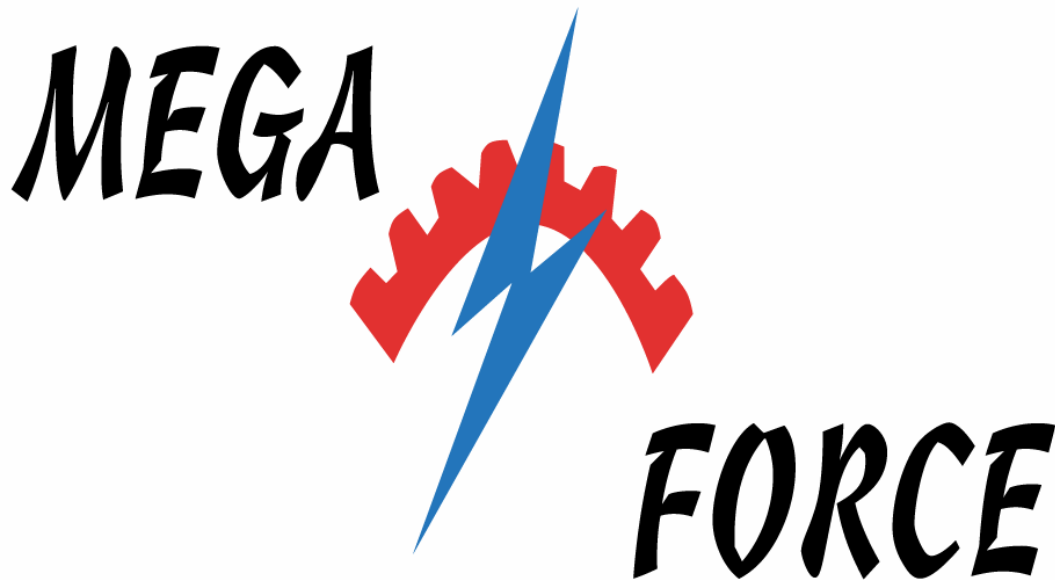


**DIESEL ENGINES OPERATION MANUAL**



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## Chapter I

### Operation of Diesel Engines

#### A. Fuel, engine oil and cooling water

##### Fuel and oil:

Fuel 10# or 20# light diesel fuel can be used as fuel and diesel engine oil HC-11, HC-8 and HC-14 can be used as engine oil, low supercharge diesel engine oil is usually the best oil. Types of fuel and oil must be chosen in light of seasons, climate. Fuel must be deposited for a week and filtered with silk cloth, and oil must be filtered as well, and then being refilled into tanks with clean containers. Grease must be applied with grease gun timely. Inadequate operation and maintenance of oil stuff and diesel engine relative system will be naturally worn out seriously and shorten the service life or led to failure. Therefore, close attention must be paid correspondingly.

##### Cooling water:

Soft water is required because of narrow water circuits in the engine block. Water form well, spring and city-running water must be boiled or treated chemically. This is especially important for regions where water contains heavy saline-alkalinity. Or water circuits may deposit scale and lead to corrosion or failures.

#### B. Starting of diesel engine

Before starting diesel engine normal check-up must be done on different parts, what about connections, engine oil, cooling water and fuel capacity and whether there is leakage. In winter, operation and maintenance must be followed the specification for winter to refill oil and water; to rotate crankshaft for some times; to check the smooth running of moving parts; to check electric circuit systems and batteries; to check transmission etc. when every part has been correctly done, moving parts are flexible, electric circuits are firmly connected, batteries are well charged and transmission is in disengaged position, diesel engines are ready to start. Starting procedure consist of bleeding the air from the fuel system fuel had pump, and then stepping the pedal, switch on power connections with key, and observing the electric meters and then starting the engine. Power circuit must be cut-off if the engine fails to start in five seconds and an another try must be begun after two minutes but cannot be run for fifteen seconds. When the diesel engine has started, the speed can be fixed at idle speed and the key must be turned to normal position, then to check engine oil; pressure and cooling water system and control the engine running at medium speed for five to ten minutes. When the water temperature rises, load may be gradually increased.

