RAYWIN

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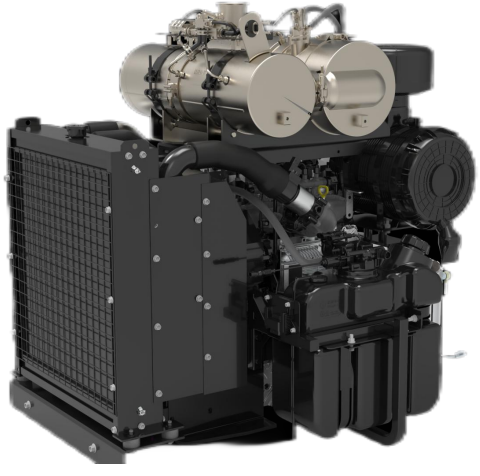
Operation & Maintenance Manual



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4D36TIG14/5
4D36TIG15/5

Please read this manual carefully before using the engine.

Raywin Powertrain Technology Co., Ltd.

Introduction

The “RAYWIN” 4D36TI series non-road diesel engines are upgraded on the basis of our company’s original products to meet the Europe Stage V requirements for the emission standard of diesel engines on non-road machinery. This series of diesel engines boasts excellent power performance, economy, reliability and durability and is mainly used for engineering machinery, agricultural machinery, marine main engines, marine auxiliary engines and generator sets, etc. Moreover, according to users’ requirements, some parts (such as oil supply system, combustion system, valve distribution mechanism and replacement of clutch housing, flywheel housing, flywheel, exhaust pipe, air inlet pipe, electrical system, external hydraulic pump interface) can be changed to fit the performance and installation requirements of different supporting machines.

In order to ensure the normal use of diesel engines, this manual mainly introduces the technical parameters, structure, performance and other knowledge of diesel engines for non-road machinery, and provides technical data on use, maintenance and failures analysis.

The data and instructions provided in this manual are subject to the current product. Since the product is being constantly improved and strengthened to meet the supporting needs of different users, if any discrepancy occurs between the product and the manual contents, the actual product sample shall prevail. Attention, please!

Before use, please read this manual carefully and use, maintain and serve the diesel engine in strict accordance with this manual.

Catalogue

Content Introduction

The "RAYWIN" brand 4D36TI series electronically controlled high-pressure common rail diesel engine is independently designed by Raywin Engine Company. This product utilizes advanced diesel engine technologies of the modern era, including four-valve, centrally located camshaft, turbocharging and intercooling, electronically controlled high-pressure common rail system, DOC+DPF+SCR+ASC post-treatment system, and others. It meets the latest European emission regulations (EU stage V) and is suitable for a new generation of environmentally friendly and energy-saving high-speed diesel engines for off-road applications. The series of diesel engines have undergone testing and verification in high-temperature (+40℃), high-altitude (4500m), and cold (-25℃) environments, demonstrating extensive geographical adaptability. They are characterized by low fuel consumption, low noise, good acceleration, high reliability, low emissions, and ease of use and maintenance. They can be applied in agricultural and gardening fields, construction equipment, power generation, marine, and industrial equipment.

This manual provides a detailed introduction to the main technical parameters, structure, principles, usage, maintenance, and troubleshooting methods of the 4D36TI series electronically

controlled high-pressure common rail diesel engine. It can serve as a reference for the use, repair, and maintenance of this machine. The illustrations, photos, and parameters in the text are for reference only, and the actual product shall prevail.

Preface

Thank you for choosing the "RAYWIN" diesel engine. This manual is prepared for you to understand the usage and maintenance of the "RAYWIN" diesel engine. To ensure your personal and property safety, please read this manual thoroughly before use.

Please keep in mind the RAYWIN service hotline and the RAYWIN service phone number in your area. If you require any services or have any questions about the engine you purchased, please contact us by phone, and we will gladly provide you with assistance.

In this manual, items marked with " " indicate potential dangers that may cause personal injury and other damage, and must be strictly observed.

In this manual, items with the "Note" prompt indicate potential dangers that may cause minor personal or mechanical damage. Please follow the operating procedures carefully.

Notice

1. To ensure your personal and property safety, please carefully read the manual before use and strictly follow the instructions for using, maintaining, and repairing the diesel engine.
2. The starting, running-in, operation, and shutdown of the diesel engine should be correctly performed according to the requirements of the manual. New or repaired diesel engines must undergo running-in before use. Through running-in, the surfaces of the moving parts of the diesel engine can achieve good coordination, thus avoiding abnormal wear and damage. The service life, reliability, and economy of the diesel engine largely depend on the quality of the initial running-in. Therefore, please strictly follow the running-in specifications. Idle running-in in one place is strictly prohibited.
3. Operators should pay attention to safety warning signs and avoid approaching areas with safety warnings when the diesel engine is running.
4. To extend the life of the starter and battery, the continuous starting time of the starter should not exceed 15 seconds. When restarting is needed, turn the ignition key back to the OFF

position and wait for 2 minutes before restarting.

5. Do not remove the air filter during use, and maintain it according to the specified procedures. When reinstalling, ensure that the upper and lower sealing gaskets of the filter element are properly installed to ensure tight sealing. When connecting the air filter with rubber tubes, secure the rubber tubes with clamps to prevent them from being worn out due to the vibration of the diesel engine. Avoid allowing unfiltered air to enter the cylinder.
6. The electronic fuel supply system is an important system of the diesel engine. Its related components: ECU, high-pressure fuel rail, high-pressure fuel pump, injector, wiring harness, related sensors, and actuators should not be dismantled or adjusted randomly. If adjustment is necessary, it must be carried out at a RAYWIN authorized technical service station.
7. After the running-in period is over, please bring your engine to our nearest authorized maintenance service station for maintenance according to the requirements of the attached "Engine Service Manual".
8. For specific details and items of the "three guarantees" period of RAYWIN engines, please

refer to the "Engine Service Manual". Please keep the "Certificate of Qualification" and "Engine Service Manual" properly.

I Diesel engine specification and data

1. Gensets engine

4D36TIG series diesel engines are applied for power generation, covering multiple speed options:1500rpm, 1800rpm and 3000rpm,and wide power range.

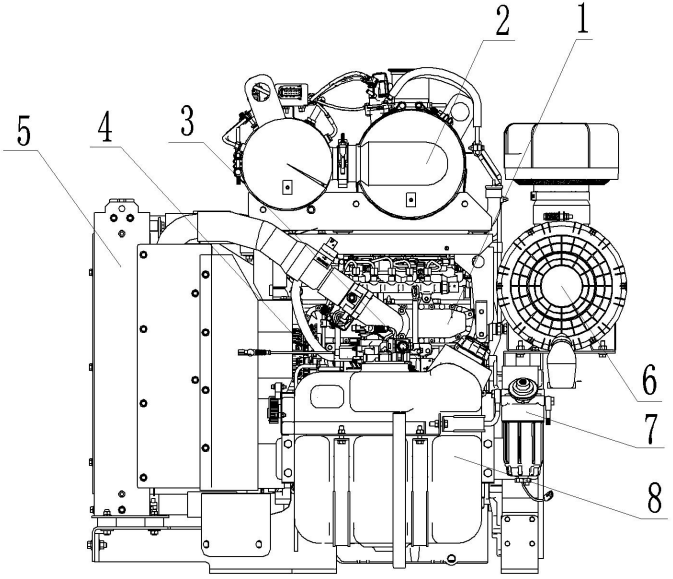
1.1.Model characters explanation

4D36TIG00/5：

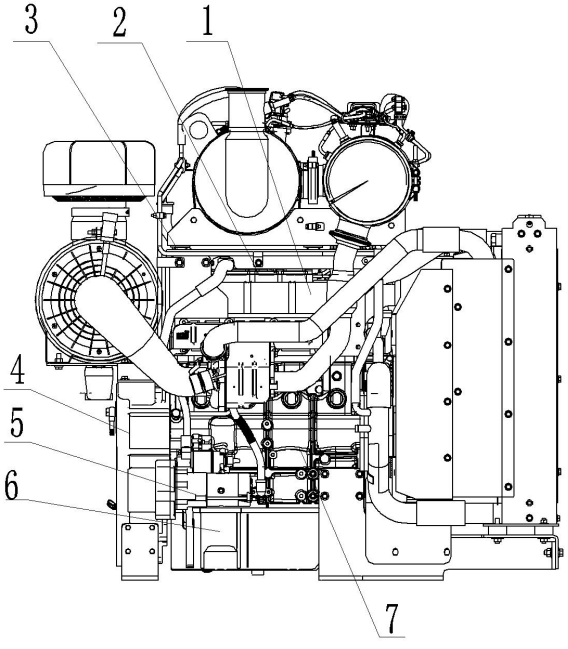
4-----4 cylinders D----series code 36—3.6 liters displacement

T----- turbocharged I----Intercooling G---- G-Drive 00----- Spectrum code

1.2. Layout



1.Intake manifold 2.Aftertreatment 3.ECU 4.Alternator 5.Radiator
6.Air filter 7.Fuel filter 8. Urea can



1.Exhaust manifold 2. Cylinder head cover 3.Cylinder head
4.Flywheel housing 5.Starter 6.Oil pan 7.Cylinder block

2.Engine Data & Specifications

2.1.Specifications

Model	4D36TIG/5	
Type	In line,4 valve per cylinders,common rail	
Cylinders-Bore×Stroke	4-100×115	
Displacement L	3.612	
Linner Type	No Linner	
Combustion type	DI	
Intake system	Turbo,intercooling	
Compress ratio	16.8:1	
Rated power/Speed kW/r/min	4D36TIG03/5	59/1500
	4D36TIG02/5	68/1500
	4D36TIG01/5	77/1500
	4D36TIG00/5	86/1500
	4D36TIG15/5	59/1800
	4D36TIG14/5	68/1800
	4D36TIG13/5	77/1800
	4D36TIG12/5	86/1800
	4D36TIG11/5	95/1800
	4D36TIG10/5	104/1800

Fuel consumption g/kW·h	≤205
fuel consumption rate %	≤0.15
Fire order	1-3-4-2
Crankshaft rotary direction	CCW（face flywheel）
Lubrication system	Pressure and splash
Cooling system	Forced circulating water cooling
Oil capacity L	10.5
Aftertreatment	DOC+DPF+SCR+ASC
Emission	EU Stage V
Dry weight kg	400

3.Main Accessory Specifications

Name		Specification
Aftertreatment	Type	DPF+DOC+SCR
	Model	RWE5-036L-S1
Urea Tank Assembly	Type	Urea Pump+Urea Tank+Urea Tank Bracket
	Model	DEV-SM

4.Main engine data

4.1Valve clearance

Table 4

Valve clearance	Inlet valve（mm）	Exhaust Valve（mm）
Cold state	0.45～0.50	0.50～0.55
Hot state	0.40～0.45	0.45～0.50

4.2.Temperature and Pressure Ranges for Diesel Engines

Table 5

Model	4D36TI
Exhaust Temperature after Operating for 15 Minutes	≤ 750℃
Engine Oil Temperature at Rated Operating Condition	≤ 130℃
Coolant Outlet Temperature at Rated Operating Condition	≤ 105℃
Engine Oil Pressure during Normal Operation	200～700kPa
Engine Oil Pressure during Idle	≥ 100kPa

4.3.Tightening Torque of Key Bolts

Table 6

Name	Specification	Tightening Torque N.m
Main Bearing Bolt	M12×1.5	140～180
Connecting Rod Bolt	M11×1.25	80～120
Flywheel Bolt	M12×1.25	100～140
Cylinder Head Bolt (KAMAX)	M15×1.5	Rotation Angle Method 80N.m+100°+90°
Fuel Pump Flange Mounting Screw	M8-8.8	22～25
Fuel Rail Fixing Bolt	M8-8.8	22～29
Common Rail High-Pressure Fuel Line Connection Nut	M14×1.5	25～30
Injector End High-Pressure Fuel Line Connection Nut	M14×1.5	25～35
Fuel Pump End High-Pressure Fuel Line Connection Nut	M14×1.5	25～35
Injector Pressure Plate Compression Nut	M10-12.9	47～52
Fuel Pump Shaft End Compression	M14×1.5	90～95

Nut		
Flywheel Housing Bolt	M12-8.8	70～110
Crankshaft Pulley Bolt	M14×1.5	200～230

