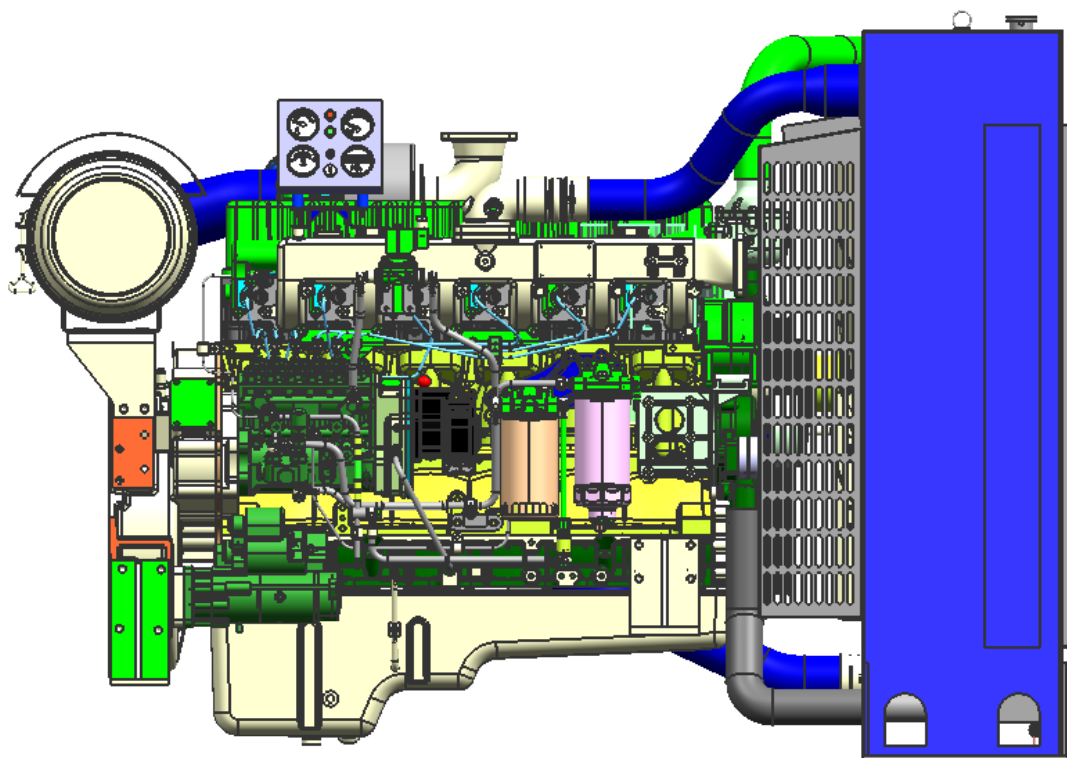


YC6MJ

YC6MJ Series Diesel Engine for Genset Workshop Manual



Please read this manual carefully prior to operation

Foreword

This workshop manual provides information covering main systems, technical parameters, specifications of main components and parts, operation, service and maintenance as well as troubleshooting.

Please read this manual carefully for operation and servicing & maintenance instructions prior to operation, and pay your particular attention to the *Precautions for Safe Operation* described below to keep engine running at optimal performance and ensure safe operation.

With continuous development and demand, product will be uninterruptedly optimized and improved and its modified products will also be continuously increased. Except for especially main modifications in design, this manual will not be altered again. Therefore, after a certain period of time, part of this manual may not comply with the engine you use, the contents of this manual are just for your reference, with your concrete engine subject to the real machine, to which kindly ask our customers to pay due attention.

This manual only provides detailed descriptions for the basic model engine, and any modifications of it are not laid out, to which we ask our customers to pay due attention and understand it well.

Yuchai reserves the explanation rights of this manual.



Precautions for Safe Operation!

1. Parts as oil pressure sensor plug, water temperature sensor plug and alarm for too low engine oil pressure are very important. In case any of them is in failure, immediately replace it with a good one to ensure normal working, otherwise the crankshaft may be burned out due to lack of the oil or the cylinder head may crack due to overheating resulted from lack of the water.

2. Keep a strict maintenance schedule as required. If oil filter is replaced, then start engine and operate it normally after the replacement, and check for leakage. Service immediately whenever leak occurs it, otherwise it will result in burning or damage of moving parts such as crankshaft, bush etc.

3. First run engine at idle speed for 3~5 minutes every time you start it, increase engine speed only when all the gauges and instruments function normally. Do not depress accelerator hard from cold-start, in case of damaging gauges and their corresponding parts & components, while speeding up wear of the engine's moving parts and damaging turbocharger as well, consequently shortening the engine's service life.

4. Do not shut down the engine suddenly from high speed and full load operating, but decrease speed and load gradually, and then run at idle speed for 3~5 minutes, otherwise turbocharger and other moving parts will be damaged, shortening engine service life accordingly.

5. Check always intake pipe for leak, air filter for block, and service immediately if you have problem with intake pipe and air filter, otherwise damage to turbocharger, scoring etc. failure will be resulted in; meanwhile, engine power will be reduced and vehicle can be operated at a lower speed only. Be sure to service it immediately at this time.

6. Service ASAP when the engine is working bad, do not operate Genset at trouble.

7. Do not approach to the rotating components and directly touch hot components (for example, exhaust pipe and turbocharger etc.) with engine running; after the engine stops, do not open water tank cap immediately to avoid being scalded.

8. Anti-freeze must be used in cooling system; otherwise, malfunction caused therefrom will not be covered in warranty.

9. Do not remove or fix relative parts and components of instruments and gauges by users themselves.

10. Do not pull out or insert any connectors or interfaces by users themselves.

11. Do not rinse engine with water or any detergent.
12. Drain off the water accumulated in the pre-fuel filter; replace the element assemblies of the pre-fuel filter and main fuel filter.
13. Before removing the battery and disconnecting the main switch of the battery, be sure to confirm the ignition switch has been turned off.
14. Hoist and transport the engine in accordance with the precautions described on the outside the package case. The place for storage of the engine shall be well-ventilated, dry, clean and free of corrosive substances. The effective preservation period of engine is indicated on engine packaging case.
15. Nameplate of a diesel engine contains basic information of the engine, including: rated power, rated rotation speed, serial number, date of manufacture, and active standard etc. YC6MJ nameplate is located on the top surface of cylinder head cover.
16. The engine model and engine ex-factory number are printed on the platform in the middle of the cylinder lower bank.
17. The safety warnings include user's precaution; crankshaft rotating/rotating danger and high temperature danger are attached to intake pipe, flywheel housing, and engine head cover near to exhaust pipe respectively.
18. Documents supplied with engine in the package case include workshop manual, parts list, tools list, certification and packing list. Please check after opened the case.

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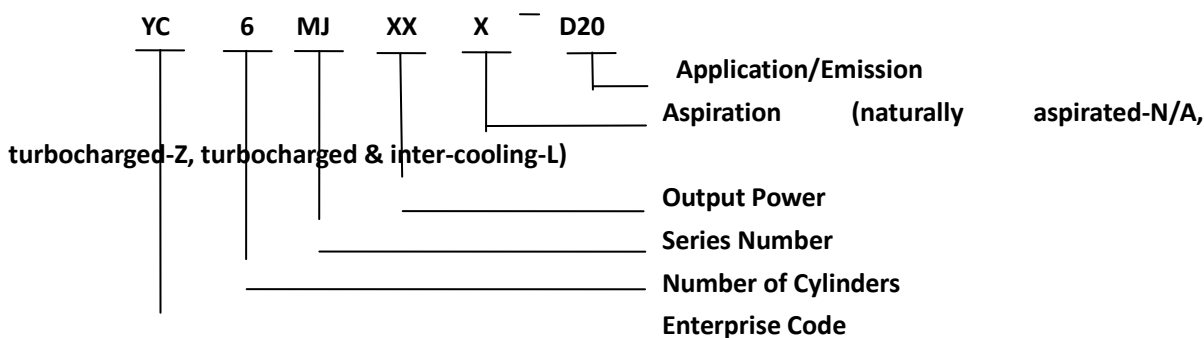
1 Overview

1.1 Product features

YC6MJ series engine for Genset is self-developed by Yuchai to meet the market needs. This engine model is highly reliable, and featured with good fuel efficiency and excellent power performance, engine is compact in design, easy maintenance and operation.

1.2 Composition and indication of engine model

The engine model is consisted of Arabic numerals and capital English letters as follows:



1.3 Main application and scope

Engine works fine under the conditions when temperature is -15°C to 38°C , and the altitude below 2000m, however, do not operate engine in submerged or fire conditions. While temperature gets lower than -15°C or higher than 38°C , or altitude is higher than 2000m, user should consult with Yuchai technical service stations to ensure engine operate normally.

2 Technical characteristics

2.1 Main technical data 1

Chart 2-1

No.	Descriptions	Technical Data	
		YC6MJ470L-D20	YC6MJ480L-D20
1	Configuration	Vertical, in-line, water cooled, 4 stroke	
2	Aspiration	Turbocharging, inter-cooling	
3	Combustion chamber	ω -shape, direct injection	
4	Number of cylinders	6	
5	Valves per cylinder	4	
6	Bore mm	131	
7	Piston stroke mm	145	
8	Total displacement L	11.726	
9	Compression ratio	16.8:1	
10	Liner type	Wet	
11	Dry weight kg	≤ 1050 (water tank is not included)	
12	Compression pressure ($n \geq 200$ r/min) MPa	≥ 2.5	

13	Overall dimensions (L×W×H) mm	Without water tank: 1820×900×1370 With water tank: 2100×1125×1450 (Note: overall dimensions may vary depending upon actual configuration)	
14	Lubrication method	In the combination of splash and pressure feed	
15	Start-up	Electrical	
16	Engine oil capacity L	33	
17	Firing order	1—5—3—6—2—4	
18	Crankshaft rotation direction	Counterclockwise(face to power output end)	
19	Rated power kW	313	320
20	Overloaded output power kW	344	352
21	Rated power r/min	1500	
22	Overloaded speed r/min	1500	
23	Fuel consumption at rated mode g/ (kW·h)	≤210	
24	Engine oil consumption g/kW·h	≤0.9	
25	High idle r/min	650~700	
26	Fuel to be used	Summer time: GB 252—2000 top-grade, or first-grade 0#, 10# light diesel fuel Winter time: GB 252—2000 top-grade, or first-grade 0#, 10#,-20 #、-35# light diesel fuel(depending upon environmental temperature)	
27	Engine oil to be used	Summer time: CD40、CD15W-40, winter time: CD30、CD10W-30, or other engine oil that compatible with environment but not lower than CD grade of GB11122-2006	
28	Piston blow-by (at rated mode) L/min	≤170	
29	Speed decrease %	By electronic speed governor: ≤0.5	
31	Stable speed fluctuation rate %	By electronic speed governor: ≤0.5	
32	Transit speed deviation rate (for rated power) %	100% sharp decreased power	By electronic speed governor: ≤+10
		Sharp increased power	By electronic speed governor: ≤-7

33	Speed recovery time s	≤5
34	Peak air inlet resistance allowed kPa	5
35	Peak exhaust back pressure allowed kPa	10
36	Smoke number under full load FSN	≤3.7
37	Noise L_w dB(A)	≤118

Note: rated power and other technical specs are measured when atmospheric pressure is 100KPa, air temperature is 25 °C, and humidity is 30%, when environmental conditions are differ from the standard mentioned above, you should go with GB1105-87 Performance Test Methods for Internal Combustion Engine.

2.2 Main technical data

No.	Descriptions	Technical data	
1	Oil pressure at rated speed(primary oil channel) (MPa)	0.3~0.60	
2	Oil pressure with engine idling(primary oil channel) (MPa)	≥0.1	
3	Oil temperature in oil pan (°C)	80~115	
4	Coolant temperature (°C)	75~95	
5	Exhaust temperature at rated power(after turbine) (°C)	≤580	
6	Static fuel supply angle (°CA)	10±1°	
7	Valve clearance cold state (mm)	Intake valve	0.3±0.05
		Exhaust valve	0.4±0.05
8	Valve timing (°CA)	Intake advance angle	2°after TDC
		Intake retard angle	24°after BDC
		Exhaust advance angle	39°before BDC
		Exhaust retard angle	1°before TDC
9	Valve recession (mm)	Intake valve: 1.45±0.15; Exhaust valve: 1.45±0.15	
10	Fuel injector tip protrusion (mm)	2.6±0.1	
11	Fuel injector opening pressure (MPa)	26~27.2	

2.3 Specs and model of main accessories (see Chart 2.3-1)

Chart 2.3-1

No.	Descriptions	Engine model	YC6MJ470L-D20	YC6MJ480L-D20
		1	Injection pump	Type
Model	PZ			
Plunger diameter x	Φ13×14			

		travel	
2	Speed governor (speed limiter)	Type	Electronic
		Model	ESG2002
		Code	MKL50-3800700
3	Fuel delivery pump	Type	Piston
		Model	S315B
4	High-pressure fuel line	Outer layer : length× outer diameter ×inner diameter	660×6×2.0
		Inner layer : length× outer diameter ×inner diameter	/
5	Fuel injector	Type	KBEL-P051
		Specs	Nozzle : 7 orifice 、 1294ml/30s; spray taper: 152°
6	Fuel filter	Type	Paper, spin-on
		Specs	7L/min
7	Oil filter	Type	Paper, spin-on
		Specs	120L/min
8	Oil pump	Type	Gear
		Capacity	≥190L/min
9	Oil cooler	Type	Cast aluminum housing, stacked-plate
		Core specs	heat transfer area: 0.43m ² , cooling capacity: ≥30kW
10	Thermostat	Type	Wax
		Opening temperature (°C)	80±2
		Fully opening temperature (°C)	92±2
11	Water pump	Type	Centrifugal
		Rated speed (r/min)	2950
		Flow (L/min)	≥450
		Lift (m)	15
12	Turbocharger	Type	Turbo-charging
		Model	HX55W
13	Water tank inter-cooler	Type	Tube-fin
		Specs	Water tank heat radiation area: 85 m ² , inter-cooler heat radiation area: 32 m ² 。
14	Starter	Type	DC
		Power (kW)	7.5
		Voltage (V)	24
15	Charging alternator	Type	Brushless, excitation
		Power (kW)	2
		Voltage (V)	28
17	Air filter	Type	Two-stage paper
		Model	YKQ2650U2

		Flow (m^3/h)	1600
18	Engine monitoring instrument	Type	Digital
		Model	CFZ-D

2.4 Torque of bolts, studs and nuts

Chart 2-4 YC6MJ tightening torque

No.	Description	Bolt specs		YC6MJ
		Thread diameter	Grade	Torque (N.m)
1	Main bearing bolts	M18		Torque to 50~70N.m for the first step Torque to 160~180N.m for the second step Torque to 260~320N.m for the third step
2	Head bolts	M16		1. Starting from center to edges, criss-cross tighten bolts to 30N.m in sequence as illustrated; 2. Starting from center to edges, criss-cross tighten bolts to 60N.m in sequence as illustrated; 3. Slacken bolts starting from center to edges in sequence as illustrated; 4. Starting from center to edges, criss-cross tighten bolts to 50N.m in sequence as illustrated; 5. Starting from center to edges, criss-cross tighten bolts to 110N.m in sequence as illustrated; 6. Rotate 90° starting from center to edges in sequence as illustrated; 7. Rotate 90° starting from center to edges in sequence as illustrated again; 8. Rotate 90° starting from center to edges in sequence as illustrated finally.
3	Conrod bolts	M14		170~240
4	Flywheel bolts	M16	12.9	Torque to 30~50N.m for the first step Torque to 80~100N.m for the second step Torque to 170~240N.m for the third step
5	Vibration damper bolts	M12		120~140
6	Cylinder head water outlet pipe bolts	M8	8.8	20~25

7	Exhaust pipe bolts	M10	10.9	45~55
8	Fuel pump bracket mounting bolts	M12	10.9	85~100
9	Fuel pump mounting bolts	M10	10.9	45~55
10	Fuel pump flange mounting bolts	M10	10.9	45~55
11	Injection pump drive gear bolts	M10	10.9	50~60
12	Fuel injector pressure plate	M8	10.9	25~30
13	Oil cooler core mounting bolts	M8	10.9	25~35
14	Oil cooler cover mounting bolts	M8	10.9	25~35
15	Rocker arm seat mounting bolts	M10	10.9	40~55
16	Crankshaft rear oil seal mounting bolts	M8	8.8	20~25
17	Cylinder head cover bolts	M8	8.8	20~25
18	Charger bracket	M10	10.9	40~55
19	Oil filling port	M10	8.8	40~55
20	Charger mounting bolts	M10	10.9	45~55
21	Crankcase bolts	M8	10.9	25~35
22	Water pump(base plate) mounting bolts	M10	10.9	45~55
23	Turbo mounting bolts	M10	10.9	45~55
24	Turbo mounting nuts (Spiralock nut)	M10		65~70
25	Idler gear shaft mounting bolts	M10	10.9	60~80
26	Camshaft thrust plate bolts	M8	10.9	25~35
27	Intake pipe bolts	M10	8.8	35~45
28	Front, rear engine eye bolts	M12	10.9	80~100
29	Oil pan connecting bolts	M8	8.8	20~30
30	Oil pump mounting bolts	M10	10.5	45~55
31	Oil strainer mounting bolts	M12	10.9	85~100
32	Fuel filter mounting bolts	M10	10.9	45~55
33	Flywheel housing mounting bolts	M14	10.9	150~200
34	Gear housing cover plate bolts	M12	10.9	85~100

Chart 2-5 Recommended tightening torque value for other bolts

Thread	NPT 1/8	NPT 1/4	NPT 3/8	NPT 1/2	NPT 3/4	NPT 1
Torque value (N • m)	8~14	24~34	47~68	68~95	88~102	

Chart 2-6 Recommended tightening torque value for screw plugs

Thread	Torque value (N•m)
M6	10~20
M8	20~30
M10	30~40
M12	60~70
M14	80~100

3 Basic structure and maintenance

3.1 Cylinder block and crankcase

YC6MJ cylinder block is cast in HT250 and crankcase is cast in RuT340, while separated into two parts along the center axis of the crankshaft. The top part is cylinder block and the bottom is crankcase. There is no sealing gasket between cylinder block and crankcase. Before installing the crankcase, clean the surface, and then spread with LOCTITE510 adhesive. The cylinder block and crankcase are fastened by 14 M18 main bearing bolts tightened with required torque, and then 25 M8 hex socket head bolt are tightened.