#### C. Running-in of diesel engine

Run-in operation must be done before a new diesel engine comes into operation, in order to ensure the moving parts smooth running, and prevent these parts from abnormal wear and troubles. Experience proves that engines service life, reliability and economic depend largely on the engine run-in under the instruction of run-in specification.

Before the engine are delivered form the works, the measure already have been taken to limit the rated fuel supply, when engine run-in have been completed, the nylon washer on the fuel limiting screw can be taken off.

##### Specification on engine run-in:

Engine run-in is normally about 60 hours together with vehicle and if it calculates by mileage, engine must be run-in for about 2500 Km; including idle run-in 200Km; and then with load below 70% of rated load run for about 1500Km, its speed below 60% of engine rated speed; in the period between 1500-2500 Km vehicle load can be up to 90%, and vehicle speed can be up to maximum rated speed.

All fastening parts and working condition must be checked up, after engine run-in 2500Km, and the bolts on cylinder head must be tightening once more.

The oil in the pan must be replaced, after engines have run 500, 1000 and 2500 Km respectively, the filter elements must be cleaned at same time, and apply grease to all grease nipple.

#### D. Operation of diesel engine

In most case, the charge of engine speed and load should be gradually, avoiding sudden and instant step on paddle, except for few circumstances. Constant attention be paid to the reading of all meter and engine operation conditions (noisy operation and exhaust smoke) during engines or vehicles in operation, and emergency measures must be taken whenever engine operated abnormally.

#### E. Stop of diesel engine

Speed and load can be reduced till 800-1000r/min and continue to run for 3-5 minutes before engine stop. Whenever engine comes to stop, paddle should be released, switching off fuel shut-off handle to cut-off the fuel into the engine, and then engines stop immediately. Turning the key to cut-off the power connections after vehicle have stopped.

#### F. Operation in plateau region

When engine operation in plateau region, the altitude over 1000m above sea level, the injection pump must be readjusted on injection pump test stand, according to the height and related regulation, reduce the fuel delivery to prevent the engine from overload.

### Chapter II

#### Maintenance of Diesel Engine

Regular maintenance is once of the import items to operate engine rationally. Therefore, careful maintenance can be performed under criterions if the customers want to keep the engines in excellent working condition and serve reliably for long term.

The maintenance criterions below are the content on limited maintenance period and minimal operation worked out under engines good and normal condition. Our customers may make any proper alternations according to local environment and working conditions.

Diesel engine maintenance is graded as follows:

- a. Routine (shift) maintenance (or regular maintenance) (8-10 hours)
- b. First grade (accumulative 50 hours in operation, approx. 2000Km in vehicles operation).
- c. Second grade (accumulative 200-250 hours in operation, approx. 10,000Km in vehicles operation).
- d. Third grade (accumulative 600-750 hours in operation, approx. 30,000Km in vehicles operation).
- e. Maintenance on winter operation.
- A. Routine maintenance.
  1. Checking lube oil in the pan, finding out the cause when lube oil level rises, and refill it to the set value.
  2. Checking cooling water capacity.
  3. Checking the bolts on engine and auxiliary systems.
  4. 4.Cooling water should be drained out when engines are placed in environment below 5
  5. Keeping engine clean and necessary wash is required.
  6. Getting rid of all troubles whenever find out.

#### B. First grade maintenance

The work below must be done after the routine maintenance has completed:

1. Discharging the engine oil and fuel in both filters and cleaning both filter elements. Changing both engine oil and fuel filter elements when maintenance is done every 4,000Km.
2. Cleaning the dust in air filter.
3. Checking the tension of bolts of fan and air compressor.
4. Checking engine idle speed and making adjustment every other maintenance. Correct reassembling must be guaranteed in the course of maintenance, after the operating the engine, and checking the working condition and getting rid of all troubles (the rest maintenance below should be done this way).