4.4.General Bolt and Nut Tightening Torque (Reference)

Table 7

Bolt Strength Grade	Nominal Bolt Diameter (mm)							
	6	8	10	12	14	16	18	20
	Tightening torque N.m							
4.6	4～5	10～12	20～25	35～44	54～69	88～108	118～147	167～206
5.6	5～7	12～15	25～31	44～54	69～88	108～137	147～186	206～265
6.6	6～8	14～18	29～39	49～64	83～98	127～157	176～216	245～314
8.8	9～12	22～29	44～58	76～102	121～162	189～252	260～347	369～492
10.9	13～14	29～35	64～76	108～127	176～206	274～323	372～441	529～637
12.9	15～20	37～50	74～88	128～171	204～273	319～425	489～565	622～830

II Usage of Diesel Engines

1.Diesel

To ensure the reliability of the fuel supply system, it is imperative to use clean diesel fuel produced by formal national petroleum companies. In areas with environmental protection requirements, diesel fuel that meets environmental regulations must be used. When refueling on your own, the fuel container must be clean and dedicated for this purpose; the diesel fuel added to the tank must undergo sedimentation for over 48 hours, and only the clean diesel fuel from the upper part of the container should be used. The selection of diesel fuel grades is related to the ambient temperature. When the ambient temperature is low, paraffin in the diesel will precipitate, and the viscosity of the diesel will increase, which may block the fuel line, causing starting difficulties and black smoke emissions. Conversely, using diesel fuel designed for winter in summer can reduce the viscosity of the diesel due to high temperatures, leading to poor lubrication of the fuel supply system, potentially damaging the fuel injection pump and injectors, and causing delayed ignition, resulting in insufficient power and white smoke emissions. Therefore, different grades of diesel fuel should be selected based on the climate conditions of different seasons and regions. Please select diesel fuel according to the climate conditions in your area, as required in the following table, and ensure that the sulfur content in the diesel is less than 50ppm.

Ambient Temperature	T≥4℃	-5℃≤T＜4℃	- 14℃≤T＜-5℃	-29℃≤T＜- 14℃	-44℃≤T＜-29℃
Diesel Type	0# light diesel	-10# light diesel	-20# light diesel	-35#light diesel	-50#light diesel

1.1.Requirements for Diesel Cleanliness

Compared to traditional mechanical fuel systems, electronically controlled systems have more stringent requirements for fuel cleanliness. Electronic control systems have higher fuel pressures, more precise control, and more delicate coordination of internal moving parts. Unclean fuel can reduce the service life of fuel injection pumps and injectors.

1.1.1. Diesel filters are key components to ensuring diesel cleanliness. Electronically controlled high-pressure common-rail diesel engines adopt two-stage dedicated and efficient diesel filters, namely the Pre-fuel filter (coarse filter) installed on the equipment and the diesel filter (fine filter) installed on the engine.

1.1.2. The diesel filter and Pre-fuel filter must be used with the dedicated parts provided by the RAYWIN supporting manufacturer. RAYWIN shall not provide warranty for any malfunctions such as starting difficulties, insufficient power, wear and tear of fuel system components, etc.

caused by the use of inferior diesel filters and Pre-fuel filters by users.

1.1.3. Please be sure to replace the diesel filter element regularly according to the maintenance regulations.

Attention: Please use regular diesel. Any diesel engine failure caused by the use of inferior diesel will disqualify you from enjoying the quality warranty rights.

a)Pre-fuel filter requirements

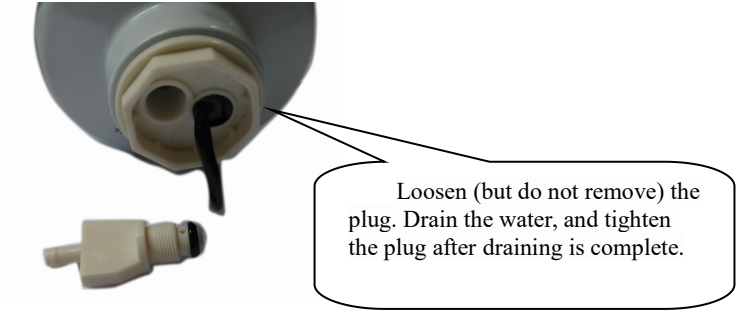
The water content in diesel is extremely harmful to the common rail system！

The presence of water in diesel will cause corrosion and wear to the high-pressure fuel pump, fuel rail, and fuel injectors. If the diesel filter water level warning light on the dashboard comes on, it indicates that the diesel filter is filled with water, and the water should be drained immediately.

Steps for Draining Water：

1）Loosen the water drain plug (but do not fully unscrew it), let the water out until diesel fuel starts to flow。

2）After draining the water, tighten the water drain plug securely



Attention: When the diesel filter water level warning light on the dashboard turns on, please drain the water promptly!

b)Removal of Air from the Fuel Lines

If air enters the fuel lines, it is necessary to use the manual fuel pump on the diesel filter to expel the air from the fuel lines and high-pressure fuel pump. Ensure that the fuel lines and high-pressure fuel pump

are filled with fuel before starting the engine.

Attention: The air inside the high-pressure fuel lines and fuel rails will automatically be expelled back to the fuel tank during the operation of the high-pressure fuel pump. It is not allowed to loosen the high-pressure fuel line nuts for air removal.

The steps and precautions for air removal are as follows:

1）Loosen the exhaust screw on the diesel filter, repeatedly press and release the manual fuel pump to pump fuel, and tighten the exhaust screw after no air is expelled from the exhaust screw.

2）Loosen the exhaust screw on the pre-fuel filter, repeatedly press and release the manual fuel pump to pump fuel, and tighten the exhaust screw after no air is expelled from the exhaust screw

3）Use the manual fuel pump to pump fuel until the fuel injection pump is filled with fuel.

2.Oil

Note: It is essential to use the CK-4 grade diesel engine-specific oil specified by RAYWIN Power. Otherwise, you may not be able to enjoy the quality warranty benefits.

The viscosity of engine oil is related to ambient temperature. When the ambient temperature decreases, the viscosity of the oil increases, which in turn increases the starting resistance, making it difficult for the diesel engine to reach the starting speed, resulting in difficulty in starting. Therefore, in different regions and seasons, it is necessary to select different viscosity grades (brands) of engine oil based on different ambient temperatures according to the table below.

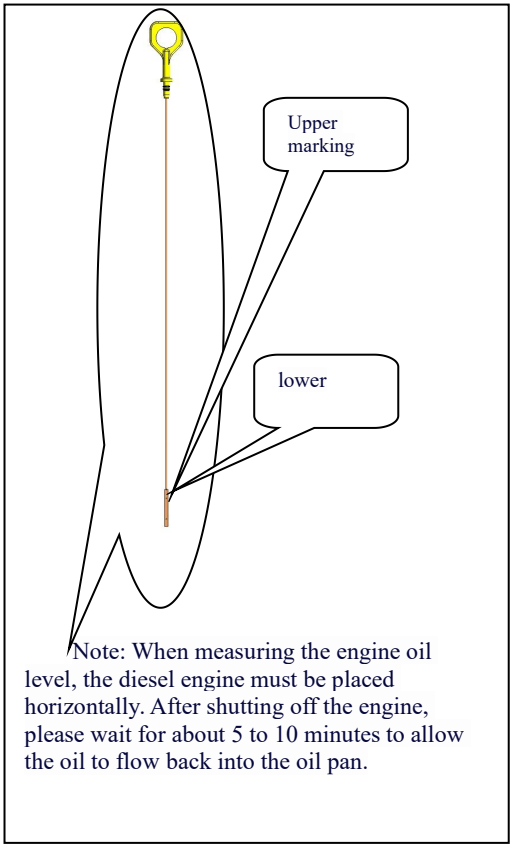
Ambient temperature	Oil type
-10℃～0℃≤	15W/40
-20℃～-5℃	10W/30
-30℃≤	5W/30
Frigid regions	0W/30

2.1.Checking Engine Oil Level：

1）Shut off the engine when it is at normal temperature and wait for 5 minutes.

2）Pull out the dipstick, wipe it clean with a cloth, and then re-insert the dipstick all the way to the bottom

3）Pull out the dipstick again and check the engine oil level. Verify if the oil level is between the upper and lower markings on the dipstick. If it's not, add engine oil accordingly.



Note: When measuring the engine oil level, the diesel engine must be placed horizontally. After shutting off the engine, please wait for about 5 to 10 minutes to allow the oil to flow back into the oil pan.

2.2.Change Oil

Please make sure to replace the engine oil and oil filter regularly according to the maintenance regulations. If the engine starts frequently or often operates under high speed and heavy load, the oil change interval should be shortened.

Attention: Please make sure to regularly check the

engine oil level and replace the oil. If the oil level suddenly rises or drops, immediately inspect the cause.

3.Coolant, battery, power steering pump, air compressor

Please make sure to use antifreeze with anti-freezing, anti-boiling, anti-corrosion, anti-rust, and anti-scaling properties as the engine coolant.

Attention：

1）Apart from its anti freezing function, antifreeze also provides corrosion protection, boiling prevention, and scale prevention for the coolant.

2）According to the ambient temperature in the diesel engine's usage environment, different freezing points of coolant should be selected. The freezing point of the coolant should be at least 10℃ lower than the lowest temperature in that region to avoid losing its anti freezing effect.

3）Purchase qualified antifreeze products from reputable and well-known manufacturers that have been tested and certified by the nationally designated testing stations. Avoid purchasing inferior products to prevent damage to the engine and unnecessary economic losses.

4）Do not mix antifreeze products of different brands to avoid chemical reactions that may compromise the comprehensive performance of the antifreeze.

5）When you find suspended particles, sediments, or a foul odor in the antifreeze, it indicates that the antifreeze has deteriorated and become ineffective. Immediately clean the cooling system and replace all the antifreeze.

6）Avoid direct contact with or inhalation of antifreeze. If your skin comes into contact with it, rinse it off immediately with water. Dispose of waste liquid properly to avoid environmental pollution.

7）When the coolant level suddenly drops, immediately inspect the cause.

8）Do not open the coolant compensation tank or radiator cap when the engine is hot. Otherwise,

there is a risk of burns

3.1. Battery

1）Keep the surface of the battery clean and dry. If there is any corrosive liquid, wash it off with alkaline water.

2）Ensure that the battery terminals are clean and secure.

3）If the engine is not going to be used for 7 days or longer, disconnect the positive terminal of the battery (or turn off the main power switch) to prevent battery drainage。

 Attention：

1）Do not place the battery near fire, smoke, or electric sparks. The hydrogen released during the battery reaction can explode.

2）Avoid letting battery fluid come into contact with your skin, eyes, fabrics, or painted surfaces. Do not rub your eyes after touching the battery. Thoroughly wash your hands. If battery acid comes into contact with your eyes, skin, or clothing, immediately rinse with water for at least 15 minutes and seek medical attention immediately.

3） In winter, the capacity of the battery decreases rapidly with decreasing temperature, and its discharge rate drops sharply. Therefore, it is recommended to have the battery checked at a designated service station before winter arrives and replace it if necessary.

① During cold seasons, ensure that the battery is fully charged.

②Cold starts require greater current consumption, so it takes longer to recharge the battery after starting compared to normal temperatures。

③Undercharged batteries have a low electrolyte gravity, which is prone to freezing and can damage the battery.

④In winter, pay attention to keeping the battery warm.

⑤Refilling the battery with distilled water should be done shortly after the engine starts.

⑥If you refill the battery with distilled water after the engine has been running, the newly added distilled water may not mix well with the original electrolyte, potentially causing unmixed distilled water to remain on the top and freeze.

4.Aqueous urea solution

The 4D36TI series diesel engine employs an SCR system for post-treatment, which requires the

consumption of aqueous urea solution. Aqueous urea solution, also known as "Tianlan", is a mixture composed of 32.5% urea and 67.5% water. It will solidify and freeze when the ambient temperature drops below -11℃.

