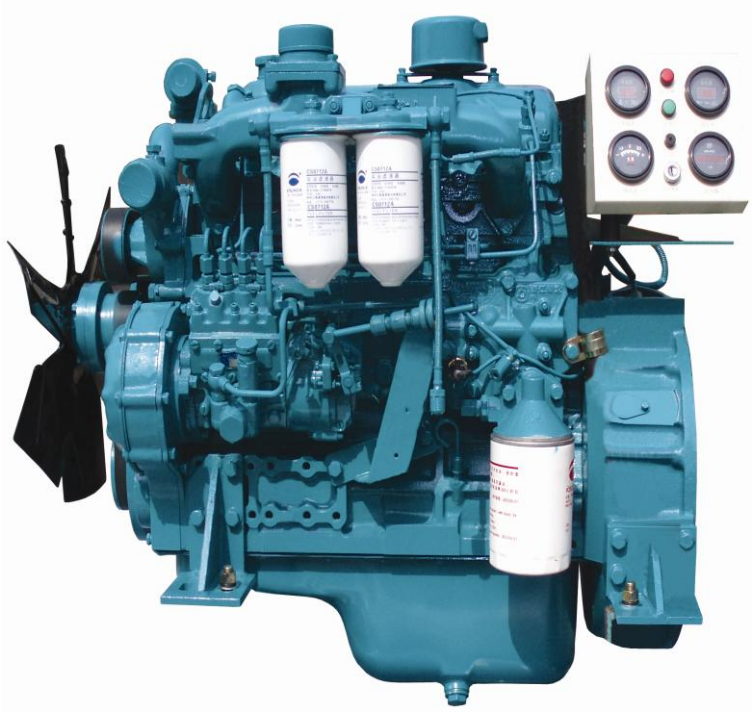
YC4D60-D21 /YC4D85Z-D20

YC4D60-D21 /YC4D85Z-D20 SERIES DIESEL ENGINE GENERATOR OPERATION & MAINTENANCE MANUAL



Guangxi Yuchai Machinery Co., Ltd

Diesel Manufacturing Licence NO.：

Company Name	Type specification	Licence NO.	term of validity	issuing date	explanation	reported agency	archive NO.	province
Yuchai Machinery Co.,Ltd.	Mult-cylinder diesel(for engineering plant use)	XK06-205-00187	2008.07.01	2003.07.02	licence-issuing	machinery product examination department	903	guangxi

Respected Yuchai's customer:

Welcome you to join the jade firewood machine user ranks, heartily hope our machine can bring the billowing source of wealth and the long-time good luck to you. This product uses the advanced technical design, the quality reliable, the service life is long, has the good power and the efficiency. In order to enable the machine the high performance to obtain a better display, and guaranteed the machine the safe operation, invites you before the use first in detail reads the textbook instruction for use below, and specially pays attention "the safe driving matters needing attention".

CAUTIONS ON SAFE DRIVING：

1. The oil pressure gauge probe,water temperature gauge probe,and particularly the low pressure alarm are the three very important components,of which immediate replacement is required for any malfunction.It is desired to always maintain the normal function of these components,any failure to comply with that may easily lead to crankshaft burn due to oil shortage or cylinder head crack due to overheat from water shortage.

2. After cleaning the oil filter gauze or during the process of replacing filter gauze, it should be noted to reinstall the filter only after refilling oil fully,and start the engine on idle running immediately after reinstallation；meantime,check if there is any sign of leakage to any filter.Correct the leaking filters or it may easily lead to crankshaft burn caused by oil shortage.

3．Each time you start the vehicle,first start the engine on idle running for 5 to 10 minutes till the engine warms up and all gauges working in normal function,then start to move.Never put the vehicle to sudden acceleration from cold-start.For any dramatic speed-up on cold status will damage the instruments and their corresponding parts and components and accelerate the wear and tear of engine's kinetic parts,consequently it will shorten the engine's life cycle.

4． Start the engine on first gear,no chuggle idling.

5．Avoid any sudden stall and quenching the engine at high speed,high load status,the appropriate way is to gear down the engine gradually and stop the vehicle after 5-10 minutes of engine idle running.

6．Strictly adjust the injection advance angle of the turbocharger engine according to the requirements specified in the Operation Mannual.When the engine power is decreasing,first check the intake pipe to find if there is any leakage and check the air cleaner for the clog of stuff.

7．Anytime you find the vehicle and/or engine is not working normally,stop it immediately to correct the malfunction ,never allow the vehicle running under an abnormal state.

8．Don't directly touch the high temperature parts (such as exhaust pipe) of the engine when you check it,don't open the radiator cover immediately just after stop,for this may cause physical burn.

9．Send the engine to a consignment technical service station of Yuchai for a run-in serviced when it reaches its first 1500-2500 km of mileage,or you will the warrantyfor this engine.

10．Anti-freeze coolant shall be used in the cooling system; otherwise no quality guarantee will be born by the Manufacturer.

11．The engine's normal working condition is -15℃~40℃n temperature and below 2000m in altitude,any operation under water or in fire are prohibited. Clean the air filter gauze during dusty and windy condition, replace the filter gauze immediately once it is found to be damaged. Please consult Yuchai's technical or service departments for working below -15℃or above 40℃or over 2500m in altitude, so that effective measures can be taken to ensure normal function.

12．Operate and maintain the engine improperly will lower the engine performance of power,economy,emission and life cycle,and also do harm to the environment.The cause and troubleshooting can be founded in the table I、table II、table III and “safety caution”.

13．Hoisting and transporting the engine according to the notes on the engine’s package, and store the engine in a condition of dry,clean,good ventilate and with no corrosiveness things. The engine’s storge is no longer than 12 months (counted from the ex-factory date)

14．Please open the radiator cap in the meantime while adding water to the diesel engine.

Foreword

YC4D60-D21、YC4D85Z-D20 series diesel engines are developed by Yuchai in the purpose of satisfying the diesel generator set market requirement. This model bases on the foundation of high-quality product YC4108Q、YC4108ZQ, and assimilate the diesel engine technique characteristics of generator set,which is the amalgamation of our company's abundant experience and overseas advanced technology.YC4D85Z-D20 engine bases on the model of YC4D60-D21 engine, adopt exhaust gas turbocharging technique ,which is good in motive force and fuel efficiency and meet the emission and low noise requirement. The series has good performance in motive force 、fuel efficiency and dependency. The model, compact, simple, easy maintenance.

This manual introduces the main technical specifications、the basic assemblage requirements、the engine adjustment、the operation and maintenance and the troubleshooting of the YC4D60-D21、YC4D85Z-D20 engine. Proper operation and maintenance will prolong the use life and ensure safety in operation. Please read this Manual carefully before use, and pay special attention to CAUTIONS ON ENGINE USE. To ensure the engine use properly and maximize the client's economic effectiveness, please make the engine maitenance work actually.

This manual is only about the basic model of this series generator set ,which is the same for operation and maintenance the modified models.As requirements for technology is developed so fast,modification will be carried out without information.

This manual is explained by YUCHAI Technology Centre and YUCHAI Technology Service Centre takes charge of the technology consults and advices.

Guangxi Yuchai Machinery Co. Ltd

Contents

Engine specifications and accessories

Engine specifications

No.	Name	Specifications	
1	Model code	YC4D60-D21	YC4D85Z-D20
2	Type	vertical, in-line, liquid-cooled and four-stroke engine	
3	Liner	wet type	
4	Combustion chamber	directing injection and reentrant ωtype	
5	Intake	natural aspirated	turbocharged
6	Cylinder number	4	
7	Cylinder bore (mm)	108	
8	Stroke (mm)	115	
9	(L) Displacement	4.214	
10	Compression ratio	17：1	
11	Rated power (kW)	37	45
12	Rated speed (r/min)	1500	
13	Rated fuel consumption (g/kW.h)	≤240	≤230
14	Min. continuous idle speed (r/min)	≤700	
15	Steady speed regulation (%)	≤3	
16	Transient speed regulation (%)	±7	

17	Stabilizing time (s)	≤5	
18	Speed fluctuation (%)	0.5	
19	Oil consumption (g/kW.h)	≤1.8	
20	Soot (FSN)	≤4.0	
21	Exhaust temperature (℃)	≤550	
22	Noise limit [dB(A)]	≤108	≤109
23	Fire order	1-3-4-2	
24	Piston average speed(m/s)	5.75	
25	Rotation direction of crankshaft	counterclockwise (face to output end)	
26	Lubrication system	combination of splash and pressure	
27	Cooling system	pressurized circulating liquid cooling	
28	Start system	24v electric	
29	Net weight (kg)	360	370
30	Dimensions (length×width×height) (mm)	1032×722×948	1032×704×1254

