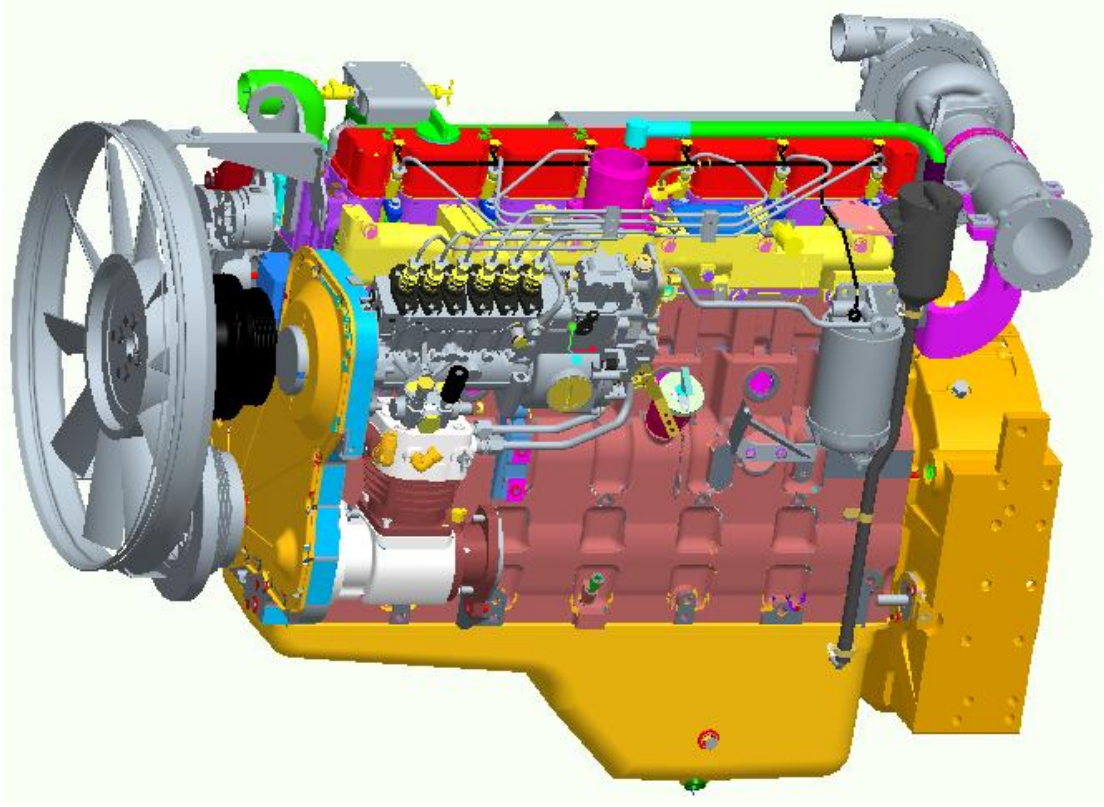
Operation and Maintenance Manual of D9 & 6CL Series Diesel Engines

Shanghai Diesel Engine Company, Ltd.



Operation and Maintenance Manual of D9 & 6CL Series Diesel Engines

Contents

1 Introduction

1.1 To User and Operator

D9 and 6CL series diesel engines, newly developed by SDEC and compliant with Stage 2 emissions regulation, are ideal powers for vehicles, construction machineries, tractors, marine propellers, generator sets and other industrial applications with maximum output power of 258 kW.

This manual covers the engine specifications, basic structure, operation, adjustment, maintenance, trouble-shooting as well as replacement, repair and adjustment of main components of D9 and 6CL series diesel engines. It is expected to be a guild-line or instruction for users.

Because of continuous change and improvement, the products contained in this manual may be different from the products you have purchased. For any questions, please call our technical center for inquiry. Please indicate your engine's model, order number and date of production during inquiry so that we can provide you with better services. This manual will be revised according to engine improvements.

Use appropriate fuel, lube oil and coolant according to the requirements of the manual.

Operate and maintain the diesel engine according to this manual´ s regulation, and keep regular maintenance records.

Any comments and suggestion are welcomed. Please send your letter at Technical Center of SDEC, zip code: 200438

1.2 Important Notices of Safety

All safety notices and warnings should be carefully read and fully understood before any periodic maintenance of an engine or repair of a broken-down engine.

The sign "▲" in this manual presents that there are potential dangers that could cause personal injury or death. However, these dangers can be prevented, if one pays more attention and adopt necessary steps. Please keep the notices of safety in mind at anytime, for it is impossible for us to predict all possible dangers.

▲Warning: The following diesel engine components are not allowed to be repaired due to personal safety issues and should be replaced if damaged:

Balancing weight
Fan assembly
Fan shaft base assembly
Fan mounting plate
Fan bolt
Fan Shaft
Flywheel
Flywheel-crank connector
Flywheel bolt
Lifting plate
Compressor housing of turbocharger
Turbine housing of turbocharger

Turbocharger oil inlet piping

Damper bolt

Connecting rod bolt

Fuel shut–off solenoid assembly

High and low pressure fuel piping

▲Be sure to operate in a safe surroundings and be ware of potential hazards at any time.

▲Be sure to wear protective glasses and shoes during operation.

▲Be sure to wear working clothes in operation and do not wear loose or broken clothes.

▲Be sure to disconnect wiring of battery before repair, or disconnect air piping if an air motor is applied to start the engine in order to prevent accidental starting, and put a sign of "Shut Down" in operation room or at controls.

▲Do not pry fan to make engine rotate. This kind of abnormal operation will cause serious personal injury or damage to fan blades.

▲Be sure to shut off and cool down the engine first, and then loosen the cover of the water–filler slowly to relieve cooling system pressure, when diesel engine is operating or coolant is hot.

▲Do not repair until the diesel engine is secured on wood blocks or a special rack. No floor jack or hook is allowed to be used for repairing the engine.

▲Please first relieve the pressure of air, lubrication and cooling systems before disassembling or loosening any pipes. Do not check leakage by hand. High–pressure fuel or lube oil will do personal injury.

▲Use hoisters or accessory equipment to move parts weighed over 20kg in order to prevent personal injury. Be sure that the chain, hook and cord are firm and the hoister's load capacity is appropriate. And the hook position should be proper too. If necessary, please use lever to assure that the hook has no side load.

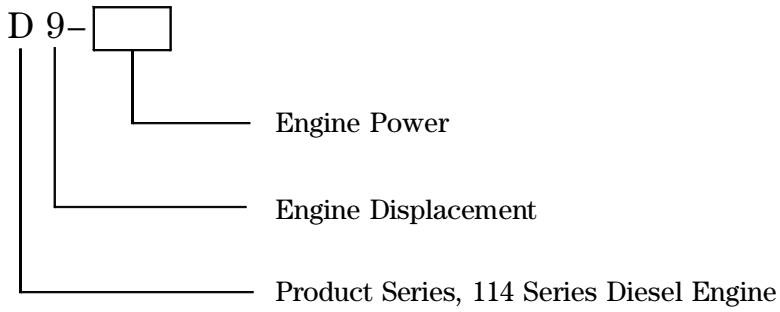
▲Do not spray antiseptic into eyes and drink it, for it consists of alkali. Please clean it with soap and water promptly in case of splashing on skin.

▲Be careful of ether, formaldehyde, ethane and butanone, for they are all inflammable. Be sure to abide by the manufacturer's regulation during operation.

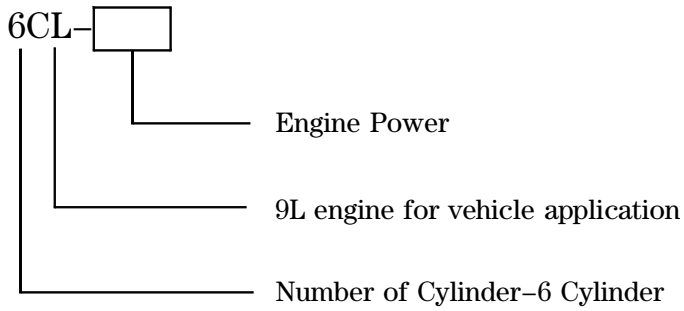
1.3 Engine Model Designation

1.3.1 Engine Series – Displacement – Rated Power

1.4 Diesel Engine Nameplate

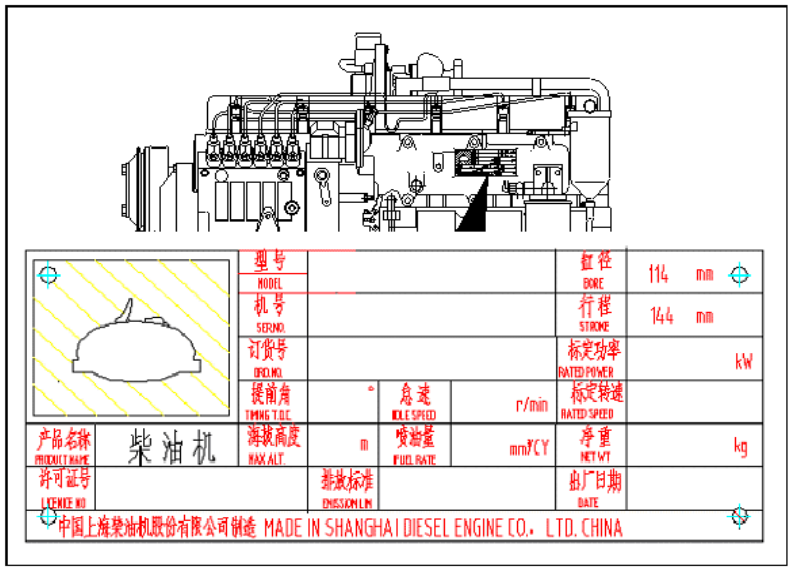


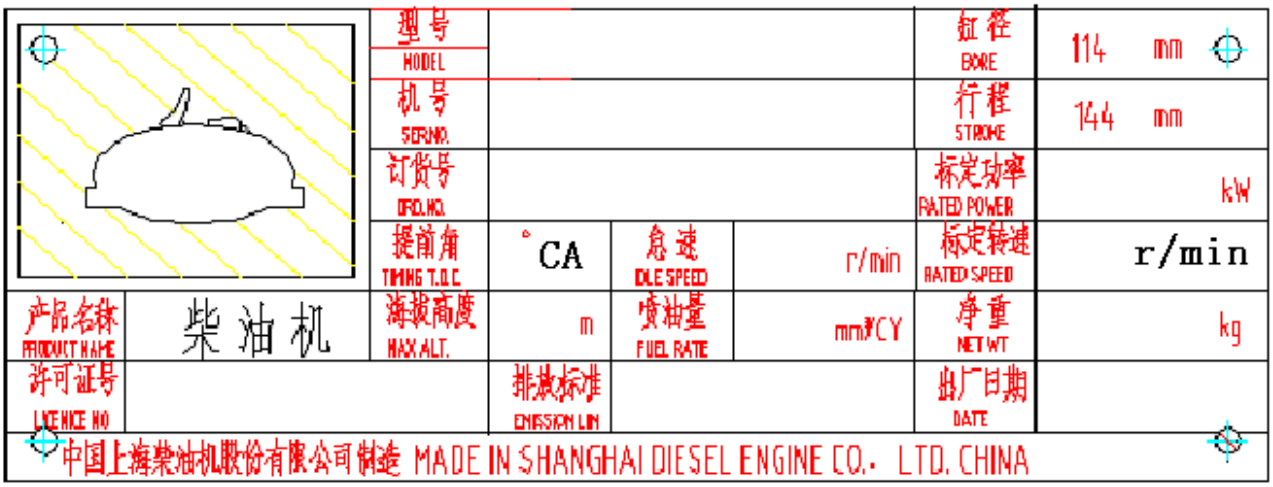
1.3.2 Number of Cylinder – Code of Vehicle Application – Rated Power



Note: A rated power is indicated by metric horsepower unit (PS) with a cardinal umber.

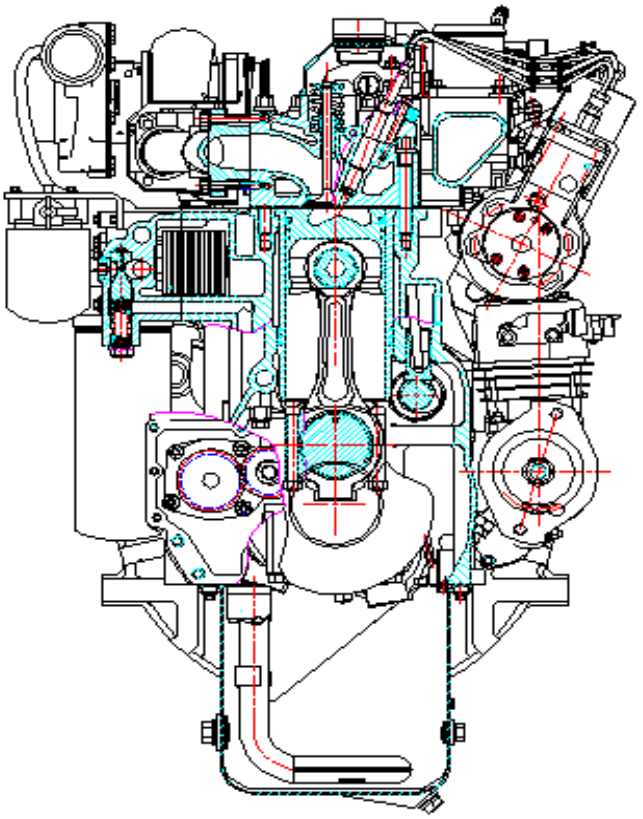
Diesel engine nameplate covers main specifications and parameter of the engine you purchased. It is important information with which users can buy spare parts and request service from our company.



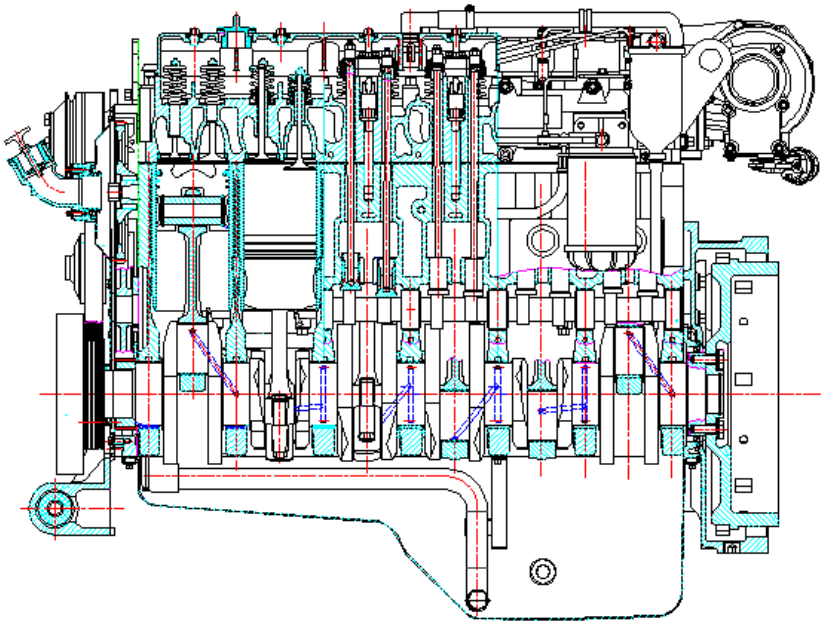


△Attention: No replacement of the engine nameplate is allowed without a written consent from our company!

1.5 Cross Section of the Engines



Cross Sections of D9 & 6CL Series Engines (Transverse)



Cross Sections of D9 & 6CL Series Engines (Longitudinal)

2 Basic Engine Technical Specifications and Parameters

2.1 Basic specifications

Model		D9	6CL
Type		4–stroke, water cooled, on–line, direct injection	
Number of cylinder		6	
Bore diameter, mm		114	
Stroke, mm		114	
Total displacement, l		8.82	
Compression ratio		18 : 1	
Rated power for vehicle application (kW) / Rated speed r/min			174~258 / 2200
1h rated power (kW) / Rated speed r/min		142~162 / 2200	162~225 / 2200
12h rated power (kW) / Rated speed r/min		129~147 / 2200	148~205 / 2200
Mean piston speed at rated engine speed, m/s		10.56	
Fire order (from engine frond end)		1–5–3–6–2–4	
Rotating direction (viewed at flywheel housing end)		Counter clockwise	
Starting mode		Electric start	
Net weight, kg		660	
Overall dimension	Length, mm	1162	
	Width, mm	706	
	Height, mm	1052	

2.2 Main Parameters

Parameter \ Engine model	D9	6CL
Valve timing: (°) Crank angle	Intake Open: 22.5 BTDC Intake Close: 34.5 ABDC Exhaust Open: 67.5 BBDC Exhaust Close: 25.5 ATDC	
Valve clearance (Engine in cold) Intake valve, mm Exhaust valve, mm	 0.3 0.5	
Advanced injection angle, (°) Crank angle (BTDC)	See engine nameplate	
Lubricating system		
Lube oil pressure, kPa At low idle (allowed minimum) At rated (allowed minimum)	 100 350	
Relieve valve pressure, kPa	505	
Opening pressure difference of oil filter bypass valve, kPa	170	
Rated mass flow of oil pump, l/min	138	
Max. oil temperature in oil pan, °C	95 ~ 122	
Oil pan capacity, L ("High"– "Low" marks on oil stick)	19 ~ 15	
Total system volume, L	≈25	
Cooling system		
Thermostat Opening temperature, °C Full opening temperature, °C Lift, mm	 76~78 90 ≥9	
Upper tank temperature, water tank Max, °C Min, °C	 95 70	
Pressure of pressing cover(for upper tank temperature of 95°C), kPa	50	
Pressure of coolant @ 2200r/min, kPa	96	

Coolant flow (thermostat full opening and engine at 2200 r/min)		≥275
Coolant Volume, L		8.2
Intake and exhaust system		
Allowed max intake resistance at rated condition (with dry type air filter), kPa		2.5
Allowed max pressure drop from air compressor outlet to intake manifold, kPa		13.6
Allowed max resistance at turbocharger outlet, kPa		10.0
Allowed max exhaust temperature，°C		750(Gas at turbine inlet)
Fuel injection system		
Max inlet resistance of fuel transfer pump, kPa		13
Max pressure of fuel transfer pump outlet, kPa		196
Max pressure drop of fuel filter, kPa		35
Piping pressure of fuel injection pump, kPa		265
Max resistance of fuel return line, kPa		70
Mechanical governor		
High and low idle speed, r/min		See engine nameplae
Stabilized speed ratio	Variable speed type	≤12%
	Max–min type	≤13%
Electrical system		
Recommended min battery capacity		
24Vsystem: *		
–18℃ cold starting current, A(spare capacity current, A) **		900(320)
0℃ cold starting current, A(spare capacity current, A) **		640(240)
Starting motor		
Voltage, V		24
Power, kW		7.5
Alternator		
Voltage, V		28
Current, A		36 or 55; or 110 or140

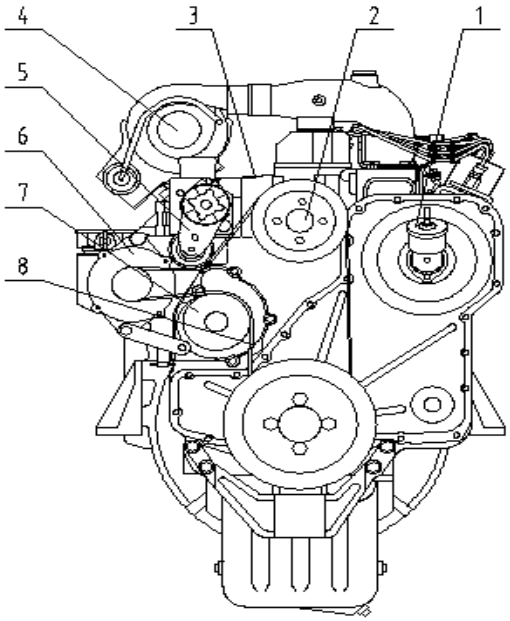
* It consists of two 12V batteries in series. Cool starting current of each battery is set at –18℃.

** With a given battery dimension, the current of spare capacity is defined by the number of electrodes, and continuous starting time is determined by the spare capacity.

3 Engine Structure

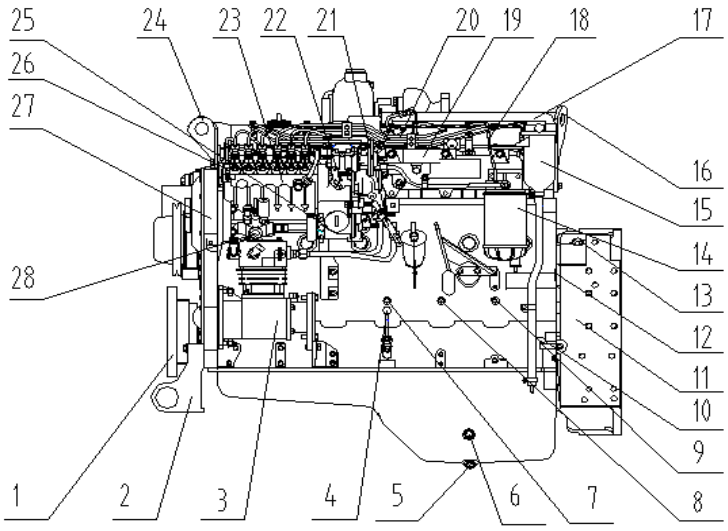
3.1 Diesel Engine Outline

Engine outlines vary according to their models. Here provides basic engine outlines of D9 and 6CL series engine for reference.



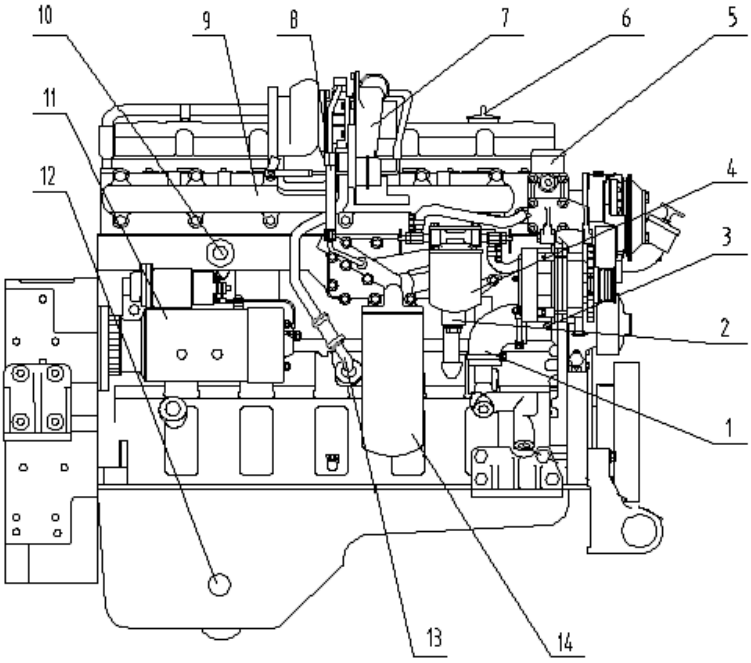
Front View

1.Oil filler cover, 2. Fen pulley, 3.Warm water taken port (Z1/2), 4.Turbo air inlet, 5.Tensioner, 6.Alternator, 7.Water pump, 8.Drive belt



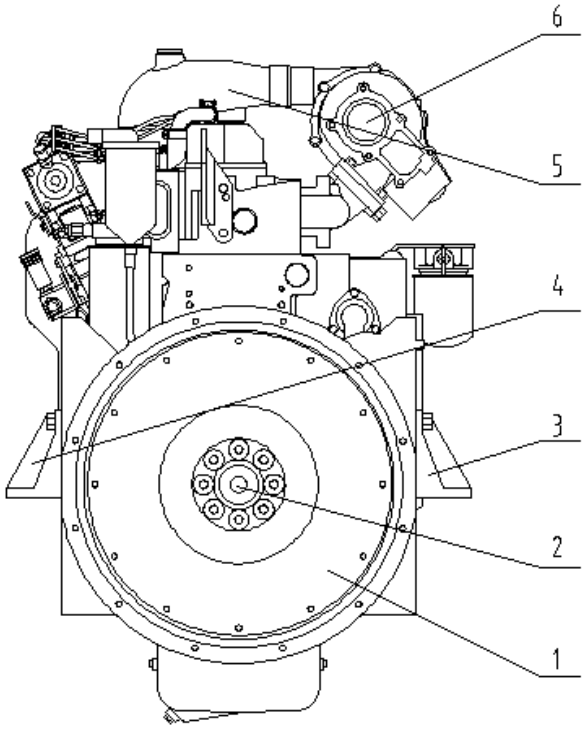
Left Side View

1.Crankshaft damper, 2.Front engine support, 3.Air compressor, 4.Oil dipstick, 5.Oil drain plug, 6.Oil temperature sensor port, 7.Oil pressure sensor port, 8.Oil pressure warning device, 9.Oil pressure sensor port, 10.Engine timing pin, 11.Fly-wheel housing, 12.Barring port, 13.Engine speed sensor port, 14.Fuel filter, 15.Oil mist precipitator, 16.Rear lifting plate, 17.Engine vent pipe, 18.Injector fuel return pipe, 19.Intake manifold, 20.High pressure fuel line, 21.Adapt of throttle level, 22.Emergent engine shutoff handle, 23.Fuel injection pump, 24.Front lifting plate, 25.Fuel injection pump timing pin, 26. Fuel pump injection drain fitting, 27.Gear housing, 28.Fuel transfer pump



Right Side view

1.Water inlet elbow pipe, 2.Oil pressure regulating valve, 3. Water temperature sensor for cold start 4.Water filter, 5.Water outlet pipe, 6.Oil filling cap, 7.Turbocharger, 8.Turbocharger oil inlet pipe, 9.Exhaust manifold 10.Coolant heater mounting hole, 11.Starting motor, 12.Electric heater mounting port (M22×1.5), 13.Turbocharger oil return pipe, 14.Oil filter



Rear View

1.Flywheel; 2.Bearing, 3.Right engine support, 4.Left engine support, 5. Compressor outlet pipe, 6.Turbine outlet port

3.2 Intake and Exhaust System

For a naturally aspirated diesel engine, air is inducted from an air filter to an intake manifold and then into the cylinder for combustion. After combustion, gas is discharged from the cylinder through an exhaust manifold to outside.

For turbocharged diesel engine, air is aspirated from an air filter to the compressor of a turbocharger and then is compressed by the compressor into the cylinder for combustion through an intake manifold. After combustion, gas is transferred through an exhaust manifold to the turbine housing of the turbocharger and propels the turbine wheel. The turbine and the compressor are on the same shaft, so that the turbine can drive the compressor to compress air into the cylinder. Because air density has been increased through this compression process, more air can be supplied into a cylinder and more fuel can be injected for the combustion. Apparently, the diesel engine can produce more power.

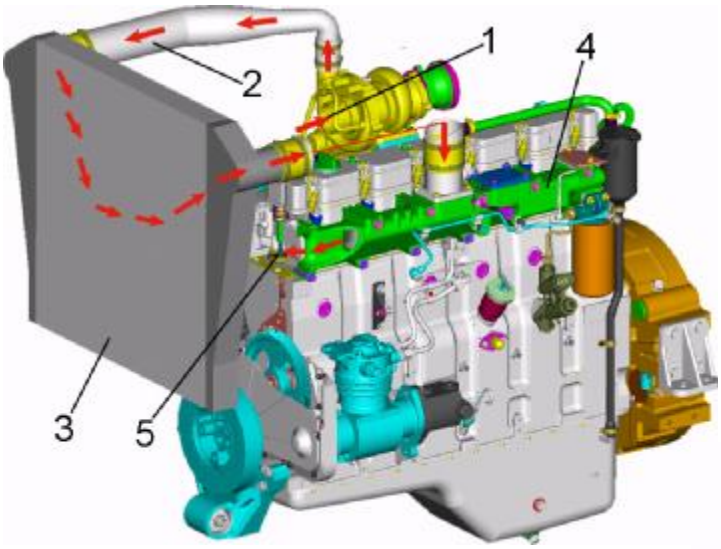
For turbocharged diesel engine with intercooler, compressed air from the compressor of a turbocharger will be first transferred into an intercooler and then into a intake manifold. Because air is cooled through the intercooler, its density has been further increased. With more air and more fuel, the engine can provide more power.

Most turbocharged diesel engines with intercooler for vehicle application are equipped with an air–air intercooler that is installed on chassis. This kind of intercooler has a better cooling effect and can improve engine performance and decrease harmful contents of exhaust gas. In this system, compressed air from the compressor goes into an air–air intercooler and then to an intake manifold through pipes of large diameter.

Some turbocharged diesel engines are equipped with a turbocharger waste–gate to limit the maximum boost pressure. A pressure controller controls a waste–gate. When compressed air pressure from the intake manifold overcomes a spring force in the controller, the waste–gate opens. The degree of opening varies depending on the extent of air pressure overcoming the spring force. The waste–gate is placed between turbine exhaust inlet and outlet. When it opens, it will release a part of the gas around turbine wheel. With less gas propelling turbine, turbocharger speed and boost pressure can be decreased.

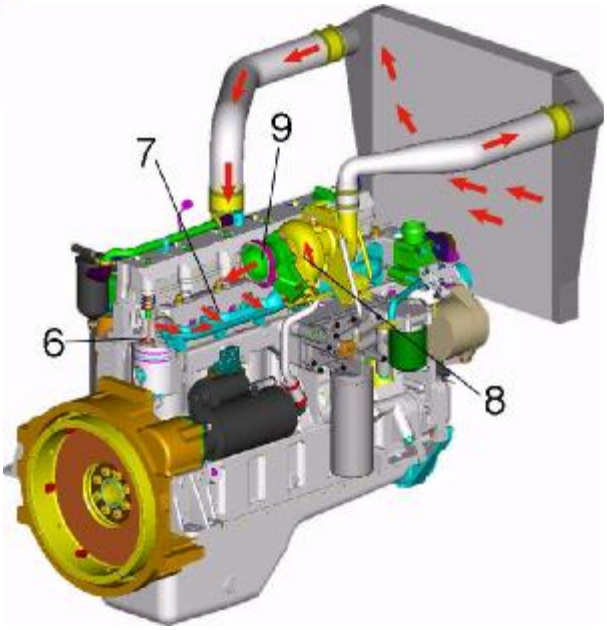
△Attention: Turbocharger is crucial to a diesel engine's performance, so it is not permitted to disassemble it. The waste–gate controller is also a crucial part to the turbocharger. Do not disassemble the waste–gate controller and its bracket, or cylinder pressure and thermo load will increase, resulting in a short engine life.

The shaft of a turbine and compressor is supported by two sliding bearings in the middle case of a turbocharger. Filtered pressed lube oil is transferred to rotating bearings and trust bearings through oil grooves of the middle case. Lube oil lubricates and cool rotating parts, making them run in good conditions, and then returns to oil pan through oil return line. The oil return line should be always kept clean. If it is blocked or damaged, the oil pressure of the middle case will increase so that oil will leak into the compressor impeller or turbine wheel.



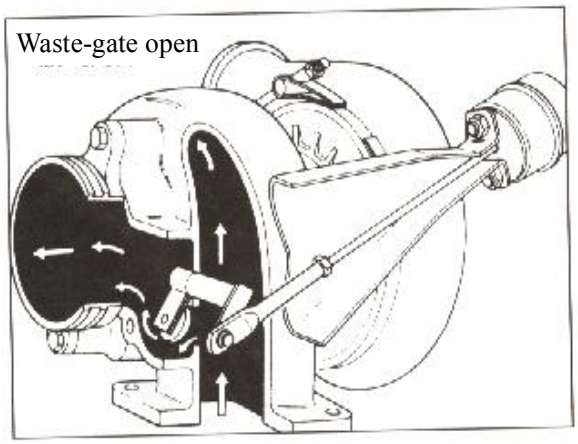
Intake system

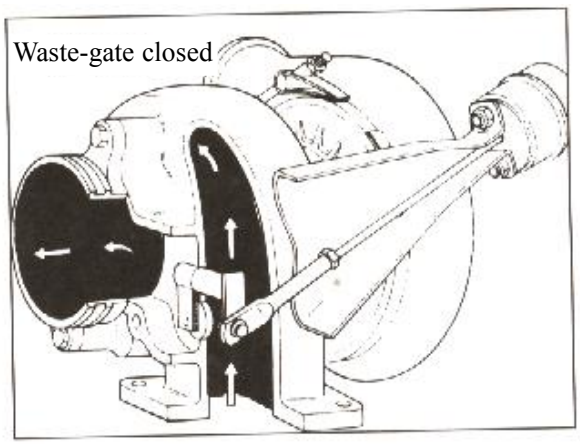
1.Turbocharger air inlet
2.Intercooler air inlet pipe
3.Intercooler
4.Intake manifold
5.Intake valve



Exhaust system

6.Exhaust valve
7.Exhaust manifold
8. Turbine housing with two gas inlets
9. Turbine outlet





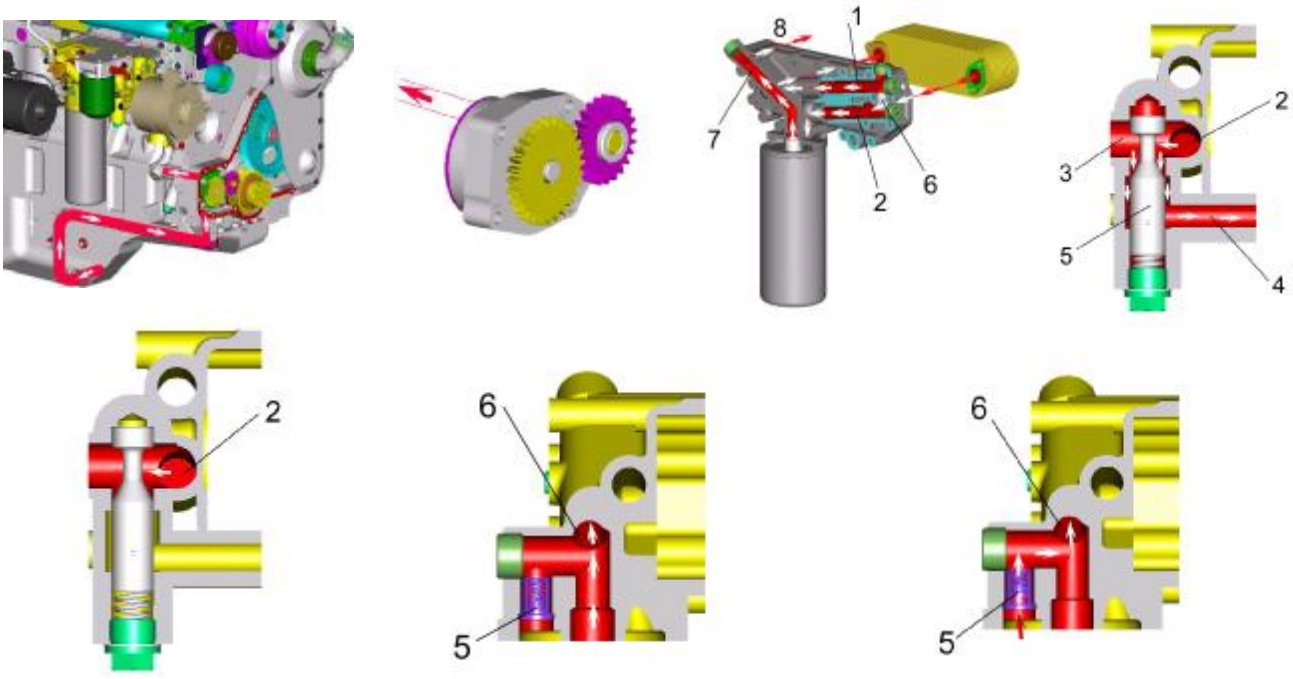
Flow Chart of Intake and Exhaust System

3.3 Lubrication system

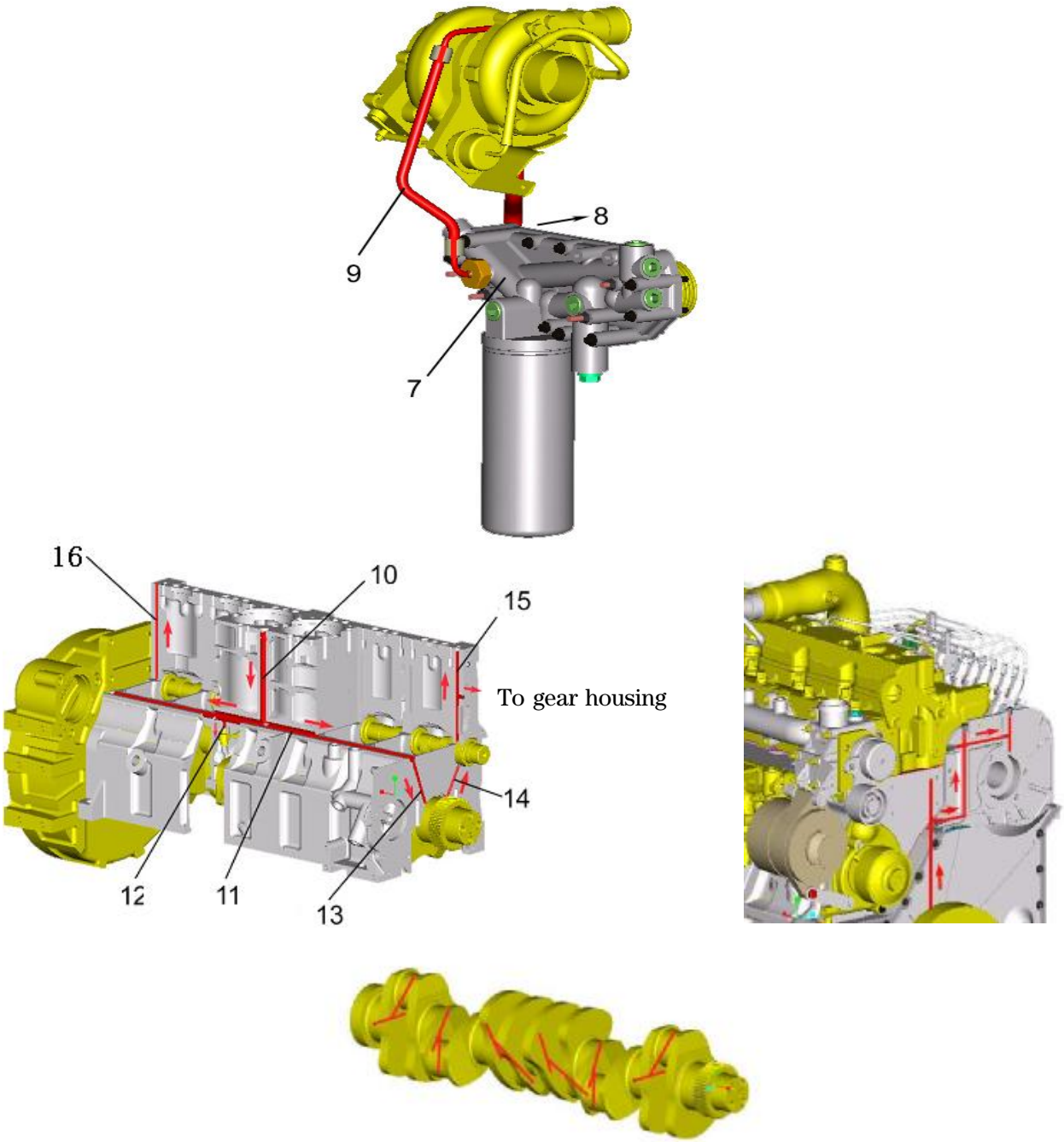
In lubrication system, oil begins to flow from the oil pump, which sucks lube oil from the oil pan through a rigid oil pipe and sends oil to the oil cooler inlet pipe (1). Lube oil flows through the cooler. core and is cooled by coolant that flows the passages between core and outer plate of the oil cooler From the oil cooler, oil flows into an oil filter inlet (2) and an oil pressure regulator valve (3), which keeps closed when oil pressure is below 505 kPa. Once oil pressure is over 505 kPa, it will open and bypass a part of oil to the oil pan through oil pipe (4) and release the pressure of lubricating system. A conical surface on the pressure regulating valve body forms an inlet passage with variable cross sec–tion to adjust oil pressure.