There are seven main bearings in block, the width of all main bearings is equal, and the thrust plates are set at two sides of the second main seat.

The cylinder block has wet liner. The thickness of the liner wall is 8.5 mm and its inner surface is special plateau mesh texture so that it has good wear resistance and can accelerate break-in.

The rear end of the block is a gear chamber cover and there is no sealing gasket between them, but the LOCTITE510 adhesive. There is a sealing gasket between the installing surface between the flywheel housing and the gear chamber cover. The gear chamber and flywheel case are into one part. The gear train lies at the rear end of the block with steady driving and little impulsion.

There is a thorough main oil channel at the right and middle side of the block. A closed secondary oil channel in the left and middle side of the block and provide oil to six piston oil spary to cool the piston effectively.

Seven camshaft bearing seats locate at the right and inner side of the block. There is a water jacket for the oil cooler on the side of the block with six entrances to cross flow water passages.

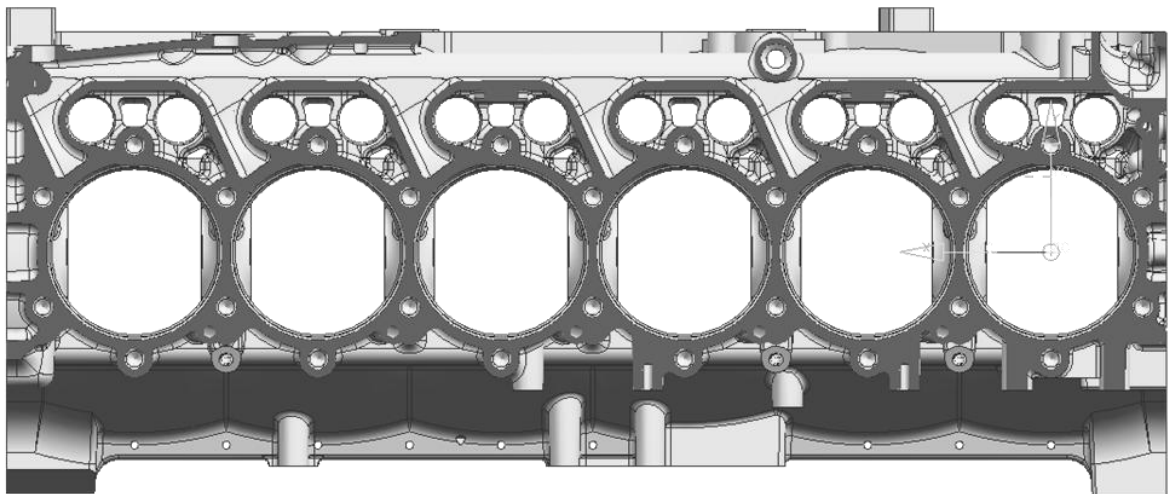


Fig. 3-1 Crankcase

Oil pan is located at the lower part of cylinder block with capacity of 33L.

Apply oil to bearing faces and screw thread with before mounting main bearing bolts, and then hand-tighten the bolts. Do not tighten the main bearing bolts for one

time, tighten evenly in turn for three steps as tightening sequence shown in the diagram. Tightening torque of main bearing bolt is 240~320N.m.

Tighten to (50~70)N•m for the first step;

Tighten to (160~180)N•m for the second step;

Tighten to (24~320)N•m for the final step.

Be sure to check crankshaft to see if it moves free as you proceed.

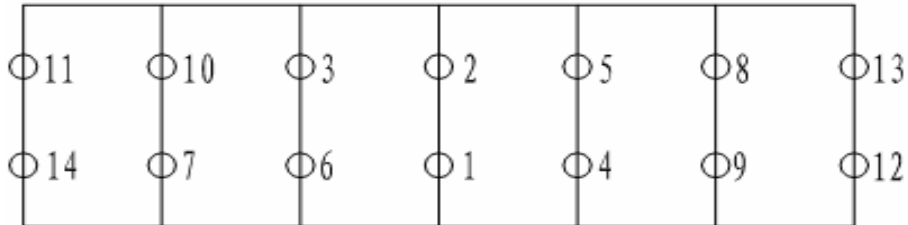


Fig. 3-2 Tightening sequence of main bearing bolts

3.2 Cylinder head

Cylinder head is formed in one piece featuring with high rigidity and high reliability. 4-valve is designed in configuration, taper of intake valve and its insert ring is 120°, taper of exhaust valve and its insert ring is 90°. Intake valve recession is factory set for 1.45±0.15mm, and exhaust valve recession is factory set for 1.45±0.15mm.

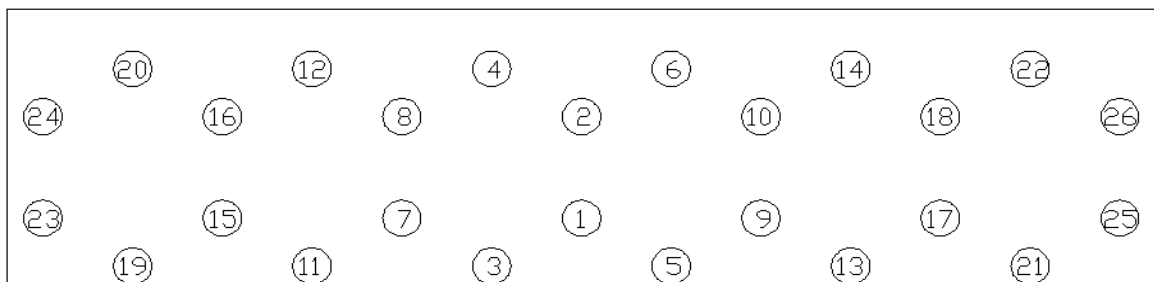
Tighten the cylinder head bolt by hands. There are 26 bolts need to be tighten.

Since the cylinder head bolts bear a large preload, the tightening torque and order for the cylinder bolts should be strictly controlled to lessen the distortion and ensure a good seal. The pull of cylinder head bolt should be much than 172kN.

Chart 3-1 Head bolts torque

No.	Description	Thread specs	Technical conditions
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No.	Description	Thread specs	Technical conditions
1	Head bolts torque	M16	<ol style="list-style-type: none"> 1. Head bolts front end, within 40mm, bearing surface has thin oil, no dripping when thread end is downwards. 2. Starting from center to edges, criss-cross tighten bolts to 30N.m in sequence as illustrated; 3. Starting from center to edges, criss-cross tighten bolts to 60N.m in sequence as illustrated; 4. Slacken bolts starting from center to edges in sequence as illustrated 5. Starting from center to edges, criss-cross tighten bolts to 50N.m in sequence as illustrated; 6. Starting from center to edges, criss-cross tighten bolts to 110N.m in sequence as illustrated; 6. Rotate 90° starting from center to edges in sequence as illustrated; 7. Rotate 90° starting from center to edges in sequence as illustrated again; 8. Rotate 90° starting from center to edges in sequence as illustrated finally. <p>Head long bolts can be re-used for three times.</p>
2	Head cover bolts fasten bolts torque	M8	(15~20) N.m, tighten in three steps



The torque, tightening sequence of main bolts, secondary bolts of cylinder head are illustrated in Fig. 3-3 below.

Head bolt length after tightening is (1.2~1.4)mm, it can be used for three times.
 Cylinder gasket is steel capable of preventing damage. Refer to Fig.3-4.

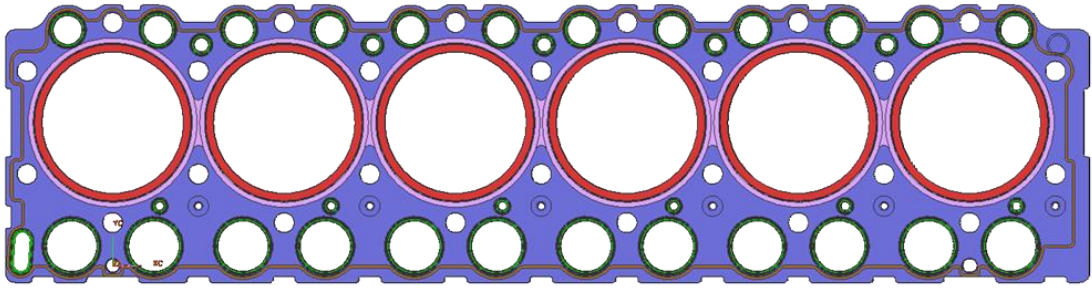
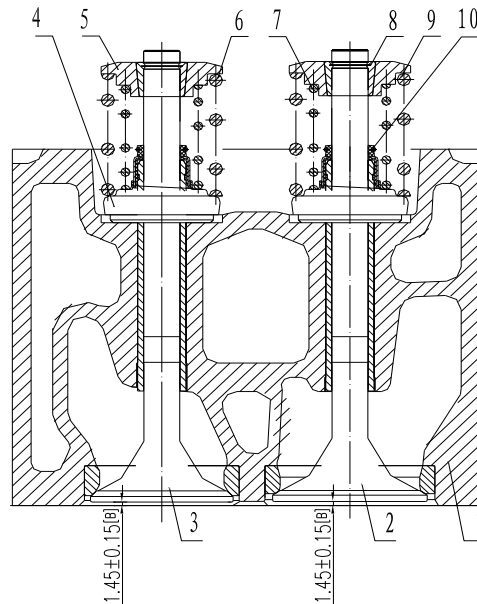


Fig. 3-4 Head gasket

- 1—Cylinder head kits(cylinder head, intake valve seat, exhaust valve seat, valve guide, bowl-shape plug)
- 2—Intake valve;
- 3—Exhaust valve
- 4—Valve spring lower seat kits
- 5—Valve spring upper seat
- 6—Exhaust valve
- 7—Valve spring inside
- 8—Valve lock
- 9—Intake valve spring
- 10—Valve stem oil seal

Fig. 3-5 valve recession checking



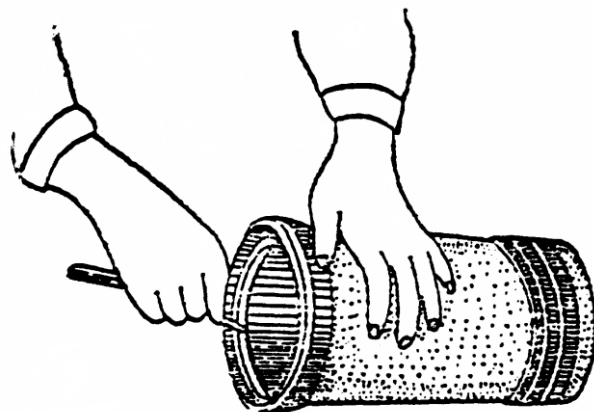
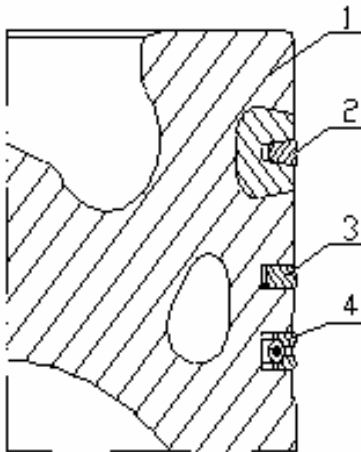
3.3 Crank connecting rod mechanism

Piston connecting-rod assy refers to Fig.3-6. The piston and piston pin are clearance fit. First position the small end of the connecting-rod between the two piston pin holes. Make sure the forward mark on the connecting-rod be in accordance with the forward arrow on the piston crown. Then insert the piston pin into the pin bore and tap it lightly with a soft metal or wooden hammer and install the snap rings. Make sure the piston and connecting-rod wiggle smoothly after installation. Next mount the piston rings with special tools. The face with mark must be up ward.

Fig. 3-6 Piston connecting-rod assy

There are three rings provided per piston. The top compression ring can seal high temperature and pressure gas. It is of barrel faced and soft ring with keystone molybdenum coated and ceramic pervaded which has good conformance to the liner, wear-resistance under high temperature and anti-sticking snap ring function. The second ring is an oil scraper ring with taper face and can well seal the gas and oil. The third ring is a multi-piece ring to scrape oil (Fig.3-7).

In order to seal well, the axial clearance and closed gap must be accordance with the prescript shown in Chart 2-3. The method of measuring the closed gap is: horizontally position the rings into the liner bore (it can be achieved by pushing the rings with piston), and then measure the closed gap with the feeler gauge (Fig.3-8).



1-Piston 2- Compression ring 3-Oil scraper ring

4-Oil ring kits

Fig.3-7 Piston rings mounting direction

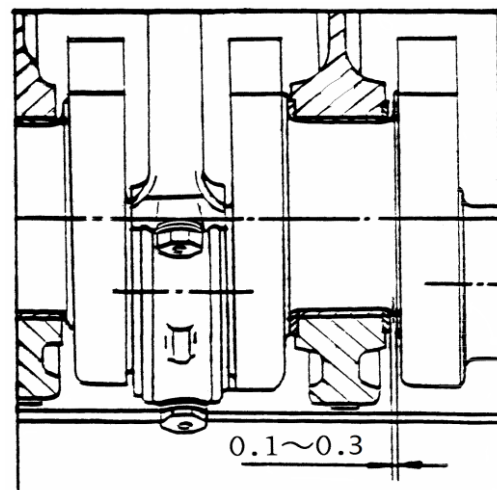
Fig.3-8 Measurement of piston ring close gap

During installing the piston-connecting rod assembly into the liner, the arrow on the piston crown should point to the front end of the engine. Be sure to stagger three piston rings' gaps to have good seal performance, Fig. 3-9. During the installation of the conrod bolts, they can be screwed to the bottom by hand and then tightened by a torque wrench. The tightening torques of the connecting-rod bolts are 170~240N.m in three steps evenly:

first $40 \pm 10\text{N.m}$, second $90 \pm 10\text{N.m}$ and finally $170 \sim 240\text{N.m}$. Make sure the crankshaft rotates freely after tightening. The piston has inner oil cooling gallery and is cooled by oil sprayed from the piston cooling nozzle, which can prevent the piston overheating.

The piston cooling nozzle must be tested to make sure oil sprayed into the oil gallery in the piston. The crankshaft has a thrust plate mounted at the second crankshaft bearing seat to prevent the crankshaft from endwise movement. The axial clearance of the crankshaft must be between $0.102 \sim 0.305\text{mm}$, Fig. 3-10.

- Cast iron ring gap opening**
- 2nd compression ring gap opening**
- Piston pin direction (face forwards)**
- Spiral expand spacer gap opening**
- 1st compression ring gap opening**
- Fig. 3-9 Piston ring gap direction**
- Fig. 3-10 Measurement of crankshaft axial clearance**



The front oil seal of the crankshaft is installed on front oil seal seat and the rear oil seal is mounted into the flywheel case. In order to make sure the oil seals be installed to their correct position reliability, the special tools must be used. After the installation of the rear oil seal assembly, tighten the bolts crossly and diagonally in two steps: first, tighten all bolts to $10 \sim 13\text{N.m}$ and second to $20 \sim 30\text{N.m}$.

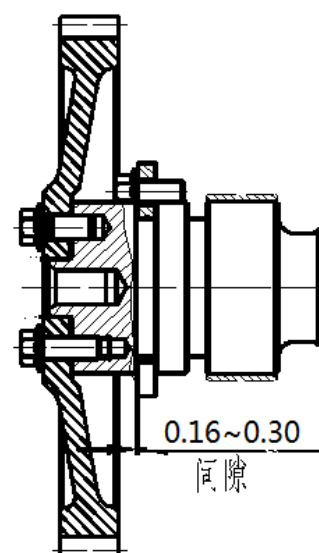
The flywheel is position assembled to the rear flange on the crankshaft. During assembly, keep the joint surface clean and good condition. The flywheel tightening bolts should be tightened in multi-steps evenly and diagonally. The final tightening torque should be $180 \sim 240\text{N.m}$.

The crankshaft belt pulley damper is tightened to the crankshaft by bolts crossly and diagonally, the tightening torque of bolts is $130 \pm 10\text{N.m}$.

Be sure to maintain conjunction surface clean and in good condition while mounting oil pump, torque of inlet/outlet port of connecting flange bolts are $45 \sim 55\text{N.m}$.