- Please refill the aqueous urea solution at a reputable gas station. Using inferior aqueous urea solution may cause diesel engine fault alarms, which will affect your normal use of the equipment.
- When the level of the aqueous urea solution is close to the 10% mark of the urea tank, please refill it promptly. Do not wait until the urea is completely depleted to add more; otherwise, it will cause the equipment to be speed-limited. Since there are currently fewer places to refill urea, please try to keep the solution in the urea tank at or near the upper mark, or carry several buckets of urea in your vehicle as a backup.
- Aqueous urea solution is somewhat corrosive. If it comes into contact with your eyes, skin, or clothing, rinse immediately with water for at least 15 minutes and seek medical attention promptly.

5.Starting a Diesel Engine

Starting Steps and Precautions:

a.If preheating is required during startup, first turn the ignition switch to the ON position and wait for the preheating light to go off.

b.After the preheating light goes off, use the ignition key to turn on the power and observe if the electrical instrument indications are normal.

c..Turn the ignition key to the "Start" position; the starter should not run for more than 5 seconds each time. If it fails to start, wait for 10-15 seconds before trying again.

d.Immediately release the ignition key after the diesel engine starts；

e..After starting, do not immediately operate the diesel engine at high speed. Check if the oil pressure indication is normal. When the ambient temperature is low, warm up the engine after starting it.

Attention: When the fault indicator light on the instrument panel is on, please promptly have it inspected and repaired at an authorized service station.

6.Running-in of Diesel Engine

Before using a diesel engine, it is necessary to undergo a running-in process. This running-in allows the surfaces of all moving parts of the diesel engine to achieve good coordination, thus avoiding abnormal wear and damage. The service life, operational reliability, and economy of the diesel engine largely depend on the quality of the initial running-in, so please strictly follow the running-in specifications.

The running-in of the diesel engine can be carried out together with the supporting machinery, with a running-in time of 40 to 60 hours. During the running-in period, the load should not exceed 70% of the specified load, and the speed should not exceed 80% of the rated speed. Avoid letting the engine idle for extended periods. After the running-in is complete, the user should perform the break-in maintenance according to the requirements in Chapter 4.

a.It is not allowed to operate the diesel engine when the coolant is boiling, and it should not be operated for extended periods at excessively high or low water temperatures.

b.It is not allowed to let the diesel engine idle for more than 10 minutes.

Attention: It is prohibited to perform running-in without load.

7.Operation of Diesel Engine

During engine operation, before a malfunction occurs, there may be some signs that should draw our attention. During operation, please pay attention to whether the indications of various instruments are normal. If there are abnormalities, stop immediately and check.

1）Oil pressure:If the oil pressure warning light flashes repeatedly during the diesel engine's operation, it indicates that the oil pressure is low, and the engine should be stopped for inspection.

2）If the fault indicator light on the instrument panel comes on during operation, please promptly have it inspected and repaired at an authorized service station

3）Engine Waterproofing: In principle, the height of the control unit and wiring harness from the water should exceed 200mm to avoid damage and malfunction of the electronic control system due to water ingress.

4）Coolant Temperature: When the water temperature is too high (exceeding 105℃), the engine will enter a thermal protection state, and the ECU will automatically reduce the engine's output power.

In severe cases (when the water temperature exceeds 108℃), it will automatically shut down. At this time, the user should carefully examine the cause and eliminate it.

5）If the water temperature does not reach 70℃, it indicates that the engine is too cold, which may lead to early wear. Thermal insulation measures should be taken, such as adding a protective cover to the radiator.

6）Engine Noise: Abnormal sounds emitted from the engine and its related components indicate that the engine is not working properly or there is friction in the moving parts. The engine should be stopped for inspection.

7）Exhaust Color:

If the engine exhaust emits a large amount of white smoke or black smoke, it indicates that the engine combustion is abnormal, and the engine should be stopped for inspection

Attention：

（1） Do not immediately stop an overheated engine.

（2）It is not allowed for the diesel engine to operate under excessive load for a long time.

（3）It is not allowed for the diesel engine to operate when the coolant is boiling, and it should not operate for extended periods when the water temperature is too low.

（4）It is not allowed for the diesel engine to idle for more than 10 minutes.

（5）It is strictly prohibited to immediately add cold water to the engine under high temperature and water shortage conditions.

8.Stopping a Diesel Engine

1) Before stopping the diesel engine, the load should be removed first.。
2) Before shutting down the diesel engine, let it idle for 3 to 5 minutes to allow it to cool down sufficiently. During this time, check for any "three leaks" (oil, water, and gas), abnormal noises, and ensure the oil pressure is normal. Avoid suddenly stopping the engine when it is overheated or under excessive load, as this may damage the turbocharger and the engine。
3) After stopping the engine, wait for 25 seconds before turning off the main power switch. The Electronic Control Unit (ECU) requires some time to store the engine's operating parameters after the key switch is turned off. Otherwise, the fault light may remain on when restarting the engine。

4) When the ambient temperature is below 0℃, after stopping the engine, turn on the water drain switches of the engine block and radiator to drain all the coolant water to prevent the engine block, water pump, and radiator from freezing. If an appropriate antifreeze is used, there is no need to drain the water. When using a generator set, it is recommended to connect the water jacket heater switch to ensure smooth starting the next time the machine is operated.

9.Safety Warning

1) During the operation of a diesel engine, please do not touch the exposed rotating parts such as fans, pulley, and belts to avoid injury from rotating parts.
2) Operators must not immediately open the radiator's water fill cap when the diesel engine is hot to prevent being scalded by high-temperature steam.
3) When the diesel engine is hot, avoid touching high-temperature parts such as the exhaust pipe to prevent burns.
4) It is strictly prohibited to add cold water to the engine when the diesel engine is overheated and lacks water.
5) Diesel engines emit harmful gases such as CO_2 and soot during operation. Effective ventilation must be ensured during use.

6) When a diesel engine is operating, the impact of exhaust gas, smoke, and noise on the surrounding environment, personnel, and objects must also be considered.
7) Diesel engines are equipped with aftertreatment devices. During operation and before shutdown, the surface temperature of the aftertreatment device is high. Avoid parking it directly above flammable items.

III Diesel Engine Maintenance and Servicing

1.First service

As most off-road machinery operates in harsh environments, its degree of deterioration is determined by the duration and condition of use. If neglected, the performance of the machinery's structure and components will also degrade, potentially leading to irreparable wear and tear of the diesel engine. To ensure that your diesel engine maintains its optimal technical condition and operates reliably for an extended period, it is crucial to conduct regular inspections and technical maintenance in accordance with

the technical specifications outlined in this chapter. The initial service or maintenance should be performed after 50 hours of operation.

Maintenance items are as follows:

1）Replace engine oil and oil filter cartridge.
2）Replace diesel filter cartridge and pre-fuel filter cartridge.
3）Replace air filter element or clean the air filter element with compressed air.
4）Check the intake air piping for any air leakage or damage.
5）Check the radiator and maintain the coolant level within the specified range。
6）Check for any leakage of fuel, oil, coolant, and sealing surfaces, and address any leaks.
7）Check and adjust the belt tension, visually inspect the belt for any abnormal wear.
8）Check if all external components of the diesel engine are securely connected and have no loose parts.
9）Check if the engine ECU and wiring harness are securely fixed, with no loosening.
10）Check the engine idling status, slowly accelerate and listen for any abnormal engine noises.
11）Query the electronic control diagnostic system's fault memory and clear any stored fault codes.

Note: Before removing or inserting wiring harness connectors, remember to first turn off the ignition switch for 30 seconds and then disconnect the main battery switch!
When performing welding work, it is imperative to turn off the main power supply and unplug all connectors from the ECU and sensors!

2.Regular maintenance

After the initial service, in addition to routine maintenance, it is recommended to perform regular maintenance according to the operation manual. The contents are as follows:

1) Replace engine oil and oil filter cartridge.
2) Replace diesel filter cartridge and pre-fuel filter cartridge.
3) Replace the air filter element or clean the air filter element with compressed air.
4) Clean the oil pan.
5) Check the intake air piping for any air leakage or damage.
6) Check the radiator and expansion tank, maintaining the coolant level within the specified range.
7) Check for any leakage of fuel, oil, coolant, and sealing surfaces, and address any leaks.
8) Check and adjust the belt tension, visually inspect the belt for any abnormal wear.

9) Check if all external components of the diesel engine are securely connected and have no loose parts.
10) Check if the engine ECU and wiring harness are securely fixed, with no loosening.
11) Check the engine idling status, slowly accelerate and listen for any abnormal engine noises.
12) Query the electronic control diagnostic system's fault memory and clear any stored fault codes.

3.Routine Maintenance

In addition to the mandatory initial running-in maintenance and regular mandatory maintenance, users should pay attention to checking the following items during daily maintenance：

1）Check if the oil level is between the upper and lower marks on the dipstick. If it is insufficient, add more oil.
2）Check if the oil has deteriorated. If so, replace it promptly.
3）Regularly (e.g., within a week) drain the water from the drain cup of the Pre-fuel filter.
4）Clean the air filter element with compressed air. Due to the significant differences in equipment usage and convenience, the maintenance and replacement intervals should be adjusted flexibly.
5）Check if there is any air leakage or damage to the intake air piping.
6）Check if the ECU wiring harness and connector plugs of various sensors are securely connected.

Keep the electronic control wiring harness and connector plugs dry and clean. It is prohibited to directly wash the components and connector plugs of the engine's electronic control part with water.

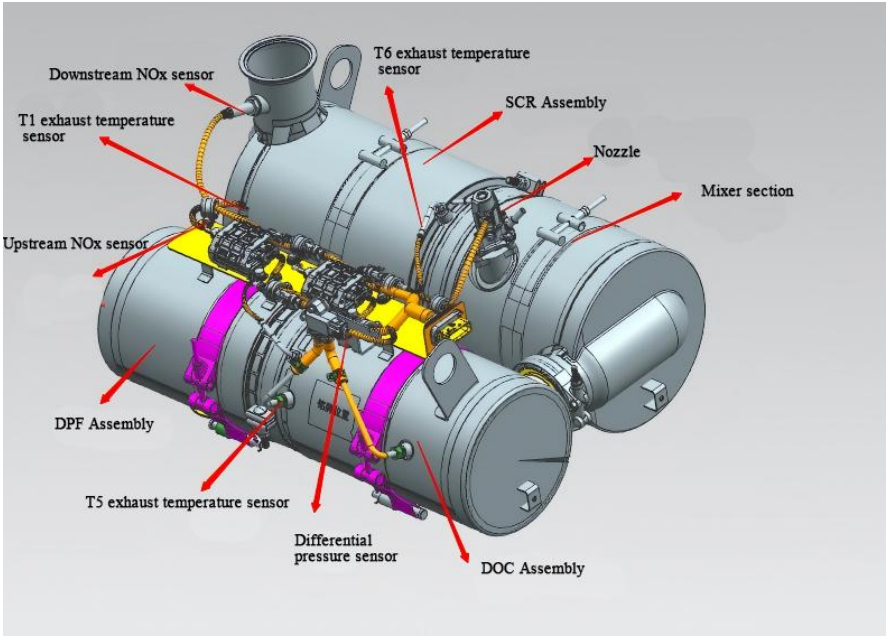
7）Check if the ventilation filter screen of the fuel tank is damaged or clogged.

4.Inspection and maintenance of catalytic aftertreatment components

The post-treatment system consists of a diesel oxidation catalyst (DOC) and a diesel particulate filter (DPF) system. Diagram of the system composition:

Notice：

1）Tampering with or dismantling any part of the after-treatment system is illegal.



2）The DPF catalyst contains precious metals, and it cannot be washed with water or exposed to fire.

3）During DPF regeneration: The EPC light or OBD light on the instrument panel will flash (indicating that the DPF has entered regeneration mode); the idle speed will be 1000 rpm; acceleration will not

be limited, and the duration is ≤ 40 minutes (usually completed in 15 minutes).

4）If the engine is shut down or fails to regenerate multiple times before regeneration is completed (forcing the termination of regeneration), a regeneration lock will occur (the EPC light or OBD light on the instrument panel will flash and exit after a maximum of 40 minutes). The engine speed will be limited to 1500 rpm, and the diagnostic tool can read that the carbon load is greater than 23g-26.4g. At this time, it is necessary to go to the service station for regeneration activation to avoid DPF burnout.

5）On-road regeneration: Operation or carbon loading reaching the limit triggers on-road regeneration. It is best to maintain high rpm during this time. If there are flammable or explosive materials around the working environment, it is necessary to press the regeneration prohibition switch to exit regeneration mode.