### C. Second grade maintenance

The work below must be done after the first maintenance has completed:

1. Cleaning oil pan and oil suction screen under the oil pump.
2. Cleaning fuel filter elements.
3. Cleaning air filter elements and its dust receiver.
4. Checking and adjusting valve gap.
5. Cleaning fuel tank, fuel supply pump screen and fuel line.
6. Blowing away the dust in electric generator and starter by compressed air, checking all parts and keeping every part in good working condition.

### D. Third grade maintenance

1. Cleaning cooling system.
2. Cleaning engine oil cooler.
3. Cleaning air filter element
4. Check fuel injection pressure and fuel spray, and cleaning, washing and adjusting injector if necessary.
5. Checking fuel advance angle adjusting if necessary.
6. 6.Checking the bolts on cylinder head, connecting rod main bearing, and tightening the loose ones till their set value are met.
7. Checking water pump internal seals and refilling fresh grease.
8. Removing and checking electric generator and starter, cleaning maintenance them and refilling grease.
9. Removing and maintenance of cylinder head and regrinding valve is usually decided according to working condition.
10. Removing and adjustment of injection pump is usually decided according to working condition.
11. Checking of oil delivery of oil pump is usually decided according to working condition.
12. Except for the first time, the later every third grade maintenance, all parts of engine must be inspected, and according to working condition give necessary maintenance and adjustment.

### E. Maintenance on winter operation

Engine must be specially cared when operate at below 5

1. Winter engine oil and fuel must be used to engines and special attention must be paid to water content in fuel to avoid fuel circuit block.
2. Deicing liquid had better filled into cooling systems, or cooling must be drained when the water temperature fall down to 40-50 after engine has stopped.
3. Vehicles should not be put in the open in winter, or cooling water and engine oil must be heated to preheat the engines when starting. Soon after all this has been prepared engine may start without much difficulties at environmental temperature below -20

## Chapter III

### Diesel engine main part and system

#### A. Engine cylinder block assembly

Engine block is an integral casting of crankshaft case and cylinders, in which full-support main bearings are used, and it is made of alloy casting iron. Dry and thin wall cylinder liners are used, which are made of boron phosphorous cast iron with wall thickness of 1.5mm, interference fitted between cylinder liner and bore of 0.01-0.03mm. The liner top extrudes the block top desk 0.05-0.12mm, and neighboring cylinder the extrusion difference not exceeds 0.05mm. Special tools should be used to remove cylinder liner. Cylinders and cylinder liners must be kept dry, clean and oil-free inside and outside when replacement.

Engine block must be withstood 392KPa (4 Kgf/cm) hydraulic pressure test of water jacket at least for 3 minutes

without any leakage. The oil gallery must be understanding 784 KPa (8 Kgf/cm) oil pressure test at least for 3 minutes without any leakage.

There are two tappet chamber windows on the left side of engine block, the rear window cover has a joint connecting with the vent pipe. There are oil cooler and fuel injection pump on the right side of engine.

Close attention must be paid to gasket, when assemble oil pan the screws tightening starts from centre to either side alternatively with proper tightening torque to avoid oil pan deformation.

There is a dipstick on the left side of the engine block where the oil level should be always laid between two from where chassis is connected with engine.

#### B. Cylinder head assembly

C. The cylinder head is a four-cylinder unit, made of alloy cast iron. The cylinder head must be withstood 392KPa (4Kgf/cm<sup>2</sup>) hydraulic pressure test at least for 3 minutes without any leakage.

D. There is a valve cover on cylinder head, on which is a oil filler.

E. Close attention must be paid to oil holes and seals, when assemble cylinder gasket to avoid making errors. Piston gap must be measured whose value is 0.9-1.1 mm when new gasket is replace.