Technical data of adjustment and control for engine

Item		YC4D60-D21	YC4D85Z-D20
(MPa) Oil pressure	at rated speed	0.25～O.6	
	at idle speed	≥0.1	
Oil temperature		≤100	
Cooling water outlet temperature		75～95	
Static fuel supply advance angle (ºCA)		14±2	
Cold valve clearance (ºCA)	Intake valve	O.40±0.05	
	Exhaust valve	0.45±0.05	
Valve timing (ºCA)	Intake valve advance open	14	
	Exhaust valve lag close angle	44	
	Exhaust valve advance open angle	56	
	Intake valve lag close angle	12	
Valve recession height (mm)		1±O.2	
Protrusion height of fuel injector over cylinder head bottom surface (mm)		3.6±O.1	

Cylinder compression clearance (mm)	1±O.1
Oil volume (L)	13(11 in oil sump)

Tightening torques of the connecting screw thread

1. Tightening torques of main bolts and nuts are shown below:

Description	Tightening torque(N•m)	Description	Tightening torque(N•m)
Cylinder head bolt	210～250	Flywheel bolt	170～210
Main bearing bolt	220～260	Crankshaft belt pulleyfastening bolt	≥300
Connecting rod bolt	160～200	Camshaft gear locking bolt	≥300

2. Except for the important connecting screw thread, tightening torque of other bolts and nuts can be selected according to the table below:

Screw thread specifications	M6	M8	MlO	M12	M14
Tightening torque(N·m)	10～20	20～30	35～55	70～90	110～130

Main parts fit clearances

No.	Description	Prescribed dimensions (mm)	Type of fit	Assembly tolerance (mm)
1	Exhaust valve seat insert/exhaust valve	$\Phi 44.5^{+0.025}_{0}/\Phi 44.5^{+0.095}_{+0.070}$	interference	0.045～0.095
2	Intake valve seat insert/exhaust seat	$\Phi 48.5^{+0.025}_{0}/\Phi 48.5^{+0.139}_{+0.114}$	interference	0.089～0.139
3	Valve guide/cylinder head valve guide hole	$\Phi 16^{+0.018}_{0}/\Phi 16^{+0.046}_{+0.028}$	interference	0.010～0.046
4	Valve guide/exhaust valve stem	$\Phi 9.5^{+0.019}_{0}/\Phi 9.5^{-0.04}_{-0.062}$	radial clearance	0.040～0.081
5	Valve guide/intake valve stem	$\Phi 9.5^{+0.019}_{0}/\Phi 9.5^{-0.025}_{-0.047}$	radial clearance	0.025～0.066
6	Rocker arm bush/ rocker arm shaft	$\Phi 25^{+0.021}_{0}/\Phi 25^{-0.02}_{-0.041}$	radial clearance	0.020±0.062
7	Cylinder bore/diameter of the lower part of the piston skirt	$\Phi 108^{+0.022}_{0}/\Phi 107.86\pm 0.01$	radial clearance	0.130～0.172
8	Valve tappet/cylinder block tappet hole	$\Phi 28^{+0.052}_{0}/\Phi 28^{-0.02}_{-0.041}$	radial clearance	0.020～0.093

9	Camshaft bearing bore in cylinder block /camshaft bearing bush	$\Phi 62\,^{+0.03}_{0}/\Phi 62\,^{+0.106}_{+0.087}$	interference	0.057～0.106
10	Camshaft bearing bush/camshaft journal	$\Phi 58.5\,^{+0.03}_{0}/\Phi 58.5\,^{-0.03}_{-0.06}$	radial clearance	0.03～0.09
11	Timing idle gear bush/idle gear shaft	$\Phi 55.5\,^{+0.03}_{0}/\Phi 55.5\,^{-0.03}_{-0.06}$	radial clearance	0.03～0.09
12	Timing idle gear/idle gear shaft	$28\,^{0}_{-0.08}/28\,^{+0.17}_{+0.07}$	axial clearance	0.07～0.25
13	Top ring groove height/top gas ring height	2.695 ± 0.015 / $2.605\,^{-0.01}_{-0.03}$	axial clearance	0.085～0.135
14	Second ring groove height/second gas ring height	$2.5\,^{+0.10}_{+0.08}/2.5\,^{-0.010}_{-0.025}$	axial clearance	0.09～0.125
15	Oil ring groove height /oil ring height	$3.5\,^{+0.04}_{+0.02}/3.5\,^{-0.010}_{-0.025}$	axial clearance	0.030～0.065
16	Connecting rod bearing (with shell)/crankpin	$\Phi 66\,^{+0.089}_{+0.040}/\Phi 66\,^{0}_{-0.019}$	radial clearance	0.040～0.108
17	Connecting rod bush/piston pin	$\Phi 38\,^{+0.036}_{+0.025}/\Phi 38\,^{0}_{-0.011}$	radial clearance	0.025～0.047

18	Piston pin/pin boss	$\Phi38^{+0.012}_{+0.005}/\Phi38^{0}_{-0.011}$	radial clearance	0.005～0.023
		$\Phi40^{+0.012}_{+0.005}/\Phi40^{0}_{-0.06}$		0.005～0.076
19	Cylinder block main bearing (with shell) /crankshaft journal	$\Phi85^{+0.122}_{+0.060}/\Phi85^{0}_{-0.022}$	radial clearance	0.060～0.144
20	Camshaft spacer/thrust disk	$5^{+0.12}_{+0.06}/5^{-0.04}_{-0.08}$	axial clearance	0.10～0.20
21	Width of the oil pump rotor /depth of bore in oil pump body	$22^{0}_{-0.021}/22^{+0.08}_{+0.05}$	axial clearance axial clearance	0.05～0.101
22	Outer diameter of outer rotor/ bore in oil pump body	$\Phi69.7^{0}_{-0.08}/\Phi69.8^{+0.15}_{+0.05}$	radial clearance	0.15～0.33
23	Oil pump shaft bushing(I)/oil pump shaft	$\Phi19^{+0.075}_{-0.050}/\Phi19^{+0.025}_{+0.012}$	radial clearance	0.025～0.063
24	Oil pump shaft bushing(II)/oil pump shaft	$\Phi15.8^{+0.075}_{-0.050}/\Phi15.8^{+0.024}_{+0.012}$	radial clearance	0.026～0.063
25	End gap when ring inserted in gauge		clearance	0.4～0.6
			clearance	0.35～0.55
			clearance	0.30～0.55
26	Crankshaft axial clearance		axial clearance	0.1～0.27
27	Backlash of gear in mesh		clearance	0.07～0.25

Specifications of main parts and accessories

No.	name		type / model code	
			YC4D60-D21	YC4D85Z-D20
l	Fuel injection pump assembly	model code type plunger diameter plunger stroke governor type	4J Ⅰ203 ①9.5mm 9mm mechanical variable-speed governor	4J Ⅰ203 ①9.5mm 9mm mechanical variable-speed governor
2	Fuel injector assembly	model code type precision pairs type injection pressure	CKBL685004 long multi-hole nozzle ZCKl55S529 23±0.5MPa	CKBL685004 long multi-hole nozzle ZCKl55S529 23±0.5MPa
3	Fuel filter		CX0710 paper element and rotation	
4	Oil filter		CX0818 paper element and rotation	
5	Thermostat		model code : 145 type : wax opening temperature : 70±2℃ full opening temperature 78±2℃	
6	Fan		ϕ450 axial flow	
7	Starter generator		voltage : 24V power : 4.8kW	
8	Charging generator		voltage : 28V power : 750kW	
9	Belt		8PK1760 V-ribbed belt used in vehicle	
1O	Turbocharger			TB28

Charter two Main installing requirements

Installation of the crankshaft

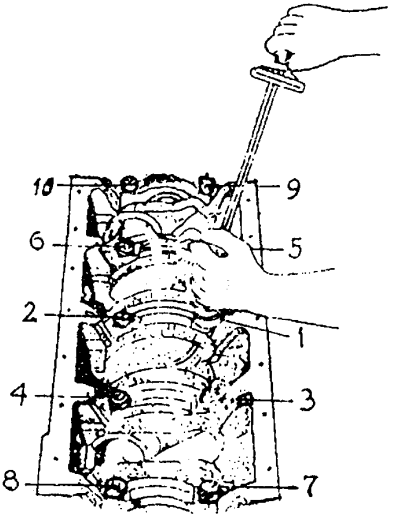


Figure 1 Tightening order of the main bearings

During crankshaft installation, the main bearing bolts should be tightened from thrust gear (the third gear) to both ends in order, and in three steps: First, tighten to 60~80N.m;

Then, tighten to 160~180N.m;

Finally, tighten to 220~260N.m.

During every time, the crankshaft should be rotated to check the mobility. It should be able to rotate freely after the final tightening. The axial clearance should be between 0.1 and 0.27mm.