6）Parking regeneration: When the carbon loading reaches the limit, the parking regeneration indicator light will flash slowly, and the vehicle needs to be parked in an open area.

7）Service regeneration: When the carbon loading reaches the limit, the service regeneration indicator light will flash quickly. It is necessary to go to the Raywin designated service station for physical carbon cleaning to avoid causing blockage in the after-treatment system.

8）When the driver warning light is on, it is necessary to go to the service station for repairs as soon as possible. Operating time exceeding 36 hours with a fault will limit torque.

The indicators related to the after-treatment system and their functions are listed below：

1）Parking Regeneration

The DPF regeneration reminder light remains on, indicating to the operator that the equipment needs to be parked for parking regeneration. Under the premise of ensuring driving safety, the operator should park the equipment as soon as possible in an open area without safety hazards around and complete the DPF regeneration work according to the requirements.

a. When the regeneration status light remains on, pressing the parking regeneration switch will put the engine into the parking regeneration mode.

b. When the regeneration reminder light is flashing, pressing the parking regeneration switch will also put the engine into the parking regeneration mode

Notice：

Before regeneration, all the following conditions must be met：

① The engine speed is 0;

② The accelerator pedal is not pressed;

③ The brake pedal is not pressed;

④ The clutch pedal is not pressed;

⑤ The gear is in neutral;

⑥ The vehicle's handbrake is tightened;

⑦ Start the engine and let it idle;

⑧ There are no DPF or engine-related faults;

⑨ The water temperature is above 50℃.

Warning 1: If the operator fails to actively perform the parking regeneration within a limited time, the equipment will trigger a speed limit function, during which there is a risk of damage to the engine and after-treatment system!

Warning 2: The regeneration temperature is high, so please ensure that there are no combustible materials near the exhaust system or the equipment. Do not trigger parking regeneration in flammable and explosive areas such as gas stations and dusty places.

After completion, the engine speed will return to idle, and the DPF light will automatically

go off, indicating the end of regeneration. The operator can then operate the equipment normally.

Warning: During the regeneration process, the operator should monitor the entire vehicle nearby and place warning signs around the engine compartment to avoid burns caused by accidental contact with the engine. Unless there are special situations that endanger the safety of the equipment or personnel, in which case the operator should press and hold the DPF regeneration switch for more than 3 seconds to exit the parking regeneration.；

2）Service Regeneration

Regeneration Reminder Light

Regeneration Status Light

Regeneration Inhibit Light

If the DPF regeneration reminder light flashes rapidly, and the fault light remains on, the machine will be under torque and speed limitation. It is necessary to go to the nearest service station for ash cleaning, smoke removal, and maintenance. After the necessary procedures are completed, the machine can return to normal operation.

Notice：

Regeneration Reminder Light constantly on: It indicates that regeneration is required.

Regeneration Reminder Light flashing: It indicates that the DPF is clogged and immediate parking regeneration is needed. If the light continues to flash after the completion of parking regeneration, the after-treatment system needs maintenance.

Regeneration Status Light on: It indicates that the engine is currently undergoing either parking regeneration or on-road regeneration.Regeneration Inhibit Light: It indicates that the regeneration inhibit switch has been pressed. Under this condition, the engine will not enter regeneration mode.

Maintenance of Aftertreatment

During the usage of the aftertreatment system, routine maintenance should be performed according to the following requirements. The maintenance should be done by professional maintenance personnel.

DPF Cleaning

Good usage and maintenance are essential to ensure the continuous and normal operation of the catalytic aftertreatment components:

Check the integrity of the insulation material in the exhaust system. If the insulation material on the surfaces of the exhaust manifold, turbocharger, exhaust pipe (between the turbocharger and the catalytic aftertreatment component), and the catalytic filter component is missing due to usage or maintenance, it will reduce the passive regeneration capability of the DPF. This will lead to frequent activation of active regeneration and parking regeneration, resulting in increased fuel consumption.

Regularly inspect the sensor harness to avoid displacement and burning due to close proximity to the surface of the catalyst.

Perform DPF cleaning and maintenance.

Since DPF regeneration leaves behind non-combustible ash, the equipment should be regularly cleaned (every 2000 hours). If the engine malfunctions, such as oil burning, causing complete blockage of the DPF, it also needs to be repaired at a service station. In both cases, the clamps at both ends of the DPF need to be removed, and the DPF itself needs to be dismantled. Using specialized equipment, over 90% of the accumulated ash and carbon deposits can be removed.

5.Maintenance Cycle of the 4D36TI Series Engines

item	Maintenance intervals												
	50hrs	100hrs	250hrs	400hrs	500hrs	1 or 2 mouths	3 mouths	800hrs	1500hrs	3000hrs	1 years	2 years	3 years
Check the fuel line connections and drain the water from the diesel	☆												
※0il change	★first		☆										
Check position ofbattery electrolyte		☆											
Check fan belt tension and damage		☆											
Check radiator hose and hose clamp		☆											
※Changel oil filter	★first		☆										
Check the intake line			☆										
Change fuel filter			☆										
Clean core of air filter			☆										
Clean inner of fuel tank					☆								
Replace fan belt					☆								
Recharge battery		☆				☆							
Change core of air filter					☆								
Check valve clearance								☆					
※Check injector									☆				
Replace intake tube system												☆	
Replace battery												☆	
Replace radiator hose and hose clamp												☆	
Replace fuel hose and clamp												☆	
Replace radiator coolent(LLC)												☆	
Clean inside the water jacket and the radiator												☆	
Clean the urea tank											☆		
Clean the urea filter bag											☆		
Replace filter													☆
Clean the water cut-off solenoid valve												☆	
Note: After running 50 hours,please change oil and oil filter													
According U.S. EPA off road emission standard,above items listed as the important items by our company													

5.1. Maintenance of Urea Tank

（1）Urea Solution Refilling: To prevent overflow due to excessive urea, the urea solution in the urea tank generally should not exceed the maximum fill line. When the urea solution level drops below 20%, it is necessary to add more urea solution.

Fig.5-1The position of the maximum fill line

（2）Periodically inspect the vent valve or filling port. If white crystals are found, they can be rinsed off with clear water or wiped away with a damp cloth.

（3）Occasionally check the condition of the connectors of the plugs and pipelines.；

（4）Clean the urea tank once every 12 months: Open the drain plug at the bottom of the urea tank, clean it with clear water, drain out any sediments in the tank, let it dry, and then refill with qualified urea solution.

5.2.Maintenance and Care of the Supply Module

(1)For the after-sales disassembly of non-air-assisted pump components, the parts of the non-air-assisted system that can be removed and replaced individually include: water-cut-off solenoid valve (water valve), purge pump, secondary filter, and urea filter bag.

(2)Maintenance Process of the Urea Filter Bag

The Necessity of Urea Filter Bag Maintenance: If the urea filter bag is not maintained for a long time, it may become clogged, preventing the metering pump from drawing urea. This can lead to cavitation in the pump and result in a failure to build pressure, triggering the failure warning light and driver alert light. If the fault is not repaired promptly, it may result in torque and speed limitation of the vehicle. Therefore, it is recommended to clean and maintain the urea filter bag once every 12 months.

Disassembly of Urea Filter Bag: To replace the urea filter bag, first remove the module. The urea filter bag is located at the bottom of the module and is fixed to the module via a cover plate. The disassembly process is illustrated in Figures 5-2 to 5-5.




Fig. 5-2~5-5 Removal Process of the Urea Filter Bag

1）Unscrew the cover plate screws

2）Remove the cover plate

3）Pull out the filter screen

4）Completion of filter removal

Assembly of Urea Filter Bag: Install the O-ring and O-ring seat between the urea filter bag and the exhaust port connector inside the exhaust port connector. Then, align the filter bag with the metering pump and exhaust pipe interface, press firmly, and finally secure it with cover plate screws,

as shown in Figures 5-6 to 5-9

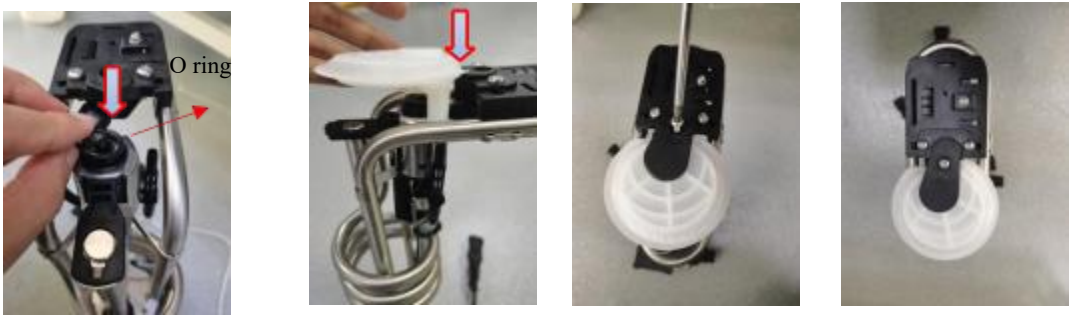


Fig. 5-6 ~ 5-9: Installation Process of the Urea Filter Bag

1）Install the sealing O-ring

2）Install the filter screen

3）Install the cover plate

4）Completion of installation

(3)Maintenance and Care of the Secondary Filter

To prevent clogging of the filter element due to prolonged operation, which may affect the injection function of the aftertreatment system, it is recommended to replace the filter element every 100,000 kilometers as part of the maintenance schedule.

(1) Disassembly Tools: Adjustable wrench or wrench size 24; Vice grips (or pliers)

(2) Disassembly Process:

Fig. 5-10 ~5-13: Disassembly Process of the Secondary Filter

① Use a wrench size 24 or vice grips to unscrew the secondary filter end cap

counterclockwise;

② Use vice grips to remove the filter element, and rinse it clean with water.

③ Use compressed air to dry the moisture and reinstall it in its original position.

2.3 Maintenance and Care of the Purge Pump

(1) Disassembly Tools: Allen wrench size 3

Fig. 5-14~5-16: Disassembly Method for the Purge Pump

(2) Disassembly Steps:

① Use an Allen wrench size 3 to unscrew the three bolts counterclockwise.

② After removing the bolts, take off the purge pump along with the breather tube (note: the breather tube is connected to the purge pump

After maintenance is completed or a new purge pump is installed, please pay attention to the installation position of the breather tube to ensure it is aligned as shown in the diagram below.

Fig. 5-17 Diagram of Purge Pump Installation Position

2.4 Maintenance Process for the Solenoid Valve for Water and Power Cut-off

The necessity of maintaining the solenoid valve for water and power cut-off: Various impurities present in the coolant of the entire vehicle can cause the water valve to remain open or get stuck. If it remains open, it can lead to continuous heating of urea by the antifreeze, triggering a fault indication of

excessive urea tank temperature. If it remains closed, the coolant cannot enter the urea tank in winter conditions, preventing urea heating, which can result in a fault indication of failed thawing. Therefore, it is recommended to perform maintenance on the solenoid valve for water and power cut-off every two years.

（1）Maintenance Procedure When the Solenoid Valve for Water and Power Cut-off is Not Experiencing Sticking or Constantly Open Fault

1）Tool：Flathead screwdriver

2）Operating Method

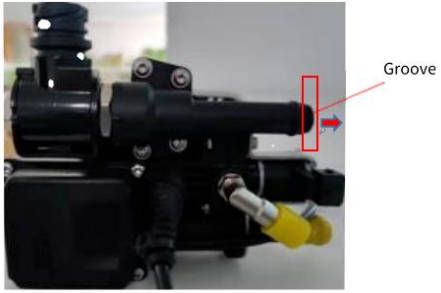


Fig.5-18: Diagram for Removing the Filter Screen of the Solenoid Valve for Water and Power Cut-off

① Insert a flathead screwdriver into the groove marked by the square and apply force in the direction of the arrow to remove the filter screen inside the water pipe, then rinse the filter screen thoroughly;

② Reinstall the cleaned filter screen.;

Note: The filter screen for the solenoid valve for water and power cut-off is only available in products manufactured after October 2022. All products manufactured before this date do not have a filter screen. If no filter screen is found during maintenance, users need to be informed to add one.

