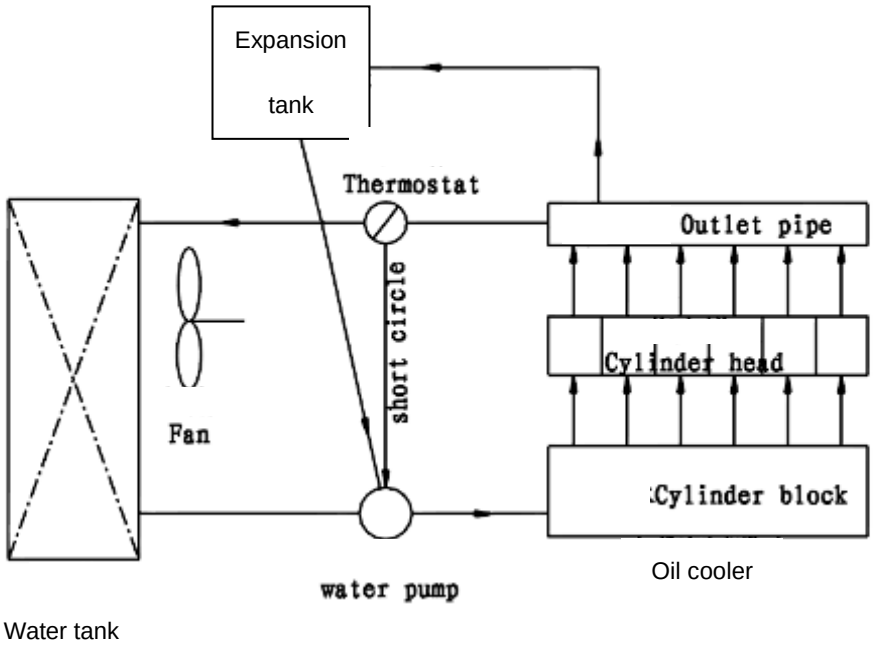


Figure 2-5 Circulation of cooling system

For the 6M16 four-valve diesel engine for power generation, there is a water drain hole is designed at the oil cooler cover (figure2-6).

Caution: After shutdown of diesel engine in winter or in cold region (ambient temperature is below 5°C), if no anti-freeze additive is added in the coolant, open the discharge valve on the oil cooler to drain the cooling water to prevent the diesel engine body from being frost cracked.

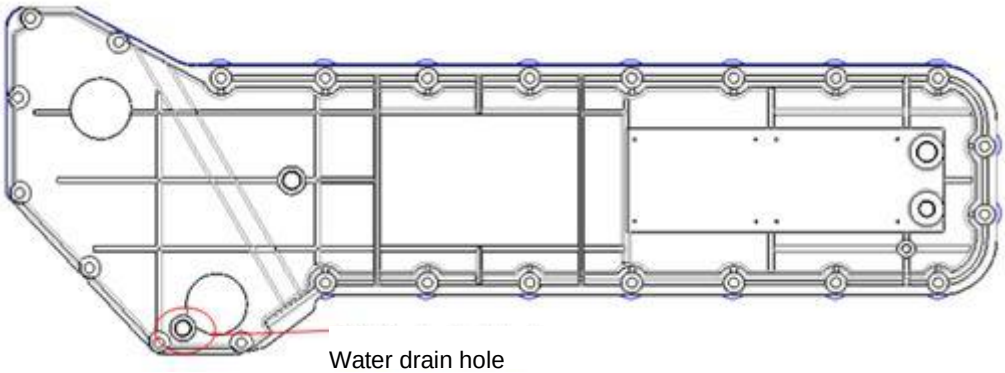


Figure 2-6

2.5 Electrical units

The electric system is composed of alternator, starter and monitoring instrumentation.

2.5.1 Alternator

The alternator is of 3-phase AC alternator, and DC current will be generated after silicon rectification. Rotation direction: clockwise (viewed from drive end). Figure 2-7 shows the circuit

diagram of the alternator.

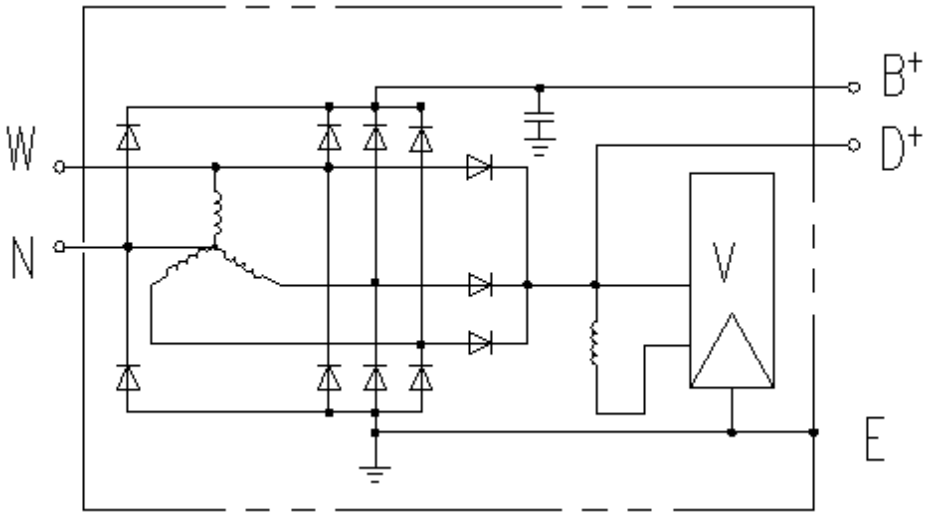


Figure2-7

Precautions during installation and wiring of the alternator:

a) It should be fully cooled;

b) It must be dust-proof, splash-proof and oil-proof;

c) Check the tension of alternator belt;

d) It can only connect with voltage regulator and battery.

2.5.2 Starter

DC starter: 24V and 5.4kW; rotation direction: clockwise; 11-tooth gear.

