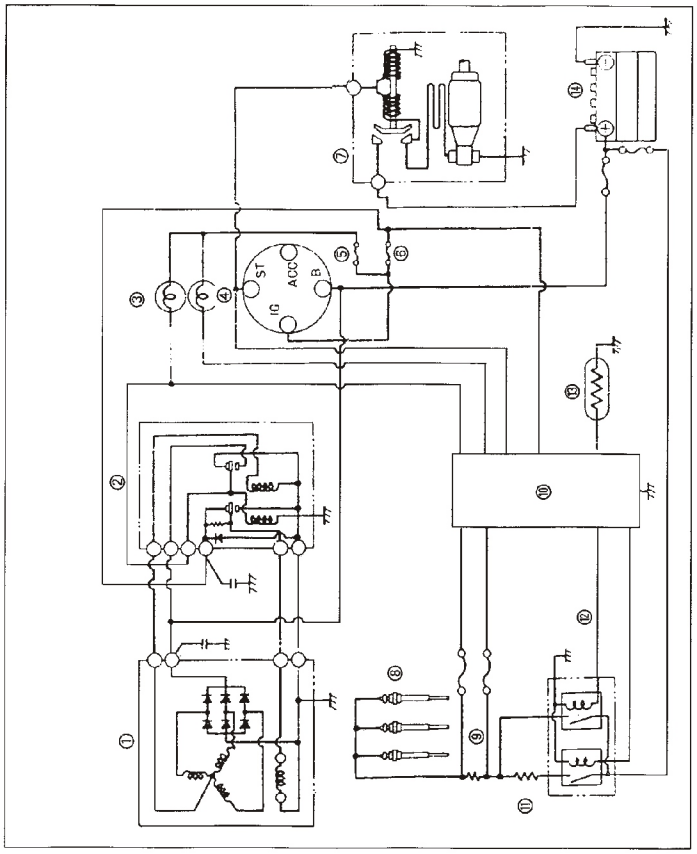
User Manual of Diesel Engine

Electric Wiring Diagram



(1) The alternator
(2) The voltage regulator.
(3) The CHG indication lamp.
(4) The hot insulation indication lamp
(5) The Current meter (10A)
(6) The generator (15A)
(7) The starter motor
(8) The grow plug
(9) The current sensor
(10) The warm-up timer
(11) The grow plug resistance
(12) The grow plug relay
(13) The water temperature sensor
(14) The battery

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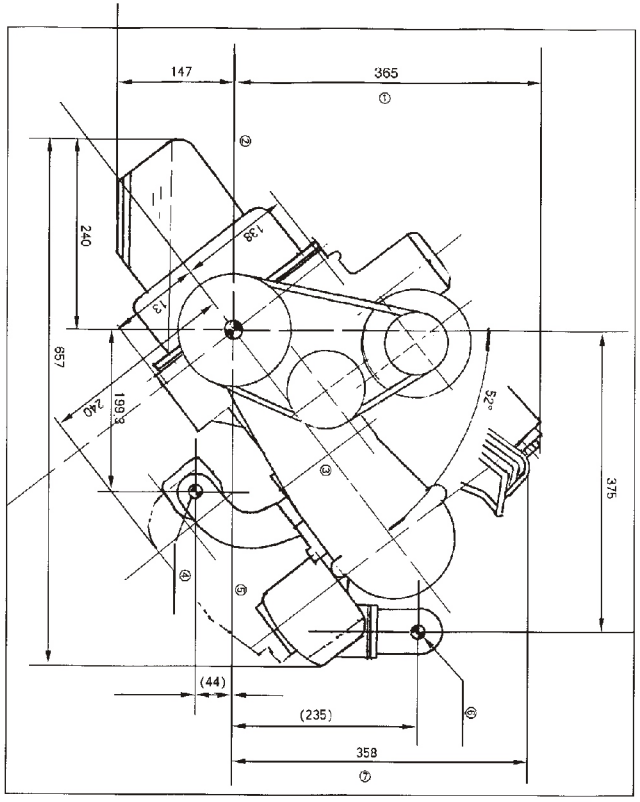
11. APPENDIX

The outline of the tilt-position engine



①To the oil pump MAX. height position
②The center line of the crankcase.
③The center line of the engine.
④Supercharger
⑤The center of the exhaust export
⑥The center of the inlet
⑦To oil pipe MAX height

NOTE: According to actral requirement, the dimension ① and dimension ⑦ can be deduced further.

10. STORAGE

10.1 Storage

10.1.1 The diesel and spare parts and tools leaved from the factory should be wrapped in the water-proof plastic cover. The bottom bracket should be mounted at the casing box bottom. And the casing box should closed and clenched firmly.

10.1.2 The casing box should be put the dry and ventilated room. Forbid putting it the open air, and putting it with the chemical (such as pesticide and chemical fertilizer).

10.1.3 The effective period of the oil seal is one year. Check the corrosion of the diesel after one year. Store the engine after coating it with oil seal if necessary.

1. SAFETY INFORMATION

1.1 Safety Marks

- Be sure to read and follow the instructions on the manual and safety marks.
- Operating the engine without proper training or instruction is not allowed.
- CAUTION: Many accidents are resulted from false operating. For your safety, please obey to the following instructions:

[OPERATING NOTICE]

Covers important safe information. Be sure to pay special attention to and follow it, otherwise the engine performance will decrease or the engine fault and parts damage will result.

1.2 Safety Caution

Be sure to pay attention to the following safety cautions while running the engine:

⚠ DANGER

CAUTION: To avoid being scalded with vapor.

■ Do not open the radiator cap while the engine is running, otherwise the vapor scald will result. Be sure to open the radiator cap with cloth covered it after the engine temperature decreased, and tighten the radiator cap while the engine is running.

⚠ DANGER

CAUTION: To provide well ventilation for the battery.

■ To keep the battery at well-ventilated place and far away from the fire, otherwise hydrogen explosive will result.

⚠ DANGER

CAUTION: To avoid fire resulted from improper operating.

■Use the recommended grade diesel oil. Other fuels such as gasoline and kerosene will cause engine rough running, fuel injection system fault even the fire or explosive. Be sure to use the recommended fuel described in this manual.

■Refuel in a well-ventilated area with the engine stopped. Keep flames and sparks away. If the fuel spilled, immediately clean up the overflowed fuel with rag.

■ Keep the engine far away from gasoline, kerosene, match and other explosive or flammable materials, otherwise will result fire.

⚠ WARNING

CAUTION: To avoid inhale the poisonous exhaust.

■ The exhaust contains poisonous content. Do not run the engine at poor ventilated places, such as confined rooms, tunnels, tents and cabins. Be sure run the engine at well-ventilated place.

⚠ WARNING

CAUTION: To avoid being caught into the moving parts.

■ When the engine is running, keep your hands, body and clothes away from rotary parts such as cooling fan, V-type belt and starter axle.

⚠ CAUTION

CAUTION: To avoid touching the hot parts to prevent from scald.

■ Be careful not to be scaled with hot engine body when the engine just stopped. Keep hands, body and clothes far away from muffler, exhaust pipe and radiator etc parts.

