

Specification for
SINOTRUK
Marine Diesel Engine
Marine-Tec USA (March 2018)



Special Instructions

- Privately removing the lead seal for fuel amount from the fuel pump is forbidden to ensure the customer's legitimate rights.
- Any adjustment or lead seal removing on the injection pump will incur engine guarantee in invalidation.
- Any dismantlement to the injection pump, a precise component, will incur the engine guarantee in invalidation.
- Any dismantling or impacting on the turbocharger rotor, a precise high rotating component, will incur engine guarantee in invalidation.
- The main bearings and the connecting bolts are designed with strict torque and turning angles, and any loosening or dismantling to them will incur engine guarantee in invalidation.
- Always make sure the coolant and the oil are enough whenever running the diesel engine.
- The connecting bolts can only be used for once.

Instructions

- 1 The engine guarantee will be void if privately removing is done to the lead seal or increasing to the acceleration on account that the diesel engine has been strictly tested in compliance with the stipulation, and the accelerator sealed and limited before shipping.
- 2 Those who operate the diesel engine shall read the specification with care so that they will know better about the diesel engine construction and operate the engine exactly as guided in the specification.
- 3 Keeps the engine running-in for 50 hours if it is a new one.
- 4 Slowly speed up the engine after a cold start is done and don't keep it idling for long with no load on. Always stop it after keeping it running at a low speed with no load for 5-10 mins. Never try to stop the engine abruptly after it runs with heavy load.
- 5 Always drain the water in the water tank and the diesel engine after stopping it if the ambient temperature is likely to fall below 0°C with no antifreeze additive in usage.
- 6 Always keeps the engine working with the air filter to stop air into the cylinder without filtration.
- 7 Always fill with the right filtrated fuel and oil as stipulated by using a special clean container. Fuel has to be settled for more than 72 hours.
- 8 Only professionals can perform repair for the electricity system.
- 9 When shipped, the diesel engine is normally oil sealed for fear of rust, which is normally terminated in one year, when inspection shall be done and necessary reinforce taken.
- 10 Engine quality feedback.

Files have been built up for tracing diesel engine, so that customers shall fill in the cards as required and post them to us to keep contact.

11 Steyr WD415, WD615, D12 series diesel engine are products of high performance, and when the engine part or component need repairing, work shall be done exactly as listed in Steyr series diesel engine parts catalogue and maintenance manual; when the engine part or component needs changing, only products approved by the leading manufacturer can be purchased to ensure the engine's performance, reliability and life.

Preface

WD415, WD615, D12 diesel engine series are the high speed engines designed by introducing the advanced foreign techniques while manufactured in China. Being featured with compact structure, high reliability, excellent power and economy, they are easy to start, operate and maintenance, meeting with Euro II emission standard in particular (namely National emission B standard), which makes them the best choice for main and subsidiary power in the heavy duty truck, engineering machinery, stationed power and marine.

Steyr marine diesel engine series, derived from Steyr diesel engine series, are the ideal power for the small-sized marine, such as high speed vessels, yachts, shuttle boats, start barges, ferries, dredger fishers and so on, and can work at the power station together with the marine generate set. The engine can match the marine gear case and is equipped with sea water pump and fresh and sea water heat exchanger. The expiration for Steyr marine diesel engine series is 12 months since the boat is purchased or 800 hours after the engine runs (whichever comes first).

The specification, an addition to *Operation and Maintenance Manual for Steyr Series Euro II Diesel Engines*, illustrates the way to assembly, operate and maintenance Steyr marine diesel engines series. Whereas the structure will be revised with the product development, it is hoped that technical information from our company shall be timely concerned and any change to it can not reach each customer.

When performing the operation and maintenance, it is suggested that the customer refers to *Operation and Maintenance Manual for WD415/WD615/D12 Series Euro II Diesel Engines Operation, Maintenance Disk for WD615/D12 Series Euro II Diesel Engines* so that they can have a comprehensive understanding about the structure and its parts and components.