Installations of the piston and the connecting rod

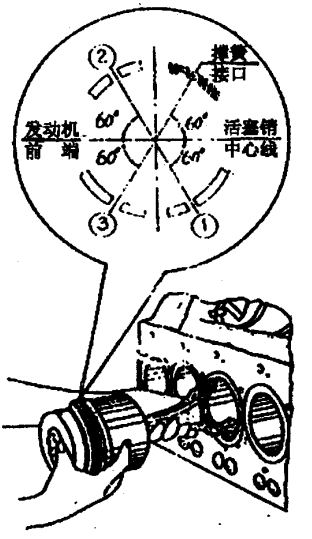


Figure 2 Orientation of the gap of piston rings

When installing the piston rings, put the surfaces marked upward (the second positive twist ring inner fillet upward). During positioning the piston-connecting rod assembly into the cylinder bore, stagger the joints in turn as shown in Figure 2, and put the arrow marked on the top surface of piston towards the front end of the engine. Remember spreading some clean oil before tightening connecting-rod bolts. The tightening torque should be between 160~200N.m, and completed in three steps:

First, tighten to 50~70N.m;

Then, tighten to 100~120N.m;

Finally, tighten to 160~200N.m.

Installation of the camshaft

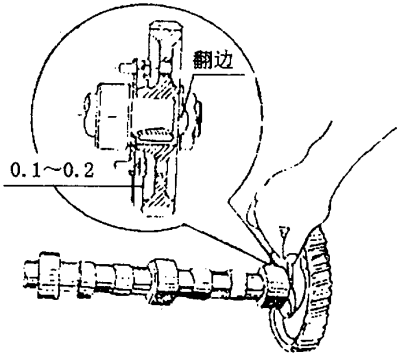


Figure 3 Camshaft axial clearances

Position the camshaft into the cylinder body with caution to make sure not scratch the surfaces of the journals, cams, and liners. And then install the circlip, cam thrust plate, cam gear, and cam retainer. Finally, tighten fastening bolt with more than 300N.m tightening torque. The camshaft should be able to rotate freely, and its axial clearance is between 0.1~0.2mm.

Installation of the valves and valve guides

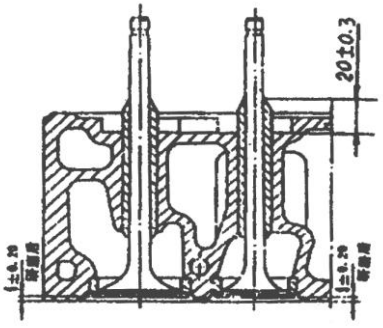


Figure 4 Installation of the valves and valve guides

The valve guides should be pressed in at normal state with 20±0.3mm distances between their top surfaces and the surfaces of the cylinder head spring seats. Both the valve face angles of intake and exhaust valves are 45°. The valves and valve seat inserts should be grinded in pair, and checked through kerosene. It must be guaranteed that kerosene don't leak within three minutes. The valve recession heights of the valves should be between 1±0.2mm.

Installation of the injectors

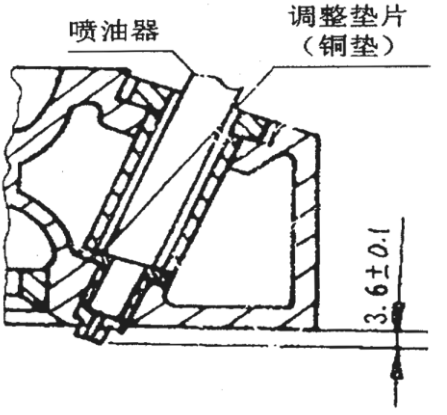


Figure 5 Installation of the injector

Before mounting the cylinder head, the injectors should be installed in the cylinder head first. The nozzles should protrude 3.4±0.1mm from the bottom surface of the cylinder head, which can be ensured by adjusting the width of the injector washer. And then remove the injectors to prepare for following installation. As long as adjusted, the injectors and washers cannot be exchanged during installation.

Installation of the cylinder head

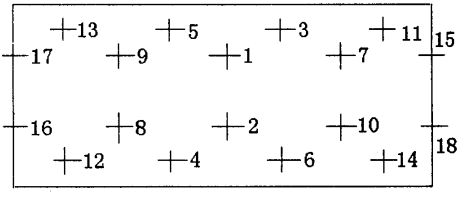


Figure 6 Tightening orders of the cylinder bolts

During cylinder head installation, the cylinder head bolts should be tightened to a tightening torque of between 210~250N.m, don't finish that in once time and following the sequence shown in Figure 6 in three steps:

First, tighten to 60~80N.m;

Then, tighten to 120~140N.m;

Finally, tighten to 210~250N.m

Installation of the gear train

The crankshaft timing gear, injection pump gear, and camshaft gear should all be accordance with the timing requirement, so there are timing marks, which should be aligned during installing the gears, on them and timing idle gear. Oil the tooth surface after installing. The range of the gear meshing clearance is between 0.07~0.25mm.

Caution

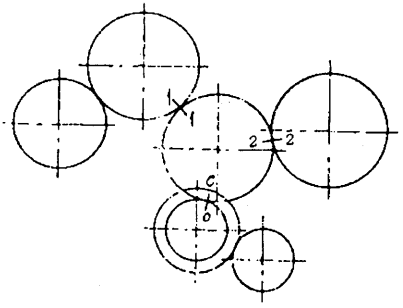


Figure 7 Installation of the gear system

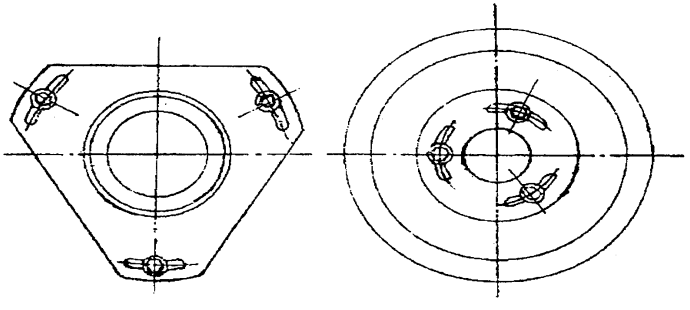
1. Every component should be cleaned before being installed, especially the oil passages, no dirt is permitted in them.
2. No corrosion, burr, or scratch is permitted on the fit surfaces of every component.
3. Friction surfaces and important fit surfaces should be oiled before installing.
4. Fit clearance (or interference) should be accordance with the requirement offered in the main fit clearance (or interference) in chapter 1.

Charter three Engine adjustments

Fuel supply advance angle adjustment

Technical data : Static fuel supply advance angle is 14±2°CA before TDC.

Fuel supply advance angle check: Unscrew the nut which connects the high pressure fuel line for the No.1 cylinder and fuel injection pump, crank the crankshaft slowly until the fuel level in the delivery valve holder begins to fluctuate. At this time, the timing value indicated by the pointer on the gear housing and the dial on the belt pulley damper is the fuel supply advance angle.

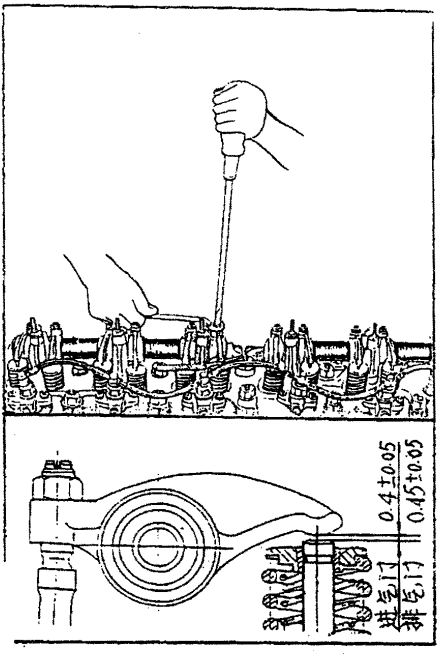


a、adjustment for the shaft of fuel injection of pump

b、adjustment for the flange of fuel injection of pump

Figure 8 Fuel supply advance angle adjustment

Figure 9 Adjustment of the valve clearance



Fuel supply advance angle adjustment: There are three rectangle slots in the joint flange of the fuel injection pump, through which three bolts are used to fasten the fuel injection pump to the gear housing. After unscrewing these bolts, the fuel injection pump can be rotated around its axis with small angle in order to adjust properly the fuel supply advance angle. Crank the crankshaft to the position at which the fuel will be delivered to the No. 1 cylinder according to the above method, unscrew these bolts on the flange and all the joint nuts for the high pressure fuel lines, rotate the pump a certain angle as required (inner direction which means to increase the fuel supply advance angle, outer direction which means to decrease the fuel supply advance angle), then fasten the bolts on the flange. Check and adjust the fuel supply advance angle to prescription, then fasten the bolts on the flange.