F. Before assembly of cylinder head 20g lubeoil should be applied uniformly into internal circumference of each cylinder. Then cylinder head and block can be fixed with locating bushes and connected with bolts and screws with tightening torque from 107.8~117.6N.m(11~12Kgf.m), starting from 58.8N.m(6Kgf.m) at first and then tighten them again to reach set value in sequence as follow:

	15	7	6	14	
16	8	1	5		13
	I	II	III	IV	
17	9	2	4		12
	18	10	3	11	

#### C. Crankshaft and flywheel assembly

Crankshaft is made of high strength nodular cast iron or alloy steel with four balance weights on the web. Main bearings are made of steel back and high tin aluminum alloy bearing of 10 pieces in two different kinds. Keeping bearing backs oil-free to avoid affection of heat dissipation when assemble bearings. The material of thrust washer is same as main bearing which is installed on the fourth bearing seat and positioned by the lower thrust washer extended tail, keeping the working surface (the side with oil groove) towards crank-web.

The combining machining of main bearing caps and engine block are marked with numbers and serial numbers on the caps. The fourth bearing cap is positioned by bush. The rest bearing are positioned by lugs. The tip of triangle mark of caps is facing the front of engine block and numbered beginning from the front when assemble them. The main bearing bolt tighten torque is 216~235N.m(22~24Kgf.m) starting alternatively tightening from the centre towards the two sides and when tightening is done, the crankshaft can be rotated smoothly.

At the rear of crankshaft is a flywheel connected with bolts. The bolt tightening torque is 196~216N.m(20~22Kgf.m), sequenced according to diagonal line alternatively. The swing error allowance of flywheel and end plane is below 0.2mm. The bolt tightening torque of flywheel housing is 127~147N.m(13~15Kgf.m). There is a damper in front of crankshaft and fixed on the crankshaft by staring jaw; its tightening torque is 392~441N.m(40~45Kgf.m). Strike with hammer is forbidden when assemble and removing flywheel.

Crankshaft, flywheel and damper are all balanced, therefore rebalance is required when changing parts. Flywheel housing and front gear box cover are fitted with oil seals therefore close attention must be paid to them when they were removed to avoid damage.

#### D. Piston and connecting rod assembly

The top of piston is designed to facilitate thermal flow, its skirt is of variable oval barrel surface and with slipper ends. There are two compression rings and one oil ring. The first one is top and bottom face chrome-coated with barrel surface ring, and the end with marl is upwards when it is assembled/the second one is excircle tapered and chamfered twist ring, and the end with chamfer is downwards when it is assembled. The oil ring has an coiled spring expander with surface chrome-coated, and spring connecting point and oil ring open is at  $180^{\circ}$  when it is assembled. Special expander should be used when piston rings is assembled to avoid over expanding or it may be broken. The ring should be rotated freely in groove and fallen freely into bottom of the groove by gravity. When the rings are put into cylinders, the first ring open and thrust plane of cylinder is at an angle of  $45^{\circ}$ . The open of second ring is at an angle of  $180^{\circ}$  with first ring open. The oil ring open is at an angle of  $90^{\circ}$  with first and second open. The intake valve recess on the piston top is towards the front when it is assembled. And all moving parts must be applied with lubeoil.

Connecting rods are made of forged steel which are numbered on its caps and bodies in order to avoid errors and mistakes in direction. The tightening torque of connecting rod bolts is  $118\sim 127\text{N.m}$ ( $12\sim 13\text{kgf.m}$ ). Connecting rod bearings material is the same as main bearings.

Pistons must be heated to  $60\sim 80^{\circ}\text{C}$  when piston pins are assembled. When connecting rods are assembled, the operator is facing the top of piston, the intake valve recess on the piston top is at the left side the locating notch inside the big end of connecting rod are strictly controlled and assembly weight deviation is below 20g.

#### E. Transmission gear

The timing marks on gear surface must be correctly set when gears are assembled, in order to ensure correctly air and fuel supply. Idler shaft oil hole must be aimed at the central direction between crankshaft gear and camshaft gear. Screws and bolts should firmly tightened but gear axial gap should not be affected and every gear rotates freely without any objection.