（2）Maintenance Procedure When the Solenoid Valve for Water and Power Cut-off is Experiencing Sticking or Constantly Open Fault

1）Tool：Flathead screwdriver, torx screwdriver

2）Disassembly Operating Method

Fig. 2-19: Locations of the Four Screws on the Solenoid Valve for Water and Power Cut-off

① Repeat the operation in (1) to clean the filter screen of the solenoid valve for water and power cut-off;

② Use a torx screwdriver to unscrew the four fixing screws on the solenoid valve for water and power cut-off, and remove the four screws, sealing ring, and solenoid valve in sequence; all disassembled components are shown in the diagram below;

③ Clean the impurities inside the water valve.;

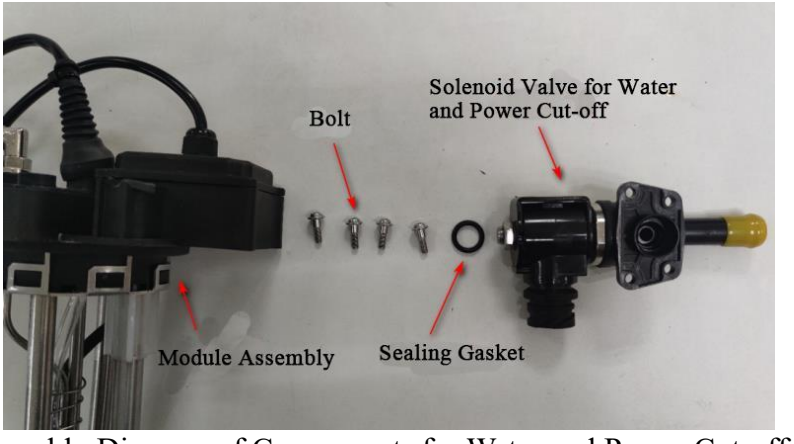


Fig. 2-20 Assembly Diagram of Components for Water and Power Cut-off Solenoid Valve

3）Installation Procedure for the Solenoid Valve for Water and Power Cut-off

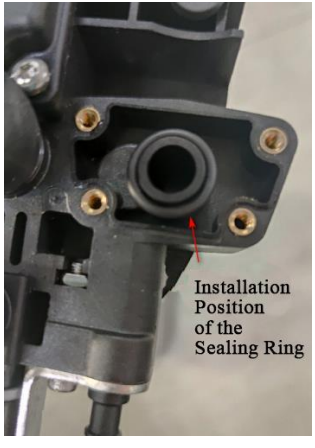


Fig. 2-21 Fig. 2-22 Fig.2-23

① First, install the sealing ring to the designated position; ② Secure the solenoid valve for water and power cut-off and install the four screws in sequence; ③ After installation, confirm the specific position of the material number.

5.3. The maintenance process of urea filter bags

The necessity of maintaining urea filter bags: If the urea filter bags are not maintained for a long time, they can become clogged, preventing the metering pump from drawing in urea. This can lead to the pump developing a void, resulting in a fault message indicating failure to build pressure in the metering pump. The fault light and operator warning light will illuminate. If the fault is not addressed in a timely manner, it can lead to torque and speed limitations in the equipment. Therefore, it is recommended to clean and maintain the urea filter bags every 12 months.。

5.2.1Maintenance cycle of the table below:

Note: the use of harsh conditions (minimum temperatures below - 20℃, or the highest temperatures higher than 35℃, or environmental dust content in the high desert, mine site, construction sites, coal yards, etc.), it is necessary to shorten the replacement cycle of engine

5.4.Maintenance and servicing of purge pumps.

It is recommended that purge pumps be serviced every 6 months. After the maintenance is completed or a new purge pump is installed, please ensure that the installation position of the breather pipe is properly aligned, as shown in the diagram below.

5.5.The maintenance process of the water shut-off solenoid valve

The necessity of maintaining the water shut-off solenoid valve: As various impurities in the coolant of the entire vehicle can cause the water valve to remain open or get stuck, a constantly open valve would lead to the continuous heating of the urea by the antifreeze, resulting in a fault message indicating excessively high temperature in the urea tank. On the other hand, if the valve remains closed, it would prevent coolant from entering the urea tank in winter conditions, resulting in the inability to heat the urea, and leading to a fault message indicating failed defrosting. Therefore, it is recommended to perform maintenance and servicing on

the water shut-off solenoid valve every 6 months.

5.6.Technical maintenance for winter use

When using in winter, special attention should be paid to the following:

When the ambient temperature is below 0°C, paraffin wax will precipitate from diesel fuel, making it viscous and reducing its fluidity. Using summer diesel during winter may likely lead to malfunctions.

It is necessary to use winter-grade fuel and oil, and pay attention to the water content in the fuel to prevent freezing.

1）The cooling system must be filled with antifreeze suitable for the ambient temperature.

2）In severe cold seasons and regions, it is advisable to avoid parking the equipment outdoors.

3）When cold-starting, wait until the preheating indicator light changes from solid to flashing before starting the engine.

The requirements for the use and maintenance of diesel engines are generally as described above. We encourage all users to carefully read and follow these instructions. Through regular and effective maintenance, the engine can be kept in optimal condition, reducing unnecessary repairs, minimizing downtime losses, ultimately saving you on usage costs, and increasing efficiency.

 Attention:

1)The usage and maintenance requirements for diesel engines are outlined as above. Please

read them carefully, users.

2)Through regular, reasonable, and effective maintenance, the engine can be kept in its optimal condition at all times, reducing unnecessary repairs, minimizing downtime losses, ultimately saving you on operational costs, and increasing your benefits.

IV Analysis and Troubleshooting Methods for Common Faults of Diesel Engines

Notice：Please note: It is recommended to have all troubleshooting methods handled at a RAYWIN authorized service station. Otherwise, you may lose your warranty rights.。

1.Difficulty in starting a diesel engine

Fault Characteristics and Causes	Troubleshooting Methods

1.Check the fuel system a)Improper selection of fuel grade; b)No fuel in the fuel tank or the tank switch is not turned on; c) Air mixed into the low-pressure fuel line; d) Water mixed into the fuel; e) The fuel line or filter is clogged with impurities for a long time.	a) Select the correct grade of fuel based on the regional climate and temperature differences; b) Fill the fuel tank with fuel and turn on the fuel tank switch; c) Loosen the vent screw, repeatedly press the manual fuel pump on the fuel-water separator (coarse filter) to remove air, and then tighten the vent screw. If necessary, visit a RAYWIN service station for assistance; d) Loosen the drain plug on the water separator located at the lower end of the coarse filter to drain any accumulated water; e) Regularly remove the filter for cleaning or replace the filter element.
2.Insufficient cylinder pressure a) Leakage in the valve; b) Leakage at the joint between the cylinder head and the engine block; c) Wear, coking, or overlapping of the piston ring opening positions;	a) Replace the valve spring if its elasticity has decreased; grind the valve if its conical surface is not tightly sealed; b) Replace the cylinder gasket; c) Remove any coking, replace the piston rings, and adjust the opening positions of the piston rings;

d) Wear of the cylinder bore or piston exceeding the specified limit.	d) Replace the engine block or the piston.。
3.Excessively low temperature a) Diesel fuel has high viscosity, making it difficult to atomize and even clogging the fuel line; b) The preheating device fails or the timing of starting in the preheated state is not appropriate.	a) Heat the cooling water and switch to an appropriate grade of diesel fuel; b) Check the corresponding wiring harness and relay; start the engine immediately when the preheat light is flashing (not constantly on).
4.Check the electrical system a)Insufficient battery charge or undersized battery configuration; c)Poor contact in the electrical system wiring; c)Faulty electromagnetic switch of the starter; d)The starter gear cannot engage with the flywheel ring gear; e)Poor contact between the starter brushes and the commutator;	a) Charge or replace the battery with one that meets the requirements; b) Tighten the electrical system wiring; c) Repair the starter electromagnetic switch or replace the starter; d) Identify and address the cause; e)Repair or replace the brushes and clean the commutator surface with fine sandpaper,then blow off the dust. f) Check the corresponding wiring harness and relay, and replace the preheating device.

f) Failure of the preheating device.	

2.Unstable minimum idle speed (idle speed)

Fault Characteristics and Causes	Troubleshooting Methods
1.The minimum stable no-load speed (idle speed) is too low, less than 680 rpm.	1.Go to a RAYWIN service station to inspect the common rail system
2.Air has mixed into the low-pressure fuel line.	2.Loosen the vent screw, repeatedly press the manual fuel pump on the pre-fuel filter to remove air, and then tighten the vent screw. If necessary, visit a RAYWIN service station for assistance.
3.Insufficient cylinder compression pressure a) Valve leakage; b) Leakage at the joint between the cylinder head and cylinder gasket; c) Wear, coking, or overlapping of the piston ring	a) Replace the valve spring if its elasticity has decreased; grind the valve if its conical surface is not tightly sealed. b) Replace the cylinder gasket. c) Remove any coking, replace the piston

opening positions; d) Wear of the cylinder bore or piston exceeding the specified limit.	rings, and adjust the opening positions of the piston rings. d) Replace the engine block or the piston.
4.The accelerator pedal and its related wiring harness have malfunctioned, with the warning light illuminated, and the idle speed rising to 1100 rpm.	5.Inspect the relevant parts and replace them if necessary. Go to a RAYWIN service station for handling.

3.Unstable speed of diesel engine

Fault Characteristics and Causes	Troubleshooting Methods
1.Check the fuel lines: a) Air mixing in the low-pressure fuel lines; b) Excessive water content in the fuel; c) Fuel leakage in the fuel lines.	a) Loosen the exhaust screw, repeatedly press the manual oil pump on the Pre-fuel filter to expel air, and then tighten the exhaust screw. If necessary, seek assistance at the RAYWIN service station. b) Replace the fuel. c) Tighten the fuel pipe connections or replace the fuel pipes.

2.Poor sealing of the cylinder head gasket.	2.Check the cylinder head bolts and cylinder head gaskets, tighten the bolts or replace the cylinder head gaskets.
3.Abnormal operation of the electronic control system.	3.Visit the RAYWIN technical service station to inspect the common rail system.

4.Low Power

Fault Characteristics and Causes	Troubleshooting Methods
1.The air filter element is clogged.	1.Clean the air filter element and replace it if necessary.
2.The intercooler is too dirty.	2.Remove debris and dust from the exterior of the intercooler.
3.The exhaust manifold and exhaust pipe are clogged.	3.Clear debris from the exhaust pipe.
4.Air has mixed into the low-pressure fuel line.	4.Loosen the exhaust screw, repeatedly press the manual oil pump on the Pre-fuel filter to expel air, and then tighten the exhaust screw. If necessary, seek assistance at the RAYWIN service station.

5.Insufficient fuel in the tank and poor quality of fuel.	5.Fill the fuel tank to its full capacity and use fuel that meets the specified requirements.
6.Insufficient turbocharging pressure.	6.Adjust or replace the turbocharger.
7.Minor blockage in the after-treatment device.	7.Operate the vehicle at medium to high speed for 20 to 30 minutes with an empty load.
8.Severe blockage in the after-treatment device (system torque limitation).	8.Go to the RAYWIN service station to replace the after-treatment device.

5.Diesel engine speed is limited.

Fault Characteristics and Causes	Troubleshooting Methods
1.Faults in fuel lines, diesel filter, or fuel pump a) Air mixed inside, warning light on, and engine speed limited; b) Water mixed inside, warning light on, and engine speed limited	a) Loosen the exhaust screw, repeatedly press the manual oil pump on the Pre-fuel filter to expel air, and then tighten the exhaust screw. If necessary, seek assistance at the RAYWIN service station. b) Loosen the drain screw of the Pre-fuel filter located at the lower end of the coarse filter to drain out the accumulated water

	inside.
2. Check for faults in the brake switch and corresponding wiring harness relay, accelerator pedal sensor, and related wiring harness. Engine speed drops to 1100 rpm, and the warning light is on.	2. Inspect the mentioned parts and replace them if necessary.
3. Faults in the intake air pressure sensor or related wiring harness, with the warning light on. Engine speed is limited to around 1600 rpm.	3. Inspect the mentioned parts and replace them if necessary.
4. Faults in the water temperature sensor or related wiring harness, with the warning light on. Engine speed is limited to around 1500-2000 rpm.	4. Check if there is any open circuit, loose connection, or short circuit in the mentioned parts.
5. Faults in the camshaft sensor or related wiring harness, and corresponding engine components, with the warning light on. Engine speed is limited to around 2500-2600 rpm.	5. Check if there is any open circuit, loose connection, or short circuit in the mentioned parts.
6. Faults in the speed sensor and its related wiring harness. The fault light is on, leading to the shutdown	6. Check if there is any open circuit, loose connection, or short circuit in the

of the air conditioning system and limiting the engine speed.	mentioned parts.

