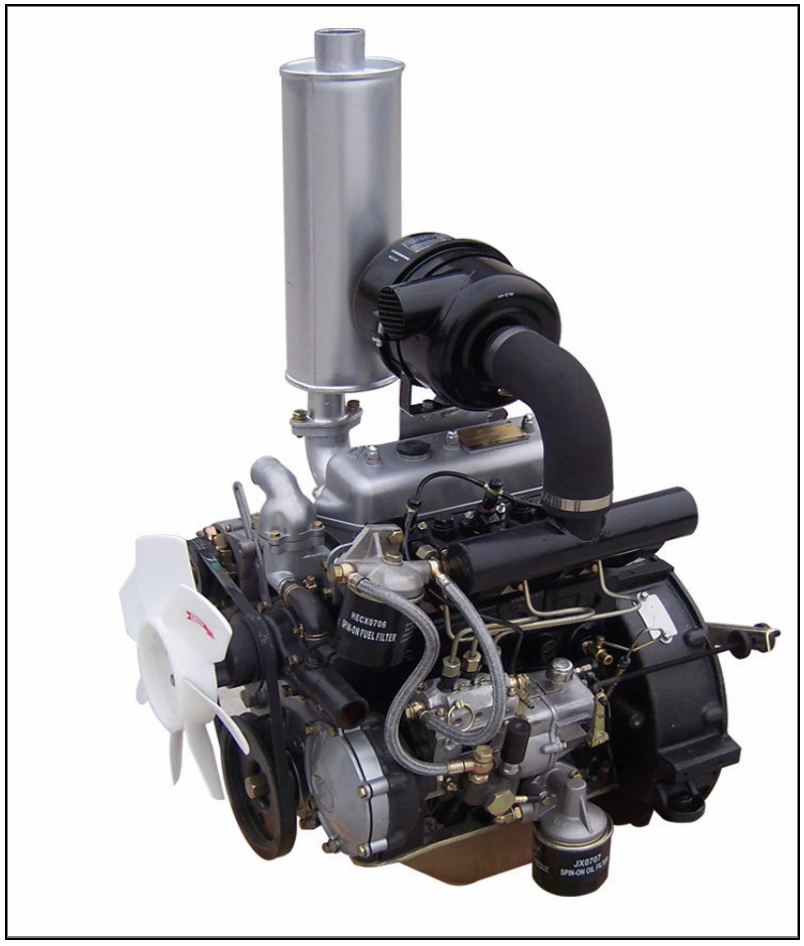
DIESEL ENGINE

OPERATION & MAINTENANCE MANUAL



Warning Notice

1. It is strictly forbidden to use inferior and dirty diesel fuel or lube oil, please choose to use fuel and lube oil with stipulated number according to the instruction.
2. It is strictly forbidden to leak out from an intake system (air filters, pipelines and connecting components).
3. It is strictly forbidden to have hard water (well water or spring water) as cooling water, if necessary to apply the hard water, soften it first.
4. It is strictly forbidden to start under the circumstances of lack of lube oil or water.
5. It is strictly forbidden to operate at overload or under other conditions against the rules.
6. It is strictly forbidden to regulate the fuel injection pump at well.
7. It is strictly forbidden to change the diameter of the pulley.
8. To control the starting time (less than 15 seconds) and the starting interval (more than 2 minutes) strictly.
9. It’s a must to maintain the diesel engine technically in the allotted time.
10. Unskilled workers are not allowed to dismantle and assemble the engine its spare parts.

CONTENTS

SECTION 1. DEIESEL ENGINE SPECIFICATIONS AND TECHNICAL DATA

1. Specification of diesel engine (see Table 1 & Table 2)

Table 1 (For generating sets)

	380D		385D		480D		485D		YND485D		490D		4100D		4102D		4105D	
Continous Output（KW））	10	12	11	13.2	13.9	16.2	15.3	18	16.8	20	19	23	25.2	30	29.7	36	31.5	37.8
Standby Output（KW）	11	13	12	14.5	15.2	17.8	16.8	19.8	18.5	22	21	26	28	33	33	40	35	42
Speed（r/min）	1500	1800	1500	1800	1500	1800	1500	1800	1500	1800	1500	1800	1500	1800	1500	1800	1500	1800
Type	Water cooling, in-line, four stroke, direct injector(385D: Vortex)																	
Bore×stroke （mm）	80×90		85×90		80×90		85×90		85×95		90×100		100×105		102×118		105×118	
Cylinder number	3		3		4		4		4		4		4		4		4	
Intake method	Natural aspirate																	
Displacement （L）	1.357		1.532		1.809		2.043		2.156		2.54		3.298		3.857		4.087	
Fuel consumption（g/KW.h）	≤246		≤267.9		≤242		≤240		≤240		≤240		≤238		≤237		≤235	
Cooling method	Closed water cooled																	
Governing method	Mechanical																	
Stable governing rate	≤5%																	
Volt	12V												24V					
Starting method	Electric starting																	
Crankshaft orientation	Counterclockwise (face to output end)																	
Flywheel Shell	SAE4#-7.5												SAE3#-8 / SAE3#-10				SAE3#-11	

Table 2 (For waterpump sets)

		380G	385G	480G	485G	490G	4100G	4102G	4105G	4108G	6105G	6102BZS
Type		Vertical, water-cooling, 4-storke, direct-injection										
Number of cylinders		3		4							6	
Bore×Storke (mm)		80×90	85×90	80×90	85×95	90×100	100×105	102×118	105×118	108×118	105×118	108×118
Compression ratio		18					17.5				17	
Total displacement (L)		1.357	1.532	1.809	2.043	2.54	3.298	3.857	4.087	4.324	6.131	5.785
Rated power	KW	20	24	27.8	34	42	58	66	70	81	95	125
	HP	27	31.5	37	46	58	78	90	95	110	130	170
Rated speed (r/min)		3000										
Fuel consumption (g/kW.h)		≤247	≤278.8	≤247			≤238				≤228	
Rotating direction at output end		Counter-clockwise										
Lubriction method		Pressure and splash										
Starting method		ELECTRIC										
Net mass (kg)		180	185	220	230	280	330	350	380	400	580	580
Overall dimension (L×W×H) (mm)		587×494×610		687×494×610	687×494×628	805×600×709			896×600×730		1200×662×885	

2. Specification of main accessories (see Table 3)

Table 3

Designation		Specification									
		380	385	480	485	YND485	490	4100	4102	4105	4108
Fuel injection pump	Type	Ⅰ Pump									
	Governor	All-speed, mechanical centrifugal									
	Plunger diameter (mm)	7			7. 5		8	8. 5		9	
	Fuel felivery pump	Single-acting piston type									
Fuel injection	Model	P78-1					P46-28	P46-30			
	Nozzel set	CN-DLLA154S423	ZS4S1	CN-DLLA154S423		ZCK154S425	CN-DLLA154S254	CN-DLLA155S295C1	CDLL154S640D		
	Diameter of nozzel hole (mm)	4-φ0.23					5-φ0. 23	5-φ0.29			
	Injection pressure (Mpa)	19.5±0.5									
Lube pump	Type	Rotor						Gear			
	Speed (r/min)	1300					1500				
	Capacity (L/min)	18					26. 9	37		40	
	Pressure (Kpa)	600									
Water pump	Type	Centrifugal, volute, single-suction									
	Speed (r/min)	3000			4000					3000	
	Capacity (L/min)	80			170		270	230		200	
	Lift (m)	5			8		9	10		9. 5	
Starting motor	Type	Series DC motor									
	Model	QD138Y					QD15J	QD2519			
	Voltage (V)	12						24			
	Power (kw)	2. 5						4. 5			
Dynamo	Type	Silicon rectifying shunt dynamo									
	Model	JFWZ11					JFWZ15	JFWZ25		JFWZ27	
	Voltage (V)	14						18			
	Power (kw)	350					500			750	
Fuel filter	Type										
	Model	CX0506A						CX0708		CX0810B	
Lube oil filter	Type	Single stage, paper element									
	Model	JX0707					JX0810	JX0814			
Air filter	Type	Single stage, paper element									
	Model	K2007/K1317A									K1522