3.4 Valve train and gear train

The valve train is composed of the valve assembly and its driving train. The valve assembly includes valve, inner and outer valve springs, valve key, valve stem oil seal, valve guide, and valve spring upper retainer and valve spring bottom retainer components. The valve driving train contains camshaft, lifter, push rod, rocker arm support seat, rocker arm components, timing gear for camshaft and so on. Oil is delivered to lifter from block and flows to the rocker arm components and last to the



rocker arm holes along the valve push rod.

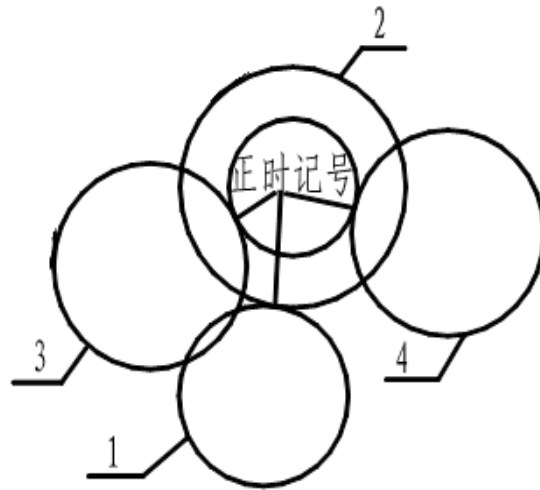
The bottom arranged camshaft is of fully supported structure. It is made up of material which is better than 45# steel in whole to improve its intensity and surface hardness. The camshaft timing gear is positioned by a locating pin and tightened to the end face of the camshaft by 4 M8 bolts in order to improve reliability. The axial clearance of the camshaft controlled by thrust washer must be between 0.06~0.22mm, Figure 2-10.

Rocker arm shafts are bolted to cylinder head by three M10 bolts, clearance fit for rocker arm shaft and rocker arm shaft seat is 0.029~0.071mm. Use specialized tool kit for dismantling and reassembling.

To ensure engine run at optimum performance, after the valve guide is pressed into the cylinder head, the height from the valve guide upper face to the bottom face of the valve spring bottom retainer should be $22\pm 0.2\text{mm}$ (Fig.3-5). The valve face angles of the intake valves and their seats are 120° and the valve face angles for exhaust are 90° . This can ensure good seal performance and serviceability. The materials with good wear-resistance for intake valve and its seat. After the valves are installed onto the cylinder head, they and their seats must be ground to make sure the seal band width be: intake valve 1.63~1.83mm and exhaust valve 1.52~1.82mm. The valve recession should be controlled strictly to meet specifications: intake valve $1.45\pm 0.15\text{mm}$ and exhaust valve $1.45\pm 0.15\text{mm}$.

Be sure to check and adjust valve clearances on a regular basis to have engine work fine. When the engine is in a cold state, the intake valve clearance is $0.3\pm 0.05\text{mm}$ and exhaust valve clearance is $0.45\pm 0.05\text{mm}$. The method of checking and adjusting the valve clearances is: Rotate the crankshaft to TDC on the compression stroke for cylinder #1, and then adjust the 1#, 2#, 3#, 6#, 7#, 10# valve. Rotate again the crankshaft for 360° to adjust the 4#, 5#, 8#, 9#, 11#, and 12# valve. The valve adjustment can be made by adjusting the valve adjusting bolts, i.e. loose the tightening nut of adjustment bolt and screw the adjustment bolt out and in, then check the clearance between the rocker arm and end of the valve stem with a feeler gauge, fasten the tightening nut afterwards.

The gear system is designed in the configuration with gear housing positioned at the rear end. The gear housing and the flywheel case are built in one piece. This kind of structure make the transmission steady, little impulsion and this design for the gears utilizes the patent: point and line meshing gear which can reduce the contact stress to increase effectively the contact fatigue intensity in order to decrease the noise. The idle gear components contain a large and a small idle gear. They are assembled through interference fit. The large idler gear, crankshaft timing gear and PTO gear are spur gear. The small idler gear and its driving gears are helical gear. Through the hole with kidney shape on the large idler gear, the timing mark 1 and 2 on the small idler gear can be seen. During the assembly, they must be aligned to avoid bad performance. Through the hole with kidney shape, the mesh clearance can be checked between the small idler gear and the other gears. The backlashes of the gears for YC6MJ should be 0.07~0.20mm, Fig.3-12.



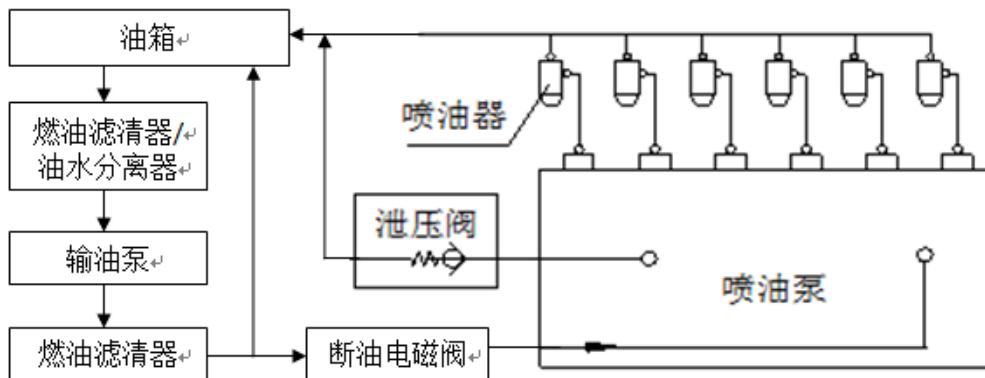
- 1. Crankshaft timing gear 2. Idler gear kits
- 3. Camshaft timing gear 4. Fuel injection pump gear

Fig. 3-12 Gear train

3.5 Fuel System

YC6MJ

The schematic diagram of YC6MJ fuel system, as shown in Fig.3-13



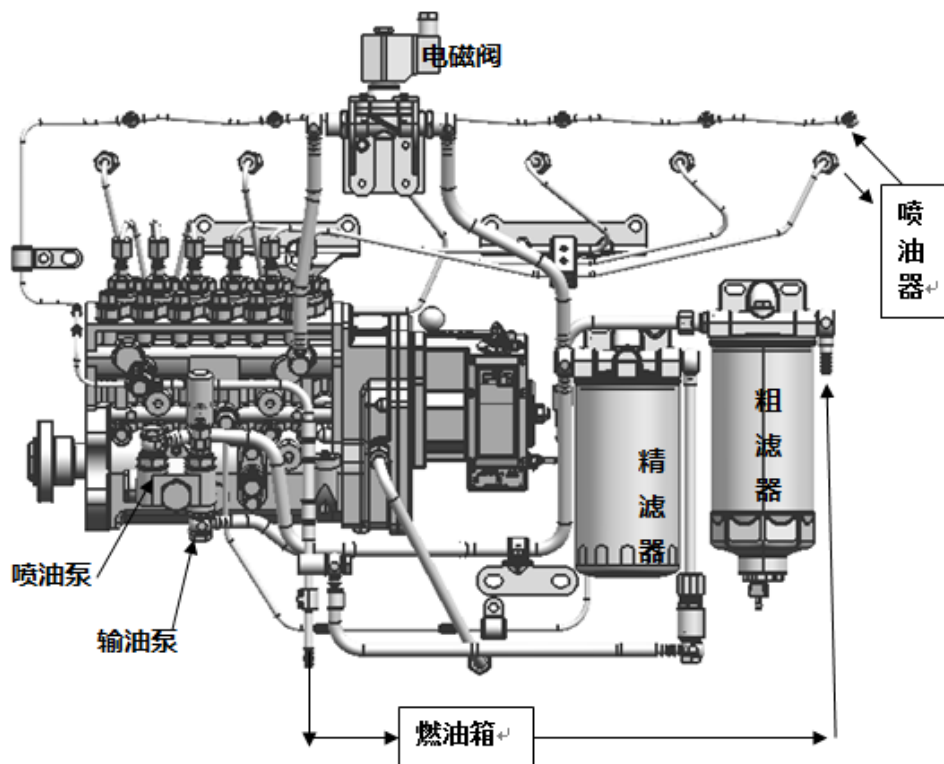
- 油箱 fuel tank 喷油器 fuel injector 输油泵 fuel delivery pump 柴油滤清器 fuel filter
- 断油电磁阀 fuel shut off solenoid 喷油泵 fuel injection pump
- 燃油滤清器/油水分离器 fuel filter/fuel-water separator

YC6MJ

Fuel supply system includes fuel tank (provided by users), fuel supply pump, low pressure fuel pipe, fuel filter/fuel-water separator, injection pump (with electronic speed governor), high pressure fuel pipe and injectors, low-pressure fuel line. Refer to Fig. 3-14. The purpose of fuel supply system is to the right amount of clean fuel to each cylinder at

proper time with a controlled rate and pressure, adequately atomize the fuel and rapidly mix it with the air in the cylinder for good combustion. Fuel supply system is essential to engine power performance, fuel economy, noise and emission.

Fuel transfer process: fuel is conducted from fuel tank, after going through the transfer pump, it enters primary filter /secondary filter, and then the fuel shutoff solenoid, and it's flowing into injection pump in which the fuel is pressurized, after atomizing, charge of fuel is sprayed to combustion chamber via fuel injector. On the other hand, the surplus coming from fuel injector, injection pump, and secondary filter will flow back to fuel tank afterwards.



电磁阀 Solenoid 喷油器 Fuel injector 精滤器 Secondary filter
粗滤器 Primary filter 燃油箱 Fuel tank

Fig.3-14 Fuel feed system

Fuel shutoff solenoid is provided in fuel line, solenoid voltage is 24V. Activate through the engine monitor instrument when you have emergency shutdown. For daily operation, please use fuel shutoff lever located in speed governor.

3.5.1 Fuel Injection Pump

YC6MJ uses P7100 or PZ fuel injection pump adopting fully enclosed housing and suspended plunger barrel to boost the stiffness of construction. The plunger sleeve and the delivery valve couples are mounted in the flanged barrel. Fig. 3-15.

Follow the instructions below before operating

- Check the static fuel supply advance angle (refer to Chart 2-2), adjust if it is out of the specification range.
- Remove air from fuel injection pump.
- Check the fuel shutoff unit to see if it works fine, fix it if necessary.

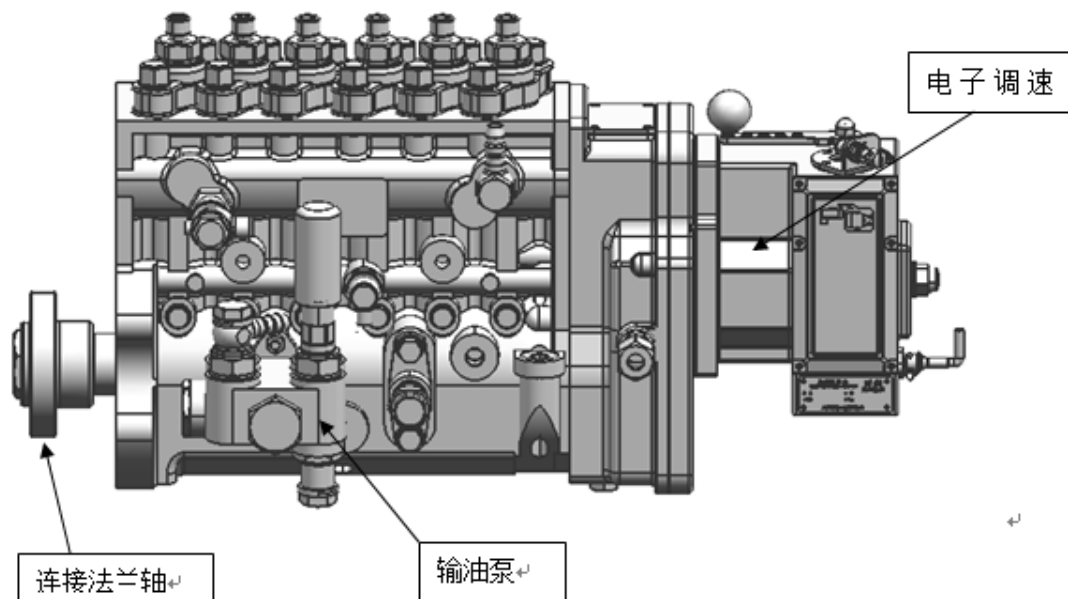


图 3-15 Fig. 3-15

电子调速 **electronic speed governor** 连接法兰轴 **connecting flange**
 输油泵 **fuel delivery pump**

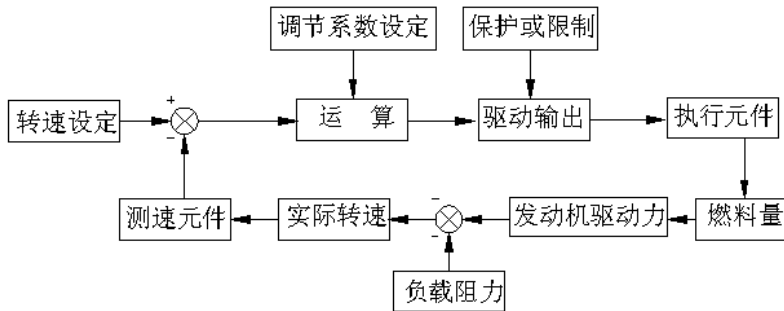
The injection pump assembly is constructed to high precision. When a problem occurs, please do not dismantle and install the pumps randomly. They should be sent to the maintenance center authorized by YUCHAI or a nearby maintenance point for repair.

3.5.2 Speed governor (Speed limiter)

YC6MJ is equipped with electronic speed governor in fuel injection pump.

3.5.1.2 Electronic speed governor

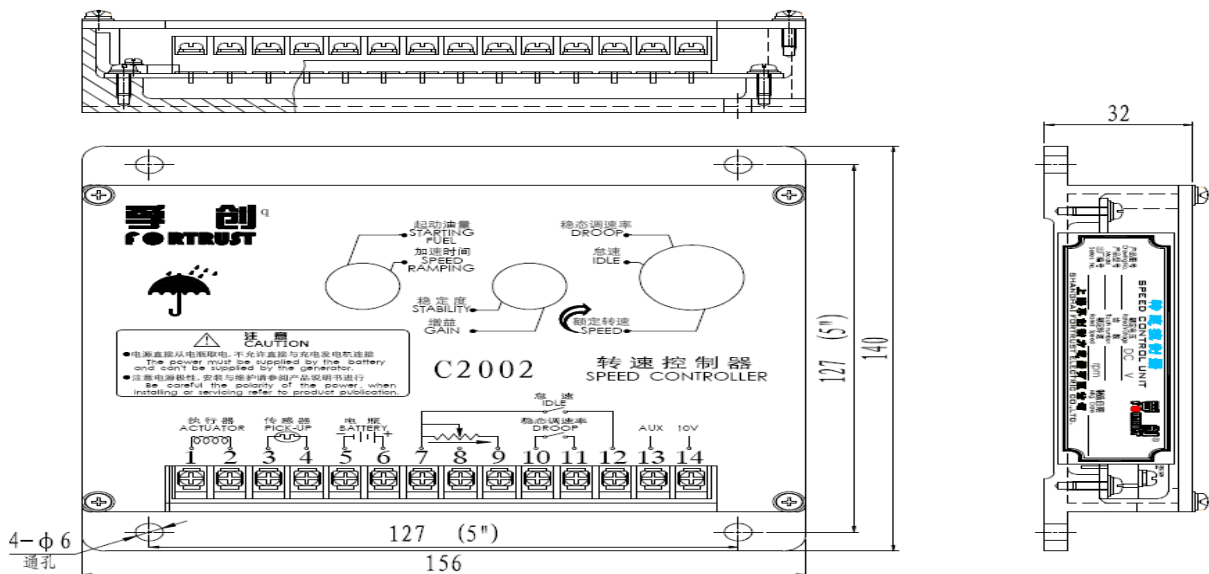
转速设定 speed setting 测速 speed measurement 比较 comparison 运算 calculation
 驱动输出 driver output 执行元件 actuator element 调节系数设定 adjust coefficient
 setting 保护或限制 protection or limitation 测速元件 speed measurement element
 发动机驱动力 engine drive force 燃料量 fuel quantity 负载阻力 load resistance
 Figure 3-16 schematic diagram of operating principle

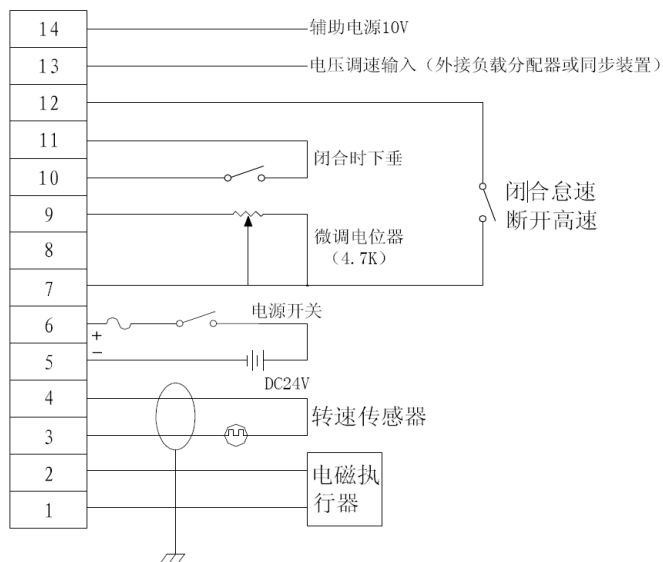


Electronic governor consists of electromagnetic actuator, speed controller, speed sensor, etc., electronic governor plays the part of speed setting, speed measurement, comparison, calculation, driver output, adjust coefficient setting, actuator element, protection or limitation, each mechanism or component can form a closed-loop control system (as shown in Fig. 3-16)

Speed limiter

Fig. 3-17 C2002 speed controller external appearance and installation dimension
 10V auxiliary power 10V
 Voltage speed-regulating input (external load divider or synchronization unit
 it's downward when closing trimmer potentiometer
 it returns to idle after closing





断开高速 it goes in high speed after disconnecting
电源开关 power source switch 转速传感器 speed sensor
电磁执行器 Electromagnetic actuator
Fig. 3-18 C2002 speed controller wiring diagram

Speed limiter is fitted on control box or fixed onto other engine peripheral devices. Install the speed controller in the place where is dry with favorable temperatures as much as possible. Be sure to fit speed controller vertically when it is very humid. Installation dimension and wiring diagram refer to Fig. 3-17, Fig. 3-18.