If the bolts is adjusted to the dead position on the rectangle slots in the flange and the fuel supply advance angle still does not meet the prescription, remove the gear housing cover plate of the fuel injection pump, unscrew the three bolts used to fasten the gear of the fuel injection pump, rotate the pump (inner direction which means to decrease the fuel supply advance angle, outer direction which means to increase the fuel supply advance angle). At last fasten the bolts. Check and adjust the fuel supply advance angle to prescription according to the above method, then recheck whether the bolts are fastened and install the gear housing cover plate. Pay attention to not damaging the gasket during adjustment in order to avoid the fuel leakage.

Adjustment of the valve clearance

Technique demand (cold state)

Intake valve clearance: 0.4±0.05mm;

Exhaust valve clearance: 0.45±0.05mm

To determine the compression TDC of the first cylinder: Rotate the crankshaft to make the TDC indicator, which is mounted on the gear house cover, point to the "0" position on the belt pulley damper. Then go on rotating in a small range of angles (10°~20°) clockwise and counterclockwise. When the intake and exhaust rockers of the first cylinder do not swing but those of the forth cylinder swing, rotate the crankshaft back to make the indicator point to the "o" position. At this time, the piston of the first cylinder is on the compression TDC. If counter, that indicates the forth piston is on the compression TDC. The first piston can reach the compression TDC by rotating the crankshaft 360°

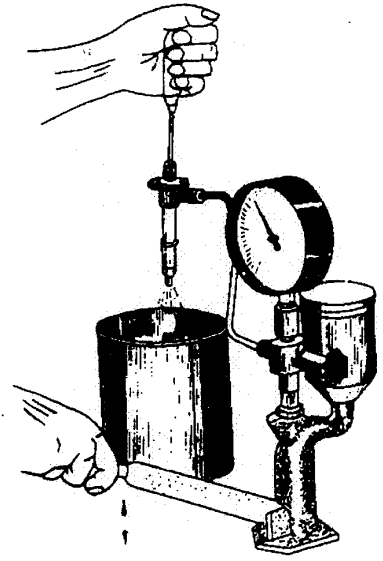


Figure 10 Fuel injection pressure adjustments

To adjust valve clearance: Rotate the crankshaft to the position that the first piston is on the compression TDC, when the No.1,2,3 and 6 valves can be adjusted; and then rotate the crankshaft 360°, when the No. 4, 5, 7 and 8 valves can be adjusted. First, loose the tightening nut of the adjustment bolt and screw the adjustment bolt out to the suitable position. Then put the feeler gauge into the gap between rocker and the end of valve stem. Next screw in the adjustment bolt till rocker can fasten the feeler gauge. Finally, tighten

the tightening nut. A correct valve clearance should be able to allow the feeler gauge move with slight resistance.

Fuel injection pressure adjustment

Technique demand

Fuel injection pressure 23±0.5MPa

26±O.5MPa(turbo charge)

Fuel injection pressure adjustment: Remove the pressure-adjusting screw thimble, screw in or out the pressure-adjusting screw as required. Screwing in means the increase of the injection pressure, on the contrary, screwing out means the decrease of the injection pressure. The fuel injection pressure can be adjusted on special test rig.

Oil pressure adjustment

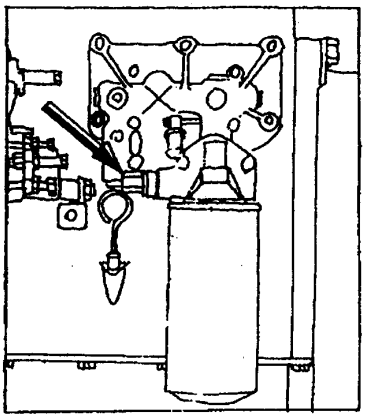


Figure 11 Oil pressure adjustments

Technical data :

Oil pressure at idle speed ≥ 0.1MPa

Oil pressure at rated speed : 0.25～0.6MPa

Oil pressure adjustment: The oil pressure can be adjusted by the adjusting screw of relief valve on the oil filter. During adjustment, remove the nut on the relief valve, unscrew the locking nut, screw in the adjusting screw with screwdriver, then the oil pressure will be increased. If the adjusting screw is screwed out, the oil pressure will decrease. After the adjustment, fasten the locking nut and nut. If the adjusted oil pressure does not meet the requirement, check the trouble in the oil passages carefully and troubleshoot them.

Operation of diesel engine

Selection of fuel, lubricating oil and coolant

1. **Fuel**

The fuel should be selected according to ambient temperature. The selection should comply with Light Diesel Fuel (GB252 choice fuel and first class fuel).

Ambient temperature	above 4℃	above -5℃	above -14℃	above -29℃	above -44℃
Light Diesel Fuel #	0#	-10#	-20#	-35#	-50#

2. **Oil**

Lubricating oil should be selected according to the ambient conditions. The class of oil should not be lower than CD class of GB11122-1997:

Ambient temperature	summer	above 0	above-15	above-30
Diesel Fuel #	15W/40CD 40CD	15W/30CD 30CD	15W/30CD	5W/30CD

3. **Coolant**

The coolant should be anti-freezing, especially when the engine is used in the plateau and in cold weather (below 0℃). It is good for the engine. The most used anti-freezer is glycol-water, which is a mixture of glycol and water (soft water is best. If well water, spring water or other hard water is used, it should be mixed with 2g tri-sodium phosphate and a liter water in order to be softened). Selection of different proportionality coolant should vary with the ambient temperature.

Glycol percentage	Density of glycol-water g/cm3	Freezing point ℃
28	1．034	-10
38	1．050	-20
48	1．063	-30
55	1．072	-40
60	1．078	-50
68	1．087	-68

Note: When the percentage of the glycol is above 68%, its freezing point rises. So the percentage of the glycol should not be above 68% when you make up anti-freezer. Glycol is a transparent, viscid, poisonous liquid. Wash your skin with water immediately if it contacts your skin. Glycol is flammable. So, do not weld or light fire when there is coolant leakage.

When there is an emergency, anti-freeze can be replaced by soft water, such as tap water and rain water. If well water, spring water or other hard water is used, add 2g tri-sodium phosphate per liter water in order to soften the liquid. If hard water is not softened before using as a coolant, there will be scale on the wall of water jackets of diesel engine, and the deposit will weaken cooling effect and cause the engine to overheat.

Preparations before starting the diesel engine

To make sure that the engine would run properly, the following steps should be done before starting the engine every time.

1．Check the oil level in the oil sump. The level should be within the upper and lower scale limits of the oil gauge. If the oil volume is not enough, add some oil as required.

2．Check the diesel fuel level in the fuel tank, add some fuel if necessary.

3．Check the coolant level, add some coolant if necessary.

4．Check if there is air in the fuel pipe. De-aerate fuel if there is air in the fuel pipe.

5．Check if electrical system works properly.

6．Check the tension of the driving belt. The tension should be moderate as required.

7．Perform every kinds of technical maintenance as required.

Starting the diesel engine

The engine cannot start unless the preparations have been completed and confirmed to comply with requirements.

5． Procedures of starting the diesel engine

Switch on the start switch or press the button of start. After the engine starts, switch it off.

6. Check following items after start

(1) Check the oil pressure. It should not be lower than 0.1MPa

(2) Check whether the water pump operates properly and whether the coolant runs into water jacket of the diesel engine

(3) Check the leakage of oil, fuel, and oil. And if there is leakage, shoot the trouble

(4) Check if there are abnormal noises

◆ **Attention:**

1．Do not crank the engine for more than 10 seconds at a time. And if the engine fails to run after the cranking, the cranking should not be repeated within at least one minute. If the engine fails after cranking for three times successively, troubleshoot and crank again.

2．Switch off start switch immediately after starting the engine. If not, diesel engine, through the flywheel gear, will drive the starter rotating at a very high speed and the starter will burn.

3．After the start, engine should not speed up abruptly.

4．When the engine must be cold-started and it has no oil and water temperature stabilizers, the engine should not run at a high speed immediately. In this case, the

engine should keep idling for 5 minutes with no load

Operating the diesel engine

1. Requirements of using engine

(1)When the diesel engine is cold-started, it should keep idling for 5 minutes with no load. Even if it is warm-started, the engine must run after the oil pressure is established.

(2)When the diesel engine is cold-started, it should not run with the throttle completely open and should not run with full load and at high speed. It should steadily speed up and run after water temperature rises above 60℃.

(3)New engine or an engine after overhaul needs 50-hour break-in. Screw off the break-in stop only after this break-in period. Afterwards engine can operate as normal.