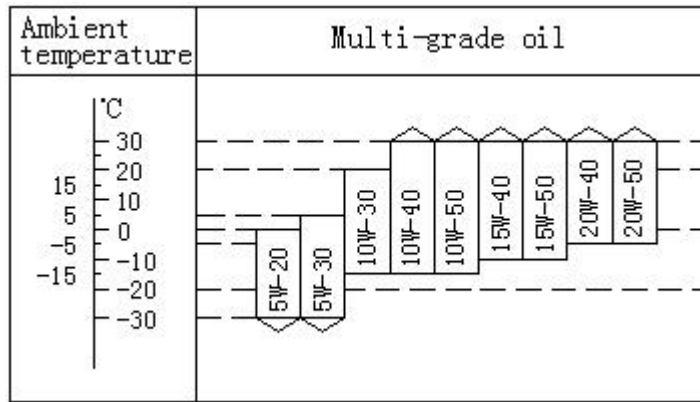
It will be greatly appreciated that any advice are given on improving the products by our company, which are possibly revised on the performance and the structure to meet with various requirements, based on the fact that the diesel engines are ranging from functions to characteristics.

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Oil that meets with GB11122-1997 is required for L-ECD diesel engine, and the grade can be chosen in comply with the ambient temperature as shown in figure 1.

Figure 1-1 Selection of oil grade



Multi-grade oil is recommended, since the viscosity of multi-grade oil goes down mildly as the temperature rises, which ensures good lubrication even if the temperature is fluctuates over a wide range.

1.2.6 Cooling medium

Internal circulation cooling system: fresh water (treated to prevent both rust and incrustation.)

External circulation cooling system: fresh water or sea water

1.3 Instruction for SINOTRUK diesel engine series and purchase order number

1.3.1 Model number of SINOTRUK Steyr marine diesel engine

Figure 1-2 WD Series Marine Engine

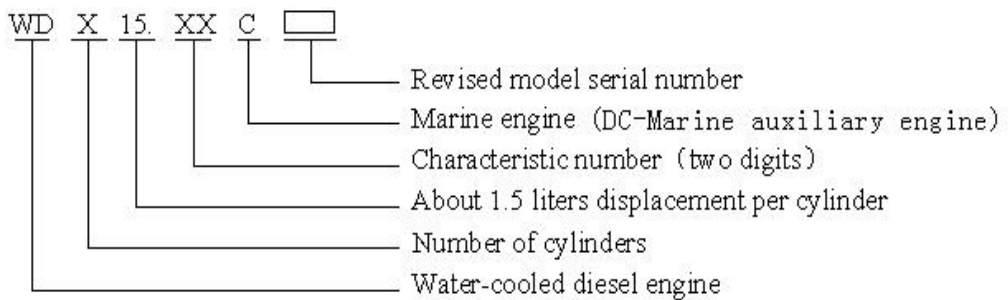
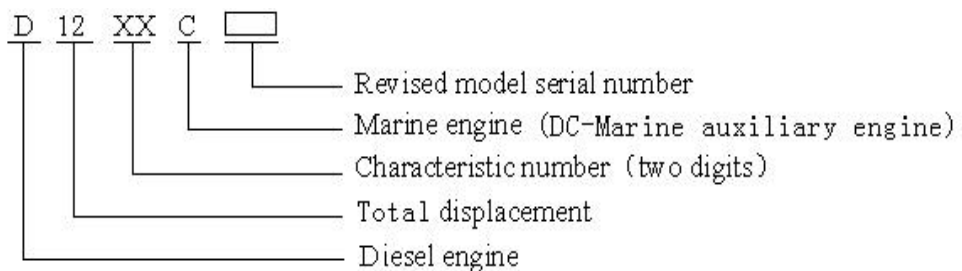