■Do not operate the engine after drinking alcoholic beverage.

9.12 The engine oil level rises

The cause of the fault	Elimination method
1. There is water leakage at the cylinder head gasket	1. Repalce the cylinder head gasket
2. There is water leakage in the cylinder head or engine body	2. Check and repair, or replace

9.10 Engine oil consumption is over large

The cause of the fault	Elimination method
1. The engine oil viscosity is too low, and its brand isn't proper	1. Replace the engine oil brand
2. The gap between piston and cylinder is too large, and the oil hole in the piston circle groove is clogged.	2. Clean or replace the oil hole
3. The piston ring is clogged circuit groove or the installation position of the	3. Clean, repair or replace
4. There isoil leakage in the front seal and rear seal of the crankcase	4. Check and replace the relative parts
5. The engine oil temperature and pressure is excessive	5. Decrease the temperature, check and regulate the pressure-limited valve
6. There is oil leakage in the air valve seal	6. Replace the air valve seal

9.11 There is abnormal sound when running the engine

The cause of the fault	Elimination method
1. The gap between piston and cylinder is too large	1. Replace the piston ring, piston, and bore the cylinder if necessary.
2. The gap between piston pin and small-end bush of connecting rod is too large	2. Repalce the worn parts, keep the specified gap
3. The gap between main bush and the connecting rod bush is too large	3. Replace main bush, connecting rod bush, keep the radial gap specified
4 The gap between the piston ring and piston ring circuit groove is too large	4. Replace the piston ring, and replace the piston if necessary
5. The gap between pressure surface and thrust piece is too large	5. Replace the thrust piece, and keep the specified gap
6.The piston bumps into the air valve	6. Check the clearance height
7. The abrasion of the gears is serious, and the gap between the gears is excessively large. There is a clash bump when reducing the speed suddenly	7. Judge whether replace the gear or not according to the abrasion degree
8. The timing of oil supply is too early	8. Check and regulate the timing of oil supply
9.The oil injector assembly is snapped	9. Clean or replace the nozzle assembly

Safety information about inspection and maintenance:

⚠ DANGER

CAUTION: To avoid touching the battery electrolyte.

■The electrolyte contains diluted sulphuric acid, which can cause blindness and burn if eyes or skin contacted with it. If electrolyte splash into your eyes, flush thoroughly with water immediately and call a physician.

⚠ WARNING

CAUTION: To avoid short circuit to prevent from fire.

■ Do not confuse the earth terminals while checking electric system; otherwise the fire will result from short circuit.

⚠ WARNING

CAUTION: To avoid being caught into the rotary parts.

■Be sure to carry out maintenance with the engine stopped.

■Do not remove the cover of rotary parts.

⚠ CAUTION

■Do not rebuild product without permission.

■ Do not release the control the high-speed limiting screw and oil level limiting bolt, otherwise the engine life will be shortened. Any rebuilding or disassembling of the engine will decrease safety even cause severe accident. If necessary, contact your local agents for replacing the genuine parts or technical support.

2. PRODUCT INSTRUCTION

2.1 Main Specifications and Data

Item \ Model	KM376QC	KM376G	KM376AG
Type	In-line, 4-stroke, water-cooled	In-line,4-stroke, water-cooled	Tilt, 4-stroke, water-cooled
Combustion chamber type	Swirl type		
Bore×cycle(mm)	76×73	76×77	
Cylinder no.	3		
Piston displacement (L)	0.993	1.048	
Fire order (from the free end)	1-2-3		
Compression ratio	21.5		
Rated power (kW)	25	18.7/20.6	19.5/23
Rated speed(r/min) (15 minutes power)	5000	3000/3600	3000/3600
Max torque/speed (N.m/r/min)	54/≤3200	56/≤3000	62.5/≤3000
Min fuel consumption at max throttle (g/kW.h)	312	300	300
Max steady speed at zero-load(r/min)	5800±150		
Idle speed(r/min)	900±50		
Lube oil/fuel consumption ratio at full speed and full load	≤0.8%		
Exhaust smoke FSU	4.4		
Rotation direction (in the face of flywheel)	Counterclockwise		
Starting system	12V DC electric start		
Lubricating system	Pressure and splash		
Overall dimension (L×W×H) mm	594×451×623		
Net weight (kg)	≤110	≤110	≤110

9.9 Engine oil pressure is abnormal

The cause of the fault	Elimination method
1. The engine oil lack of pressure or the pressure is too low	
(1) The engine oil in the oil sump is not enough	(1) Refill the engine oil up to the specified level
(2) The engine oil becomes thin	(2) Choose the specified fuel type
(3) The oil pipe is broken, pipe connector is loosened, and there is oil leakage in the oil pipe	(3) Replace or tighten it
(4) The gap of the engine oil pump is too large	(4) Replace it
(5) The plunger of pressure-limited valve isn't quick and the spring is broken or distorted	(5) Replace it
(6) The drive pin of engine oil pump is broken	(6) Replace it
(7) The fit clearance between the main bearing and connecting rod is too large	(7) Check, adjust or replace
(8) The plug of the oil pipe is loosened	(8) Check the plug
(9) The engine oil air filter is clogged by the dirt.	(9) Check and clean air filter
(10)The engine oil filter is too dirty	(10) Clean or replace the element
(11)	(11) Check and replace
(12) The engine oil manomenter is broken	(12) Replace
2. The engine oil pressure is over high	
(1) The adjustment of the pressure-limited valve is not right, and the engine oil can't return	(1) Check and adjust
(2) The air temperature is over low, and the oil viscosity is too large	(2) Use the specified fuel type, its viscosity will fall automatically after warming up
(3) The lubrication at the camshaft neck is not good	(3) Eliminate the dirt that restricts the engine oil, and clean the oil passage of the cylinder head.

9.8 The engine temperature is over high

The cause of the fault	Elimination method
1. The water temperature of exhausted is over high	
(1) The water in the reservoir is not enough	(1) Add water, and eliminate the air
(2) The dirt clings to the surface of the radiator pieces and copper pipes	(2) Clean the dirt with the compressed air
(3) The scale deposit in the cooling system is too thick to cool the system down	(3) Clean the scale deposit.
(4) There is water leakage in the pump or the shaft of pump is broken, the impeller can't rotate	(4) Disassemble, check and repair
(5) The fan belt is broken or too loosened	(5) Replace the belt or adjust the belt tension
(6) The cooling water line pipe or engine cooler is clogged	(6) Clean the water line
(7) The thermoregulator is damaged	(7) Replace it
(8) The diesel runs under over load	(8) Reduce the load
2. The engine oil temperature is over high	
(1)The engine oil is insufficient or excessive	(1) Add the engine oil as specified
(2) The engine cooler is clogged by dirt	(2) Clean it
(3) The quality of the engine oil is bad	(3) Replace the engine oil as specified
(4) The amount of air flee is excessive in crankcase	(4) Check the air flee for the piston ring
(5) The cooling water temperature is over high	(5)Reduce the temperature as described above
(6) The diesel runs under over load	(6) Reduce the load
(7)The engine oil temperature meter doen't work	(7) Replace it