3. Main technical data of diesel engine (see Table 4)

Table 4

			380	385	480	485	YND485	490	4100	4102	4105
1	Valve lash (mm)	Intake valve (cold)	0.2~0.25						0.35~0.4		
		Exhaust valve (cold)	0.25~0.3						0.4~0.45		
2	Sinkage of valve (mm)		0.7~0.9					0.5~0.7	0.6~0.8		
3	Torque limits of main bolts and nuts (N.m)	Cylinder head bolts	175~195					125~145	160~200	120~140	
		Main bearing cap bolts	110~130			175~195		140~160	200~240	180~220	
		Connecting rod bolts	50~60			110~130	140~160	100~120	200~240	100~120	
		Flywheel bolts	60~70				70~80	100~120	100~140	130~150	
4	Temperature limits (℃)	Exhaust temperature (1500r/min & 1800r/min)	≤550								
		Exhaust temperature (3000r/min)	≤600						≤620	≤640	≤660
		Cooling water	80~95								
		Lube oil	≤95								
5	Lube oil pressure (Mpa)	At normal operation	0.2~0.5								
		Att min. steady speed	≥0.1								

SECTION 1. DEIESEL ENGINE SPECIFICATIONS AND TECHNICAL DATA

Ⅰ. Specification of main accessories (see Table 1 & Table 2)

Table 1

Designation		Specification								
		380D	385D	480D	485D	YND485D	490D	4100D	4102D	4105D
Fuel injection pump	Type	Ⅰ Pump								
	Governor	All-speed, mechanical centrifugal								
	Plunger diameter (mm)	7			7. 5		8	8. 5		9
	Fuel feivery pump	Single-acting piston type								
Fuel injection	Model	P78-1					P46-28	P46-30		
	Nozzel set									
	Diameter of nozzel hole (mm)	4- ϕ 0.23					5− ϕ 0. 23	5- ϕ 0.29		
	Injection pressure (Mpa)	19.5±0.5								
Lube pump	Type	Rotor						Gear		
	Speed (r/min)	1300					1500			
	Capacity (L/min)	18					26. 9	37		40
	Pressure (Kpa)	600								
Water pump	Type	Centrifugal, volute, single-suction								
	Speed (r/min)	3000			4000					3000
	Capacity (L/min)	80			170		270	230		200
	Lift (m)	5			8		9	10		9. 5
Starting motor	Type	Series DC motor								
	Model	JX0707					JX0810	JX0814		
	Voltage (V)	12						24		
	Power (kw)	2. 5						4. 5		
Dynamo	Type	Silicon rectifying shunt dynamo								
	Model	JF11					JF15	JF25		JF27
	Voltage (V)	14						18		
	Power (kw)	350					500			750
Fuel filter	Type									
	Model	CX0506A						CX0708		CX0810 B
Lube oil filter	Type	Single stage, paper element								
	Model									
Air filter	Type	Single stage, paper element								
	Model	K1317A								

SECTION 2. Operation and safety requirements of diesel engine

1. Please pay more attention to safe operation so as to protect your life and property safety. If you do not abide by the operation regulations, there may be fatal accident or machines and tools accident, even the hazard.

2. It is common that many accidents of great damages on engines are caused by that the operator does not understand operation essentials, adjustment and maintenance, so the operator shall have the technical training so as to master the abilities for operation, maintenance and etc, and after that, the operator may carry out the operation.

3. Although the diesel engine has advanced technology and high quality, it is required for correct operation and careful maintenance so as to exert the best functions.

4. Please strictly follow the oil use regulations and choose light diesel oil in compliance with GB252-2000 regulations and No. 0 light diesel in summer. In the southern area in winter (temperate zone), please use -10 or -20 light diesel, and in northern area (Frigid Zone) use -30 and -35 light diesel. When using CD and CF grade diesel engine oil as regulated by Changcheng Petroleum Company CYJ03A-711105-401, please choose the model according to the specification, otherwise it might bring severe damage to your diesel engine.

5. Long-term anti-frozen and anti-rust liquid or soft water for automobile use shall be adopted; otherwise the cooling system water loop will be blocked.

6. It is very important for the function and life of the diesel engine to have “clean air, oil and water”. Please pay special attention to keep the air filter, oil filter and diesel filter according to technical requirements during work.

7. Please keep safe when carrying out maintenance or disassembly work, and try to avoid accidents of injuries due to impact on the body during machine operation, parts disassembly or improper use of tools.

8. Make sure the diesel engine is always in clean and complete status. Before disassembly and assembly of the parts, clean or wipe the parts clean to guarantee the assembly quality. Complicated adjustment or maintenance shall be carried out indoors to avoid contamination inside the diesel engine by the environment.

9. The automobile use supercharged diesel engine shall not adopt the operation method as “accelerating-turning off-free gear sliding”. If the diesel engine stops working, the supercharger will be damaged due to lack of lubrication cooling from high temperature.

10. The manufacturer shoulders no responsibility for all consequences caused by presumed change of diesel engine structure.

11. The manufacturer shoulders no responsibility for consequences that violate

discharge as regulated by provisions, such as disassembly the high pressure, oil supply and timing system without authorization of the manufacturer, which will influence the function and discharge of the diesel engine

12. Only good quality components in compliance with the quality requirements can be used to replace the old parts.

13. When transporting, loading or disassembly the diesel engine assy, proper hoisting tools shall be used, and hoisting cook shall be used to guarantee safety.

14. Preparation before start

1) Check if the joints that fix the diesel engine are reliable and if the operating handle is flexible.

2) Rotate the crank for several times to check if the moving parts are flexible and if there is any obstacle.

3) Check if the oil surfaces inside the oil sump and injection pump are within regulated scale range, and if the oil tank is full and if the fuel loop is smooth.

4) Turn on the fuel tank valve to check if there is air inside the oil loop, if yes; loosen the discharge bolts of the diesel filter and injection pump. Then press handle pump on the transmission oil pump until the air inside the oil loop is discharged completely. Then screw up the discharge bolt before loosening the high-pressure oil pipe joint nut at the end of the oil injector. Rotate the rank to discharge the air inside the high-pressure oil pipe. After air is totally discharged, screw up the pipe joint nut and meanwhile check if there is any oil leakage at each oil pipe joint.

5) Check if the water tank is filled with coolant, and if there is any water leakage at the water pipe joints.

6) Check if the joints of the parts of diesel engine are reliable or not. Check if the storage battery is charged sufficiently, and if the joints of the lines of electric appliance system are correct and reliable.

15.Start of the diesel engine

1) Position the timing handle and medium speed position;

2) Rotate the ignition switch to open position, and press the start button to make the diesel engine start. If the diesel engine cannot be started, loosen the button right away and wait for 2 to 3 minutes to restart it. If the diesel engine fails in starting for three times successively, check the fault cause and eliminate the faults before restart.

3) After the diesel engine is started, loosen the button, and rotate the ignition switch to another position. Connect the generator charging circuit to charge the generator. At the same time, adjust the gun to observe the rotation velocity meter. Make the diesel engine run in low speed and check if the diesel engine is normal or if there is any abnormal sounds. Especially pay attention to see if the pressure of oil is correct. Then pull the timing handle gradually to make the rotation speed of

diesel engine reach rated speed, and warm the machine without load.