Specifications:

Voltage: DC24V (range: 18V~32V)

Speed fluctuation ratio: $\leq \pm 0.25\%$

Stable governor rate: 0~5% adjustable

Environmental temperature: $-40^{\circ}\text{C} \sim +85^{\circ}\text{C}$

Environmental humidity: <95%

Electromagnetic actuator

Electromagnetic actuator is divided into two types (built-in and external), built-in means electromagnetic actuator has replaced high-pressure fuel pump mechanical governor, instead, it integrated with fuel pump directly to form a part of it, and internal actuator rack bar has linkage with high-pressure fuel pump rack. Fuel shutoff handle is fitted around outside of actuator, so as to limit maximum fuel supply quantity through making adjustment to the position of fuel shutoff handle.

YC6MJ series is equipped with built-in electromagnetic actuator.

Speed sensor

Speed sensor uses passive magneto-electric speed sensor, speed measurement gear rotates to change magnetic gap, producing inductive electromotive force in probe coil. Fit speed sensor to engine trigger wheel, determine engine speed by inductive flywheel teeth. When you touch the gear top and go back for 1/2—3/4 round (approximately 0.45mm)

Warning: speed sensor is provided for electronic governor only; avoid operating it

together with other speed measurement system or unit.

3.5.3 Fuel delivery pump

On the fuel delivery pump is installed a hand priming pump for de-aeration from the fuel pipeline. For operation press down the knob repeatedly to draw the fuel from the tank, at the same time loosen the de-aeration screw to expel the air. After operation release your hand to have the knob reset. In addition, there is a small filter screen in the fuel inlet union bolt which shall be removed and cleaned frequently to avoid clogging which will result in detriment of the fuel supply.

3.5.4 Fuel injector

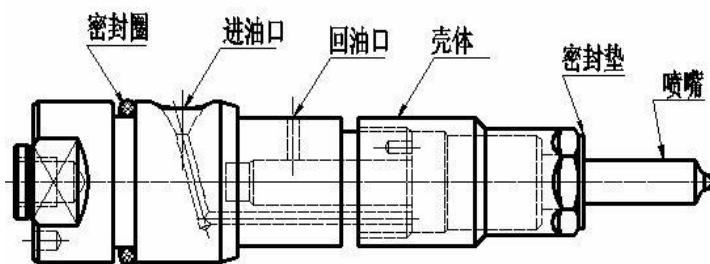
密封圈 Seal ring 进油口 inlet port 回油口 return port 壳体 body

密封垫 seal gasket 喷嘴 nozzle

YC6MJ is designed in 4-valve configuration and adopts model P injector (as shown in Fig. 3-19), which is composed of cover body, mating parts, pressure-regulating

spring. The opening pressure is governed by the pre-load of the pressure-regulating spring. The pre-load can be adjusted by changing the thickness of gasket of spring seat.

Fuel injector must be fitted to their original places, they are must not be intermixed for fit. Sealing gasket should be replaced with the new one of same thickness, in case of affecting nozzle protrusion and engine performance. Atomization and spray pattern of injector should be normal, and no fuel dripping is allowed.

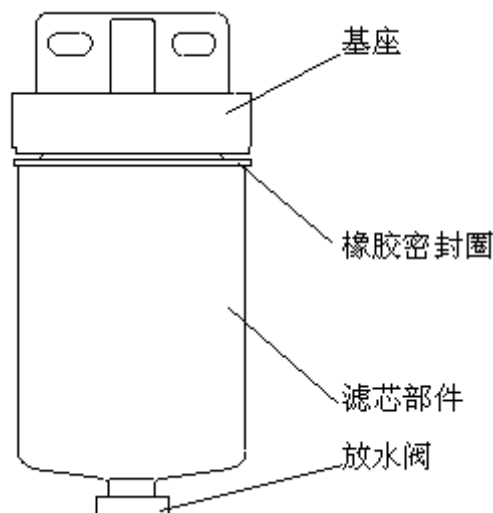


The injector is made of special material by special process, though its appearance is similar to that of the conventional injectors, but performance and pressure tolerable varies, so it cannot be replaced by other type of injectors, otherwise it may cause problems or damage the engine.

Caution: do not approach and touch nozzle or fuel spray.

3.5.5 Fuel filter

The fuel filter is designed with high-precision and high flow rate, as shown in Fig. 3-20. Replace fuel filter element with engine operating for 400 hours in case restriction is higher, causing insufficient fuel feed. When assemble filter element, fill up fuel filter with clean diesel fuel to prevent air from entering the fuel feeding system, causing difficult start and



rough running, then lubricate rubber seal ring with a small amount of clean oil and assemble integrated filter element afterwards. (Retighten 3/4-1 turn after seal ring are in firm contact with filter base)

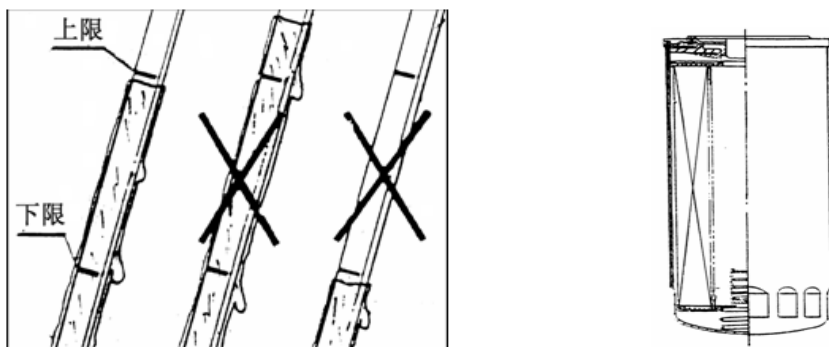
基座 base 橡胶密封圈 rubber seal ring 滤芯部件 filter element kits

3.6 Lubrication system

The lubrication system functions to convey the clean lube with satisfactory pressure and temperature to all friction surfaces for sufficient lubrication so as to ensure all parts work fine. Please refer to Important Notices for users for detailed knowledge of engine oil.

Check oil level in oil sump at a regular basis. Make ensure oil level stay between upper and lower limit in oil dipstick (as shown in Fig. 3-21). Fill if insufficient, do not over fill. Have oil changed with engine operating for 250h. Shorten oil change interval if you have a frequent start-up or operating engine at high speed, heavy load frequently. Oil sump capacity is approximately 33L. Oil drain screw plug is bolted to the lower part of oil sump.

Oil filter is paper, spin-on filter element type (as shown in Fig. 3-22). Have oil changed with engine operating for 250h. Fill up new filter with clean oil, and then lubricate rubber sealing ring with a small amount of clean oil when installing filter. Lubrication flow schematic diagram is shown in Fig. 3-23.



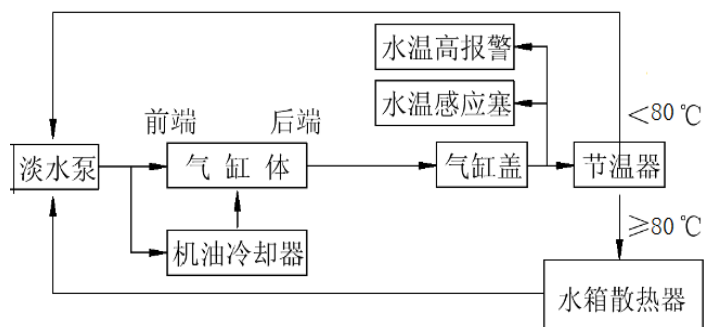
3.7 Cooling system

YC6C series diesel engine adopts forced close-loop circulation cooling system, coolant can be clean soft water, but rust-proof, antifreeze is better. It is ideal to have engine water outlet temperature controlled to be 80°C~95°C, while oil temperature to be 90°C~115°C.

Water pump and fan are key parts of the cooling system and the structure is as shown in Fig 2-28. Fill grease into water pump bearing tank through the grease nozzle on the water pump after the diesel engine works for accumulated 50 hours.

Use steel pipe or hose with good rigidity between water pump water inlet port and radiator in case of getting sucked flat. Fan is axial flow type.

At the front end of water outlet pipe, two thermostats are mounted in parallel.



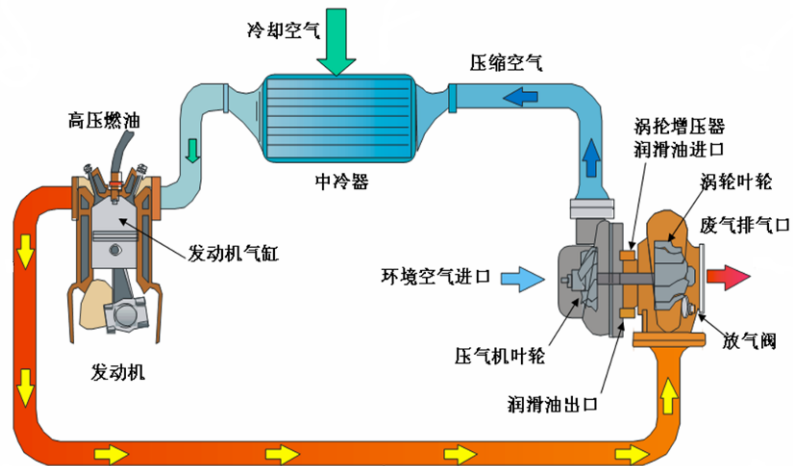
Do not remove the thermostat while operating, in case of affecting engine performance.

Engine is built with a forced, closed-loop fresh water system inside. (As shown in Fig. 3-24)

淡水 Fresh water pump 前端 front end 后端 rear end 气缸体 cylinder block
 机油冷却器 oil cooler 水温报警器 water temperature alarm
 水温感应塞 water temperature sensor 气缸盖 cylinder head 节温器 thermostat
 水箱散热器 radiator

3.8 Turbocharging system

YC6MJ。



YC6MJ is built with turbocharging system in design. Operational schematic diagram is shown in Fig. 3-25.

气缸 cylinder 压缩空气 compressed air flow 中冷器 intercooler
 环境空气进口 ambient air inlet port 压气机叶轮 compressor impeller
 润滑油进口 lubricant oil outlet port 放气阀 air bleeding valve
 废气排出口 exhaust gases outlet port 涡轮叶轮 turbine impeller
 润滑油进口 lubricant oil inlet port of turbocharger
 涡轮增压器润滑油进口 lubricant oil inlet port of turbocharger

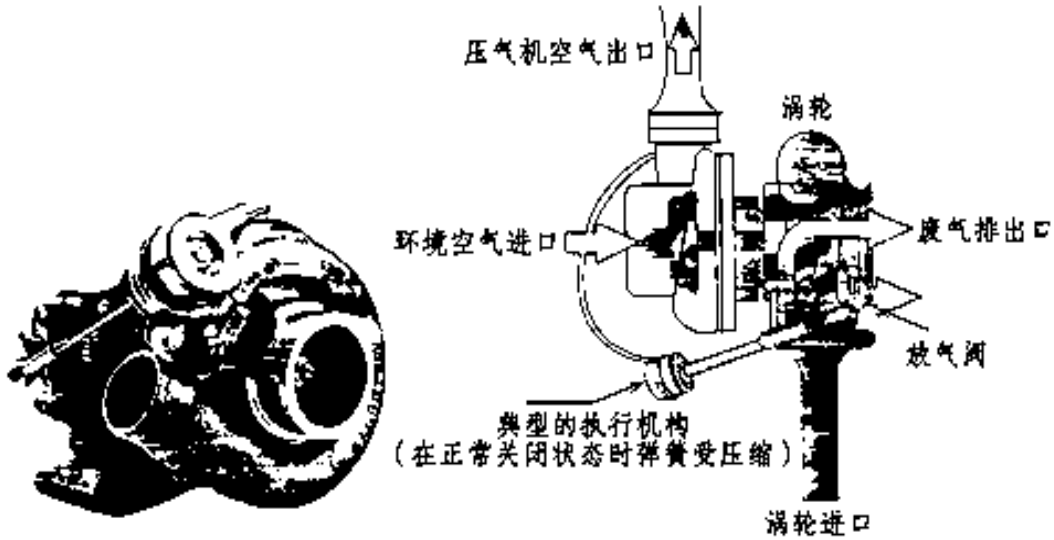
Fig. 3-25 Operational schematic diagram

As exhausted gas enters into turbine from the exhaust pipe with engine operating, the heat energy rotates the turbo, and the air compressor that shared the same shaft with turbo. The compressor inhales and compresses the air, and then drawn into intake pipe, the cooled and expanded air that have left from the turbine is to be delivered to engine exhaust system via turbine shell into atmosphere afterwards.

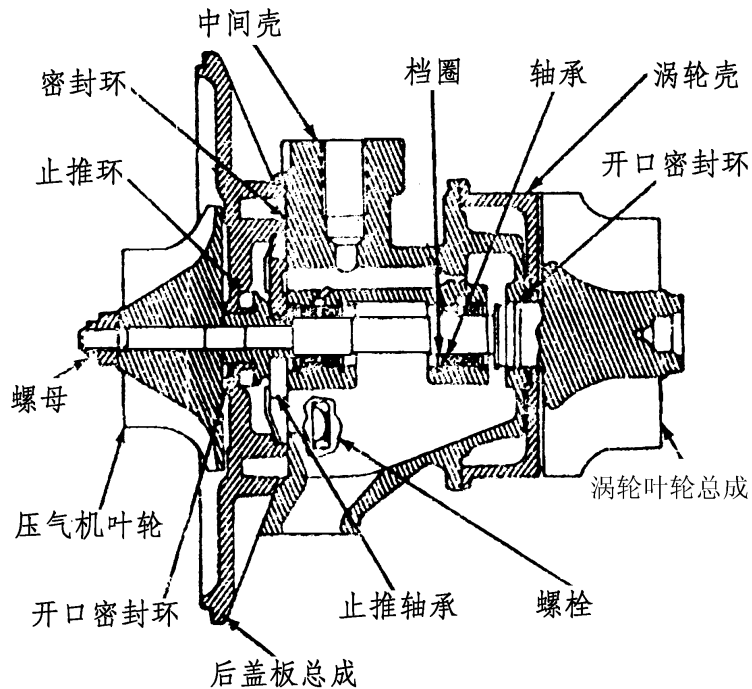
Air density is increased after compressed, creating a more extensive combustion while fuel supply system is working, thus to improve power output and fuel efficiency.

Turbocharging & inter-cooled is to cool the compressed air, increasing air density as well as the amount of air quantity, thus to increase power output, while reduce combustion chamber temperature.

Turbocharger is shown in Fig. 3-26, Fig. 3-27 and Fig. 3-28. Turbocharger also can be designed without the by-pass valve in configuration.



压气机空气出口 Compressor air inlet port 涡轮 Turbine
 涡轮进口 Turbine inlet port 环境空气进口 Ambient air inlet port
 放气阀 Air bleed valve 废气排出口 Exhausted gas outlet port
 典型的执行机构 (在正常关闭状态时弹簧受压缩)
 Typical actuator mechanism (spring is compressed at close state)
 Fig.3-26 Turbo



中间壳 Intermediate housing 密封环 Seal ring 挡圈 Retaining ring 轴承 Bearing
 涡轮壳 Turbine housing 开口密封环 止推环 Thrust ring 螺母 Nut
 压气机叶轮 Compressor impeller 后盖板总成 Rear cover plate assy
 止推轴承 Thrust bearing 螺栓 Bolt
 压板 Pressure plate 螺栓 Bolt 压气机壳 Compressor housing
 中间壳转子总成 Intermediate rotor assembly 涡轮壳 Turbine housing

Fig.3-28 Turbo components

The turbocharger is designed as a high precision assembly with high spinning speed. Do not disassemble it, if a problem occurs, please have it fixed by mechanics at authorized service center. Follow the instructions below while operating:

Let engine run at idle speed before oil pressure builds up.
 Make sure temperature and speed decrease gradually from the peak before shut down engine.