Figure 2-8 shows the circuit diagram of the starter. Wiring terminals of the starter:

30 connected to the anode of battery;

31 connected to the ground;

50 connected to the solenoid switch.

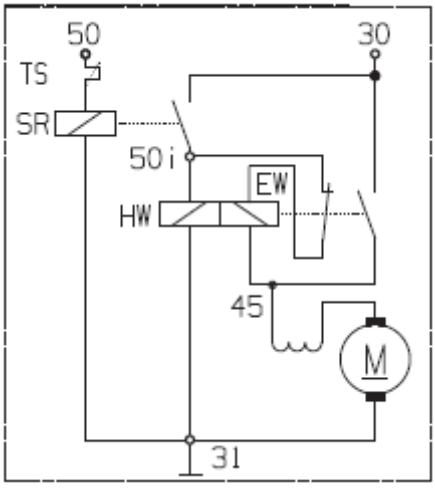


Figure 2-8

2.5.3 Storage battery specifications

2×12V 165Ah, 180Ah is available.

3. Installation and use of the diesel engine

3.1 Unsealing of the diesel engine

After opening the engine packing case, please first check the engine and its accessories according to the packing list, and check the engine appearance for damage and loose connections before carrying out the following operations:

1) Wipe away the rust proof coat or anti-corrosion agent on surfaces of exposed components;

2) Discharge the sealing oil from the fuel filter and fuel system components (it is allowed to run the engine with load only when the sealing oil is used up and the normal diesel fuel has been supplied). Notice: The oil seal is only effective for one year, and when the time is up, please get your engine inspected and take necessary remedies.

3) Rotate the flywheel and spray solvent into the intake pipe until the oil sealing oil in the cylinder is completely removed.

4) Spray solvent into the turbocharger intake/exhaust ports until the oil sealing oil is completely removed.

5) Add oil to the oil pan as required.

6) Add coolant to the engine cooling system. The coolant should be softened fresh water containing anti-freeze additives.

Notice: Do not start the diesel engine until it is installed and connected into position. Keep good ventilation if the engine runs in enclosed environment, make sure that the exhaust gas be discharged into the atmosphere.

3.2 Hoisting of the diesel engine

When hoisting up and down of the diesel engine, it should be slow and keep the engine crankshaft centerline horizontal, and never hoist it obliquely or from one side (as shown in figure 3-1).

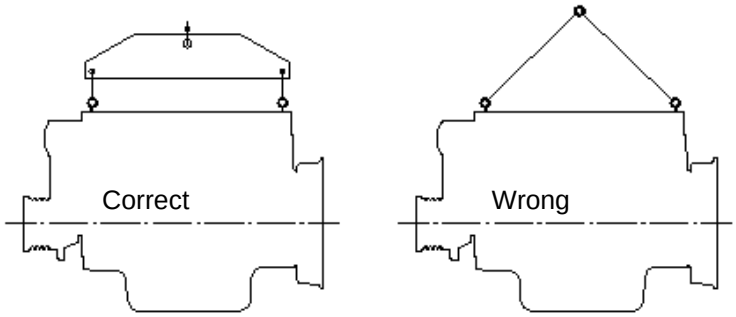


Figure 3-1 Hoisting of the diesel engine

3.3Installation of the diesel engine

3.3.1 Installation of the diesel engine

When installing, it should be ensure that the axis of diesel engine crankshaft is coaxial with that of input shaft of external device and flexible coupling should be used so that the crankshaft is not affected by the additional force originated from the installation avoiding damage of diesel engine thrust bearing.

3.2.2 Installation of air intake system

The air intake port of the diesel engine should be arranged at the rainproof, cool and ventilated place with less dust. The intake pipe of diesel engine should have the fewest elbows, and large arc transition should be used. The air filter at the air inlet should be provided with a protective cover to

prevent water and pollutant from entering the diesel engine.

3.3.3 Installation of exhaust system

The external exhaust pipe must be steel pipe avoiding excessive bends, and it should be firmly fixed. No vibration of such pipe is allowed, and it shall not impose any force on the expansion pipe of the diesel engine. After installation of the exhaust system, the exhaust back pressure of the diesel engine shall not exceed 7.5kPa avoiding impacts on performance of the diesel engine. Since the surface temperature of the exhaust pipe is high during operation of the diesel engine, the exhaust pipe must be installed away from flammable objects, and the external exhaust pipe must be provided with thermal insulating device on the surface to prevent workers from being burnt.

3.3.4 Installation of cooling system

The inner cooling pipelines of the diesel engine have been connected before delivery, and no installation is required. The cooling water pipes should be made of anti-corrosion materials, and it should minimize the pipe length and elbow number as possible. The inner diameter of the water pipe shall not be less than that of the pipe joint to reduce the resistance in the water pipe and improve the efficiency of water pump.

3.3.5 Precautions for installation of front end output of diesel engine

The front end output belt pulley of diesel engine can be used to drive small machines like water pump and generator, and they should be arranged symmetrically on both sides of the diesel engine to avoid unidirectional pulling force on the crankshaft of diesel engine. If large machine is to be driven, flexible coupling must be used for connection. Such coupling should be installed based on the specified alignment accuracy and the coaxial accuracy should be calibrated regularly during operation to avoid damage to diesel engine components.

3.3.6 Refer to the above related sections for installation of other components of the diesel engine.

3.4 Preparations before starting the diesel engine

1) Coolant level check

The coolant level can be checked from the inspection hole on the expansion tank; if the coolant is insufficient, open the filler port cap to refill. It is prohibited to add a large amount of coolant when the engine is still hot to prevent the parts from being damaged due to sudden temperature change.

2) Check the fuel level

3) Check the engine oil level

The engine oil level of oil pan should be in between the upper and lower scale lines of dipstick. Add oil from the oil filler port if necessary.

4) Check all accessories of diesel engine for reliable connections and solve any abnormal phenomenon.