2.2 Specifications and Data of Key Parts

Item		Specifications and Data
Fuel injection pump	Type	VE distributor pump
	Model	VE3/9F2500LND
	Plunger diameter	9mm
	Governor	Mechanical full length
Fuel injector	Model	S series; (P series) thread coupling
	Nozzle type	Dual function throttling pintle nozzle
	Fuel delivery pressure	13.5~14.5Mpa
Lube oil pump	Working speed	2500r/min
	Working pressure	249Kpa
	Flow volume	Above 20L/min
Cooling water pump	Type	Centrifugal
	Speed	5000r/min
	Flow volume	55L/min
Lube oil filter		Screw-in type

Item		Specifications and Data
Generator	Type	Silicon rectifying, parallel excitation
	Voltage	14V
	Rated current	40A (45A in cold area)
Starter motor	Type	DC motor
	Voltage	12V
	Power	1.4kW
Glow plug	Working voltage	11V
	Working seconds	7-8 seconds
	Working temperature	Above 750℃
Thermoregulator		Paraffin type
Diesel oil filter		Paper element (with fuel/water separator and portable pump)

2.3 Main Adjusting Data Table

Item / Specification		Normal adjusting data value	Limit value
Non-compression space height inside the cylinder		0.7-1.0mm	
Fuel delivery timing		When the piston is at the upper dead point, the stroke of fuel pump plunger is: 0.97±0.03mm or 0.89±0.03mm	
Fuel spraying pressure (two bundle)		13.5-14Mpa(green) and 14.1-14.5Mpa(pink)	
Valve close and open phase	Intake valve	Open at BTDC16° ±10°; close at ABDC 40° ±10°	
	Exhaust valve	Open at BBDC52° ±10°; close at ATDC 14° ±10°	
Valve clearance (cold state)		Intake 0.25±0.05mm; exhaust 0.3±0.05mm	
Valve (intake&exhaust) joint ring width		1.2-1.6mm	
Valve sunk volume		0.7-1mm	
Belt tension		Press the belt down 6-7mm with 10kg pressure (New belt: press down 5-6mm)	
Lube oil pressure		0.4-0.6Mpa, idle speed≥0.15Mpa	
Lube oil temperature		60℃~110℃	
Drained water temperature		≤95℃	
Exhaust temperature		≤750℃	

9.5 The running is not stable

1.There is some air in the fuel system	1. Check the air leakage and remedy the fault then eliminate the air in the fuel system
2.The speed-regulating slide cushion lost its flexility	2. Send the oil pump to the service station
3.The speed-regulating level is worn or not flexible	3. Send the oil pump to the service station
4.The fuel distributed to each cylinder is not even	4. Send the oil pump to the service station
5.One of the nozzles is bad	5.Check and replace the bad nozzle

9.6 Stopping the engine suddenly

The cause of the fault	Elimination method
1.The fuel in the tank is used out	1. Add fuel to the fuel tank
2.There is some air in the fuel line	2. Exliminate the air in the fuel line
3.The fuel filter is clogged	3. Clean or replace the element
4. The plunger and inner oil ring is snapped	4. Send the oil pump to the service station
5. The plunger spring is broken	5. Send the oil pump to the service station
6. The solenoid plug of fuel pump is not electrified	6. Check the circuit
7. The denticulate belt is broken	7. Replace and test
8. The crankcase can't crank	8. Replace and test
a) The piston sticks to the cylinder	a) Send it to the service station
b) The oil pressure is too low and the lube oil is not enough to cause the crankshaft sticking to cylinder.	b) Send it to the service station and check the lubricating system.

9.7 The engine can't stop when the solenoid is cut off

The cause of the fault	Elimination method
1. There is some fault about the solenoid	1. Replace the solenoid and clean the element
2. The seal surface of the solenoid loses its seal function	2. Send the oil pump to the service station
3. The switch of the solenoid doesn't work	3. Replace or repair

9.3 Fuel consumption is too large

The cause of the fault	Elimination method
(1) Fuel leakage	(1) replace or tighten securely
(2) idle speed is too high	(2) regulate idle speed
(3) the max rotation speed is too high at the no load	(3) check the max speed set bolt of the injector pump
(4) injection timing is abnormal	(4) regulate the injecting timing
(5) injector or nozzle assembly doesn't work normally	(5) Clean, regulate

9.4 The power is not enough

The cause of the fault	Elimination method
(1)The air cleaner is too dirty and the fuel is restricted	(1) Clean and replace
(2) The throttle doesn't work normally	(2) Regulate the throttle
(3) Fuel pipe is clogged,	(3) Check and clean
(4) There is leakage or there is some air in the fuel system	(4) Tighten it again, eliminate the air in the system
(5) The speed-regulation spring is slack	(5) Regulate the max speed limited screw
(6)The timing of the supplying fuel is not correct.	(6) Regulate it as specified
(7) There are some faults in the injector	(7) Check the pressure of oil injection and atomization condition
(8)The air cleaner is too dirty	(8) Clean and replace the element
(9) Mix air phase or valve clearance isn't correct	(9) Check and regulate it
(10) The compression pressure of the cylinder is not enough	
① There is air leakage at the valve	① Abrade the surface or replace the valve and valve base ring
② There is air leakage at the cylinder cushion	② Replace the cylinder cushion
③ The cylinder, piston ring or piston is worn out	③ Replace the relative parts and abrade the cylinder surface
④ There is air leakage when install the injector	④ Replace the seal gasket or adiabatic line of the nozzle
⑤ The bolt of the cylinder is loosened	⑤ Tighten the bolt again as required

2.4 Tightening Torque of Main Bolts and Nuts

	Thread specification	Tightening torque (Nm)	Bolt qty.
Cylinder head bolt	M12×1.25	90+10	8
Camshaft bearing bolt	M8	16±1	8
Main bearing bolt*)	M10×1.25	60±5	8
Oil sump bolt	M6	5.5±1.5	20
Connecting rod bolt	M9×1.0	47±5	6
Flywheel bolt	M10×1.25	55±5	6
Thread of fuel injector body	M20×1.25	60±10	3
Glow plug thread	M10×1.25	12±2	3
Other bolts and nuts			
	M6	7.5±1.5	
	M8	18.5±3.5	
	M10×1.25	37.5±7.5	
	M12×1.25	60±10	

Note: *Turbocharger-type: main bearing bolt M12×1.25;
tightening torque 85±5N.m.

2.5 Operation Control Device

The operation control device connected to warm-up unit, electric starter and fuel pump solenoid valve respectively.

The electric wiring of the control device is as below figure 2-1.

The electric wiring of the starting motor is as below figure2-2.

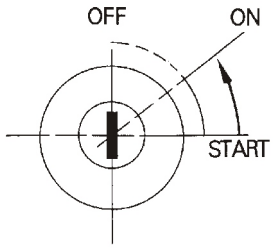
Recommended voltage is DC 12V.

Recommended current is less than 90A.

The electric wiring of the glow plug is as below figure 2-3.

The resistance of the glow plug is 0.4~0.6Ohm.

The function and operation of the electric starting switch is as below.



The operation procedure
Of the switch is:
OFF→ON→START→ON

Rotary 3-position switch

The key can be pulled out when the switch is on OFF position. Meanwhile, the current is cut off at this position.