6.Diesel engine shutdown

Fault Characteristics and Causes	Troubleshooting Methods
1.Faults in fuel lines, diesel filter, fuel pump, or fuel injector a) Air mixed inside, causing the warning light to illuminate; b) Particulate impurities mixed in the fuel pump or injector, causing the warning light to illuminate.	a) Loosen the exhaust screw, repeatedly press the manual oil pump on the Pre-fuel filter to expel air, and then tighten the exhaust screw. If necessary, seek assistance at the RAYWIN service station. b) Check if the overflow valve of the fuel pump is stuck, and replace it if necessary. Inspect the fuel injection volume and return volume of the injector to ensure they are normal, and replace it if necessary.
2.Faults in the intake air pressure sensor or related wiring harness, causing the warning light to	2.Check if there is any open circuit, loose connection, or short circuit in the mentioned

illuminate.	parts.
3.Faults in the rail pressure sensor and its related wiring harness, causing the warning light to illuminate.	3.Check if there is any open circuit, loose connection, or short circuit in the mentioned parts.
4.Wear and tear of the injector valve seat	4.Visit the RAYWIN technical service station to inspect and replace the injector.
5.Damage to the rail pressure sensor.	5.Visit the RAYWIN technical service station to inspect and replace the high-pressure fuel rail.
6.Damage to the flow control unit of the fuel injection pump	6.Visit the RAYWIN technical service station to inspect and replace the high-pressure fuel pump.

7.Abnormal Exhaust Emission

Fault Characteristics and Causes	Troubleshooting Methods

1.White smoke emission a) Water entering the cylinder; b) Water present in the fuel.	a) Inspect and troubleshoot the issue; b) Replace the fuel.
2.Blue smoke emission a) Oil leaking into the combustion chamber, piston rings installed in the wrong direction, stuck, or excessively worn; b) Large gap between the valve stem and guide; c) Damaged valve stem oil seal.	a) Adjust or replace the piston rings; b) Replace the valves; c) Replace the oil seal.
3.Black smoke emission a) Blockage in the air filter and exhaust pipe; b) Poor valve sealing; c) Dirty intercooler; d) Abnormal operation of the electronic control system.	a) Clear the dust in the air filter and exhaust pipe, or replace the air filter element; b) If the sealing of the valve cone is not tight, grind the valve; c) Clear debris and dust from the surface of the intercooler; d) Visit the RAYWIN technical service station to inspect the common rail system.

8.Diesel engine overheating

Fault Characteristics and Causes	Troubleshooting Methods
1.Insufficient or contaminated coolant in the radiator	1.Fill or replace the coolant in the radiator
2.Blockage in the cooling system.	2.Remove scale, dirt, and ensure the pipes are unobstructed; check if the front surface of the radiator is accidentally covered with plastic sheets, paper, or other objects.
3.Loose water pump belt.	3.Adjust the tension of the water pump belt.
4.Abnormal operation of the water pump.	4.Repair or replace the water pump.
5.Failure of the thermostat.	5.Repair or replace the thermostat.
6.Poor quality of lubricating oil.	6.Replace the lubricating oil.
7.Malfunction of the water temperature gauge.	7.Replace the water temperature gauge.
8.Overload operation of the diesel engine.	8.Reduce the load.

9.Diesel engine produces abnormal noise during operation.

Fault Characteristics and Causes	Troubleshooting Methods
1.The gap between the piston and cylinder is too large, resulting in a knocking sound from the cylinder after the diesel engine starts. This sound will reduce as the diesel engine warms up.	1.Replace the piston or cylinder liner.
2.If the gap between the piston pin and pin hole is too large, the sound will be light and sharp, especially more noticeable at idle speed.	2.Replace parts to ensure the specified clearance.
3.If the clearance between the main bearing and connecting rod bearing is too large, you can hear the impact sound of components when the diesel engine speed suddenly decreases, and the sound will be heavy and powerful at low speeds.	3.Replace parts to ensure the specified clearance.

4.If the axial clearance of the crankshaft is too large, you can hear the impact sound of the crankshaft moving forward and backward at idle speed	4.Replace the crankshaft thrust washer to ensure the specified clearance.
5.If the valve spring breaks, you can hear a noisy sound or a light rhythmic knocking sound at the cylinder head cover.	5.Replace the parts.
6.If the piston top hits the cylinder head or valve, you can hear a metal impact sound near the cylinder head at low speeds.	6.Adjust the valve timing or replace the cylinder head gasket.
7.If the gear clearance is too large due to wear, you can hear the impact sound at the gearbox when the speed suddenly decreases.	7.Replace the gears according to the situation.
8.If the generator's main shaft is worn, it will produce an abnormal sound, which may lead to abnormal battery voltage.	8.Replace the generator according to the situation, and measure the battery voltage with a multimeter.

10.Excessive oil consumption

Fault Characteristics and Causes	Troubleshooting Methods
1.Excessive lubricant, leading to excessive oil splashing.	1.Drain part of the engine oil
2.Oil leakage from various seals.	2.Check and replace the gaskets.
3.The oil return hole of the oil ring on the piston ring is blocked by carbon deposits.	3.Clean the carbon deposits from the oil return hole.
4.Poor quality of the engine oil.	4.Replace the engine oil.
5.Wear and seizure of the piston rings.	5.Replace the piston rings.
6.Excessive clearance between the cylinder bore and piston.	6.Replace the engine block or pistons
7.Wear of the valve stem oil seal.	7.Replace the valve stem oil seal.

8.Severe blockage of the air filter, causing oil spraying from the oil filter.	8.Replace the air filter element or oil filter

11.High fuel consumption

Fault Characteristics and Causes	Troubleshooting Methods
1.Air filter is clogged.	1.Clean the air filter element or replace it.
2.The intercooler is too dirty.	2.Remove debris and dust from the exterior of the intercooler.
3.There is a fuel system leak.	3.Tighten the fuel line connections, replace the fuel lines, and inspect the fuel pump for any damage.
4.The exhaust pipe is clogged.	4.Remove dirt and debris from the exhaust pipe.
5.The quality of the fuel is poor.	5.Use the specified type of fuel.

6.The valve is leaking.	6.Grind the valve seat or replace it.
7.Insufficient cylinder compression pressure.	7.See item 2 under "Difficulty Starting the Diesel Engine" in (I).
8.Insufficient boost pressure.	8.Adjust or replace the turbocharger.

12.Fault in the Lubrication System.

Fault Characteristics and Causes	Troubleshooting Methods
Low oil pressure a) Insufficient oil in the oil pan; b) Blocked oil passage; c) Blocked oil filter d) Overheating of the diesel engine, high oil temperature, and diluted oil	a) Fill the oil to the oil dipstick mark; b) Clean the oil circuit and blow it out with compressed air; c) Clean the oil filter or replace the filter element; d) Reduce the load, replace the oil, and lower the oil temperature.

2.Poor oil quality	2.Replace the oil that meets the requirements.
3.The pressure regulating valve in the gear chamber is stuck, causing excessive oil return.	3.Repair or replace the pressure regulating valve.
4.Blocked oil pump filter screen.	4.Clean the oil pump filter screen.
5.Wear of the inner and outer rotors of the oil pump or excessive end clearance.	5.Adjust or replace the inner and outer rotors of the oil pump.
6.Broken oil pipe or loose connection.	6.Replace the oil pipe or tighten the connections.
7.Failure of the oil pump assembly.	7.Repair or replace parts of the oil pump assembly.
8.Wear of the connecting rod bearing shell and main bearing shell.	8.Replace the connecting rod bearing shell and the main bearing shell.
9.Damage to the oil pressure gauge.	9.Replace the oil pressure gauge.

13.Cooling System Failure

Fault Characteristics and Causes	Troubleshooting Methods
1.Excessively High Water Temperature a) Insufficient cooling water; b) Weak radiator cap spring; c) Loose or damaged water pump belt; d) Thermostat malfunction; e) Abnormal operation of the water pump; f) Excessive scale buildup in the cooling water passage; g) Radiator blockage; h) Radiator leakage; i) Water pump leakage; j) Loose or ruptured connecting hose of the radiator.	a) Fill the radiator with sufficient cooling water; b) Replace the radiator cap spring; c) Adjust the tension of the water pump belt or replace the water pump belt; d) Replace the thermostat; e) Repair or replace the water pump; f) Clean the cooling water passage to remove scale buildup; g) Clean the radiator tubes and clear any blockages; h) Repair or replace the radiator; i) Replace the gaskets or seals; j) Tighten the connections of the radiator's connecting hoses or replace the hoses
2. Excessively Low Water Temperature	a) Replace the thermostat;

a) Thermostat malfunction; b) Improper choice of thermostat; c) Too low ambient temperature.	b) Select according to specifications; c) Set up wind protection measures.

14.Aftertreatment System

Fault Characteristics and Causes	Troubleshooting Methods
1.OBD Light First-Level Alarm (OBD Light Flashes Intermittently) a) There is no significant drop in engine power, but the differential pressure sensor is loose or damaged. b) There is no significant drop in engine power, but the aftertreatment device is slightly clogged.	a) Check, repair, or replace the differential pressure sensor. b) Check the DOC+DPF+SCR aftertreatment system, or run the engine for 0.5 hours to clear it, and erase the fault code.
2.OBD Light Second-Level Alarm (OBD Light Stays On) a) There is a significant drop in engine power due to severe clogging or burnout of the aftertreatment device	a)Check and replace the DOC+DPF+SCR aftertreatment system, and clear the fault code.

3.Operator Alarm Light Slow Flashing a) There is a significant drop in engine power due to low urea fluid level.	a)Check the aftertreatment system and add urea.
4.Operator Alarm Light Fast Flashing a) Engine speed is limited to 1000 rpm, indicating that the urea fluid level is empty	a)Check the aftertreatment system and add urea.

15.Starter failure

Fault Characteristics and Causes	Troubleshooting Methods
1.Starter does Not Rotate a) Poor contact in connecting wires; b) Insufficient battery charge; c) Poor contact of the carbon brush. d) Circuit break in the starter itself.	a) Clean and tighten the contacts; b) Fully charge the battery; c) Clean the surface of the commutator; d) Repair or replace the starter.
2.Starter Spins But Starts Weakly a) Wear and tear of the bearing bush;	a) Replace the bearing bush; b) Clean the surface of the commutator;

b) Poor contact of the carbon brush; c) Commutator unclean or burned; d) Wire terminal desoldered; e) Poor contact;	c) Clean the oil stains and polish with fine emery cloth; d) Solder the loose wire terminals firmly; e) Clean and tighten the contact points; f) Repair the switch; g) Fully charge the battery or replace it with a battery of sufficient capacity.
3.Gear retraction is difficult, and the contact piece of the electromagnetic switch is fused.	3.Replace the electromagnetic switch.