16.Operation of diesel engine

1) When the coolant temperature reaches 50℃, and the oil temperature over 40℃, working with load is permitted. When using marked power, the water temperature shall reach about 80℃.

2) Increase or decrease of the diesel engine load and rotation speed shall be carried out evenly and gradually. Under normal conditions, it is not allowed to add or remove the load suddenly.

3) During the operation time of the diesel engine, pay attention often to seek if the readings on the instruments on the instrument panel are normal. Pay attention to the exhausted gas color and the operation sound. Stop the machine for inspection if there is anything abnormal.

17.Stop of the diesel engine

1) Before the diesel engine is stopped, the load shall be gradually reduced as well as the rotation speed. Run the diesel engine without load at the idling spot for 3-5 minutes before operate the stop handle to stop the diesel engine.

2) After the diesel engine is stopped, rotate the ignition switch to the middle.

3) When the environmental temperature is lower than 5℃ in winter, after the diesel engine is stopped, open the water discharge switch on the machine and the radiator when the water temperature is lower than 60℃ to discharge to coolant so as to avoid the machine is frozen and thus cause crack. If coolant is added in the water, it is not necessary to discharge the water then.

18.Safety requirements on the diesel engine

1) Prevention facilities warning marks must be installed on all exposed rotating parts and transmission structure that might hurt the operators when the diesel engine is used for machine set. Preventive mask and separating shield shall be rigid, which can only be dismantled when using tools.

2) The working site for diesel engine must enjoy good ventilation. Ventilating facilities shall be installed in the places where might gather combustible, toxic or asphyxial gases.

3) Anti-slippery cover must be available in the diesel engine operation places. Guardrails shall be installed in such operation areas such as working path, operation platform and stairs so as to avoid sliding of operators or articles.

4) When using the diesel engine, necessary instruments such as water temperature meter and oil pressure meter and indication system that guarantee the normal operation shall be provided.

5) If such errors as abnormal sound, machine lifting or lubrication stops during the test run of the diesel engine, or the humidity at the exhaust exit in combustible and explosive environment exceeds the regulated limit, fuel shall be cut off fast (pull the stop handle and cut off the fuel pipe, etc.) and air (block) inlet

or other effective measures can be carried out to stop the motor quickly.

6) Oil inlet of fuel tank and the exit of ventilation hole shall be placed far from high temperature surface and electric components. The caps shall guarantee no leakage of fuel will occur when the fuel tank is bumped.

7) Warning mark shall be placed at prominent position when configuring the radiator so as to inform the operator not open the water inlet cover of the radiator under hot status of the motor to avoid hurt by high temperature vapor.

8) The surface of exhaust pipe and that of the muffler of the diesel engine are very hot, so the operator shall pay attention not to touch the aforesaid high temperature surface to avoid hurt. If the user is putting heat preservation materials on such high temperature surfaces as protection, pay attention not to let any fuel leak to the heat preservation materials so as to avoid fire.

9) When the diesel engine is used in the following places, the high temperature surfaces such as surface of exhaust pipe and that of the muffler shall be cooled or set with effective preventive measures and warning marks. Heat preservation materials shall not be burned and pay attention not to let any fuel leak to the heat preservation materials so as to avoid fire.

1.Ship; 2. Petroleum industry; 3. Coal mine; 4 Chemical industry;
5. Generation of power; 6. Fixed use

SECTION 3. Technical maintenance of diesel engine

In order to make the diesel engine work regularly and reliably, reduce the worn of components and prolong the use life, the following technical maintenance system must be followed regularly to carry out maintenance on the diesel engine.

1.Daily maintenance

1. Check if the oil surface inside the oil sump is between the two scales of the oil gauge and close to the upper one. After oil is filled to the upper scale of the new machine or the diesel engine that has not been used for a long time, run the engine for 5-10 minutes in low speed and then stop. Re-measure the height of the oil with oil gauge.
2. Check the water quantity inside the radiator.
3. Check the oil surface of the internal machine of oil injection pump accelerator, and supplement to regulated position when it is not sufficient.
4. Check the water, oil and air leakage of the diesel engine.
5. Remove the water, oil and air leakage of the diesel engine.
6. Check the fixing of the stands and joints of the diesel engine and the connection of other driven equipment.
7. Keep the diesel engine clean. Remove oil, water and dust with dry cloth or mop soaked with a little gasoline. Specially keep the electric equipment clean and dry. Remove the dust on the radiator pieces of the water tank.
8. After running for 50 hours, oil inside the sump, injection pump and accelerator of the new diesel engine shall be changed. Clean the filtering core of the oil filter, oil sump and oil gathered filtering net.
9. Remove all found errors and abnormal phenomena.

2.Maintenance after 100 hours' operation

Besides the items in "daily maintenance", the following jobs shall be added as well:

1. Change the oil inside the oil sump.
2. Clean or change the filtering core of the oil filter.
3. Clean or change the filtering core of the oil filter (or after 200 hours of working in total).
4. Check the fixing conditions of the cylinder cover bolt.
5. Check if the clearance between the air valves complies with the regulations, and adjust if necessary.
6. Check the tension of the fan belt, and adjust if necessary.
7. Clean the dust accumulated in the air inlet pipe, dust pan of the air filter and on the surface of paper filtering core, and remove the dust inside the air exhaust pipe and the muffler.
8. After 200 hours running in total, check the oil injection pressure and the

injection status. Clean the needle valve parts if necessary, and re-adjust the oil injection pressure.

9. Check the battery voltage and electric liquid proportion, which shall be 1.27-1.28 (when the air temperature is 20℃). If the proportion is reduced to 1.14, charge the battery. The electrolyzed liquid surface shall be 10-15mm higher than the electrode board, and supplement distilled water when the electrolyzed liquid is insufficient.
10. Components disassembled due to maintenance work shall be cleaned before re-assembly, and the installation position shall be guaranteed correctly. Then start the diesel engine and check its operation. Remove errors and abnormal phenomena found.

3.Maintenance after 500 hours' operation

Besides the items in **"maintenance after 100 hours' operation**", the following jobs shall be added as well:

1. Check the oil injection pressure of the injector and observe the pulverization quality of oil injection. Clean the needle valve parts and re-adjust the oil injection pressure if necessary.
2. Check the working conditions and the oil supply advanced angle of the oil injection pump, re-adjust if necessary. Re-adjust the oil supply to the oil pump on the oil pump test bench if conditions allow.
3. Check the sealing conditions of air inlet and exhaust valve and the air valve stand. Grand and rectify if necessary, and re-adjust the clearance between the air valves.
4. Check the fixing status of connection rod bolt and main bearing bolt.
5. Re-fasten the bolt of the cylinder cover, and adjust the clearance between the air valves according to the regulations.
6. Clean or change the filtering core of the air filter.
7. Clean the cooling system. The detergent comprises 150g NaOH and 1L water. Before cleaning, discharge the water in the cooling system, and fill it with detergent. Start the diesel engine after reserving the detergent for 8-12 hours, and stop when the water temperature reaches the working temperature. Discharge the detergent immediately to avoid the furring deposit. Clean the cooling system with water at last.
8. Check the working conditions of the thermostat, and check the water drop inside the water discharging hole in the water pump. If water drop is serious, replace the water seal.
9. Check if the joints of the electric circuits of the electric equipment are firm, and if the lead contact is good. If there is burning mark found, clean it immediately.
10. After 1000 hours of working accumulatively, add the following work:

(1) Generally inspect the parts of the diesel engine, and carry out necessary repair and adjustment.
(2) Dismantle the generator and the motor to clean the old butter on the bearing and replace new butter, meanwhile check the gears on the driving motor.
11. After 1500 hours of working accumulatively, add the following work:
(1) Dismantle the cylinder cover, check other parts between air valve and air valve stand and cylinder cover set.
(2) Remove the deposited carbon on such parts as cylinder lid, cylinder cover, piston and piston ring, and clean thoroughly.
(3) Check and measure the abrasion of piston and piston ring.
(4) Check and measure the abrasion of internal holes of cylinder cover.
(5) Check and measure the abrasion of crank necks.
(6) Check and measure the abrasion of main shafting and connection rod shaft.
(7) Clean the oil tunnels inside the engine and change oil.