When the switch is on ON position:

(1) the warm-up indicating lamp of glow plug will keep light for 7~8 seconds, and then goes out automatically.

(2) The solenoid of fuel injection pump is acted.

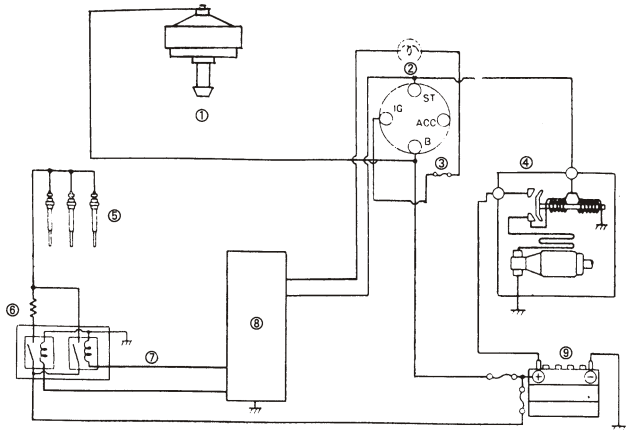
When the switch is on START position, release the key and let it automatically return back to ON position. The solenoid of fuel injection pump is acted, however the glow plug is still unconnected.

9.2 The exhaust gas is excessive and its color is abnormal.

The cause of the fault	Elimination method
1. The smoke exhausted is too thick	
(1) the injecting timing is improper	(1) Adjust the injecting timing
(2) the fuel filter is restricted	(2) Replace the fuel filter
(3) the assembly in injector nozzle doesn't work normally.	(3) clean, repair
2.the exhaust gas is black smoke	
(1) Fuel injector is clogged by the carbon cumulated and the needle valve is blocked up	(1) Check, repair or replace
(2) The load is too large	(2) Reduce the load to the specified range
(3) Fuel injection is too late, part of fuel is burnt in the exhausting course	a) Replace the cable or tight connection
(4) The clearance is not accurate and it's seal is not effective.	(4) Check the valve clearance and seal surface of valve
(5) The distribution of the fuel to each cylinder isn't even	(5) Regulate the fuel distribution of each cylinder
(6) The inlet pipe and air cleaner is clogged, so the air is restricted	(6) Remove the air cleaner and clean it
3. the exhaust gas is white smoke	
(1) Injection pressure is too low, atomization isn't good, and there is oil leakage	(1) Check, regulate, repair or replace the nozzle assembly
(2) The temperature of the cooling water is too low	(2) Increase the temperature of cooling water
(3) The cylinder is penetrated by water	(3) Check the cylinder head shim
4. The exhaust gas is blue smoke	
(1) The piston ring is worn excessively or engine oil enters into the combustion chamber in cause of the spring of the carbon clogged is not enough.	(1) Clean or replace the piston ring
(2) The engine oil level is too high	(2) Drain out the excessive engine oil
(3) The installation of the air ring is converse in up and down direction	(3) Make the surface marked with "T" toward up
(4) Valve seal is damaged	(4) Replace the valve seal

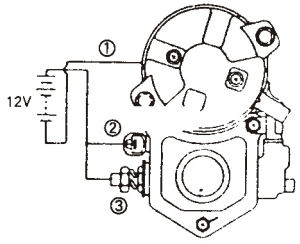
9. THE ENGINE FAULT AND THE ELIMINATION METHOD

The cause of the fault	Elimination method
1. Starting speed is low.	
(1) Battery electric amount isn't enough or the connection is loosened.	(1) Charge the battery; tighten the connection and repair the terminal if necessary.
(2)The contact of between the carbon brush and rectifier is poor.	(2) Repair or replace the carbon brush
(3)The gear of the starter engine can't be embedded into flying wheel circle	(3) Revolve the flying wheel until the small regulating gear levels with the denticulate circuit
(4) The electric battle cable is too long, too thick; voltage decrease is too large.	(4) Replace the electrical battle cable
2.the fuel system doesn't work normally.	
A. There is no fuel injected.	
(1) The fuel in the tank is used up.	(1) refuel the fuel and drain out the air
(2) There is fault in the solenoid Injection pump	
a) The cable is cut and the connection is loosened	a) Replace the cable or tight connection
b) The winding of the solenoid is damaged	b) Replace solenoid
c) The solenoid element is snapped	c) Replace solenoid
d) There is fault in the starter switch	d) Check or replace
(3)There is some air in the injector pump	(3) Drain out the air, tighten the connection of the oil pipe
(4) Fuel filter element is clogged	(4) Clean or replace fuel filter element
(5) The plunger of the injection pump is broken or snapped	(5) Replace the parts of the injector pump distributor.
(6) The transmission bolt in the plane cam of the injector pump is broken	(6) Replace the transmission bolt in the plane cam of the injector pump
(7) The inner oil ring of the injector pump is snapped	(7) Replace the parts of the injector pump distributor.
B the warm-up system doesn't work normally	
(1) The grow plug relay doesn't work normally	(1) check and repair, or replace
(2) Warm-up timer doesn't work normally	(2) check and repair, or replace
C Water temperature sensor doesn't work normally	C check and repair, or replace
D Injector doesn't inject fuel or atomization quality is too bad	
(1) Nozzle is snapped	(1) Replace the nozzle assembly
(2) The atomization quality of nozzle is too bad	(2) Replace the nozzle assembly
(3) Pressure-regulating spring is broken	(3) Replace pressure-regulating spring
(4)There is oil leakage at the high-pressure oil seal	(4) Replace the fuel injector assembly.



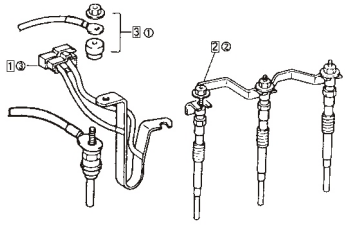
1. The solenoid of fuel injection pump
2. Warm-up indicating lamp
3. Voltmeter (10A)
4. Starter motor
5. Glow plug
6. Glow plug resistance
7. Glow plug relay
8. Warm-up timer
9. Battery

Figure 2-1 The electric wiring diagram of control device



1. Housing ground
2.Terminal 50
3. Terminal 30

Figure 2-2 Electric wiring diagram of starter motor



1.To the solenoid of fuel injection pump
2.To warm-up indicating lamp
3. To voltmeter (10A)

Figure2-3 Electric wiring of glow plug

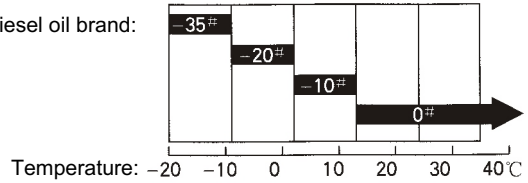
3. PREPARATION BEFORE OPERATION

3.1 Prepare the Fuel, Lubricating Oil and Cooling Water

3.1.1 Fuel

(1) To keep the engine in best working condition, be sure to use the recommended fuel: light diesel oil JIS K2204 (GB252-87)

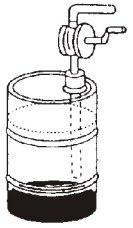
However, be sure to choose the appropriate brand for the light diesel oil according to actual ambient temperature.