There is a bypass valve (6) between oil cooler inlet and oil filter inlet. When an engine has a cold start or operates after a cold start, oil pressure drop through the cooler core will increase because oil is cold and stiff. Once the pressure drop reaches 170 kPa, the bypass valve will open and let a part of oil bypass the oil cooler to the oil filter inlet (2) directly in order to prevent an instant high pressure and oil shortage in the lubricating system. There is also a bypass valve (5) on the oil filter base. Oil flows into main oil passage in the cylinder block through the oil filter under normal engine operation. But if the filter is blocked and pressure drop though the oil filter will reach 170 kPa, the bypass valve opens and let unfiltered oil go directly to filter outlet (6) to prevent oil shortage in the engine.

From the oil filter, oil flows into the filter oil outlet on the filter base (6), where oil flow is divided into two parts. One part flows into turbocharger through turbocharger oil inlet pipe (9), and the other flows along passages (7) and (8) into the cylinder block and to main oil passage (11) through a vertical passage (10).



1.Oil cooler oil inlet passage, 2.Oil filter inlet passage, 3.Oil pressure regulating valve chamber, 4.Passage for oil returning to oil pan after regulating valve open, 5.Oil pressure regulating valve, 6.Bypass valve, 7.Oil filter outlet passage, 8.Oil to the main oil passage after filtered, 9.Turbocharger oil inlet pipe

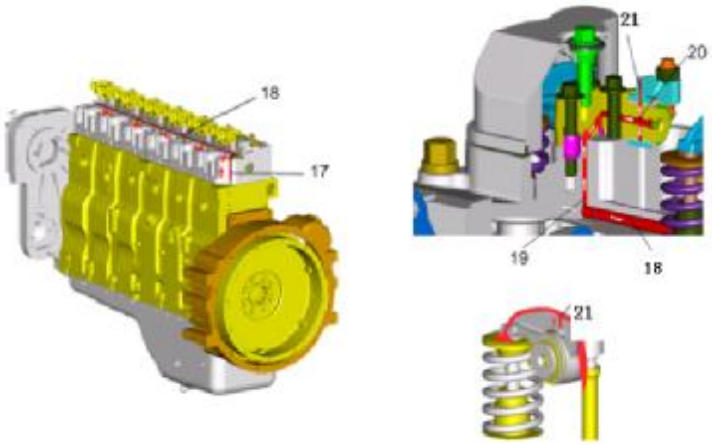


Main oil passage (11) is a deep bore throughout the cylinder block in lengthwise direction and is connected with sub-passages, transferring oil to places in need through those sub-passages. Through six vertical passages (12), oil can be sent to the piston cooling nozzles below, which spray oil to cool piston and lubricate piston pin. Seven slant passages (13) connect the main oil passage with upper oil groove of main bearing bores, which are connected with cam bearing bore by another seven slant passages (14). Through those sub-passages, oil from main oil passage can be transferred to the main bearings and camshaft bearings. Oil flowing into the main bearing can be transferred into crankshaft and lubricate connecting rod bearing through the oil passages in the crankshaft. A vertical sub-passage

(15) on the front end of the cylinder block is a connection between the outer oil groove of the first camshaft bushing (starting from engine gear end) and the oil passage of the gear housing. Oil can be transferred to fuel injection pump though this vertical passage. There is an overflow hole on the upper side of injection pump, through which oil in the injection pump can return to the oil pan.

Vertical oil passages (16) (17) on the cylinder block and head are connected with the outside oil groove of No.7 camshaft bushing bore. Through these vertical passages, oil can be transferred from camshaft bushing to the main oil passage (18) of valve rocker levels, which is a deep bore throughout the cylinder head in lengthwise direction and can bring oil to the rocker level shafts through vertical oil passages (19) and lubricate a rocker level through a small hole (20). There is a small hole (21) on each rocker lever. Oil in the rocker lever flows out of the hole, and flows along a groove on the rocker lever to the valve stem and to push rod bowl for lubrication. Oil in the valve chamber returns to the oil pan through push rod holes in the cylinder head and block.

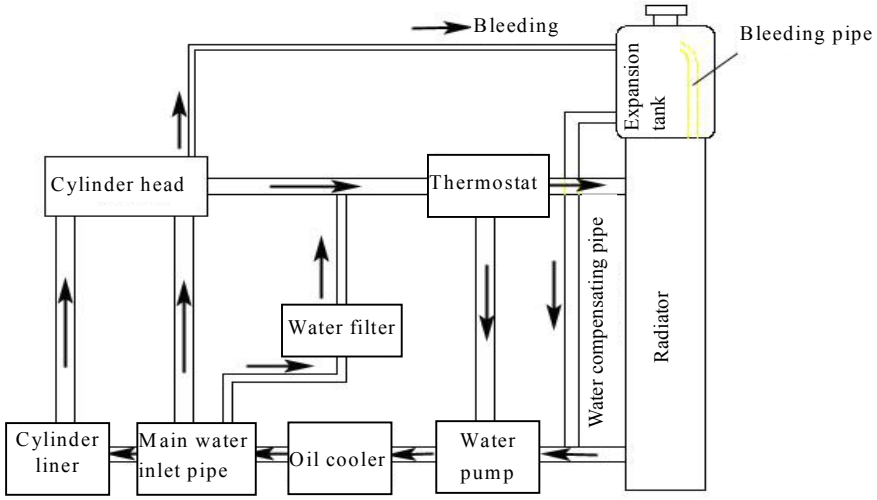
Front gears are lubricated by splashed oil from main bearing and Camshaft bushing cylinder 1 as well as fuel injection pump oil return. Oil returns to the oil pan through the lowest oil groove in the gear housing.



3.4 Cooling system

Cooling system is mainly designed to take away the heat generated by an engine. The rest heat, which is not taken away by cooling system, is taken by exhaustion and radiation.

The cooling systems of D9 and 6CL series engine are shown below.



Coolant flow path:

The water pump sucks coolant in a radiator through water inlet pipe (1) and pumps it to the water chamber of oil cooler (3) along the water passage in the cylinder block (2).

Coolant in the cooler flows into the main water inlet line (5) after traveling through water passages between oil cooler core plates(4). In main water inlet line, coolant flow is then divided into two routes. One flows through vertical water lines (6) (one for each cylinder) to the exhaustion side of cylinder head, and the other flows through horizontal water inlets (7) (one for each cylinder) to cylinder liner water jacket.

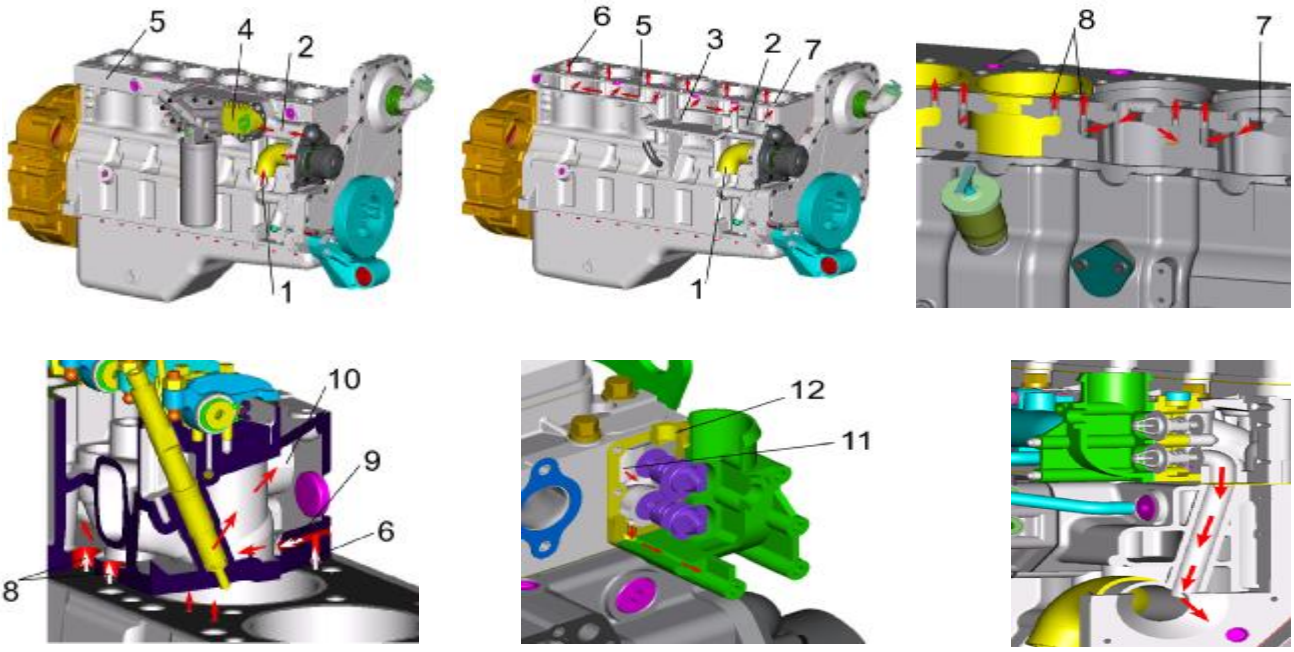
After flowing across through the upper coolant jacket of the cylinder liner and cooling the liners, the coolant flows into the cylinder head water jacket on the intake side through two vertical water passages of each cylinder (8).

Coolant in the cylinder head flows through the horizontal passages (9) (one for each cylinder) across the cylinder head center to cool the valve bridges and injectors, and then to the intake side. Then it joins with the coolant from the cylinder liners and returns upwards the exhaust side along the upper side (10) of cylinder head water passage.

After returning to the exhaust side, coolant flows vertically to the main water outlet (11) and then into the thermostat (12).

When coolant is at low temperature, the thermostat is always closed. Coolant flows into the water pump inlet through the bypass passage. With coolant temperature increasing, two thermostats begin to open and let a part of coolant flow to radiator. When water temperature is over 90℃, both thermo regulators fully open and the bypass passage is closed so that all coolant flows to the radiator.

After returning to the exhaust side, coolant flows vertically to the main outlet (11) and then into the thermostat (12).



1.Inlet elbow pipe of water pump 2.Water passage in the cylinder block 3.Water jacket of oil cooler 4.Oil cooler 5.Main water inlet pipe 6.Vertical sub passage in head on exhaust side 7.Water inlet of cylinder block 8.Vertical water passage 9. Horizontal water passage 10.Water flowing back and upwards 11.Main water outlet of cylinder head 12. Thermostat hosing

3.5 Fuel system

Fuel system consists of fuel tank, pre-filter or filter mesh with fuel/water separator, fuel transfer pump, fuel filter, low pressure fuel line, fuel injection pump, injector, injector fuel return line, high pressure fuel line, fuel injection pump fuel return line, and so on.

Fuel transfer pump (4) is driven by the camshaft of the fuel injection pump. Between fuel transfer pump and fuel tank, there is a pre-filter (2) with oil/water separator or a filter mesh to filter larger impurity and separate water. Fuel transfer pump delivers fuel to fuel filter, and then to fuel injection pump (10) along a low-pressure fuel line.

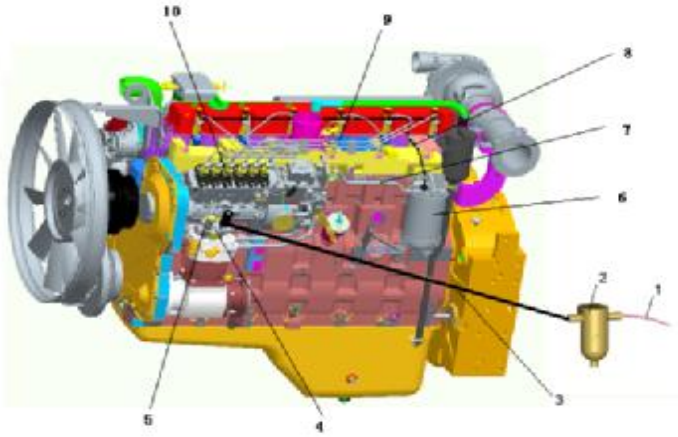
D9 and 6CL series engines are equipped with three types of fuel injection pumps, including PX of Shanghai Denso, P7100 of Bosch, and PS7100 of Longke, Shandong. Fuel injection pump provides high-pressure fuel and sends it along high-pressure fuel pipes (9) to injector (11).

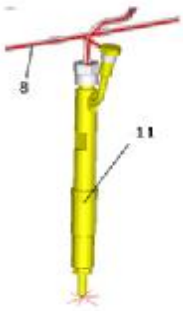
Both D9 and 6CL series are equipped with a close-type multi-orifice injector. When high-pressure fuel reaches the injector and the fuel pressure overcomes the injector spring force, needle valve is opened and fuel is injected into the combustion chamber.

Fuel leakage through needle valve can be transferred to injector fuel return line (8) and along it to fuel filter.

Extra fuel from the pump can be sent back to fuel tank through an overflow valve on the pump and along fuel return line.

△Attention: Change fuel filter and pre-filter periodically and clean pre-filter at the specified, otherwise engine power will decrease, or even fuel injection pump and injector will be damaged.

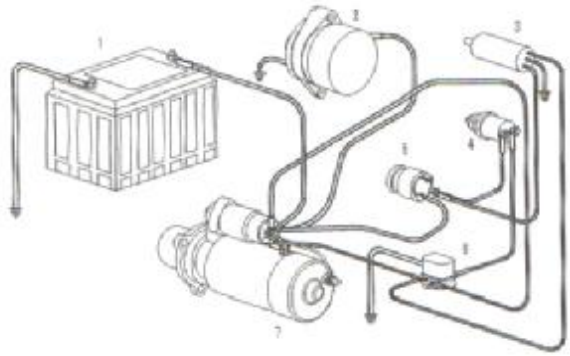




1.Suction pipe from fuel tank
2.Fuel pre-filter
3.Fuel transfer pump inlet pipe
4.Fuel transfer pump
5.Fuel transfer pump outlet pipe
6.Fuel filter
7.Fuel injection pump inlet pipe
8.Fuel injector return pipe
9.High-pressure fuel pipe
10.Fuel injection pump
11. Injector

3.6 Electrical system

The basic components of an electric system are starting motor and alternator. Some engine models are also equipped with fuel shutoff solenoid and preheating cold staring aiding apparatus. The above parts will be explained independently, but they should be viewed as one system.



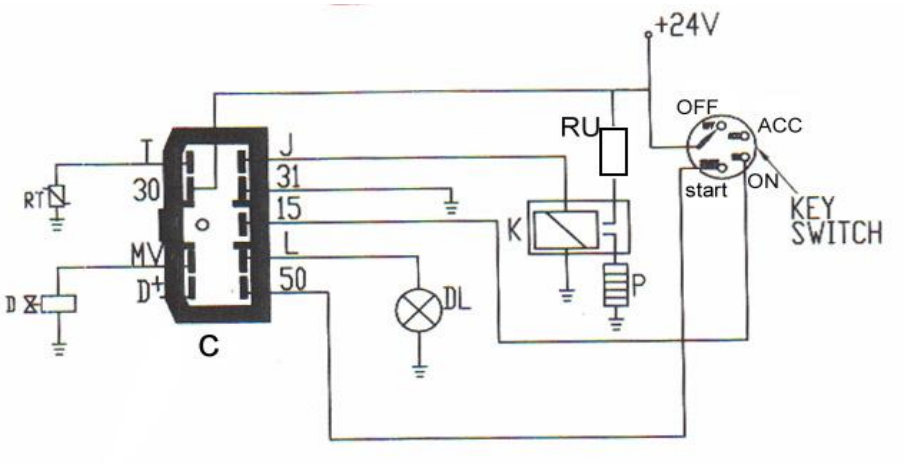
1.Battery, 2.Alternator, 3.Shutoff solenoid, 4.Starting button 5.Key switch, 6. Starting relay, 7.Starting motor

3.7 Preheating cold starting aid

9 and 6CL series diesel engines can start at as low temperature as –15℃ without any cold starting aid. It is common to use cold starting aid when temperature is below –10℃. The aid will be helpful to eliminate white smoke when the engine in warm–up period after cold starting.

The aid consists of glow plug, solenoid, fuel inlet line, electronic controller, relay, temperature sensor, indicator, etc.

▲Warning: Ether cannot be used with this apparatus!



Pre–heating cold starting aid diagram

P – Glow plug D – solenoid RT – Water temperature sensor DL – Indicating light
K – Relay D+ – D+ end of alternator RU – Fuse C – Controller

Before starting diesel engine, first turn the starting key to "ON" position. The battery begins to supply power from plug–in (15) to controller C. The resistance of water temperature sensor RT of thermo–resistance type increases with the decrease of temperature. When the temperature of water in the engine is below 0℃ (set at 0℃ initially), the controller connects its inner current relay and current gets into the controller from plug–in (30). This current will flow from plug–in J to relay K coil through controller inner relay and makes the relay K on. At this time, battery current flows from relay K touch point into glow plug P and the plug P starts to be heated. Meanwhile, indicating lamp DJ is lighted indicating the glow plug P is being heated. When the plug P starts to be heated, controller begins timing. After 50s, preheating process is over. The controller supplies the plug P with electricity power on and off by the current relay in order to provide it with 28V over–voltage protection. At the same time the solenoid relay in the controller has been connected, and current flows from the plug–in (15), solenoid relay, plug–in MV into the solenoid coil D, so that the fuel route is connected. Indicating lamp DJ begins to flash, indicating that the preheating is over and the engine can be started up.

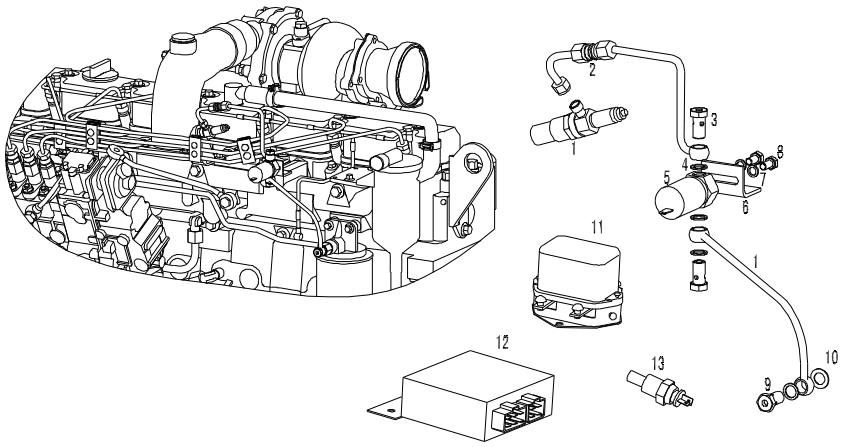
After the preheating, controller begins timing. If starting is not carried out within 30s, the controller stops pre–heater to work by switching off the circuits of the pre–heater, the solenoid, the indicating lamp, making the pre–heater get over–time protection. If one tries to start the engine again, he must turn the key to "OFF" position first and then wait for 5 seconds before repeating the above process.

After the preheating, controller begins timing. If starting is carried out within 30s, turn the key to

"START" position, starting signal will be transferred from plug-in 50 to controller, and controller begins timing. If engine is not started in 3s and the controller does not get the signal from alternator D+, controller will change on-off electricity power supply mode to continue supply mode in order to adapt a sharp voltage drop at battery end of the starting motor. If engine is started successfully within 3s, controller stops 30s over-time protection after getting a signal from alternator D+ and make the current relay provide electricity power to the glow plug in on-off mode to start 28V over voltage protection. If starting is not successful, turn the key back to "ON" position and stop starting. From the moment the key returns to "ON" position, the current relay still provide electricity power continuously to the glow plug in 5.5s. If within 5.5s there is no starting operation, the current relay will stop working.

When starting motor drives the engine, fuel transfer pump provides fuel through solenoid into the glow plug. The fuel is ignited promptly by the heated glow plug and forms flame, preheating intake air. Preheating is helpful for easy starting of the engine.

When the engine runs in a stable state after starting, preheating can be shut down to extend the glow plug's life. Turn the key to "OFF" position to shut down the preheating. If there is white smoke after starting, properly prolong heating intake air. The controller will shut down the preheating if the key is not turned off in time or preheating takes too long. Preheating time is depending on the thermo-sensitive resistance, and is longer with lower environmental temperature. As the temperature of engine intake air drops from 0 to -32℃, the preheating time will be extended from 85s to 180s.



1.Preheating plug
2.Fuel Outlet line of Shutoff Solenoid
3.Banjo bolt
4.Copper washer
5. Shutoff Solenoid
6. Solenoid bracket
7.Spring washer
8. Hex bolt
9.Banjo bolt
10.Copper washer
11.Solenoid relay
12.Preheating controller
13.Water temperature sensor

3.8 Air Compression System

Air compression system consists of an air compressor driven by gear, a compressed air preserver and lines between them. Apart from an intake unload valve demanded by some customers, the air compressor is also equipped with a pressure regulating valve.

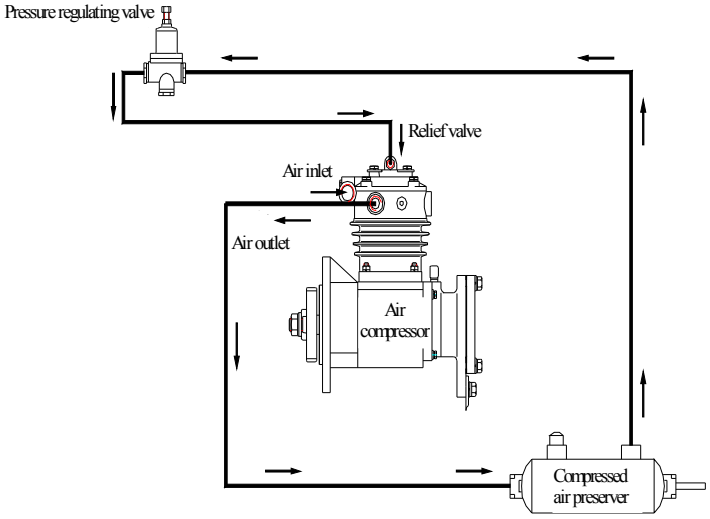
D9 and 6CL series diesel engine adopt an air compressor with single cylinder piston. The air compressor has two working modes in continuous operation when adopting intake unloading: on-load and off-load, determined by the air pressure regulator and relief valve.

The intake unloading valve is used to make the air compressor run in off-load mode when air pressure is up to specified pressure(784kPa) so as to decrease power of driving the air compressor and loss of engine boost pressure (this is for an air compressor that takes air from engine intake manifold).

When air pressure rises to the specified pressure (784kPa), the main valve of the pressure regula-

tor opens and compressed air in the compressed air preserver flows into the unloading valve, so that air compressor intake valve keeps open and air compressor stops to provide air to the system.

After air in the air compression system is consumed, air pressure within the system decreases and the pressure regulator will release compressed air in unloading valve so that the air compressor inlet valve return to normal operation, and the air compressor again provides air to the system.



4 Engine Operation

Before operating the engine, select engine oil, fuel and coolant of appropriate types according to the specific environment and condition. The technical specifications of the selected engine oil, fuel and coolant should comply with the stipulations in Chapter 8.

4.1 Engine Startup

Before startup, the engine should be maintained on a daily basis following the stipulations in Chapter 5.

4.1.1 Routine Startup

For routine startup, pay attention to the following:

●Disconnect the engine from the transmission or set the gearbox to idle position.

●Set the shutdown solenoid, electric switch and mechanical controller to the running position.

●For the engine with various speed governor,set the throttle to a position slightly higher than idle speed position (around 700r/min); while for the vehicle engine with non-various speed governor, push the throttle pedal to the end and release the pedal before the starting motor is engaged.

△Attention:To prevent starting motor from damage, the engaging time of the starting motor should not exceed 30 seconds each time, and the interval between two consecutive startups should be 2 minutes.

●The oil pressure gauge of the engine must display readings within 15 seconds upon startup.

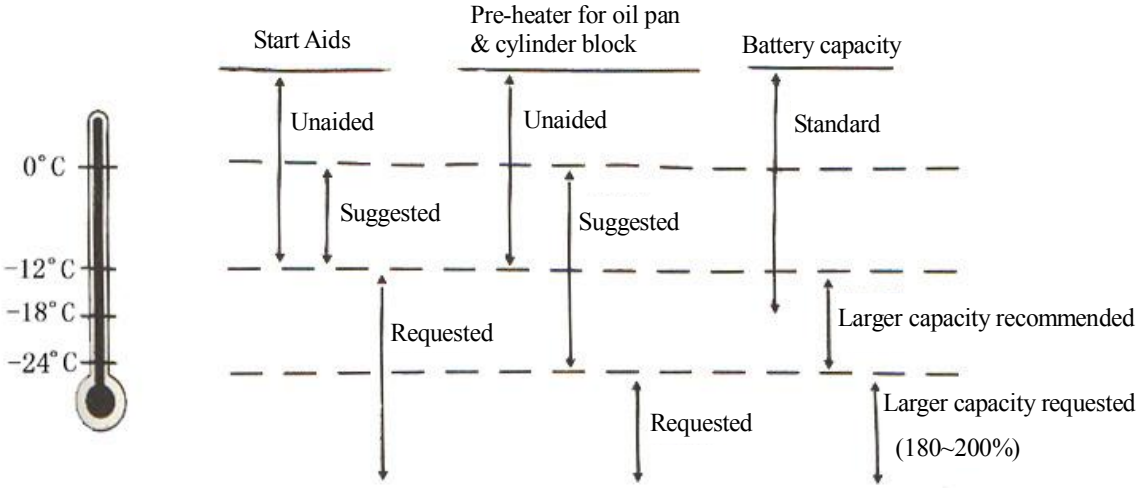
●During cold startup, the engine should increase speed slowly to make sure the bearings get sufficient lubrication and to ensure stable oil pressure.

●Increase load gradually only after 3~5 minutes of idling at 1000r/min. User cannot accelerate and add load immediately upon startup.

△Attention: You must not idle engine for too long, otherwise the engine will be damaged. During idling, the temperature in the combustion chamber is low, and fuel cannot combust completely, which will result in build-up of carbon that will congest oil injection nozzle, and stuck piston ring and intake and exhaust valves. If the temperature of the coolant is lower than 60℃, fuel will also wash away the engine oil on the surface of the cylinder liner and dilute the engine oil in the oil pan, thus preventing all moving components from getting proper lubrication.

4.1.2 Low–Temperature Startup

Refer to the following diagram to see whether auxiliary steps are needed for cold weather startup.



D9 and 6CL engines are equipped with intake air preheating accessory device for use in cold weather startup. This device consists of glow plug, solenoid, fuel inlet pipe, electronic controller, temperature sensor, indicating lamp, etc. Being controlled by electronic controller, it only works when the temperature of coolant in the engine is lower than 0℃.

●Before startup, insert the electronic key and turn it from "OFF" position to "ON" position. Turn on the circuit of pre–heater when the indicating lamp is lighted, indicating the glow plug heats up.

●Turn the electronic key from "ON" position to "START" position to start the engine, after indicating lamp starts to flash about 50 seconds.

△Attention: If startup does not happen within 30 seconds after indicating lamp starts flashing, the electronic controller will automatically disconnect the preheating circuit, solenoid circuit and indicating lamp circuit and start delay protection. If another startup is initiated, turn the electronic key back to "OFF" position, and wait for 5 seconds before repeating the above process.

●Other instructions are the same as 4.1.1 routine startup

△Attention: Application of any starting liquid even with dosing device for cold weather startup will speed up the abrasion of the cylinder liner and piston ring.

▲Warning: It is not allowed to use the starting liquid near fire, pre–heater or flame ejector. Do not breathe starting liquid fumes. Using excessive starting liquid will damage the engine.

▲It is not allowed to have volatile fuel as auxiliary means for cold startup in underground mine or tunnel operation.

4.1.3 Startup after long–time shutdown or change of lube oil

For startup of the engine after replacement of lube oil or shutdown longer than 30 days, it is required to fill up the lubricating system.

● Shut off throttle or disconnect the electrical wire of the shutdown solenoid (some engines with the solenoid) to prevent the engine from ignition and startup.

● Use starting motor to rotate the crankshaft until the oil pressure meter displays pressure.

● Open the throttle or link the connecting wire of the shutdown solenoid.

● Start up the engine as per 4.1.1 (routine startup) or 4.1.2 (cold weather startup).

● Discharge the air in the fuel system according to the instruction in 5.6.2.

4.2 Engine Operation

● For new engines or engines after overhaul, follow the instructions in Chapter 9 Running-in of New Diesel Engine" for breaking-in before full-load operation.

● When diesel engine is running at a speed lower than the speed of peak torque, time of running under full throttle should not last longer than 1 minute.

●Regularly check the oil pressure and coolant temperature during the engine operation by referring to "Main Specifications and Parameters of Diesel Engine" in Chapter 2. If operating parameters do not comply with the regulations, stop the engine to find the cause and make repairs where necessary.

△Attention: Continuous operation with coolant temperature below 60℃ or above 100℃ will cause damage to the engine.

● If the coolant temperature is too high, reduce the engine speed or shift to a lower gear or do both until the temperature returns to normal operation range. Otherwise, follow Chapter 6 "Guidance on Troubleshooting" to check for the reason and solve the problem.

● Most malfunctions give early warnings. Observe the performance change of the engine, listen to the noise, or check whether the engine shows any of the following appearances that indicate needs for repair.

-Engine misfire
-Poor smoke color
-Vibration
-Abnormal noise
-Low power
-High oil consumption
-High fuel consumption
-Abrupt change of pressure or temperature during engine operation

△Attention: Over speed (speed higher than high idle speed) will cause damage to the engine.

● Prevent engine from running over speed. When the vehicle is driving downhill, use the gearbox and brake to control the vehicle speed and engine speed.

4.3 Engine Shutdown

●After full-load operation and before shutdown, be sure to gradually reduce the engine speed and load, and run for 3~5 minutes at the idle to make the diesel engine cool down gradually and evenly.

●Unless forced to do so, it is not allowed to make a sudden shutdown during the high-load operation, otherwise overheating will cause severe malfunction.

5 Maintenance of Engine

5.1 Maintenance Sheet

Users should carry out regular maintenance according to this sheet. The maintenance cycle should be shorten when the engine frequently works under a temperature lower than –18℃ or higher than 38℃, or in a dusty environment or under a condition of frequent shutdown.

Maintenance Sheet for D9 Diesel Engine

Daily maintenance Or refill fuel	Every 3 months 250 hrs or 10,000km	Every 6 months 500 hrs or 19,000km	Every 12 months 1000 hrs or 38,000km	Every 2 years 2000 hrs or 77,000km
Checking	----------Replacement----------			
●Oil level	●Oil ★	●Oil★	●Oil★	●Oil★
●Coolant level	●Oil filter	●Oil filter	●Oil filter	●Oil filter
●Fuel/water separator	●Coolant filter	●Coolant filter	●Coolant filter	●Coolant filter
●Driving Belt	●Element of Fuel /water separator	●Element of Fuel /water separator	●Element of Fuel /water separator	●Element of Fuel /water separator
●Fan		●Fuel filter	●Fuel filter	●Fuel filter
●Leakage				●Coolant
●Fastener	----------Replacement----------			
			●Valve lash	●Valve lash
	----------Checking----------			
	●Air filter	●Air filter	●Air filter	●Air filter
	●Intake system	●Intake system	●Intake system	●Intake system
	●Intercooler	●Intercooler	●Intercooler	●Intercooler
		●DCA Concg	●DCA Concg.	●DCA Conc
		●Antifreeze Concg	●Antifreeze Concg	●Antifreeze Concg
		●Fuel system venting	●Fuel system venting	●Fuel system venting
			●Fan hub	●Fan hub
			●Bushing of Tensioner	●Bushing of fan
			●Tensioner	●Bushing of tensioner
				●Tensioner
				●Damper
				●Air Compressor

Note:The replacement cycle of lube oil for the engine in general application is 350hrs or 22,000km, and that for the engine as city bus power or operating in dusty environment, or/and in extremely cold area, or/and high plateau is 250 hrs or 10,000 km.

5.2 Maintenance Records

- ●Users should make record of regular maintenance.
- ●Users can refer to this format to record of their own maintenance activities.

Maintenance Records

Series No._____ Order No._____ Model_____

Name of user_____ Name/Series No. of Equipment_____

Date	km (hr) or Time interval	Actual mileage	Maintenance	Maintenance person	Remarks

5.3 Tools for Maintenance

Basic tools required for maintenance of the engine

Sleeve	Wrench	Other tools
19mm	22mm	Filter wrench (75–80, 90–95, 118–131mm)
17mm	19mm	Torque wrench (80 ~300N·m)
14mm	17mm	Bolt wrench
	14mm	Valve lash gage (0.30 and 0.50 mm)
	13mm	DCA inspection case
	10mm	Barring gear

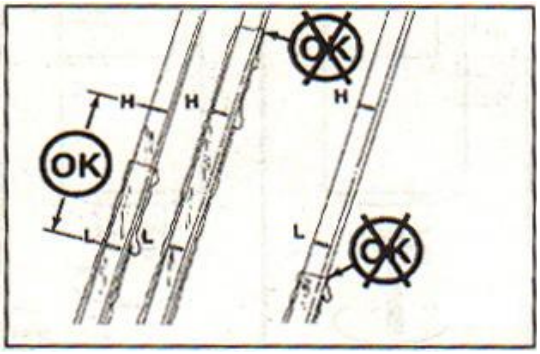
5.4 Daily maintenance

Preventive maintenance of the engine starts from understanding the engine and its own working condition. Regular maintenance such as checking for levels of lube oil and coolant, leakage, loosened or damaged parts, worn or damaged belt and any change on the engine should be done before starting the engine.

5.4.1 Inspection of engine oil level

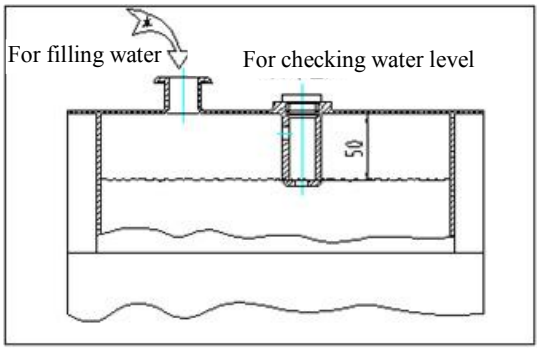
Inspection of lobe oil level should be made at least 5 minutes after the engine shuts down to make sure there is enough time for the lube oil to flow back to the oil pan When the level is lower than the "L" mark (low level) or higher than the "H"(high level)on the oil dipstick, you mustn't start up the engine.

The amount of difference between low and high ("L" to "H") levels is around 3.8 liters.

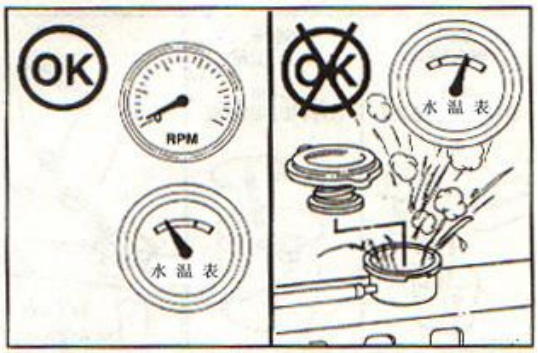


5.4.2 Inspection of Coolant Level

Open the water filling cover or the level inspection port of the radiator or expansion tank to check the coolant level.

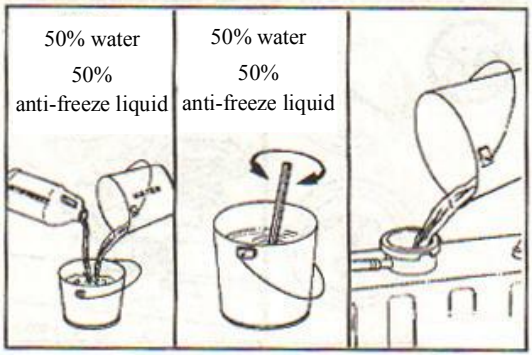


▲Warning: Open the water filling cover or the level inspection port of the radiator or expansion tank to check for coolant level only when the temperature of the coolant inside the engine drops to below 50℃. If the cover is removed soon after the engine stopped, personal injury can occur from heated coolant spray or steam. Remove it slowly to gradually relieve the pressure of the coolant system.

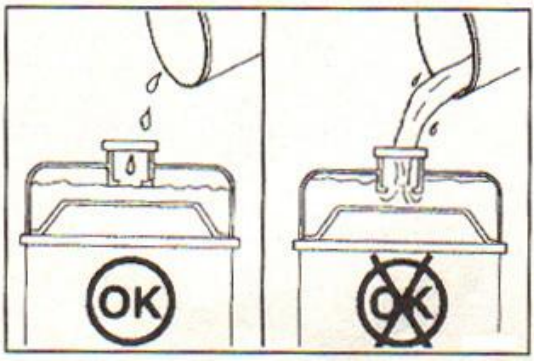


The amount of coolant and concentration of DCA4 additive filled into the engine should be accordance with chapter 8. If the antifreeze additive is needed, it must be mixed before hand, for the heat-transfer ability of anti-freeze additive is different from that of water. Overheat will cause if it is added into the engine without pre-mixing.

▲Warning: If the DCA4 additive is not used in coolant, engine liner will have cavity erosion, which will dramatically shorten its use life. If the air-discharge hole and water-outlet hole of the engine is rusted and blocked, air will be blocked, causing engine overheated, while in cold winter, air-block can make it difficult to drain coolant water, causing the cylinder block cracked and other severe accidents.

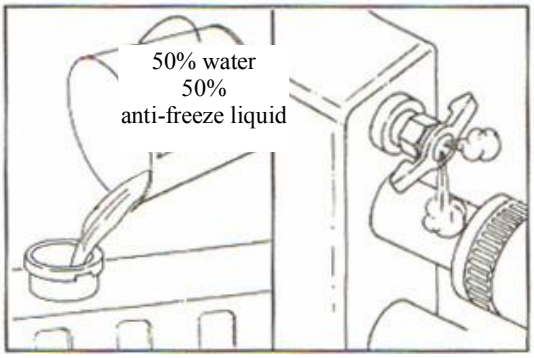


Fill coolant into the cooling system till the coolant level reaches the filling neck of the radiator or expansion tank.



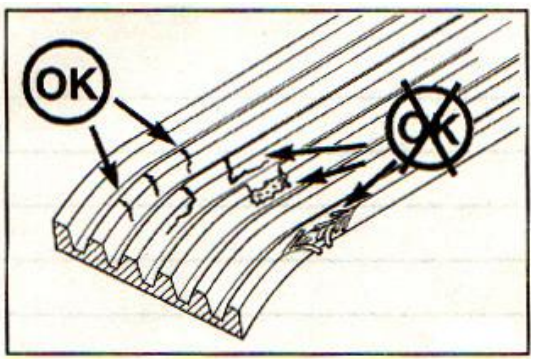
While filling coolant, the air-discharge valve of intercooler (if available) should be opened in order to discharge the air within the coolant channel.