#### F. Air supply system.

##### 1. Valve train

The Valve train of this engine is overhead valve type. Camshaft is made of specially selected 45# steel on which three bearing journals and eight cam lobes are all case-hardened. There is thrust plate in front of the first bearing journal, and the camshaft axial clearance is  $0.06\sim 0.138\text{mm}$ . There is a discontinuous oil supply groove in the first bearing journal towards cylinder head. The oil pump drive gear is located on the centre of the camshaft.

The tappet is of cylinder shape, made of chilled cast iron and tappet centre is 2mm offset to the cam centre, therefore the tappet may continuously rotates, thus may evenly wear and prevent from scuffing.

The push rod is a hollow steel tube with steel ball and bowl head by friction welded on either end. The rocker is made of forged steel, and rocker bracket is made of cast aluminium with three different kinds and six pieces. The rocker is firmly supported. The pressured oil coming from cylinder head lubricates rocker and shafts.

Valve and its seat are made of special material. The valve and seat are lapping fitted, the sealing band of which is a continuous uniform ring band of  $1.4\sim 2.0\text{mm}$  in width, with excellent sealing tightness of kerosene in gas port for 2 minutes without leakage. Valve leakage may affect operation of engine and even lead to the valve and seat burning damage. Checking the sealing state during operation must be done according to the maintenance requirement and practical working condition. Valve lapping has to be done if necessary.

Valve guide is installed with an oil seal to avoid oil from flowing into cylinder which causes burning.

The end of valve stem should be extended higher than upper spring seat plane no less than 0.9 mm when assembled.

## 2. Adjustment of valve gap

Valve gap is important to engine operation. Therefore, it is essential to check and adjust the valve gap under the maintenance specification and practical operation. Cold intake and exhaust valve gap is 0.4 mm and way to adjust is as follows:

To rotate crankshaft set the dead centre mark on the damper pulley (rotate clockwise for one scale) to meet exactly the point on gear box cover, meantime, the first and fourth cylinder piston are in the position of compression top dead centre according to rocker arm in loose condition.

When the first or fourth cylinder is in the position of compression top dead centre, the valve marked with "0" can be adjust, and when the second or third cylinder is in the position of compression top dead centre. The valve marked with "\*" can be adjust as follows:

## 4. Air filter:

5. The air cleaner is of cyclone dust collecting paper element type which is usually cleaned and changed under the maintenance specification. Early maintenance and change of element can be made in case of discovery of element or seal damage of the engine is running under dust; working condition.

6. The engine service system consists of fuel supply pump, fuel injection pump, speed governor, fuel injection auto-advancer, fuel filter, fuel injector and high and low pressure line, into fuel injector, and is injected into combustion chamber in the form of small droplets. The fuel leaked from injector and the excessive fuel in fuel supply pump run through low pressure line back into fuel supply pump run through low pressure line back into fuel tank. There are non-return valve on the connection bolts of fuel filter and fuel injection pump in order to prevent fuel running back during operation and prevent air from entering the fuel system to ensure the pressure stability in the feed chamber of fuel injection pump.

1. Fuel supply pump is of piston type, installed at the side of injection pump, and is driven by the eccentric-cam on the camshaft. Hand pump can be applied to bleed the air in the fuwl system when engine fails to start.

2. The fuel filter is of paper element type which can be gotten rid of trouble some dust and prolong the service life of fuel pump, therefore it is necessary to clean and change the filter element under the maintenance specification. Above 90% initial filterability of filter element and initial resistance below 19.6KPa (0.2Kgf/cm), without any leakage or internal short circuit.

3. Fuel injection pump is Bosch pump type A. The plungers barrel, delivery and the valve body are all matching pieces, they cannot be exchangeable. The Fuel injection pump is forced lubrication.