4. Sealing and preservation of diesel engine

When the diesel engine is to be stopped for a long time, the following methods can be taken for sealing and preservation:

1. After stopping the engine, discharge oil, coolant and fuel thoroughly when they are hot. Clean the oil sump and the filter.
2. Clean the dust and oil on the surface. Apply anti-rust oil onto the parts that are not coated. No oil shall be applied onto rubber and plastic products.
3. Heat the filtered oil to 110-120℃ until foams disappear totally. Then fill the dehydrated oil to the oil sump until it reaches the upper scale of the oil gauge and turn the crank to make the whole lubrication system full of oil.
4. Add some dehydrated oil to the cylinder from the oil injector installation hole on the cylinder lid and then turn the crank to make the oil adhere onto piston, piston ring, cylinder cover and air valve sealed surface.
5. The mouths of air inlet and exhaust pipes (muffler) shall be blocked with wood lid or wrapped with plastic cloth to avoid immunities enter.
6. Diesel engine shall be placed in dry and clean locations with good ventilation. It shall be covered to avoid dust drop. It is prohibited to pile chemical products near the diesel engine.

The aforesaid oil sealing method can be used to preserve the machine for 3 months. When exceeding such time limit, re-seal it with oil.

SECTION 4. Adjustment of diesel engine

1. Adjustment of clearance between air valves

When carrying repair or technical maintenance to the diesel engine, check the clearance between the air valves. The adjustment method for clearance between the air valves and the air distribution structure is as follows (**please refer to the figure 1):**

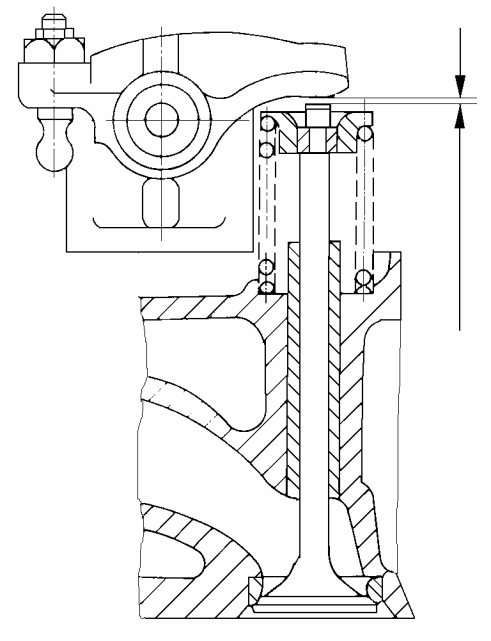


Figure 1 Adjustment of clearance between the air valves

1、Disassemble the cylinder cover, check and fasten the bolt on the compressing air valve rocker shaft stand

2、Turn the crank to the first cylinder piston stop position, when the "0" scale on the crank belt wheel aims exactly with the indicator in the timing gear cover.

3、Insert the thick and thin dividers respectively into the air inlet and exhaust valves of the fist cylinder and the rocker, check and adjust the clearance between the air valves and keep the cool clearance between within regulated value. After that, according to the cylinder working order 1-3-4-2 to half rotate the crank (i.e. 180^0), and adjust the clearance between the air valves.

2. Adjustment of advance angle for oil supply

In order to obtain the most economic fuel consumption rate and good operation functions of the diesel engine, the advance angle for oil supply shall be adjusted properly. The adjusted value of the advance angle for oil supply must comply with the requirements of technical parameters of the diesel engine.

The method for adjusting the advance angle for oil supply is as follows:

1. Remove the air inside the fuel system, and repeated the rotating of crank to make the oil injection pump full of fuel. Dismantle the high pressure oil pipe of the first cylinder, and slowly turn the crank in positive directions, and pay close attention to the oil surface inside the oil pipe joint hole. When the oil surface waves, stop rotating the crank.

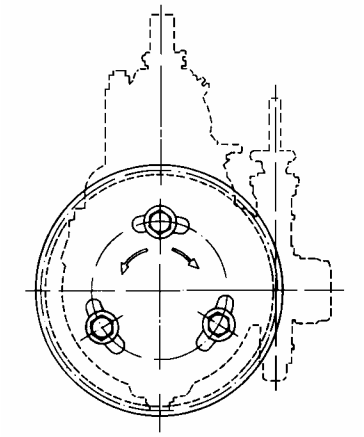


Figure 2 Adjustment of advance angle for oil supply

2. Check the stop point mark on the flywheel observation window to aim the upper scale of the flywheel (or the upper scale on the crank belt wheel) to see if it complies with the aforesaid regulated optimal angle scale.

3. If the advance angle for oil supply is too large or too small, loosen the 3 nuts on the triangle flange pan of the oil injection pump to carry out adjustment. From the front to the rear, the oil injection pump will move clockwise, and the advance angle for oil supply gets smaller. When it is moved anti-clockwise, the advance angle for oil supply will enlarge. (**please refer to the figure2**)

3.Adjustment of oil injector

The test and adjustment of oil injector shall be carried out on the test bench for oil injector, with its purpose to adjust the oil injection pressure. Observe the pulverization quality and the remove the errors. When the oil injection pressure of the oil injector is too high or too low, injection abnormal or the parts are damaged, the diesel engine might have errors during operation such as block smoke, power and rotation velocity decreases, temperature discharge too high or impact on the cylinder, etc. The judgment on oil injector with errors can adopt stop-in-turn method, i.e. loosen the connection nuts between oil injector and high pressure oil pipe one by one to stop oil injection, meanwhile observe the color of smoke

exhausted. If there is any oil injector with faults, stop the oil injection and no smoke will be discharged; rotation velocity changes little or without any change. It is also feasible to rotate the flywheel one by one to listen to the oil injection sound. When clear sound is lost, it means the oil injector in this cylinder might have errors on it.

1、Adjustment of the oil injector

(1) Handle the pump to the gauge pressure close to the oil injection pressure, and then slowly press the handle pump to increase the surface pressure to regulated oil injection pressure. Observe the oil injection hole, where should not have oil drop or leakage. If after several times of test, there is still oil drop, dismantle the injection nozzle parts to clean, check or grind before carrying out the test.

(2) Adjust the oil injection pressure to regulated pressure, and dismantle the pressure adjusting nut on the front of the oil injector. Take out the internal pressure adjusting spring, and adjust the starting pressure through adjusting the thickness of the adjusting pad. Increase the thickness of the pad and the oil injection starting pressure will be enhanced. If the thickness of the pad is decreased, the oil injection starting pressure will decrease.

(3) Observe the spraying quality. Carry out pulverization test in the once/second oil injection speed. The oil shall be even fog without any visible splashed oil foam, partially uneven thickness or single side injection abnormal, etc. Clear sound shall occur when cutting off the fuel. In general, abnormal oil injection occurs because of the inflexible movement of injection nozzle needle valve. The drop of oil on the injection hole usually occurs because of damage on the sealed surface, and the oil separation from the carbon accumulation on the nozzle or heat deformation.