Check the starting system for normal wiring and check and ensure that the battery is sufficiently charged. Open the valve of fuel tank and remove the air inside the fuel system by operating the manual pump of the injection pump.

3.5 Starting of the diesel engine

Turn on the instrument power switch, and press down the starting button. If the engine cannot be started within 10s for the first attempt, repeat the above starting process after 1min. If the engine cannot be started for 3 successive times, stop the attempt and find out and solve the malfunction before retry. Once the engine is started, release the starting button, and check the readings of instrumentations. The oil pressure should be immediately displayed on the oil pressure gauge. Please note that the cold engine should not run at high speed it should run at idle speed for some time.

3.6 Stopping of the diesel engine

Before stop the diesel engine, you should remove the load and reduce the engine speed to (600~1000) r/min and running for several minutes. Switch off the power supply to instruments after shutdown. If emergency shutdown is needed, press down the stop button, or rapidly cut off the fuel supply pipe of the injection pump or block the air filter inlet port.

3.7Running of the diesel engine

1) After starting, run the engine at idle speed for several minutes. Then increase the speed to the rated and add some load. After the water temperature is above 60°C and the oil temperature is above 50°C, the engine can be operated under full load. Both the load and speed must be increased gradually, and sudden loading or unloading should be avoided.

2) It is recommended to run the engine with medium load during the running-in period (50h).

3) It is prohibited to run the engine at idle speed for a long time to avoid oily smoke.

4) During normal operation of diesel engine, it is allowed to run continuously at rated power and

rated speed. After unloading, the diesel engine should run at idle speed for 1 to 2 minutes before shutting down.

5) During operation, pay attention to the following parameters and the related places:

Main oil passage pressure: (350~580) kPa;

Main oil passage temperature at rated condition: (85~105) °C;

Outlet temperature of coolant: ≤98°C;

Exhaust temperature after turbine: ≤550°C;

Intake temperature after intercooler: (50~55)°C

Check the color of exhaust gas to estimate the working performance of fuel injector and the operating load; if the color is abnormal (i.e., black smoke), stop the engine for troubleshooting.

Notice: Check the diesel engine for water, air and oil/fuel leakages during operation; and if any, stop the engine for troubleshooting.

6) The operator should acknowledge the following features of the engine:

a. The engine power increases along with the speed, and reaches its rated value at rated speed.

b. Provide the diesel engine with inspection and maintenance at the required time intervals for routine inspection and technical maintenance.

3.8Operation of diesel engine in winter

1) Fuel: Choose the diesel fuel of proper grade depending to the ambient temperature in winter;

2) Lubricating oil: Choose the lubricating oil of different viscosities based on the season;

3) Coolant: Add anti-freeze into the cooling system, and determine the antifreeze grade and mixture ratio according to the ambient temperature.

4) Startup: Use starting aid when necessary in winter. After starting the engine, the running speed and load of diesel engine can be increased only after the oil pressure and water temperature become normal.

5) Battery: Before the advent of cold season, make sure to check the electrolyte level, viscosity and unit voltage of the battery; and if the diesel engine is to be withdrawn out of service for a long time and the ambient temperature is very low, it is recommended to remove the battery and keep it in a warm room;

6) Shutdown: To stop the engine in cold weathers, unload the engine first, and run it at idle speed

for (1~2) minutes, and wait for a while until the water temperature and oil temperature lower down; the coolant containing antifreeze additives should not be drained out after shutdown. However, if the coolant contains no antifreeze additive, make sure to open the drain valves or drain plugs on the engine block and oil cooler cover to fully drain off the coolant to prevent the engine from being frost cracked.

3.9Power definition and usage conditions of diesel engine for land power generation

3.9.1 Power definition

COP (Continuous Power)

The maximum power at which the diesel engine continuously runs with constant load and unlimited running time every year. It is ISO standard power.

PRP (Prime Power)

The maximum power at which the diesel engine continuously runs with variable load and unlimited running time every year. It is ISO standard power which the load can exceed 10% of the rated load at most.

ESP (Emergency Standby Power)

It is the maximum power in a certain variable power series, the diesel engine can run at this power for 200h per year. It is ISO standard power with limited fuel consumption.

3.9.2 Running conditions and applications of different powers

Table 3-1 Running condition sand applications of different powers of diesel engine

Power category	Running conditions	Applications
COP	1. Unlimited running time for every year; 2. Running with constant 100% of rated load; 3. Without overload capacity.	Be possible to run under high temperature and high altitude conditions
PRP	1. Unlimited running time for every year; 2. With the average load rate not exceeding 70% during every continuous 250h running duration; 3. Running for no more than 500h every year at 100% of rated load; 4. Be able to run for 1h at the overload rate of 10% within each 12h, and with the accumulated running time not exceeding 25h every year.	Be used under the agreed conditions for power output, e.g., the curtailment of utility power. The generating set can be synchronized to the power system of public utilities.
ESP	1. The annual running time not exceeding 200h, including the annual 25h running time at the most at 100% of rated load. 2. The average load rate not exceeding 80% within each 24h operation cycle; 3. Without overload capacity. 4. The diesel engine starts up without engine warming process, completing the acceleration to the rated speed from startup within 10s. For natural aspiration diesel engine, it shall be provided with pre-heating device when the ambient temperature is below 5°C so as to guarantee that the outlet water temperature of diesel engine is over 30°C; when the ambient temperature is over 5°C, no preheating device is required. For the turbocharged diesel engine, if the ambient temperature is below 10°C, the preheating device is required so as to guarantee that the outlet water temperature of diesel engine is over 30°C; if the ambient temperature is over 10°C, no preheating device is required.	To provide emergency electric power supply during power outage

4. Maintenance of the diesel engine

4.1 Fuel, lubricating oil, coolant and auxiliary materials for the diesel engine

4.1.1 Fuel

Summer: No. 0 diesel fuel(GB252) shall be used.