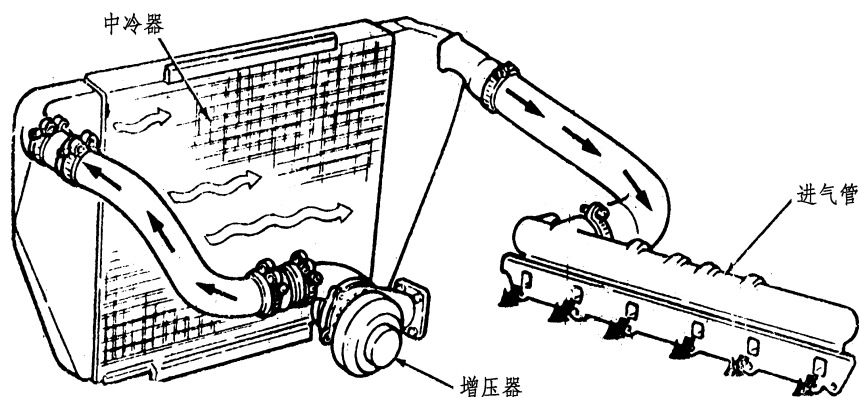
Pre-lubricate the turbocharger. After changing oil and servicing (e.g. drain oil), the turbocharger should be pre-lubricated ahead, crank the crankshaft several revolutions before the engine starts. After starting, let engine run at idle speed for a while to build up the oil pressure before running it at high speed.

Be careful to start engine at low temperature. When the ambient air temperature gets too low or the vehicle has sit for a long period of time, oil pressure and flow rate will take longer than usual to function normally. After starting, run engine at idle for a couple of minutes before it works fine.

Do not run engine at idle speed too long.

3.9 Inter-cooler

中冷器 Inter-cooler 进气管 inlet pipe 增压器 turbocharger



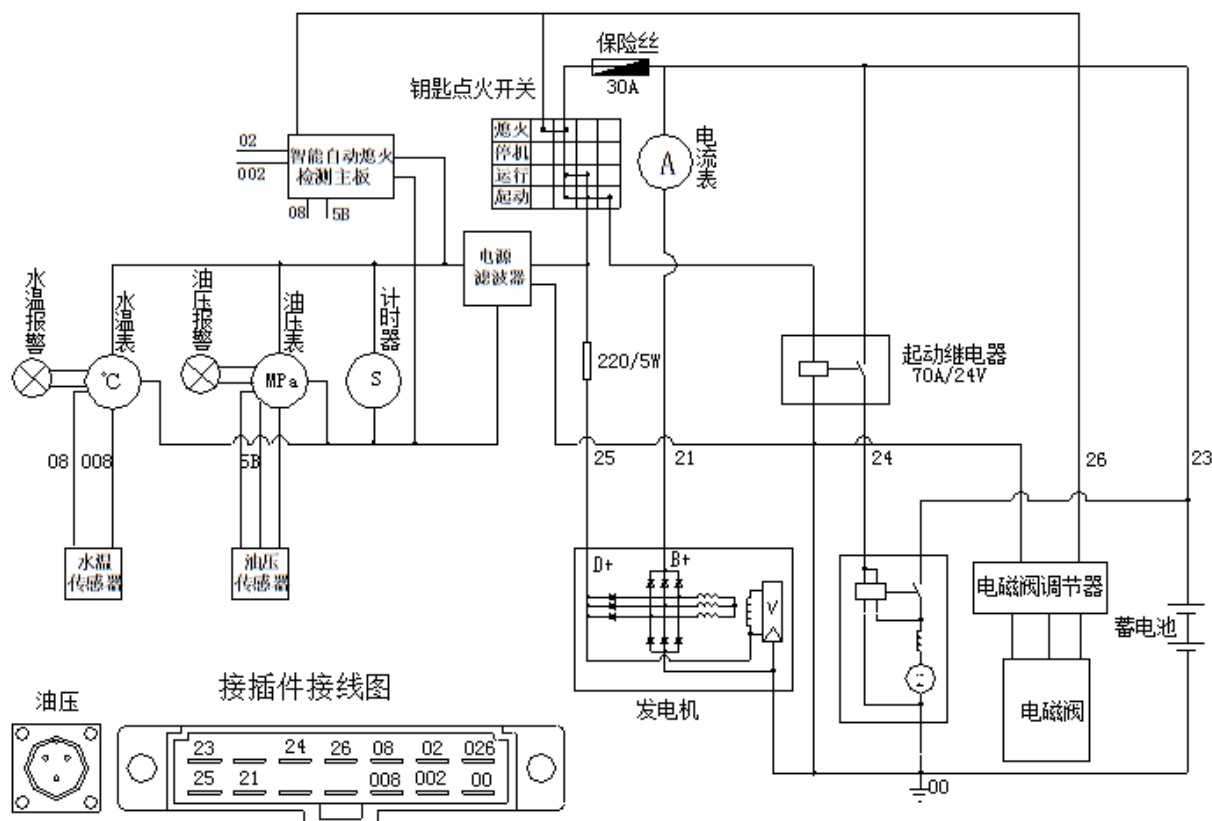
The air from the turbocharger will be conducted to the wind-air or water-air intercoolers installed in front of radiator, instead of entering the air intake pipe directly. The density of compressed air is increased after cooled, helping to improve engine performance. As shown in Fig. 3-29

Boosted air is flowing through inter-cooler flat pipe, plate-fin is provided around its surface to carry away the heat.

The common trouble of intercooler is air leak, which will reduce engine power, turbocharger pressure and increase the exhaust temperature. The intercooler with air leakage should be welded up. You always have an air leak from connection and welded joints between flat pipe and plate-fin, housing and air chamber, and box. The best way to check is to pressurize the intercooler to 207Kpa and then apply soap water to locate the exact leak position.

3.10 Electrical system

Electrical system is composed of starting system and monitor system. The start system includes battery (provided by users), charge alternator, start motor, cathode switch(provided by users) and start-up switch (located at dashboard). The monitor system includes instrument assembly, temp sensor, lube pressure sensor and speed sensor. Operational diagram is as shown in Fig. 3-30.



保险丝 fuse 钥匙点火开关 ignition switch 电源滤波器 EMI filter 电流表 ammeter
智能自动熄火检测主板 intelligent automatic shutdown check main board
水温报警器 water temperature alarm 水温表 water temperature indicator
油压报警 oil pressure alarm 油压表 oil pressure indicator 计时器 timer
水温传感器 water temperature sensor 油压传感器 oil pressure sensor
发电机 alternator 启动继电器 start-up relay 电磁阀调节器 solenoid regulator
电磁阀 solenoid 蓄电池 battery 接插件接线图 connector wiring diagram
油压 oil pressure

Fig. 3-30 electrical system schematic diagram

3.10.1 Start system

This series is equipped with electrical start-up system.

Activate cathode switch (provided by users) DK, and then press down the start-up switch on the dash to let electric current through magnet coil in relay of the starter to move the magnet, connect and crank starter, pinion is automatically thrown out to engage with the flywheel ring gear, engine is turned over at this point.

3.10.11 Start motor

The purpose of the DC starter is to overcome the resistance resulted from engine cylinder compression, friction and inertia etc., and make engine reach the starting speed needed for the engine to move from a state of rest and to accomplish its firing & combustion and transfer to normal operation. As shown in Fig. 3-31

YC6MJ series starter is 24v and 7.5kW. It consists of the series-wound motor which produces torque, the clutch which makes the small gear of starter engaged or disengaged with gear ring of flywheel, the magnet switch connects or disconnects the circuit running between starter and battery.

Instructions to servicing & maintenance

A. Check the battery power, lead wire connection and DC starter mounting bolts to make sure that they are secured.

B. Each start-up cannot exceed 5 seconds. If it fails to start, the interval of a continuous start-up should at least be more than 2 minutes. In the event of three successive start-up failures, find out the causes and resolved before the next start step.

C. Turn off the start-up switch immediately after engine cranked and turned over.

D. Be sure to keep all parts of DC starter clean and dry.

E. Check and make adjustment to DC starter once every year.

1. Starter switch panel
2. Electromagnetic switch casing
3. Electromagnetic switch coil
4. Earth switch
5. Active iron core
6. Reset switch
7. Fork
8. Eccentric screw
9. Drive end-cover
10. Castle nut
11. Starter shaft
12. One-way clutch
13. Armature
14. Magnetic pole
15. Brush
16. Housing

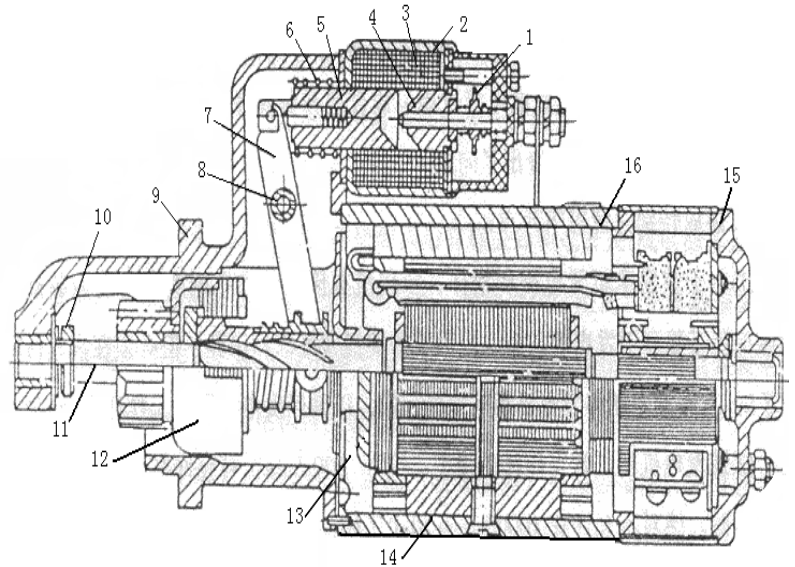
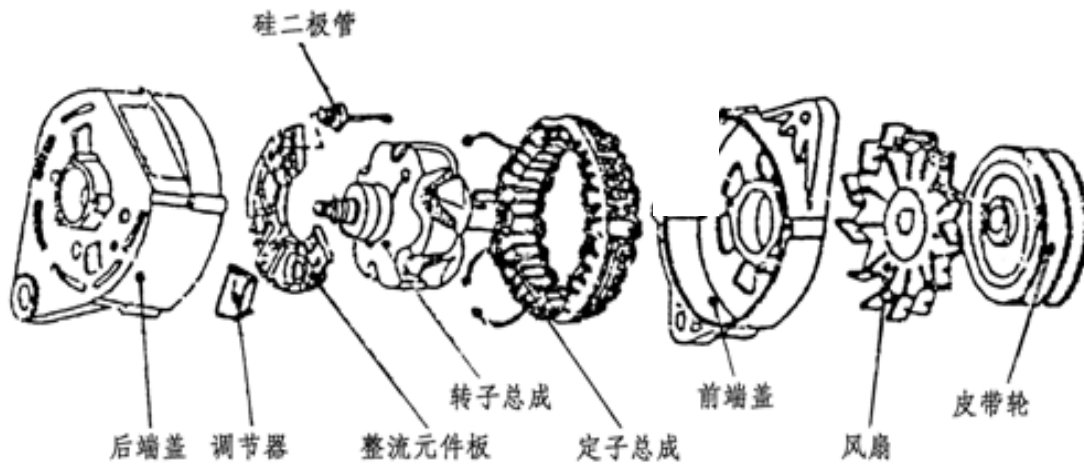


Fig. 3-31 DC starter

3.10.1.2 Charging alternator

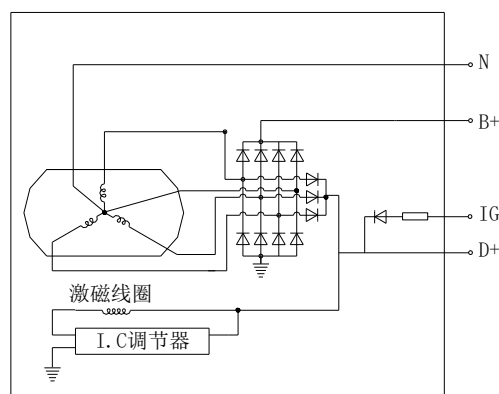
The charging alternator is silicon rectifying integral brushless excitation type. It is belt drive with 28V voltage rating and 2kW power rating. The rough drawing of its electrical system is shown as Fig. 3-32.



整流元件板 rectification electrical element assembly 转子总成 rotor assembly 定子总成 stator assembly
 前端盖 front end cover 风扇 fan 皮带轮 belt pulley
 激励线圈 excitation coil 调节器 regulator

Fig. 3-32 details of silicone rectification, brushless alternator

Fig. 3-33 schematic diagram of alternator electrical system



Instructions for operating and servicing

Operate correctly can ensure a longer service life and reduce repair in it. Improper operation and maintenance may cause damage.

A. The earth electrode of battery should be as same as the one in alternator. The earth electrode of the silicon rectifying AC alternator of YC6MK diesel engine is negative, so the earth electrode of battery on the ship is required to be negative, otherwise, once the live wire of battery contacts alternator live wire terminal, battery will discharge through the silicon diodes, causing damage.

B. All terminals of silicon rectifying alternator should be correctly connected.

Generally, alternator has four terminals:

B+: Armature terminal

D+: Magnetic field terminal

N: Neutral

W: Speed measurement terminal

Earth terminal

C. Disconnect negative switch after stopping engine to avoid battery discharge to alternator exciting windings for long, causing damage.

D. When the alternator is working, do not check if alternator generates electric power by scratching and sparking the B+ terminal with a screwdriver or any other metal article, in case of causing damage to alternator or harness burnt out.

E. Service timely whenever the alternator fails to generate electrical power. Do not operate it for long. If a diode is lost, the alternator will not generate electrical power, so a continuous running of alternator will inevitably cause the other diode and three-phase stator winding to burn out.

F. Never check the insulation property of alternator with a 220V AC voltmeter or mega-meter, otherwise overvoltage will break or damage the rectifier diode.

G. The alternator drive belt tension shall be properly set, ensure that it is neither too loose nor too tight. If a belt is too loose, it is likely to slip, causing a shortage of electrical power; if a belt is too tight, it is likely to damage the belt or alternator bearing. When you set the tension, press down with hands on the middle of belt, if belt bends 10-15mm, you

can tell it is a right tension.

H. How can you tell if the charging system of alternator is good? The battery generates a great deal of electrical power to starter with engine starting, resulting in a reduction in its end voltage; after engine is running, alternator will supplement battery the power immediately until the end voltage of battery reaches adjuster 's limited voltage, and you can tell that the battery is fully charged. The output voltage level of alternator can be measured by connecting a voltage meter to the two terminals of battery.

Important Notices

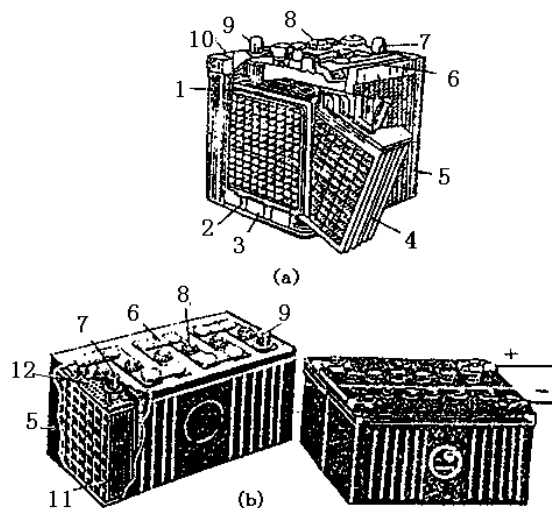
☆ This alternator has no brush and slip ring to wear and burn out, so you won't be bothered by the problem of unstable excitation current and not generate electrical power, therefore no need to repair and maintenance regularly, however, it is required to dismantle periodically for inspection to ensure alternator work reliably.

☆ Always keep exterior of the silicon rectifying alternator clean, and check for connection between lead and terminal for secure. Periodical inspection and maintenance:

A. Remove dust inside alternator with compressed air, and clean out residual sludge with gasoline.

B. Check if the alternator terminals are firmly connected and in good contact.

C. If there is noticeable play in the bearing or abnormal sound is coming out from bearing, replace timely. Apply grade 1~3 compound calcium-sodium base lubricant grease to the bearing during maintenance.



1、隔板 2、凸棱(肋条) 3、负极板 4、正极板 5、电池槽 6、连接条
7、正极柱 8、加液孔盖 9、负极柱 10、密封胶 11、极板组 12、防护板

隔板: Battery separator 凸棱(肋条): Rib 负极板: Negative plate 正极板: Positive plate
 电池槽: Battery container 连接条: Connecting strip 正极柱: Positive terminal
 加液孔盖: Cap of liquid filling hole 负极柱: Negative terminal
 密封胶: Sealant 极板组: Plate groups 防护板: Baffle

图 3-34 蓄电池的结构 Fig. 3-34 details of battery

3.10.1.3 Start-up battery (battery cell)

The series engine adopts two 12V, 195Ah above lead battery, connecting conductor sectional is set for 85~107mm². The battery are used to supply electric power to DC starter when engine starts; supply power to electrical equipments when alternator doesn't charge or alternator voltage is low; if electric load overloads the alternator, battery will provide supplementary power to the electrical equipment; If battery power is low, and charging alternator electric production beyond load limit, alternator will charge the battery, battery acts as an electrical storage device at this time.