2. Points that always need careful check when engine is running

Check if the lubricating oil pressure is normal. The pressure should be lower than 0.1MPa when the engine is idling and should be within 0.25MPa and 0.6MPa when the engine is running at high speed.

Check if the coolant temperature is normal. The temperature should be controlled within 75℃ and 90℃.

Always observe abnormal noises when the engine is running. If there are abnormal noises, stop the engine and troubleshoot

Pay attention to the sealing of every water passage and the fuel pipe. If there is leakage, remedy it immediately.

◆ **Attention:**

1. Do not keep the engine idling for more than 5 minutes, not more than 10 minutes at its minimum.

2. Do not run the engine if it malfunctions.

3. The exhaust manifold temperature is very high when the diesel engine is operating. Do not touch the exhaust manifold lest skin be scalded. Do not place inflammables or explosives near the exhaust manifold in case of accident.

Stopping the diesel engine

1. Keeps the engine idling for 3 to 5 minutes before stopping it, especially when the engine runs with heavy load and at high speed. Do not stop the engine sharply unless there is an emergency.
2. When the ambient temperature is below 5℃ and the coolant is not anti-freezing, discharge all of the coolant water after stopping the engine to avoid engine damage by frost crack
3. Generally, discharge all of the coolant water when the engine will be parked for a long time.
4. Shoot troubles that occurred when engine was running after engine stops. Always check the engine and make sure that the engine runs in proper technical state.
5. Maintenance must be available as required after diesel engine stops

Storage

1. Diesel engine should be stored in warehouse, which is dry, with ventilation, and without corrosive matter.
2. If diesel engine will be stored for a long time, discharge all of the coolant. Diesel engine must be well cleaned with necessary oil sealing in case of rusting.

Charter Diesel engine maintenance

Break-in of the diesel engine

It is very important for new engine or an engine just after overhaul to have a 50-hour break-in. This break-in period can improve performance of friction pair and is essential to ensure the operating dependability and lifespan of diesel engine. If conditions permit, run the engine at the speed of 1500r/min and under 25%, 50% and 75% full load, each load an hour.

Special attentions during break-in period:

(1) Do not accelerate abruptly when the diesel engine just starts.

(2) Before running engine, keep the engines idling with no load and at low to medium speed for at least 5 minutes.

(3) When engine is running, do not increase load abruptly. Increase load slowly.

(4) Replace the lubricating oil when the engine runs for 50 hours. Replace the oil again after break-in period (50 hours). Since then, oil can be replaced as required in maintenance procedures that will be mentioned afterwards.

Requirements of technical maintenance

Maintenance period	Items	Procedures
Daily maintenance	1.Check the fuel level in the fuel tank. 2.Check the water level in the radiator. 3.Check the oil level in the oil sump. 4.Check if there is coolant, oil, or fuel leakage 5.Check the tension of the driving belt.	 See Chapter 5 See Chapter 5
After every 50 hours	In addition to item 1 to item 5 above, 6.Check the sureness of the bolts on cylinder head. 7.Check the clearance of the intake and exhaust valves. Adjust it if necessary. 8.Check the injection advance angle. Adjust it if necessary. 9.Check the operating pressure of the injector and check the atomization condition. 10.Clean the inlet screen of the oil pump.	 See Chapter 3 See Chapter 3 See Chapter 3 See Chapter 3 See Chapter 3

每150小时 After every 150 hours	In addition to item 1 to item 10 above, 11. Clean the air cleaner 12.Check the electrical wirings and the contact condition of the circuit joints. 13.Add calcium-sodium base grease on the water pump bearings. 14.Check the torque of main bolts and nuts. 15.Please remove the scale in the water jacket if there is excessive water deposit. 16.Replace the lubricating oil.	 See Chapter 5 See Chapter 5 See Chapter 5 See Chapter 5
Prescribed period on filters	17.Replace the oil filter when replace lubricating oil. 18.Replace the fuel filter.	Prescribed on filters

◆ **Attention:**

1、When the engine runs for 1200~1500 hours, take apart the oil sump, disassemble the main bearing shells, thrust plate, connecting rod bearing shells, crankshaft bearing shells and check their wear conditions. Replace the one that wears out and clean the oil sump at the same time. Then assemble them altogether.

2、If anyone or more is replaced, such as crankshaft, piston, piston ring, cylinder sleeve, connecting rod, connecting rod bearing shell, main bearing shell, crankshaft thrust plate, camshaft, camshaft bushing, tappet, cylinder block etc., diesel engine can run properly only after the break-in period. Engine cannot run with heavy load and at high speed just after replacement lest the components be destroyed and engine lifespan be reduced.

3、When engine is used under clean ambient condition, the maintenance period can be observed as detailed in the diagram shown before. But if the ambient condition is harsh and there is heavy dust, reduce the maintenance period of the air cleaner according to specific case.

1. Maintenance methods

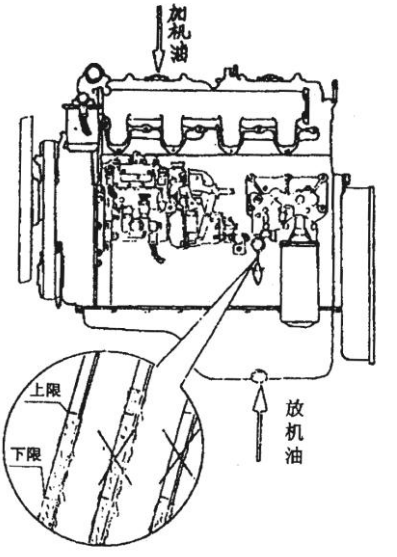


Figure12 check and replace the oil

Always check the oil level in the oil sump: There is an oil gauge at the left side of the cylinder block (look from the side of flywheel). Before checking the oil level, bring out the oil gauge and wipe it dry. Then, put the gauge in and bring it out again to check the oil level. The level should be within the upper and lower limits of the oil gauge (as shown in Figure 12). If the level is not enough, add some oil, as required, from the cylinder head cover. Total oil volume in the oil tank is about 13L, and the oil volume in the oil sump is about 11L. At the bottom of the oil sump, there is an oil passage screw plug, which can be used when we need to replace the oil. Replacing oil should be done just after stopping engine. At this time, foreign matters and oil are mixed and can be replaced together. Waste lubricating oil should be collected after being replaced in order to prevent polluting environment.

2、De-aerate the fuel in the fuel pipe

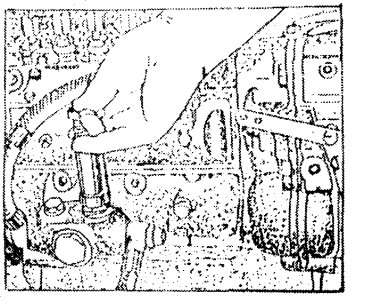


Figure 13 De-aerate the fuel in the fuel pipe

Outside the fuel injection pump, there is a fuel supply pump, which is equipped with a hand priming pump. The hand priming pump can be used to de-aerate the fuel in the fuel pipe. When using the hand priming pump, revolve the handle cap and it will rise up. Push the cap down again and again, the fuel can be pumped from the fuel tank to each fuel passage and the fuel chamber. At the same time, loosen the air outlet screw plug and expel the air out. After using the hand priming pump, revolve back the handle cap in case that the air go into the fuel supply system.

3、 Check and adjust the belt tension

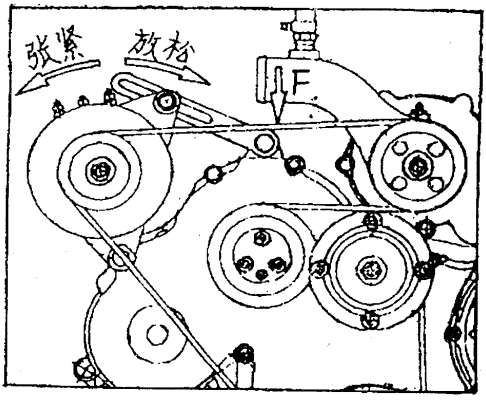


Figure14 Check and adjust the belt tension

Driving belt must be properly tensioned. Inspect the driving belt deflection by pushing on the belt with a force of about 4~5kg midway between pulleys. If the belt deflects about 10~15 mm, the tension is just as required. If the belt tension is too loose or too tight, adjust the tension by relocating the position of the generator.

4、 Discharge the coolant

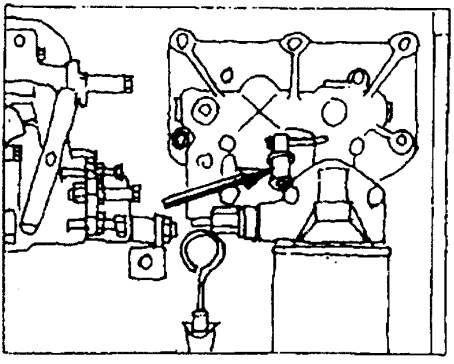


Figure 15 Discharge the coolant

There is a water drain valve on the case of the oil cooler at the left side of the cylinder block (look from the side of the flywheel). It is used to drain the water coolant in the water jacket of the diesel engine. After draining the water coolant, close the valve.