Winter: generally -10# diesel fuel shall be used; however, -20# diesel fuel shall be used if ambient temperature is lower than -15ºC, -35# diesel fuel shall be used if ambient temperature is lower than -30ºC.

The fuel used must conform to the requirements specified in section D.1 of Appendix D to the national standard GB 20891-2014.

4.1.2 Lubricating oil

For Baudouin Power industrial diesel engine, grade CF-4 lubricating oil shall be use. See Table 4-1 for details.

Table 4-1Baudouin Power special oil

Type	Category		Packing capacity
Diesel engine oil	CF-4	10W/30	4L，18L，170kg
		15W-40	
		20W-50	

For Baudouin Power special oil, please select the oil viscosity according to the ambient temperatures with reference to table 4-2.

Table 4-2 Oil viscosity grade and applicable temperature

SAE viscosity grade	Ambient temperature (°C)
10W-30	-25~35
15W-40	-20~40
20W-50	-15~50

Notice:1) Check the oil level in the oil pan before starting the diesel engine.

2) Do not check the oil level while the engine is still running.

3)It is not allowed to mix the Baudouin Power special engine oil with other oils.

Table 4-3 Oil filling volume and number of filters of Baudouin Power 6M16 diesel engine

Engine model	Oil filling volume (L)	Number of filters		
		Diesel engine		
		Oil filter	Fuel filter	
			Primary filter	Secondary filter
6M16	22~26	2	1	2

Remarks:

1) The oil filling volume in the table is for reference only. The actual filling volume is based on the markings of oil dipstick.

2) If Baudouin fuel system protector or fuel filter with water separator is equipped, their filter elements shall be replaced when replacing the fuel filter.

4.1.3 Coolant

The diesel engine cooling system must be filled with pure coolant. The coolant can be used to prevent freezing under cold weather and to prevent boiling under high temperature. Furthermore, the coolant contains rust-inhibiting and anticorrosion additives, which can offer special protection to the water tank and engine cooling chamber, and avoid cylinder liner and cooling system corrosion.

Baudouin Power special coolant swith freezing points of-25°C, -35°C and -40°Care available. Please choose different coolant according to the local ambient temperatures. Please choose the coolant based on the local ambient temperatures in such manner that the freezing point of coolant should be lower than the local air temperature of about 10°C.

Table 4-4 Special Coolant for Baudouin Power Heavy-Duty Engine

Type	Designation	Packing
Heavy-duty engine coolant	HEC-II-25 HEC-II-35 HEC-II-40	4kg，10kg

Notice:

(1) Check the coolant regularly to prevent corrosion damage. Replace the coolant if necessary.

(2) Never use water or low-grade coolant.

4.1.4 Auxiliary materials

Table 4-5 Auxiliary materials

No.	Name	Color	Function and application
1	Molykote Pulver (fine molybdenum powder)	Black	Applied on flat and smooth metal surfaces to prevent seizing For instance: Applied onto outer surface of cylinder liner
2	Molykote G-N plus (Molybdenum disulfide, oil solution)	Dark grey	Achieve lubrication function before lubricating oil pressure is built up For instance: Applied onto intake valve stem

Table 4-6 Application of sealant for diesel engine

Grade	Major application	Application part	Supplements
Baudouin special sealant 242	Applied onto the threads to prevent looseness due to vibration, with moderate strength.	Flywheel housing bolt Camshaft thrust plate bolt Camshaft timing gear bolt Intermediate idler gear bolt Front end cover bolt Oil filter head bolt Oil cooler bolt Screw plug of oil cooler regulating valve Bolt of oil pump return pipe fixtures Suction strainer bolt Bolt of sensor and wiring harness fixtures	Alternatively, DriLoc204 thread-locking adhesive can be used for pre-coating
Baudouin special sealant 262	Applied onto the external threads for locking, sealing, preventing vibration from causing looseness	Cylinder head auxiliary bolt	
Baudouin special sealant 271	Locking and tightening	Bowl-shape plug for oil hole	
Baudouin special sealant 277	For sealing between core and hole	Other bowl-shape plugs	
Baudouin special sealant 270	For sealing of cylinder head top surface	Push rod tube and cylinder head	
Baudouin special sealant 518 (updated product based on 510)	Applied on shining metal surface for sealing	Mating faces of cylinder block and crankcase Cylinder block front end face and the front end cover Connecting plate between the rear end face and flywheel housing Mating faces of oil filter seat and crankcase Water pump rear cover and cylinder block front end face Flywheel housing and connecting plate Mating faces of cylinder block and oil cooler cover Mating faces of cylinder block and oil filler port cover plate	

4.2Routine maintenance of the diesel engine

1) Check the coolant level, engine oil level and fuel level; and refill if necessary;

2)Check for oil, water and gas leakages;

3) Check the connection reliability of external parts and accessories;

4) Check the tension of belt;

5) Check the oil pressure of diesel engine;

6) Check the connector and wire connection;

7) Check the water temperature of diesel engine;

8) Check the temperature and color of exhaust gas, sound, vibration and speed of diesel engine.

- Check the liquid level and coolant temperature

Check the coolant level through the glass sight hole. And if it is insufficient, open the filler port cap to add coolant, as shown in Figure 3-1.

Notice: Before opening the filler cap, push down the air bleeding button to avoid personal injuries by the hot coolant while the engine is hot.