Construction of the battery is shown in Fig. 3-34. It is mainly composed of the plate, cell divider, external casing, electrolyte, connecting strip etc. The working principle of the battery is the following: when the battery is charging, the electrolyte converts the electrical energy into and stores the chemical energy; when the battery is discharging, the electrolyte converts the chemical energy into and outputs the electrical energy.

Battery operation, servicing & maintenance

- a. In case of plate and shell damaged due to vibration, place battery gently and firmly into mounting frame.
- b. Lead wire and pole should be connected in firm and contact well.
- c. When assemble storage battery, connect live wire end (+) firstly and then two groups battery in parallel and series, earth end (–) afterwards. Battery disassembly is just the reverse.
- d. Use only pure sulfuric acid and distilled water and prevent metal conductor etc. foreign matters from falling into when fill up electrolyte; keep battery clean always; in case of oxide, apply lubrication grease (petrolatum oil) after removed oxide from connecting strap and pole.
- e. Check electrolyte level in battery always. Electrolyte level should be 10-15mm higher than plate, and add only distilled water when insufficient. Sulfuric acid solution can only be added unless the electrolyte level dropped is confirmed to be caused by electrolyte spilling.
- f. Use suction densitometer to measure electrolyte density, density requirements refer to table 3-5. Also use thermometer to measure electrolyte temperature (Fig.3-35)

Chart 3-2 Electrolyte density

(g/cm ³)	(g/cm ³)
1.26-1.28	1.15
Setting value(g/cm3)	Serviceability limit(g/cm3)
1.26-1.28	1.15

Electrolyte temperature increases or decreases 1°C, then electrolyte density subtracts or adds 0.0007 g/cm3 to convert to standard density value of 20°C.

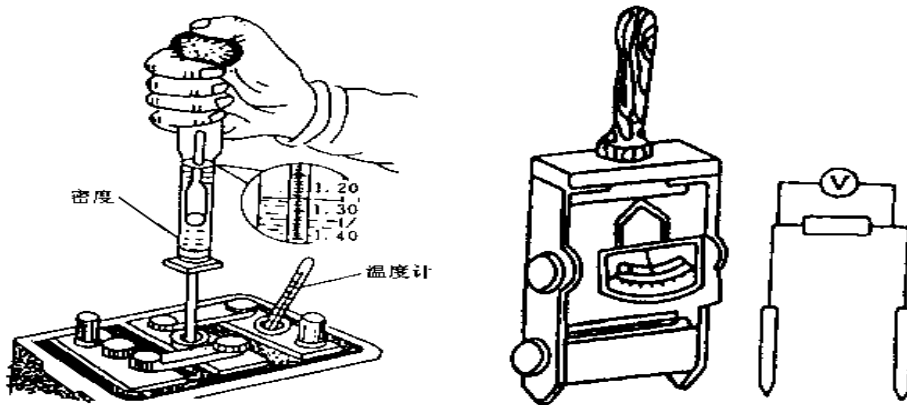
If just fill up distilled water or force to discharge, then not to measure electrolyte density immediately as electrolyte is uneven at this time. Use high discharge rate meter to measure discharging voltage with (Fig. 3-36), discharging voltage refers to Chart 3-3.

Chart 3-3 Discharging voltage

(V)	(V)
2.0	<1.75
Setting value(g/cm3)	Serviceability limit(g/cm3)
2.0	<1.75

g. Keep battery in charging status in the cold winter days in case of freezing, causing plates to be bended, active materials to fall off or shell to be damaged. Electrolysis distilled water fill up in winter should be performed before charging battery or start engine.

h. Adjust properly the electrolyte density in summer and winter. Draw out a small amount of electrolyte and then apply distilled water in summer, while apply some electrolyte with density 1.4 g/cm³ in winter.



i. If accumulator is stored and not used for 1-2 month, then fully charge the battery firstly and ensure electrolyte density meet the requirements prior to store.

Fig.3-35 measure electrolyte density and temperature

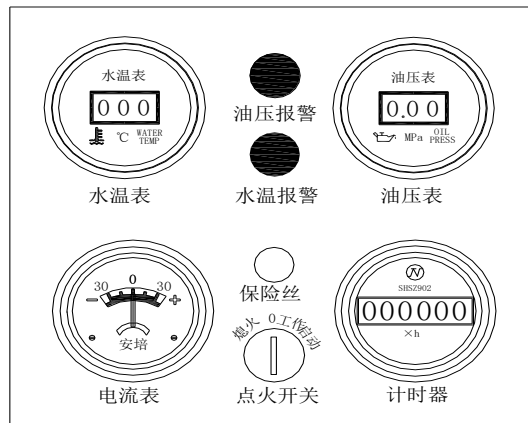
Fig.3-36 measure discharging voltage

3.10.2 Monitoring system

Instrument assy consists of instruments & gauges, sensors and wiring harness. It can be customized application.

Instrument dashboard is equipped with water temperature indicator, oil pressure, battery ammeter, timer (operating time), switch and indicator lamp (as shown in Fig. 3-37).

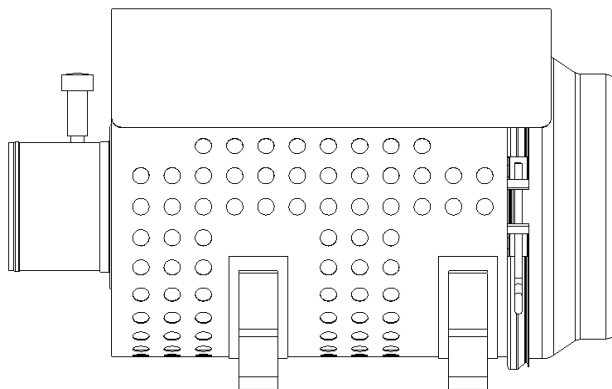
Output terminal is provided at the back of instrument, controlling and collecting signal, engine start-up/shutdown through wiring harness.



水温表 Water temperature indicator 油压报警 oil pressure alarm 油压表 oil pressure indicator 水温报警 water temperature alarm 保险丝 fuse 点火开关 ignition switch 计时器 timer 电流表 ammeter 熄火 shutdown 启动 start
图 3-37 仪表面板 Fig. 3-37 instrument dashboard

3.11 Air filter

The purpose of air filter is to filter the dust and impurity held in the environmental air that inhaled into the engine so as to ensure air clean in the cylinder and reduce the wearing between the cylinder and piston, the piston groups, and the parts of valve group. Refer to Fig. 3-38.



Important notices for air filter maintenance

When the filter element gets dirty after being used for a period of time, intake resistance will get higher, resulting in power loss, exhausting with black smoke, rising exhaust temperature and causing a hard start-up. Generally, check air filter periodically or change air filter with engine running for 250 hours.

Check air filter indicator on a regular basis. Service filter element if indicator turns red or arrow points to 6.2kPa, reset button after completion.

4 Operating environment and installation

4.1 Operating environment

Engine is working fine with rated power under the standard condition (absolute atmospheric pressure is 100 kPa, environment temperature 25 °C, relative humidity 30%).

User should provide low temperature starting device if engine operates under the conditions when temperature is lower than 0 °C. User also can mention to fit additionally the low temperature starting device when place order.

When environmental condition is more severe than standard condition (but altitude not exceeding 2500 meters), engine can operate normally at regulated power (which is the power after modified). Power is reduced by 2% whenever temperature exceeds 11 °C; power is reduced by 4% whenever altitude rises 300 meters. You can contact company sales departments or agents for help when altitude exceeds 2500 meters.

4.2 Storage and mounting position

- a. Well vented.
- b. Weather-proof, components and parts are protected and free from rain, snow, flood and sun.
- c. Do not have engine exposed in contaminated air, such as dust, smoke, oil smoke, vapors and corrosive gases.
- d. Trees are not available around. Places that power pole will fall down or objects will fall off from vehicle or crane.

4.3 Hoist

Two engine eyes are provided in engine for lifting. Use steel cables and facilities with suitable length and lifting capability to lift the engine.

Lift the engine assembly that packed well. The points of lifting should be in accordance with the marks in package case when lifting the engine.

Notices

- a. Engine eyes cannot be used for lifting the whole Gen-sets.
- b. Improper lifting way or incapable lifting facilities will cause personal injury or equipments damaged.

4.4 Assembly

4.4.1 Installation of Engine Matched with Alternator

The engine is suitable for matching with the single bearing generator. The elastic coupling plate of the single bearing generator can be matched with the SAE flange interface of the generator, so it is convenient to be interfaced with the prime motor for its higher precision of fitting tolerance. The joint of the generator's SAE flange interface and the joint of the flywheel housing are designed inter-matched, and so their proper alignment can be obtained without any adjustment of their coaxiality

The application of alternator is as shown in Fig. 4-1

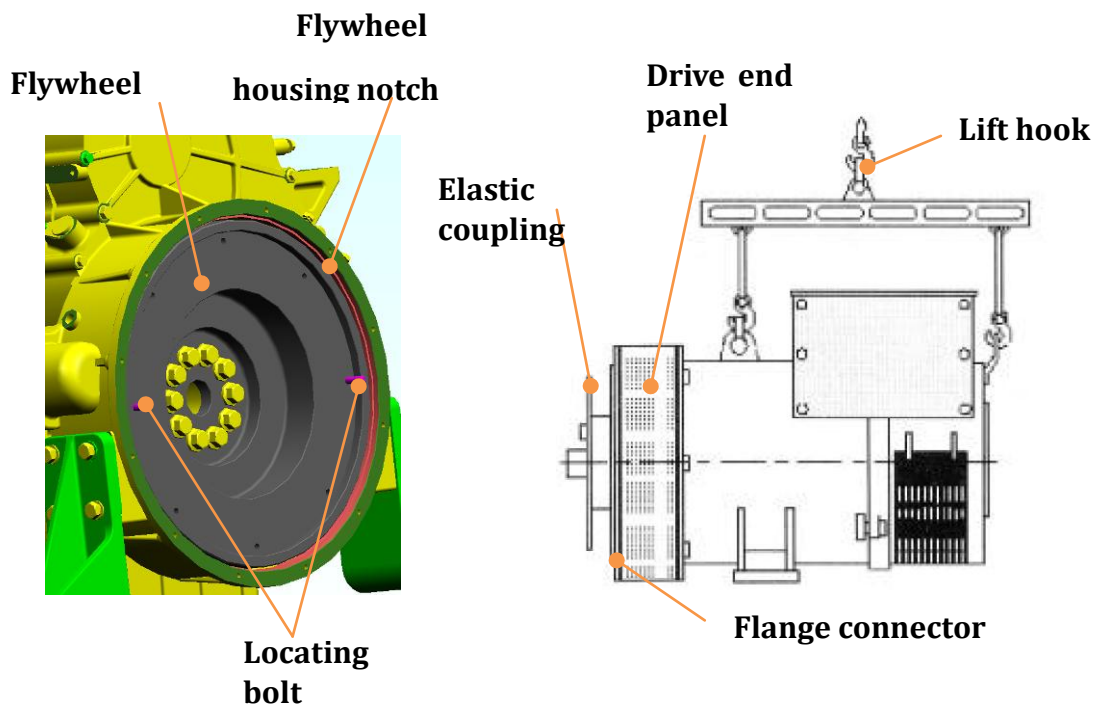


Fig. 4-1 Installation schematic diagram

Instructions for fitting alternator to engine

- 1) Install the two M12 studs diagonally on the flywheel for positioning.
- 2) Dismantle the cover plate at the drive end of the generator and remove the elastic coupling plate and the fixing plate between the flange interfaces.
- 3) Hang up the generator through its hooks by using the sling rope.
- 4) Move the generator close to the engine, paying due attention to alignment of the mounting hole with the two positioning studs and closing of the flange interface joint with the joint of the flywheel housing. Tighten the binding bolt of the flange interface with the flywheel housing first, making proper connection of the engine with the generator; remove the positioning studs and then tighten the bolt fixing the elastic coupling plate to the flywheel.
- 5) Check whether there is any clearance between the generator foot and machine stand; if yes, put any metal shims to guarantee firm footing of the generator; you cannot tighten the generator foot on the installation face of the stand when there is any clearance, otherwise it will result in serious consequences.
- 6) It is recommended to use the flange-faced bolt of class 10.9 (Q184 series) as the binding bolt for the generator connecting plate and flywheel, the tightening moment of which shall be controlled as 200~250N.m. Never use the spring washer, because it will increase the stress, resulting in damage of the coupling plate.
- 7) The tightening moment for the bolt connecting the flange interface with the flywheel housing shall be(95~135)N.m.

Note: Crankshaft flywheel assembly is internally and externally balanced from factory. Users must not replace the flywheel, we will not assume any responsibility for consequences rising thereof.

4.4.2 Vibration Damper installation

Engine is the vibration source. In order to reduce vibration source expansion, vibration damper should be equipped between engine and braces, generator and braces.

4.4.3 Radiator and inter-cooler installation

Water tank radiator heat dissipating area and shroud are well designed, and supplied with engine.

Water tank kit should be fitted with vibration damper onto engine brace. It is ideal to have 1/3 projection width of fan blade tip extended into shroud, and the front end of fan should be (120-170) mm to inter-cooler core. Fan blade tip and shroud is approximately 15-20mm. see Fig. 4-2.x

$$H = (120 \sim 170) \text{ mm}$$

$$L1 = 1/3L$$

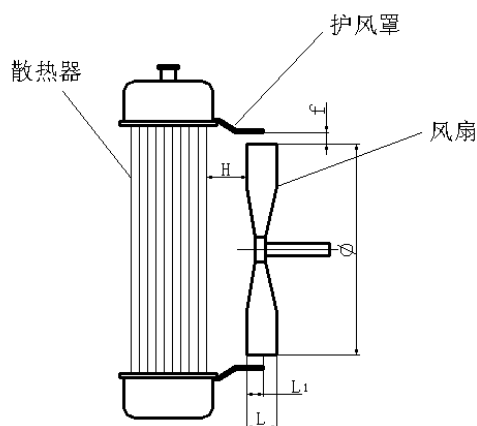
散热器 Radiator 护风罩: Shroud 风扇: Fan
H: The distance from front end of fan to radiator core

L1- The distance the projection width of fan blade tip projects to shroud

f- Radial clearance of shroud and fan blade tip

风扇直径: Fan diameter

Fig. 4-2 Requirements for fan installation



4.4.4 Smoke-exhaust system

支撑 support 消声器 muffler 膨胀管 expansion pipe 涡轮后排气接管 exhaust pipe after turbine

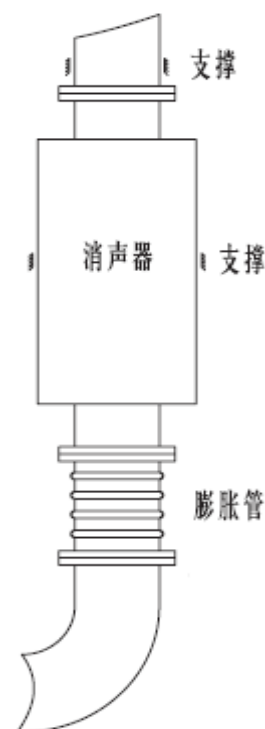
The engine is installed with a smoke-exhausting duct with the expansion joint for transition which is to be used by the gen-set auxiliary's suppliers. When the customer designs the smoke-exhauster system, for smoother exhaust it is required to have an exhaust port with a diameter of more than $\Phi 125\text{mm}$ and the exhaust back pressure of less than 10KPa, because too big back pressure will exert a negative impact on the output power, fuel consumption and exhaust temperature of the engine.

Precautions to Be Taken by Customers during Designing Smoke-exhauster System

a) The muffler and exhaust pipe added by the customer shall be supported with the stand (or hanger). It is strictly forbidden to put such weight on the engine exhaust pipe (or turbocharger), otherwise it will damage the engine exhaust pipe (or turbocharger), shortening the service life of the gen-set.

b) It is prohibited that any condensed water flows back to the engine through the exhaust port.

c) It is recommended to design and install the smoke-exhauster system by the professional personnel.



4.4.5 Electronic speed governor (only applied for electronic fuel pump)

Vehicle will have better governing performance with electronic speed governor. Usually the electromagnetic actuator has already been installed in the fuel injection pump, tacho-controller & its auxiliaries and connecting cables will be installed by the customer (with the exception of self-matched gen-sets), tacho-sensor has also been installed on the flywheel housing. When the engine is delivered at the works the clearance between the tacho-sensor and flywheel as well as the knobs on the tacho-controller has been adjusted. No adjustment is to be done by the customer himself.

When it is really necessary to make readjustment, it shall be carried out by the specialized personnel after careful reading the Operation & Maintenance Manual of Electronic Governor.

The tacho-controller shall be installed in a protective box without any strong shock, vibration and electromagnetic interference, it is also necessary to have sufficient space for installation, maintenance and heat dissipation and its exterior casing shall be properly grounded.

Wiring of the electronic governor system shall be strictly done according to the Operation & Maintenance Manual of Electronic Governor.

4.4.6 Start motor wiring

The sectional area of the interconnecting wire between batteries, accumulator & mains switch and accumulator & terminal screw of the electromagnetic switch M10 shall be 85~107mm², and that between the electromagnetic switch M4 & starting relay – 7~8cm². Their length of the wire shall be as shorter as possible and their sectional area may be properly increased or decreased depending on the length. The starting relay shall be as closer as possible to the starting motor.

It is not allowed to have any wrong connection of wires and bare wire ends shall not be contacted or too close to the exterior casing to prevent the starter from short circuiting or unexpected starting.