In order to prevent air blocking, the coolant must be filled slowly, wait at least 2 or 3 minutes to discharge the air fully before closing the valve.



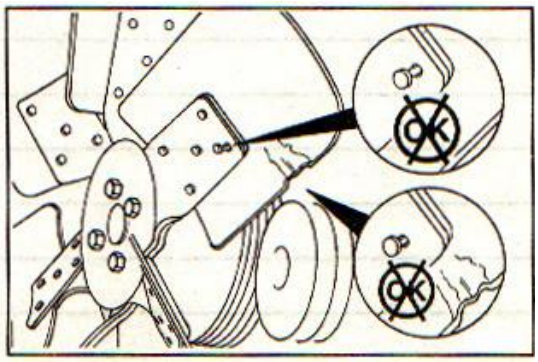
5.4.3 Check Drive Belt

Visually inspect the belt. Check the belt for intersecting cracks. Transverse (across the belt width) cracks are acceptable, longitudinal (direction of belt length) cracks that intersect with transverse cracks are not acceptable. Replace the belt if it is worn out or flakes. Refer to chapter 7 for replacement procedure.



5.4.4 Checking Cooling Fan

Visually inspect the fan. Check for any possible problems such as: cracks, loosened rivets, loosened or bent fan blades. Make sure the fan is installed securely. Fasten the bolts or replace the damaged fan when necessary.

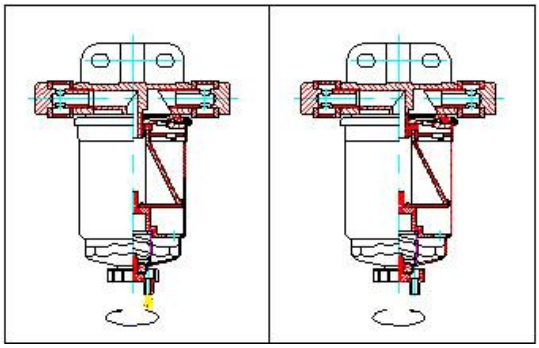


▲Warning: Damage of fan blades can cause severe accidents, such as personal injury. No dragging or prying of the fan is allowed, nor using of fan to barring the engine.

5.4.5 Drain Water and Sediment in The Fuel–Water Separator

Drain the water and sediment from the fuel–water separator (if any) every day.

Open the bottom valve on the fuel–water separator or fuel filter (if any) to drain the water and sediment until the clear fuel spills. Then close the drain valve.



△Attention: If too much sediment is drained, it is recommended to replace the fuel–water separator in order to ensure the smooth starting of the engine.

5.5 Maintenance Every 10,000km, 250h or 3 months

The following maintenance is based on accomplishment of daily maintenance:

- ●Replacement of lube oil and filter;
- ●Replacement of coolant filter;
- ●Inspection of air filter;
- ●Inspection of air intake system;
- ●Inspection of intercooler.

5.5.1 Replacement of Lube Oil/Filter

The lube oil will become dirty and oil additive in the oil will be less after some period of engine operation. Therefore, it is required to replace lube oil and filter in certain period to remove suspending contaminants in the oil.

Replacement Period of Lube Oil/Filter

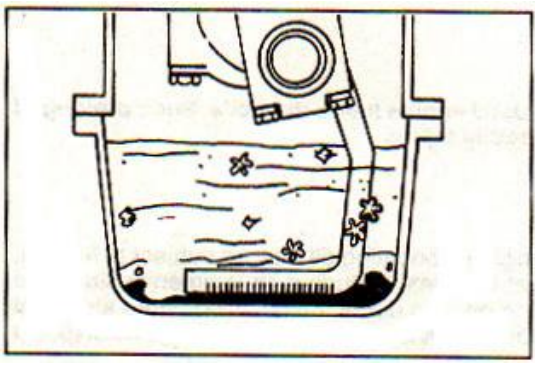
The replacement period of lube oil and filter given in the Maintenance Table in Section 5.1 is for engine of general purpose. Replacement period varies according to engine application. The following table gives the recommended value for main purpose. As for purposes not included here, refer to the maintenance table or the recommended values for the similar purposes.

Application	Replacement Period of Lube Oil/Filter		
	Kilometer	Hour	Month
Regional transport truck Intercity bus Vehicle with over 2,800km per month	22,000	350	3
Dumper Cement truck, tipping lorry Shuttle or transit bus School bus Fire truck	10,000	250	3
Sightseeing bus Box–style delivery truck	14,000	350	6
Truck crane Site handling machine	10,000	250	3
Paving equipment, cranes, bulldozer, backhoe shovel	×	250	3
Farm tractors Harvester Irrigation equipment Generator set Air compressor Fire pump Pleasure boat	×	250	6
Working boat	×	250	3

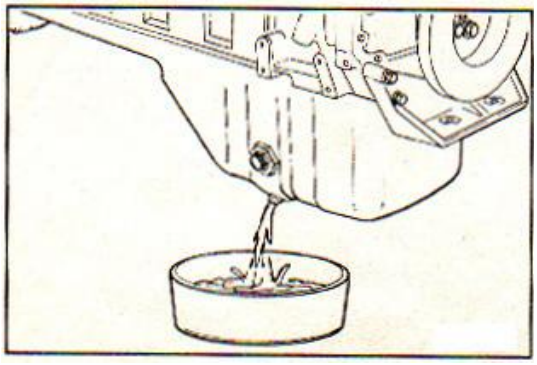
△Attention: Even if the engine is in service, the replacement period of lube oil should not extend the recommended value in the above table by any means.

Replacement of Lube Oil

Drain only when the oil is hot and the contaminants are in suspension.



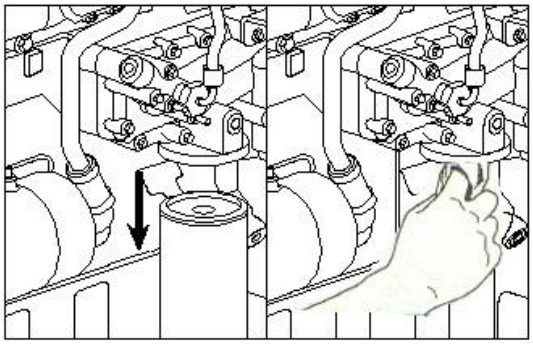
Shut the engine off when water temperature reaches 60°C. Remove the oil drain plug.



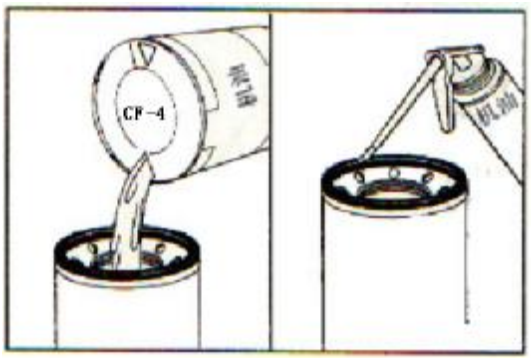
Replacement of Oil Filter

Clean the area around the lube oil filter base. Turn the filter off. Clean the O-ring surface of the filter base.

△Attention: The O-ring can stick on the filter base. Make sure it is removed before installing the new filter.

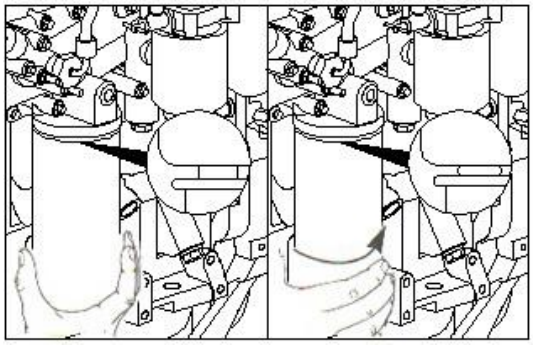


△Attention: Fill the filter with clean lube oil before installation. Apply a light film of lube oil to the sealing surface of the filter base before installing the filter.



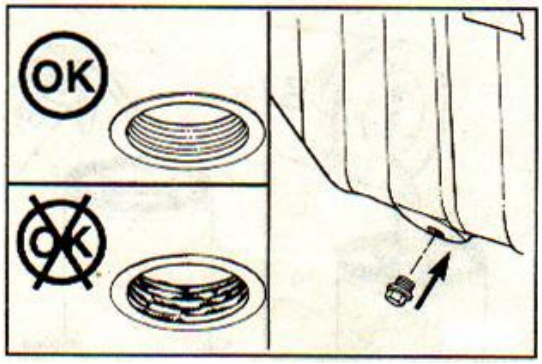
Install the filter as per the instruction provide by the filter manufacturer.

△Attention: Over–tightening of the filter will distort the threads or damage the O–ring.



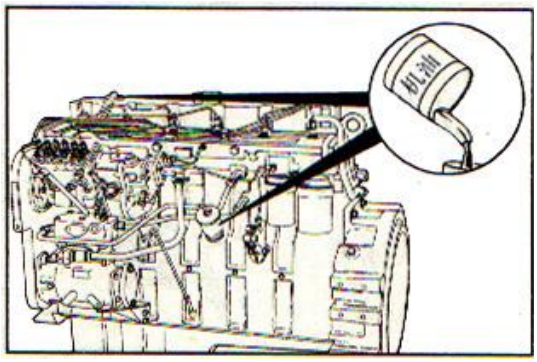
Check and clean the threads of the drain oil plug and sealing surface.

Install the drain plug.
Tightening torque: 80 Nm
56 Nm (aluminum oil pan)

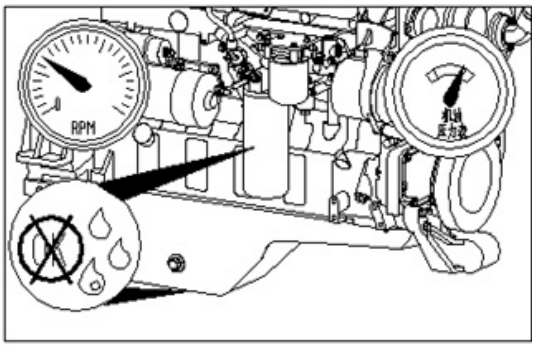


D9 and 6CL engines can use high quality multi–viscosity lube oil CD 15w–40 in all seasons. For extremely cold area, refer to instruction in Section 8.2 for selecting proper lube oil according to specific engine operation environment.

Add clean lube oil to the appropriate oil level.
The capacity of the lubricating system is 24L.

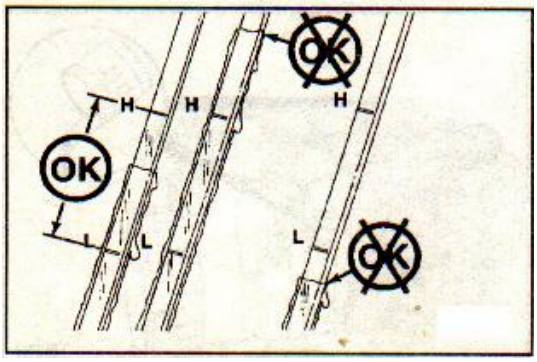


Start up the engine at idle to inspect for leakage at the oil filter and the drain plug.



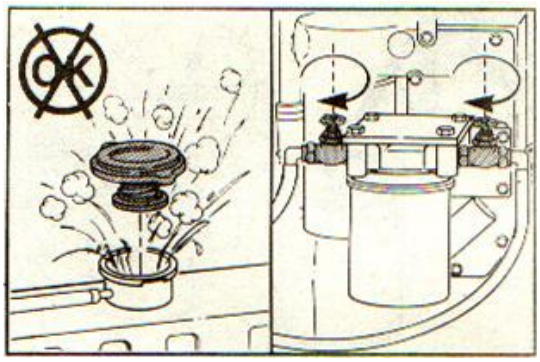
Stop the engine and wait approximately 15 min–utes to let the oil drain from upper parts of the en–gine and then check the oil level again.

Add oil when necessary to bring the oil level to the "H"(high) mark on the dipstick.

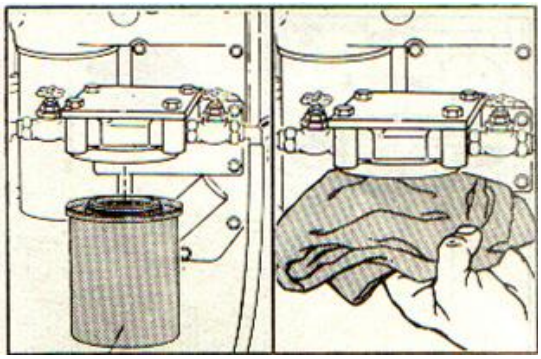


5.5.2 Replacement of Coolant Filter

▲ Warning: The water filling cover of radiator cannot be removed immediately when engine is hot, especially when the engine has run full–load, for hot vapor will cause severe personal injury. Remove the cover only when the coolant temperature drops to be–low 50℃. Shut the water inlet and outlet valves before replacing the coolant filter, otherwise hot vapor of coolant will cause severe body injury.

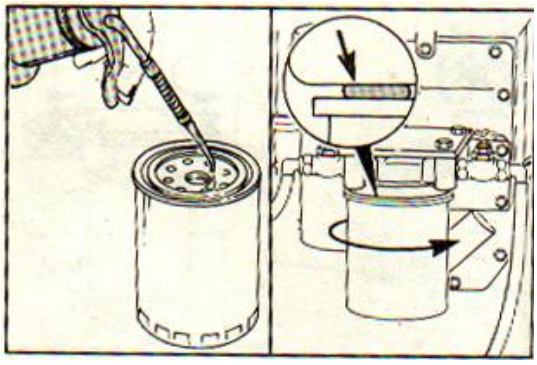


Remove the coolant filter and clean the sealing surface of the filter base.



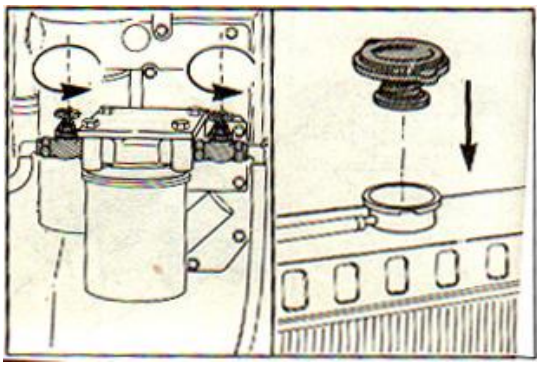
Apply a light film of lube oil to the sealing surface before installing the coolant filter. Install the coolant filter as specified by the filter manufacturer.

△Attention: Over-tightening of the filter can distort the threads or damage the filter base.



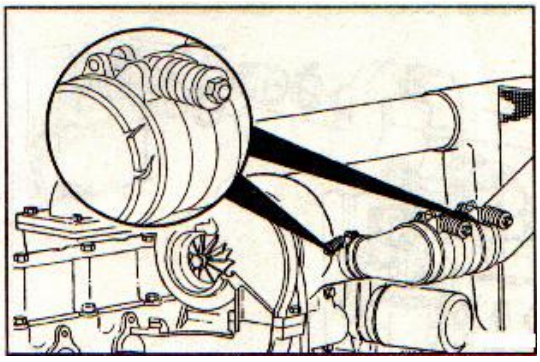
Open the water inlet and outlet shut-off valves of the coolant filter, and install the water filling cover of the radiator.

▲Warning: If you forget to open the valves, the coolant system will lose its corrosion protection, which will cause severe damage to the engine.



5.5.3 Inspect Air Intake System

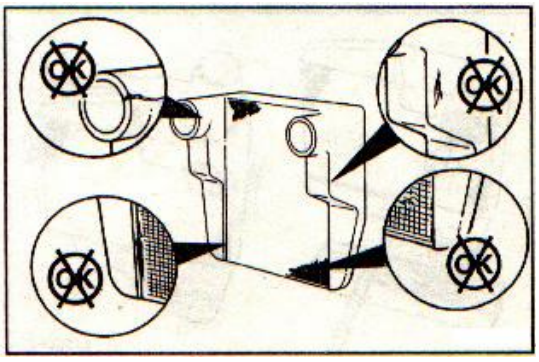
Inspect the intake hose for crack or holes or loosened clamps. If any, tighten or replace the parts as necessary to make sure the air intake system does not leak, otherwise it will cause damage to engines.



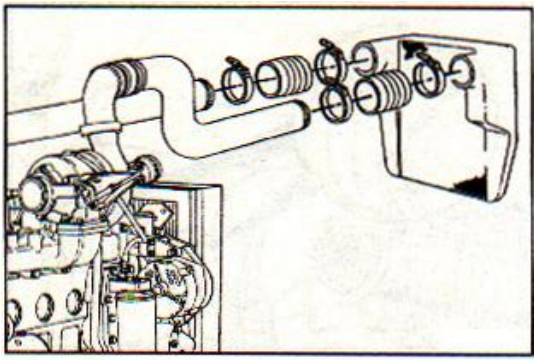
Inspection/Maintenance of Intercooler

Inspect the inlet and outlet chambers of the intercooler visually for cracks, hose or other damages.

Inspect the tubes, fins and welds for break, de-welds, or other damages.

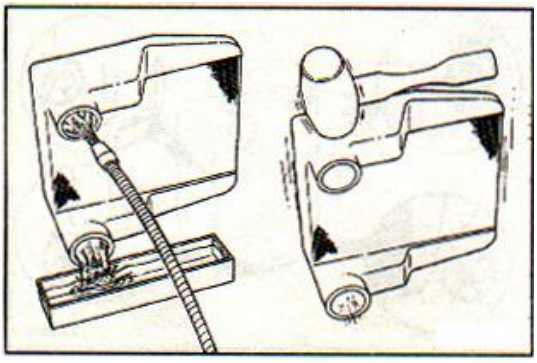


The intercooler should be removed and cleaned when oil or trash is found in it caused by turbocharger failure or other reasons.



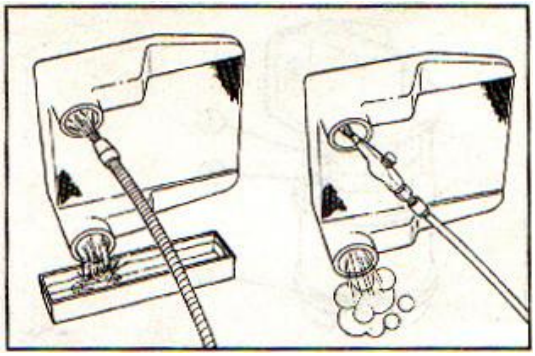
△Attention: It is not allowed to use corrosive detergent to clean the intercooler. Or it will cause serious damage to the intercooler.

Use solvent to wash the internal chamber of the intercooler along the direction of airflow. Vibrate or hit the intercooler lightly with rubber hammer to get trash out and then wash it way.



Wash intercooler internally with warm soapy water to remove the remaining solvent after the intercooler has been thoroughly cleaned with the solvent. Rinse thoroughly with clean water.

Blow compressed air along the direction of airflow and try the interior of the intercooler thoroughly.



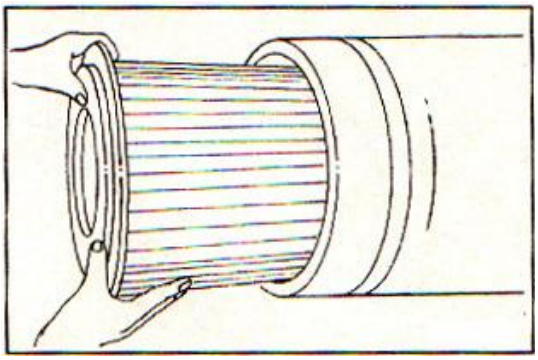
Inspection of Air Filter

Replace the air filter when max. air intake restriction exceeds following values:

Turbocharged engine: 6.2 kPa

Naturally aspirated engine: 5.0 kPa

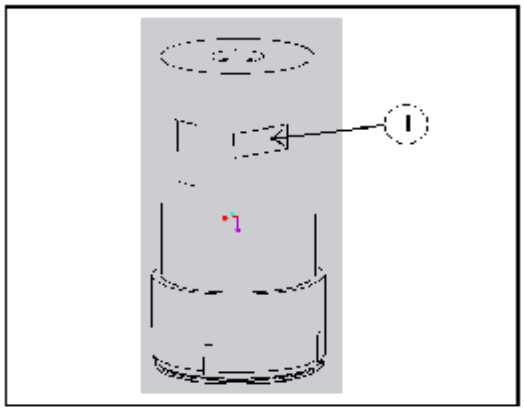
△Attention: Check max. air intake restriction only when engine operates at rated condition.



Make regular check of maintenance indicator (if available). Replace the element of the air filter if the indicator turns to red.

Press the button switch on the indicator to reset after replacing the element.

▲Warning: It is not allowed to start up the engine without air filter. Air must be filtered before going to the engine to prevent dust and garbage from entering the engine to cause early abrasion.



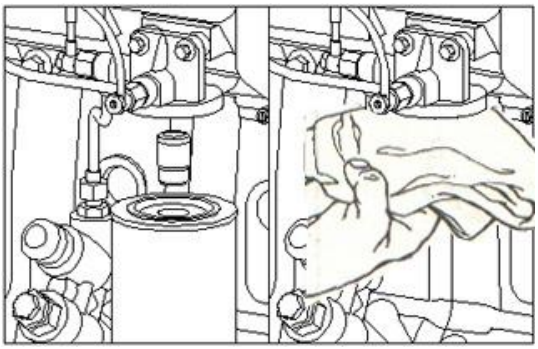
5.6 Maintenance Every 19,000 km or 500 hrs or 6 months

Add the following maintenance on the basis of daily maintenance and the previous periodic maintenance.

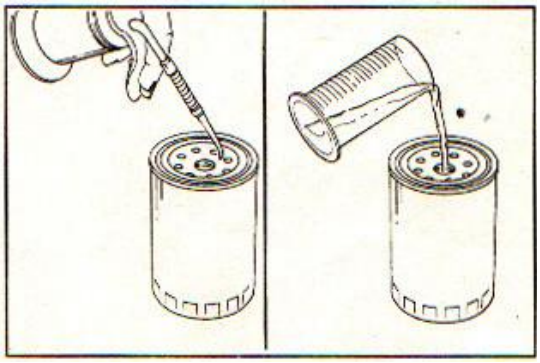
- ●Replacement of fuel filter
- ●Discharge of air in fuel system
- ● Check concentrations of antifreeze and DCA additives.

5.6.1 Replacement of Fuel Filter

Clean the surrounding of fuel filter base, turn the filter off and clean the sealing surface of the filter base.

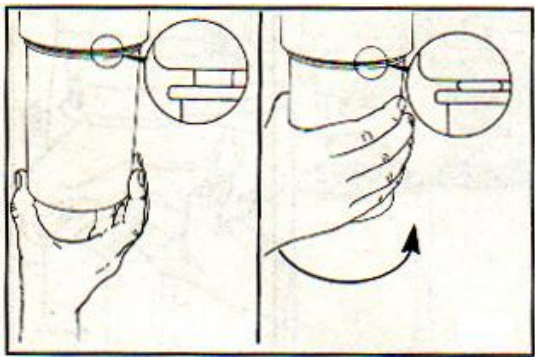


Fill the new fuel filter with clean diesel fuel and use clean lube oil to lubricate the O-ring.

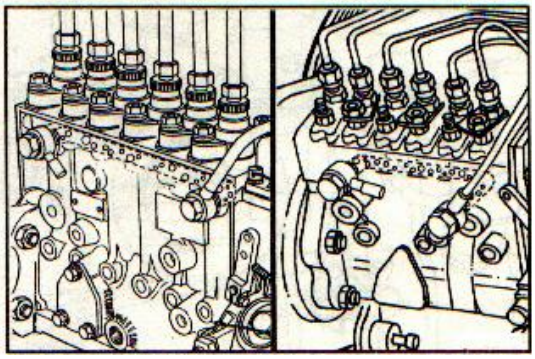


Install the filter as specified by the filter manufacturer.

△Attention: In order to avoid fuel leakage, fasten the filter, but don't over-tighten it, which may distort the threads or damage the filter.



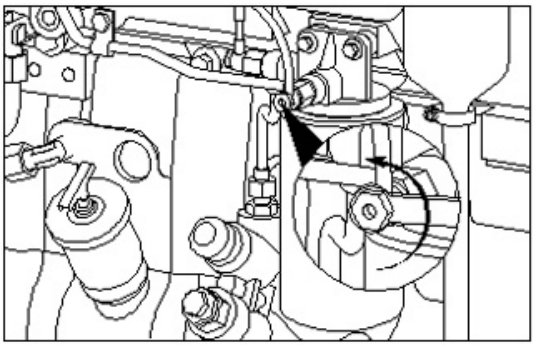
5.6.2 Discharge of Air in Fuel System



A overflow valve is provided at the fuel inlet chamber of an injection pump. If the displacement of the fuel filter is conducted according to the instruction of the filter manufacturer, the small amounts of air that goes into the fuel system during the replacement can be vented automatically.

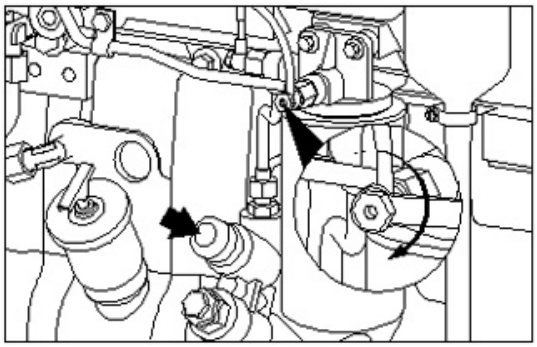
Manual bleeding of fuel lines is required if the followings occur.

- ●Unfilled up of the fuel filter prior to installation;
- ●Replacement of the injection pump;
- ●Replacement of low pressure fuel line or loosened high-pressure fuel line;
- ●Initial start of engine or no engine operation after engine start up;
- ●Run-out of fuel in the vehicle fuel tank.



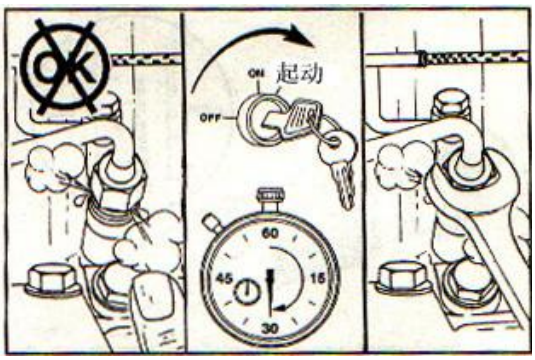
Discharge of Air in Low Pressure Lines/and Fuel Filter

Open the venting screw on the fuel filter base to discharge the air.



Press the priming pump on the fuel transfer pump to pump the fuel till it goes out of the vent screw and then tighten the screw with a torque of 9N.m.

High Pressure Lines Venting

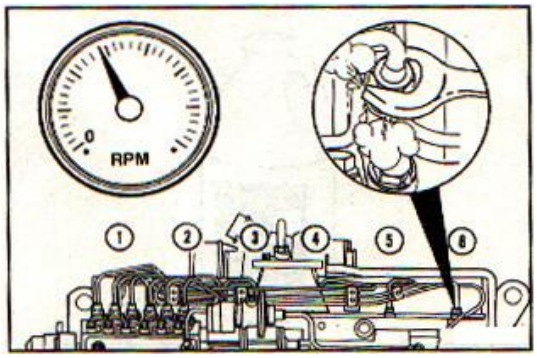


Loosen one or more line nuts on the injectors and start the engine with the starting motor to allow entrapped air to bleed from the lines. Then retighten line nuts.

▲Warning: The fuel pressure in the line is high enough to penetrate the skin and cause serious body injure.

Note: When using the starting motor to vent the system, do not engage it for more than 30 seconds at a time. The time interval between engagements should be over 2 minutes.

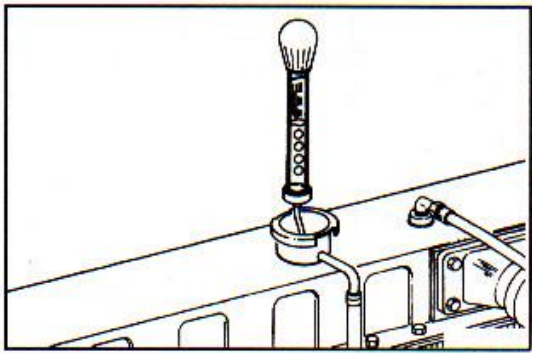
Start the engine and vent one line after another until the engine runs smoothly.



5.6.3 Checking Concentrations of Antifreeze and DCA Additives

Use freezing point measurement instrument to check the concentration of antifreeze additives. Antifreeze additive is necessary for all climates. It broadens coolant operation range by raising its boiling point and reducing its freezing point.

The concentration of antifreeze additive should be controlled to make the freezing point of the coolant 10℃ lower than the lowest local temperature. The ratio of the antifreeze additive to water and freezing point are specified in Section 8.3.



Check concentration of coolant additive

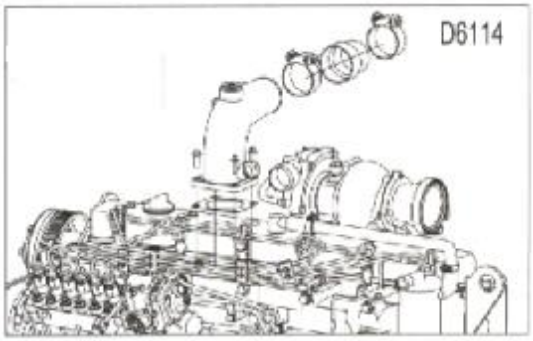
Use DCA4 concentration inspection box to check DCA4 concentration. Refer to the instructions enclosed in each inspection box for the checking method.

△Attention: In order to protect the cooling system, coolant must contain the additive with proper concentration. Refer to instructions in Chapter 8 for the value. If the concentration is lower, the cooling system components will be corroded, which will even cause severe damage to the engine; and if is too high, coolant will turn into paste to block the flow, thus causing engine overheat.

5.7 Maintenance Procedures at 38,000 km, 1,000 h or 1 Year

Add following maintenance on the basis of accomplishment of the daily and periodic maintenances:

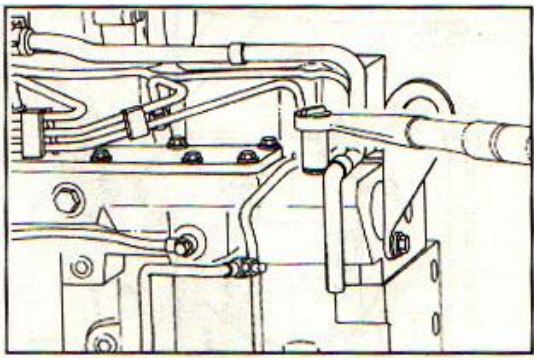
- ●Adjustment of valve Clearance
- ●Check of drive belt tension
- ●Check of tensioner bearing
- ●Check of fan



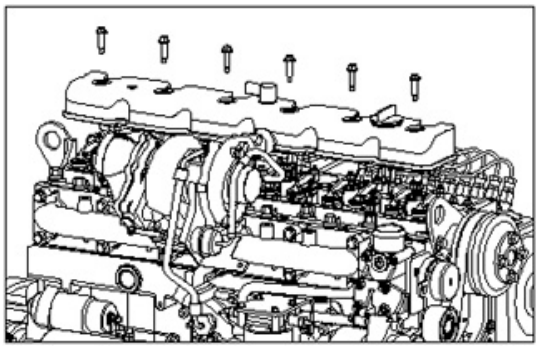
5.7.1 Valve Clearance Adjustment

Remove the air crossover-tube if available.

First disconnect the supporting clamps, hose clamp and crankcase vent lines and than remove the valve cover.

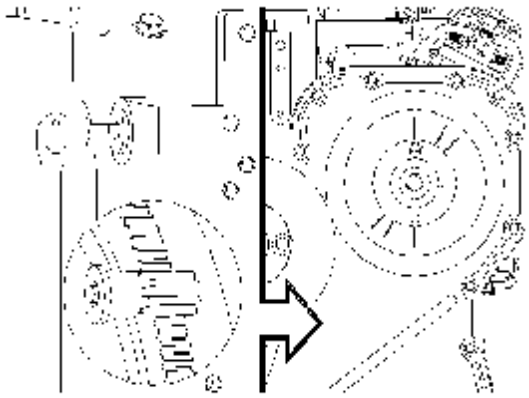


Remove the valve cover.



Locate TDC of Cylinder No.1 by barring the crankshaft slowly using a barring tool. Insert the tool into the barring hole on the flywheel housing and engage the flywheel ring gear.

When the engine timing pin engages the hole in the crankshaft gear, cylinder 1 is at TDC on the compression stroke.



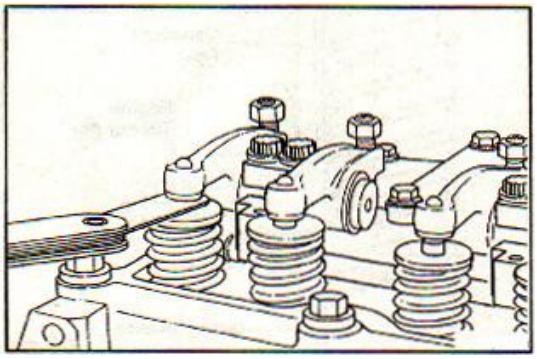
Check and set the valve clearance using feeler gauge.

Check and set valve clearance when engine colds down below 60℃:

Intake: 0.30 mm

Exhaust: 0.50 mm

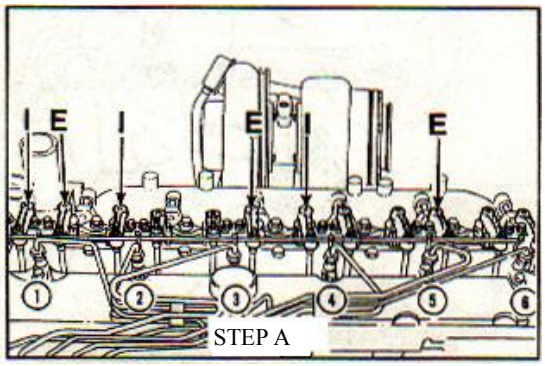
△Attention: The clearances are correct when a little resistance is "felt" by moving the feeler gauge between the valve stem and the rocker lever.



Define TDC of Cylinder 1. Check and adjust the valves clearance as per STEP A (I=Intake; E=Ex–haust).

After tightening the rocker lever lock nut, check the valve clearance to make sure the valve clearance has not changed.

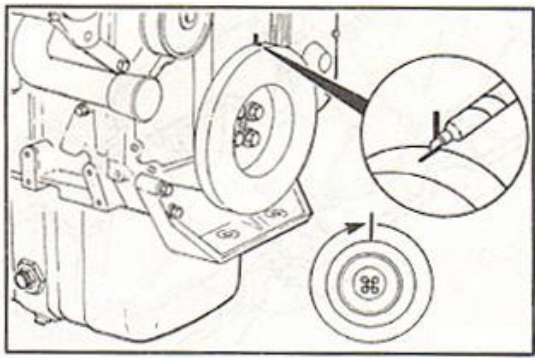
Torque Value: 24 Nm



STEP A

Mark the vibration damper and rotate the crankshaft 360 degree.

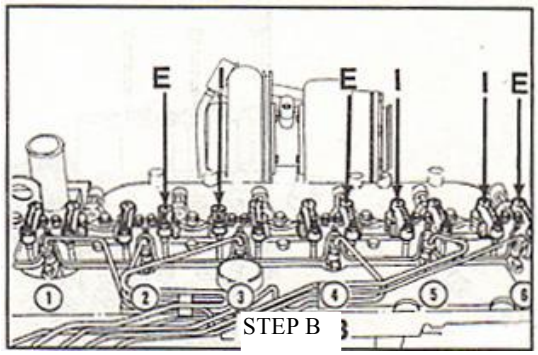
△Attention: Be sure that the engine– timing pin is disengaged to prevent the pin from damage.



Check and adjust intake and exhaust valve clearances as per STEP B.

Recheck the valve clearances for change after tightening the rock arm adjusting nuts.

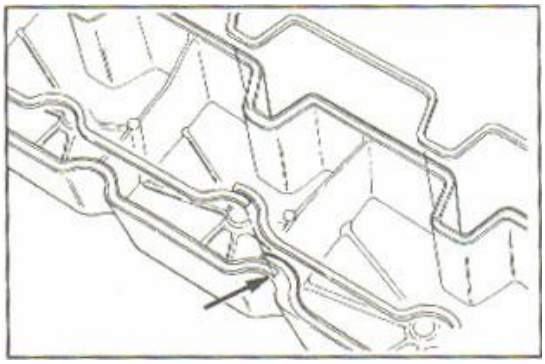
Tightening torque: 24 Nm



STEP B

Install the rubber seal into the groove of the valve cover, starting from the overlap area shown in the illustration. Do not stretch the rubber seal.

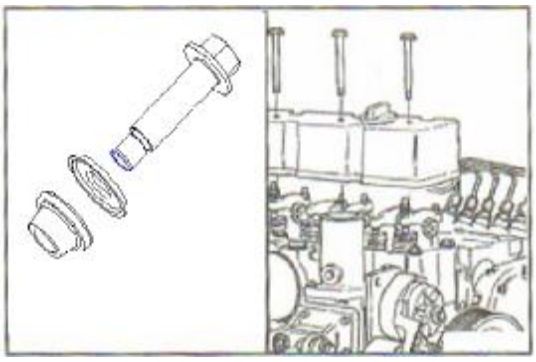
It the length of the seal is longer, cut it to have proper overlap.



Install new sealing o-rings on the cap screws.

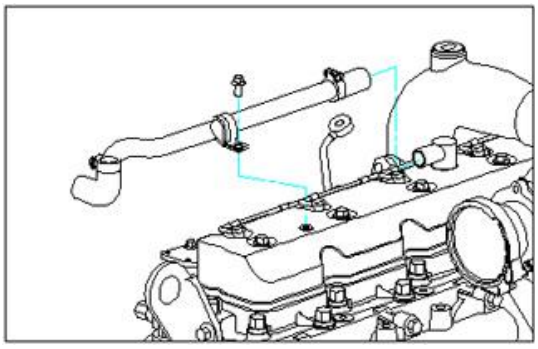
Install the valve cover.

Tightening torque: 25 Nm



Install the crankcase vent tube and secure with the supporting clamps, and then the hose and clamps.

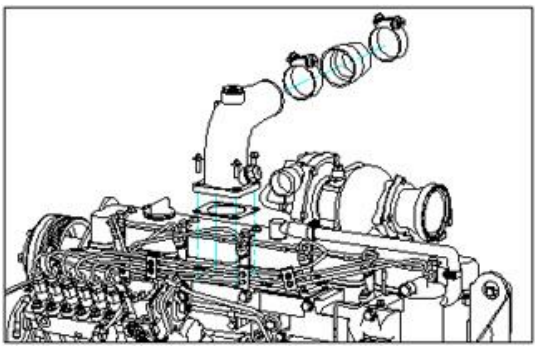
Torque for tightening clamps: 25 Nm



Install the air crossover tube and hose.