4. High pressure fuel pipe:i.d.\*o.d.length=2\*6\*600mm

5. Fuel injector:

Fuel Injector is long-body, close type with four holes, dia.0.30mm and the angle between holes is 154. The opening pressure is 19100+490KPa. Pressure deviation on same engine is below 490KPa

The injector is installed on the cylinder head at an including angle of 23 with tapered washed at the head and dust ring at the middle.

If some troubles were happened to injector, the engine will operation with excess smoke, the power loses, and the fuel consumption increases. The defect injector can be found on running engine by disconnected the high pressure line of injector one by one. And carefully observe the exhaust smoke and the speed change of the engine. The injector also can by checked by naked eye on injector tester, to observe the injection spray. When the injector work normally, the fuel droplets in spray should very fine and even, and without larger droplets escape from the spray.

#### 6. Speed governor

The max fuel delivery and max speed limiting screw are properly adjusted before delivery, so it is not necessary to readjust unless needed. If trouble has been found, it should be readjusted on fuel injection pump test stand to avoid from accident causes damage. The readjusted of governor must be followed the instruction of pump manufacturer.

#### 7. Injection angle auto-advancer

The injection auto-advancer is built-in mechanical, centrifugal type. The advance performance is  $4.5+30'/1600-1900r/min$

#### H. Lubrication system

Lubrication system lubricates moving parts to reduce friction loss and wear. Besides, lubeoil also plays a part of cooling, washing and sealing, lubrication system consist of oil pump, oil filter, oil cooler, pressure control valve and pipe line etc. Detail see forced lubrication system diagram of the diesel engine.

1. Oil pump is gear type, which is fixed at left side of centre of crankshaft case and through drivenshaft driven by the gear on the camshaft. The axial clearance of driven gear is 0.2-0.3mm. The gears on gear shaft and camshaft are lubricated by pressured oil. Close attention must be paid when removal.
2. Oil filter is of paper element, filter should be well sealed and leakage and short-circuit must be avoided when filter is assembled. The opening pressure of by-pass valve is 137Kpa
3. Oil cooler is composed of fins and pipe, which is installed at the right side of the engine block. The opening pressure of by-pass valve is 196Kpa. The oil is running directly into the main oil gallery without cooling when oil temperature is low and cooler's resistance is high.
4. Pressure control valve is installed at the right side of engine block main oil gallery with opening pressure of  $441+49Kpa$
5. Lubrication system maintenance:

The oil level in oil pan must be checked before starting the engine. The oil level must be within the two marks of oil dipstick. Diesel engine oil 14# is used in summer, 8# or 11# is used in winter. Low supercharger diesel engine oil had better be used.

After running of 500, 1000, and 2500 Km in running period. The oil in oil pan must be changed and filter must be cleaned. Afterwards, the changing and cleaning of oil and filter element is done according to the items concerned in chapter three. Grease must be refilled in each grease nipple at regular intervals. The maintenance of lubrication system is done timely, and the more thoroughly the better, because it may help our customers to use engine reliably and to operate in long term with satisfactory. Close attention must be paid to pressure gauge during operation. The oil pressure is 196-540Pa in normal operation and over 78KPa in idling operation.

#### I cooling system

The cooling system is close forced circulation water cooling type. Water temperature in cooling system is kept at 75-90, low temperature will lead to water of engine abnormal operation or failures.

##### 1. Cooling water circulation:

Water flows out from water pump outlet to the right side of engine block. Cools the oil cooler at first then flows into cylinder water jacket and cylinder head, from there goes into the thermostat in the front of cylinder head, the holes of cooling water in cylinder head and engine block are made casting and drilling. These holes are different in sizes. Therefore close attention must be paid to be restricted, especially care to the cooling water jet for cooling the triangle area among valves and nozzle, or it lead to overheat in this area and damage the fuel injector. Therefore, soft water must be used. Otherwise it may causes troubles.

2. Water pump is centrifugal type. The axial clearance between impeller and pump case is 0.3-0.8mm. when water seals break down, leakage will take place, so they must be repaired timely.