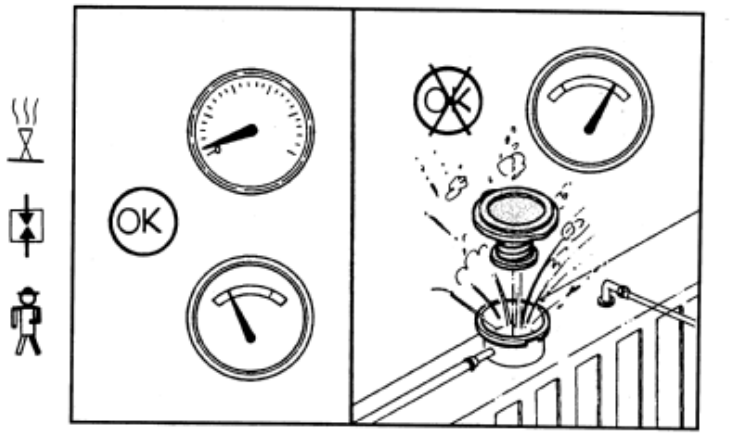


Figure4-1 Coolant filler port cap

- Check the oil level

It is not allowed to start the engine when the oil level is below the lower marking or above the upper marking.

When checking the oil level, stop the engine and wait for at least 5 minutes, enabling the oil to flow back to the oil pan.

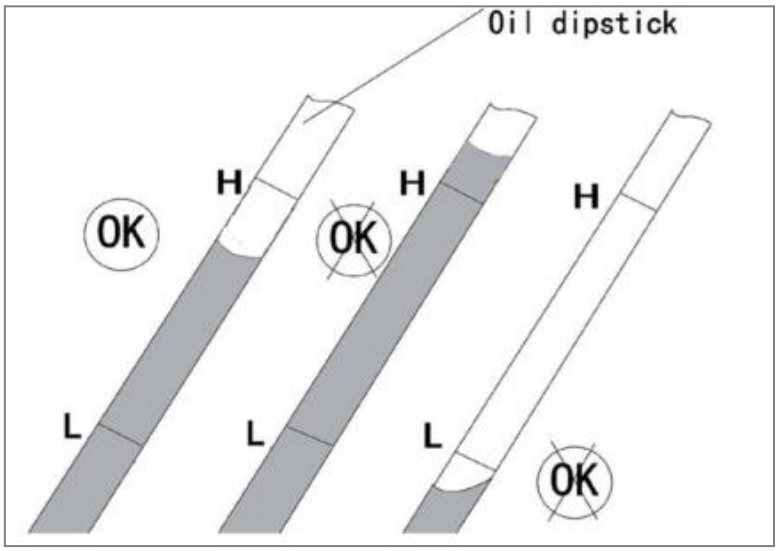


Figure4-2Checking of oil level

- Check the fuel level

Check the fuel level indicator on dashboard and add fuel if necessary.

- Check the engine for water, gas and oil leakages
- Check the fan

Visually check the fan blade for damage, and check the connecting bolts. As shown in figure 4-3.

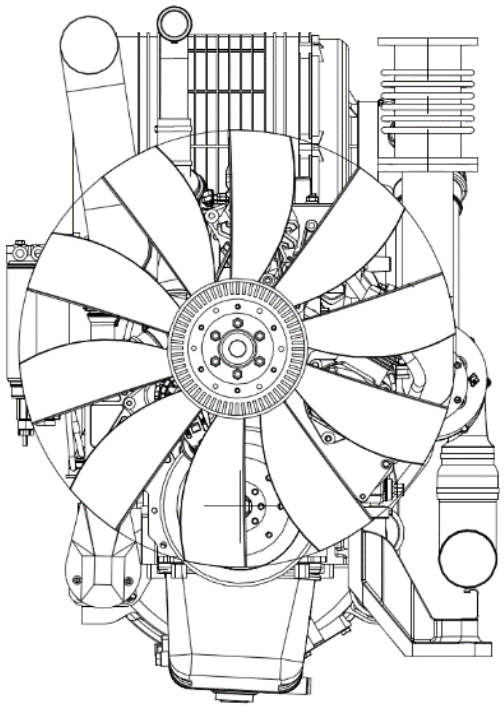


Figure4-3

- Check the belt tension

The belt is automatically tensioned by the ten sioner. You can check the tension of belt by pushing the belt with hand.

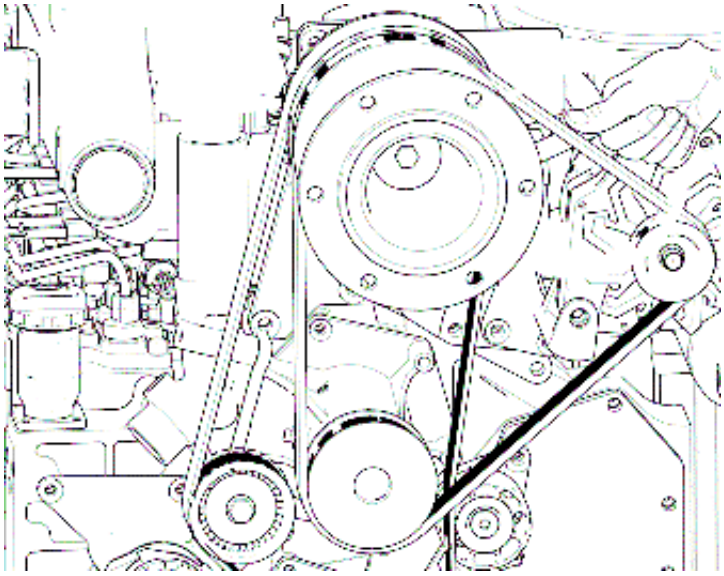


Figure 4-4 Check the color of exhaust

- Check the color of exhaust gas (figure 4-5)

The normal color of exhaust gas is light grey. Do troubleshooting if the color has changed.

Figure 4-5 Exhaust gas color checking

- Check the running sound of the diesel engine.
- Check the speed and vibration of the diesel engine.

4.3 Regular maintenance of the diesel engine

Table 4-7Maintenance items of the diesel engine

Maintenance item	First inspection	Routine inspection	WD1	WD2	WD3	WD4
Replace diesel engine oil	●	●	●	●	●	●
Water pump leakage checking	●		●	●	●	●
Replace oil filter	●	Each time when replacing the engine oil				
Check and adjust the valve clearance	●		●	●	●	●
Replace fuel filter			●	●	●	●
Cleaning fuel pump strainer			●	●	●	●
Check coolant volume and refill if necessary	●	●	●	●	●	●
Fasten cooling pipe clamp	●					
Fasten intake pipe and hose	●		●	●	●	●
Clean air filter element				●	●	●
Check and tighten the V-belt	●	●	●	●	●	●
Note:“●” refers maintenance is needed.						