(2) Fuel usage

The fuel with water or dust contaminated will cause the rough running of the engine. Be sure to use the clean container for storing the fuel, meanwhile, the container must be stored at a clean and dry place. Then suck out the upper level clean fuel with a pump as below figure.

[OPERATION NOTE]



■The improper fuel cannot make the engine achieve the best performance, and even cause the fault of the part.

■Only use the upper level clean fuel. Do not use the lower deposited fuel.

3.1.2 Lubricating oil

(1) Do use L-ECD grade oil; the quality index is 15W/30 or 15W/40.

(2) The usage of lubricating oil:

A. Carefully store and use the lubricating oil. Avoid any dust and impurity in the oil.

B. Do not mix two different type lubricating oil, otherwise the lubrication performance will be decreased.

8.3 The adjustment of the fuel injector

The test and regulation of the injector should be done on the fuel injector test bed. Its purpose is regulating the oil pressure and watching the atomization quality and eliminating the fault.

1. Pump the oil by using the hand pump unit the injection pressure is 14±0.5Mpa, check the Injection condition and atomization quality whether accords with injection requirement. If there is oil leakage or dropping in the injector, you should remove the fuel injecting assembly to clean or repair it until make injection up to requirement.

2. The adjustment of injection pump.

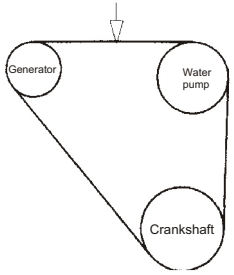
Pump the oil by using the hand pump. When the reading of the fuel injection starting pressure can't reach 13Mpa, you can remove the injection assembly by increasing the thickness of the adjustment shims to improve the injection pressure until the pressure reading is up to standard. If the reading is over 13Mpa, you should reduce the thickness of the adjustment shims.

8.4 The adjustment of the injection pump

Injection pump has been tested and adjusted before leaving from the factory. If you need to readjust it, you should perform the adjustment on the test bed according to relative regulations.

8.5 The adjustment of the V belt

As shown in the figure, make the tension check in the arrowhead direction. As to new products, put a 100N force on the it and loosen the belt until looseness degree reaches 4～5 mm. Under the normal condition, put on a 100N force until the looseness degree is 6～7mm. If you put on a 100N force but the looseness is no less than 9mm, replace the V belt.



8.2 The adjustment of the injection timing

In order to obtain the most economical fuel consumption ratio and better running performance, the injecting ahead angle should be set properly. The adjustment method of KM376QC/ KM376ZQC ahead angle should be as followed:

(1) Crank the crankshaft to make crankshaft lies on the 30 spot NO.1 cylinder (In other word, it's the injection pump bolt fan mark)

(2) Loosen the mounting nuts in the fuel injection pump and the bolts in the supporting plate of the fuel injector rear end until the fuel injection pump can revolve. Then keep the fuel injection pump toward the inner surface to the bottom.

(3) Install the lever-type micrometer calipers in the front end of the fuel injection pump, and let the pointer needle point at naught.

(4) Crank the crankcase to make NO.1 cylinder of the engine stay at upper dead center of the compression stroke.

(5) Turn the injection pump toward outside surface slowly until the reading of the meter is 0.97±0.03mm.

(6) Check the meter again. (Crank the crankcase to position 1, watch the reading of meter whether reset to naught position. Then crank the crankcase until it reaches the upper dead center, check the meter reading whether is 0.97± 0.03mm. If the reading is right, the adjustment is completed. If the reading isn't right, repeat the above adjusting steps.)

(7) Tighten loosened nuts and bolts above mentioned.

[OPERATION NOTE]

Using the improper type lubricating oil will burn out the inner part of the engine, even cause the engine to wear rapidly. And the service life of the engine will be also shortened.

3.1.3 Cooling water

Be sure to adopt tap water as cooling water.

[OPERATION NOTE]

■Be sure to add anti-rusting or anti-freeze solution to the cooling water.

■ Add anti-freezing solution to the cooling water in winter, otherwise, the frozen water may damage the cooling water system.

A. Anti-rusting solution:

Be sure to use the superior quality anti-rusting solution. But do not use it in winter because it may freeze when the air temperature is low. Its standard mixing ratio is 6%.

B. Anti-freezing solution:

Be sure to use the superior quality anti-freezing solution. However, it's not necessary to use it with anti-rusting solution simultaneously. This kind of solution can be added to cooling water in all seasons. Its mixing ratio is 30%~55%.

[OPERATION NOTE]

■ If the mixing ratio of anti-freezing solution is too low, cooling water will freeze in low temperature, which causes damage or rust to the water pipe.

■ If the mixing ratio of it is too high, the engine performance will be decreased.

The lowest temp℃	-15°	-20°	-24°	-29°
Mixing ratio %	30	35	40	45

Use the commercial available anti-freezing solution with the mixing ratio recommended by manufacturer, meanwhile, it must be replaced every year.

3.2 Preparation before starting

3.2.1 Add the lubricating oil

(1) The amount of the lubricating oil added should flush with height of the lubricating oil level in the oil sump. Put the engine on a level surface at first, then check the oil level.

(2) The lubricating oil level in the oil sump should between the lower and upper marked line of the oil stick.

[OPERATION NOTE]

■ The lubricating oil level in the oil sump should between the lower and upper marked line of the oil stick. If the lubricating oil is not enough, it will damage the engine easily. However, if excessive, the lubricating oil will spill over from the air opening hole.

3.2.2 Refill the fuel tank

(1) Add the fuel to the fuel tank.

Add the fuel without containing dirt and water. To prevent the fuel from overfilling during the running course, the amount of the refilled fuel should be 90% of the fuel tank capacity.

⚠ DANGER

Make certain whether the type of the fuel refilled is right or not. If improper fuel is added, it will cause the fire. If the fuel is overfilled, wipe it up at once.

(2) Eliminate the air in the fuel system

When refill the fuel at first time or refuel the tank normally as required, you should eliminate the air in the fuel line which begins from the fuel tank, though water-oil separator or fuel filter or primary oil delivery pump, to the fuel injection pump.

If the air mixes with the fuel in the fuel line, the fuel injection pump won't provide the high-pressure fuel for the fuel injector, and the engine can't start also.

This product adopts the VE distributor pump, and the lubricating and cooling of the VE distributor pump relies on the fuel. So if the fuel is cut off, it will result in damage of VE distributor pump.

8. THE ADJUSTMENT OF THE TECHNICAL DATA

KM376 series engines are different from the general-use diesels in the structure. In order to ensure maintenance quality, please read this additional section carefully.

8.1 The adjustment of valve clearance

The valve clearance refers to the cam surface the clearance of inlet valve should be 0.25 mm in cold condition, and that of the exhaust valve should be 0.30 mm. In hot condition, the clearance of inlet valve should be 0.30 mm, and that of the exhaust valve should be 0.35mm. If the clearance is improper, make it reach to the standard by adjusting the shim thickness.