4.4.7 AC alternator wiring

The charging generator of the engine is an integrate alternator with a built-in regulator and its main functions are to charge the accumulator and provide the working power mains for the electrical equipment. Wiring of the alternator shall be correct and its terminals shall be connected as follows:

B+ — Armature terminal;

W — Speed indicator terminal;

D+ — Electrical resistance indicator lamp (3W-5W)

E — Connected to housing

B+ The sectional area of the wire connecting to terminal B+ is to be 6mm², but that for other terminals – 1.5~2.5cm².

Note: For the reason that the stator coil is connected to the silicon rectifying element, it is forbidden to check the insulation of the alternator with AC mains or mega-meter, otherwise the silicon rectifying element will be broken or damaged.

Important notices for preparing electrical Wiring

1) Wires cannot be tied up and fixed together with fuel pipes, ventilation ducts, oil pipes etc.; if it is necessary to be tied up and fixed together, you should add something for

heat insulation or protection from vibration.

2) Wires shall be firmly tied up along the arrangement line to prevent the wires from swaying and friction with the cylinder block.

3) Wires shall be arranged away from high temperature components, such as turbocharger, exhaust manifold and so on.

5 How to operate the engine

5.1 Preparatory Work before Starting

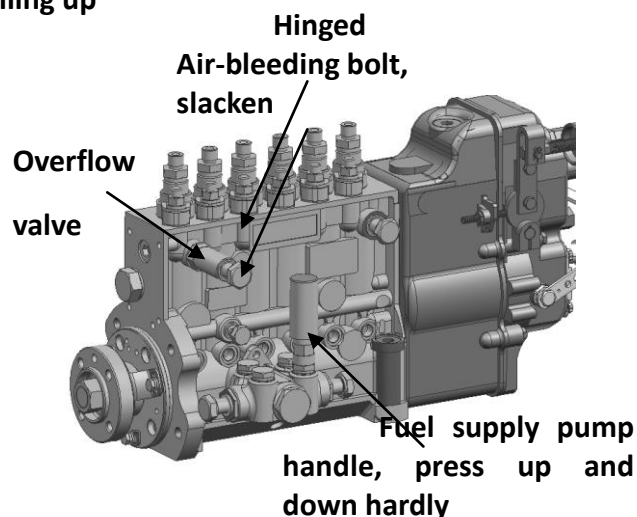
5.1.1 Check lube

1) For new engine or overhauled engine, it's required to fill up oil to the upper limit of oil dipstick; Be sure to maintain oil level stay between upper limit and lower limit

2) Choose the right oil that compatible with environments according to different environmental temperatures, refers to requirements in Chart 2-1.

3) For new engine that just operated (or overhauled engine that put to work again) ,remove oil inlet pipe nut from the top of turbocharger and fill 50~70mL clean lubrication oil to lubricate turbocharger bearings. Reassemble turbocharger oil pipe.

Note: clean up the spilled oil while you're filling up



5.1.2 Check fuel

1) Check if oil level stays within upper limit and lower limit of oil dipstick in fuel tank, replenish if insufficient.

2) Refer to Chart 2-1 for *How to choose the right fuel*.

3) For new engine or engine that has sit for a long time, if there is air in pipelines, discharge air first before starting, follow the instructions below:

A. Slacken hinged bolt located in fuel pump spillover valve .

B. Press fuel pump handle up and down continuously until there is no air bubble come out from fuel drain screw.

Notices

i. Tighten the fuel tank cap.

ii. Clean up in which the fuel spilled out.

Not allow smoke or open flame around engine.

4) Fuel tank design

- a). The location of oil outlet port is higher than fuel tank bottom for 40~50mm in order to prevent deposits in fuel tank bottom from sucking into engine.
- b). Ventilation hole is formed in fuel tank, and the ventilation hole should be with the function to prevent dust and water from entering fuel tank also.
- c). Fuel receiver is provided in the lower part of fuel tank functioning to collect and use the overflow fuel, or the fuel drain channels can be designed by the side of fuel tank for draining away the overflow fuel.
- d). Apply the fuel tank inner wall with fuel- proof and rust resistance coating that not fall off easily.
- e). Inspection port should be provided in fuel tank for ease of inspecting and servicing.
- f). User should provide a fuel-water separator when the operating environment humidity is high.

5.1.3 Check coolant in water tank

- 1) The method of filling up coolant for the first time to new engine that just begins to operate or the overhauled engine.
 - a) Check to make sure that all water drain plugs are closed.
 - b) Turn on warm-wind valve switch in main water outlet pipe.
 - c) Fill coolant into water tank radiator slowly in order to remove air that in water passages. Close warm-wind valve switch when there is no water bubble come out from warm-wind valve.

Not allow to fill up coolant with engine operating!

- 2) Fill up coolant to radiator until the coolant level in the radiator is higher than radiating fins (approximately 20-40mm from the top of water tank). See Fig. 5-2
- 3) Check if grooves in external surface of radiating fin of water tank are clogged, clean up immediately if necessary.
- 4) Coolant specs is shown in Appendix.

For new engine that just begin to operate or the overhauled engine, after checking, start and operate engine until thermostat opens fully(approximately 85℃) and then stop engine. Open radiator cap to check level height after coolant is cooled down. Check oil level. Replenish if coolant and oil is insufficient.

5.1.4 Check air/oil/water leak

Visually inspect for oil, fuel and water leakage after oil, fuel and water is filled up. Find out causes and service if there is.

5.1.5 Check electrical system

Ensure that electrical connection is correct and proper and lead contact is in good condition according to electrical installation diagram or schematic diagram.

Follow the instructions to check electronic governor

- 1) Check actuator's interface, sensor's interface and fastening screw of lead connector for secure, tighten immediately if there is any insecure.
- 2) Drive manually the rocker arm of actuator for several times, its movement should free and no retardance. Do not start engine if there is retardance.
- 3) Check the actuator output shaft, which should at the position of supplying no fuel.

Remove the viewing hole cover plate of intermediate part in order to observe.

5.1.6 Check air filter

Check air filter installation for secure and leakage. When intake system has air leakage, the unclean air won't be filtered but enter into cylinders, resulting in premature wear of cylinders, pistons and valves, also shortening engine service life.

5.1.7 Check battery voltage and electrolyte

Installation should be in firm to avoid vibration and damage plate and shell.

For new accumulator that is not be used yet, it should be charged with floating charger to the saturation state at the beginning.

Notice:

- a) Wear acid-proof apron, face guard or protective goggles when servicing accumulator. Rinse with lots of fresh water once electrolyte splash down skin or clothes.
- b) Working with naked fire or electrical sparks is not allowed around accumulator.
- c) Do not short-circuit the positive pole and negative pole in case of the spark or explode.

5.2 Start engine

For engine that equipped with electronic speed governor, fuel supply quantity of injection pump is controlled by electrical governor in order to control engine speed.

5.2.1 Ways to start an engine

- 1) Starting by button.
- 2) Start by electrical key.
- 3) Electrical starting system is installed by users.

5.2.2 Instructions to start an engine

- 1) Close power source switch.
- 2) Equipped with electrical governor) Close governor power source switch, and set the high/low switch to the low position
- 3) Press down the starting button or turn on the electrical key switch, if blast sound can be heard inside cylinder, it indicates starting is succeed.

Notices:

- a) Every starting time is about 5 seconds; the longest time not exceeds 10 seconds. The interval between every two times starting should be 1-2 minutes.
- b) Release starting button or key switch once the starting successfully, otherwise starting motor will be damaged.
- c) Check and service if successive starting for three times fails. Refer to *Subsection 7: Common malfunctions and troubleshooting* for details.

5.3 Engine running

Operate engine at idle speed for 3-5 minutes after started successfully in order to have various moving parts established lubrication oil film to avoid wear.

5.3.1 Electronic speed governor system

During the ex-works test of the engine the idle speed has already been adjusted to 650-700r/min; if the customer is to have another value, it shall be adjusted by the professional personnel according to Operation & Maintenance Manual of Electronic Governor, who will make micro-adjustment by rotating the knob: rotating clockwise for increasing the speed and counterclockwise for decreasing the speed. Carefully observe with engine running idle

- a) The oil pressure shall not be lower than 0.1MPa;
- b) Any fuel, oil, water or gas leaking is not allowed.

Put the “High/Low” changeover switch to the “high” position and the engine will increase the speed; if the increased speed is not within the rated speed range, you can regulate it in the two ways:

- a) In case of the big difference of the rotation speed, regulate the “rated speed” knob, rotating clockwise for increasing the speed and counterclockwise for decreasing the speed.
- b) In case of the small difference of the rotation speed, regulate it with the remote-control potentiometer: rotating clockwise for increasing the speed and counterclockwise for decreasing the speed. When the specified value is reached, tighten and lock the nut on the potentiometer.

5.3.2 Mechanical speed governor

Adjust throttle handle, run engine at 650-700 r/min for 3-5mins to check oil pressure, air/water/oil leak. If no problem occurs, increase speed to 1500 r/min through throttle handle and lock up handle afterwards.

5.3.2 Keep a close eye while engine operating

- 1) Check water, oil, fuel and air for sealing condition. Eliminate immediately if leakage occurred.
- 2) Oil pressure gauge functions to detect engine oil pressure and the normal value is within 0.3—0.6MPa. Stop and check engine timely if oil pressure is not presented or oil pressure value is over high.
- 3) Cooling water temperature gauge functions to detect the temperature after the engine is cooled by coolant. The normal value is within 80—95°C. Normal operating temperature can be reduced by 5°C if ambient temperature is low.
- 4) Oil temperature gauge functions to detect the diesel fuel temperature during engine's operating. The normal value is within 80°C—115°C.
- 5) Exhaust is an index of reflecting engine operation and engine performance. Exhaust with smoke may be caused by inferior fuel, too much fuel, injectors faulty, unclean air filter or poor mechanical status.
- 6) Check and service timely if engine is exhausted with heavy black smoke.
- 7) If oil temperature increases abruptly is not caused by the increased load, then it may be caused by mechanical malfunctions. Shut down engine immediately and check.

5.3.4 New engine break-in

New engine or overhauled engine is not allowed to be operated with heavy load from the beginning. And within the first 60 hours, engine should be not operated at rated

power that exceeding 75% in order to ensure good break-in.

5.3.4 Keep a close eye on warning signals

Operators can tell from the symptoms before components faulty and engine is damaged should pay due attention to warning signals (e.g. oil pressure reduces abruptly) and abnormal sound.

5.4 Shut down engine

5.4.1 Steps to shut down engine

- 1) Reduce load step by step to no- load.
- 2) Set the “high/low” switch to low position when electrical governor is used, while set the throttle to idle-speed position when mechanical governor is used. Run engine at idle-speed working condition for 1-3 mins to allow lubrication oil and cooling water take away heat from combustion chamber etc. parts.
- 3) Press down shut down button or set the electrical key to shutdown position to stop engine.
- 4) Close electrical governor power source switch.
- 5) Close accumulator power source switch to prevent accumulator from discharging to generator excitation windings too long, causing excitation windings and other equipments damage.

Notices:

- a) Not allow to stop engine abruptly in case of turbocharger overheat causing seizure of bearing or failure of oil seal.
- b) Prevent engine from running at idle-speed too long.

5.4.2 Engine emergency shutdown

Stop engine urgently once one of the following malfunctions occurred during operation.

- a) Severe and abnormal sound of knock
- b) Severe malfunctions of certain part of engine resulted from components being damaged.
- c) Piston, crankshaft, connecting rod and governor and so on moving parts seized.
- d) Engine endangers operator, outbreak of fire or other severe natural disasters.

Emergency stop steps:

- a) Remove all loads from engine immediately
- b) Press down the stop button or place stop handle in injection pump to the stop position to force engine to be stopped rapidly.

5.4.3 What should do after engine shutdown

Drain off cooling water completely after stop when environmental temperature is lower than 5°C or engine is stopped for a long time.
Oil seal engine if stopped for more than one month.

6 Engine servicing & maintenance

Maintenance timely, carefully and properly in order to ensure engine normal operation, extend service life and save money, while reduce wear and prevent malfunctions.

- Normal service(daily);
- 1st major service(with engine operating for 100h);
- 2nd major service (with engine operating for 250h);
- 3rd major service(with engine operating for 1,500h);

6.1 Normal service

- 6.1.1 Check fuel tank capacity and fill up.
- 6.1.2 Check oil level in the oil sump, and replenish if insufficient
- 6.1.3 Check and eliminate potential water/oil /air leak.
- 6.1.4 Check gauges and instruments, and observe if the reading is normal, fix or replace if damaged as soon as possible.
- 6.1.5 Check accessories for secure.
- 6.1.6 Check coolant level in heat exchanger, replenish if needed
- 6.1.7 Maintain engine in clean condition, particularly keep the electrical devices free of oil stain and sludge.

6.2 1st major service

In addition to normal service, the following items should be checked periodically with engine running for every 100 hours.

- 6.2.1 Check water pump belt for tension, adjust if necessary.
- 6.2.2 Check and adjust intake valve and exhaust valve clearances
- 6.2.3 Check battery electrolyte; refill it if inadequate.
- 6.2.4 For new engines (or for overhauled engine), replace oil during Normal Service.
- 6.2.5 Clean air filter and fuel supply pump inlet filter screen.
- 6.2.6 Replace oil filter spin-on filter element if oil pressure gets low (When you do have the oil replaced, be sure to also replace the filter element).

6.3 2nd major service

Except for 1st major service, the following items should be checked periodically with engine running for every 250 hours:

- 6.3.1 Check fuel injector opening pressure, and adjust if necessary
- 6.3.2 Check static fuel supply advance angle, and adjust if necessary.
- 6.3.3 Check intake valve and exhaust valve for seal performance, grind if necessary.
- 6.3.4 Check water pump overflow hole for water dripping, change water seal before it getting serious.
- 6.3.5 Check main parts and components, such as main bearing bolts, cylinder head bolts and connecting rod bolts for secure. Torque to specs if loose.
- 6.3.6 Replace oil.
- 6.3.7 Remove water scale if water temperature gets higher.
- 6.3.8 Clean breather strainer screen.

6.4 3rd major service

Check and adjust engine whole assembly during Major Service (with engine running for every 1,500 hours) (Refer to Normal Service and Major Service (with engine running for every 250 hours) to eliminate potential problems. Disassemble the engine if you got problem such as serious air and oil leak, premature wear in cylinder bore and oil pressure is out of specification, etc. If engine works fine, then perform the condition-based maintenance or extend the Major Service (with engine running for every 1,500 hours) properly.

6.4.1 Disassemble and rinse the whole engine to remove carbon deposit, oil sludge and caking. Rinse all lube piping and fuel piping.

6.4.2 Check valves, valve seats, valve guides, valve springs, push rods and rocker arms for wear, grind or replace if necessary.

6.4.3 Check piston rings, cylinder bores, small end bushing of connecting rod and connecting rod shaft holes for wear, all the parts can be replaced except boring cylinder bore or adding cylinder liner that used for repair if necessary.

6.4.4 Check main bearing shell for wear, replace with new ones if necessary

6.4.5 Check gears for wear and backlash, replace if necessary.

6.4.6 Check injectors for spray atomization and pattern, grind injector coupled parts or replace with new ones.

6.4.7 Check inner and outer rotor of oil pump as well as oil pump body, replace if necessary.

6.4.8 Check alternator and starter, and clean parts, bearings, and fill up new lube grease.

6.4.9 Check turbocharger bearing clearance, replace turbocharger if necessary.

6.4.10 Check inter-cooler for air leak, and fix it if necessary.

6.5 Practical technology maintenance

Maintenance items	Time (h)	Break-in period	100	200	300	400	500	600	700	800	900	1000	1100	1200
	Time (Month)		1	2	3	4	5	6	7	8	9	10	11	12
Clean engine assembly			△	△	△	△	△	△	△	△	△	△	△	△
Check and adjust belt tension		○	△	△	△	△	△	△	△	△	△	△	△	△
Check and clean air filter element					△		△		△		△		△	
Replace air filter element									△					
Check acceleration and de-acceleration performance and exhaust condition		○	△	△	△	△	△	△	△	△	△	△	△	△
Check cylinder compression pressure														

Check and adjust valve clearance	○			△				△			△		
Check air, water and oil leaks	○	△	△	△	△	△	△	△	△	△	△	△	△
Check lubricant oil cleanliness and residual		△	△	△	△	△	△	△	△	△	△	△	△
Replace lube	○			△		△		△		△		△	
Replace engine oil filter assembly				△		△		△		△		△	
Check head bolts tightening condition	○												
Remove sediment from fuel filter	○	△	△	△	△	△	△	△	△	△	△	△	△
Check fuel injector working pressure	○												
Check injection timing													
Remove sediment from fuel filter													
Check injector pressure													
Check if injection pump works fine					△			△			△		
Check thermostat function		△											
Clean cooling system													
Check if turbo works fine													
Clean breather filter core				△		△		△		△		△	
Check and clean the inner cavity of inter-cooler													
Check and clean the inner cavity of heat exchanger													
Check electrical system connection condition			△	△	△	△	△	△	△	△	△	△	△

Remarks: Item marked with O should be performed by Service Station

7 Engine common troubles and troubleshooting

7.1 Engine cannot start

Causes	Solutions
Too low starter rotating speed.	Check starting system, and the starting speed cannot be lower than 110r/min.
Air exists in fuel feeding system.	1. Check whether the connector of fuel supply pipe is loose. Loosen the air-bleeding bolt of the fuel filter and pump the hand pump to deliver fuel until there is no air bubble in the fuel split out. 2. Unscrew the high pressure fuel pipe joint at fuel injector end; feeding the fuel by the hand pump until there is no air bubble in the fuel spilt out.
Fuel pipeline is blocked.	Check whether the fuel feeding pipeline is unobstructed or not.