5、Clean the inlet screen of the oil pump

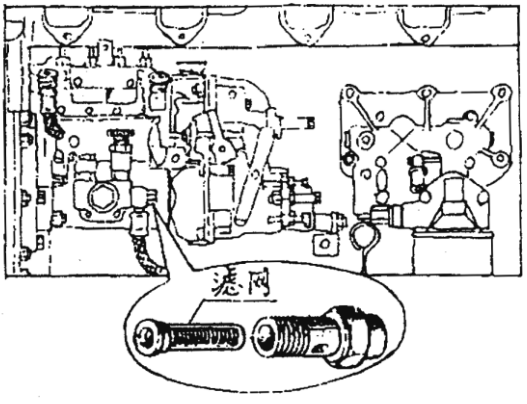


Figure 16 Inlet screen filter of the fuel pump

There is an oil pump outside the fuel injection pump. At the joint of the fuel inlet of the fuel supply pump, there is a filter screen, which is used

to filter contaminants. It needs cleaning timely. When cleaning, screw down the hinged screw on the fuel control lever, take out the filter screen and clean the screen with fresh diesel fuel. After cleaning, install back the screw.

6、Clean the air cleaner

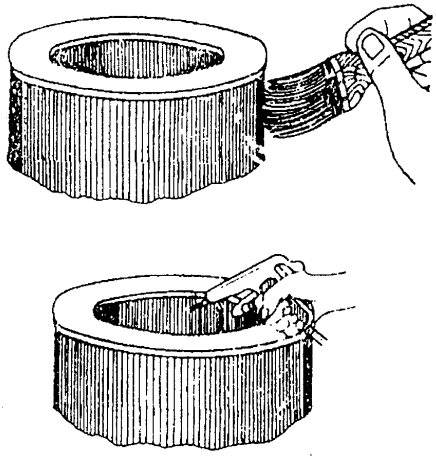


Figure 17 Cleaning of the air cleaner

Do timely maintenance to the air cleaner as required. During maintenance, take out the air cleaner element, brush dust off the surface of the element and then, blow it inside out with compressed air of 0.4~0.6MPa (4~6kg/cm^2). Check the element, the filter paper and the sealing ring to see if there is damage. If there is, replace it. At the same time, clean the dust off the dust chamber. Watch out that the filter paper cannot be cleaned with fuel, water, or other liquids. Under harsh condition, reduce the maintenance period of the air cleaner according to actual facts.

7、Add lubricating grease

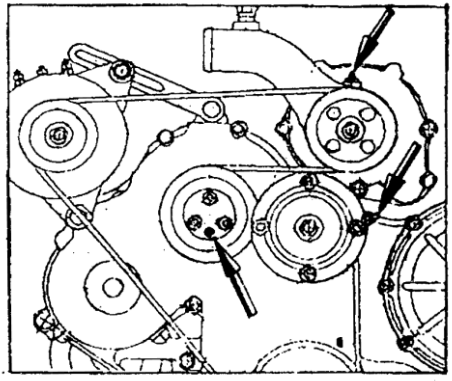


Figure18 Adding of the lubricating grease

Bearings in the water pump should be lubricated with calcium sodium base grease. Add lubricating grease in time, as required, to prevent damage to components. There is a cup for adding lubricating grease on a part of water pump. When adding grease, point the oil gun into the cup and shoot the grease into the bearings.

8、Scrub the water deposit off

Scrub the water deposit off the coolant tank wall and the water jacket with cleaning liquid in time, in order to ensure cooling effectiveness and avoid overheating of the diesel engine.

Generally, the cleaning liquid is appropriated as follows: add 750~800g sodium hydroxide and 150g kerosene per 10-liter water and mix the three evenly.

Cleaning procedures: Drain the water coolant in the water tank and add the cleaning liquid into the tank. Run the diesel engine with cleaning liquid as coolant water in medium speed about 10~15 minutes, warming up cleaning liquid. Let the cleaning liquid remain in the tank for about 12~15 hours and run the engine again in medium speed about 10~15 minutes. Then, discharge all of the cleaning liquid and add water into the tank. Again, run the engine in medium speed for some time and drain the water. At this time, the cleaning is completed. If the water deposit is serious, repeat the procedure aforementioned 2~3 times.

Note: Sodium hydroxide is strongly basic. Do not eat or touch it. If your skin contacts it, please rinse you skin immediately with water.

Charter 6 Normal trouble and Troubleshooting

Determine the location of the troubles and remove them immediately when diesel engine does not operate normally. Forbid running a malfunctioning vehicle, or it will affect the work of engines.

The manual presents common troubles and troubleshooting methods only for reference. Because the knowledge about troubleshooting is simple and not comprehensive, please pay more attention to it. When not being sure of the trouble cause, do not tackle it without authorization to avoid larger damage. It should be done that informing and consulting with technical Yuchai service station or asking the near special units to deal with.

Diesel engine can not start or start difficultly

Possible causes	Remedies
Insufficient power or bad terminals connection contact	Charge or replace the battery. Check for looseness of the contacts of the electrical equipment or bad contact due to rustiness and then deal with it.
Fuel pipe clogged or insufficient oil supply	Determine the location of the clog and clear it. Clean filter element.
Air exists in the oil line	Check for looseness and damage of the joints of fuel pipe, remove or replace them if necessary and then clear air in the oil line.
Too much oil deposit in cylinder	Close the throttle, rotate the crankshaft by motor, drain excess oil deposit in cylinder, and especially par more attention to overhauled engine.

Fuel supply pump does not apply fuel or applies fuel irregularly	Check for leakage of the delivery valve and inspect whether injector is worn-out, plunger is seized, and if plunger spring and delivery valve spring is broken. Remove them in time.
Insufficient compression pressure due to piston ring or Cylinder much worn-out;	Check and replace the piston ring or Cylinder
Blow-by valve	Check the valve clearance and seal of valve. Grind or readjust the valve if necessary.
Incorrect fuel injection advance angle	Check and adjust it
Incorrect valve timing	For the overhauled engine, pay attention to the timing marks alignment on timing gears.

Insufficient power output

Possible causes	Remedies
Oil advance angle changes	Check and adjust according to regulation
Faulty injector	Check the working pressure or atomization of the injector, replace the needle valve precision pair if necessary.
Incorrect intake and exhaust valve clearance or bad seal of valve	Check and adjust the valve clearance according to prescription; check the seal of the valve, grind it if necessary

Overheat engine	Check the level of cooling water, add enough water if necessary; check for the leakage of the water pump or the looseness of the belt, remove or require it if necessary; check for thickness of scale in water passage, remove it if necessary.
Air cleaner choking	Replace the filter element.
Fuel supply pipe clogged	Check and clean it.
Faulty injection pump	Check for leakage of the delivery valve and inspect whether plunger is worn-out, and if the plunger spring and delivery valve spring is broken, replace the damaged parts, cylinder gasket and readjust oil pump if necessary.
Cylinder gasket damage or leakage	Replace it.
Too high exhaust back pressure	Clear the exhaust passage and muffler
Excessive blow-by	Check the piston, piston ring and cylinder sleeve. If they are much worn out or ring elasticity is insufficient, replace them.
Intake pipe leakage (Turbocharger)	Check the oil pipe and remove leakage.
Turbocharger is out of order	Determine the location of the troubles and remove it.

Abnormal noise during engine operation

Possible causes	Remedies
Incorrect injection timing or injector stuck and high frequency knock noise in cylinder.	Check the injector; replace the needle valve precision pair if necessary. Check the fuel injection advance angles, if it changes, adjust to the prescription.
Clash due to too large clearance between piston and cylinder sleeve	Check the wear of the piston and cylinder sleeve, replace them if necessary.
Clash due to too large clearance between connecting rod bearing bushing, main bearing bushing and journal	Check if the bearing bushing and crankshaft are much worn out, replace or press in the oversized bearing bushing if necessary.
Knock due to valve touching cylinder	Check and adjust the valve clearance. Inspect the valve timing for the overhauled engine
Clash due to too large crankshaft axial clearance	Check the wear of the thrust plate, replace it if necessary.
Abnormal knock due to valve spring crack	Stop immediately to check and replace the damaged parts.
Too large valve clearance and heavy noise around cylinder head	Adjust the valve clearance

Exhaust with abnormal smoke color

Possible causes and condition	Remedies
Exhaust with black smoke	deal with by the conditions of Insufficient power
Exhaust with white smoke ① Bad atomization of injector ② Water in cylinder or diesel ③ Some cylinder doesn't work when operating at low speed on cold day ④ Incorrect fuel injection advance angle	Check the working conditions; replace the excessive blow-by if necessary. Check diesel, if there is water in it, replace it, Otherwise, check for damage of the cylinder head parts which may cause water leak, replace the damaged ones. Close the shutter door when the ambient temperature is low, and make the operating temperature rise quickly to avoid running long time at low temperature. Check and adjust fuel injection advance angle
Exhaust with blue smoke ① Too much oil in sump ② Operation at zero load and low speed for too long time ③ Sticking, much wear or inverse installing orientation of piston rings, oil blow-by and burn in cylinder ④ Oil seeps through the gap between valve guide and stem due to valve guide is much worn.	Check the level of oil, drain it if necessary. Decrease time of the operation at zero load and low speed to avoid oil blow-by and burn in cylinder Replace the piston ring if necessary. Check the clearance between the valve and guide, Replace it if necessary.