Tightening torque of the tube: 25 Nm

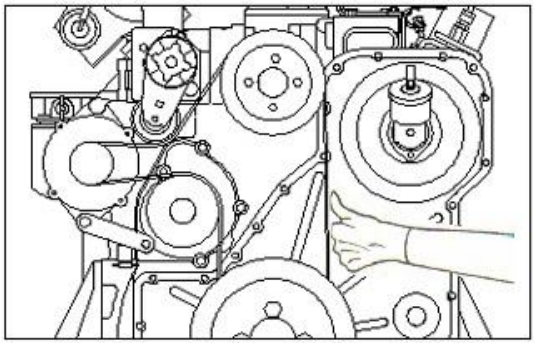
Tightening torque of the clamp: 9 Nm



5.7.2 Checking Drive Belt Tension

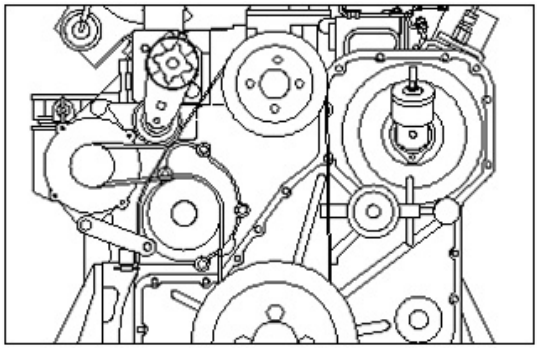
Measure the deflection of belt at the longest span.

Maximum deflection: 13mm



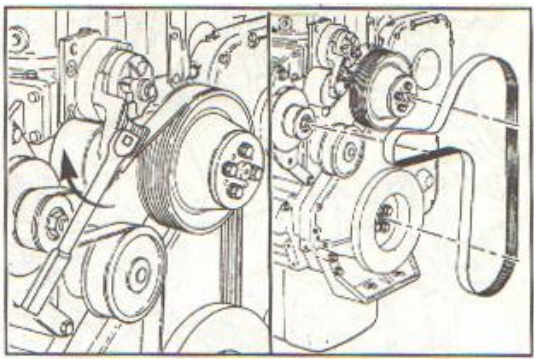
The belt tension can be measured at the longest span if a special tension gauge is available.

Tension Limit: 360~490N

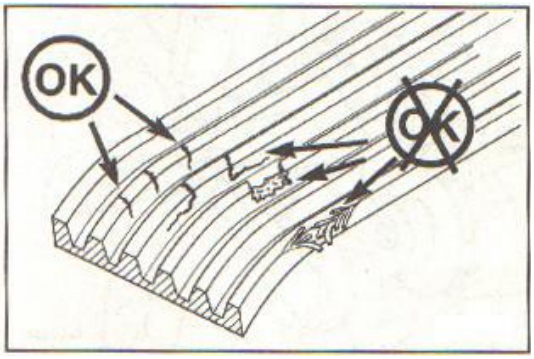


5.7.3 Checking Drive Belt, Tensioner Bearing and Fan Hub

Remove the drive belt.

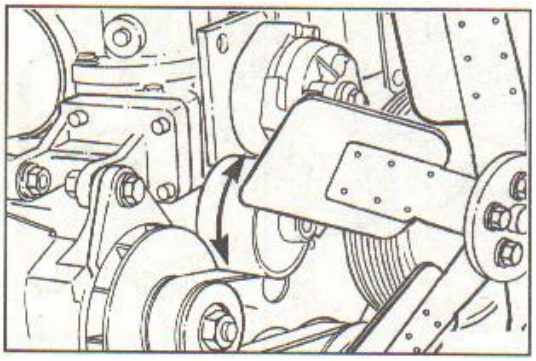


Inspect the drive belt for damage.



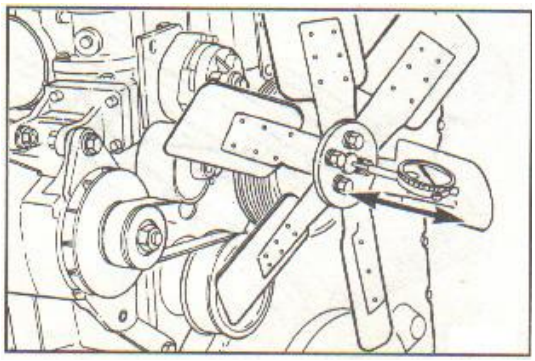
Rotate and check the tensioner for abnormality.

Note: The fan hub should rotate freely without any struck or wobble.



Rotate the fan and check the fan hub bearing for abnormality.

Note: The fan should rotate without any vibration or excessive endplay.

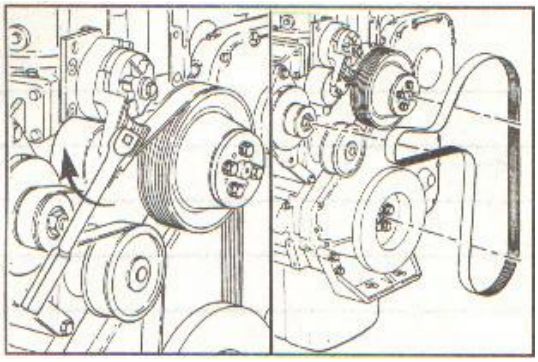


Installation of Drive Belt

Service Tip:If difficult is experienced in installing the drive belt (the belt seems too short), position the belt over the grooved pulleys first and then slide the belt over along the water pump pulley while holding the tensioner up.

Check the tensioner fasteners for loosening.

Tightening torque: 45 Nm



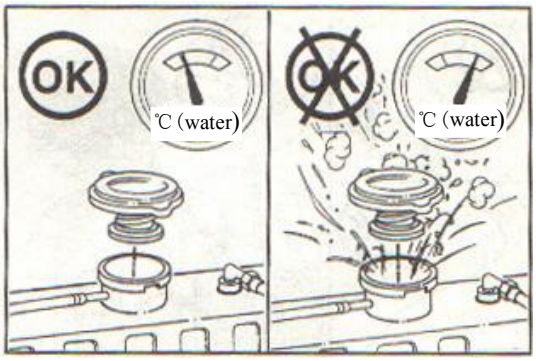
5.8 Maintenance at 77,000 km, or 2000 h or 2 Year

Add the following maintenance on the basis of accomplishment of daily and periodic maintenance mentioned earlier:

- ●Flush of the cooling system and replacement of the coolant
- ●Inspection of the vibration damper
- ●Inspection of air compressor

5.8.1 Flush of Coolant System

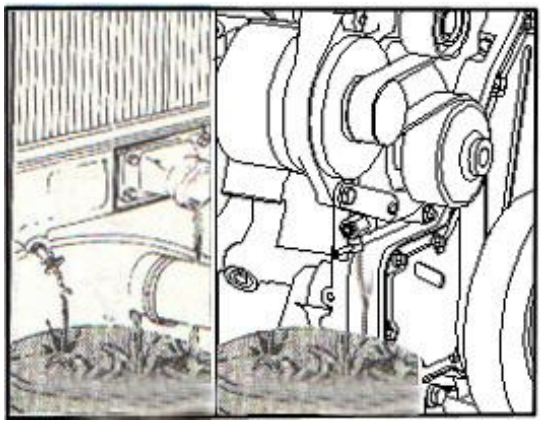
After long-time use of the engine, the antifreeze additive in the coolant will turn into organic acid because of heat and oxidation, which will cause severe corrosion to soldering tin. Meanwhile, as time passes, the additive in coolant will have more and more sediment in the glycol antifreeze, thus causing a drop of its anti-corrosion ability, and the sediment will also block the flow of coolant. Besides, with long-time use of the engine, the concentration of mineral substances in the coolant will become higher. The lube oil and exhaust gas leaking into the coolant will contaminate the coolant. In order to ensure cooling and anti-corrosion effectiveness, it is required to clean the cooling system regularly, even using coolant filter and having regular maintenance. It is recommended to replace the coolant and clean the cooling system every two years; otherwise the replacement and cleaning period must be shortened. Procedures for cleaning of cooling system as follows:



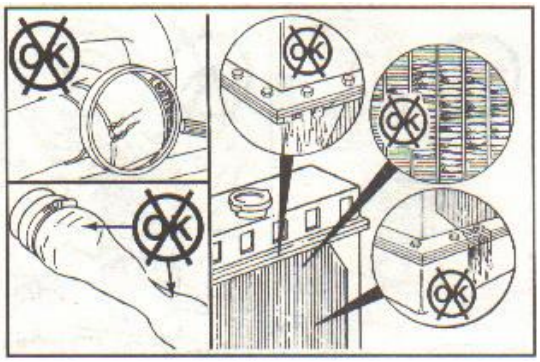
Draining of Coolant

▲Warning: Wait until the temperature is below 50℃ before removing the coolant filling cap on the radiator (cooling system pressure cap). Failure to do so can cause personal injury from heated coolant spray.

Drain the cooling system by opening the draining valve on the radiator and the lube oil cooler. For most applications the capacity of a cooling system is 25~30 liters.



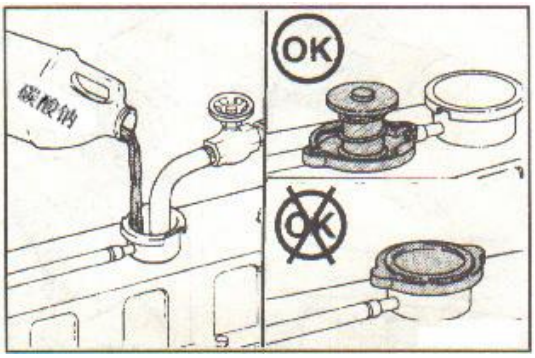
Check for damaged hoses and loose or damaged hose clamps. Replace as necessary. Check the radiator for leaks, damage and build up of dirt. Clean and repair as necessary.



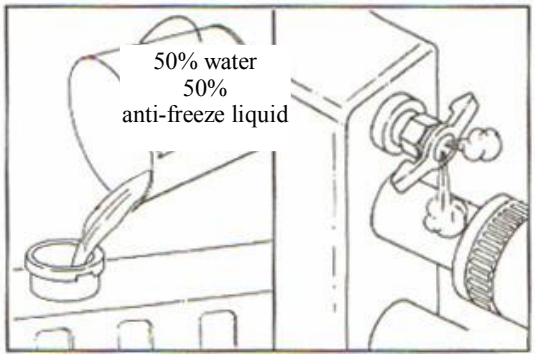
Fill up the system with a mixture of sodium carbonate and water.

Note: Put 0.5 kg of sodium carbonate in every 23L of water to get the proper mixture.

△Attention: Do not install the radiator cap. The engine is to be operated without the radiator cap during the process of flushing cooling system.

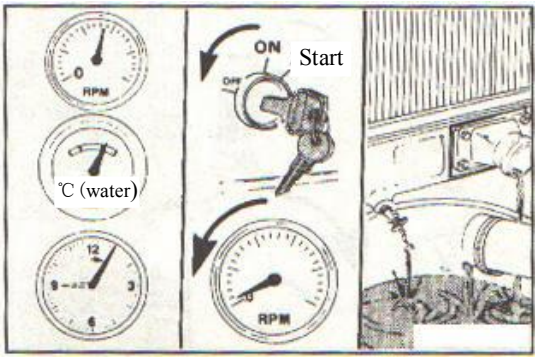


△Attention: During filling the cleaning mixture, air must be vented from the engine coolant passages. Open the engine venting petcock and the petcock on the intercooler for intercooled engines. The system must be filled slowly to prevent air locks. Wait 2 to 3 minutes to allow air to be vented, and then add mixture to bring the level to the bottom of the radiator filler neck.



Operate the engine for 5 minutes with the mixture temperature above 80℃.

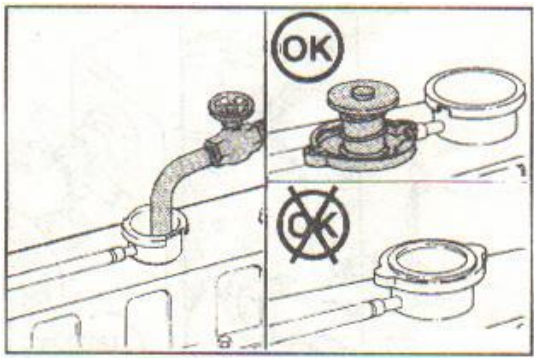
Shut the engine off, and drain the cooling system.



Fill the cooling system with clean water.

Note: Be sure to vent the engine and intercooler for complete filling.

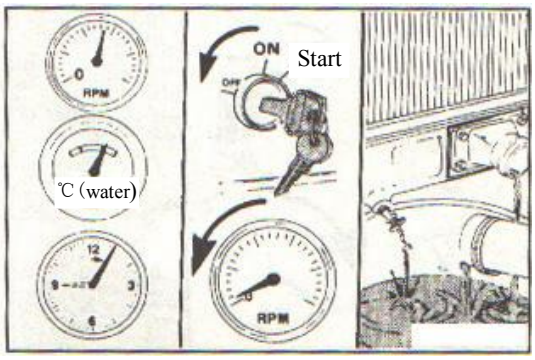
Note: Do not install the radiator cap or the new coolant filter.



Operate the engine for 5 minutes with the coolant temperature above 80℃.

Shut the engine off, and drain the cooling system.

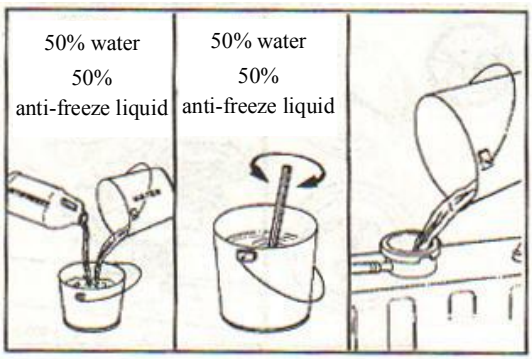
Note: If the water being drained is still dirty, the system must be flushed again until the water is clean.



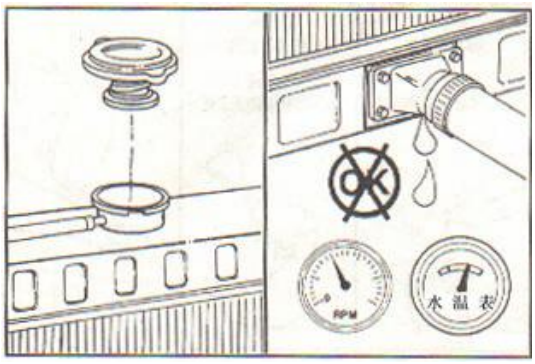
Cooling System Filling

△Attention: Never use water alone for coolant. Damage from corrosion can be the result of using water alone for coolant.

Refer to Section 8.3 for preparation of antifreeze coolant. If use antifreeze coolant, water and antifreeze must be mixed before being added to the system.



△Attention: During filling, air must be vented from the engine coolant passages. Open the engine venting petcock and the petcock on the intercooler for intercooled engines. The system must be filled slowly to prevent air locks. Wait 2 to 3 minutes to allow air to be vented, and then add mixture to bring the level to the bottom of the radiator filler neck.

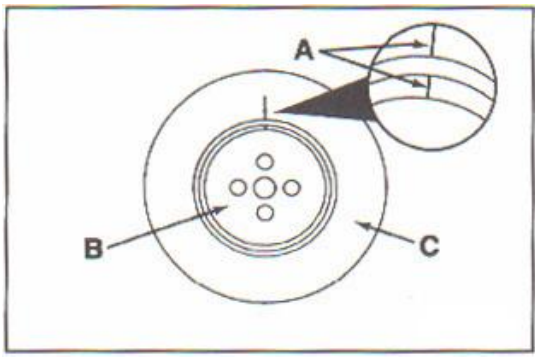


Install the pressure cap. Operate the engine until it reaches a temperature of 80℃, and check for coolant leaks and add coolant as necessary.

Wait until the coolant temperature is below 50℃ before removing the pressure cap and check for coolant level. Add more when necessary.

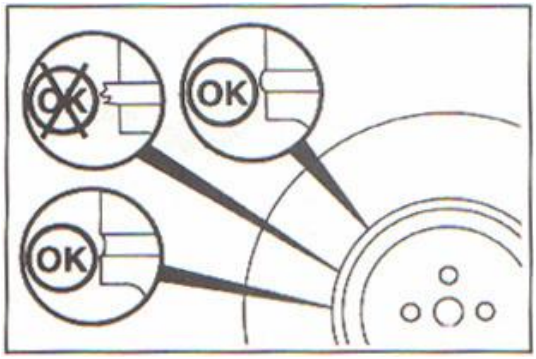
5.8.2 Vibration Damper Inspection

Check the index lines (A) on the damper hub (B) and the inertia member (C). If the lines are more than 1.6mm out of the alignment, replace the damp.



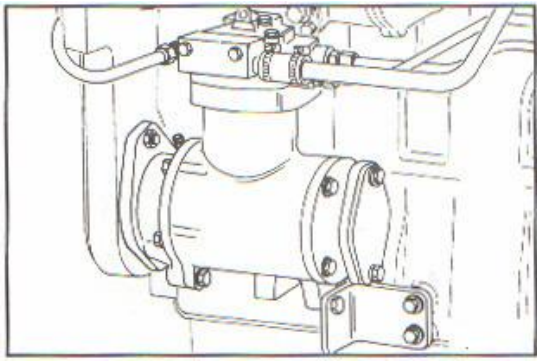
Inspect the rubber part for deterioration. If pieces of rubber part are missing or if the elastic part is below metal surface over 3.2 mm, replace the damper.

Note: Replace the damper if the inter ring is moved outwards against the outer ring.



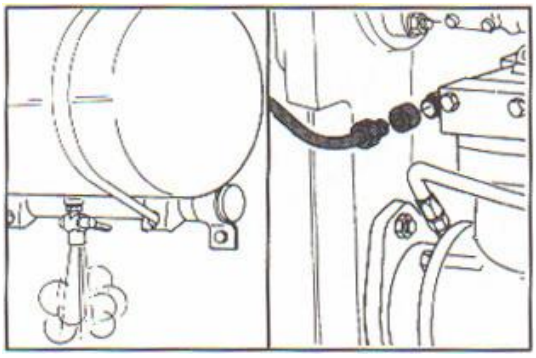
5.8.3 Air Compressor Inspection

All air compressors have a small amount of lubricating oil carry over which lubricates the piston rings and moving parts. When this lubricating oil is exposed to normal air compressor operating temperatures over a period posits. If the following inspections are not done, the air compressor piston rings will be affected by high operating temperatures and pressures and will not seal correctly. The lube oil will become paste or have carbon buildup when circulating in the air compressor under normal operation over a period.

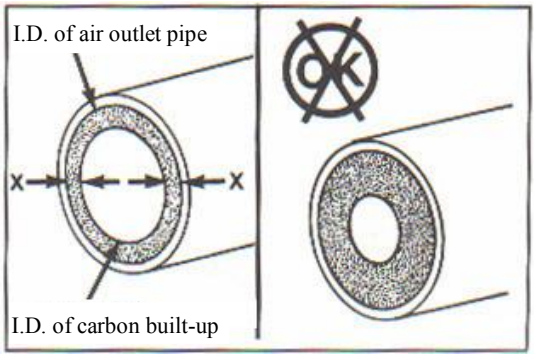


Inspect the air compressor discharge

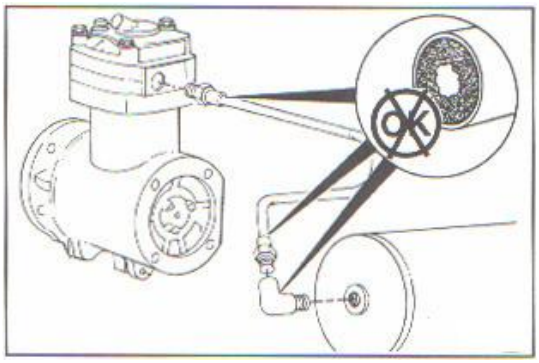
Drain the compressed air preserver to release the system air pressure. Remove the discharge line from the air compressor.



Measure the total carbon deposit thickness inside the air outlet pipe as shown. If the total carbon deposit (X+X) exceeds 2mm, clean and inspect the cylinder head of the air compressor, the valve assembly, and the pipe. Replace them if necessary.

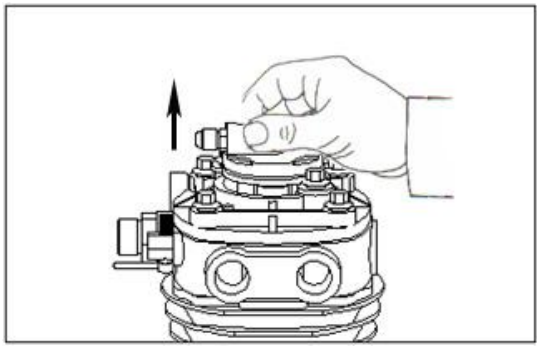


If the total carbon deposit exceeds specifications, continue checking the air outlet pipe between air compressor and compressed air preserver until total carbon deposit is less than the specification. Clean or replace any lines or connections that exceed this specification.

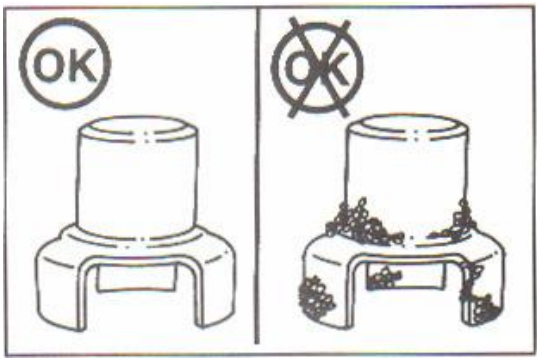


Inspection the air intake valves.

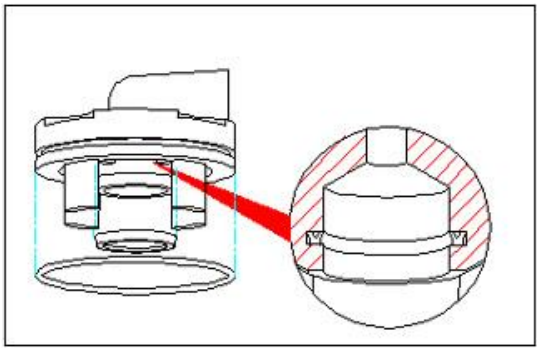
▲Warning: When remove the capscrews of pressure relief valves, push against the pressure relief valves housing. Otherwise, sudden releasing of the spring may cause the body harm.



Inspect the pressure relief valves for carbon deposits. Clean it if thick deposit. Check the cylinder head of the air compressor, intake and exhaust valves. Replace them if necessary.



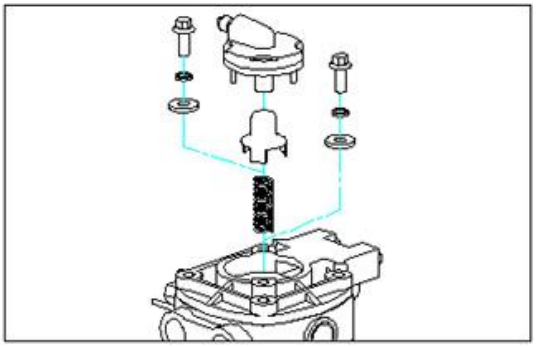
If slight carbon deposit on the pressure relief valves, replace a new O-ring on housing and Y-ring in the hole of housing.



Place anti-seized additive on the outer surface of pressure relief valves.

Coat the O-ring with clean oil. Install the pressure relief valves into the air compressor cylinder head and tighten the bolts.

Torque value: 14 Nm



6 Troubleshooting

This chapter mainly introduces the typical engine operation malfunction, probable cause and solution. For the malfunctions, usually an operator can determine and repair them according to the guide. If the malfunctions are not listed here, a user can consult with the affiliated maintenance center authorized by SDEC.

The following working procedure is recommended to address the malfunctions:

●Before dealing with the malfunction, know the malfunction in detail: for example, the working condition of the engine has been under before the malfunction: such as load, altitude, environment temperature, dust, road condition etc. The nature of malfunction: whether it is incremental, sudden or periodic, whether it is after the fuel or oil replacement, etc. Malfunction signs such as exhaust fume color, coolant temperature and consumption or leakage, engine oil temperature and consumption or leakage, or fuel consumption, engine noise, etc. Whether the coolant is contaminated with oil, iron rust, sediment, etc. Whether the engine oil is contaminated with water or fuel. And the engine vibration , etc.

●Analyze the malfunction carefully and completely;

●Establish relationship between the malfunction sign and engine system and its basic parts;

●Establish relationship between the recent maintenance or repair and the present malfunction;

●Double check the engine before disassembling;

●Start from the easiest and most apparent malfunction;

●Confirm the malfunction and repair completely;

●Start up the engine to prove that the malfunction is fixed after repair.

6.1 Malfunction sign

This section lists some typical malfunction signs. If engine operation shows any sign, user should inspect and analyze it in time, and, adopt proper procedure to fix it. Otherwise severe engine accident will happen.

●Engine can not rotate or rotates slowly

●Engine hard to start or will not start–exhaust smoke present

●Engine rotates, but will not start, no smoke from exhaust

●Engine starts, but will not keep running

●Engine can not shut down

●Warm engine speed unstable at idle

●Engine hunting at idle

●Engine oil pressure too high

●Engine oil pressure too low

●Engine oil consumption too high

●Coolant temperature too high–overheat gradually

●Coolant temperature too high– overheat suddenly

●Coolant consumption too high

●Coolant temperature too low

●Coolant contaminated

- Engine oil contaminated
- Fuel or engine oil at exhaust manifold
- Black smoke when loaded
- White smoke when engine warmed up
- Engine cannot reach rated speed when loaded
- Engine power insufficient
- Engine misfire
- Fuel knock
- Fuel consumption too high
- Engine vibrates intensely
- Engine noise– intense
- Alternator– no charge or low charge
- Excessive blow–by from crankcase
- Air compressor noise high
- Air compressor pressure rises slowly
- Air compressor pressure too low
- Cold starting auxiliary apparatus malfunction

6.2 Inspection and repair of the malfunction

Read the troubleshooting table carefully before starting inspection and repair to minimize repair time, follow the order in the table to take measures until the problem is solved.

Engine cannot rotate or rotates slowly

Cause	Correction
The engine not engages the driven equipment well	Disengage the driving equipment and inspect load of malfunctioning auxiliary parts
↓Normal	
Crankshaft's rotation restricted	Rotate engine with barring gear and inspect rotational resistance
↓Normal	
Starting circuit loosen or corroded	Clean and tighten circuit connection
↓Normal	
Battery not sufficiently charged	Inspect battery voltage, and charge if necessary
↓Normal	
Starting motor solenoid has no voltage	Inspect solenoid voltage
↓Normal	
Starting motor failure	Replace the starting motor. Refer to section 7.5
↓Normal	
Starting motor rotates but engine does not rotate	Remove the starting motor and check flywheel ring gear and spring of starting motor for damage

Engine starts with trouble or doesn't start, but with exhaust smoke

Cause	Correction
Starting procedure incorrect	Refer to section 4.1 to check correct starting procedure
↓Normal	
Starting engine speed too low	Check starting engine speed, refer to measure of "Engine cannot rotate or rotate slowly"
↓Normal	
Electrical or manual shutdown lever improperly adjusted	Adjust electrical or manual shutdown lever
↓Normal	
Starting procedure improper	Checkout correct starting procedure.
↓Normal	
Not using cold starting auxiliary in winter or engine not in use for a long time	Inspect/repair cold starting auxiliary equipment as necessary
↓Normal	
Air in the fuel system	Bleed fuel system and inspect the leaks in fuel suction line
↓Normal	
Fuel from injection pump returning to fuel transfer pump inlet	Inspect oil return pipe whether it is inserted into the bottom of fuel tank
↓Normal	
Fuel return over-flow valve failure	Inspect injection pump oil return over-flow valve. Refer to section 7.4
↓Normal	
Fuel supply blocked	Clean or replace pre-filter or strainer, inspect the flow resistance of fuel pipe
↓Normal	
Intake system blocked	Inspect the flow resistance in intake system
↓Normal	
Fuel contaminated	Verify by operating the engine with a temporary fuel tank
↓Normal	
Incorrect fuel injection pump timing	Identify top dead center, Inspect fuel injection pump timing. If necessary, check fuel wave in the fuel deliver valve to inspect/measure injection pump timing
↓Normal	
Fuel injector damaged or failure	Inspect/replace fuel injector
↓Normal	
Valve clearance adjusted improperly	Adjust valve clearance
↓Normal	
Engine compression pressure too low	Measure compression ratio to clarify the problem
↓Normal	
Fuel injection pump damaged or failure	Remove and check the injection pump

Engine rotates, but doesn't start without exhaust smoke

Cause	Correction
No fuel in fuel tank	Add fuel
↓Normal	
Electrical or manual shutdown lever not set at operation position	Inspect lead if it has loosened and function of magnetism coil. Inspect and set manual lever at operation position
↓Normal	
Starting procedure not proper	Inspect correct starting procedure
↓Normal	
No fuel in fuel injection pump inlet chamber	Loosen bleeding plug on fuel filter cover, inspect hand prime pump to see if it has fuel. Inspect or replace fuel transfer pump as necessary.
↓Normal	
If engine not used for a long time or started for the first time after replacing fuel system parts	Bleed the air in fuel system.
↓Normal	
Fuel from injection pump returns to fuel transfer pump inlet	Inspect fuel return line to see if it is inserted into the bottom of fuel tank
↓Normal	
Fuel injection fuel return over–flow valve failure.	Inspect fuel return over–flow valve on fuel injection pump. Refer to section 7.4
↓Normal	
Fuel filter blocked by water or other contamination	Drain water in the fuel/water separatoror replace fuel filter. Refer to Chapter 7.4
↓Normal	
Fuel injection pump timing incorrect	Inspect fuel injection pump timing. Refer to section 7.4
↓Normal	
Fuel injection pump is damaged or failure	Remove, check and inspect fuel injection pump. Refer to section 7.4
↓Normal	
Incorrect camshaft valve timing	Inspect/Check drive gear timing

Engine starts, but cannot keep running

Cause	Correction
Idle speed set too low	Adjust idle speed. Refer to section 7.4
↓ Normal	
Engine starts with load.	Disengage driven equipment and inspect for loading resulting from malfunctioning accessories
↓ Normal	
Intake or exhaust system restricted or engine shutdown device doesn't work	Inspect air intake and exhaust system resistance, make sure engine shutdown solenoid not to move shutdown lever too soon.
↓ Normal	
Air in the fuel system or supply fuel not sufficient.	Bleed the fuel system and inspect leaks in fuel suction pipe
↓ Normal	
Fuel filter blocked or fuel separates out wax matter because of cold weather.	Drain fuel/water separator or replace filter. Inspect fuel wax matter in winter
↓ Normal	
Fuel supply restricted	Clean or replace fuel pre–filter or strainer, inspect and clean inside of fuel pipe thoroughly
↓ Normal	
Fuel contaminated	Verify by operating the engine with a temporary tank of good fuel
↓ Normal	
Incorrect fuel injection pump timing	Inspect/Check fuel injection pump timing
↓ Normal	
Incorrect valve train timing	Inspect/Check drive gear timing

Engine cannot shut down

Cause	Correction
Electrical or manual shutdown lever not set at stop position	Inspect shutdown solenoid circuit. Inspect shutdown lever to see if it is locked. Inspect the stopping arm return spring of the governor to see it can pull the lever to shutdown position
↓ Normal	
Smoke inhaled into intake manifold when the engine operates	Find and isolate smoke source
↓ Normal	
Fuel leaks into intake manifold	Inspect cold starting heater installed on the air intake manifold to see if it leaks oil, Replace it if necessary.
↓ Normal	
Fuel injection pump malfunctions	Remove and calibration fuel injection pump. Refer to section 7.4

Engine idle speed is unstable in warm state

Cause	Correction
Idle speed set too low	Inspect and adjust the low idle screw setting
↓Normal	
Air in the fuel system	Bleed the air in fuel system and inspect the leaks in fuel suction part
↓Normal	
Fuel return over–flow valve failure	Inspect/replace fuel return over–flow valve. Refer to section 7.4
↓Normal	
Fuel transfer pump failure	Inspect/replace fuel transfer pump. Refer to section 7.4
↓Normal	
Fuel supply restricted	Clean fuel pre–filter and strainer and check fuel line resistance
↓Normal	
Fuel injector nozzle blocked or failure	Inspect/replace fuel injector nozzle
↓Normal	
Fuel injection pump timing incorrect	Inspect fuel injection pump timing. Refer to calibration 7.4
↓Normal	
Engine support damaged	Replace the support
↓Normal	
Valve clearance adjusted improperly	Adjust intake and exhaust valve clearance. Refer to section 5.7.1
↓Normal	
Engine compression pressure too low	Check compression pressure and repair as required.
↓Normal	
Fuel injection pump failure	Remove the pump for calibration and check the dirty in deliver valve. Refer to section 7.4

Engine hunts at idle

Cause	Correction
Fuel level in fuel tank too low	Adding proper amount of fuel
↓Normal	
Idle speed set too low	Check/adjust low idle speed screw
↓Normal	
Idle speed adjusted incorrectly	Inspect and adjust again
↓Normal	
Air in the fuel system	Bleed the fuel system and check leaks in fuel suction pipeline
↓Normal	
Fuel supply restricted	Clean or replace fuel pre-filter and strainer, Inspect and clean inside of fuel line thoroughly
↓Normal	
Fuel injection pump abrasion or malfunction	Remove fuel injection pump for calibration and check or replace fuel injection pump. Refer to 7.4
↓Normal	
Fuel injector failure	Check/remove the injector. Refer to section 7.4

Lube oil pressure too low

Cause	Correction
Incorrect lube oil level	Add or drain lube oil. Refer to section 5.5.1
↓Normal	
Lube oil pressure regulating valve failure	Inspect and clean, replace it, if damaged. Refer to section 7.2
↓Normal	
Fuel in the lube oil, but engine operation normal	Remove and inspect the inner cover sealing in the fuel transfer pump, replace leaked fuel transfer pump and lube oil. Refer to section 7.4 and 5.5.1
↓Normal	
Lube oil diluted by fuel, engine operation in rough or power in drop	Inspect fuel nozzle to see if it seized. Replace fuel injection pump and lube oil if fuel nozzle is good. Refer to section 7.4 and 5.5.1
↓Normal	
Lube diluted by water	Look for cause of the lube oil dilution, and replace Lube oil. Refer to section 5.5.1
↓Normal	
Improper lube oil specification	Check lube oil specification. Refer to section 8.2
↓Normal	
Pipeline connection loosened or oil passage expansion plug dropped	Inspect for lube oil leaks at the front end of cylinder head and along the block on fuel injection pump side, lube oil cooler housing and gear housing.
↓Normal	
Engine coolant temperature over 100℃ causing oil viscosity decrease	Refer to troubleshooting procedure for the cause of coolant temperature abnormal
↓Normal	
Lubricating oil pressure gauge malfunction	Check lube oil pressure gauge.
↓Normal	
Pressure regulation valve locked on the start position or spring damaged	Inspect or clean. Replace spring if damaged. Refer to section 7.2
↓Normal	
Lubricating oil filter blocked	Replace lube oil or oil filter. Refer to section 5.5.5 and 7.2
↓Normal	
Lubricating oil cooler blocked	Inspect or replace oil cooler. Refer to section 7.2

Lube oil pressure too high

Cause	Correction
Pressure switch/ pressure gauge failure	Inspect pressure switch and pressure gauge function.
↓ Normal	
Engine operation temperature too low	Refer to malfunction troubleshooting procedure –coolant temperature too low
↓ Normal	
Lube oil viscosity too dense	Make sure lube oil qualified. Refer to section 8.2
↓ Normal	
Pressure regulation valve locked at "Close" position	Inspect/replace pressure regulation valve. Refer to section 7.2

Lube oil consumption too high

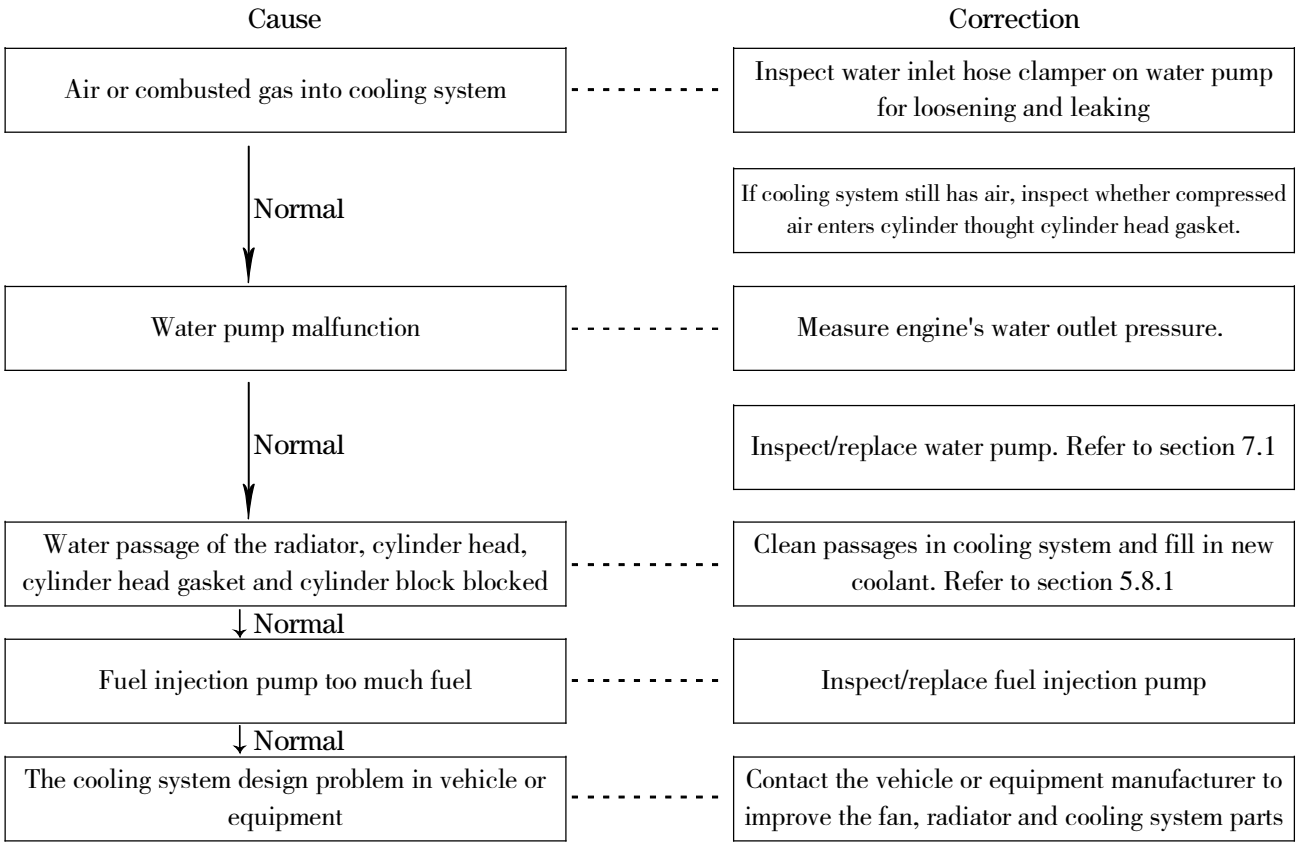
Cause	Correction
External surface leaking oil	Inspect engine oil leaking
↓ Normal	
Oil over–filled in crankcase	Inspect oil level. Refer to section 5.4.1
↓ Normal	
Specification or viscosity of lube oil quality incorrect	Insure the specification of oil. Refer to section 8.2
↓ Normal	Check whether the decreased viscosity is caused by lube oil diluted by fuel
	Inspect/shorten the period of oil replacement. Refer to section 5.5.1
Oil cooler leakage	Check for lube oil in the coolant
↓ Normal	
Air compressor overflowed with oil if installed	Refer to troubleshooting procedure "air compressor inducting oil to air system"
↓ Normal	
Too much blow–by from Crankcase forcing lube oil to the engine ventilation system	Inspect ventilation pipe for evidence of oil linking, inspect oil mist precipitator, measure blow–by from crankcase and repair as required
↓ Normal	
Turbocharger leaking oil into intake or exhaust manifold	Inspect the oil trace at turbocharger air inlet or exhaust outlet
↓ Normal	
Valve stem seal worn out	Inspect/replace valve stem seal
↓ Normal	
Piston ring failure, lubricating oil consumption too much	Inspect with compression method, and repair as required

Coolant temperature above normal– overheat gradually

Cause	Correction
Coolant level too low	Add the coolant by referring to calibration 5.4.2. Check and remove water leaking Refer to troubleshooting procedure "coolant consumption too much"
↓Normal	
Radiator and intercooler radiating fins blocked or damaged (only for vehicle)	Inspect radiator and intercooler radiating fins. If necessary, clean or repair it
↓Normal	
Air flow through radiator insufficient or blocked	Inspect as required, repair of fan shroud, fan sensor and fan clutch
↓Normal	
Belt on water pump or fan loosen	Inspect the belt tensioner. Refer to section 7.1
↓Normal	
Radiator hose depressed, blocked or leaked	Inspect the hose and replace it necessary
↓Normal	
Incorrect lube oil level	Add or drain lube oil. Refer to section 5.5.1
↓Normal	
Fan shroud damaged or separated from fan	Inspect fan shroud, repair/replace or reinstall
↓Normal	
Radiator pressure cap improper or malfunction	Check radiator pressure cap, and replace it if necessary
↓Normal	
Anti–freeze fluid concentration too high	Inspect the concentration, drain part of coolant, and then add water. Refer to section 8.3 and 5.4.2
↓Normal	
Water temperature sensor or gauge damaged	Inspect sensor and water temperature indicator, repair or replace it if necessary
↓Normal	
Thermostat fixed improperly, failure or damaged	Calibrate/replace the thermostat. Refer to section 7.1
↓Normal	
Radiator shutter opened incompletely or radiator wind blocker closed in winter	Inspect shutter, repair and replace it, if necessary, and open radiator wind blocker
↓Normal	

(To be continued)

Coolant temperature above Normal– overheat gradually (continued)



Coolant temperature above normal– overheat suddenly

Cause	Correction
Coolant level low	Add proper amount of coolant, refer to section 5.4.2
↓Normal	
Coolant temperature sensor malfunction	Calibrate/replace sensor
↓Normal	
Coolant temperature indicator malfunction	Check temperature gauge, if necessary, repair or replace it
↓Normal	
Fan belt damaged or loosened	Check belt tensioner, refer to section 7.1
↓Normal	
Radiator hose depressed, blocked or leakage	Inspect hose
↓Normal	
Radiator pressure cap improper or damaged, specific pressure of the cap set too low	Inspect radiator pressure cap
↓Normal	
Thermostat incorrectly installed or damaged	Inspect thermostat, and replace it if necessary. Refer to section7.1
↓Normal	
Radiator shutters opened incompletely or radiator wind blocker closed in winter	Inspect shutter, repair and replace it if necessary. Open radiator wind block, and check shutter openness
↓Normal	
Air or combusted gas into cooling system	Inspect for the cause of air or combusted gas into cooling system
↓Normal	
Ventilation pipe on the engine or radiator blocked or pipe arrangement improper	Inspect ventilation pipe arrangement and dredge the ventilation pipe
↓Normal	
Water pump malfunction	Inspect water pump operation and replace it if necessary. Refer to section 7.1

Coolant Consumption too high

Cause	Correction
Radiator or cab heater leaking water	Inspect radiator, heater, hoses and connection to locate the leak
↓Normal	
External engine leaking water	Inspect engine and components for seal, or gasket and water drain –cock leaks
↓Normal	
Overheating or leaking compressed air resulting in overflow of the radiator	Inspect for cause of overheat and air leaks (refer to troubleshooting procedure – coolant temperature above normal)
↓Normal	
Lube oil cooler in gearbox leaking water	Inspect if coolant and lube oil in gearbox mixed
↓Normal	
Cylinder head and its gasket of water cooled air compressor leaking water	Inspect lube oil for leaked coolant. Inspect/replace the air compressor cylinder head or its gasket. Refer to device manufacturer specification
↓Normal	
Intercooler leaking water (if the engine is turbocharged with intercooler)	Inspect/replace intercooler, inspect intake manifold or lube oil for coolant. Refer to section 7.1
↓Normal	
Lube oil cooler leaking water	Inspect/replace oil cooler, inspect lube oil for leaked coolant
↓Normal	
Cylinder head gasket leaking water	Inspect/replace cylinder head gasket
↓Normal	
Cylinder liner seal leaking water	Remove oil pan and inspect cylinder liner seal for leak
↓Normal	
Cylinder head cracking, expansion plug on the cylinder head leaking	Inspect/replace cylinder head
↓Normal	
Coolant passage in cylinder block leaking	Inspect/replace cylinder block. Refer to engine overhaul manual

Coolant temperature below normal

Cause	Correction
Too much air through radiator	Inspect fan clutch and fan as required. Refer to manufacturer specification
↓Normal	
Radiator shutters stuck at maximum open position	Inspect shutters, repair or replace it if necessary.
↓Normal	
Thermostat damaged, malfunction, incorrect or failure	Inspect thermostat, and replace it if necessary. Refer to section 7.1
↓Normal	
Fan malfunction	Inspect fan for continuous operation
↓Normal	
Temperature sensor failure	Inspect/check sensor and clean cylinder head water outlet
↓Normal	
Temperature indicator failure	Calibrate temperature indicator, and replace it if necessary.