2、Disassembly and repair of oil injector

(1) When disassembling the oil injector, clean the external part to make the nozzle face upward and clamp it to the table plier with bronze pad. Screw down the nut to take out the needle valve parts and pull out the needle valve to soak into clean diesel. Turn the oil injector for 180^0 and clamp. Take down the pressure adjusting nuts and screws to take out pressure adjusting spring and top rod.

(2) If the needle valve parts are snapped or the pulverization is not good, clean it right away. If the needle valve parts are snapped, soak them in diesel for some time, and then clamp the needle valve with iron thread plier, and pull out lightly to avoid napping. When cleaning the needle valve parts, scratch with wooden piece with gasoline or diesel but metal piece is not allowed. When the needle valve and its parts are not smooth or the movement is inflexible, grind adjustment can be carried out. Use clean diesel when grinding. Grinding in pairs shall not impact on the needle valve or its stand, and clean after grinding without any metal dirt reserved.

4.Adjustment of lube oil pressure

Adjustment of oil pressure is shown in **Figure 3**. Loosen and fasten the nuts; adjust the nuts with spanner to make the oil pressure within 200-600kPa (it is allowed to be higher when the machine is cold). Screw up the nuts after adjustment.

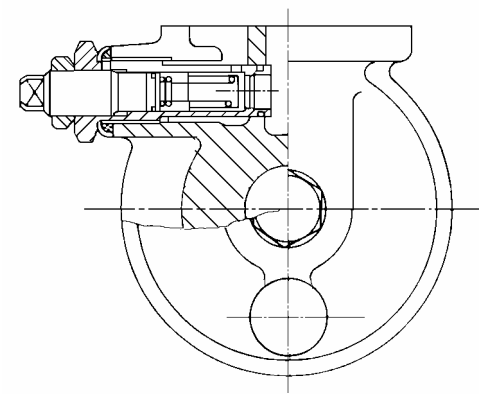


Figure 3 Adjustment of oil pressure

5.Adjustment of oil injection pump

The oil injection pump has been adjusted and checked before delivery. If re-adjustment is required, it shall be carried out on special oil injection pump test bend for standard oil injector and standard length high pressure oil pipe according to relevant instructions on oil injection pump.

SECTION 5. Diesel Structure

1. Cylinder Head

The cylinder head is made of HT200 cast iron (with copper chrome). Fix it on the cylinder body with bolts for the cylinder head. When tightening the bolts for assembling, torsion spanner is employed to tighten as **the figure 4** indicated below, then the required tightening force moment is achieved. After the cylinder head has been assembled and heated for the first time, all the bolts for the cylinder head shall be re-tightened as required and readjust clearance of the air valves.

The air inlet and air outlet is made of different materials. The air inlet, air outlet and valve seat have been matched and grinded to avoid air leakage.

When the air valve and seal surface of the valve seat are burned, air leakage, grinding is required. After grinding is completed, check air leakage of the valve and inspect the sealing conditions.

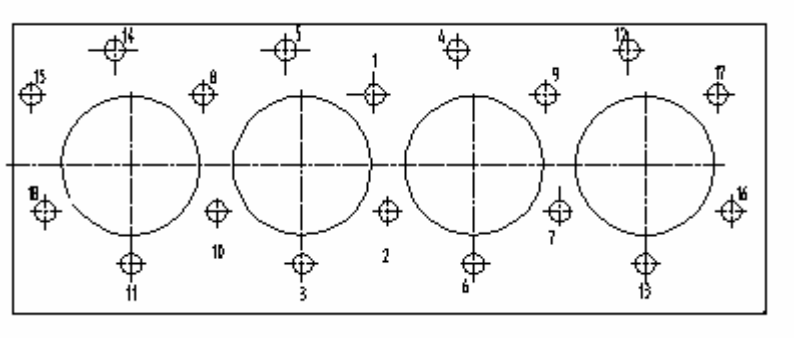


Figure 4: Screwing sequence for bolts on the cylinder head

The valve seat is made of alloy cast iron. Normal width of the air valve and valve seat is 1.2-1.6mm. After long-term use and grinding for many times, if the sealing surface becomes wider which leads to poor sealing, reamer is adopted to amend inner hole positioning of air valve conduit, then grind the valves and the inner hole positioning as required.

As for a new one, sinking distance between the plane of the air inlet and air outlet and the plane of the cylinder head is 0.6-0.8mm, as **figure 5** indicated. After amendment to it for many times, the sinking distance may be increased. When it exceeds 2mm, it is recommended to change the valve seat.

The valve clearance shall be checked regularly. See Section 1 of Chapter V for detail on adjustment methods. If the valve clearance is excessive, it may affect correctness of gas distribution and timing and increase noise of the valve structure; insufficient clearance may lead to incomplete closing and burning of the air valve.

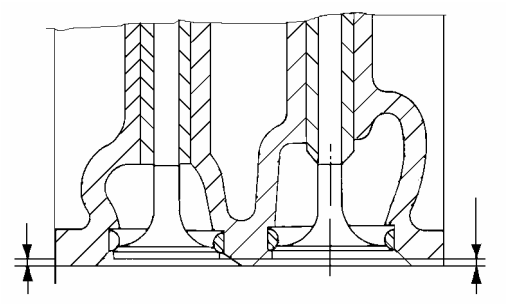


Figure 5: The air valve is sinking

2.Cylinder Body

The cylinder body is made of cast iron HT250 and portal shape structure is adopted. Besides the installation hole, bolt hole for cylinder head on the top of the cylinder body, the water hole to the cylinder head, and lubricant hole at the back of the cylinder body to the cylinder head are on it.

Water pump and gear transmission system are installed at upper part and lower part of front-end of the cylinder body. Fly wheel casing or clutch casing is installed at back-end of the cylinder body. The lubricant inlet and bolt hole for installing crankcase oil tray are located at the bottom of the cylinder body. When dismantling the diesel for repair, each oil channel shall be repaired to ensure clean and unblocking. Bulkhead of each channel shall be sealed and oil leakage is not allowed.

The main bearing is of fully-supported suspension type. Matching borizing is employed for main bearing casing and the cylinder body. Matching marks are marked on the cylinder body and main bearing casing. Any exchange or reverse assembling is not allowed. The main shaft bushing is the shafting bushing of high tin bronze zergal. When dismantling it for cleaning, do not mistake the upper and low shaft bushings (the upper shaft bushing with oil groove). The thrust plate is locates at the last piece of the main bearing. Each of the two is located at the front and back end respectively. The thrust plate bears axial thrust of the crankshaft, with oil groove on the work surface and the reverse side. After crankshaft assembly is completed, it shall be flexible.

The cylinder sleeve is made of boron cast-iron and of wet type. Flange surface of the cylinder surface is 0.04-0.14mm higher than the body top to ensure sealing of cylinder sleeve and head. **See figure 6.**

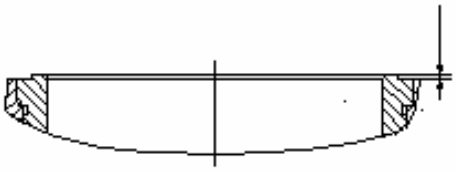


Figure6: Flange of cylinder sleeve higher than the body top

3．Piston and Connecting Rod

The piston connection rod assembly consists of piston, piston ring, piston pin, retainer ring, connecting rod, connecting rod casing, connecting rod bolt, connecting rod bushing and connecting rod lining and etc. Mass deviation of the connecting rod assembly of the piston for the same diesel shall be no more than 3g. BH122A is employed for the piston.