Figure 1-3 D12 Series Marine Engine



1.3.2 Purchase order number of SINOTRUK Steyr series marine diesel engine

Figure 1-4 WD Series Marine Engine

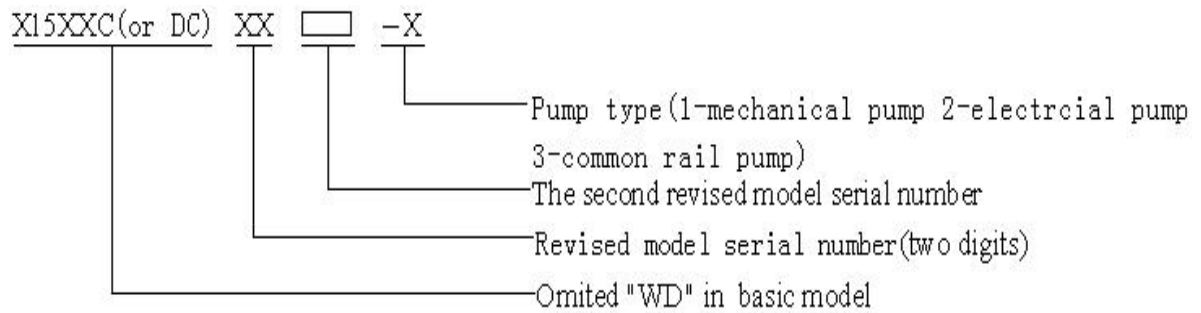
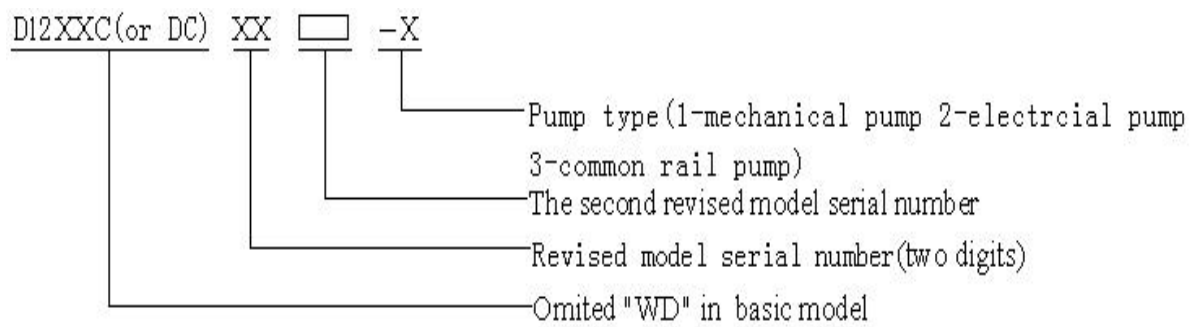


Figure 1-5 D12 Series Marine Engine



Engines of the same model have the same rated power/rpm when they share the same revised model serial number whereas different numbers for a second revising which indicates the slightly different requirements of customers.

1.4 Main technical characteristics of Steyr series marine diesel engine

1.4.1 Main technical characteristics of WD415 series marine diesel engine

Table1-1 WD415.16 series marine diesel engine parameter

Item Model	WD415.16C			WD415.16DC	
	41516C01	41516C02	41516C03	41516DC01	41516DC02
Type	4 strokes, water-cooled, in-line, direct-injection				
Method of aspiration	Turbocharged				
Number of cylinders	4				
Bore×stroke (mm×mm)	126×130				
CR/SHF rotation direction (from free end)	clockwise				
Firing order	1-3-4-2				
Displacement (L)	6.484L				
Rated power/Speed(kW/r/min)	103/2100	100/1800	92/1500	91/1500	58/1500
Overload power/Speed (kW/r/min)	113/2163	110/1858	101/1545	100/1500	64/1500
Rated fuel consumption rate (g/kW·h)	220	220	215	215	215
Maximum combustion pressure(MPa)	13.5				
Compression ratio	17:1				
Oil-fuel consumption ratio	0.4				
Method of starting	Electric starter				
Turbocharge ratio	1.85				
Idle speed (r/min)	600 ±50			700± 20	
Crankshaft type	integrated				
Net weight (kg)	800				
Dimension L×W×H (mm)	1610× 830× 1170				

Table1-2 WD415.24 series marine diesel engine parameter

Item Model	WD415.24C					WD415.24DC	
	41524 C01	41524 C02	41524 C03	41524 C04	41524 C05	41524DC01	41524DC02
Type	4 strokes, water-cooled, in-line, direct-injection						
Method of aspiration	Turbocharged and intercooled						
Number of cylinders	4						
Bore×stroke (mm×mm)	126×130						
CR/SHF rotation direction (from free end)	clockwise						
Firing order	1-3-4-2						
Displacement (L)	6.484L						
Rated power/Speed(kW/r/min)	158/ 2100	148/ 1800	135/ 1500	123/ 1500	115/ 2000	125/ 1500	145/ 1800
Overload power/Speed (kW/r/min)	174/ 2163	163/ 1858	148.5/ 1545	135/ 1545	126./ 2060	137.5/ 1500	159.5/ 1800
Rated fuel consumption rate (g/kW·h)	212	210	205	205	215	205	210
Maximum combustion pressure(MPa)	14.5						
Compression ratio	17:1						
Oil-fuel consumption ratio	0.4						
Method of starting	Electric starter						
Turbocharge ratio	1.85						
Idle speed (r/min)	600 ±50					700 ± 20	
Crankshaft type	integrated						
Net weight (kg)	800						
Dimension L×W×H (mm)	1255×830×1170						