Coolant contaminated

Cause	Correction
Coolant used for a long time or incorrect mixture of antifreeze, DCA4 and water	Drain up and flush the cooling system, fill it with correct mixture of antifreeze, DCA4 and water. Refer to section 5.8.1
↓Normal	
Gearbox's lube oil cooler leaking oil	Inspect/replace oil cooler. Refer to device manufacturer specification
↓Normal	
Oil cooler, cylinder head gasket, cylinder head and engine cylinder block leaking oil	Refer to troubleshooting procedure "Lubricating oil consumption excessive"

Lube oil contaminated

Cause	Correction
Coolant in the oil and internal engine component leaks	Refer to troubleshooting procedure of " Coolant loss excessive"
↓ Normal	
Excessive oil sludge	Check lube oil and filter replacement intervals. Refer to Chapter 5.5.1
↓ Normal	Use the lube oil of right quality. Refer to Chapter 8.2
Fuel in the lube oil and engine operating too cold	Inspect if engine have idled too long so that the engine runs at below normal temperature
↓ Normal	
Fuel transfer pump seal leaking	Replace fuel transfer pump. Refer to Chapter 7.4
↓ Normal	
Injector needle valve not sealing	Repair and replace malfunctioning injector. Refer to Chapter 7.4
↓ Normal	
Fuel injection pump plunger worn out	Replace fuel injection pump. Refer to Chapter 7.4

Fuel and lube oil leaking from exhaust manifold

Cause	Correction
Air intake restricted	Inspect/replace air filter element, refer to section 5.5.3
↓ Normal	Engine idling time should not too long
Injector needle valve stuck	Locate and replace malfunctioning injector, refer to section 7.4
↓ Normal	
Turbocharger oil return pipe blocked	Inspect/clean inside of oil line thoroughly
↓ Normal	
Turbocharger sealing ring leaking oil	Inspect/replace turbocharger. Refer to section 7.3

Black smoke under load

Cause	Correction
Engine overloaded	Shift to lower gear
↓Normal	
Air in fuel system	Drain air and inspect fuel suction part leakage
↓Normal	
Air filter blocked	Inspect/replace air filter. Refer to section 5.5.3
↓Normal	
Air leak between turbocharger and intake or exhaust manifold	Inspect and fix the leaking at the turbocharger compressor outlet, intercooler air inlet and outlet pipes and hoses
↓Normal	
Air blocked in the intercooler	Inspect/replace intercooler radiating fins, and clean or repair it if necessary
↓Normal	
Incorrect fuel injection pump timing	Inspect and adjust fuel injection pump timing. Refer to section 7.4
↓Normal	
Excessive washers under injector nozzle	Remove extra washers
↓Normal	
Injector nozzle malfunction	Remove and test injector nozzle, and replace it if necessary. Refer to section 7.4
↓Normal	
Turbocharger malfunction	Replace turbocharger. Refer to section 7.3
↓Normal	
Engine running too cold (coolant outlet temperature below 60℃)	Refer to the troubleshooting procedure of "Coolant temperature too low"
↓Normal	
Air/fuel controller malfunction or fuel injection pump supplies too much oil	Remove and calibrate the fuel injection pump. Refer to section 7.4
↓Normal	
Piston ring sealing failure	Check compression pressure in cylinder, and repair it as required.

White smoke when Engine in warm

Cause	Correction
Starting procedure incorrect	Verify correct start procedure. Refer to chapter 4.1
↓Normal	
Coolant temperature too low	Refer to the troubleshooting procedure of "Coolant temperature too low"
↓Normal	
Air intake temperature too low	Refer to shutter operation in vehicle operation manual, and inspect air inlet heater if necessary
↓Normal	
Fuel quality too bad	Verify by operating the engine with a temporary tank full of qualified fuel, and clean the fuel tank
↓Normal	
Fuel injection pump timing adjusted incorrectly	Identify the TDC. Inspect/adjust fuel injection pump timing, and check fuel injection pump timing by observing fuel wave at the fuel delivery valve if necessary. Refer to section 7.4
↓Normal	
Fuel return over–flow valve failure	Inspect/replace fuel return over–flow valve. Refer to section 7.4
↓Normal	
Fuel transfer pump failure	Inspect/replace fuel transfer pump. Refer to section 7.4
↓Normal	
Excessive washers under injector	Remove extra washer
↓Normal	
Fuel injector damaged	Replace fuel injector. Refer to section 7.4
↓Normal	
Coolant leaking into combustion chamber	Refer to the troubleshooting procedure of "Coolant consumption excessive"
↓Normal	
Fuel injection pump failure	Remove and calibrate fuel injection pump. Inspect the fuel deliver valves for dirty. Refer to section 7.4

Engine failed to reach the rated speed when loaded

Cause	Correction
Vehicle overloaded	Reduce load or shift to lower gear
↓Normal	
Throttle linkage adjustment incorrect	Check throttle linkage and adjust stopping screw of full travel to high idle
↓Normal	
Tachometer malfunctioning	Calibrate with pocket or digital tachometer
↓Normal	
Air/fuel controller pipe line leaking air and /or restricted	Tighten connections and clean inside of pipeline thoroughly, and replace pipeline if necessary.
↓Normal	
Air inlet of intercooler blocked	Inspect intercooler element and clean or repair it if necessary. Refer to section 5.5.3
↓Normal	
Fuel supply blocked	Replace fuel filter and check fuel pipe line and strainer for blocked
↓Normal	
Fuel quality too bad	Check with temporary fuel tank with qualified fuel
↓Normal	
Engine shutdown lever not disengaged completely	Inspect/adjust engine shutdown linkage
↓Normal	
Fuel return over–flow valve failure	Inspect/replace fuel return over–flow valve Refer to section 7.4
↓Normal	
Fuel transfer pump damaged	Inspect/repair or replace fuel transfer pump refer to section 7.4
↓Normal	
Fuel injection pump damaged	Remove and calibrate fuel injection pump. Refer to section 7.4

Engine power output insufficient

Cause	Correction
Vehicle overloaded	Inspect for failure parts, additional loading caused by other damaged vehicle parts
↓Normal	
Throttle linkage adjustment improperly	Inspect/adjust throttle linkage as per specification of full travel of the linkage
↓Normal	
Part of mechanical engine shutdown lever blocked	Inspect/adjust the engine shutdown solenoid linkage
↓Normal	
Fuel quality poor	Verify by operating the engine with a temporary fuel tank with good fuel
↓Normal	
Air pipe of air/fuel controller leaking, turbocharger waste-gate control membrane crack, air control pipe of the waste-gate damaged	Tighten fittings and replace pipe, fittings and control membrane if necessary
↓Normal	
Air/fuel controller pipe restricted	Inspect the line between the intake manifold and air/fuel controller
↓Normal	
High pressure fuel pipe or connection leaking	Tighten/replace fitting or high pressure fuel pipe. Refer to section 7.4
↓Normal	
Air in the fuel system	Bleed the fuel system and inspect fuel inlet pipe leaking
↓Normal	
Fuel supply restricted	Clean pre-filter and strainer, inspect fuel inlet pipe resistance and replace fuel filter
↓Normal	
Fuel return over-flow valve failure	Inspect/replace fuel return over-flow valve. Refer to section 7.4
↓Normal	
Fuel transfer pump damaged	Inspect/replace fuel transfer pump. Refer to section 7.4
↓Normal	
Lube oil level too high	Drain oil to normal level
↓Normal	

(To be continued)

Engine power output insufficient (continued)

Cause	Correction
Air intake temperature too high	Make the air outside of the engine cover flow into turbocharger in hot weather
Normal	Inspect intercooler element for blockade
	Inspect inner resistance of intercooler, clean or replace the intercooler. Refer to section 5.5.3
	Inspect/clean line before the intercooler
Air intake or exhaust system restricted	Inspect intake or exhaust system resistance, and inspect air filter, replace it if necessary
↓ Normal	
Fuel temperature high (>70℃)	Fill in the proper amount of fuel, close the fuel heater
↓ Normal	
Leakage between turbocharger and intake manifold	Inspect turbocharger compressor outlet pipe, intercooler connecting pipe and hose for leak
↓ Normal	
Leakage between turbocharger and exhaust manifold	Inspect and fix the leaking and inspect exhaust manifold for crack
↓ Normal	
Injection nozzle worn out or failure	Inspect/replace injection nozzle. Refer to section 7.4
↓ Normal	
Turbocharger damaged	Inspect boost pressure. Replace turbocharger if boost pressure is too low. Refer to section 7.3
↓ Normal	
Valve clearance improper	Adjust valve clearance correctly, inspect push rod, valve spring etc. Refer to section 5.7.1
↓ Normal	
Fuel injection pump timing incorrect	Inspect fuel injection timing. Refer to section 7.4
↓ Normal	
Fuel injection pump worn out or failure	Remove fuel injection pump and check the injection quantity. Refer to section 7.4
↓ Normal	
Compression pressure low	Inspect compression pressure, repair as required

Engine misfiring

Cause	Correction
Fuel contaminated	Verify by operating the engine with a temporary fuel tank that contains good fuel
↓Normal	
Air in fuel system	Bleed the fuel system, inspect fuel suction line for leaking
↓Normal	
High pressure fuel pipe leaking	Inspect loosen fitting, inspect and replace damaged high pressure fuel pipe
↓Normal	
Fuel return over–flow valve failure	Inspect/replace fuel return over–flow valve. Refer to section 7.4
↓Normal	
Fuel transfer pump failure	Inspect/replace fuel transfer pump Refer to section 7.4
↓Normal	
Fuel supply restricted	Clean fuel pre–filter and strainer, inspect fuel pipe resistance, and replace fuel filter
↓Normal	
Incorrect valve clearance adjustment	Inspect push rod, valve spring and adjust the valve. Refer to section 5.7.1
↓Normal	
Fuel injection nozzle blocked or failure	Replace fuel injection nozzle. Refer to section 7.4
↓Normal	
Incorrect fuel injection pump timing	Inspect/adjust fuel injection pump timing. Refer to section 7.4
↓Normal	
Compression pressure of one cylinder or more too low	Check compression pressure and find out the cause (piston ring, cylinder head gasket or valve)
↓Normal	
Incorrect valve train timing	Inspect/correct gear system timing
↓Normal	
Camshaft, push rod damaged	Inspect/replace damaged parts

Engine knock

Cause	Correction
Air in the fuel system	Bleed the fuel system and check fuel suction pipe for leak
↓Normal	
Fuel quality poor	Verify by operating the engine with a temporary fuel tank with good fuel
↓Normal	
Engine overloaded	Check the engine for exceeding design load with low gear
↓Normal	
Fuel injection pump's timing incorrect	Inspect fuel injection pump timing, refer to section 7.4
↓Normal	
Fuel injector malfunction	Remove fuel injector, inspect, and repair. Refer to section 7.4

Engine fuel consumption too high

Cause	Correction
Fuel leakage	Inspect for outer leaking and lube oil diluted by fuel: Inspect the inner leaking of fuel transfer pump and fuel injection pump
↓Normal	
Extra load caused by auxiliary apparatus malfunction	Inspect/repair the auxiliary apparatus and vehicle parts (refer to requirement of manufacturer)
↓Normal	
Incorrect operator technique	Inspect and correctly adjust the operation of gear shifts and idling
↓Normal	
Fuel quality poor	Verify by operating the engine with a temporary fuel tank with good fuel
↓Normal	
Improper intake or exhaust system resistance	Refer to the troubleshooting procedure of "Excessive exhaust black smoke"
↓Normal	
Incorrect fuel injection pump timing	Inspect and adjust fuel injection pump timing. Refer to section 7.4
↓Normal	
Fuel injector worn out or malfunction	Inspect/replace fuel injector. Refer to section 7.4
↓Normal	
Valve leaking	Inspect/adjust valve. Refer to section 5.7.1

Engine vibrates intensely

Cause	Correction
Engine not running smoothly	Refer to the troubleshooting procedure of "Engine running unstable or misfire"
↓Normal	
Engine mounts loose or damaged	Inspect/replace Engine mounting bracket (refer to the maintenance requirement provided by the manufacturer)
↓Normal	
Fan damaged or accessories malfunction	Inspect/replace vibration parts (refer to the maintenance requirement provided by the manufacturer)
↓Normal	
Vibration damper malfunction	Inspect and replace vibration damper. Refer to section 5.8.2
↓Normal	
Fan drive shaft part malfunction	Inspect/replace fan drive shaft part. Refer to section 7.1
↓Normal	
Alternator bearing worn out or damaged	Inspect/replace alternator. Refer to Chapter 7.5
↓Normal	
Flywheel eccentricity	Inspect/check flywheel eccentricity. Refer to section 8.6.22
↓Normal	
Moving parts loosen or damaged	Inspect for the cause of damaged crankshaft and connecting rod and unbalance. Contact the service centers authorized by our company for this task.
↓Normal	
Drive system parts worn out and unbalanced	Inspect/replace it per requirement of the manufacturer

Excessive engine noise

Cause	Correction
Drive belt whistling, tension insufficient or abnormally high load	Inspect the belt tensioner and check the drive belt, to make sure water pump, tensioner, fan hub and alternator rotate freely
↓ Normal	Inspect the tension of accessory drive belt (refer to requirement of device manufacturer), make sure the accessories rotate freely
Intake and exhaust system leakage	Refer to the troubleshooting procedureof "Exhaust black smoke under load"
↓ Normal	
Valve clearance too large	Adjust the valve clearance. Make sure the push rods are not bent or the rocker levers are not severely worn out. Refer to section 5.7.1
↓ Normal	
Turbocharger noise	Inspect turbocharger impeller and turbine wheel for housing contact
↓ Normal	
Gear noise	Check/replace vibration damper. Refer to section 5.8.2

Alternator not charging or insufficient charging

Cause	Correction
Battery connections loose or corroded	Clean/tighten battery connections
↓ Normal	
Improper Battery condition	Check the battery charging condition
↓ Normal	
Alternator belt slipping	Inspect/replace the tensioner
↓ Normal	
Instrument or indictor lamp malfunction	Check/replace the instrument or lamp
↓ Normal	
Alternator wires loosen or damaged	Repair wires
↓ Normal	
Alternator malfunction	Replace alternator. Refer to section 7.5

Excessive engine blow-by

Cause	Correction
Ventilation pipe of crankcase blocked	Check ventilation device and ventilation pipe for blocked
↓Normal	
Turbocharger seal leakage	Inspect turbocharger seal
↓Normal	
Air compressor failure	Inspect air compressor
↓Normal	
Valve guide over worn	Replace cylinder head and contact the service center authorized by SDEC for the task
↓Normal	
Piston ring damaged or worn out	Inspect piston ring and cylinder liner, and contact the service center authorized by SDEC for the task

Excessive noise from air compressor operation

Cause	Correction
Too much carbon buildup in the air compressor	Inspect air compressor for carbon buildup
↓Normal	
Air compressor drive gear or the engine gear system damaged	Inspect the condition of each gear, repair if necessary
↓Normal	
Air compressor inner damaged	Remove air compressor. Refer to section 7.6

Too much oil in air compressor (pumping oil to air system)

Cause	Correction
Air compressor cylinder or piston ring worn out or damaged	Inspect air compressor outlet

Air compressor pressure rises slowly

Cause	Correction
Air system leakage	Inspect air compressor gasket for leakd or other air system for leaking as per the requirement of manufacturer
↓Normal	
Too much carbon buildup in air compressor outlet	Inspect outlet pipe
↓Normal	
Air compressor relief valve failure	Inspect relief valve operation
↓Normal	
Air compressor intake, exhaust valves leaking	Inspect intake/exhaust valves.

Air compressor cannot keep enough air pressure (Unable to pump air continuously)

Cause	Correction
Air system leaking excessively	Inspect air system pipe line, refer to the requirement of the manufacturer
↓Normal	
Air regulator failure or adjustment incorrect	Inspect air regulator valve

Air compressor cannot pump

Cause	Correction
Air system leaking excessively	Inspect air system pipeline. Refer to the requirement of manufacturer
↓Normal	
Air regulator failure or adjust incorrectly	Inspect air regulator operation
↓Normal	
Air compressor relief valve failure	Inspect relief valve operation

Air compressor will not stop pumping

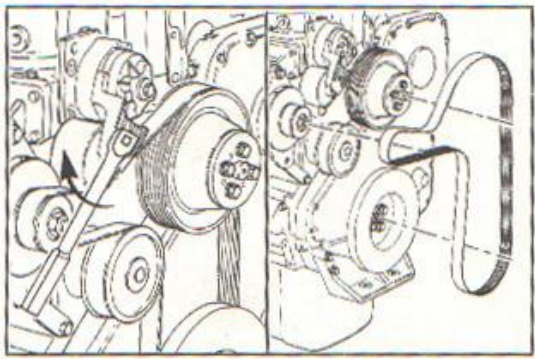
Cause	Correction
Air system leaking	Inspect air compressor gasket for leaking Refer to the requirement of manufacturer
↓Normal	
Air compressor relief valve cannot get correct signal from air regulator	Inspect air regulator operation
↓Normal	
Air compressor relief valve leaks	Inspect relief valve operation
↓Normal	
Improper air compressor relief valve spring	Inspect relief valve spring specification and load

Preheating plug for cold starting (auxiliary) malfunction

Cause	Correction
Indicator lamp not flashing, preheating plug heating not high enough	Start after the indicator lamp flashes
↓ Normal	
The time from indicator lamp flashes to start up too long	If the time from indicator lamp flashes to start up is over 30s, Re-connecting air intake preheating auxiliary apparatus circuit
↓ Normal	
Voltage lower than 20V (24V battery cell)	Charge or replace battery
↓ Normal	
Indicating lamp failure	Inspect light bulb, socket, wire etc
↓ Normal	
Preheating plug failed to heat	Inspect/repair the preheating plug circuit
↓ Normal	
Electrical heater of preheating plug damaged	Inspect preheating plug electrical heater
↓ Normal	
Temperature sensor damaged	Inspect temperature sensor, replace if necessary
↓ Normal	
Engine circuit system damaged	Inspect the grounding, insulation for worn, connection corrosion and other defects
↓ Normal	
Fuel to preheating plug shortage	Inspect the sediment in fuel pipe, heat fuel pipe and preheating plug to remove wax sediment
↓ Normal	
Solenoid not opened	Inspect solenoid
↓ Normal	
Preheating plug filter blocked	Remove fuel pipe, clean filter
↓ Normal	
Carbon buildup on preheating plug or it blocked	Inspect preheating plug for carbon buildup and blockage
↓ Normal	
Fuel pipe leakage	Repair leakage
↓ Normal	
Controller grounding wire damaged	Inspect the grounding for corrosion or loose connection
↓ Normal	
Controller without voltage	Inspect the controller connections "15" and "30" for loosening, corroded or damaged. Inspect the circuit and start switch
↓ Normal	
Controller damaged	Inspect the controller logic or replace the controller

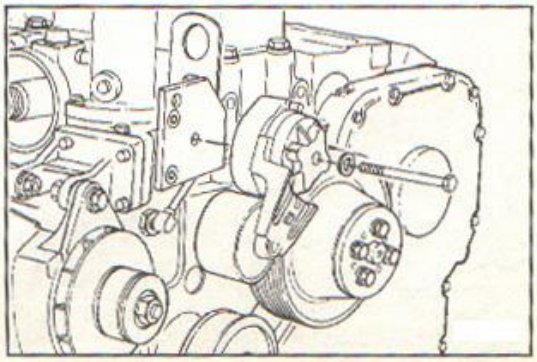
7 Replacement, Repair, Installation and Adjustment

7.1 Replacement, Repair, Installation and Adjustment of Cooling System Components, and Replacement of Drive Belt



Rotate the tensioner with torque drive in the direction of wind-up to remove or install the belt. Do not rotate it in opposite direction of wind-up can cause the tensioner arm to break.

Replacement of Belt Tensioner



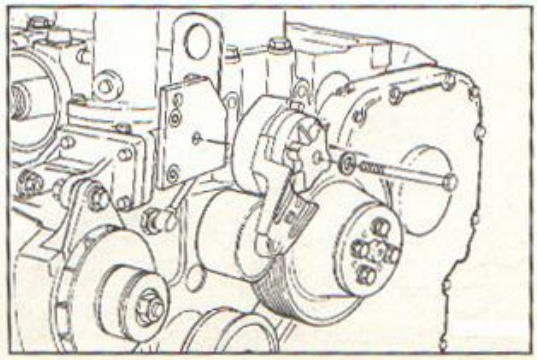
Preparatory Step:

●Remove the drive belt.

Remove the belt tensioner from the bracket.

△Attention: There are two threaded holes in the bracket for installing the tensioner. Check the location of these holes when removing to avoid installing the tensioner in wrong position.

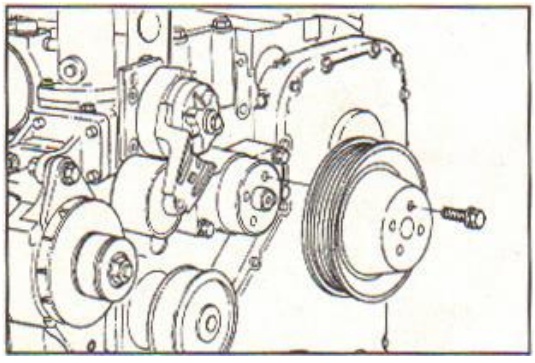
Installation of Belt Tensioner



Torque value: 45 Nm

△Attention: Keep the position of installation identical to that of removal.

Replacement of Fan Pulley



Preparatory Step:

●Remove the drive belt.

△Attention: Loosen the capscrews before removing the belt and torque the capscrews after the belt is installed.

Removal and Installation of Fan Pulley

Remove the four capscrews, fan and spacer.

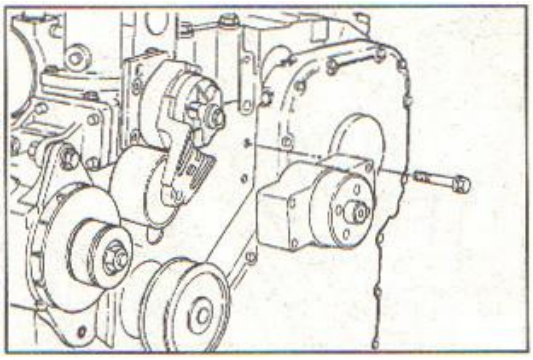
Install the pulley in the reverse order of removal.

Torque value: 80 Nm

Replacement of Bearing Base of Fan Pulley

Preparatory Steps:

- ●Remove the drive belt.
- ●Remove the fan pulley.



Removal and Installation of Bearing Base of Fan Pulley

Remove the four capscrews and replace the bearing base of fan pulley.

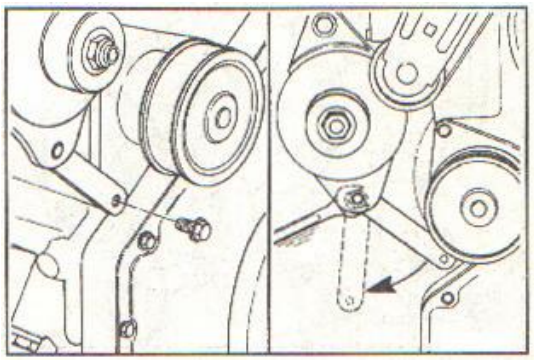
Torque value: 25 Nm

Replacement of Water Pump

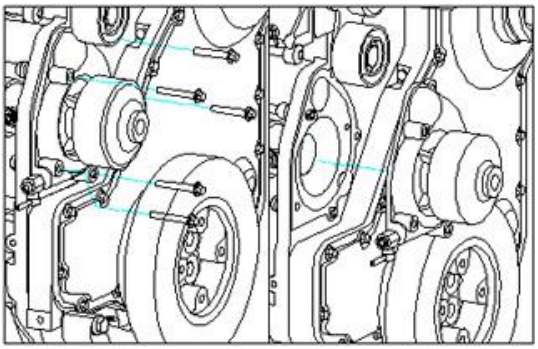
Preparatory Steps:

- ●Drain the coolant.
- ●Remove the drive belt.

Remove the alternator link.

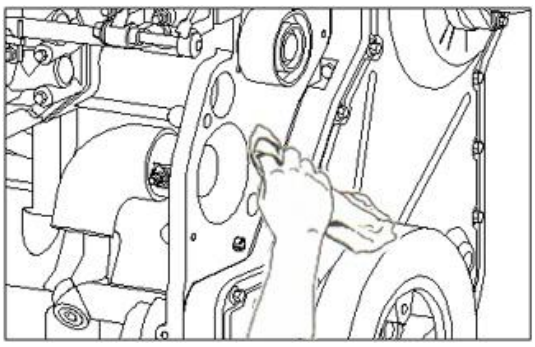


Remove water pump.

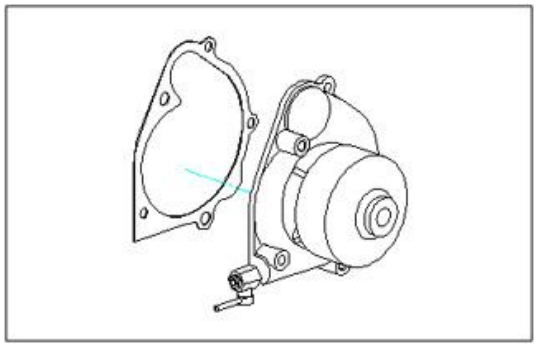


Remove old gasket and clean the sealing surface on the cylinder block.

△Attention: If the outlet of water drain in the cylinder block is blocked, clean it.



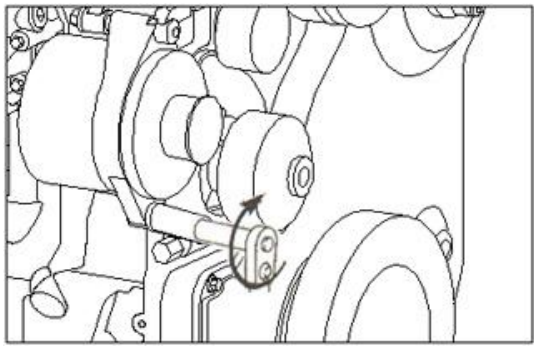
Install a new gasket.



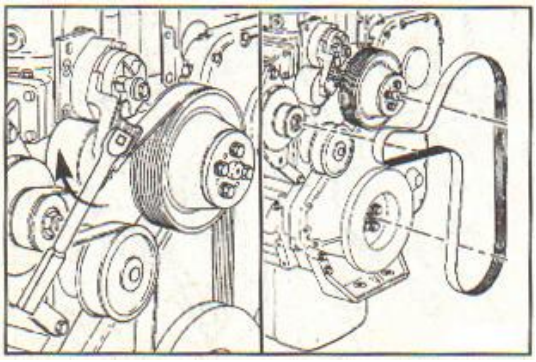
Install water pump and alternator link

● Torque value of water pump capscrew: 25Nm

● Torque value of alternator link capscrew: 45Nm



Lift tensioner arm to install drive belt.



Replacement of Thermostat

Preparatory Steps:

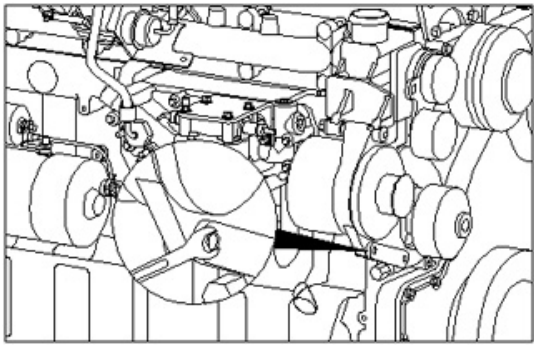
● Disconnect the cable between alternator and battery.

● Drain 2~3 liters of coolant.

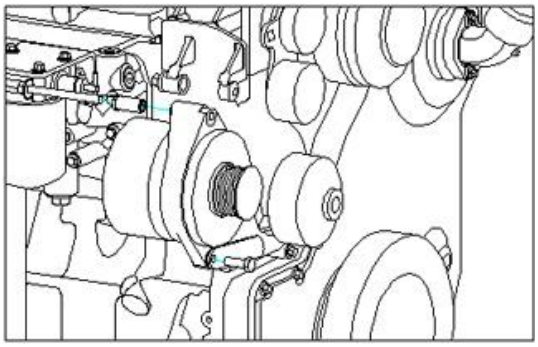
● Remove the water outlet hose.

● Remove the drive belt.

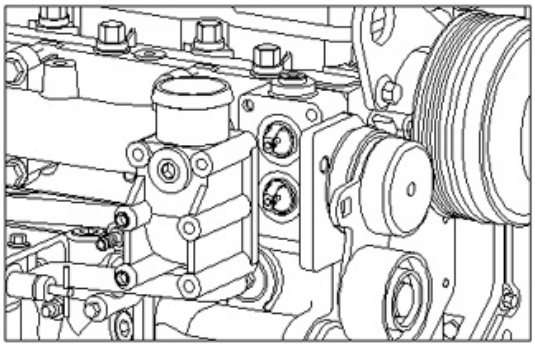
Loosen the capscrew to the alternator link.



Remove the alternator mounting capscrew and alternator.

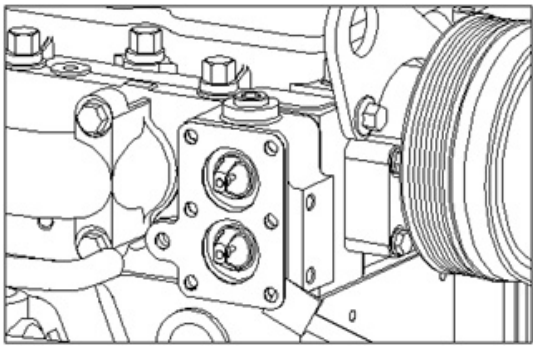


Remove the alternator bracket and water outlet hose.

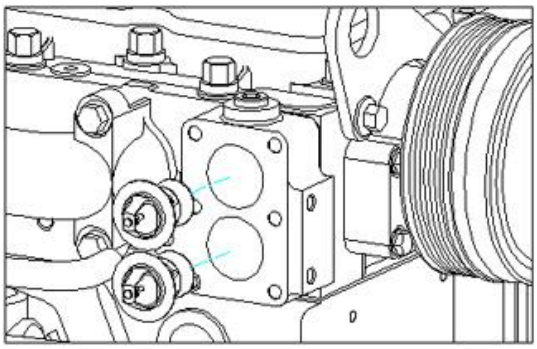


Remove the thermostat and clean the gasket surface.

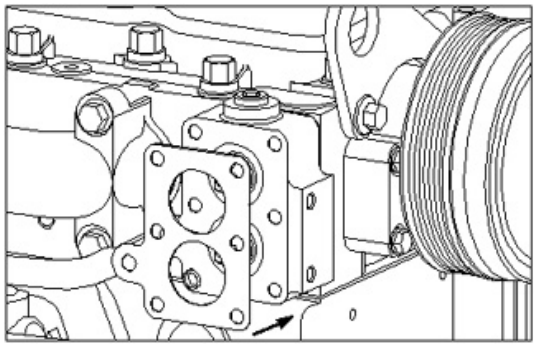
△Attention: Do not let any debris fall into the thermostat chamber when cleaning gasket surface.



Install a new thermostat.

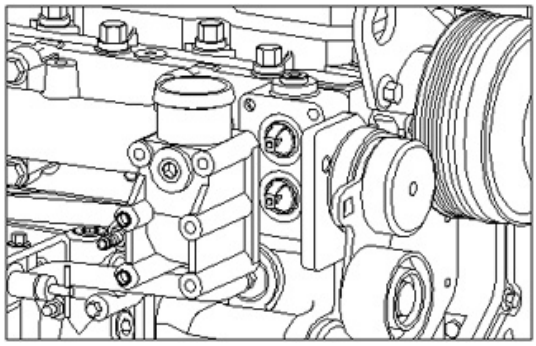


Install a new gasket.



Install water outlet hose and alternator bracket.

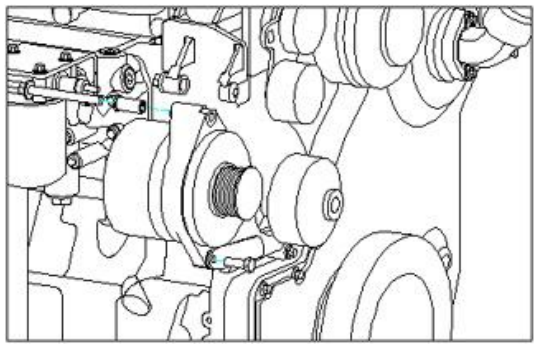
Torque value: 25 Nm



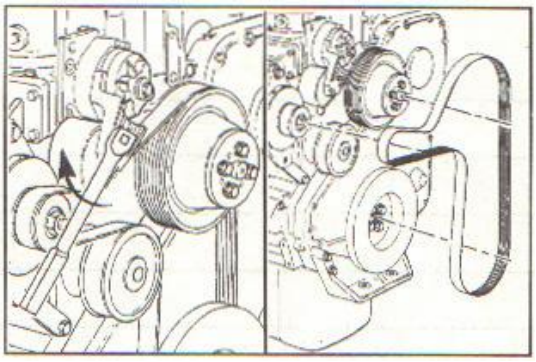
Install alternator.

●Torque value of alternator mounting capscrew: 45 Nm

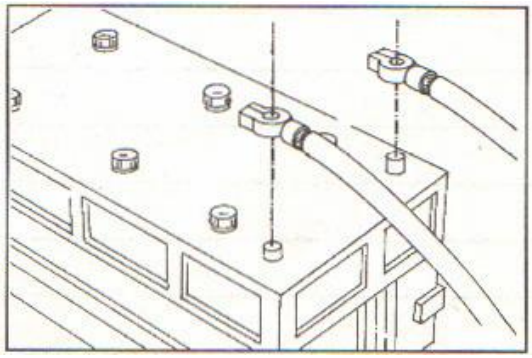
● Torque value of alternator link capscrew:45 Nm



Install the drive belt.