4.4 Regular maintenance cycle of the diesel engine

Table 4-8Maintenance cycle of the diesel engine

Items	Operation conditions
First inspection	After running 30~50 hours
Routine inspection	Every 250 hours of running
Level 1 maintenance	Every 500 hours of running
Level 2 maintenance	Every 1000 hours of running
Level 3 maintenance	Every 2,000 hours of running
Level 4 maintenance	Every 4,000 hours of running
Note: The maintenance cycle mentioned here is calculated based on the condition that the engine is running 1500 hours per year. For engines running time less than 500 hours per year, the maintenance cycle is half. For engines running time more than 1500 hours per year, the maintenance cycle is 1.5 times of the above. If the generating set is used for standby power supply, the lubricating oil should be replace every year.	

4.5Maintenance of the diesel engine for long-term storage

4.5.1 Oil sealing method

Add lubrication system corrosion inhibitor to the lubricating oil. Start the engine and then stop it after running for (5~10) minutes. Remove the original diesel fuel inlet pipe and insert it into the barrel containing sealing oil for fuel system. Remove the air in the fuel system and start the diesel engine, run the engine at 2/3 of rated speed and then stop it after 15 minutes. Drive the engine with starter motor and spray oil sealing oil for intake/exhaust manifold to the inlet port of turbocharger with air spray gun. Stop spraying after the oil mist discharging out continuously from the exhaust manifold for 15s. Remove the pipe for oil sealing and close all exposed pipe ports of diesel engine with plastic covers. Coat the unpainted surfaces (except monitor and control apparatus, rubber hoses and warning signs) of diesel engine with rust resisting oil. Wrap up the diesel engine with plastic-film bag and store the engine in a dry and ventilating warehouse.

4.5.2 Oil used for oil sealing of diesel engine

Table 4-9 Oil used for oil sealing of diesel engine

No.	Name	Specification (code)
1	Oil sealing oil for fuel system	Spindle oil
2	Oil sealing oil for intake/exhaust system	Spindle oil

5.Common faults and troubleshooting

5.1Diagnosis and adjustment methods

Generally, the common diagnostic methods for malfunctions of diesel engine are as follows:

(1) Observation method: Judge the malfunction situation by observing malfunction features such as exhaust smoke color of diesel engine (figure 5-1).

(2) Listening diagnosis method: Judge the location, feature and extent of malfunction by listening the abnormal noise of diesel engine (figure 5-2).

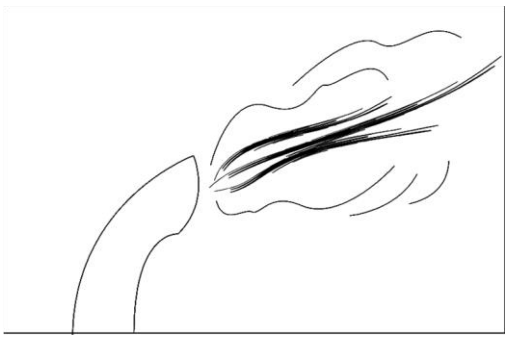


Figure 5-1

Figure 5-2

(3) Cylinder deactivation method: Generally, cut off the fuel supply to the suspect malfunctioned cylinder, and compare the working condition of the diesel engine before and after stopping fuel supply to narrow down the scope for further determination of the malfunction location or cause.

(4)Comparison method: Replace a certain assembly or component to determine whether there is failure.

Notice:

(1) The cause of diesel engine malfunction shall be determined carefully. Before the cause is basically found, do not disassemble the diesel engine at will. Or it will not only eliminate the malfunction, but also lead to more serious malfunction due to improper assembly after removal.

(2) Inspection and maintenance on critical components such as high-pressure fuel pump and turbocharger shall be performed by experienced personnel using special instrument or equipment. Users without experience shall not disassemble or adjust them.

5.2Common faults and troubleshooting

5.2.1 The diesel engine cannot be started

Cause	Troubleshooting
(1) Air trapped in fuel system	Remove the air in fuel system. Check the pipe joints for leakage and repair if any.
(2) Fuel injection pump malfunction	Check the plunger and delivery valve. Repair or replace the damaged parts.
(3) Fuel injector malfunction	Check the atomization of fuel injector, repair if necessary.
(4)Valve timing or fuel supply initial angle is wrong	Check and adjust.

(4) High-pressure fuel pipe damaged or there is fuel leakage	Repair or replace.
(5) Insufficient compression pressure in cylinder	Check the sealing of valve and cylinder gasket and check for worn piston rings. Repair or replace the faulty parts if any.
(6) Ambient temperature is too low	Use auxiliary start device.

5.2.2 Engine stopped soon after startup

Cause	Troubleshooting
(1) Air trapped in fuel system	Check the fuel pipe and its joint for leakage. Check whether the bleeder screw is securely tightened. Expel the air out of the fuel system.
(2) Fuel filter clogged	Take down the filter body. Remove dirt and moisture. If necessary, replace the filter element.
(3) Poor fuel quality with excessive moisture	Clean the filter, and replace fuel.
(4) Idle speed is too low	Re-adjust.