3. Thermostat is wax type model 145B when water temperature is lower than 76, the thermostat is closed, it makes a small cycle and the water coming out from the cylinder head will all flow back into the water pump. When water temperature or rises higher than 86, makes a big cycle, all water flows into radiator and cools there. Thermostat cannot be removed under any condition.

4. Cooling system maintenance:

Only soft water can be used during the winter (boiling the water or making chemical treatment, putting 40g sodium hydroxide in 1 liter water, in which later can be poured into 60 liters water and refilled into the radiator after filtered).

Checking the water level in radiator before vehicle put into operate, refilling till the water overflow from the radiator.

Deicing liquid had better be used during the winter, or when environment temperature is below 5 or the cooling water must be drained out, when engine is stopped and water temperature is at 40-50, when hot water is used to heat the engine, it should not be too hot at beginning to avoid engine block and cylinder head cracking.

There may be some scale formed in cooling system after the engine operates for a long time. Cleaning can be done as follows: pump the mixture made of 700-800g sodium hydroxide and 150g kerosene into water. Diesel engine operates at medium speed for 5-10 minutes and remains standstill for 10-12 hours, then the engine operates again for 10-15 minutes and drains the liquid mixture and cleans the cooling system with fresh water.

Checking and maintaining the water pump belt's tension regularly pulley is pressed by 4-5kg weight, the deflection is between 10-15 mm. neither too tight nor too loose.

- I. Electric system

The starter and generator of this diesel engine is 12v or 24v. there is a vacuum pump mounted behind the generator and the shaft of vacuum pump is aligned with shaft of generator.

- J. Supercharging system

1. Basic principle

The exhaust from engine has certain quality of pressure and temperature, so it has certain amount of energy, when it flow through turbo vane, it can be converted into rotating mechanical energy. The turbine drives a coaxial compressor vane at the same speed, it increase the incoming fresh air density, and flows through intake pipe into the cylinder increasing the charge of air, it means more fuel can be injected into the cylinder and more power output from the engine. So the supercharge technology can increase power output without change the displacement and speed of engine. It is a effective measure to improve power output, fuel economy, reduce emission, so it is the present trend of engine development.

At plateau region, the air is thin and lack oxygen because of low air pressure, the power output of natural aspirate engine will reduce for every increase of 1000m lose 10% of power. But supercharge engine has less affect on power by the altitude, because the supercharger operation at plateau its speed will increase as the altitude increase, so the supercharge pressure also increase, which compensate the affection of power loss due to increasing altitude. In general cases, the power loss only 3% for every 1000m for supercharging engine. So it is effective measure to recovery the engine power when it is used at plateau area.

2. Lubrication

Lubrication of supercharger comes from engine main oil gallery, oil return by gravity and flows back to oil pan, in order to avoid supercharger leakage, care must be take to check the oil flow of oil supply and return line to ensure normally and reliably work of supercharger, any leakage are not allowed, and oil return line cannot restricted.

3. Brief introduction of structure of turbocharger

Turbocharger are normally consist of turbine, middle body, and compressor three part.

In order to further improve the performance of turbocharger diesel engine, to meet operation requirement of matching power machinery, a turbocharger with exhaust release valve has development, that is there are two types diesel engine: general type turbocharger diesel engine and turbocharger diesel engine with exhaust release valve.

a. Turbine

Ti included turbine housing, single stage radial turbobane, it is a energy coverter. Exhaust from engine flow through housing into nozzles at certain direction inject to vane of turbine, convert the heat energy and pressure into kinematic energy, make high speed rotation of turbine.

b. Middle body

Middle body id the supporting body for rotor assembly and compressor housing, turbine housing, it is also used as oil reservoir for lubrication and cooling the float bearing and rotor shaft.

c. Compressor

It included single stage centrifugal compressor van, diffuser, and compressor housing. The air through air filter is sucked in by high speed rotating compressor housing its pressure further increased, and the air become more dense, so more air can flow into cylinder.