Too low oil pressure

Possible causes	Remedies
Insufficient oil in sump	Add oil to adequacy.
Oil pipe clog or leakage	Check the detailed cause, and then clean the coarse filter element or the oil strainer screen
Pressure adjustment valve failure	Check the pressure adjustment valve, replace it if necessary.
Pressure indicator or transmitter failure.	Check the cause and then replace it.
Diluted oil	Check if incorrect brand oil is used or oil temperature is too high. If the cause is the former, replace oil, otherwise find out the reason of the latter and then deal with it.
Too large assembly clearance of oil pump	Check it, replace if necessary.
Journal bearing wear or too large clearance	Check and replace the journal or associated parts.
Oil cooling plug clogged	Clean it, replace if necessary.

Too high oil pressure, much diluted oil, excessive oil consumption

Possible causes	Remedies
Too high diesel engine load	Be careful not to pull out the lead seal on the injection to avoid engine operating at over load which will damage the engine forepart.
Incorrect engine oil grade	Select oil according to the brand prescription.
Piston ring stuck or seriously worn causing gas blow-by and oil pumping-up.	Dismantle, check and clean the piston and piston ring, replace the piston ring and cylinder sleeve if necessary.
Oil groove and bore of piston and piston ring clog	Dismantle and clean, and then reinstall it.
Oil cooling plug clog	Clean, replace if necessary.
Diluted oil due to diesel or water in it	Check the cylinder sleeve seal ring, oil cooler, injection pump, injector, cylinder head, and cylinder head washer, replace them if necessary.

Too high water outlet temperature

Possible causes	Remedies
Insufficient cooling water or too small water flow	Check the level of cooling water, add water to adequacy if necessary; check for looseness of the belt, adjust it if necessary; check for leakage of the water pump, repair it in time if necessary; check and replace the damaged thermostat.
Too much scale in water passage and tank	Clear it.
Thermostat failure	Check and replace the damaged thermostat
Water temperature indicator damaged and transmitter failure	Check and compare the actual temperature with the indication, if they are not same, replace the transmitter or water temperature indicator.
Cooling fan damage	Repair or replace.
Water pump damage	Repair or replace.

Engine stops by itself

Possible causes	Remedies
Fuel is used up	Check and add fuel, and remove the air in the oil line.
Oil line clogged or much air entering	Check and clear the oil line; remove the air in the oil line; determine the location of the intake and then remove it.
Bushing burned due to the blockage in lubrication oil line.	When the water temperature is normal, it will lead to engine to stop immediately. Dismantle the sump, check and repair it, and then replace the damaged parts.
Overheat piston scraping due to lack of water or too high water temperature.	At first, make engine cool naturally (make sure not to add cold water or wash engine with it), then try to rotate the crankshaft. If it is jammed, start engine after adding cold water, or else move engine, check and repair it, then replace the damaged parts.

Engine over-speeding（Speed rises sharply）

Possible causes	Remedies
Injection pump (governor) is in trouble	Pull the stop handle when engine over-speeding, if the engine is fail to stop, brake it with engaging a gear in transmission, or other measures should be taken to force it to stop, such as sealing off the inlet, cutting off the fuel pipe and etc. After engine has stopped, adjust and repair it, replace the damaged parts if necessary.

Common trouble and troubleshooting remedies for injection pump

Possible causes	Remedies
Injection failure: ① No oil in oil tank. ② Air or leaks in oil line. ③ Oil line clogged. ④ Fuel pumps failure. ⑤ Plunger precision pair worn out, snapped or spring cracked	 Check and add oil to adequacy. check and remove air ,block up the **leakage** Check and remove the blockage. Determine the location of the trouble and repair it. Determine the location of the damaged part and repair or replace it.
Insufficient or uneven outlet oil ① Insufficient inlet oil pressure. ② Leaky oil outlet valve or spring crack. ③ Plunger precision pair is out of order due to dirty or much wear. ④ Loose plunger control gear.	Check the condition of fuel pump and blockage of oil line, if necessary, remove it. If there is leakage, lap in pair; if there is damage, replace parts. Check and wash the oil line and precision pair, and replace the much worn one. Check for the looseness of the plunger control gear, tighten to the signal if necessary; regulate the injection pump on test bench better.

Common trouble and troubleshooting remedies for governor

Possible causes	Remedies
Unsteady speed (engine hunting): ① Inflexible flyweight or flyweight holder of governor. ② Improper idle adjustment ③ Governor components worn out	Determine the location of the troubles, and then repair it, replace parts and wash it if necessary. Readjust the idle adjusting screw. Check and repair it. (By specialist manufactures)
Speed always lower than calibrated speed. ① Adjusting spring deflection. ② Control handles mis-positioning. ③ Adjusting rack and pull bar jammed or loose.	Regulate properly and replace the spring by professionals, do not do it without authorization. Determine the location of the blockage, and then regulate and remove it. Check and adjust it, then ensure the rack slides flexibly and the gear ring is not loose, otherwise readjust and repair it.
Speed rising promptly to abnormal state(runaway) ① Adjusting rack or throttle pull bar stuck. ② The pin connecting adjusting rack and pull bar drops. ③ Governor spring crack.	Regulate and repair it. Reinstall it and, if necessary, replace the damaged parts. Replace it and then readjust the injection pump on test bench.

Common trouble for fuel supply pump

Possible causes	Remedies
Check valve and piston wear or spring crack	Check and repair, replace it if necessary.
Oil leak around joints	Tighten or replace the seal gasket.
Outlet screen clog	Check and clean it.
Oil and air leak around hand pump	Dismantle and repair, replace it if necessary.

Common trouble and troubleshooting remedies for injector

Bad atomization of injector and insufficient or without fuel injection	
① Needle precision pair stuck and injection orifice clogged	Clear the carbon deposit and dirt. Clean and grind it, replace if it cannot be reconditioned.
② High pressure pipe joints leakage	Determine the location of the troubles, and then recondition or replace it.
③ Dirt on surface of needle	Clean it.

Low injection pressure ① Pressure adjusting screw looseness	Readjust and tighten the stud.
② Pressure adjusting spring crack	Check and replace.
③ Pressure adjusting spring deflection	Check and replace.
④ Spring seat and stem damage	Repair or replace the damaged parts.
⑤ Needle stuck	Clean and grind it.
Injector oil leak ① Bad seal of needle precision pair	Grind it after cleaning, replace it if ineffective.
② Needle stuck	Clean and grind, replace it if ineffective.
③ Nozzle retaining nut damage and deflection	Replace it.
④ Sealing surface of injector body and needle body damage	Lap in pair after cleaning, replace it if it can not be reconditioned.

Annex: Anti-freeze solution and its application guide

Currently, water is widely adopted as the cold-medium of the water-cooled engine, including hard water and soft water. River water, well water, spring...etc. enrich water with the mineral material as hard water, being subjected to hot empress the mineral quality sink wall to become water dirt in water set with spread the hot machine, dying down diesel engine to spread thermal energy dint, the serious hour will appear an urn of set and live cold wreath to chafe, the piston choked to death. But the water tank knot dirt hereafter will cause the water temperature go up and open a pot.

Therefore must use the soft water as the anti-freeze. The in common solu tion of transferring the hard water into soft water is to boil hard water to r emoves sediments. The more exhaustive method is to add to soften in the hard water, such as adding 0.5 baking sodas of ～ lg(pure alkali) or the O.5 ～ O.8 g hydrogen to oxidize (caustic soda).

There is much weakness using the water as the anti-freeze.1)it is easy to be come water dirt.2) the freezing point of water is an O ℃, it is easy to freez e a jelly crack an air cylinder body and spread a hot machine easily in winter. 3)The boiling point of water is 100 ℃ , because the machine widespread adopt technique of turbo-charger, the normal water temperature is 105 ℃s for 9 5 ℃～s, will usually appear to open a pot in summer.4)The cooling system is se wn a medium soldering by six kinds of metals iron castings, aluminums, steels, r ed coppers, brasses and the water tank to constitute, water, imply water of mis cellaneous quality especially, as to it's have a corrosion function, appear rusty wi th cave eclipse phenomenon.