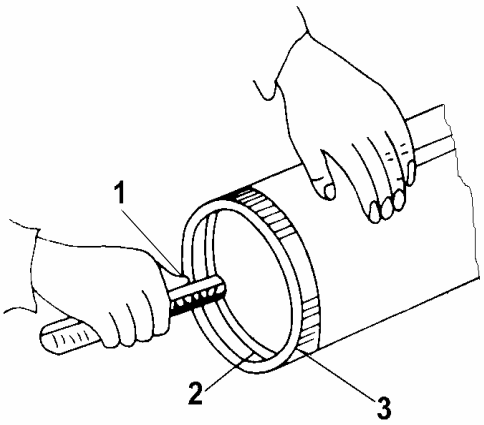


Figure 7: Measure clearance of piston ring
1.Gap feeler 2. Piston ring 3. Cylinder sleeve

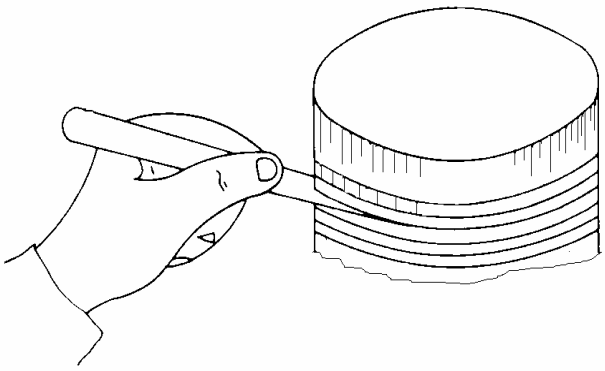


Figure 8: Measure end face clearance

The gaseous ring is made of alloy cast iron. External circle of the first gaseous ring is coated with porosity chrome, which can reduce abrasion between cylinder sleeve and piston ring. The second one is a distorted ring, the marked surface faces the top face. Reversing assembly is not allowed.

Caulking ring is employed for the oil control ring. As its resilience reduces by abrasion, it still remains a certain of radial resilience; therefore, it extends service life of the oil control ring. Please check clearance of the opening before installing the piston. Keep the piston ring flat, 15-20mm away from top face of the cylinder sleeve. Then measure it with a gap feeler, clearance of the first gaseous ring's opening shall be 0.3-0.5mm. Clearance of the second gaseous ring's opening shall be 0.4-0.6mm. See **figure 7** for detail. If clearance of the opening is smaller, amend it with a file; if clearance of the opening is larger, change a new one. In addition, it is necessary to measure the end face clearance between the piston ring and the piston ring groove with a gap feeler. Clearance for the first gaseous ring shall be 0.08-0.12mm,and the second gaseous ring shall be 0.03-0.065mm. (**See figure 8 for detail**.)

Special purpose tool shall be employed for dismantling the piston ring. When assembling, opening positions of each piston ring shall stagger 120 degrees and not put on the direction of the piston pin.

During maintenance, if the piston ring can not move smoothly, immerse it in diesel (diesel or petroleum) for twenty-four hours or longer, then knock on the piston ring. After it is released by itself, take it out of the diesel and clean it with diesel or carbon tetrachloride.

Check if there is any rupture or crack on the piston ring, change a new one if any defect is

found.

40Cr steel with die forging technology is made of the connecting rod. Section surface of the connection rod body is I-beam axle. The connecting rod and connecting rod casing shall be corresponding borehole. Assemble it with marks and no error shall be made during assembly. Bolts for connecting rod is made of 40CrMo steel. The upper and lower shaft bushings for the connecting rod are made of copper-lead alloy and tin-aluminium with support. When the clearance exceeds its limit value by abrasion or the surface wears off or burns, please change the new ones in couple.

Before overhaul for the diesel or assembling (disassembling) the connecting rod assembly, clean the deposit carbon and oil stain on upper part of the cylinder sleeve. Coat clean engine oil on cylinder trepan boring, external surface of the piston, piston ring, shaft bush for connecting rod, crankshaft, connecting rod journal and etc, then place the guide bush on the cylinder sleeve. Rotate the crankshaft, assemble the connecting rod in the cylinder sleeve carefully, and tighten the bolts in turn with required force moment

4.Crankshaft and Flying wheel

The crankshaft is made of spheroidal graphite cast iron QT800-2 with tufftride treatment. Timing gear for the crankshaft and belt pulley are installed at the front of the crankshaft. The flying wheel is installed at the back flange and positioned by the positioning pin. Seven bolts are used for tightening the flying wheel as specified force moment. The bolts for the flying wheel are made of 40Cr steel with hardening and tempering treatment. One 6203-Z bearing is installed at the center of flange of the back of the crankshaft to support the transmission shaft of the transmission case. Scale mark is provided at belt pulley of the crankshaft for observing the angle of advance for oil blowout.

The flying wheel is made of HT200 cast iron. Ring gear of the flying wheel made with No.45 steel is located at the external circle of the flying wheel. Scale mark is provided at flying wheel for observing the angle of advance for oil blowout.

5.Cam Shaft

The cam shaft is made of No.45 steel. When the cam shaft is rotating, the cam pushes the standing pillar to control air inlet and air outlet of each cylinders.

Thrust flange is provided for the second shift bearing of the cam shaft. Depending on thrust surface of the second shift cam bearing casing, it can control axial direction drunkenness of the cam shaft. Bearings for each shift of the cam shaft receive lubricant from the main oil channel. When installing lining for the front end, please check the oil holes of the lining and body are connected or not.

6.Gear Transmission System

The gear transmission system consists of timing gear for crankshaft, timing gear for camshaft, timing gear for fuel injection pump and one inertia pump. Each timing gear is

marked with timing gear except the gear for hydraulic pump. Tooth position of the gear shall be in corresponding position, (the gear marked with number shall be in the middle of gears with adjacent numbers), to ensure mutual motion relation of the parts, see **figure 9** for detail. When installing gear for fuel injection pump separately, the angel of advance for oil supply shall be met first, and no mark is necessary. If marking is required, marks of the said three positions shall be aligned.

Special purpose tools are employed for assembling and disassembling for timing gear of the crankshaft. Timing gear of the cam shaft may be installed by utilizing the two M8 screws on wheel spoke of the gear and serrated screws. Slippage positioning is employed for timing inertia gear and the body. The timing gear of fuel injection pump is installed at the advancer for oil supply, which is fixed on the cam shaft of the fuel injection pump. Only by unscrewing one M14*1.5 screw of the advancer, should we take out the gear for fuel injection pump and advancer for oil supply.

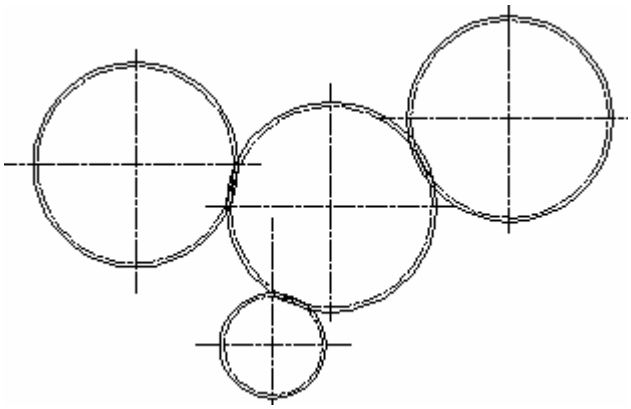


Figure 9: Mark for timing gear tooth

7.Fuel and Speed Adjustment System

Fuel and speed adjustment system is the main operational parts of the diesel, which includes fuel conveying pimp, diesel filter, oil blowout pump, adjuster, advancer, high& low pressure oil duct and etc. See **figure 10** for detail.