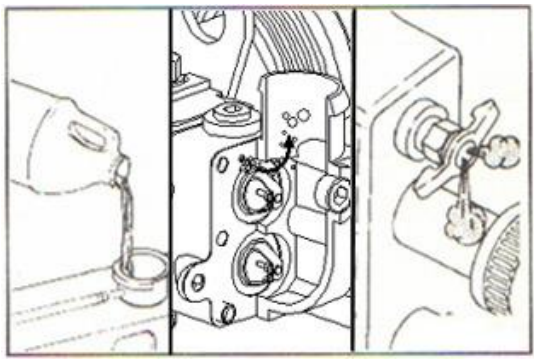


Connect the cable between alternator and battery and tighten the fittings.



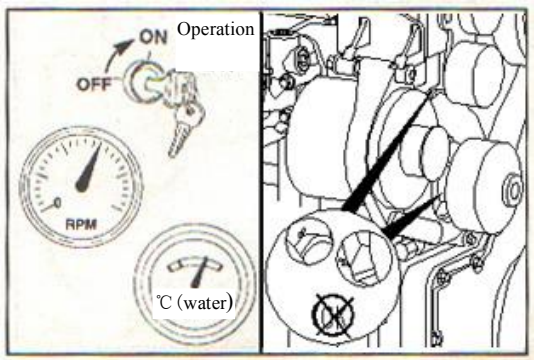
After replacement and installation, fill up the cooling system with coolant specified in this manual.

△Attention: During filling, air must be vented from the engine coolant passages. Be sure to open the petcock on the intercooler for intercooled engine. The system must be filled slowly to prevent air locks. Wait 2 to 3 minutes to allow air to be vented. Then add coolant to bring the level to the radiator inlet.



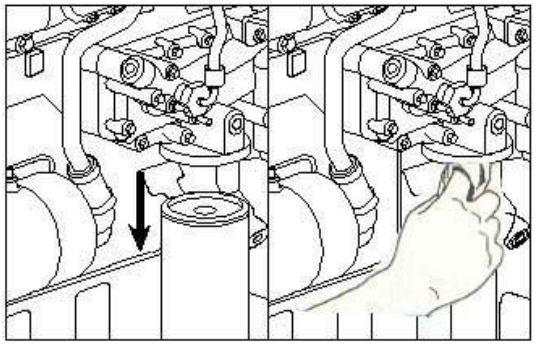
Install the pressure cap.

Operate the engine until it reaches a temperature of 80℃ and check for coolant leaks.

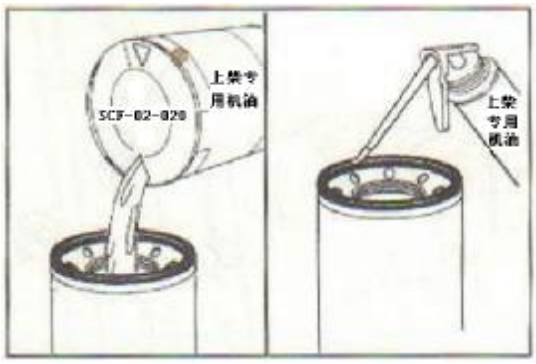


7.2 Parts of Lubricating System–Replacement, Repair, Installation and Adjustment Oil filter–Replacement

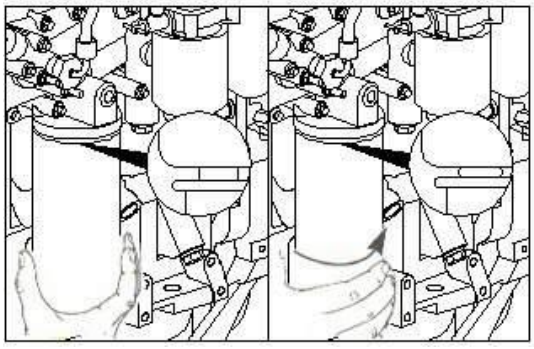
Clean the debris from around the oil cooler base. Remove the oil filter with ratchet and clean the sealing surface of oil cooler base.



Apply a light film of clean lubricating oil specified by SDEC (Shanghai Diesel Engine Company) to the gasket sealing surface before installing the oil filter, and fill up the oil filter with clean oil.



Install the oil filter to the filter base. Turn the filter with hand until it reaches the surface of the base, then turn it 3/4 circle more with ratchet or follow the manufacture´ s instructions for tightening.

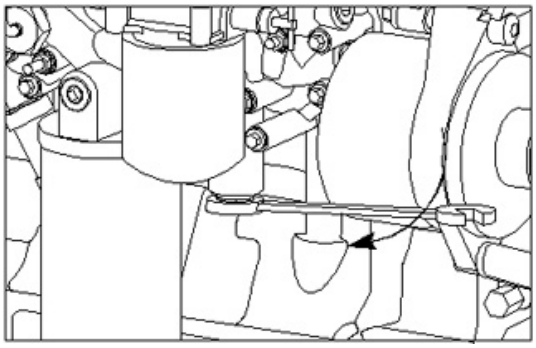


Replacement of Oil Pressure Regulator, Valve and Spring

Preparatory Steps:

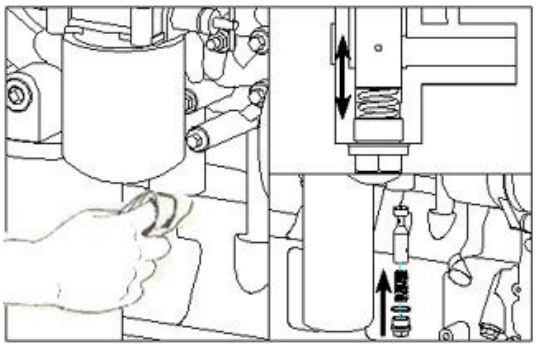
● Clean debris from around oil pressure regulator.

● Remove the plug, regulator valve and spring.



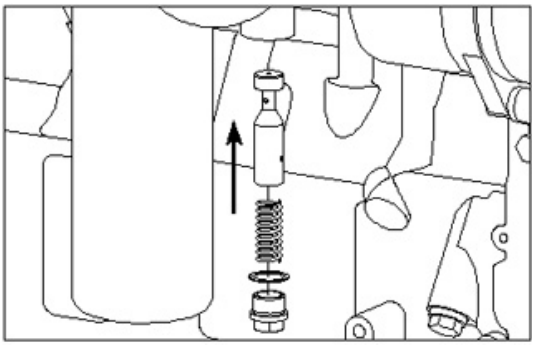
Clean and inspect the regulator valve and the bore before assembly.

△Attention: The valve must move freely in the bore.



Install the regulator valve and spring.

Torque value: 80 Nm

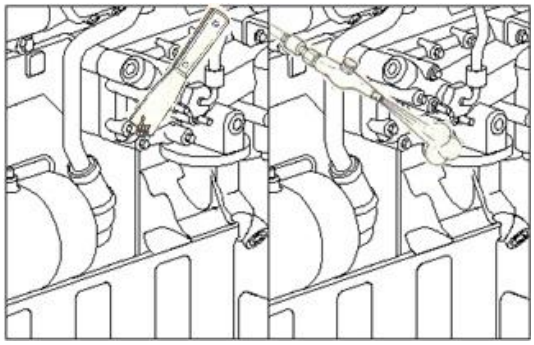


Replacement of Oil Cooler

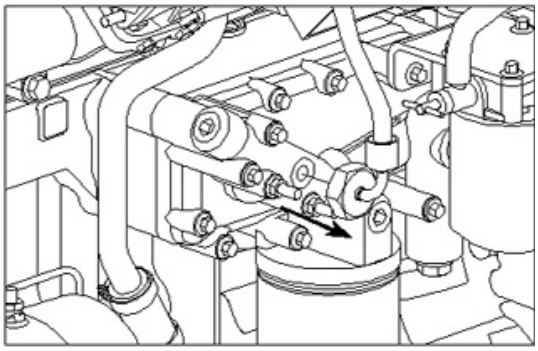
Preparatory Steps:

- Drain the coolant.
- Remove the oil filter.

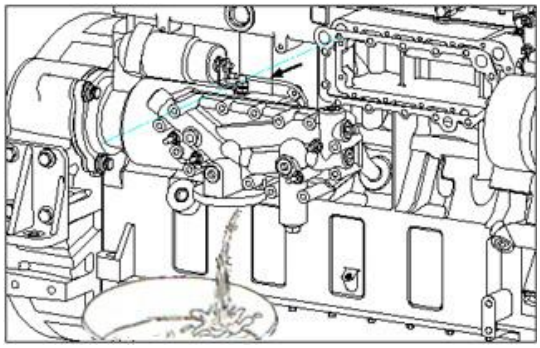
Clean all debris from around the oil cooler.



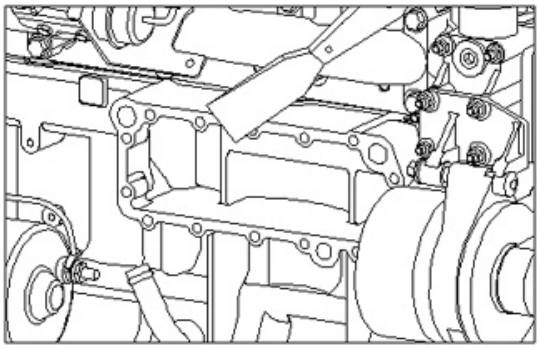
Remove the turbocharger oil inlet line from the oil cooler cover.



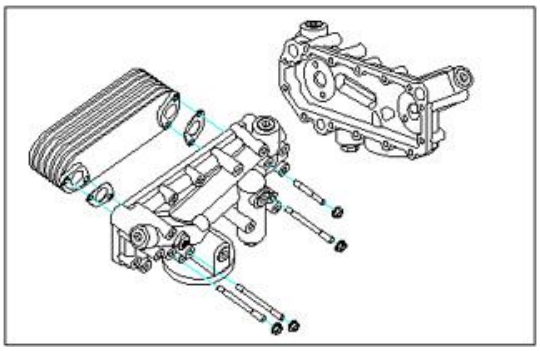
Remove the oil cooler cover and element (re–move them together).



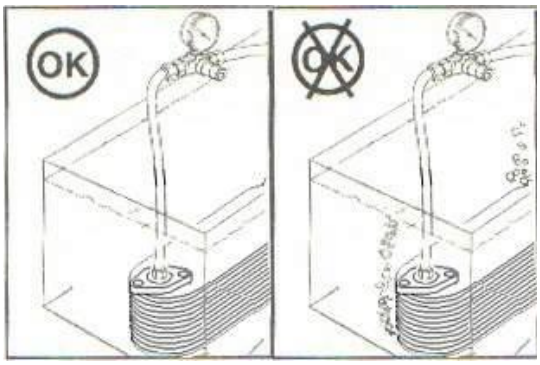
Clean the sealing surface of cylinder block.



Depart the oil cooler cover and the cooler element. Clean the inlet and outlet flange surfaces of the element and sealing surface of the cover.

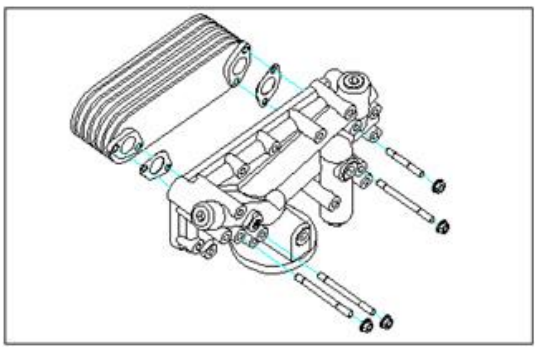


Pressurize the element with 490 kPa to check it for leaks. If leaks happen, replace the element.



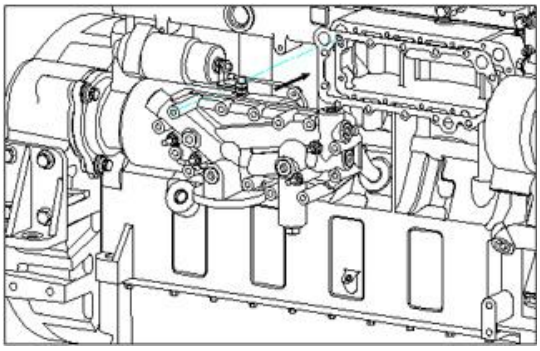
Install a new oil cooler element gasket, and then assemble the oil cooler cover and element.

Torque value: 25 Nm



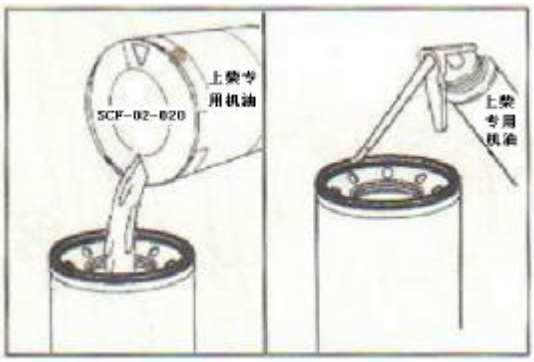
Assemble the oil cooler cover, element and oil cooler gasket to the cylinder block.

Torque value: 25 Nm



Install a new lubricating oil filter.

Follow the instructions for replacement of oil filter.

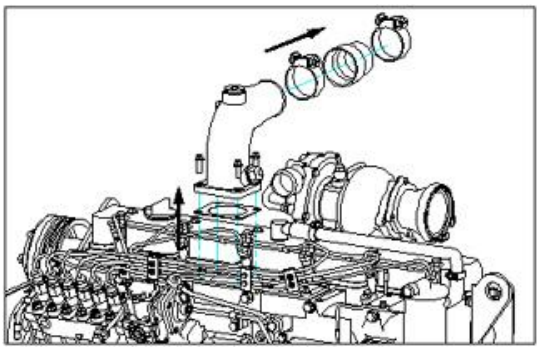


7.3 Parts of Air System–Replacement, Repair, Installation and Adjustment

Replacement of Compressor Air Outlet Pipe

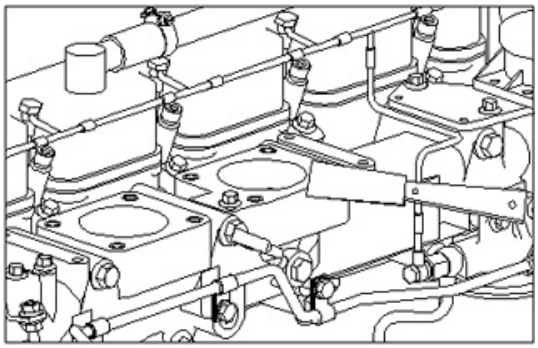
Loosen the hose clamp of air crossover tube.

Remove the capscrews of the compressor air outlet pipe. Remove the air outlet pipe and gasket.



Clean the sealing surface of intake inlet.

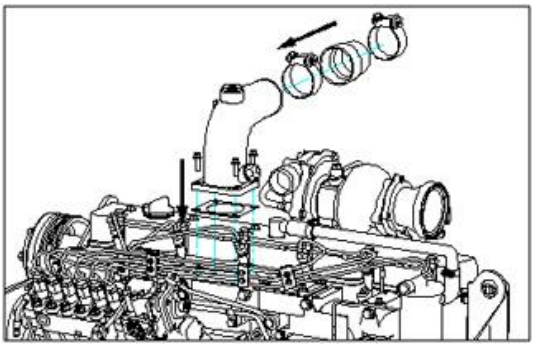
△Attention: Keep the gasket material and any other material out of the air intake manifold.



Install the compressor air outlet pipe, air crossover tube (hose) and a new gasket.

Torque value of the capscrews of compressor air outlet pipe: 25Nm

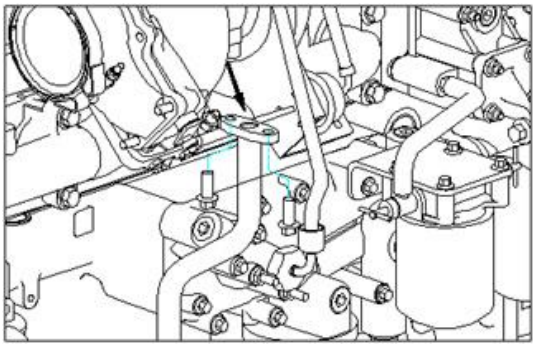
Torque Value of hous clamp: 5 Nm



Replacement of Turbocharger

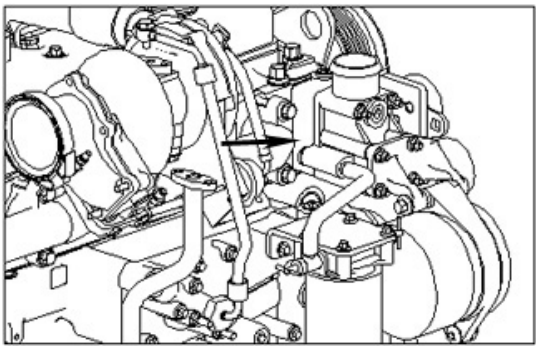
Preparatory Steps:

- Remove compressor exhaust pipe.
- Disconnect intercooler hoses.
- Disconnect the waste –gate actuator line.
- Disconnect air inlet pipe of the compressor and the exhaust pipe of the turbine.

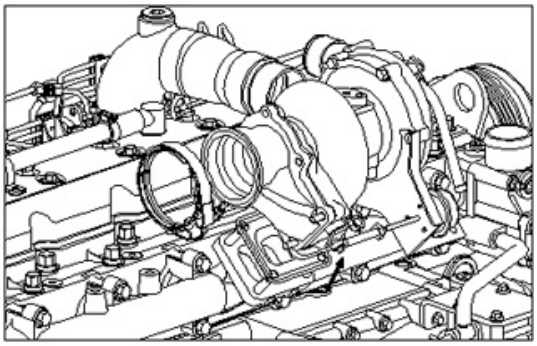


Remove the oil drain tube.

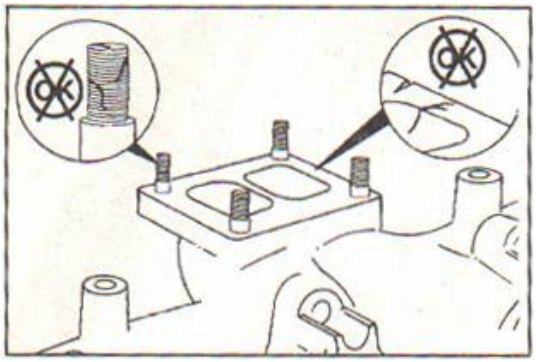
Remove the oil supply line.



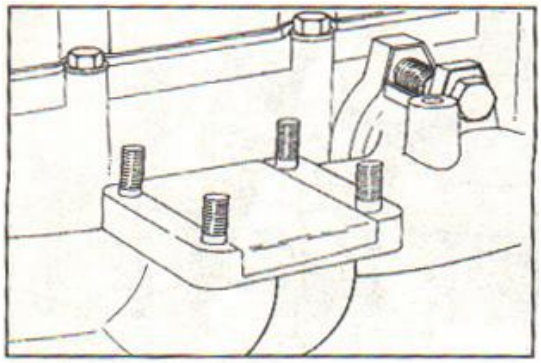
Remove the exhaust pipe clamp of turbine, turbocharger and gasket.



Clean the sealing surface of the exhaust manifold. Inspect the sealing surface and mounting studs for damage.

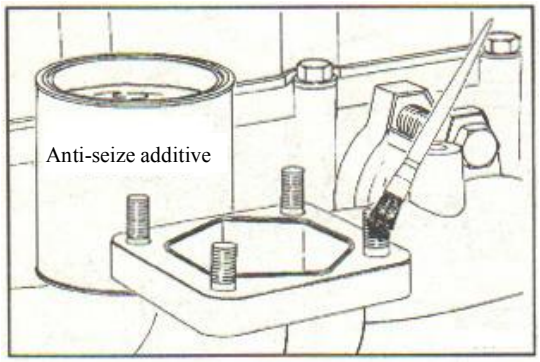


If the turbocharger is not to be immediately replaced, cover the opening to prevent any material from falling into the manifold.



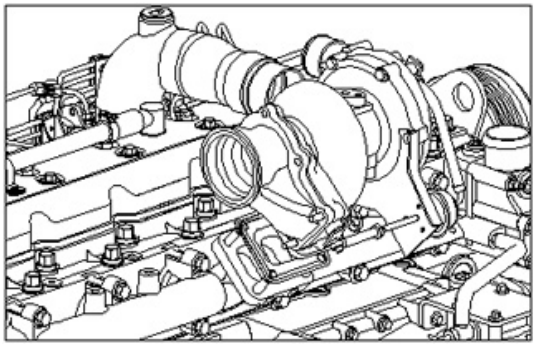
Install a new gasket.

Apply anti-seize additive (Loctite 76732) to the mounting studs.



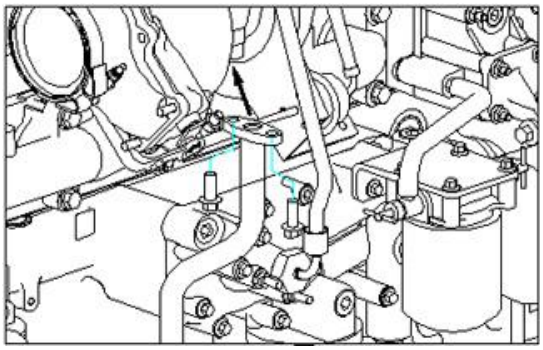
Install the turbocharger.

Torque value: 45Nm



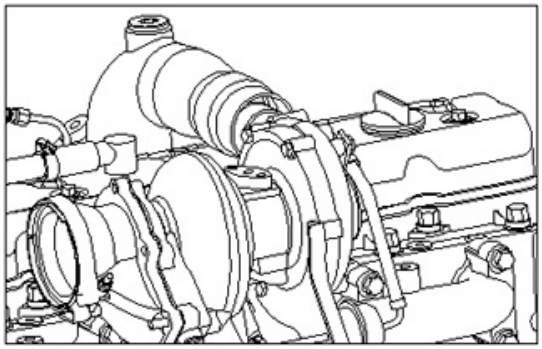
Install the turbocharger oil drain tube and a new gasket.

Torque value: 25Nm



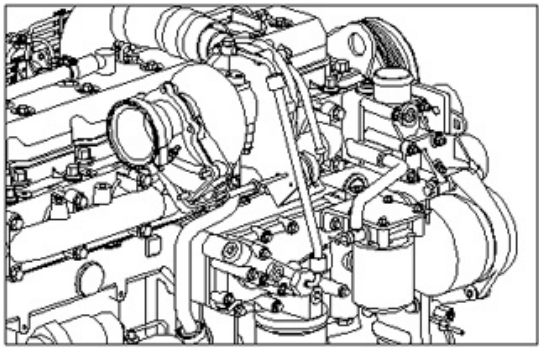
Pour 50~60 cc oil specified by SDEC into the oil inlet of the turbocharger. Rotate the turbine wheel to allow the lube oil to enter the bearing housing.

△Attention: The new turbocharger should be pre-lubricated before the engine starts.

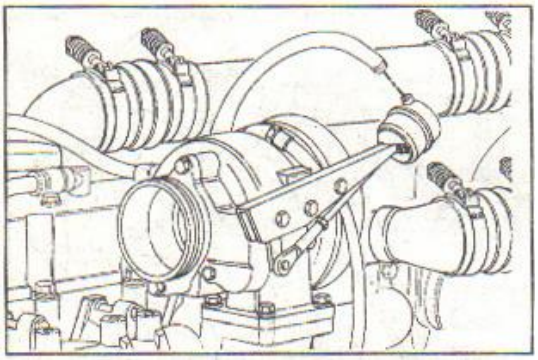


Connect the oil supply line.

Torque value: 15Nm



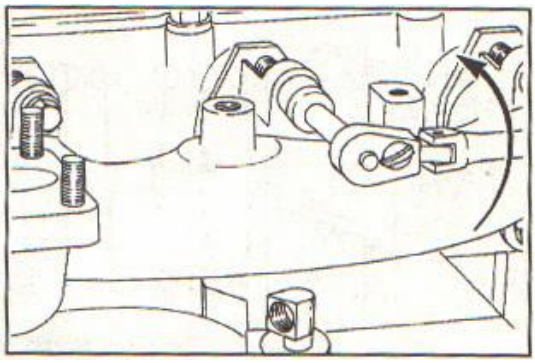
Connect the waste-gate actuator line.



Replacement of Exhaust Manifold and Gasket

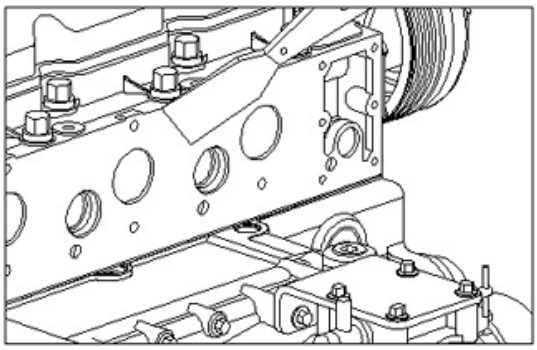
Preparatory Steps:

- Remove the air crossover tube.
- Disconnect the intercooler hoses.
- Disconnect the air inlet pipe of the compressor and the exhaust pipe of the turbine.
- Remove the turbocharger.
- Remove the heat shelter

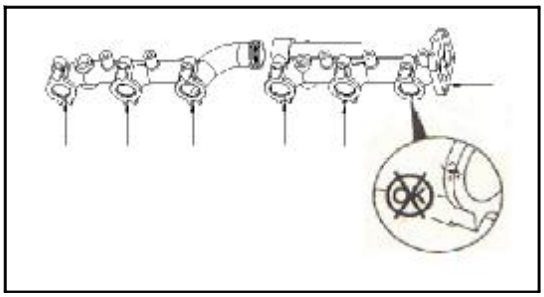


Remove the exhaust manifold and gaskets.

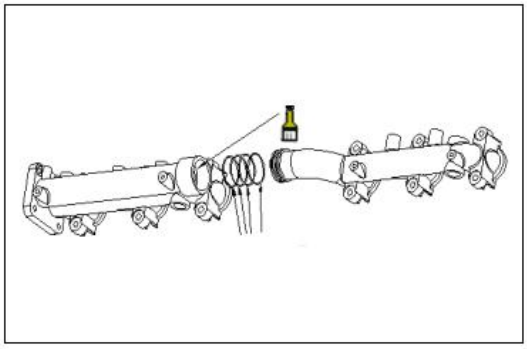
Clean the exhaust manifold sealing surfaces.



Inspect the exhaust port surfaces for scratches and burn-out.

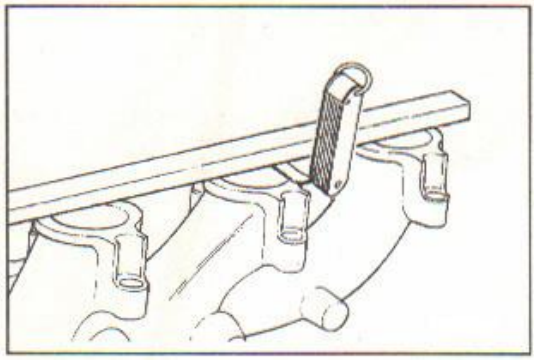


Clean buildup carbon on sealing ring grooves and connecting hole surfaces. Check the rings and replace them when seriously deformed.

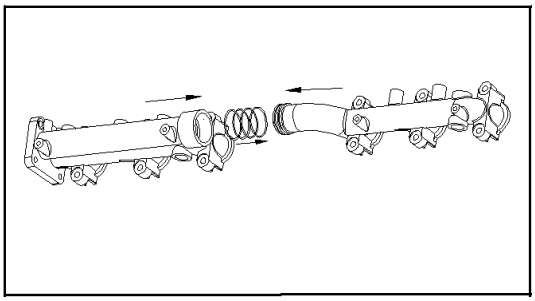


Place a straight edge across the exhaust ports to check for flatness.

Flatness value≤0.20mm



Install the sealing rings and connect two segments of the manifold.

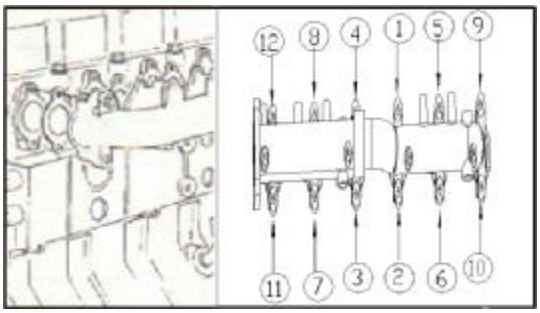


Install the exhaust manifold and new gaskets.

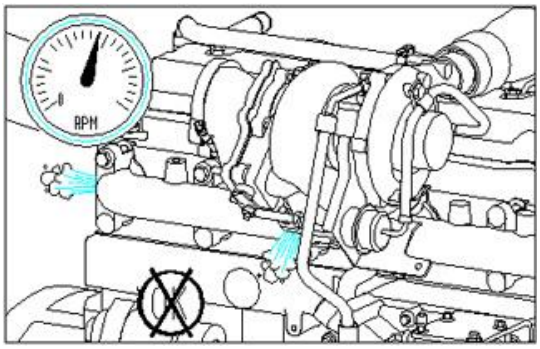
Follow the tightening sequence shown in the illustration and tighten twice.

Torque value(first time): 25Nm

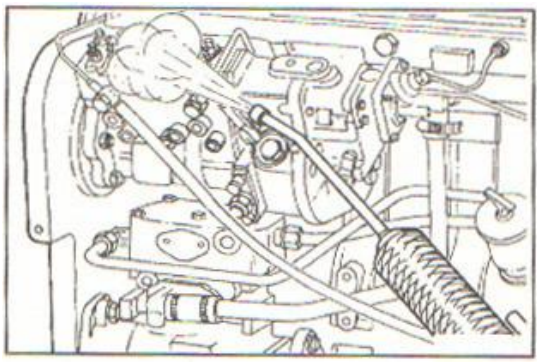
Torque value(second time): 45Nm



Install the parts previously removed. Operate the engine and check for leaks.



7.4 Replacement, Repair and Installation and Adjustment of Fuel System parts

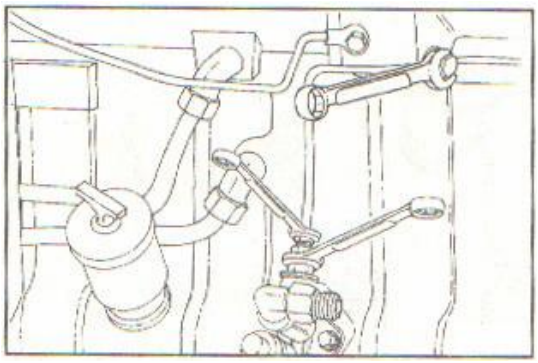


Preparatory Steps:

●Clean all parts of fuel system

△Attention: Thoroughly clean all fittings and components. Make sure that debris, water, steam or cleaning solution does not reach the inside of the fuel system.

Replacement of Low Pressure Fuel Line



Preparatory Steps:

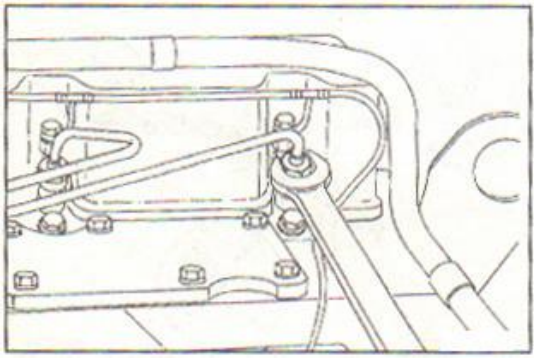
●Cleaning debris from fittings.

Disconnect the fuel line from the fuel transfer pump and fuel filter.

△Attention: Use two wrenches to loosen the line fitting of the fuel transfer pump.

Torque value: 25Nm

Replacement of High Pressure Fuel Lines



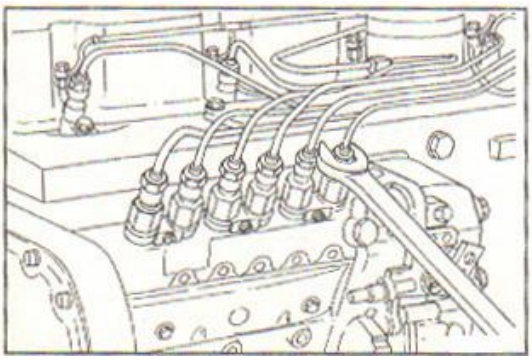
Remove the high pressure fuel lines.

Clean debris from around the fuel lines.

If only replace one line, just remove its vibration isolating clamper.

Disconnect the lines from the fuel injectors.

△Attention: Prevent debris from falling into the fuel injection pump.



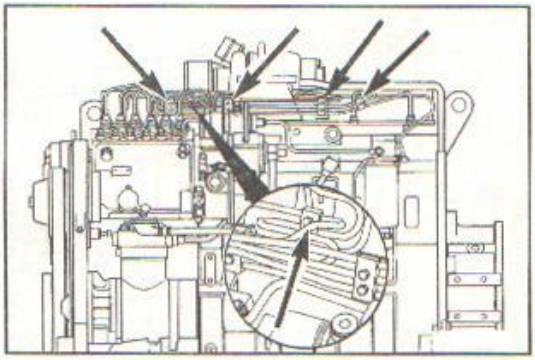
Disconnect the lines from the fuel injector pump.

△Attention: Prevent debris from falling into the fuel deliver valve of the fuel injection pump.

Installation of High Pressure Lines

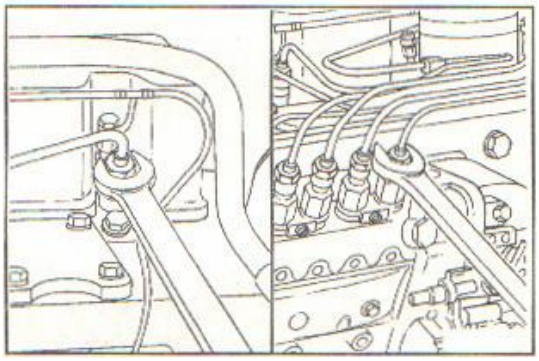
Loosen the capscrews of vibration isolating clamper so the fuel lines can be easily moved.

Note: To prevent breakage to the fuel lines, they must be connected to the injector and fuel injection pump in a "free" state without forcing the connecting fittings.



Install the lines in the reverse order of removal.

△Attention: If removed, install the vibration isolator clamper in the original position and make sure the lines do not contact each other or another component.



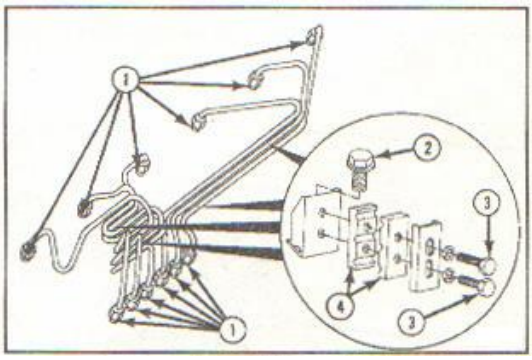
Tighten all fittings and mounting hardware.

Torque value:

Line fitting nuts: 45Nm

Support bracket capscrews: 25 Nm

Vibration isolating clamper: 6 Nm



Replacement of Fuel Drain Manifold

Clean debris around the fuel drain manifold.

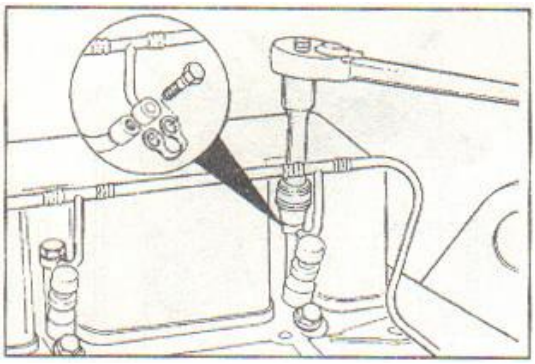
Remove the banjo bolt from the injectors and fuel filter base.

Install the fuel drain line in the reverse order of removal.

Torque value:

Fuel filter base banjo bolt: 15Nm

Injector banjo bolt: 9 Nm

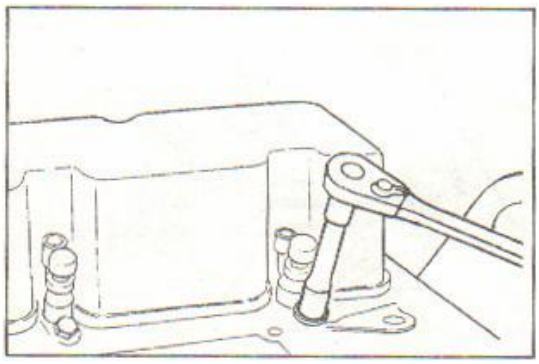


Replacement of Injector

Preparatory Steps:

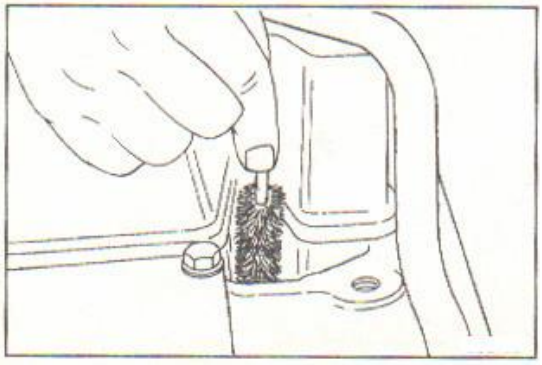
- ●Thoroughly clean around the injectors.
- ●Disconnect the high pressure fuel lines.
- ●Disconnect the fuel drain line.

Remove the injectors.



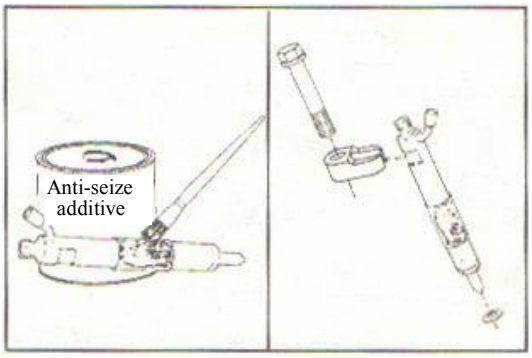
Clean the injector nozzle bores.

△Attention: If the injector sealing sleeves are melted, it is an indication the engine has been operating in overloaded condition.



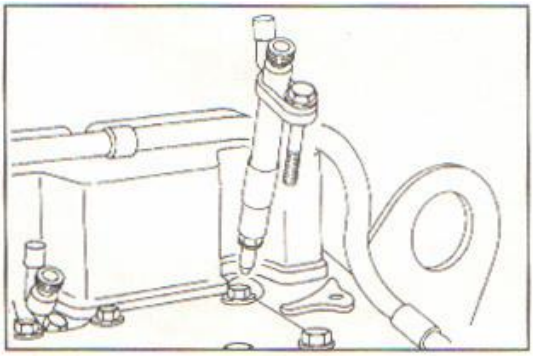
Lubricate the sealing lips of the sleeve with anti-seize additive (Loctite 7673). Assemble the injector, a new copper washer and the injector clamper.

△Attention: Install only one washer.



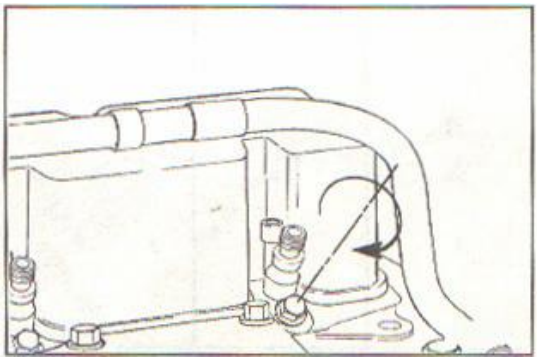
Install the injectors into the injector bores.