1.4.2 Main technical characteristics of WD615 series marine diesel engine

Table 1-3 WD615.61series marine diesel engine parameters

Item Model	WD615.61C					
	61561C01N	61561C02N	61561C03N	61561C04N	61561C05N	61561C06N
Type	4 strokes, water-cooled, in-line, direct-injection					
Method of aspiration	Turbocharged					
Number of cylinders	6					
Bore×stroke (mm×mm)	126×130					
CR/SHF rotation direction (from free end)	clockwise					
Firing order	1-5-3-6-2-4					
Displacement (L)	9.726L					
Rated power/Speed(kW/r/min)	110/ 1800	140/ 1800	110/ 1500	120/ 1500	155/ 2000	91/ 1500
Overload power/Speed (kW/r/min)	121/ 1858	154/ 1858	121/ 1545	132/ 1545	170.5/ 2060	100/ 1545
Rated fuel consumption rate (g/kW·h)	220	220	220	220	220	220
Maximum combustion pressure(MPa)	13.5					
Compression ratio	17:1					
Compression pressure	>2000					
Oil-fuel consumption ratio	0.4					
Method of starting	Electric starter					
Turbocharge ratio	2.08					
Idle speed (r/min)	600 ±50					
Crankshaft type	integrated					
Net weight (kg)	850					
Dimension L×W×H (mm)	1580×830×1170					

Item Model	WD615.61DC			
	61561DC01N	61561DC02N	61561DC03N	61561DC04N
Type	4 strokes, water-cooled, in-line, direct-injection			
Method of aspiration	Turbocharged			
Number of cylinders	6			
Bore×stroke (mm×mm)	126×130			
CR/SHF rotation direction (from free end)	clockwise			
Firing order	1-5-3-6-2-4			
Displacement (L)	9.726L			
Rated power/Speed(kW/r/min)	115/ 1500	122/ 1800	91/ 1500	138/ 1800
Overload power/Speed (kW/r/min)	126.5/ 1500	134/ 1800	100/ 1500	152/ 1800
Rated fuel consumption rate (g/kW· h)	220	220	220	220
Maximum combustion pressure(MPa)	13.5			
Compression ratio	17:1			
Compression pressure	>2000			
Oil-fuel consumption ratio	0.4			
Method of starting	Electric starter			
Turbocharge ratio	2.08			
Idle speed (r/min)	700± 20			
Crankshaft type	integrated			
Net weight (kg)	1000± 40			
Dimension L×W×H (mm)	1580× 830× 1170			

Table 1-4 WD615.64 series marine diesel engine parameter

Item Model	WD615.64C			WD615.64DC	
	61564C01N	61564C01N	61564C03N	61564DC01N	61564DC02N
Type	4 strokes, water-cooled, in-line, direct-injection				
Method of aspiration	Turbocharged				
Number of cylinders	6				
Bore×stroke (mm×mm)	126×130				
CR/SHF rotation direction (from free end)	clockwise				
Firing order	1-5-3-6-2-4				
Displacement (L)	9.726L				
Rated power/Speed(kW/r/min)	147/1500	158/1800	147/1800	145/1500	145/1800
Overload power/Speed (kW/r/min)	162/1545	174/1858	162/1858	159.5/1500	159.5/1800
Rated fuel consumption rate (g/kW·h)	215	215	215	220	220
Maximum combustion pressure(MPa)	13.5				
Compression ratio	17:1				
Compression pressure	>2000				
Oil-fuel consumption ratio	0.4				
Method of starting	Electric starter				
Turbocharge ratio	2.08				
Idle speed (r/min)	600 ±50			700 ± 20	
Crankshaft type	integrated				
Net weight (kg)	1000± 40				
Dimension L×W×H (mm)	1580× 830× 1170				

Table 1-5 WD615.67 series marine diesel engine parameter

Item Model	WD615.67C		
	61567C01N	61567C02N	61567C03N
Type	4 strokes, water-cooled, in-line, direct-injection		
Method of aspiration	Turbocharged and intercooled		
Number of cylinders	6		
Bore×stroke (mm×mm)	126×130		
CR/SHF rotation direction (from free end)	clockwise		
Firing order	1-5-3-6-2-4		
Displacement (L)	9.726L		
Rated power/Speed(kW/r/min)	176/1800	180/2000	164/1500
Overload power/Speed (kW/r/min)	194/1858	198/2060	180/1545
Rated fuel consumption rate (g/kW·h)	208	210	205
Maximum combustion pressure(MPa)	14.5		
Compression ratio	17:1		
Compression pressure	>2000		
Oil-fuel consumption ratio	0.4		
Method of starting	Electric starter		
Turbocharge ratio	2.08		
Idle speed (r/min)	600 ±50		
Crankshaft type	integrated		
Net weight (kg)	1050 ± 40		
Dimension L×W×H (mm)	1912×830×1170		