5.2.3 Insufficient engine power

Cause	Troubleshooting
(1) Intake system (air filter) is clogged	Check the air filter and intake pipe. Clean or replace the filter element.
(2) Exhaust back pressure is too high	Check and adjust the valve timing. Check the exhaust pipe for clogging. Remove clogging if any.
(3) Insufficient pressure in turbo charging system	Check and troubleshoot the leakage in the connecting pipe.
(4) Turbocharger malfunction	Replace the assembly.
(4-1)Compressor, turbine flow passage clogged	Wash or replace.
(4-2) Floating bearing failure	Replace
(4-3)There is carbon or sludge deposit at the back of turbine and compressor	Clean
(5) Fuel pipe leaks or is clogged	Check the fuel pipe and its joint for leakage. Check the fuel filter for contamination. Tighten and clean the fuel pipe. Replace the fuel filter element.
(6) Poor fuel quality	Clean the fuel tank, fuel filter and fuel pipe. Replace fuel.
(7) Instable atomization of fuel injector	Check fuel injection pressure. Check the injector for soot deposition. Adjust and repair the injector.
(8) Incorrect valve timing or fuel supply timing	Check and adjust
(9) Engine oil level in oil pan is too high	Referring to the oil dipstick, drain excessive oil.
(10) Cylinder gasket leaks	Check the compression pressure in the cylinder while the diesel engine is hot. Replace the damaged cylinder gasket.
(11) Piston ringis worn or broken. Excessive bearing shell gap	Replace the worn parts, or overhaul the diesel engine.
(12) Cylinder liner or pistonis worn or scratched	Over haul the diesel engine.

5.2.4 Excessive fuel consumption

Cause	Troubleshooting
(1) Intake system clogged	Check the air filter and intake pipe for clogging. Remove clogging if any
(2) Exhaust back pressure is too high	Check the exhaust pipe and brake valve for clogging. Remove clogging if any
(3) Poor fuel quality	Replace fuel in accordance with the requirements
(4) Fuel pipe clogged	Check the fuel pipe for clogging. Remove clogging if any
(5) Fuel pipe leaks	Check the fuel pipe for leakage. Remove leakage if any
(6) Instable atomization of fuel injector	Check, adjust and repair the fuel injector
(7) Cylinder gasket leaks	Check the compression pressure in the cylinder
(8) Excessive bearing shell gap, diesel engine overhaul is needed	Check and overhaul the diesel engine
(9) Piston scuffing	Replace the cylinder liner, piston and piston rings
(10) Insufficient pressure in turbo charging system	Check and troubleshoot the leakage in the connecting pipe
(11) Turbocharger malfunction	Check and replace the assembly

5.2.5 Engine exhaust gas is black

Cause	Troubleshooting
(1) Intake pipe is clogged or exhaust back pressure is high	Clean the intake or exhaust pipe
(2) Poor fuel quality	Clean the fuel system, replace fuel
(3) Instable atomization of fuel injector	Check, repair or replace
(4) Insufficient pressure in turbo charging system	Check and troubleshoot the leakage in the connecting pipe
(5) Turbocharger malfunction	Check and replace the assembly

5.2.6Engine exhaust gas is white or blue

Cause	Troubleshooting
(1) Poor fuel quality with excessive moisture	Replace fuel.
(2) Coolant temperature is too low	Check the operating temperature of the thermostat. Replace it if necessary
(3) Sealing ring of turbocharger damaged	Check and replace
(4) Thrust bearing of turbocharger damaged	Check and replace
(5) Oil return pipe of turbocharger clogged	Wash or repair
(6) Instable atomization of fuel injector	Check and repair
(7) Low compression pressure, incomplete combustion, piston scuffing	Check the piston rings, cylinder liner and cylinder gasket. Repair the damaged ones
(8) piston ring and cylinder liner	Continue running-in
(9) Piston ring gaps are not staggered	Adjust or reassemble
(10) Oil control ring failure	Replace
(11) Excessive clearance between piston and cylinder liner	Repair, replace

5.2.7 Oil gathering at the air inlet port and inlet pipe of turbocharger

Cause	Troubleshooting
(1) Turbocharger sealing failure	Repair or replace
(2) Oil-gas separator failure	Replace
(3) Oil pan liquid level is too high, excessive oil	Check and release appropriate amount of oil

5.2.8 Rotating speed is unstable

Cause	Troubleshooting
(1) Poor fuel quality with moisture or wax	Clean the fuel system, replace the fuel
(2) Air is sucked into fuel suction pipe	Check the fuel suction pipe and its joint for tightness. Expel the trapped air.
(3) Unstable atomization of fuel injector	Check and repair
(4) Turbocharger surging	Check and clean the compressor flow passage, remove the fouling and soot deposition
(5) Turbocharger bearing damaged	Replace

5.2.9 Oil pressure is too low

Cause	Troubleshooting
(1) There is no oil in oil pan or oil is insufficient	Check oil level and check for leakage, add oil.
(2) Engine oil grade is not compliant	Replace with compliant engine oil.
(3) Coolant temperature or engine oil temperature is too high	Check whether the cooling system works normally and eliminate the failure.
(4) Excessive resistance in engine oil filter	Replace with a new filter element.
(5) Engine oil cooler clogged	Check and clean.
(6) Suction filter, engine oil pipe, or washer of pipe joint is clogged or broken	Check the suction filter, pipe joint and oil passage for casting shrinkage porosity.
(7) Leakage from inlet pipe of engine oil pump	Check, repair or replace the inlet pipe and its joint.
(8) Failure of pressure regulator valve in main oil passage	Check, clean or repair the valve.
(9) Main oil passage clogged	Check and clean.
(10) Excessive bearing shell gap, or damaged bearing shell	Check and replace.
(11) Excessive wear of parts and components	Check and overhaul the diesel engine.

5.2.10 Coolant temperature is too high

Cause	Troubleshooting
(1) Coolant level in expansion tank is too low	Check for leakage. Add coolant.
(2) Water pump belt is slack	Adjust the belt tension in accordance with the requirements.
(3) Damaged washer or worn impeller of water pump	Check, repair or replace
(4) Damaged water pipe is sucking air in	Check the water pipe, pipe joint and washer. Replace the damaged ones.
(5) Thermostat failure	Replace.
(6) Expansion tank clogged	Check, clean and repair the expansion tank.
(7) Oil of oil panis insufficient	Check the oil level. If any leakage, repair it and add engine oil.