8.1.1 The measurement of the clearance

Measure the clearance using the ruler as shown in the figure 8-1

(1) Measure the clearance in cold condition.

(2) The rabbet in the cam should be toward up.

8.1.2 The selection of the adjusting shim clearance

$T_2 = T_1 + (A'-A)$

T_2: the thickness of the shim replaced

T_1: the thickness of the shim measured

A': the metrical value A: the standard value

8.1.3 The replacement of the adjusting shim

Press the valve tappet down using the special tools, and get out the shim used for the measurement, then replace the shims that need to install to primary position.

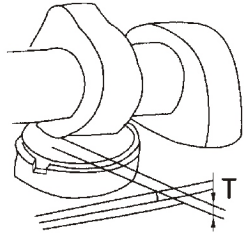


Fig. 8-1 Check the valve clearance

(7) Check the air cleaner

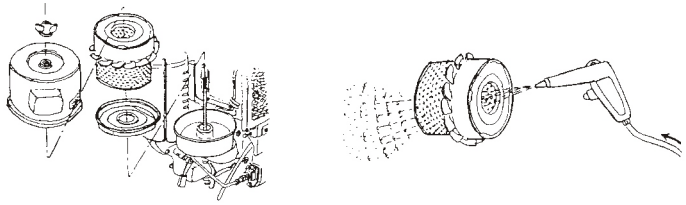
If the dust is drawn into the air cleaner and clings to air cleaner parts, it will affect the output of the engine sooner or later. When the combustion chamber draws the dust in, it will accelerate the worn of the moving parts and cause the engine not to run normally. When you run the engine in the dusty place, the service interval should be shortened as possible as you can, paper air cleaner element.

Loosen the wing nuts in center of air cleaner, remove the air cleaner cap, then get out the paper element inside the air cleaner.

Blow and clean the inner surface of the parts using the compressured air (below 0.2 Mpa). Clean the dirt and dust clinging to the surface.

If the elements are dirty or broken always, replace them with new elements.

Reinstall the paper element after cleaning the dirt and dust clinging to the air cleaner and chassis.



7.3 The technical maintenance after the engine works 1000 hours

Repeat those items as technical maintenance after working 500 hours , then perform the following maintenance items:

1. Check the tightness degree of the bolt in the connecting rod and main bearing.

2. Check the seal of the inlet and exhaust valve. If necessary, machining the surface of the valve seat over again.

3. Check the starter motor and generator. If necessary, add the lubricating oil, and run the engine at idle speed after reinstalling it. Add grease to the bearing before putting the engine to use.

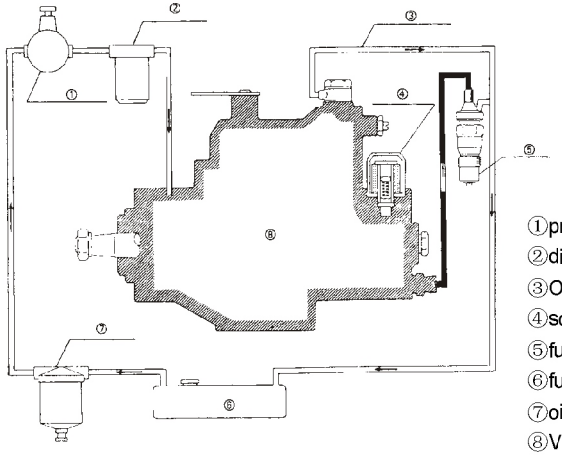
4. Check each part of the diesel engine.

5. Reinstall the parts removed in the maintenance course to primary position, eliminating the potential fault.

The fuel line of the engine fuel system is as shown in figure 3.2.2 followed:

To eliminate the air in the low-pressure fuel line, loosen the connector of the intake pipe in the VE dispensing pump at first, then expel the air from the fuel.

Inspect the connector of the VE pump return pipe. If there is a lot of fuel overflowed and no air bubble occur, It indicates that there is no air in the low-pressure fuel line.



①primary oil delivery pump
②diesel fuel filter
③Oil return tube
④solenoid valve
⑤fuel injector
⑥fuel tank
⑦oil-water separator
⑧VE distributor pump

3.2.3 Eliminate the air in the high-pressure fuel line.

The high-pressure fuel line begins from VE dispensing pump, through high-pressure fuel pipe, to the fuel Injector.

Method of the treatment: loosen the connector where the high-pressure fuel pipe connects with fuel injector, then start the starter motor and let it run at low speed until the fuel overflows around the connector, finally tighten it. If there is still some air in the high-pressure fuel-pipe, the engine won't start.

3.2.4 Add the cooling water.

(1) The water in the radiator water tank should be sufficient. Expel the air from the water line when adding the water. At the same time, check the water tank and connector of pipes for leakage, and remedy if in time.

(2) After adding water, tighten the radiator water tank cap. Otherwise it will cause scald for the hot water.

(3) If there is some air in the water line, it will cause the restriction of cooling water, even engine damage because of the excessive high temperature in the engine.

3.2.5 Check the all operation control systems, and the operation reliability of each connection. Remedy the fault as soon as find it.

3.2.6 Check the connection of the bolt mounted to ground and the driven machinery. If loosened, tighten it securely at once.

3.2.7 Before connecting the battery, make sure that the connection of the negative lapping iron and the electrical diagram is right and electric capacity of the battery is sufficient.

(6) Check the battery electrolyte

When check the electric circuit, you must close the battery switch, disconnect the ground terminal. If there is a shortcut in the circuit, it may result in fire.

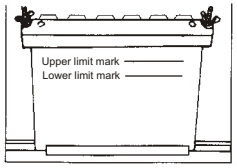
Please recharge the battery in a good ventilated place. Keep all fire sources away, because the hydrogen produced in the battery causes fire easily.

The electrolyte contains a mount of sulfuric acid. It could cause burnt injury even blind, if the eyes and skin contact with it.

Please wear the glasses and rubber gloves when you handle the battery electrolyte.

If you touch the electrolyte without precaution, use a large quantity of water to wash it and see the physician as soon as you can.

Check the electrolyte level every month. If the level is lower than the lower limit mark, refill the distilled water to the upper limit mark.



[OPERATION NOTICE]

1) If you continue to use the battery when the electrolyte is not enough, you will cause the damage of the battery. Periodically check the electrolyte capacity. If the electrolyte level is below the standard specified, please refill the electrolyte in time.

In hot summer, the electrolyte tends to be vaporized. So check it ahead of the specified time.

2) If the engine can't start using the accelerating return, use the gravity meter to measure the density. When charged fully, the density should be above the 1.27 g/ml(20 hours).

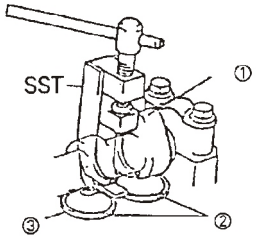
If the density is below to 1.24 g/ml, it indicates that the battery needs to be charged.

If the density doesn't increase after charging, please replace the battery.

(4) Check and adjust the valve clearance

Check the valve clearance every 100 running hours

method: check valve clearance by removing the cylinder head according to the method described in figure 8-1 of section 8.1. If you want replace the adjusting shim, use the professional tools for the engine. Then get out the shims according to figure 7-5, and replace the shims you need to install.