Table 1-6 WD615.68 series marine diesel engine parameter

Item Model	WD615.68C			WD615.68DC		
	61568C01N	61568C02N	61568C03N	61568 DC01N	61568 DC02N	61568 DC03N
Type	4 strokes, water-cooled, in-line, direct-injection					
Method of aspiration	Turbocharged and intercooled					
Number of cylinders	6					
Bore×stroke (mm×mm)	126×130					
CR/SHF rotation direction (from free end)	clockwise					
Firing order	1-5-3-6-2-4					
Displacement (L)	9.726L					
Rated power/Speed(kW/r/min)	200/ 1800	205/ 2100	180/ 1500	185/ 1500	190/ 1800	175/ 1500
Overload power/Speed (kW/r/min)	220/ 1858	225.5/ 2163	198/ 1545	203.5/ 1500	209/ 1800	192.5/ 1500
Rated fuel consumption rate (g/kW·h)	205	210	205	205	210	210
Maximum combustion pressure(MPa)	14.5					
Compression ratio	17:1					
Compression pressure	>2000					
Oil-fuel consumption ratio	0.4					
Method of starting	Electric starter					
Turbocharge ratio	2.08					
Idle speed (r/min)	600 ±50			700± 20		
Crankshaft type	integrated					
Net weight (kg)	1050± 40					
Dimension L×W×H (mm)	1920× 830× 1170					

Table 1-7 WD615.46 series marine diesel engine parameter

Item Model	WD615.46C			WD615.46DC	
	61546C01N	61546C02N	61546C03N	61546DC01N	61546DC02N
Type	4 strokes, water-cooled, in-line, direct-injection				
Method of aspiration	Turbocharged and intercooled				
Number of cylinders	6				
Bore×stroke (mm×mm)	126×130				
CR/SHF rotation direction (from free end)	clockwise				
Firing order	1-5-3-6-2-4				
Displacement (L)	9.726L				
Rated power/Speed(kW/r/min)	240/ 2100	230/ 1800	202/ 1500	202/ 1500	225/ 1800
Overload power/Speed (kW/r/min)	220/ 1858	225.5/ 2163	198/ 1545	222/ 1500	247.5/1800
Rated fuel consumption rate (g/kW·h)	210	208	205	205	210
Maximum combustion pressure(MPa)	14.5				
Compression ratio	17:1				
Compression pressure	>2000				
Oil-fuel consumption ratio	0.4				
Method of starting	Electric starter				
Turbocharge ratio	2.08				
Idle speed (r/min)	600 ±50			700 ± 20	
Crankshaft type	integrated				
Net weight (kg)	1080 ± 40				
Dimension L×W×H (mm)	1912× 830× 1170				

Table 1-8 WD615.57 series marine diesel engine parameter

Item Model	WD615.57C			WD615.57DC	
	61557C01	61557C02	61557C03	61557DC01	61557DC02
Type	4 strokes, water-cooled, in-line, direct-injection				
Method of aspiration	Turbocharged and intercooled				
Number of cylinders	6				
Bore×stroke (mm×mm)	126×130				
CR/SHF rotation direction (from free end)	clockwise				
Firing order	1-5-3-6-2-4				
Displacement (L)	9.726L				
Rated power/Speed(kW/r/min)	257/ 2000	245/ 1800	220/ 1500	220/ 1500	245/ 1800
Overload power/Speed (kW/r/min)	283/ 2060	269.5/ 1858	242/ 1545	242/ 1500	269.5/ 1800
Rated fuel consumption rate (g/kW·h)	210	205	200	200	205
Maximum combustion pressure(MPa)	16.0				
Compression ratio	17.5:1				
Compression pressure	>2000				
Oil-fuel consumption ratio	0.4				
Method of starting	Electric starter				
Turbocharge ratio	2.08				
Idle speed (r/min)	600 ±50			700± 20	
Crankshaft type	integrated				
Net weight (kg)	1080± 40				
Dimension L×W×H (mm)	1920× 830× 1170				