The fuel conveying pump takes charge of conveying the fuel to the diesel filter, then to the fuel blowout pump. The fuel generates high pressure in the fuel blowout pump, then spray into the combustion room to burn from fuel injector through high pressure duct in form of mist.

The fuel conveying pump is a single action piston oil pump, installed at the external side of the oil injection pump and driven by eccentric gear on cam shaft of the fuel injection pump.

The fuel injection pump has been calibrated by the manufacturer. Do not dismantle it without permission. If dismantling for repair and adjustment are required, please keep it clean. Plunger piston, oil outlet and other couple part can not be exchanged.

Fully mechanical adjuster is employed. Rotation speed of diesel increase relatively; when

the speed adjustment handle moves towards the direction for releasing the spring, the oil supply amount reduces and rotation speed of the diesel reduces, too. Do not change positions of the two screws for rotation speed limitation and limit screws for maximum oil amount.

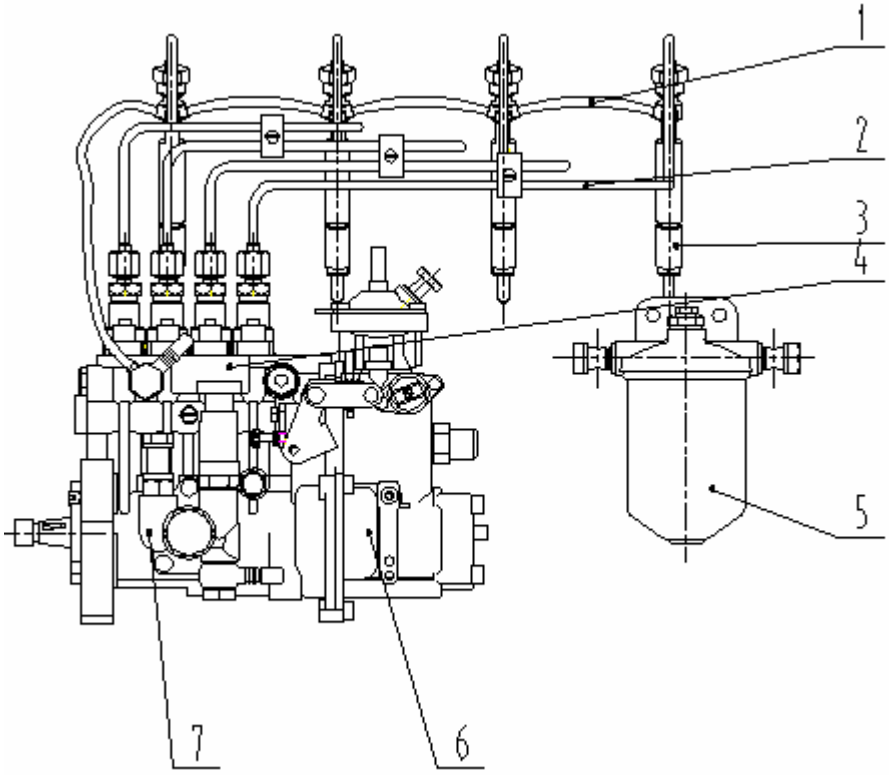


Figure 10 Fuel adjustment diagram

1. Oil return pipe 2. High pressure oil pipe 3. Oil spray pipe 4. Oil injection pipe 5.Diesel filter 6. Adjuster 7. Conveying pump

Stop working handle is installed on casing of the adjuster. When the diesel needs stopping, move the stopping working handle to realize emergency stop.

Pin valve of fuel injection nozzle and pin valve body are the precise couple parts by grinding. During dismantling, do not exchange it and keep it clean.

8.Lubrication System

The lubrication system is made up of engine oil collector engine oil pump, engine oil cleaner and ducts. See **figure 11.**

Pressure lubrication and splashing lubrication are employed for 4YDC_K diesel. Pressure lubrication is employed for main bearing of crankshaft, connecting rod bearing, cam shaft lining, swing arm shaft lining and etc. Oil spray and splashing lubrication is employed for cylinder sleeve, piston, piston pin, connecting rod lining, cam and standing pillar, air valve and air valve duct. Regular lubrication by injecting lubrication grease is adopted for rolling bear at the shaft of water pump.

The engine oil at the oil tray enters into the engine oil pump through engine oil collector and oil inlet duct. Then the oil is delivered to the engine oil cleaner after it is pressurized, and the engine oil goes through the body in three ways: one is to the main bearing through oil hole of the crankshaft; one is to lining of the cam shaft by intermittent supply from the eccentric oil groove on rear journal of the cam to lining of the swing arm shaft; the last one is to bearing of timing inertia gear. Gear pump is employed as engine oil pump. The engine oil cleaner is of single level filtration with paper type. It shall be changed regularly. During use, if the filter elements are blocked, open the safety valve to make engine oil flow into the main oil channel. At this time, the cleaning function is unavailable. Therefore, the operator shall clean or change the filter element regular as the "Technical Maintenance" required.

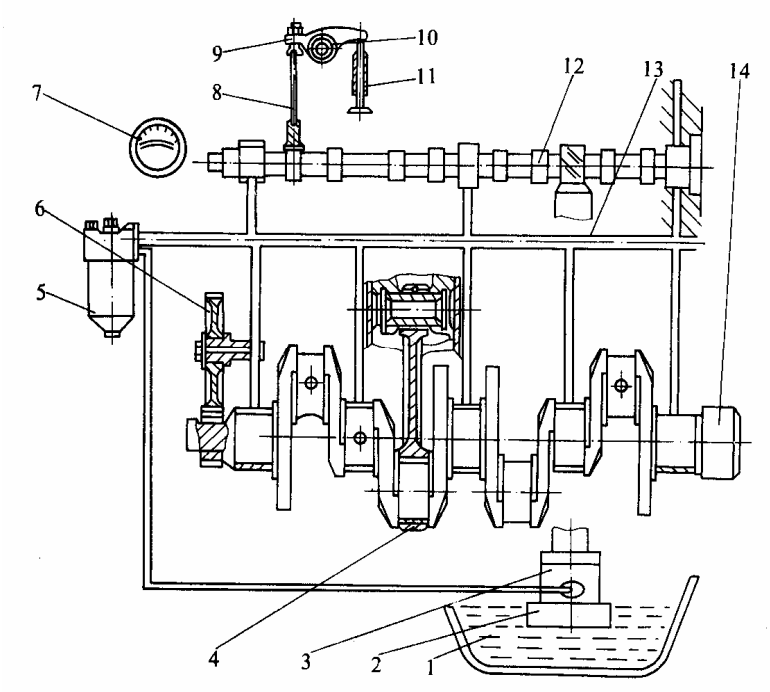


Figure 11 Lubrication system

1.Oil tray, 2.Engine oil collector 3. Engine oil pump 4. Piston connecting rod assy and cylinder sleeve 5. Engine filter 6. Gear series 7. Oil gauge 8. Push rod and standing pillar of air valve 9. valve swing arm 10. swing arm shaft of valve 11. valve and valve dut 12. cam shaft and lining 13. oil channel in the device 14. crankshaft and bearing

9. Cooling System

The cooling system is of forcible circulating water-cooled type. See **figure 12** for detail. The cooling system contains radiator, water pump, fan, heat retainer, air guide cover and etc. Cooling liquid in the radiator is delivered to water channel by water pump, then enters into the