16.Alternator failure

Fault Characteristics and Causes	Troubleshooting Methods
1.Complete lack of charging, insufficient charging, unstable charging current a) Open the rear cover of the generator and measure each diode or integrated circuit regulator with a multimeter；	a) Replace any damaged components promptly

17.Air Compressor Malfunction

Fault Characteristics and Causes	Troubleshooting Methods
1.Lack of Compression a) Air compressor's relief valve gets stuck; b) Valve plates deform or break; c) Excessive carbon deposits in the intake, exhaust ports, and chambers; d) Missing small gaskets for the air compressor's exhaust valve; e) The transmission gears of the air compressor slip	a) Check the pressure relief valve components, clean and replace failed parts; b) Reassemble or replace parts; c) Disassemble and inspect the cylinder head, clean the valve seat plate and valve plate; d) Check for missing parts and install them correctly; e) Check the compression nuts and keys of the transmission gears.
2.Insufficient Air Pressure a) The transmission gears of the air compressor slip; b) Air filter is clogged; c) The air compressor's cylinder, piston, and piston rings wear and leak; d) The air compressor's valve plates are not tightly sealed, the spring is too soft or broken;	a) Check the compression nuts and keys of the transmission gears; b) Check the air filter and dirt in the pipeline; c) Replace or repair the cylinder block, piston, and piston rings; d) Replace the air compressor valve plate

e) The bolts of the air compressor's cylinder head are loose, and the gasket is damaged, causing air leakage; f) The pipeline between the air compressor and the air storage tank is broken or the joints leak.	and spring; e) Retighten the cylinder head bolts or replace the cylinder head gasket; f) Replace the pipeline and joints
3.Oil Leakage in the Air Compressor a) Air intake is obstructed or the intake filter is not working properly; b) The air compressor's cylinder, piston, and piston rings wear excessively, or the oil ring is installed in reverse, stuck, causing oil to leak upwards; c) The air compressor is not cooled properly; d) Dirt is not regularly drained from the air storage tank; e) The air compressor runs for too long; f) The crankcase pressure of the engine is too high; g) The engine oil pressure is too high; h) The lubricating oil is deteriorated.	a) Check and replace the air compressor filter; check and remove any twists or deformations in the intake pipeline of the air compressor; b) Check and replace the air compressor piston and piston rings; c) Remove oil stains, soot, or dirt accumulated on the heat sink fins. Check the flow of the cooling pipes; d) Check and clean the air valve of the air storage tank; e) Check and repair the unloading system; f) Replace or repair the ventilation equipment of the crankcase; g) Check the lubrication pressure of the engine (at the oil inlet of the air

	compressor); h) Replace with qualified lubricating oil.

18.Fault Diagnosis of Turbocharger on Diesel Engine

When a diesel engine malfunctions, in addition to following the recommended troubleshooting and elimination methods in the manual for the diesel engine itself, it is also necessary to inspect and evaluate the working condition of the turbocharger and diagnose its potential faults.

Common faults of turbocharged diesel engines include:

1.Insufficient diesel engine power;

2.High consumption of lubricating oil;

3.Black smoke emitted from the diesel engine exhaust;

4.Loud operation noise.

Any of these faults may result from internal problems within the diesel engine or the air turbocharge system formed by the turbocharger and the diesel engine. When suspecting a fault with

the turbocharger, please do not immediately remove the turbocharger from the diesel engine, and even less should you dismantle the turbocharger. Simply replacing the turbocharger will not only fail to solve the problem, but may also lead to new issues. It is recommended to first conduct on-board fault diagnosis to identify the cause before taking corrective measures.

A turbocharger that has been operating normally is unlikely to develop its own defects in subsequent use. If the impeller of the turbocharger can rotate freely without scraping the inner shell, there is no need to rush to diagnose it as a problem with the turbocharger's operation. Experience shows that most turbocharger faults are related to improper use of the diesel engine. Therefore, the recommended on-board fault diagnosis table below is primarily aimed at the entire air turbocharge system. After completing on-board fault diagnosis and detailed record-keeping, only when necessary should the turbocharger be removed for further analysis and inspection. The analysis and inspection of the turbocharger should be carried out at a professional repair shop or the diesel engine manufacturer.

Problem	On-board Fault Diagnosis Checklist

Diesel engine emitting black smoke	Insufficient power of diesel engine	Excessive oil consumption of diesel engine	Diesel engine emitting blue smoke	during turbocharger	Turbocharger emitting periodic noise	Compressor side oil seal leakage	Turbine side oil seal leakage	Possible Causes	Measure
√	√	√	√			√		air filter is too dirty	Clean or replace the filter element
				√				leak in the pipeline between the air filter and the compressor	Tighten the fasteners or replace the seals
√	√	√	√	√				leak in the pipeline between the compressor and the diesel engine's intake pipe	Replace the seals or tighten the fasteners

			√		√	√	√	intercooler is too dirty	Clean the intercooler
			√	√	√	√	√	Air leakage at the joint surface between the diesel engine's intake manifold and the cylinder head	Replace the gaskets or tighten the fasteners
	√	√	√	√	√	√	√	Blockage in the compressor's intake pipe.	Remove debris or replace damaged parts
			√			√	√	Blockage in the compressor's outlet pipeline	Remove debris or replace damaged parts
			√			√	√	Blockage in the diesel engine's intake pipe	Remove debris or replace damaged parts

	√		√			√	√	Air leakage at the joint surface of the turbine's gas inlet	Replace the seals or tighten the fasteners
	√		√			√	√	Air leakage at the joint surface between the diesel engine's exhaust manifold and the cylinder head.	Replace the seals or tighten the fasteners.
	√		√	√	√	√	√	Blockage in the diesel engine's exhaust pipe	Remove debris
			√					Air leakage at the joint surface of the turbine's gas outlet	Replace the seals or tighten the fasteners

	√					√	√	Blockage in the muffler or the exhaust tailpipe	Remove debris or replace
√	√			√	√			Blockage in the turbocharger's oil return pipe	Remove debris or replace the oil return pipe
√	√			√	√			Blockage in the diesel engine's crankcase breather	Remove debris or replace
				√	√	√	√	Contamination or coking in the turbocharger's intermediate housing	Depending on the situation, replace the engine oil and oil filter or replace the turbocharger
√	√	√	√	√	√	√	√	Contamination on the turbine blades or compressor impeller	Clean the compressor or replace the engine oil and oil filter

	√							Wear or damage to the compressor impeller	Clean the air intake system or replace the turbocharger
√					√			Wear to the turbocharger's bearings, bearing holes, or shaft diameter	Replace the turbocharger
					√			Incorrect type of lubricating oil used	Select the lubricating oil according to the specifications

19.Cases of Fault Repair for Electronically Controlled High-Pressure Common Rail Diesel Engines

19.1. Maintenance Considerations

（1）Safety Tips

- The maximum pressure in the common rail system can reach 2000 bar (2000Kg/cm2). Do not inspect or repair the fuel injection system while the engine is running.
- It is recommended to conduct inspections or repairs 30 seconds after the engine is shut off. The following components are under high pressure：
  1.High-pressure fuel pump;
  2.Injector;
  3.High-pressure fuel line;
  4.High-pressure fuel rail；
- If maintenance measures are to be taken while the engine is running, it must be ensured that no one is within the range of possible high-pressure jets.；

- When inspecting diesel engines and their components (even when disassembled), some combustible substances may leak out, posing a serious risk of fire and explosion；
- Before starting the inspection, it is necessary to take appropriate measures such as disconnecting the battery or using non-sparking tools to avoid any potential ignition sources.

（2）Requirements for Maintenance Cleanliness

- Compared to traditional mechanical fuel systems, the fuel system of high-pressure common rail electronically controlled diesel engines has more stringent requirements on fuel cleanliness. With higher fuel pressure, more precise control, and tighter fits of internal moving parts in the electronic control system, unclean fuel can reduce the service life of the fuel injection pump and injector. Therefore, the cleanliness of the maintenance workshop is crucial. Equipment that can contaminate the fuel injection system, such as welding machines and grinding machines, should not be present as the dust and particles they generate can harm the fuel system during maintenance. Strict attention should also be paid to ensuring the cleanliness of low-pressure and high-pressure fuel lines when conducting repairs outdoors!

- When disassembling the fuel supply system, it is recommended to first clean the dust

and oil stains around the common rail components to ensure cleanliness.；

- Maintenance personnel should wash their hands before working on the fuel system, and ensure that the maintenance and assembly tools are also clean.

（3）Requirements for Maintenance Procedures

- Please strictly adhere to the torque requirements when assembling nuts and screw sockets at each connection point of the fuel system, as failure to do so may damage the fuel pump, fuel rail, or injector；

- When disassembling the injector, make sure to mark the cylinder number. When disassembling the fuel supply system, even for a short period of time, use a clean protective cap that should only be removed before reassembly. Common rail components should only be unpacked before use, and the protective caps should only be removed before assembly.

19.2.Faults and Handling

（1）Insufficient Power with Black Smoke Emission

Fault Phenomenon	Insufficient Power with Black Smoke Emission.
Cause Analysis	Main Reason： 1.Fuel quality 2.Blockage or leakage in the intake system, exhaust not flowing smoothly 3.Leakage in the intercooler 4.Turbocharger shaft clearance issues, turbine damage, or turbine seizing up
Maintenance Handling	1.Use a diagnostic tool to read fault codes, no fault codes found； 2.heck if the fuel quality is acceptable； 3.Inspect the intake and exhaust systems; Check for excessively dirty air filters, loose clamps on the intake pipe, detachment or ruptures in the intake pipe or rubber hoses causing air leaks, Leakage in the intercooler, exhaust not flowing smoothly 4.Check for excessive wear in the turbocharger shaft resulting in large clearance or seizing up. Focus on inspecting the piping from the turbocharger to the intercooler.

（2）Frequent Engine Shutdown/Stalling

Fault Phenomenon	During operation, the engine's fault light illuminated and the speed was limited. When trying to accelerate, the engine even stalled. To restart the engine after stalling, the manual fuel pump had to be pressed tightly.
Cause Analysis	The main reason for this is that the actual fuel pressure in the common rail is higher or lower than the system's required pressure. The main causes are: 1.Poor-quality diesel fuel (containing impurities or excessive water) causes clogging in the low-pressure fuel line and diesel filter, resulting in insufficient fuel supply from the fuel pump at high speeds. 2.Clogging in the diesel filter and fuel line, air ingress in the fuel line, and poor inlet and return fuel flow. 3.Incorrect values measured by the rail pressure sensor, stuck overflow valve in the fuel pump, or insufficient fuel supply capacity of the fuel pump
Maintenance Handling	1.Use a diagnostic tool to read the fault codes. The inspection of the fuel metering control unit revealed: Positive rail pressure deviation exceeding the upper limit, fault in the fuel metering control mode: Maximum rail pressure positive deviation exceeding the upper limit, affecting the set fuel flow. Fault in the fuel metering control mode: Rail pressure below the minimum limit. 2.Based on the explanation of the fault codes, it indicates a problem with the

	fuel line, resulting in insufficient fuel pressure. Start by checking the low-pressure fuel line, which is the easiest to inspect. 3.Check if the diesel filter is dirty. 4.Check that the injector return line to the fuel pump and the fuel line from the fuel pump to the fuel tank are free of any bends or kinks. 5.Check if the inlet fuel line in the fuel tank is clogged or has air ingress. 6.Check the lines from the fuel tank to the filter and from the filter to the fuel pump for any clogging or air ingress. In this case, during the inspection of the filter, it was found that the return fuel line was tied too tightly with a strapping band, causing the rubber tube to deform and resulting in poor return fuel flow, which triggered an error message from the ECU.

（3）Can not start

Fault Phenomenon	Can not start
Cause Analysis	1.Low voltage 2.ECU not powered or damaged 3.Faulty fuel pump or fuel rail

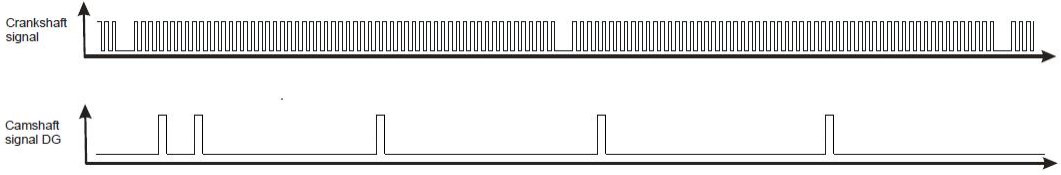
	4.Wear and tear of fuel injectors
Maintenance Handling	1.The battery voltage is insufficient, falling below 24V, resulting in too low starter speed and ECU supply voltage. 2.ECU not powered or damaged. Check if the main relay makes a clicking sound or disconnect the water temperature sensor connector to check if there is 5V voltage at the plug. 3.Faults in the fuel pump, fuel rail sensor, or fuel injectors (read fault codes with a diagnostic tool): ① Low-level errors in the fuel metering unit : Shorted to battery; Shorted to ground. Measure the resistance value of the fuel metering solenoid valve, ensuring it's around 2.5Ω, and check if the wiring to the ECU is normal. ② Faults in the rail pressure sensor: Voltage exceeds the upper limit; Voltage falls below the lower limit. Check if the wiring between the common rail pressure sensor and ECU is normal. When the ignition switch is in the ON position, use a diagnostic tool to read the data stream and ensure the signal voltage output by the common rail pressure sensor is 0.49V。 Note: Do not use a multimeter to measure the resistance of the rail pressure sensor! ③ If there are no fault codes, check if the fuel pump is supplying oil (note: this is a

	rare scenario). Disconnect the high-pressure outlet tube of the fuel pump and use the starter to crank the engine to see if the fuel pump is outputting oil in a linear flow. If the oil output is significantly less than (compared to a normal device) or there is no oil output, it's likely a fault with the fuel pump.During maintenance, technicians should not only read fault codes but also utilize the data stream from the diagnostic tool to identify any abnormalities. For example, checking the fuel system can be done by reading the data stream of the rail pressure to see if it can be established within 10-15 seconds after starting and if it's greater than 25MPa 4.Wear and tear of fuel injectors Disconnect the return fuel line from the fuel injector and start the engine. If the engine fails to start successfully but the fuel injector has already started to return fuel, it indicates wear and tear of the fuel injector, resulting in an inability to establish rail pressure.