5.2.11 Parts wear is too fast

Cause	Troubleshooting
(1) Air filter element is unqualified or damaged	Check and replace the air filter element.
(2) Short circuit of air intake system	Check the intake pipe, gasket and connecting sleeve. Repair or replace the damaged ones.
(3) Engine oil filter element is not replaced timely	Replace the filter element at the required interval.
(4) Insufficient oil in oil pan	Check the oil level. Check for and repair leakage. Add engine oil.
(5) Engine oil grade is not compliant	Use engine oil of proper grade.
(6) Engine oil is unqualified	Replace with compliant engine oil.
(7) Oil passage clogged	Clean the oil passage.
(8) Piston ring is broken or worn	Replace the piston ring.
(9) Cylinder liner or piston is worn or piston scraping	Take down and inspect the piston and cylinder liner. Repair or replace the damaged ones.
(10) Crankshaft axis is not in line with the axis of driven shaft	Check and repair the mounting bracket.
(11) Part/component is worn excessively	Check the cumulative driving distance to see whether overhaul is needed.

5.2.12 Excessive noise

Cause	Troubleshooting
(1) The fuel is poor in quality	Replace the fuel
(2) Coolant temperature is too low	Check the thermostat, and replace it when necessary
(3) Injection nozzle has poor atomization	Check, repair and adjust
(4) Vibration damper is worn or damaged	Check the damage, and connecting bolt, and replace the damaged parts
(5) Valve leaks or is adjusted inappropriately	Overhaul and adjust the valve
(6) Excessive gear clearance or tooth fracture	Check and replace the damaged parts
(7) Cylinder liner or piston is worn or piston scuffing	Check and repair or replace
(8) Push rod is bent or broken	Replace
(9) Piston ring is broken or worn	Check or replace the damaged parts

5.2.13 Starter motor does not work

Cause	Troubleshooting
(1) Fuse burnt	Replace the fuse
(2) Poor contact of circuit	Check the circuit, and tighten the terminals
(3) Insufficient charge of battery	Check, charge or replace the battery
(4) Short circuit of starter motor	Inspect and repair the starter motor or replace the starter assembly
(5) Poor contact of electric brush	Clean or replace the electric brush

5.2.14 Starter motor is powerless

Cause	Troubleshooting
(1) Battery is undercharged	Charge or replace the battery
(2) Bearing bush is worn	Replace the assembly
(3) Poor contact of electric brush	Clean or replace the electric brush
(4) Commutator is dirty or burnt	Clean the oil stain. Polish the commutator by using sandpaper, or replace the commutator assembly
(5) Terminal unsoldered	Resolder
(6) Poor contact of switch	Check and repair the switch
(7) Clutch is worn or slipping	Adjust the operating torque of the clutch or replace the clutch assembly

5.2.15 The alternator does not generate electricity at all

Cause	Troubleshooting
(1) Short circuit or open circuit, connector loosened	Check the wires of alternator and ammeter and repair if necessary
(2) Rotor or stator coil is short circuit or open circuit, or is grounded	Repair or replace the assembly
(3) The rectifier valve is damaged	Replace the assembly
(4) Damaged paper insulation of terminal, causing broken wire	Repair
(5) Regulator voltage is too low	Repair
(6) Regulator contactor is burnt	Repair or replace the regulator assembly

5.2.16 Battery cannot be charged fully by alternator

Cause	Troubleshooting
(1) Short circuit or open circuit, connector loosened	Repair
(2) Rotor or stator coil is open circuit, short circuit or grounded	Repair or replace the assembly
(3) The alternator belt is slack	Check and adjust the belt tension
(4) Damaged rectifier valve of alternator, poor contact of battery terminal	Repair
(5) The regulating voltage of regulator is too low	Adjust
(6) The field coil or resistor connection of regulator is disconnected	Repair or replace
(7) Insufficient electrolyte in battery, or battery is too old	Add electrolyte, or replace the battery

5.2.17 Charging current unstable

Cause	Troubleshooting
(1) The coil of stator or rotor is about to open circuit or short circuit	Repair or replace
(2) Poor contact of electric brush	Repair
(3) Loose or poor contact of terminal	Repair
(4) Voltage regulator is damaged	Repair
(5) Improper voltage regulation	Check and adjust

5.2.18 The battery is overcharged by alternator

Cause	Troubleshooting
(1) Short circuit in battery	Repair or replace
(2) Regulator voltage is too high	Repair or adjust
(3) Poor grounding of regulator	Repair
(4) Regulator contact failure or contaminated, or the voltage coil or resistor wire is disconnected	Repair or replace

5.2.19 Alternator has abnormal sound

Cause	Troubleshooting
(1) Improper alternator installation	Repair
(2) Rotor has come into contact with stator	Repair or replace
(3) Bearing is damaged	Replace the bearing
(4) Short circuited rectifier	Replace
(5) Short circuited stator coil	Repair or replace

6 .List of diesel engine wear parts

Name	Quantity
Cylinder head gasket	6
Turbocharger gasket	1
Exhaust manifold gasket	6
Intake manifold gasket	6
Cylinder head cover gasket	6
Poly-V belt (10PK)	1
Poly-V belt (8PK)	1
Air line connecting hose	1
Air line connecting hose	1
Thermostat	1
Fuel inlet pipe	1
Fuel return pipe	1
Oil inlet pipe of turbo charge	1
Oil return pipe of turbo charge	1
Oil inlet pipe gasket of turbo charge	1
Fuel filter element	3
Oil filter element	2

7. Contact Us

SHANDONG HEAVY INDUSTRY INDIA PVT. LTD.
S. NO 280/281, Phase II, Hinjewadi, Village Mann
Tal - Mulshi, Dist - Pune. 411 057
Maharashtra, India.
\\www.shigindia.com
Toll free number: 1800 266 2388