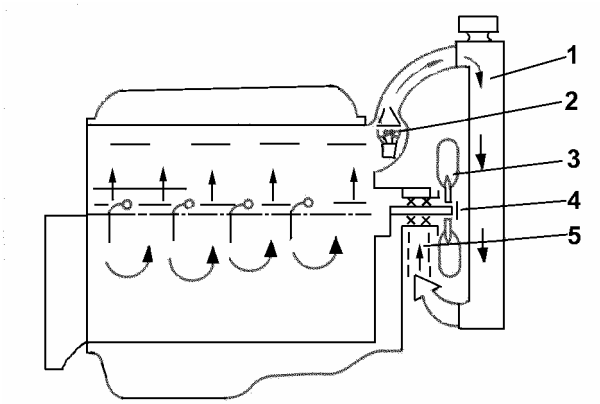
surrounding of the cylinder sleeve and last flows into cylinder header by the cylinder sleeve. The used cooling liquid returns to the radiator through heat retainer at the front of the cylinder head. When temperature of the water flowing out is less than 70℃, the heat retainer closes, and the cooling liquid flows into inlet pipe of the water pump through a small circulation on front plate of the cylinder, then it flows into the water pump a second time to realize a small circulation; when the water flowing out is 70-80℃, the heat retainer opens, and the cooling liquid flows into the header tank of the radiator through the heat retainer, and flows into the lower tank through a flat copper pipe. During the process, the cooling liquid is cooled by the drafting or exhausted by the fan. Up to now, a big circulation is completed. Air drafting or exhausting is adopted for the fan as required.

Water pump of centrifugation type is used. The water pump shaft adopts shaft connected bearing for support. Water backfill adopts graphite and ceramic backfill. The water pump is driven by belt pulley. During use, if the water backfill is damaged, which leads to serious water leakage in the lower part of the water pump, please change a new one. Do not clock the water backfill if it is damaged, otherwise, it may enter into the bearing and accelerate abrasion of the bearing.

Check and adjust tension of the belt between the water pump and belt of generator regularly as the “Technical Maintenance” required. The adjustment method is press down it 10-20mm.

Figure 12 Cooling system

1.Radiator 2. Heat retainer 3. Fan 4. Water pump 5. Inlet pipe



10. Electric system is composed of the battery, startong motor, dynamo, starting button, and instruments, etc., shown in Figure 13.

The parallel excited silicon rectifying dynamo mode JF comprises the three phase alternator and silcon diode rectifier. Be careful that the armature must be negative pole grounded. If not

the dynamo will be damaged.

Refer to operation and maintenance manual for JF series silicon rectifying dynamo for the operation and maintenance of the dynamo.

After turning on the starting switch, the flywheel gear ring is engaged with the motor pinion by the solenoid, meanwhile the flywheel is driven by closing the current circuit of starting motor.

As soon as the engine is started, the starting switch must be turned off immediately. Then the core along with the pinion return to the original place under the actuation of spring. The continuous working time for the starting motor should not exceed 15 seconds. The interval between two starting failure for three attempts.

SECTION 6. FAULTS AND REMEDIES FOR DIESEL ENGINE

1. Hard or refuse to start (see table 6)

Table 6

Causes	Remedies
1. Fuel filter and fuel pipelines blocked	1. Clean.
2. Air trapped in fuel system	2. Exhaust air and tighten all fuel pipeline connector.
3. Advanced fuel injection angle incorrect	3. Readjust it according to specification.
4. Fuel spray abnormal	4. Readjust fuel injection pressure according to specification and clean or replace injector needle valve sets.
5. Compression pressure low	5. Check and replace piston rings and cylinder liners. Grind valves. Cylinder head nuts should be tightened in case of leakage on cylinder head gaskets.
6. Valve lash incorrect	6. Adjust it according to specifications and align gear marks.
7. Battery charge insufficient	7. Charge it.
8. Wire connections loosened	8. Check and tighten wire connections. Clean up contact points.

9. Ambient temperature too low, and oil too viscous	9. Preheat cooling water and lube oil.

2. Power insufficient (see Table 7)

Table 7

Causes	Remedies
1. Compression pressure inside cylinders too low	1. Refer to item 5 in paragraph 1 and replace components exceeding wear limit
2. Advanced fuel injection angle incorrect	2. Adjust it according to specifications
3. Valve lash incorrect	3. Adjust it according to specifications
4. Fuel supply for each cylinder unbalanced.	4. Adjust fuel injection pumps to proper supply
5. Air filter clogged	5. Clean
6. Fuel injection pump, fuel injectors sets worn off or fuel injection pressure incorrect	6. Replace them whth new sets, adjust fuel injection pressure and check fuel spary.
7. Rotation speed incorrect	7. Adjust it with speed govering handle in order to reach specified speed

3. Smoking Exhaust (see Table 8)

Table 8

Cause	Remedies
1. Engines overloaded	1. Reduce the load properly and in case of unsuited
2. Fuel injectors not well atomized	2. Check the injection pressure and fuel spray. Replace then in case of damage.
3. Fuel unqualified	3. Use qualified fuel.
4. Combustion incomplete	4. Mainly caused by unqualified fuel injectors, incorrect advanced fuel injection angle, leakage at cylinder head gaskets and low compression pressure. Remedy in accordance with

	specific problems.

4. Knocking Noise in Engine (see Table 9)

Table 9

Cause	Remedies
1. Advanced fuel injection angle incorrect.	1. Readjust it according to specification.
2. Air trapped in fuel systems.	2. Exhaust air
3. Fuel supply for each cylinder unbalanced	3. Readjust fuel supply.
4. Fuel unqualified	4. Use qualified supply.
5. Wear of certain components exceeds limits	5. Replace them.

5. Lube Oil Insufficient or No pressure (see Table 10)

Table 10

Cause	Remedies
1. Oil level in oil sumps too low	1. Add oil up to mark on dipsticks.
2. Serious leakage from oil pipelines	2. Eliminate leakage.
3. Oil strainers, oil filters and pipelines clogged.	3. Clean and replace elements if necessary.
4. Oil gauges damaged or gauge lines clogged.	4. Check and replace elements if necessary.
5. Oil too thin.	5. Use qualified oil.
6. Oil sump gears seriously worn off with excessive clearance.	6. Adjust the clearance or replace them.
7. Pressure relief valves of oil filter cease to function.	7. Check and repair or readjust them.
8. Main bearing, connecting rod bearing and camshaft bushings seriously worn off with excessive clearance.	8.Check and repair or replace them.

6. Overheating of Engine (see Table 11)

Table 11

Cause	Remedies
1. Temperature of cooling water too high	
1.1. Insufficient cooling water or vapor lock in water pipes	1.1. Fill the rank to make cooling water level higher than the center line of water pump.
1.2. Bad working state of water pumps.	1.2. Check water pump clearance and tightness of belts. Eliminate leakage.
1.3. Water scale in cooling systems too thick	1.3. Remove it.
2. Oil temperature too high:	
2.1. Insufficient or excessive oil.	2.1. Check whether the oil level is between the dipstick scale lines.
2.2. Oil pressure too low with insufficient flow.	2.2. Refer to paragraph 5.
3. Engines overloaded	3. Relive load.

7. Engine Running-away (see Table 12)

Table 12

Cause	Remedies
1. Malfunction of governors.	1. Stop engines immediately, check and repair.
2. Control rod fuel injection pump gets stuck.	2. Stop engines immediately, check and repair.
3. Injection pump delivery too much.	3. Stop the engines and adjust injection pump delivery.
4. Excessive oil burnt.	4. Stop engines immediately, check and repair.