As having been overcome many disadvantages of the water-coolant, the anti-freeze solution becomes the ideal coolant which can be used in each season of the year.

1. What is anti-freeze solution?

Anti-freeze solution is a coolant used in winter to prevent frostbite. It has a long history. At the first, people added the inorganic salts into the water to lower the freezing point or raise the boiling point; then the organic alcohols (such as ethanol, methanol, etc) were added further. And in the recent years, the anti-freeze solution has developed to become the glycol and glycerol based anti-freeze solutions. But for the price reason, the

application of the new developed solutions was restricted. Nowadays, it is the glycol based anti-freeze solutions that have been accepted widely.

Anti-freeze solution is made up of raw alcohol, water and additives. The alcohol is glycol and the water is distilled water. The additives include antirust agents, anti-toxicity agents, PH regulating agents (buffering agents), antifoam agents, and other performing enhancing chemicals.

Table 1 Physical and chemical property of glycol

Density(20℃)	1.113 g/mL
Flash point	116℃
Freezing point	-13℃
Specific heat capacity(20℃)	2349J/(g·k)
Boiling point (760mmHg)	197℃
Vapor pressure (20℃)	8Pa
Vapor pressure (100℃)	2133Pa
Thermal conductivity (20℃)	2.889×0.004[W／(cm·s·℃)]

Table 2 The glycol concentration, density and freezing point of the anti-freeze solution

Freezing Point (℃)	Glycol Concentration (%)	Density (20℃)	Freezing Point (℃)	Glycol Concentration (%)	Density (20℃)
-10	28.4	1.0340	-40	54	1.0713
-15	32.8	1.0426	-45	57	1.0746
-20	38.5	1.0506	-50	59	1.0786
-25	45.3	1.0586	-45	80	1.0958
-30	47.8	1.0627	-30	85	1.1001
-35	50	1.0671	-13	100	1.1130

The anti-freeze solution is classified to be the direct-use type and the concentrated type. The concentrated type can not be used directly and must be diluted to a particular concentration as stated in Table 2 according to the operating temperature.

Nowadays there is a new long lasting effected anti-freeze solution on the market, what is its true facts? The main components of the prolonged action anti-freeze is still the glycol. The glycol features of anti-freeze and anti-boiling, which make it a necessary component for the solution and is the key factor to keep the characteristic of heat-conduction of the solution. The differences between the traditional and the long lasting effected glycol-based solutions are as follows:

Characteristic	The traditional green solution	The long lasting effected orange solution
Color	Green or green-blue	Orange or red
Standard PH value	10.5	8.5
Anticorrosion agents	Metal anticorrosion agents (e.g. tolyltriazole) + borate+ phosphate + silicate.	Organic salts as Mono-carboxylate and dicarboxylate(e.g. sebacic acid and octoic acid) + Tolyltriazole
Pollution sensitivity	Hard water	Traditional green coolant
Average maintenance life	2 to 3 years	4 to 5 years

From the above table we can see that the differences between them which lie in the anticorrosion agents. Since the long lasting effected anti-freeze solution is made up of organic acid salts, so it can make the chemistry properties more stable and the effect longer and better.

1. The five functions of the high quality anti-freeze solution

1. Anti-corrosion

Anti-freeze solution contains a system of excellent and lasting corrosion inhibitor, which achieve certain balance with the metal through various agents and form a protection film on the metal surface; moreover, it can strip the existing corrosion on the cooling system to prevent further corrosion. Tests show that qualified anti-freeze solution can be 50 to

100 times less corrosive to metal compared with water.

2. Anti cavitations

Cavitations are formed by numerous foams impinging the metal. Tests show that hard waters containing salts and bases are several dozens faster in its cavitations speed compared with that of clean soft water. While anti-freeze solution does not contain hard water, and the anti-foaming in it can inhibit the production of foams.

3. High boiling point character

The boiling point of anti-freeze solution is usually at 105℃~110℃, even higher than that of water.

4. Anti-scaling character

High quality anti-freeze solution is made from the distilled water and it contains anti-scaling agent, hence it does not produce any scale.

It has the following characters:

1) Superior anti-freeze performance

2) Anti-corrosion and anti-rust

3) Non-swelling or erosion on the rubber seal guide.

4)Preventing scaling of the cooling system.

5)Anti-foaming.

6)Low viscosity at low temperature.

7)Stable chemical properties.

III. How to select and correctly use anti-freeze solution

At present, anti-freeze solution is widely used, inadequate understanding of the characteristics, requirement and method in its use will bring some trouble to your vehicle, such as starting difficulty, leakage at pipe fittings, hose rupture, watering difficulty, radiator corrosion, cylinder sleeve cavitations, etc.

1. Principles of selecting anti-freeze solution

1) Select anti-freeze solution of different freezing points according to the ambient temperature.

Its freezing point should be approximately 10℃ lower than the lowest temperature recorded in the region's history.

2) Select anti-freeze solution according to the number of vehicles and vehicle-concentration.

For those units or departments with quite a number of vehicles that are more often used in one region, small-package anti-freeze mother liquid can be selected, which is stable in performance and convenient for transportation and storage. It can also be modulated in many flexible ways according to the use condition, achieving conservation and practicality. If there is only limited number of vehicles and they are used in different regions, you can choose the direct-use type anti-freeze solution.

1) Use high quality anti-freeze solution, never use inferior quality ones.

High quality anti-freeze solution is usually certified as passing the inspection by the State designated inspection stations. From the exterior appearance, it should be crystal clear, not turbid and have no foreign material or irritating smell. The external packing should bear detailed information on the manufacturer name, product instruction and explicit indications. Inferior quality anti-freeze solution will not be able to be anti-freeze and anti-boiling; and quite on the contrary, it will accelerate corrosion to the cooling system.

2) Use anti-freeze solution that matches the rubber sealing component/pipe.

Anti-freeze solution should have no side effect on the rubber sealing component/part, such as swelling or encroachment.

2. How to use anti-freeze solution correctly?

1) Wash the cooling system thoroughly before filling anti-freeze solution.

If you fill the anti-freeze solution without a thorough cleaning, the anti-rust performance will be weakened. Following these steps to wash it: (1) Start engine, when the coolant gets to the thermostat threshold temperature, stop the engine, then drain the coolant. (2) Use 10% caustic soda solution as coolant and make the engine run 5 minutes at high speed, let it drench for one hour, then drain it. (3) Add soft water, make the engine running at high speed for 10 minutes, and then drain the water. Repeat this step for several times till there is no pollutant out of the drained water.

2) Before filling anti-freeze solution, don't forget to check if the cooling system has any seeping points. Remove any seeping then add anti-freeze solution. Ethanediol's surface tension is low; it may easily seep through the crevices. Therefore, before you change anti-freeze solution, you should first check and fasten the branches and fittings of cooling system,to prevent any leakage.

3) Anti-freeze solution's expansibility is greater than that of water, if there is no expansion tank, you should only fill up the anti-freezing liquid to 95% of the cooling system's volume.

4) Prohibit direct filling up anti-freeze mother liquid (condensed type), prohibit modulating anti-freezing liquid with hard water.

5) Regularly check anti-freeze solution in use.

After a period of use, the anti-freeze solution will become deficient, here, first check the density of the anti-freeze solution. If the density doesn't increase, then this deficiency should be caused by seeping, you have to add anti-freeze solution of the same brand; if the density decreases, you should add condensed anti-freeze solution of the same brand; if the density decreases, this should be caused by water

vaporization, you should add the distilled water or the demineralization water. After adding distilled water or condensed liquid, you should stir it evenly then check the anti-freeze solution's density, till you get the density corresponding to the freezing point you need. Never add common water (such as river, lake, pond, well or tap water), the foreign material in it will consume certain part of aseptic.

6) Don't put off anti-freeze solutions of different brands; this will damage their respective anti-corrosion capacity.

7) The life cycle for long-term anti-freeze solution's tenure of use is usually 1~2 years, you should change it when it is overdue. To reduce any waste, when it is out of its life cycle you may first check the PH value before changing. If the PH value is higher than 5.5, you may continue using it; if PH value is lower than 5.5, you should change it timely, or it will hasten the corrosion of the cooling system. When the PH value is lower than 5, you may add prolonging agent into the freezing liquid to extend the life of anti-freeze solution by one year.

8) Don't suck ethanediol into your mouth because it is poisonous and has a damaging effect on the liver, wash after it contacted your skin. Sodium nitrite can cause cancer, don't pour the waste liquid around, which will pollute the environment.