① Max. height
② Nice
③ Tappet

Fig. 7-5

(5) Check the tightness of the bolt in the cylinder

Check the tightness of the bolt in the cylinder by using the torque wrench every 100 hours. Check the bolts in sequence as described in figure 7-6. The tightening torque should be 90^{+10}N.m.

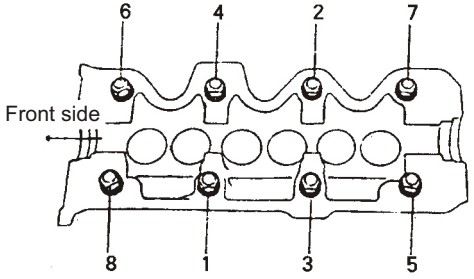


Fig. 7-6

4. OPERATION INSTRUCTION

⚠ WARNING

■Provide the engine with good ventilation condition for its running.
When running the engine, your hands, body, clothes shouldn't close to or contact with such moving parts as radiator fan, belt, drive shaft and so on. When check and service the engine near these parts, be sure that the engine is stopped. Before running it, make sure that there isn't anything left on these moving parts.

■When the engine is running or stopped not for a long time, your hands, body and clothes should not contact with the muffler, exhaust pipe and radiator.

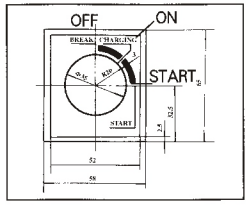
4.1 Starting

4.1.1 Start the engine under no load.

When starting the engine on the vehicle, let the vehicle to stop before.

4.1.2 Set the throttle lever at the **half-open** position when you start the engine.

4.1.3 Insert the key to the engine switch hole, then turn it to the ON position clockwise. At this time, the grow plug indicator lamp is on. After it last about 7 seconds, it goes out soon. The next step, turn the key to the START position clockwise, let the starter motor to start the engine. Finally, release the key, and it will return to ON position automatically. This is completing the engine start.



[OPERATING NOTICE]

Don't use the start switch over 15 seconds each time. If you can't start the engine, wait for 1 minute, then restart the engine. Otherwise, the long-time running with electricity overheats the engine to cause fault.

[OPERATING NOTICE]

When put the key at the ON position, 12V DC voltage will open the solenoid valve in the VE pump. If the electrical bottle voltage is lower than 8V or the cable isn't connected as required, the solenoid valve won't be opened and the engine won't start, even sudden stop will happen.

[OPERATING NOTICE]

■After starting, the starter switch key shouldn't be pulled out, but placed at ON position. If placed at the OFF position, the battery won't be charged.

[OPERATING NOTICE]

■After starting, the handling lever should be put at idle or middle-low speed position for running several minutes. Then check the all meters whether are normal or not，whether there is abnormal sound of engine. If either of them is abnormal, stop the engine to check and remedy it right away.

4.1.4 When the ambient temperature is below 5° C, it may be difficult to start the engine. Warm up the intake gas, fuel, cooling water, lube oil or use some solvent to make engine start easy.

4.2 Running

4.2.1 After starting the engine, keep it at idle state about 5 minutes then change it into medium-speed, small-load running state. Increase the load and rotary speed gradually along with the temperature of the cooling water and engine oil becoming higher and higher.

[OPERATING NOTICE]

■After starting the engine, shouldn't increase the rotary speed to high speed or run the engine under the large load suddenly. Otherwise, it will cause the damage of them even shorten the parts' service lives.

(3) Check the injecting pressure and the atomization quality of the fuel Injector

Check the injecting pressure and the atomization quality of the fuel Injector every 100 hours. (Refer to the figure 7-3)

If you find there is oil leakage, atomization quality is bad and needle valve of the nozzle is blocked, please remove and clean the injector or replace the injecting nozzle.

If you find the oil pressure isn't up to specified value, you can adjust the pressure regulating spring by adding the steel shims. Refer to figure 7-4 for the structure of the fuel injector.

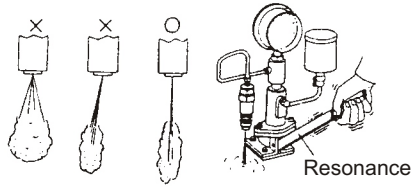
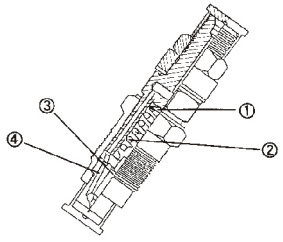


Fig. 7-3

[OPERATION NOTICE]

Fuel nozzle is a couple of exact assembly, don't replace the any of the parts solely when clean them. Don't damage the surface of the injector lower body, two terminal surfaces of the middle gasket, and main surface of the nozzle. Otherwise, oil leakage will occur, affecting the quality of atomization.



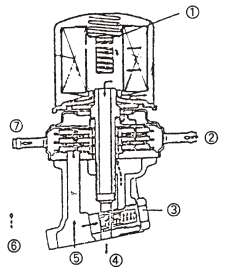
① Regulation shim of injection pressure
② Pressure-regulation spring
③ Needle valve
④ Needle valve body

Fig. 7-4

(1) Replace the engine oil, and clean the lubricating oil filter element

Replace the engine oil every 100 hours.

Clean or replace the lubricating oil filter element. (Refer to figure 7-1)



① bypass valve
② cooling water
③ bypass valve
④ To main oil passage
⑤ The oil pump troops
⑥ bypass passage
⑦ to the pump

Fig. 7-1

(2) Clean and replace the diesel oil filter element

Clean the diesel oil filter element every 100 hours and drain out the water in the sedimentation cup (refer to figure 7-2). If you find the element is broken or can't be clean, please replace it at once.

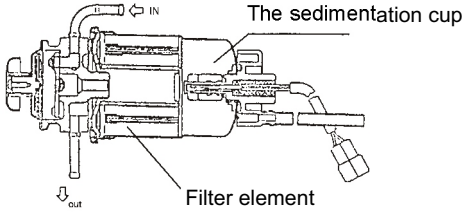


Fig. 7-2

4.2.2 When the engine is running normally, inspect the engine oil pressure and temperature, cooling water temperature and the working condition of the charging indicator frequently

Be careful to observe the color of exhaust gas and listen to the working sound during the operation.

4.2.3 In the normal run course, shouldn't increase or decrease the rotary speed and load suddenly.

⚠ WARNING

If you find one of the phenomena that the engine oil pressure is over low and the temperature of cooling water is over high (It's over the specified range in the chart 2.4); dense smoke exhausting from the engine; and there is knock sound in the normal run course, stop the engine as soon as possible and check the reason of these symptoms. Otherwise, the fault will lead to damage of the engine.

4.2.4 Provide the adequate heat preservation measure for running the engine in the winter to prevent the temperature of the cooling water and engine oil is over low. However, Provide the adequate cooling measure for running the engine in the summer to prevent the temperature of the cooled water and engine oil is over high.

⚠ WARNING

Never keep the engine running under overload for long time. Otherwise it will result in fault and shortening the service life.