Fuel pipeline is blocked.	Replace fuel filter/rotary filter element of fuel-water separator assembly.
Fuel supply pump does not supply the fuel or fuel supply is interrupted.	Check fuel inlet pipe for air leak, or fuel supply pump for block.
Injecting less fuel; injecting no fuel or low injecting fuel pressure.	Check the fuel injector for atomization. Check whether the injection pump plunger and fuel outlet valve seized or worn out excessively, and whether the plunger spring and fuel outlet valve spring broken down. If controller is electrified.
Starting system troubles :Wrong wiring connection or poor contact: Poor contact of the starter carbon brush with commutator	Check wiring for its correction of connection and reliability. Charge the battery. Repair or replace the electric brush; clean the commutator surface by abrasive paper and blow it clean.
Insufficient compression pressure; Piston ring is excessively worn out: Valve has any air leak.	Replace piston ring; add cylinder liner as per actual situation. Check the valve clearance and sealing of the valve spring, valve guide pipe and valve seat, and grind the valve seat for poor sealing performance.
Fuel shut off solenoid joint is loose, contaminated or corroded	Re-tighten, clean or replace.
Fuel supply advance angle may set wrong	Check and adjust.

7.2 Low power

Causes	Solutions
Air intake is blocked.	Check air filter and intake pipe. Clean or replace air filter element
Too high exhaust back pressure.	Check valve timing and adjust it as necessary; clean the exhaust pipe.
Insufficient pressure of turbocharged system.	Check and eliminate the leaking from pipeline and connection
Bearing fault	Replace
Air compressor and turbine air flow passage are contaminated, blocked or damaged	Clean
Inter-cooler is damage and has air leak	Fix or replace The best way is to pressurize the inter-cooler to 207Kpa, apply soapy water on the inter-cooler to find the exact

Causes	Solutions
	location of the air leakage
Fuel pipeline is leaking or blocked.	Check the fuel pipe and joints for sealing performance, and the fuel filter, fuel-water separator for block; replace the rotary filter element. Check injection sealing
Fuel pump plunger is worn out severely	Check and replace
Diaphragm of smoke limiter is damaged	Replace.
Vacuum pipe broken down and leak	Replace.
Fuel supply angle is advanced or retarded	Check and adjust.
Governor speed is set too low	Check and adjust.
Fuel injector has poor atomization	Replace fuel injector, input C31 code to calibrate again
Incorrect valve timing phase	Check and adjust valve timing and valve clearance
Air leak of cylinder gasket	Tighten the cylinder head bolt to specified torque or replace cylinder gasket
Poor sealing of the valve	Grind or replace
Engine is overheated	Check and re-set ECU MAP
Coolant temperature is too high	Check and fix radiator, temperature regulator, make adjustment to fan belt tension
Piston ring is worn out severely, broken down	Replace

7.3 Engine running with unusual noise

Causes	Solutions
Clear and sharp metal knock sound comes from cylinder, injection time is too early.	Adjust statics fuel supply angle
Unclear and deep knock sound comes from cylinder, injection time lags behind.	Adjust statics fuel supply angle
Connecting rod bearing bushing and main bearing bushing worn out severely and clash can be heard in the crankcase.	Dismantle and check the bearing bushing, if necessary, replace it and maintain the reasonable clearance as required.
Thrust main bearing shell is worn out badly, clash can be heard in the crankcase with engine running at idle speed	Replace component, maintain required axial clearance

Causes	Solutions
Clear and sharp metal knock sound comes from cylinder, injection time is too early.	Adjust statics fuel supply angle
Unclear and deep knock sound comes from cylinder, injection time lags behind.	Adjust statics fuel supply angle
The vibration damper is damaged and faulty	Check the connecting bolts and if necessary, replace them.
Valve bumps into piston	Check and make adjustment to valve timing
Drive gears worn out and has too large clearance. Clash can be heard in timing gear housing cover	Check the gear backlash and replace If necessary..
Too large clearance between piston and cylinder, clash can be heard in cylinder wall when operating	Replace the piston; add cylinder liner that used for repair if necessary. Keep good clearance between piston and cylinder.
Turbocharger surging	Remove the carbon deposit and dirt in the passage air compressor and exhaust gas path; operate at too high altitude.
Turbocharger bearing is damaged, so the rotating part bumps with the housing.	Replace the turbocharger assembly.
The valve clearance is too big; bigger sound can be heard around cylinder head.	Adjust the valve clearance.

7.4 Emit black smoke while running

Causes	Solutions
Intake is blocked	Check and clean the air filter and air intake pipe.
Poor quality of fuel.	Replace the fuel as specified.
Incorrect fuel supply, valve timing	Adjust as required
Poor atomization of fuel injector	Check, repair or replace.
Fuel pump supplies the engine with too much fuel	Check and adjust as required
Inadequate pressure of turbocharged system	Check and eliminate the leak of pipes and connectors
Turbocharger is working abnormally	Check and replace the assembly
Inter-cooler is damaged and has air leak	Repair or replace

7.5 Emit white, blue smoke while running

Causes	Solutions
Poor quality of fuel and too much content of water	Replace the fuel.
Too low temperature of coolant	Check the working temperature of thermostat, and replace it when necessary.
Incorrect valve timing	Check and adjust.
Low compression pressure; incomplete combustion.	Check piston ring and cylinder head gasket; replace.
Incorrect piston ring assembly direction; piston gap is not staggered	Check and reassemble.
Long-time running with low load	Use proper working speed and load.
Turbocharger seal ring is worn out	Check and replace.
Thrust bearing of turbocharger is worn out	Check and replace.
Turbocharger oil return pipe is blocked	Rinse and repair.

7.6 Extra-low oil pressure

Causes	Solutions
Lubricating oil becomes thin, or improperly use of lubricating oil	Select the lubricating oil as specified.
Rotors of oil pump is worn out, or has too big assembly clearance	Replace oil pump.
Clogged lubricating oil filter	Replace the rotary element.
Pressure regulating valve of oil filter is faulty	Repair.
Oil pump gear is damaged or worn out	Replace.
Cracks exist on the oil inlet pipe of oil pump	Repair or replace.
Oil pump oil inlet pipe fastening bolt is loose	Retighten it to the specified torque.
Too big clearance of bearing shell	Check and replace.

7.7 Extra-high oil pressure

Causes	Solutions
Lubricating oil viscosity is increased due to too low ambient temperature	Use the required lubricating oil, run the engine at a low speed after it is started; check it again when the oil temperature is normal.
Overflow valve is blocked	Check and clean.

7.8 High temperature, excessive engine oil consumption

Causes	Solutions
External oil line has leak	Check and fix.
Engine bears extra load	Minimize the extra load the engine has to bear.
Use improper oil	Select and use the oil as required.
Piston ring is seized or worn out seriously	Check, fix or replace when necessary.
Cylinder bore is worn out seriously	After boring cylinder, replace the piston ring with newly machined sizes, or repaired cylinder liner.
Valve guide is worn out badly, valve stem sealing fails	Check, replace.

7.9 Turbocharger common troubles and troubleshooting

No.	Causes	Solutions
1	Air intake system is blocked	Check and clean the pipe between air filter and compressor, compressor outlet port and air intake pipe
2	Air intake leaks	Check whether there is leak between air filter and compressor, air intake pipe and connecting part.; tighten the bolt and replace the gasket
3	Exhaust system is blocked	Repair and replace related parts
4	Exhaust leaks	Check whether there is leak between exhaust pipe and engine, turbo inlet port and exhaust pipe, turbo housing and intermediate housing, turbo outlet port to exhaust pipe connection; replace the gasket and tighten the bolt.
5	Rotor of compressor bumps into compressor housing and turbo housing	Replace assembly
6	Fuel leak of fuel intake/ return pipe	Replace

7.10 Common troubles and troubleshooting of electronic speed governor

Symptoms	To be checked	Checking methods
① Engine cannot	Battery voltage	5,6 terminal battery voltage is measured to be DC24V

start	Sensor	1.Improper installation of speed sensor, too large clearance is caused
		2. Speed sensor cable broken, DC resistance is measured to be 300—500 Ω
	Actuator	1. Actuator and fuel pump rack link rod are jammed
		2. Actuator cable is broken, actuator coil inner resistance is measured to be 2±0.2 Ω
② Actuator fails to fully activate the fuel valve	Battery voltage	Measure battery voltage while starting, you'll have undervoltage if voltage gets lower than 75%of rated power, be sure to charge the battery.
	Actuator	Actuator and fuel pump rack link rod are jammed
③ Rough speed	Controller	1. Adjust the stability and gain potentiometer according to the method stipulated in the manual of electronic governor, article 3.4
		2. Terminal 14 and terminal 7 voltage are measured to be 10±0.5V
	Actuator	Check if connection between actuator and fuel pump rack has gap or become loose.
	Controller	1. Wrong gear teeth setting, the rated speed is set too high.
2. Gain is set too low, sensitivity is also low, causing speed rise when the load is suddenly reduced.		
3.Speed sensor controller failure, replace		
④ Engine over-speed	Actuator	1. Actuator and fuel pump rack link rod are jammed or loose
		2. Actuator and fuel pump zero fuel supply position does not matched, disconnecting the actuator cannot shut off fuel supply
	Speed sensor	Speed sensor signal error, wiring is damaged

Appendix 1

Antifreeze

Antifreeze is the cooling fluid used to prevent freezing in winter. Because it conquers several shortcomings of water as cooling fluid, antifreeze is a very deal choice to engine and can be used all the year round. Antifreeze is required to be used in YC6MJ.

I. What is antifreeze?

Antifreeze, whose full name is “antifreeze fluid”, is the cooling fluid that can be used to prevent freezing. The earliest antifreeze was the water that was added inorganic salts to lower freezing point and increase boiling point, later alcohols (grain alcohol and methyl alcohol) were added. In recent years, glycol and glycerol antifreeze appeared. The latter is limited because of its high price, so glycol antifreeze is used widely.

Antifreeze is composed by stock solution, water and additives. Stock solution is glycol, water is distilled water and additives contain antirust, mildew preventive, PH regulator (buffering agent) and antifoam.

Chart 1 Glycol Physicochemical Properties

Density(20°C)	1.113 (g/cu.cm)
Flash point	116 (°C)
Freezing Point	-13 (°C)
Specific Heat (20°C)	2349 [j/(g·°C)]
Boiling point(760mmHg)	197 (°C)
Steam Pressure(20°C)	8 (Pa)
Steam Pressure(100°C)	2133 (Pa)
Thermal Conductivity	2.889*0.004 [W/(cm·s·°C)]

Chart 2 Concentration and Freezing Point of Antifreeze

(°C)Freezing Point	Concentration of Glycol%	Density (20°C)	(°C)Freezing Point	Concentration of Glycol%	Density(20°C)
-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

Antifreeze is divided into direct type and concentrated type. Concentrated type antifreeze cannot be used directly and must be modulated to a certain concentration according to the temperature requirements from Table 2.

At present, there is a kind of long-term effect antifreeze in market. What is it in fact? Glycol is still the basis of this long effective antifreeze. With the characteristics of preventing freezing and boiling, glycol is absolutely necessarily and key element to keep the thermal conductivity. Differences as follows:

Characteristics	Conventional green cooling fluid	Long-term orange cooling fluid
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Color	Green or blue-green	Orange or red
Standard PH	10.5	8.5
Anti-rusting	Borate and Phosphate, silicate with yellow metal anti-rusting, such as toluene pyrrodiazole	Single-carbonyl permanganate and Double-carbonyl permanganate, such as sebacic acid and caprylic acid added with toluene pyrrodiazole
Pollution influence	Hard water	Conventional green cooling fluid
Average maintenance life	2-3years	4-5years

It is obvious that the difference is anti-rusting. Long-term cooling fluid contains organic acid salt, so chemical property is more stable and life-span is longer.

II. Five functions of high quality antifreeze

1. There is a group of good and lasting inhibitor belongs to antifreeze. It is a balance between all kinds of reagents and metals, which forms a protective layer on the surface of metal and separates intrinsic rusts from cooling system. Examination proves that the rusting rate of regular antifreeze is 50 times to 100 times better than water.

2. Anti-cavitation function. Cavitation pitting is caused by uncounted bubbles striking metal. Examination proves that the cavitation pitting speed of hard water with salt and alkali is tens of times higher than soft water. Antifreeze does not include hard water and antifoam in it antifreeze can prevent the occurrence of foam.

3. High boiling function. The boiling of antifreeze is 105°C to 110°C, so it is harder to boil than water.

4. Anti-scale function. High quality antifreeze is made from distilled water and contains anti-scale, so there is no scale in antifreeze.

5. Anti-freezing function. The freezing point of antifreeze can be adjusted. It is decided by different temperatures in different places. The freezing points are between -15°C and -68°C.

High quality freeze is clear and transparent, non-turbid, no impurities and no irritating smell from appearance.

1. Good anti-freezing function
2. Antisepsis and anti-rusting function
3. No swelling and anti-rusting to rubber seal pipe
4. Prevent scale formation on cooling system
5. Anti-foaming function
6. Poor viscosity in low temperature
7. Stable chemical property

III. How to choose the right antifreeze?

At present, antifreeze is widely used. The shortage on understanding on antifreeze function, usage requirements and usage methods brings a lot of troubles in the adoption in car. Such as car falls to start, pipe junction leakage, rubber tube break, water pipe blocked, radiator rusting and cylinder sleeve cavitation pitting.

1. The principle to choose antifreeze

1) Choose antifreeze with different freezing points according to different environmental temperatures.

The freezing point of antifreeze should 10°C lower than the lowest temperature in history of location.

2) Choose antifreeze according to the numbers of vehicles and centralization situation.

Some companies and departments with many vehicles and centralized density should choose the mother solution of antifreeze with little package. This antifreeze has stable function and is easy to transport and stock because of its little package. Meanwhile, it can be adjusted to realize saving and applied aim according to different environment and different working requirements. In the case of few vehicles and separated situation, direct antifreeze is a good choice.

3) Choose high quality antifreeze prefer than poor quality antifreeze Commonly, high quality antifreezes are the regular products that have been checked by appointed check station by government. In appearance: clear and transparent, non-turbid, no impurities and no irritating smell. On the cover of products there should have manufacturer name, product instruction book and specific index explain. Poor quality antifreeze cannot protect from freezing and boiling and will speed up the rusting of cooling system.

4) Choose the antifreeze that is suited to rubber seal tube.

Antifreeze should not have the side effect such as swelling and rusting to rubber seal tube.

2. How to use antifreeze correctly?

1) Clean cooling system completely before injecting antifreeze.

If we do not clean cooling system before injecting antifreeze, anti-rusting effect will be reduced. The clean steps as follows: (1) Start engine to keep antifreeze temperature to the requirements of thermostat starting. Then stop engine and release antifreeze. (2) Take water with 10% sodium hydroxides as cooling fluid and keep engine running with high speed for 5 minutes. After one hour marinating, the water is also released. (3)Injecting soft water and keep engine running with high speed for 10 minutes then release the water totally. Repeat (3) for several times.

2) Before injecting antifreeze, we must check whether there is leakage in cooling system. Antifreeze should be injected after there is no leakage. The surface tension of glycol is weak, so it is easy to leak from gaps. So before injection antifreeze, the pipes and joints must be checked carefully to prevent from leakage.

3) The expansion rate of antifreeze is higher than water, so antifreeze only can be injected to 95% of cooling system if there is no expansion water tank.

4) Forbid to inject mother solution (concentrated type) directly and forbid to inject hard water in antifreeze.

5) Antifreeze should be checked regularly.

After a period of using, antifreeze will be less. To this point we should check density of antifreeze. If density does not increase, the reason is leakage. We should inject similar antifreeze; if density becomes lower, it is caused by water vaporizing. In this case, we should add distilled water and ionized water. After injecting distilled water and concentrated solution, antifreeze should be mixed evenly, and then we can check the density until to the requirements of freezing point. Do not inject common water (such as river water, lake water, pool water, well water and tap water, etc). Because there are some

impurities in common water, some antirust will be used on it.

6) Different antifreeze cannot be mixed so as to destroy each integrated antirust abilities.

7) The service life of long-term antifreeze is from one year to two years and must be replaced after service life. In order to reduce waste, the PH of antifreeze after service life should be checked. If PH is higher than 5.5 the antifreeze can be used continuously; if PH is lower than 5.5, the antifreeze should be replaced at once or it will speed up the rusting of cooling system. If we add prolonged effect drug, antifreeze can be used for another year.

8) Glycol is deleterious to liver, so do not breathe in. After touching skin, we should clean it with water. Nitrous acid is carcinogen and should not be released to pollute environment.

IV. Antifreeze replacement requirements

If there are no detecting facilities, please replace antifreeze according to requirements as follows:

Requirements	Operating time/ year h	Replacement intervals
All over the year	≥800	Once a year
	400~600	Once every two years
	≤200	Once every three years