Rotor shaft and turbine use friction welding to join together, compressor vane use transition fit to fit on rotor shaft, and use a lock nut to fix it. The rotor assembly are precisely dynamic balanced to ensure steady work at high speed operation condition. The rotor assembly used internal support, that is two floating bearing arranged between two vanes of rotor on the middle body, axial force are supported by thrust bearings which fixed on the middle body.

The supercharger used forced lubrication, in order to ensure enough lubrication oil and cooling effect to rotor and bearing working in normal operation.

d. Exhaust release valve

For the purpose of obtain optimal match of supercharger and engine to operate at low or moderate speed area, to ensure more air supply to engine, and meanwhile increase fuel supply, to improve the torque at engine low speed operation, the fuel economy also improved. At high speed operation of engine some exhaust are released into atmosphere through release valve, to avoid rotor over speed or excessive supercharging pressure which causes excessive combustion pressure and increases mechanical load on engine. So the use of exhaust release valve can improve the engine output torque at low speed area, and at high speed area it also consider the engine performance and engine reliability.

The open and close of release valve are controlled automatically by supercharging pressure as shown in the figure, the supercharging pressure of compressor exit are lead to a closed pressure chamber of release valve control mechanism, when supercharging pressure reach or exceed specified value, the diagram will overcome the force of spring at left side, moved the push rod to left side, and make a rotation action on rocker arm to open the release valve, then the exhaust will escape to the exhaust pipe thus control the speed rise of supercharger.

Notice:

- a. Specified value of open pressure of release valve are set in factory, the customers cannot do any adjustment, the adjust nut on the adjustable push rod cannot be moved or the engine performance will seriously effected.
- b. At any cases, the push rod of control mechanism cannot be used as handle or support weight or step by foot.
- c. If air line or control mechanism cannot be moved freely in operation, the engine must be stopped to repair it. Care must be taken that the release valve parts and closed pressure chamber are unserviceable. If defect are found the entire turbine housing must be replaced.

(4) Maintenance of supercharger

In order to ensure effectively operate of engine, the operator must operate the engine correctly, and the

supercharger must be maintenance and serviced on regular intervals. Supercharger is precise high speed machinery, its top speed is 12000r/min even more, in normal operation the speed is 8000-9000 r/min. Thus the supercharger cannot be disassemble arbitrarily unless it is necessary, when the rotor cannot rotated freely, or the performance of supercharger becoming worse, it may be cleaning without overhaul of supercharger. You can do it as follows;

- a. Clean dust and oil spot on appearance of supercharger.
- b. Remove supercharger from engine, if a supercharger with release valve, the push rod cannot be used as handle.
- c. If a supercharger with release valve, remove the air line first, then remove release valve control mechanism.
- d. Remove compressor housing, turbine housing and oil supply, return connector.
- e. Clean compressor housing, turbine housing and vanes surface.
- f. Fill some clean detergent into oil inlet, meanwhile rotate the vanes with hand, do it repeatedly until it rotate freely.
- g. Reinstall the supercharger to the engine.

Notice:

When disassemble and reassemble the supercharger care must be taken not to bump the vane, the damaged vane cannot be used again. Kerosene, gasoline or clean diesel fuel can be used as detergent.

(5) Check of supercharger

- a. Check rotor radial clearance

Use dinger to press compressor downwards, and use plug gauge to measure the minimum clearance between compressor vane and housing, this clearance should be above 0.10 mm, if clearance below this value the floating bearing must be replaced.

- b. Check axial clearance of rotor

Use a magnetic base place on the turbine exit flange surface, and a dial gauge contact with rotor shaft and surface, then axial move the shaft and observe the change of dial gauge, new supercharger the axial clearance should be 0.10 mm, operation limit value should be 0.25 mm, at this time the supercharger should be disassemble and woun parts must be replaced.