4.3 Check engine during the running

Make sure there is no abnormal case during the running referring to following items.

1. Whether the color of the exhaust gas is normal or not.

If the engine exhausts black smoke continuously, stop to check it at once. If ignore this symptom, it leads to engine run in a bad condition.

It will shorten the service life of the engine under the overload.

2. The abnormal working sound during the running

If there is abnormal working sound during the running, stop the engine right away. If you continue to run the engine, it will result in serious damage accidents.

Check all the bolts and nuts if loosened or not. Find out the reason of the fault and eliminate the trouble.

3. Avoid running the engine in the resonance range

Due to the intrinsic structure factor, the working machinery may resonate this product in certain rotary speed range. It will make the vibration of the engine become very incredible. So avoid running the engine near this rotary speed. If continue to run the engine at this case, it will result in serious damage accidents.

4. A. Add the cooling water to the cooling water tank

Inspect the cooling water whether is enough or not during the running. And supply the cooling water to the water tank in time.

B. Check the amount of the cooling water at the export hole whether reduced or not.

If the exported cooling water decreases, stop to check the engine.

C. Check the cooled water whether injected or leaked?

If there is an abnormal case, stop to check the engine right away.

If continue to run the engine lacking of the cooled water, it will cause the engine over hot to burn out the inside parts.

5. Check the oil pressure lamp whether is on and the oil pressure sign is red

If the oil pressure sign is red, stop to check the engine.

If continue to run the engine at the no-oil state it will result in burning out the inside parts.

6. Check the charging indication lamp is on.

If the charging indication lamp is on, it indicates that you can't charge the battery.

7. If there is burn or funk or smoke, please add the lubricating oil in time. You must stop the engine when add the lubricating oil. If there is an abnormal case, but you can't determine the reason, stop the engine and send to the dealer's shop to

System	Check and Service items	Periodically check interval			Remark
		Per100 hrs	Per200 hrs	Per300 hrs	
Lubricating	Replace engine oil in the sump	○			
	Clean or replace cleaner element	○			
Fuel	Check the **initial pressure** of the fuel injector		○		Send the VE pump to service station for checking
	Check atomization quality		○		
	Clean or replace fuel cleaner element	○			
	Check the VE pump			○	
Cooling Water	Replace the cooling water		○		If the antifreeze is added to water, check the antifreeze if sufficient.
	Clean the thermoregulator		○		
	Check the tension of fan bolt		○		
Air inlet pipe & Air cleaner	Clean the air cleaner element				
	Clean dust from the inlet pipe		○		
Inlet and exhaust air	Check the clearance of the exhaust and inlet valve				
	Check the phase of gas mixed			○	
Bolts and cylinder cap	Check the tightness of the bolt In the cylinder	○			
Electric Starter	Check the battery voltage and density of the electrolyte	○			
	Check the connection condition of every contact spot.		○		
Turbo-charger	Clean the dirt on the surface of air compressor	○			It's an additional item for the KM376ZQC
	Clean the dirt from impeller and engine inner surface			○	
	Check the inner rotator		○		

Note: "○" Indicates that it's a necessary item or content

7. THE METHOD OF THE MAINTENANCE AND SERVICE

In order to make the engine work normally and reliably, proper technical maintenance should be given to the diesel engine. And the technical maintenance includes following kinds: the daily technical maintenance, the periodical maintenance and the maintenance after working 1000 hours.

7.1 Daily technical maintenance

(1) Check the lubricating oil level in the oil sump whether is between the upper mark line and lower mark line of the oil dipstick and near the upper mark line. If it is a new engine or an old engine stored for a long time, add the lubricating oil up to the upper mark line and run it at low speed for 5～10 minutes before stopping it. Then measure the height of the oil level with the oil dipstick.

(2) Check the water amount in the radiator.

(3) Check the reliability and degree of tightness of cables connection.

(4) Check the leakage of water, oil, and gas.

(5) Check the degree of tightness of the supporting connection or other driven machinery.

(6) Keep the engine clean. Clean the oil and dust using dry rags or rags with detergent. Keep the electric appliance connected to the engine dry and clean especialy.

(7) Eliminate the fault and abnormal symptoms that have been found.

7.2 Periodically check and service

In order to keep the engine at good running state, the daily check is necessary.

The following table specifies the rules about when and how to check and repair the engine.

Check the engine usage, load, fuel used, lube oil quality and operation state when make the periodically maintenance. The following table describes the common cases about the maintenance.

[OPERATION NOTICE]

According to use condition, set down periodically maintenance schedule. Perform the rules to check the engine without missing as the schedule specified. In case of missing the necessary item, it will affect the durability of engine parts. As to the parts marked with (*) specially, the owner should have the proper tools and be mechanically proficient. Otherwise, please send your products to your dealers and consult with them.

4.4 Stop the engine

4.4.1 If the engine needs to be stopped, decrease the engine speed to the idle state gradually. Let the engine stop only when the temperature of the cooling water is below 70° C.

4.4.2 When you need to stop the engine, only turn the starter switch key to OFF position (refer to 4.1.1)

4.4.3 After you stop the engine in winter, you need to make antifreezing preparative.

5. BREAK-IN PERIOD AND TRIAL RUN

5.1 A new engine needs a break-in period and a trial-run course. And this course should not be less than 45 hours or 2800 km.

5.2 During the break-in period, don't let the engine stay at the high-speed state with the fuel valve open fully. And you should increase the engine load slowly, at the same time inspect the engine's running data measured by the all kinds of meters.

[OPERATION NOTICE]

To make your engine run reliably and use for a long time, provide a new engine with a break-in period.
During the break-in period, you should inspect all kinds of meters whether work normally. After the break-in period, please replace the engine oil in the oil sump.

5.3 After break-in and trial-run course, replace the engine oil in the oil sump.

Clean the engine oil filter and fuel filter. Check the tightening torques of the cylinder head bolt and the others connecting bolts. These torques should meet the requirement as specified.

6. THE STORAGE FOR A LONG TIME

[OPERATION NOTICE]

If you don't drain out the cooling reserved in the engine, it will be frozen, which will damage the parts.
In order to reuse the engine normally, the following measurements should be carried out when you store the engine for a long time.

(1) When stored for a long time in winter, the water in the engine should be drained out. (If antifreeze is used, the water needn't be drained out). Drain out the water by opening the draining water valve in the engine lower body. At the same time, open the radiator cap to drain the water.

(2) Clean the dirt, dust and oil clinging to engine body.

(3) Periodically check and replace the engine oil.

(4) To prevent the fuel vapor changing into moisture in the fuel tank, you can drain out the all of the fuel in the tank or refuel the fuel tank fully.

(5) Remove the negative terminal of the battery at the ground cable. In order to makeup the wastage that caused by discharging of battery itself. Charge the battery every month in the storage course.

(6) Add the lubricating oil to the acceleration coils and system.

(7) Coat the muffler, air cleaner, electric parts with the plastic cover to prevent the water moisture and dust entering into those parts. The places in which the engine stores should be dry and free of dust.

[OPERATION NOTICE]

When reuse the engine after storing for a long time, make the preparations as using a new engine at first.