（4）Engine hard to start

Fault Phenomenon	Engine hard to start
Cause Analysis	The main reasons are: 1.The diesel engine has not been operated for a long time. 2.There is a small amount of air or blockage in the low-pressure pipeline. 3.The crankshaft speed signal and camshaft signal are too weak, resulting in a long

	synchronization judgment time. 4.The ambient temperature is too low, and the preheating device has failed. 5.The quality of diesel fuel and oil is poor and does not meet the standards. 6.The starter or flywheel ring gear is worn or has teeth damaged. 7.The piston rings, cylinder bore are worn, or the valve sealing is not tight. 8.The battery is discharged
Maintenance Handling	1.Read the fault code to determine if there is a signal error between the camshaft and crankshaft sensors. 2.Check if the low-pressure fuel line is blocked; check if there is air ingress in the low-pressure fuel line. 3.No crankshaft signal: Fault of invalid crankshaft signal: No crankshaft signal Check if the crankshaft position sensor connector is loose or has poor contact. Inspect the connector for any short-circuit or open-circuit phenomena Here is the translation of the content you provided: Measure if the resistance of the crankshaft position sensor is around 900Ω (the actual resistance value is related to the ambient temperature). Measure if the gap between the crankshaft position sensor and the signal wheel is within 0.5 to 1.5 mm. Check if any of the teeth on the flywheel signal are damaged. Determine if there is a possibility of poor contact between the connector and the sensor. Inspect if the connector of the camshaft position sensor is loose or has poor contact.

	After replacing the fuel pump, check if the timing is incorrect. Check if there is any short-circuit or open-circuit phenomenon in the connector. Measure if the gap between the camshaft position sensor and the signal wheel is within 0.5 to 1.5 mm. ① If there is no fault code, use an oscilloscope to check the wave forms of both sensors (it is possible that the signal is incorrect, but the ECU does not report an error).  Crankshaft signal Camshaft signal 1.Check if the preheating device and related fuses, relays have failed. 2.Check if the quality of the engine oil and diesel meets the requirements. 3.Inspect if there is any gear clashing phenomenon with the starter or flywheel ring gear.

	4.Perform a compression test using a diagnostic tool to see if there is wear on the piston rings, cylinder bore, or if the valve sealing is not tight. 5.During startup, check if the battery voltage can meet the starting requirements.

（5）Engine power deficiency and limited speed torque.

Fault Phenomenon	The engine lacks power, with limited speed and torque, but there is no black smoke, and the fault light is on.
Cause Analysis	The main reasons are: 1.Faulty fuel injectors. 2.Excessively high water temperature and intake air temperature. 3.Fault in the flow metering unit. 4.Sensor failures (water-in-fuel sensor, water temperature sensor, intake air temperature and pressure sensor, accelerator pedal unit, camshaft sensor). 5.Detachment of the signal plate.
Maintenance Handling	Based on the fault code displayed by the diagnostic tool, the sensors that can cause speed limitation are as follows: 1.Check if the water-in-fuel indicator light is on and inspect if the sensor is damaged (speed limit at 2500 to 2600 r/min). 2.Check the water temperature sensor (speed limit at 2500 to 2600 r/min)

	3.Check the intake air temperature and pressure sensor (speed limit at 2000 to 2400 r/min, torque limitation). 4.Check the accelerator pedal unit (idle speed automatically increases to 1100 r/min). 5.Check if the camshaft signal plate has fallen off or if the camshaft sensor is damaged (speed limit below 2600 r/min).

（6）It requires pressing the accelerator pedal twice to increase the engine speed.

Fault Phenomenon	The need to press the accelerator pedal twice in order to increase the engine speed
Cause Analysis	Main Reason： 1.Loose or poor contact in the accelerator pedal connector 2.The brake pedal fails to return to the highest position 3.Poor contact in the wiring harness of the accelerator pedal
Maintenance Handling	1.Read the fault codes 2.Check if the connector of the accelerator pedal is securely connected 3.Check if the brake pedal springs back to the highest position 4.Check if the wiring harness connection between the accelerator pedal and the ECU is reliable 5.Inspect the wiring of the brake switch and brake relay

	6.Use a diagnostic tool to read the data stream, ensuring that the primary and secondary brake switch information is opposite.

（7）Starting time is long, resulting in speed limitation or stalling

Fault Phenomenon	Starting time is long, resulting in speed limitation or stalling
Cause Analysis	1.Air enters the low-pressure oil circuit; 2.The low-pressure oil circuit is blocked.

Maintenance Handling	The fault code read indicates: Oil Metering Control Unit (Meun) Check: Rail Pressure Positive Deviation Exceeds Upper Limit; Oil Control Mode Check Fault: Maximum Rail Pressure Positive Deviation Exceeds Upper Limit, which impacts the set fuel flow rate. 1.After purging air using the manual fuel pump and testing the vehicle, the starting time becomes shorter, indicating a possible air ingress in the low-pressure oil circuit. 2.As shown in the figure below, after reassembling a new set of oil lines and testing the vehicle without using the on-board fuel tank and piping, if the test is normal, it can be determined that there is a possibility of air ingress or blockage in the low-pressure oil circuit from the original vehicle's fuel tank to the diesel filter.  3.Carefully inspect the low-pressure oil circuit from the fuel tank to the diesel filter

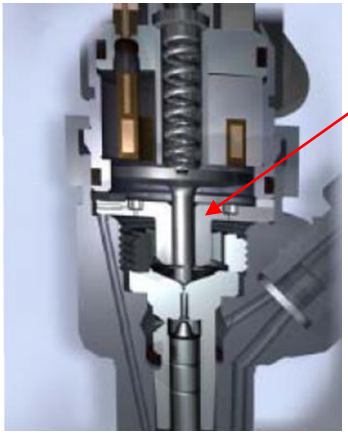
Fault Phenomenon	The long starting time is due to air in the low-pressure fuel line. If there is air in the low-pressure fuel line, when the key is turned to the "ON" position, the fuel pump's metering solenoid valve will make a loud "buzzing" sound. Although the high-pressure pump has a certain ability to self-purge, if the low-pressure fuel line continuously draws in air, as the engine speed increases, the air entering the common rail can be compressed, leading to increased pressure fluctuations and causing the rail pressure deviation to exceed the upper limit, resulting in an error message.

（8）The equipment stalls when accelerating on an uphill slope or under heavy load

Fault Phenomenon	When the equipment is accelerating on an uphill slope or under heavy load, the fault light comes on and the engine stalls. After stalling, if the key is turned back to the LOCK position and then restarted, the engine runs normally
Cause Analysis	1.Blockage in the low-pressure fuel line. 2.Wear of the fuel injector. 3.Insufficient fuel supply capacity of the high-pressure fuel pump.

Maintenance Handling	1.The diagnostic instrument reads the fault code as follows: Fuel metering control Menu check: Rail pressure positive deviation exceeds the upper limit, fuel control mode check fault: The maximum rail pressure positive deviation exceeds the upper limit and affects the set fuel flow. 2.After removing the fuel injector return pipe, compare the fuel return amount of the four injectors within one minute at idle speed. It is obviously found that the fuel return amount of one injector is greater than the other three (at 80℃ water temperature, measure the fuel return amount of each injector for 1 minute at idle speed). 3.After replacing the injector with a smaller fuel return amount, the test drive is normal.

Fault Phenomenon	Due to poor filtration by the diesel filter or impurities entering the high-pressure fuel line during maintenance, the injector ball valve becomes worn (as shown in the figure below), resulting in improper sealing. This causes an increase in the amount of fuel returned by the injector, as well as an increase in the amount of fuel supplied to the injector by the fuel injection pump. The larger amount of returned fuel from the injector will lead to increased fluctuations in rail pressure. The ECU will limit torque, and if it exceeds the maximum limit, the engine will stall。



If there are impurities attached to the ball valve in this area, it will not close properly, leading to an increased amount of fuel returning from the injector.

（9）Self-check fault light is constantly on.

Fault Phenomenon	Fault light is constantly on
Cause Analysis	1.V90 has a short circuit to ground.
Maintenance Handling	1.Use a diagnostic tool to read and clear the fault code related to V90; 2.Perform an action test on the fault indicator light; 3.Check if V90 has a short circuit to ground.

（10） Self-check fault light is not illuminated.

Fault Phenomenon	The fault light does not illuminate during the ECU self-check, but it briefly lights up when the ignition key switch is quickly turned on or off.
Cause Analysis	1.There is poor contact in the wiring, causing a broken circuit. 2.The ground wire of the fault light is short-circuited to the positive terminal of the power supply
Maintenance Handling	1.Use a diagnostic tool to read the fault code and perform an action test on it. 2.Check if there is a broken circuit in the wiring from K55 to the fault light. 3.Check if there is a broken circuit in the ground wire of the fault light. 4.Check if the ground wire of the fault light is short-circuited to the positive terminal of the power supply. 5.Check the fault light

V Preservation of diesel engines

For diesel engines that have never been used and need to be stored for a long period of time, please follow the instructions below for preparation:

1.Drain all the engine oil.

2.Open the water drain valve to drain the coolant from the diesel engine.

3.Drain all the diesel fuel from the fuel tank and fuel lines.

4.Clean the exterior of the diesel engine to remove oil stains, water marks, and dust. Apply rust-proof oil (a mixture of dehydrated engine oil and butter, evenly mixed after melting) to unpainted parts. Rubber and plastic parts should not be coated with rust-proof oil.

5.Wrap the air filter (or air intake) and exhaust pipe outlet with oil paper to prevent dust and dirt from entering.

6.Store the diesel engine or vehicle in a well-ventilated, dry, clean, and non-magnetic indoor space (temperature: -30 to 60°C, humidity: 0 to 80%). Do not stack it near corrosive chemicals, and pay attention to moisture prevention (especially for the electrical system).

For a used diesel engine or diesel vehicle that needs to be stored for a long period of time, please follow the instructions below for preparation：

1. After stopping the engine, drain the engine oil while it's still warm. Remove the oil pan, clean it, and also clean the oil strainer.

2. Open the water drain valve to drain the coolant from the diesel engine.

3. Drain all the diesel fuel from the fuel tank and fuel lines.

4. Remove dust from the air filter element (for paper-type air filters). Clean the oil-bath air filter element with diesel or kerosene.

5. Remove the intake manifold and inject 300 grams of filtered HC-8 dehydrated engine oil (i.e., heat the oil to 110-120°C until all foam disappears) into each cylinder through the intake port. Rotate the crankshaft to evenly coat the valves, cylinder liners, pistons, and other parts with oil.

Then reinstall the intake manifold.

6. Clean the exterior of the diesel engine to remove oil stains, water marks, and dust. Apply rust-proof oil (a mixture of dehydrated engine oil and grease, evenly mixed after melting) to unpainted parts. Rubber and plastic parts should not be coated with rust-proof oil.

7. Wrap the air filter (or air intake) and exhaust pipe outlet with oil paper to prevent dust and dirt from entering.

8. Store the diesel engine or vehicle in a well-ventilated, dry, clean, and non-magnetic indoor space. Do not store it near corrosive chemicals. Also, take measures to prevent moisture (especially for the electrical system).

Note: The above preservation method can preserve the diesel engine or vehicle for 18 months. If the period exceeds, the preservation can be redone according to the above method.