The injector leak-off connection must be toward the valve cover.



Install the injector clamper capscrew.

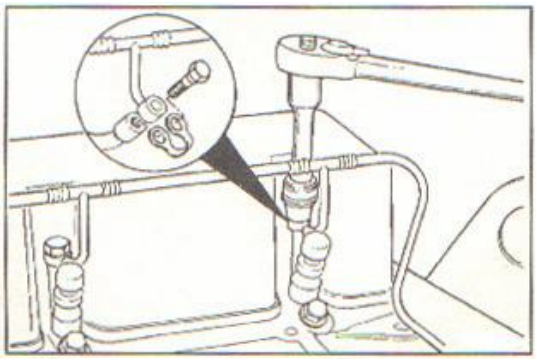
Torque value: 25 Nm



Install the fuel drain manifold.

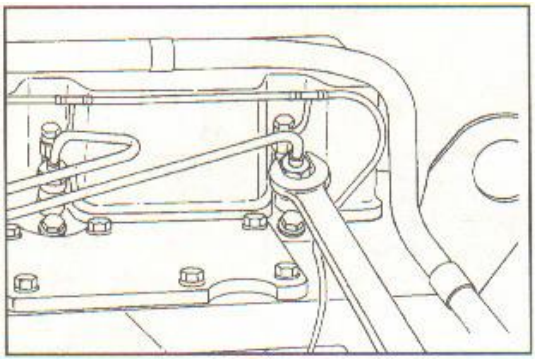
Torque value: 9 Nm

Note: The banjo bolt seal must be installed as shown in the illustration.



Install the high pressure fuel lines.

Torque value: 45 Nm



Replacement of Fuel Shutoff Solenoid

Preparatory steps:

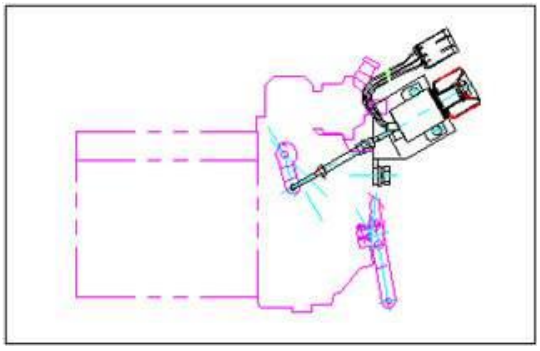
● Disconnect the wiring.

Removal and installation of R801 and R901 governor fuel shutoff solenoid

Remove the hitch pin clip, mounting capscrews and the fuel shutoff solenoid.

Install the new solenoid in reverse order of removal and connect the wires.

Torque value: 10 Nm

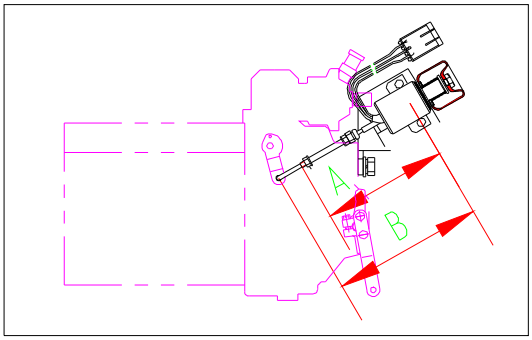


Activate the switch and check the plunger travel:

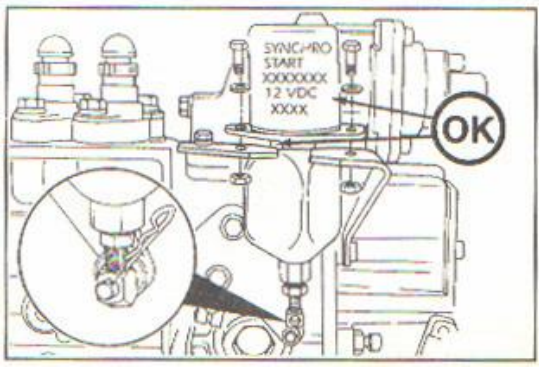
A=184±1mm

B=209.4±1mm (activated)

△Attention: After the solenoid is powered, the solenoid linkage reach out to position B where the shutoff level of the solenoid should not interfere the throttle rack of the fuel injection pump to travel to its max stroke. Adjust the length of the linkage if the interference occurs .



Note: Loosen two small hex nuts, and then turn the large hex nut on the middle of the plunger to make adjustments and tighten the small nuts after the adjustment.



Removal and Installation of RQVK Governor Fuel Shutoff Solenoid

Remove the hitch pin clip, mounting capscrews and the fuel shutoff solenoid.

Install the new solenoid in reverse order of removal and connect the wires.

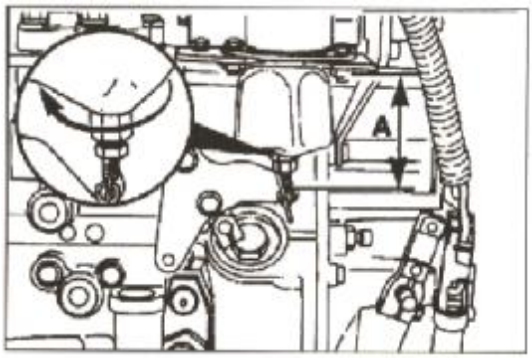
Torque value: 10 Nm

Activate the switch and check the plunger travel:

A=71.1 mm

B=46.5 mm (activated)

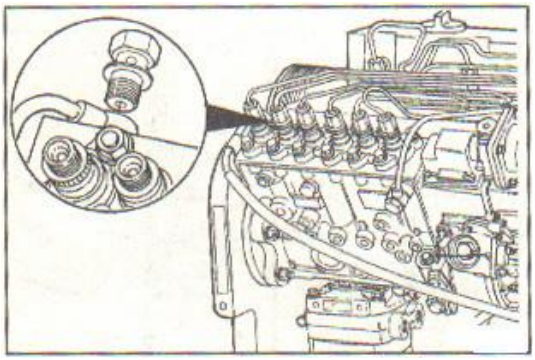
△Attention: After the solenoid is powered, the solenoid linkage draws back to position B where the shutoff level of the solenoid should not interfere the throttle rack of the fuel injection pump to travel to its max stroke. Adjust the length of the linkage if the interference occurs.



Note: Loosen two small hex nuts, and then turn the large hex nut on the middle of the plunger to make adjustments and tighten the small nuts after the adjustment.

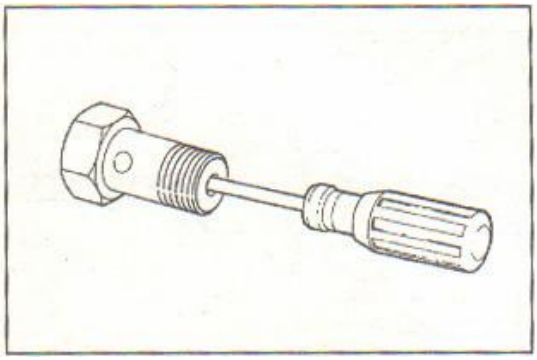
Replacement of Relief Valve of Fuel Injection Pump

Remove the relief valve and copper sealing washers.



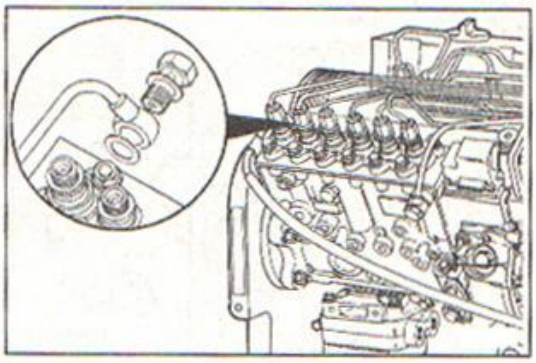
Use a small screwdriver to check the relief valve ball for seizure.

△Attention: A seized relief valve ball will result in low engine power.



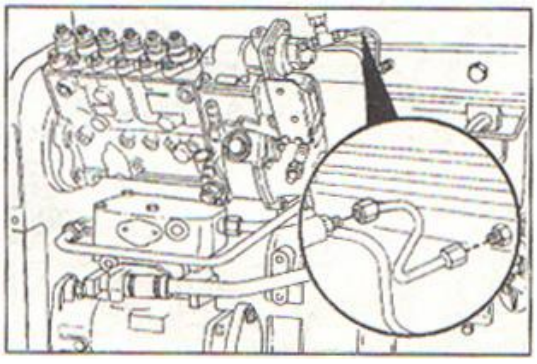
Thoroughly flush the relief valve with cleaning solution.

Install the relief valve assembly in the reverse order of removal.



Replacement of Air/Fuel Control Tube

Remove the tube.

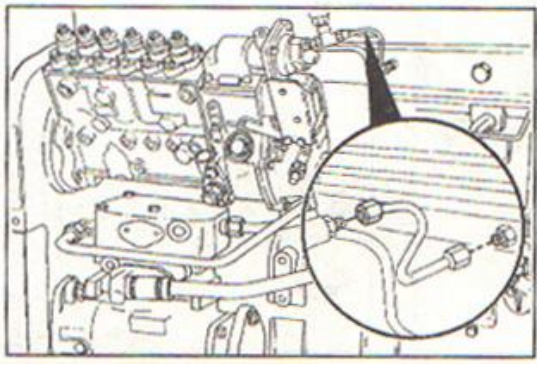


Install the tube, and use new a copper washer for banjo fitting.

Torque value:

Banjo bolt: 25 Nm

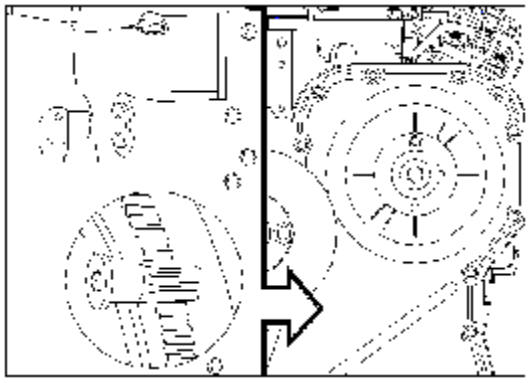
Tapered threaded fitting: 8 Nm



Replacement of Fuel Injection Pump

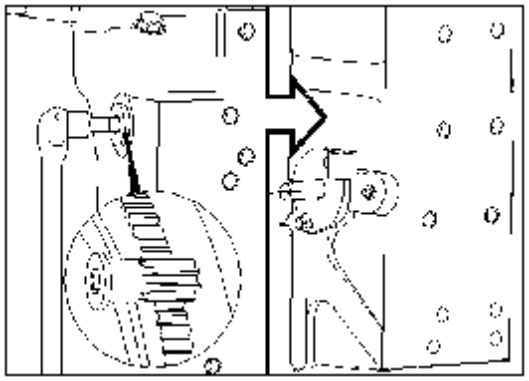
Preparatory Steps:

- Clean debris from around fuel injection pump.
- Remove all fuel lines.
- Remove control linkage.
- Remove fuel shutoff solenoid.
- Remove the air/fuel control line.



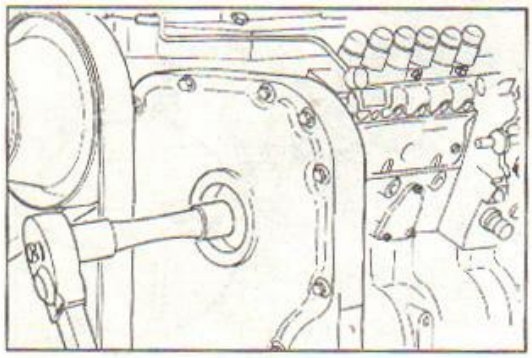
Removal of Fuel Injection Pump

Remove lube oil filling cap. Rotate the crankshaft slowly by the barring tool and define the TDC of cylinder 1 on compression stroke when the mark on the fuel injection pump gear is aligned to the mark on the gear housing cover.

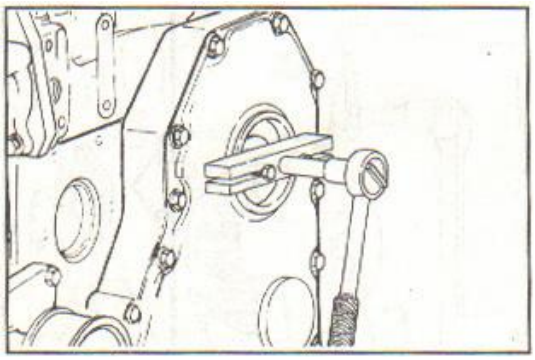


Set engine timing by slowly rotating the crankshaft and inserting the timing pin into the fly-wheel pin hole. The location of the crankshaft at this point is the TDC of cylinder 1 on compression stroke.

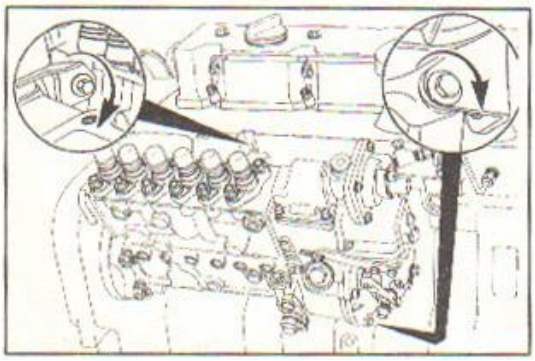
Remove the nut and washer of the fuel injection pump gear.



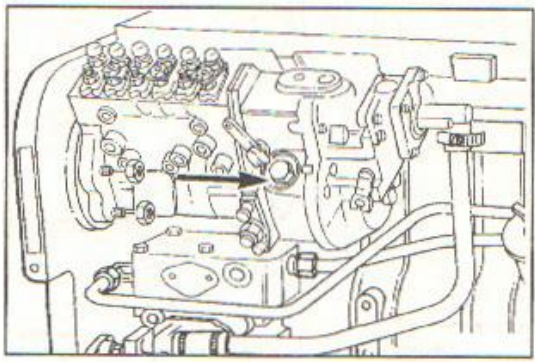
Pull the fuel injection pump drive gear from the shaft with T–bar puller.



Remove fuel injection pump rear support bracket and side support bracket.

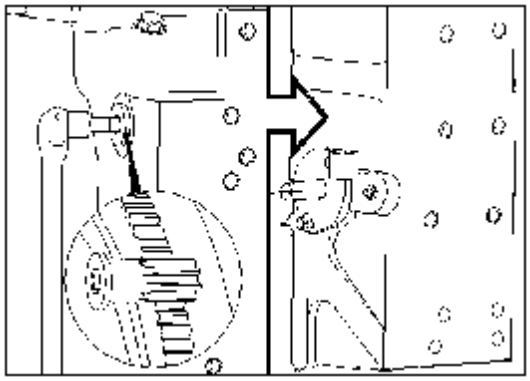


Remove the four mounting nuts and the fuel injection pump.



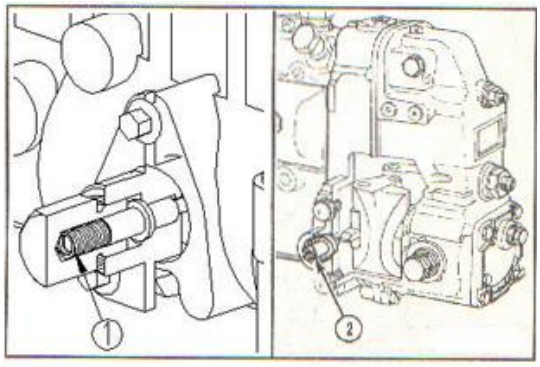
Installation of Fuel Injection Pump

Make sure the cylinder 1 at TDC of its compression stroke before installing the fuel injection pump.

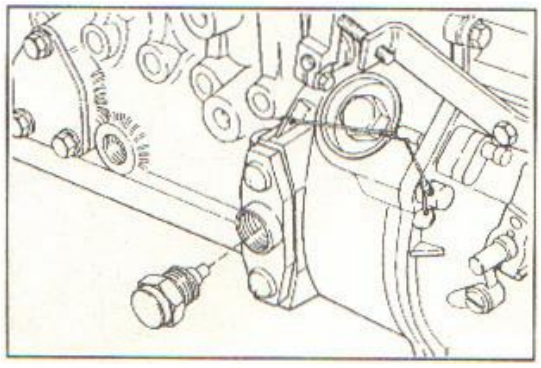


Fuel injection pumps also have their timing pins, located differently. P7N and EP–9 pumps of Japan Denso Co. have the pins in their pump housings, while P7100 pump of Bosch has the pin in its gover–nor housing.

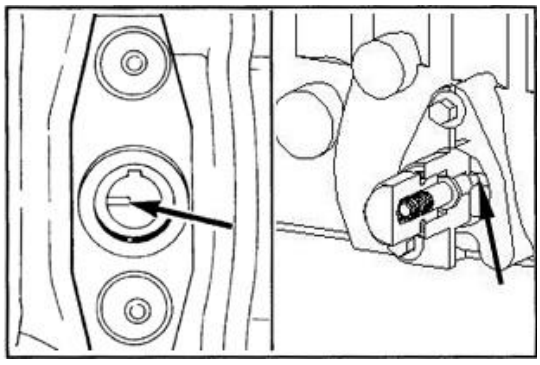
The timing pin positions the injection timing ad–vance angle (rotation angle of the fuel injection pump shaft) to the TDC of cylinder 1 at compression stroke. Insert the pin into the timing groove or timing tooth when installing the pump.



Remove the timing pin access plug and the tim–ing pin.

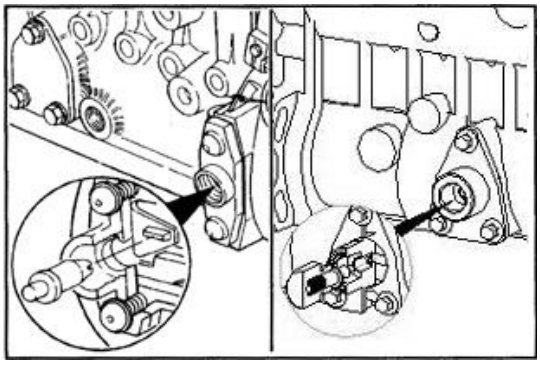


If the timing tooth (P7100) or timing groove (P7N, EP–9) is not aligned with the timing pin hole, rotate the pump shaft until the timing tooth or groove aligns.



Reverse the position of the timing pin so the slot of the timing pin will fit over the timing tooth or tim–ing groove in the fuel injection pump.

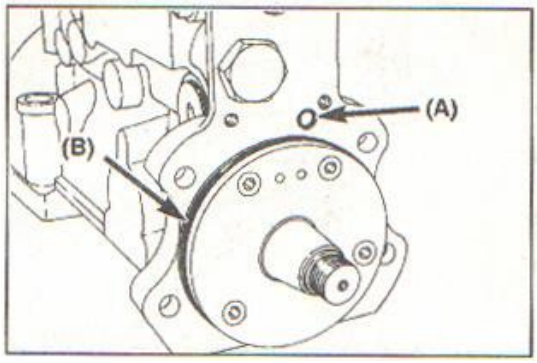
Install and secure the timing pin with the access plug.



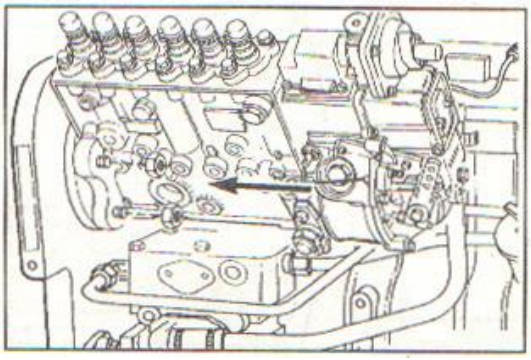
Make sure the O–ring seals for the fill orifice (A) and pilot (B) are correctly installed in the fuel injection pump and are not damaged.

Lubricate the mounting flange with clean oil.

The taper surface of the pump shaft and the inside surface of the pump gear bore must be clean and dry before installing the pump.



Slide the fuel injection pump shaft through the hole in the drive gear and position the fuel injection pump flange onto the mounting studs.



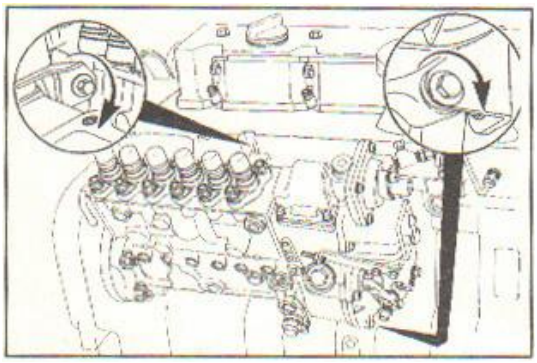
Tighten the capscrews for the support bracket and side support bracket.

Torque value:

Injection pump bracket capscrews (M10): 40Nm

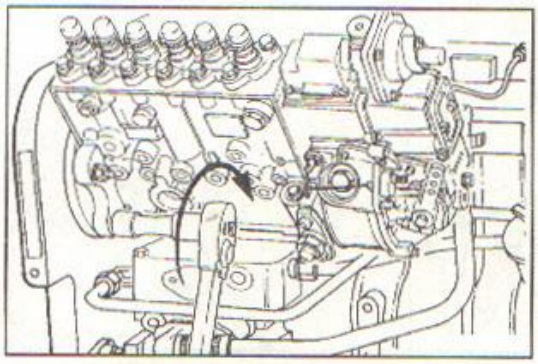
Rear support bracket capscrews (M10): 40 Nm

Side support bracket capscrews (M8): 25 Nm



Install and tighten the mounting nuts of the fuel injection pump.

Torque value: 45 Nm



Tighten the fuel injection pump drive nut.

Torque value:

P7N pump (M18): 105 Nm

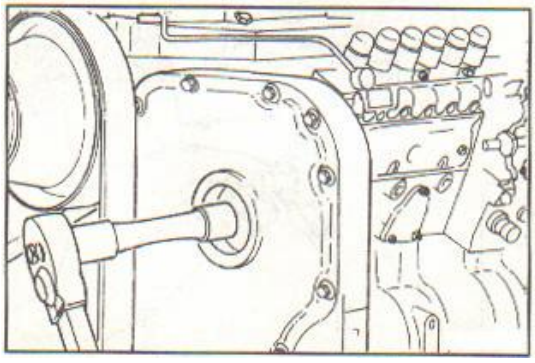
PE pump (M20×1.5): 186 Nm

EP–90 pump (M18): 137 Nm

PX pump (M20×1.5): 186Nm

P7100 pump (M20): 195 Nm

Install and tight the oil filling cap on the gear cover.



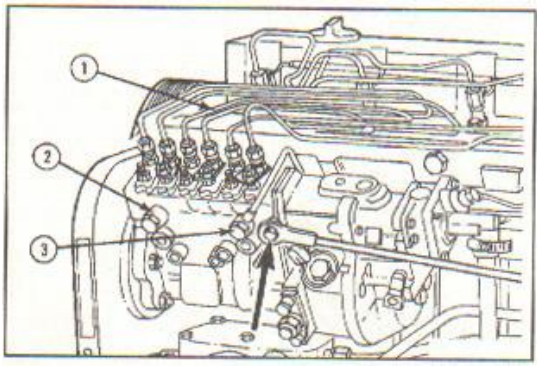
Install the fuel lines and control linkage of the governor.

Torque value:

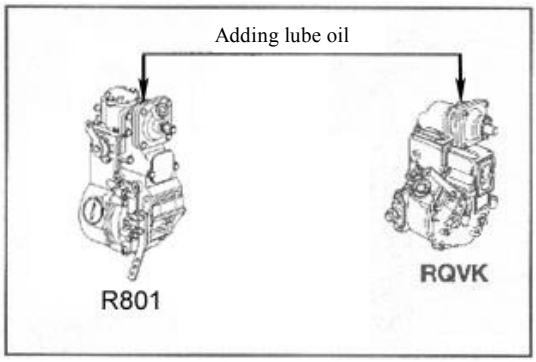
High pressure fuel lines: 45 Nm

Pressure relief valve fitting: 35 Nm

Low pressure fuel supply fitting: 35 Nm



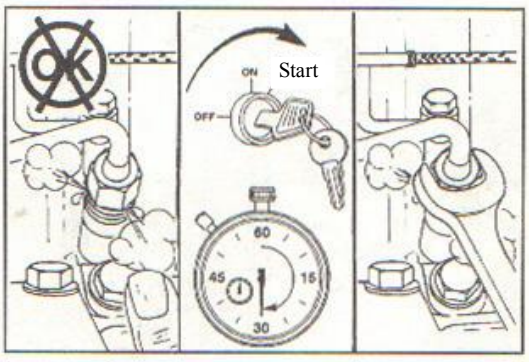
△Attention: Proper amount of lube oil 15W–40 should be added into the governor housing before engine's operation. Failure to do so will result in premature governor wear.



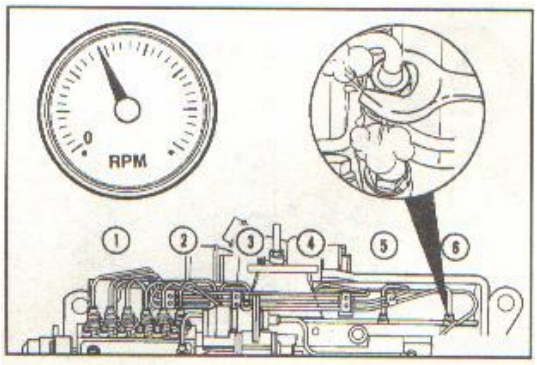
Loosen the fitting at the No.1 injector. Operate the engine to let air bleed from the fuel lines, then tighten the fitting.

Torque value: 45Nm

▲Warning: The pressure of the fuel in the high pressure line is high enough to penetrate the skin and cause serious bodily harm.



Bleed air in each high pressure fuel line separately until the engine runs smoothly.

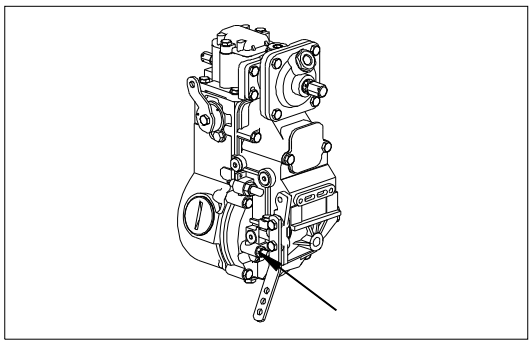


Adjustment of Idle Speed

R801 and R901 Governors

Loosen the locknut and turn the idle speed screw counterclockwise to increase idle speed and clockwise to decrease idle speed.

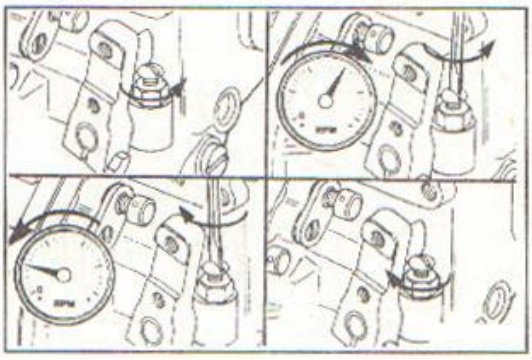
Tighten the locknut after the adjustment.



RQVK Governor

Loosen the locknut and turn the idle speed screw counterclockwise to increase the RPM and clockwise to decrease RPM. Tighten the locknut after the adjustment.

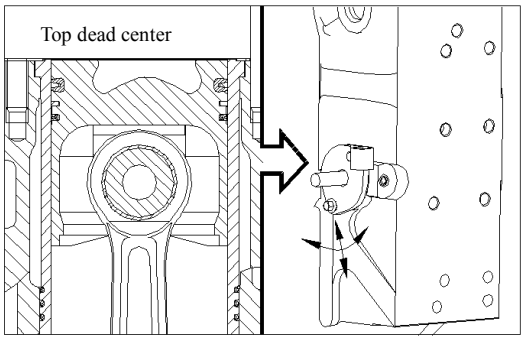
▲Warning: The block limiting maximum load screw and adjusting maximum speed of the governor have been adjusted precisely on a fuel injection pump test bed or an engine test bed. Users are allowed to adjust them. Otherwise, the diesel engine may be seriously damaged by over load or over speed.



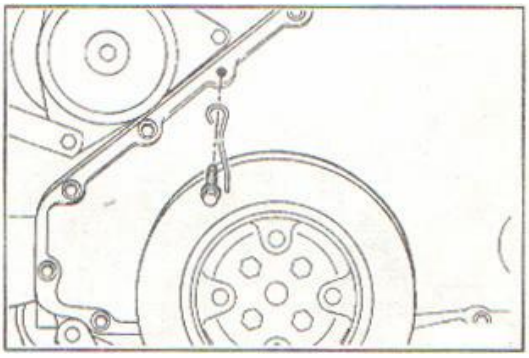
Check Injection Timing

Make sure the engine is at top dead center (TDC) on the compression stroke for cylinder 1 before checking the injection timing. The followings show how to make a mark.

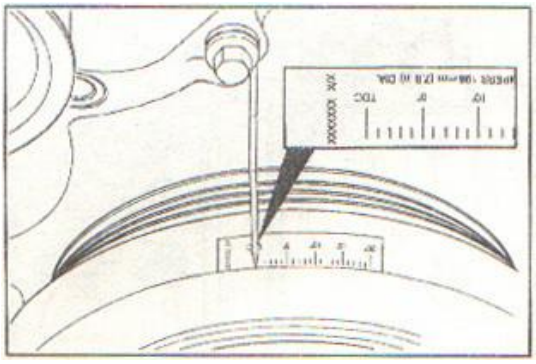
△Attention: Disengage the engine timing pin right after marking to prevent it from damage during checking the injection timing.



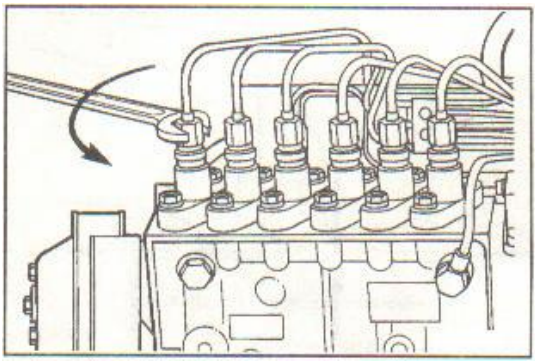
Using one of boltholes of the gear cover to create a pointer and make it point at the external circle surface of the vibration damper or the front surface of the vibration damper.



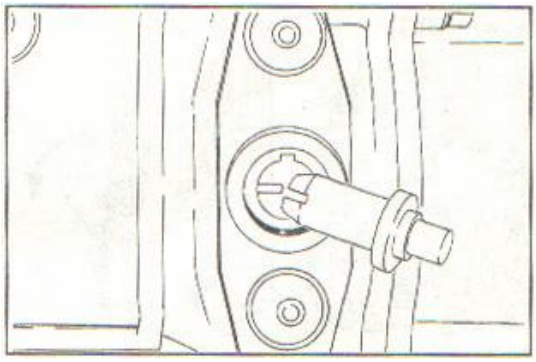
Attach a degree wheel or degree tape to the front of the vibration damper. Line the "TDC" mark up with the pointer.



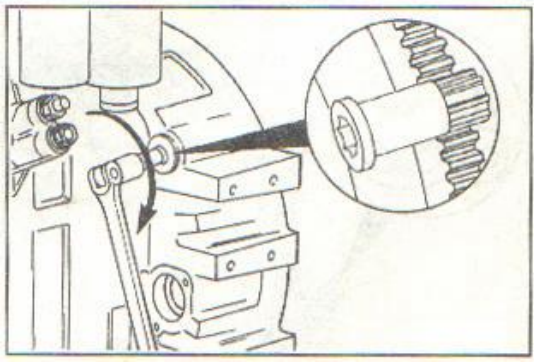
Remove the No.1 high pressure fuel line from the fuel injection pump.



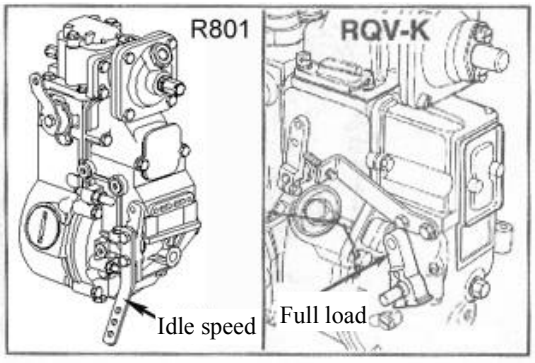
Disengage lock-timing pin from the fuel injection pump.



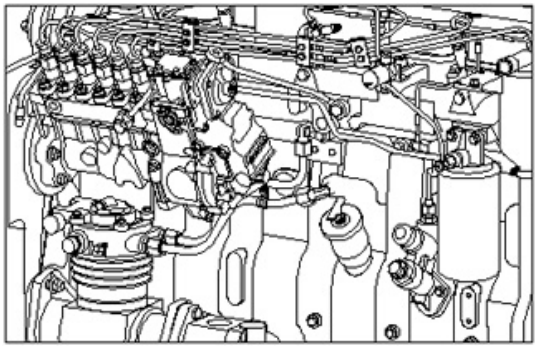
Rotate the crankshaft counterclockwise, as viewed from the front of the engine, to approximately 40 degrees before TDC.



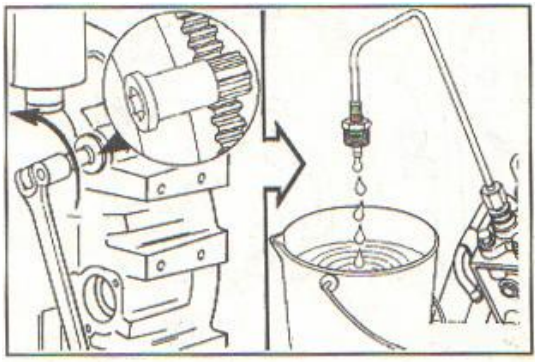
The governor throttle lever must be at the high idle throttle position when checking the injection timing.



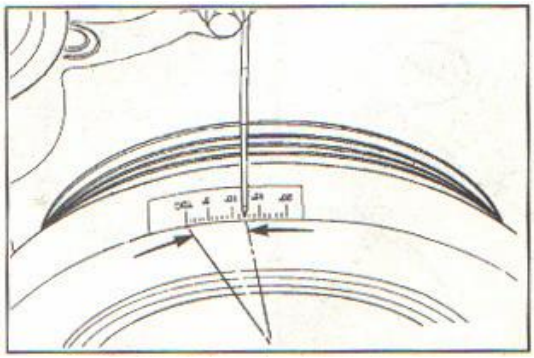
Press the priming pump and pump fuel into fuel system.



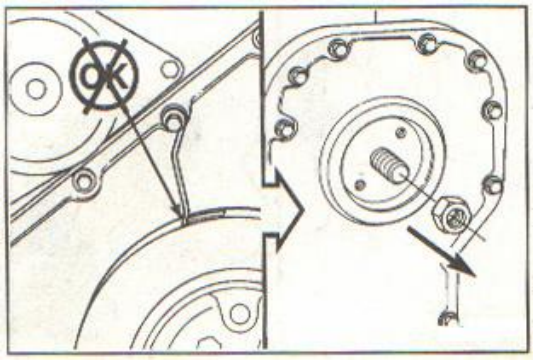
Slowly rotate the crankshaft clockwise with barring tool, as viewed from the front of the engine, until the fuel just begins to flow out of the No.1 deliver valve of the fuel injection pump and then stop rotating at once.



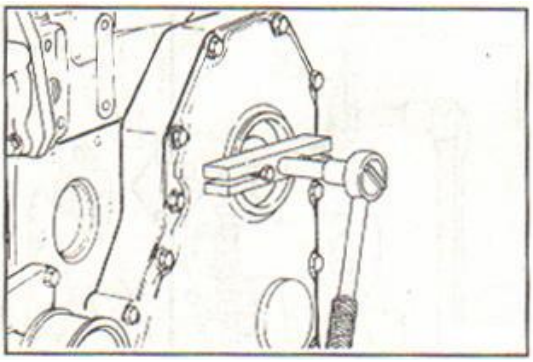
Check the degree wheel on the vibration damper to see the degree the timing pointer indicates. This is static injection timing of the fuel injection pump.



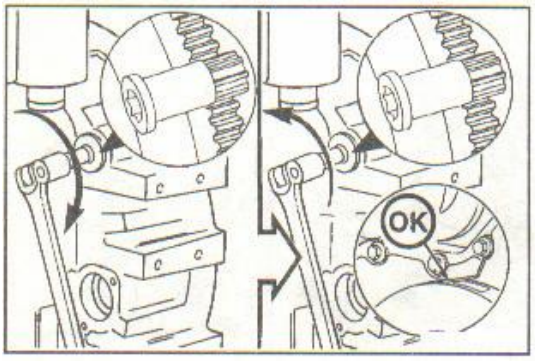
If the static timing, as measured by the above method, does not agree with the specifications you have been given, remove the nut that fastens the fuel pump drive gear to the fuel injection pump camshaft.



Use a gear puller tool and pull the fuel injection pump drive gear from the fuel injection pump camshaft.



Slowly rotate the crankshaft counterclockwise or clockwise until the timing pointer indicates the desired static injection timing.



Tighten the fuel injection pump drive nut.

Torque value:

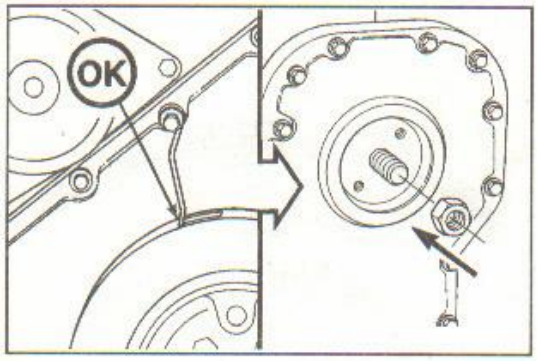
P7N pump (M18): 105 Nm

PE pump (M20×1.5): 186 Nm

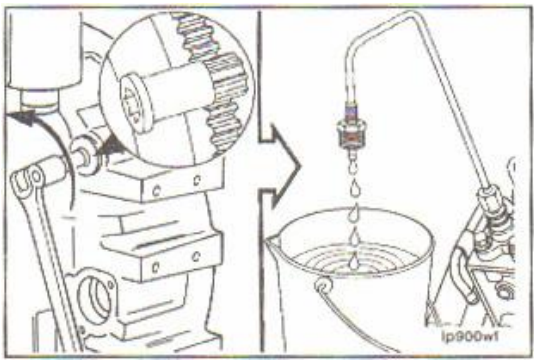
EP–9 pump (M18): 137 Nm

PX pump (M20×1.5): 186 Nm

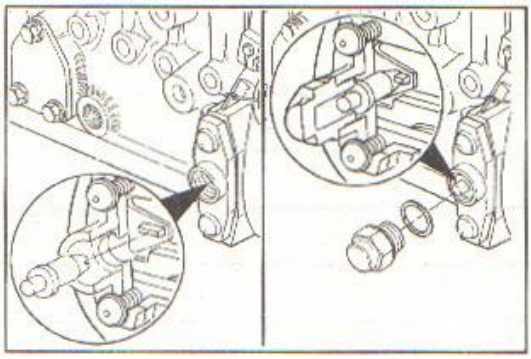
P7100 pump (M20): 195Nm



Repeat this procedure as needed until the timing is found to be in agreement with the specification.



The fuel injection pump lock timing pin should fit over the injection pump timing groove (P7N, EP–9) or timing tooth (P7100) when the engine is rotated back to its TDC of compression stroke of cylinder 1 if timing pin is correctly installed.



7.5 Replacement of Parts of Electric System

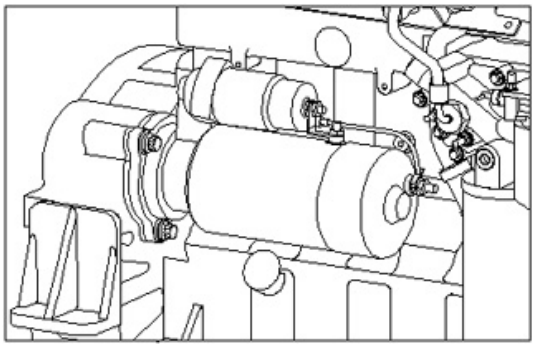
Replacement of Starting Motor

Preparatory Steps:

● Disconnect the ground cable from the battery.

● Identify each electric wire with a tag indicating location.

Remove the battery cable from the solenoid.

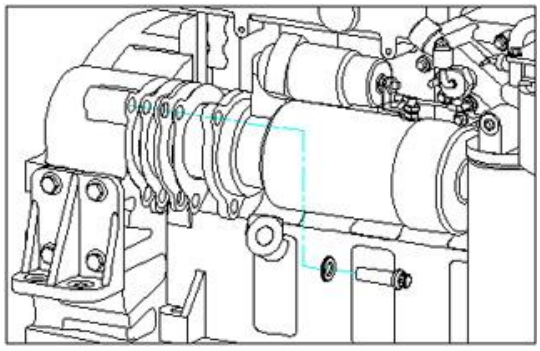


Remove the starting motor and spacer.

Install new starting motor and spacer in the reverse order of removal.

Connect ground cable back to the battery.

Torque value of starting motor: 77 Nm

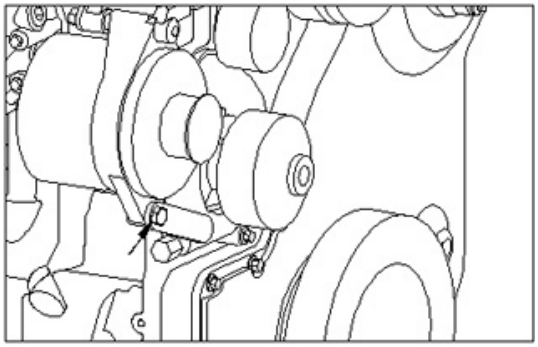


Replacement of Alternator

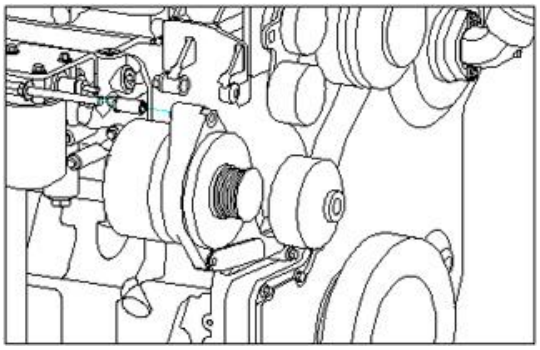
Preparatory Steps:

- Disconnect the ground cable from the battery.
- Identify each electrical wire with a tag indicating location.
- Remove the drive belt.

Remove the alternator link.

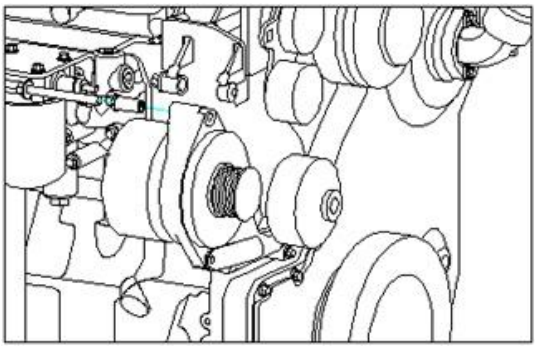


Remove the alternator mounting capscrews and nuts. And remove the alternator.



Install the alternator in the reverse order of removal.

Torque value of the alternator capscrews: 45 Nm

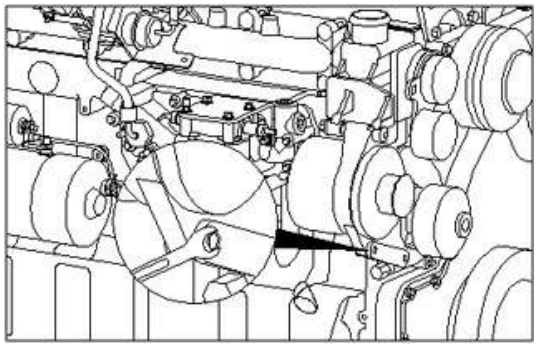


Install the alternator link.

Torque value:

Alternator end (M10): 45 Nm

Water pump (M8): 25 Nm

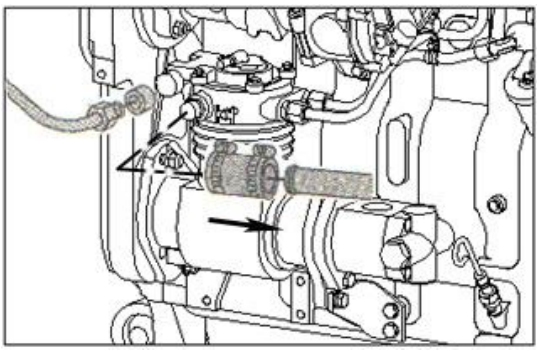


7.6 Replacement of Air Compressor

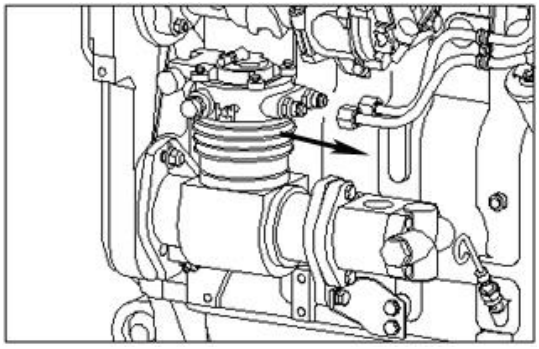
Preparatory Steps:

- Clean around the air compressor.
- Drain the engine coolant.

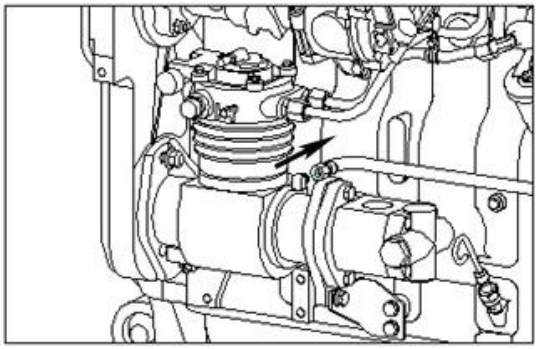
Remove the air inlet pipe from the air compressor.



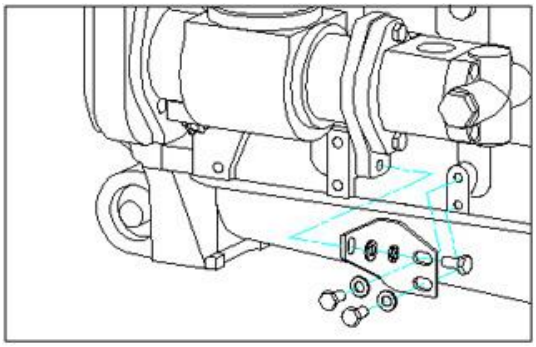
Remove the coolant lines from the air compressor.



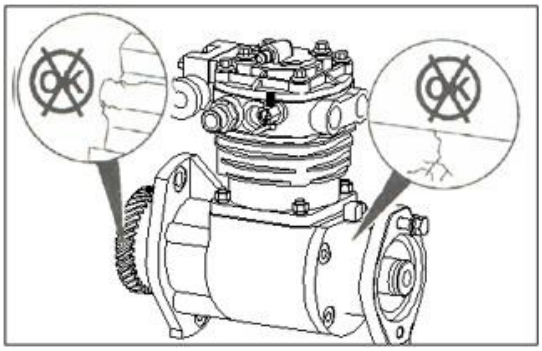
Remove the oil supply line.



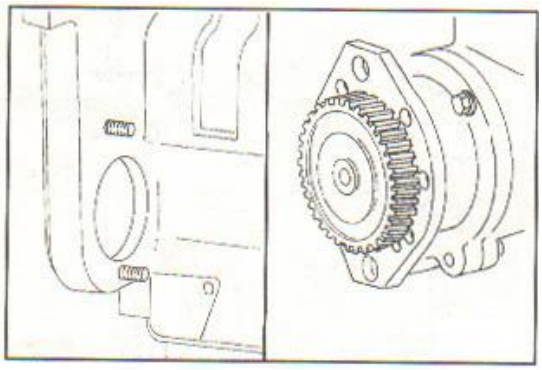
Remove the air compressor support bracket and capscrews. And remove the air compressor.



Visually inspect the compressor housing and drive gear for cracks or damage.



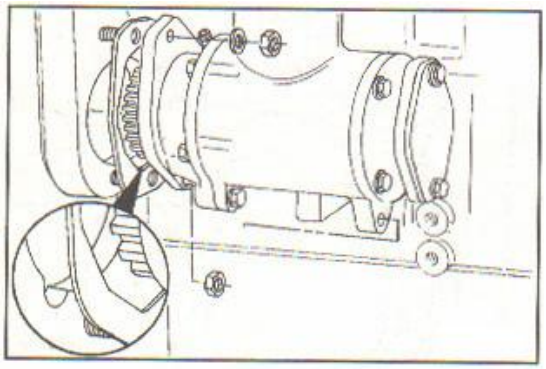
Be sure the flange surface of the air compressor and mounting surface of the gear housing are clean and not damaged.



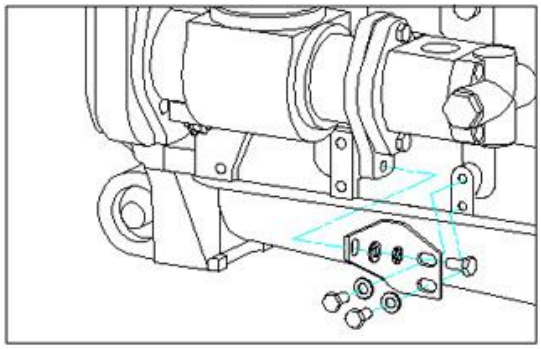
△Attention: Make sure the oil drain notch in the gear housing is not blocked. Align it with the notch in the gasket for oil drain.

Install a new gasket. Tighten the mounting nuts.

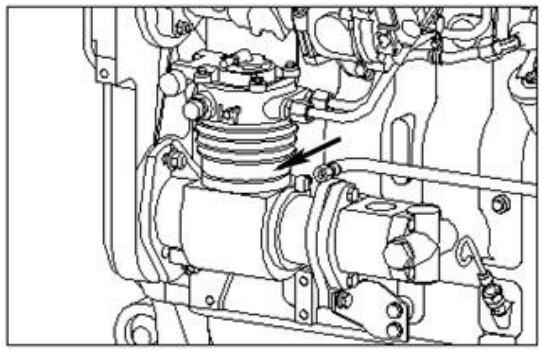
Torque value: 77 Nm



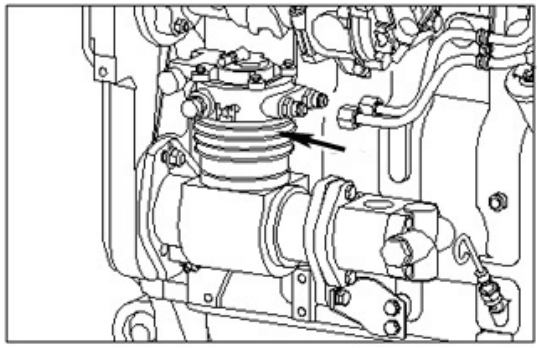
Install the air compressor brace.
Torque value: 45 Nm



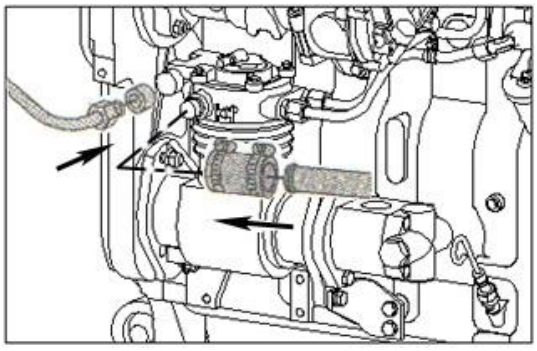
Install the oil supply line of the air compressor.
Torque value: 8 Nm



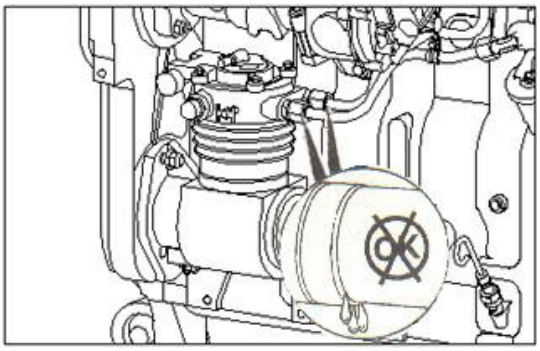
Install the coolant lines of the air compressor.
Torque value: 35 Nm



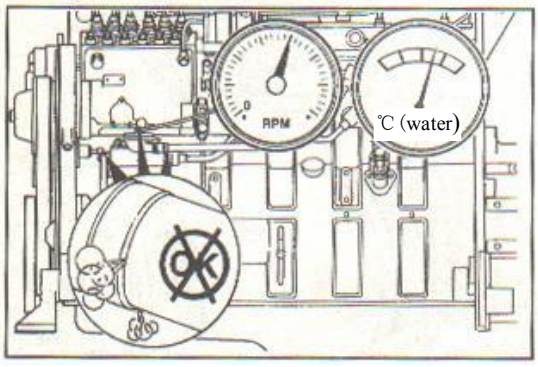
Install and tighten the air line of the air compressor.



Fill up the engine cooling system and then operate the engine to check for coolant leaks.



Check for air leaks after the system reaches air pressure of 690~862 kPa.



8 Other Engine Specifications

8.1 Diesel Fuel

▲Warning: Mixing diesel with gasoline or alcohol is prohibited. Such mixture will cause explosion.

△Attention: Because of precise dimensions of and very small clearances between fuel system parts, it is very important to keep diesel fuel clean and free from impurities and water. Water and impurities in fuel system will cause severe damage to fuel injection pump and injection nozzle. Diesel fuel must be settle sufficiently before using, or be filtered with silk cloth.

The quality specifications of diesel fuel used by these two series of diesel engines should not be inferior to National GB252 Light Diesel Fuel Specifications.

Main Specifications of Light Diesel Fuel (GB252)

Item / No.	Cetane Value	Distillation Temperature℃			Motion Viscosity (20℃) mm^2/s	Sulfur Content% (m/m)	Water % (v/v)	Acid mg KOH/ 100mL	Ash % (m/m)	Mechani-cal Impurity %	Solidi-fying Point ℃	Cold-Filter-ingPoin ℃	Flash-Point (closed)
	⩾	50% ⩽	90% ⩽	95% ⩽		⩽	⩽	⩽	⩽		⩽	⩽	⩾
10	45	300	355	365	3.0~8.0	0.5	Trace	7	0.01	None	10	12	65
0											0	4	
−10											−10	−5	
−20					2.5~8.0						−20	−14	60
−35					1.8~7.0						−35	−29	45
−50											−50	−44	

Choose diesel fuel based on engine operation environment. Select the fuel with high solidifying point for warm area, and low solidifying point for cold area. The solidifying point of the fuel must be at least 10℃ lower than the lowest temperature of operation environment to ensure enough fluidity.

To ensure sufficient lubrication of the fuel system, viscosity of the fuel must be kept at over 1.3 mm^2/s.

8.2 Diesel Engine Oil

Lube oil used in diesel engine is called diesel engine oil. Its function includes lubrication, cooling, heat transfer, flushing, sealing combustion chamber and keeping parts and components from rust.

Diesel Engine Oil Specifications

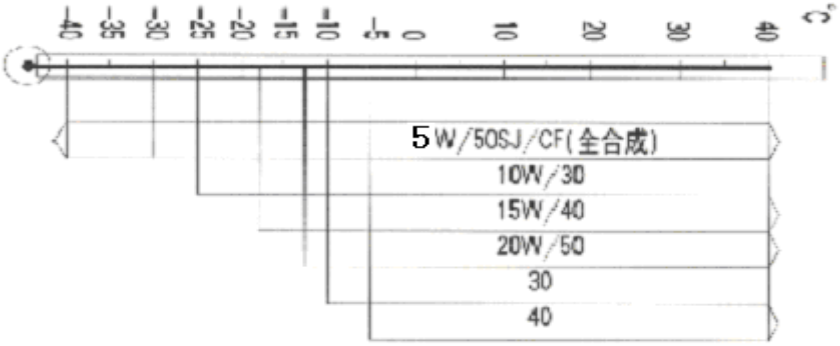
Our national diesel engine oil specification description consists of two parts: first part is viscosity grade specified by SAE (Society of Automobile Engineer) and the second quality grade by API (American Petroleum Institute). For example, Fuel 15W/40CF−4 means that the viscosity grade of the fuel is 15W/40 and quality grade CF−4.

Quality Grades are CA, CB, CC, CD, CE, CF, CG, CH and CI. Quality increases in the order.

Viscosity Grades is specified by SAEJ300 as follows:

SAE	MotionViscosity at 100℃	Low Temperature Viscosity CCS		Margin Pump Supply Temperature*	SAE	MotionViscosity at 100℃	
	mm^2/s	mpas	℃	℃		mm^2/s	
0W	⩾3.8	⩽3250	−30	−35	20	⩾5.6	<9.3
5W	⩾3.8	⩽3500	−25	−30	30	⩾9.3	<12.5
10W	⩾4.1	⩽3500	−20	−25	40	⩾12.5	<16.3
15W	⩾5.6	⩽3500	−15	−20	50	⩾16.3	<21.9
20W	⩾5.6	⩽4500	−10	−15	60	⩾21.9	<26.3
25W	⩾9.3	⩽6000	−5	−10			

The numbers 20,30,… 60 in the right column of SAE are single grade oils that are divided into two categories:W–grade defines viscosity performance only at low temperature, and non W–grade defines viscosity performance only at 100℃. Multi–grade oils have viscosity performance at both low temperature and high temperature, such as 5W/30, 10W/30, 15W/30, 15W/40, 20W/50, etc. The viscosity of single grade oil changes greatly with the change of environmental temperature, having a narrow operation range, while the viscosity of multi–grade oil changes less with the change of environmental temperature, having a larger operation range. To secure the lubrication of engine oil at high temperature, ensure the cold starting of the engine and reduce oil consumption, the multi–grade oil is strongly recommended.Refer to this table for operational temperature ranges of different viscosity grade of engine oil.



△Attention: Select engine oil with appropriate viscosity grade according to local environmental temperature.

△Attention: Engine oil specified for 114 series engines by SDED should be used for D9 & 6CL series engines.

15W/40CF4 is recommended for use in most areas. 10W/40CF4 can be used for the area whose temperature is below –15℃ to get easy cold starting.

5W/50SJ CF4 should be used for engines operating in freezing cold area whose temperature is below –23℃ and there is no measures to keep the engines warm after they stops.

△Attention:Not to use engine oil with low viscosity unless it is needed because a long time's use of it will cause excessive wears, thus shortening engine lifetime thought its low viscosity helps in cold starting.

Engine oils available in the market vary greatly in quality due to different production procedures. Use of unqualified engine oil will lead to early wear, piston scuffing, etc. Since January 2003,SDEC 114 series diesel engines have used special engine oil that is provided by strictly selected suppliers. The oil has undergone various tests and uses anti–piracy marking on the packing. Universally certified, marked, packed and priced, the special engine oil will ensure user′s interests.

SDEC′s current designated supplier of engine oil is Great Wall Lube Oil Company, Sino–PEC.

For oil supply management convenience, "SDEC Special Engine Oil Serial No." is listed below along with standard specifications:

No.	Standard Specification	SDEC′s Specified Oil Serial No.
1	20W/50 CF4	SCF–01–bucket volume*
2	15W/40 CF4	SCF–02–bucket volume*
3	10W/30 CF4	SCF–03–bucket volume*
4	5W/50SJ/CF CF4	SCF–04–bucket volume*
5	30 CF4	SCF–30–bucket volume*
6	40 CF4	SCF–40–bucket volume*

* Bucket volume has 3 sizes: 200L (170kg), 20L (16kg) and 4L (3kg), marked by 200, 020 and 004 respectively.

Engine Oil Deterioration and Change Period

Engine deterioration is caused by oxygenation under high temperature, dust, sand, metal particular off worn parts, side products of combustion and unburned fuel coming into the oil after some use, resulting in deterioration of lubrication and cooling effectiveness of the oil.Therefore, the engine oil must be changed periodically, or timely when one of characters in this table below exceeds criteria value.

Oil character	Criteria for oil change
motion viscosity change rate at 100℃, %	>±25
Palustrine content, mg KOH/g	<50% of fresh oil
Insoluble pentane, %	>3.0%
Iron content, mg/kg	>150

Oil change time period: For users without analyzing instruments, oil change period is 350 hrs or 22,000km. For engine used for city public transportation, or used in high dusty area, and/or high-altitude and/or extremely cold area, the period is 250 hrs or 10,000km.

△Attention: Do not extend oil change period or it will cause erosion, carbon buildup and wear, thus shortening the engine lifetime.

8.3 Coolant

During operation, heat generated in the parts is brought away by the coolant so as to keep the engine temperature within an allowed range. Parts of cooling system are under different level of erosion from the coolant fluid. When being heated, chemicals in the coolant can subside and deposit onto the heat- transferring surface thus lowing the cooling efficiency. Cooling system performance and cooling pump pressure as well as flow will be affected if there is air in the system, resulting in cavitation on the cylinder liner and water-pump blades. When the engine does not run and environment temperature is lower than 0℃, coolant can cause crack to the parts of cooling system. D9 & 6CL series engines have high power density and thermo load, so certain requirements for the coolant should be applied in order to maintain normal operation.

The coolant used for D9 & 6CL series Engines is a mixture of anti-freeze fluid and DCA4 additive, or of water and DCA4 (for engine used in areas always above 0℃) by certain proportions.

Anti-freeze fluid should be used for these two series engines for all climates because it raises not only freezing point but also boiling point of coolant.

▲Warning: Water or anti-freeze fluid cannot provide protection for the cooling system, and is not allowed to be used as coolant without DCA4 additive, otherwise it will cause erosion, cavitation, deposition, choking and locally over-heat, causing serious damages (piston scuffing, cylinder head cracking, fuel injection nozzle seized and burned valve, etc).

Water

Rainwater, lake or river water and pipe water can be used for making coolant. River or lake water must be filtered free from dust and sand. For area with water shortage, well or underground water must be boiled and processed with palustrine (0.67g NaOH/1L) to lower its hardness before being used. Water for coolant must be: PH=8.8-10.5, chloride ≤100 ppm, sulfide ≤100 ppm and total hardness ≤ 300 ppm.

Anti-freeze Fluid

Since water and glycol have high specific heat and heat conductivity, their mixed fluid is an ideal coolant for diesel engine. Silicate (dehydrated sodium silicate), oxide and acetic acid contents should not exceed 1,000 ppm, 5 ppm and 100 ppm respectively.

Glycol/Water Volume Ratio and Relationship with Freezing Point

Ratio of Glycol/Water	10:90	20:80	30:70	40:60	50:50	55:45	60:40	65:35
Freezing Point, ℃	−3.8	−7.5	−14.1	−22	−32	−42	−55	−64

Different freezing points (solidifying points)can be reached by adjusting the proportion of water and glycol. For most climates, we recommend the proportion of 50:50 water/glycol. The lowest freezing point is reached when the proportion is 32:68 (maximum anti−freeze capability).Glycol percentage should not exceed this value under any circumstances, otherwise the freezing point will increase, and high glycol concentration will cause precipitation and deposition inside the cooling system, choking the radiator and damaging the water pump sealing. High glycol concentration will also lower the heat conductivity of the coolant. Recommended range for glycol concentration in coolant is between 40~60%. Usually, freezing point of the selected anti−freeze fluid should be about 10℃ lower than the lowest local temperature.

Freezing point can be measured by refraction instrument or special measuring paper.

△Attention : Anti−freeze fluid must be replaced every 385,000km, or 6,000hr or 2 years (whichever comes first).

DCA4 Chemical Additive

Water or anti−freeze fluid cannot provide protection for the cooling system, and is not allowed to be used as coolant without DCA4 chemical additive. Required concentration of DCA4 additive must be applied to prevent cavitation, corrosion, deposition and air bubble in the cooling system.

Ideal concentration DCA4 in coolant for D9 & 6CL series engines is 0.264 unit/L of DCA4. It should not be above 0.528 unit/L or below 0.132 unit/L. One unit of DCA4 weighs 22.68g.

To meet the above requirements, a water filter containing similar number of units of solid DCA4 should be installed. For example, for cooling system of 30L volume, a water filter containing 12 units of solid DCA4 should be installed so that every liter of coolant contains 0.400 unit of additive.

Due to the gradual release of solid DCA4 into the coolant, for a new engine or newly coolant, when adding the additive for the first time, the water filter should be installed and powder form of DCA4 should be used. For example, for cooling system of 30L volume, apart from the already installed water filter which contains 8 units of solid DCA4, additional 7 units (about 158.8g) of powder form DCA4 can be added directly into coolant so every liter of coolant contains 0.50 units of additive. The advantage of this is to provide sufficient protection when the engine starts, because there is sufficient amount additive (0.233 unit/L) in the coolant when a certain amount of DCA4 powder is added directly.

△Attention: When using the method of water filter and DCA4 powder, total amount of DCA4 in coolant should not exceed the max. specified value (0.528 unit/L).

Water Filter

Engine coolant usually contains sand, dust, mud, dirt, oil, deposition, eroded material, consumed additive and deteriorate broken pieces of sealing fragments. Those things can cause congestion in oil filter, radiator element or coolant pipe, or wear down water pump blades, sealing and thermostat, so coolant must be filtered. The water filter on engine has two purposes: first it contains certain amount of solid DCA4 additive so to keep the required concentration of DCA4 in coolant, second it filters coolant and keep out the impurities mentioned above. Thus water filter must be used properly to ensure the life of coolant system parts and engine in general.

DCA4 in water filter will be consumed during normal operation, meanwhile impurities will accumulate in the filter, so water filter must be replaced on a regular basis.

△Attention: Replacement of water filter is required by SDEC every 8,000km, 250 h or 3 months (whichever comes first) .

DCA4 Additive Concentration Check

DCA4 water filter should be replaced at specified time to ensure the proper concentration of DCA4 in coolant, but the concentration of DCA4 must be checked under the following conditions:

●Adding more than 6 L of unprocessed coolant during maintenance;

●Before finding erosion of cooling system or eliminating leakage of sealing parts;

●When not sure if it needs replacing DCA4 water filter, check DCA4 concentration first;

●Check DCA4 concentration to determine if cooling system maintenance interval is acceptable.

DCA4 Additive Concentration Checking Method

Check DCA4 concentration in the coolant by using the DCA4 additive concentration measurement package provided along with the engine. The package includes a plastic cup for sampling measured coolant, a bottle of test paper, a color card of recommended coolant concentration. The method is as following:

(1)Fill the plastic cup in half with the measured coolant;

△Attention: It is more accurate to check the concentration of DCA4 when the coolant is warm, so do not cool it to room temperature. For newly made coolant, it is advised to warm the engine till the temperature of the coolant reach over 60℃ and then measure the concentration of DCA4 additive in the coolant.

(2)Take a test paper and dip the end with test paper sticking on it into the measured coolant for 5 seconds and then take out;

(3)Compare the dipped test paper against standard color card to define the concentration, for a test paper will change to different color when it dip in different concentration of DCA4.

Refer to this table for concentration of DCA4 additive against standard color card and measures to be taken if necessary.

Test color card	Standard concentration of DCA4 in coolant is 6 kg/L and acceptant range of DCA4 is 3~12 kg/L. Below or over concentration will have impact on engine components.	
	Concentration of DCA4 Additive	Measures to be taken for protection
	<3 kg	To replace the water filter To add DCA4 additive by 3 kg/L into the cooling system
	3 kg	
	6 kg	To replace the water filter
	12 kg	Not need
		To release 50% coolant/anti-freeze fluid by a plastic bucket and use it for next time.
	18 kg	

△Attention: Do not touch test paper with hands. Test should be performed in bright surroundings or with ample illumination. Keep test paper and cups clean.

8.4 Torque Specification for Main Bolts, Plugs, Fitters and Nuts

8.4.1 Torque Specification for Bolts

Basic Bolts in D9 & 6CL Series Diesel Engines

Item	Tightening Procedure		Torque Specification
● Connecting rod bolt (M12)	Pre-fastening torque		55±5N·m
	Final turn angle		60°±3°
● Cylinder head bolt (M14)	1 st pre-fastening torque		50N·m
	2 nd pre-fastening torque		115±5N·m
	Final turn angle	Long bolt	90°±5°
		Short bolt	60°±3°

● Main bearing cap bolt (M14)	1 st pre–fastening torque	50N·m
	2 nd pre–fastening torque	90±5N·m
	Final turn angle	90°±5°
● Flywheel bolt (M16)	Pre–fastening Torque	70±5N·m
	Final turn angle	25°±3°
● Damper bolt (M16)	1 st pre–fastening torque	50N·m
	2 nd pre–fastening torque	100±5N·m
	Final turn angle	30°±3°
● Gear housing bolt (M8)		25N·m
● Flywheel housing bolt (M12)	Cast aluminum	80±8N·m
	Cast iron	112±10N·m
● Front support bolt (M12)		112±10N·m
without front support		60N·m
● Camshaft thrust plate bolt (M8)		25N·m
● Rear crankshaft seal cover plate bolt (M6)		9N·m
● Piston cooling nozzle connection bolt (M10)		35N·m
● Engine timing pin bolt (M16)		25N·m
● Front crankshaft pulley bolt (M12)		77N·m
● Valve rocker arm bolt (M8)		25N·m
● Rocker arm adjusting bolt (M10)		45N·m
● Cylinder head cap bolt (M8)		25N·m
● Engine lifting plate bolt (M12)		77N·m

Bolts in Cooling System

Item	Torque Requirement
● Water pump mounting bolt (M8)	25N·m
● Fan pulley bolt (M12)	77N·m
● Fan bearing base bolt (M8)	25N·m
● Tensioner bolt (M10)	45N·m
● Tensioner fixing plate bolt (M8)	25N·m
● Thermostat water outlet pipe nut (M8)	25N·m
● Water inlet elbow hose clamp bolt (M6)	9N·m

Bolts in Lubrication System

Item	Torque Requirement
● Oil pump bolt (M8)	25N·m
● Oil filter (1 1/2″)	3/4 turn after contact
● Oil filter check valve spring plug (M24)	80N·m
● Oil cooler head bolt (M8)	25N·m
● Oil pan bolt (M8)	25N·m
● Oil pan drain plug (M18)	80N·m
● Oil heater bolt (M22)	80N·m
● Flange bolt of oil suction pipe (M6)	9N·m
● Oil suction bracket bolt (M6)	9N·m

● Clamp bolt of crankcase breather vent pipe (M8)	18N·m

Bolts in Intake and Exhaust System

Item	Torque Requirement
● Intake manifold bolt (M10)	45N·m
● Exhaust manifold bolt (M10)	45N·m
● Turbocharger bolt (M10)	45N·m
● Compressor outlet pipe bolt of turbocharger (M8)	25N·m
● Compressor outlet pipe clamp bolt of turbocharger t (M6)	9N·m
● Turbocharger oil inlet banjo bolt (M12)	30N·m
● Turbocharger oil drain pipe flange bolt (M8)	25N·m
● Turbocharger oil drain pipe clamp Bolt (M5)	9N·m
● Turbine outlet V–belt clamp bolt (M6)	15N·m

Fastening Bolts in Air Compression System

Item	Torque Requirement
● Air compressor (or PTO) flange bolt (M12)	77N·m
● Air compressor (or PTO) gear nut (M16)	134N·m
● Air compressor oil inlet pipe nut (M12)	15N·m
● Water inlet and outlet joint nut of air compressor (M18)	35N·m
● Bracket Bolt of air compressor to cylinder block (M10)	45N·m
● Supporting plate bolt of air compressor (M10)	45N·m

Fastening Bolt in Fuel System

Item	Torque Requirement
● Fuel injection pump flange bolt (M10)	45N·m
● Fuel injection pump gear nut	
P7N Pump (M18)	105±5N·m
PE pump (M20×1.5)	186±10N·m
EP–9 pump (M18)	137±7N·m
PX pump (M20×1.5)	186±10N·m
Bosch P7100 pump (M20)	195±10N·m
● Fuel injection pump in/out banjo bolt (M14)	35N·m
● Bolt of fuel injection pump to its support (M10)	40N·m
● Bolt of fuel injection pump bracket to cylinder block (M10)	77N·m
● Injection timing pin plug of fuel pump	15N·m
● High pressure fuel pipe joint nut (M14)	45N·m
● High pressure fuel pipe clamp support bolt (M8)	25N·m
● High Pressure fuel pipe clamp bolt (M6)	9N·m
● Fuel injector clamper bolt (M8)	25N·m
● Fuel injector drain banjo bolt	
M6	10N·m
M8	15N·m
● Fuel transfer pump bolt (M8)	25N·m
● Fuel transfer pump inlet banjo bolt (M14)	35N·m
● Fuel transfer pump outlet joint nut (M16)	30N·m
● Fuel filter (1″)	3/4 turn after contact

- Fuel filter base nut (M8) 25N·m
- Fuel filter in/out pipe banjo bolt (M12) 28N·m
- Air/fuel controller air pipe joint nut (M12) 25N·m
- Fuel shutoff solenoid bolt (M16) 10N·m

Fastening Bolts in Electric System

Item	Torque Requirement
● Starting motor bolt (M16)	77N·m
● Alternator bolt (M10)	45N·m
● Alternator supporting rod	
at water pump end (M8)	25N·m
at alternator end (M10)	45N·m
● Alternator bracket bolt (M8)	25N·m
● Alternator pulley bolt (M16)	80N·m
● Temperature sensor (Z3/8)	35N·m
● Engine oil heater (M22)	
Stamped oil pan	120N·m
Aluminum oil pan	100N·m
● Oil pressure switch (Z1/8)	20N·m

8.4.2 Bolt Performance Grade Symbol and Recommended Fastening Torque

National standard specifies that bolt performance grade consists of two numbers separated by "●". Convex or concave symbols are used at end surface of bolt head or concave symbol is used on the side of the bolt head.

First number before "●") represents 1/100 of metric tensile strength (σ_b).

Second number (after "●") represents 10 times of the ratio (Yield Strength Ratio) between metric yield strength ($\sigma_{0.2}$) and metric tensile strength (σ_b).

Recommended Fastening Torque for Bolts with Different Performance Grade

Performance Grade	8.8		10.9		12.9	
Bolt size (mm)	Torque		Torque		Torque	
	Cast iron	Aluminum	Cast iron	Aluminum	Cast iron	Aluminum
6	9	7	14	7	14	7
8	25	18	33	18	40	18
10	45	30	65	30	70	30
12	80	55	115	55	125	55
14	125	90	180	90	195	90
16	195	140	280	140	290	140
18	280	180	390	180	400	180
20	400	–	550	–	–	–

Note:1. The torque value in the above table is recommended for the fastening bolts not listed in 8.4.1.

2. Torque values in the above table are only applicable when the threads of bolts and nuts are properly lubricated.

8.4.3 Recommended Torque for Cone Plug

Cone Plug Specification		Torque (Nm)	
Thread (inch)	O.D. of effective thread (mm)	Cast iron or stee	Aluminum
1/16	8.1	15	5
1/8	10.4	20	15
1/4	13.7	25	20
3/8	17.3	35	25
1/2	21.6	55	35
3/4	26.7	75	45
1	33.5	95	60
1 1/4	42.2	115	75
1 1/2	48.3	135	85

8.4.4 Recommended Torque for Banjo Bolt

Specification	M8×1	M10×1	M12×1.25	M14×1.5	M16×1.5	M18×1.5	M20×1.5	M22×1.5
Torque (Nm)	13	22	32	45	50	65	85	105

Note: The above torques are suitable for steel–, cast iron– and aluminum–based materials.

8.5 Sealing Glue and Lubricant used for Engine Assembly

8.5.1 Specified sealing glue must be applied when assembling the following parts:

- Apply Loctite 567 to all cone plug and tapered pipe threads;
- Apply Loctite 5900 to gear housing cover and oil pan sealing surface;
- No sealing glue should be applied to all gaskets;
- Apply Loctite 11747 to all expansion plugs and rear camshaft bearing bore plug;
- Apply Loctite 271 to threads of fuel injection pump flange bolt, air compressor flange bolt, thermostat stud, oil cooler flange stud and flywheel housing bolt;
- Apply Loctite 76732 to threads of exhaust manifold bolt and turbocharger stud end at exhaust manifold;
- Apply Loctite 660 to sealing surfaces of oil filling pipes, turbocharger oil drain pipe, and oil dipstick pipe that fit with cylinder block on its both sides.

8.5.2 Engine oil of 15W–40 must be applied to the surface of fittings and threads when assembling parts as follows:

- Connecting rod bearing (no engine oil on back of bearing);
- Main crankshaft bearing (no engine oil on back of bearing);
- Camshaft lobe surface and journal;
- Tappet;
- Piston;
- Piston ring;
- Piston pin;
- Rocker arm assemble;
- Push rod;

- O-ring of cylinder liner;
- Gear tooth surface;
- Valve stem and seal;
- Engine oil pressure regulating valve;
- Engine oil filter seal;
- Fuel filter seal;
- Main bearing bolt;
- Cylinder head bolt;
- Connecting rod bolt;
- Flywheel bolt;
- Damper bolt;
- All of other fastening bolts.

9 Information necessary for Customers/Users to Feed-Back Product Quality

1. In order for us to understand and analyze product quality issue and to improve our product, we would request our costumers/users to state following items before firing a product complaint:

1)Where and when the engine malfunction happened;

2)Engine production series number, engine model, order number, date of deliver from SDEC, receiver address;

3)Engine operation condition, accumulated operation time (house or mileage), operation state (power and speed), brands of fuel and oil used;

4)Characters of driven equipment such as model, power, structure, etc.;

5)The damaged parts for claim or repaired are brought or sent to SDEC with a record or explanation of damage process for analysis. Please keep the case cite and inform SDEC to send competent personnel for analysis when there happened many or serious problems.

2. Regulation for dealing with the quality issue:

1)According to our operation manual and operation, SEDC will repair or replace an engine or components for any damage resulting from poor manufacturing proved by a technical record on the damage when it has been sold for less than 12 months, or it has been operated less than 2,000 h or 50,000 ~100,000 km for vehicle application (whichever comes first). Since warranty varies from engine model to another, please refer to the warranty book sent with the engine for specific warranty period and service.

2)Users should take responsibility for engine malfunction due to their improper operation. Also, the users are responsible for malfunction caused by their improper repair or replacement of parts.

3)Generally, if outsourced parts have quality issues, users can fire a direct complaint to the manufactory for quick solution.