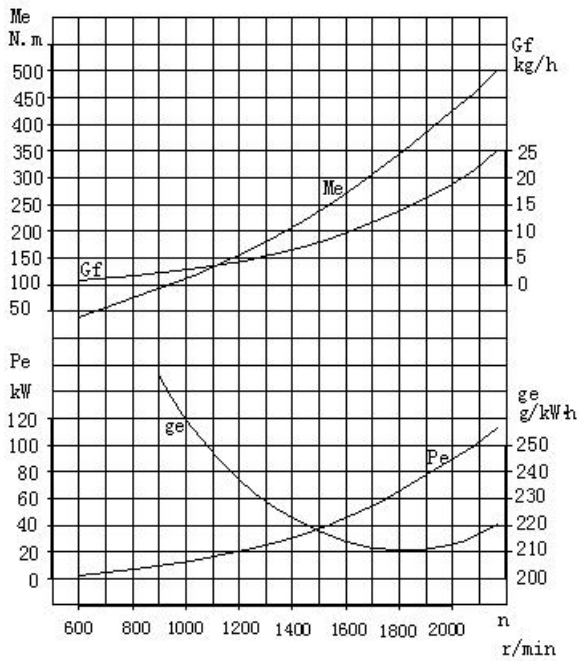
1.4.3 Main technical characteristics of D12 series marine diesel engine

Table 1-9 D12.42 series marine diesel engine parameter

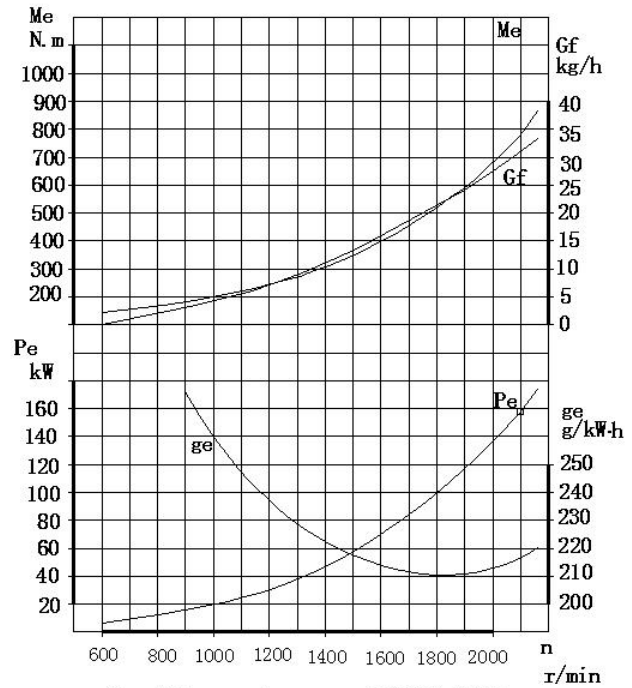
Item Model	D12.42C						D12.42DC	
	D1242 C01	D1242 C02	D1242 C03	D1242 C04	D1242 C05	D1242 C06	D1242 DC01	D1242 DC02
Type	4 strokes, water-cooled, in-line, direct-injection							
Method of aspiration	Turbocharged and intercooled							
Number of cylinders	6							
Bore×stroke (mm×mm)	126×155							
CR/SHF rotation direction(from free end)	clockwise							
Firing order	1-5-3-6-2-4							
Displacement (L)	11.596L							
Rated power/Speed(kW/r/min)	301/ 2000	295/ 1800	265/ 1500	272/ 1800	257/ 2000	331/ 2100	275/ 1500	265/ 1500
Overload power/Speed (kW/r/min)	331/ 2060	324.5/ 1858	291.5/ 1545	299/ 1858	283/ 2060	364/ 2168	302.5/ 1500	291.5/ 1500
Rated fuel consumption rate (g/kW· h)	220	218	215	218	220	220	215	215
Maximum combustion pressure(MPa)	16.0							
Compression ratio	17:1							
Compression pressure	>2000							
Oil-fuel consumption ratio	0.4							
Method of starting	Electric starter							
Idle speed (r/min)	600 ±50						700 ± 20	
Crankshaft type	integrated							
Net weight (kg)	1200							
Dimension L×W×H (mm)	1751×947(415+532)×1277							

2 Characteristic and figuration map

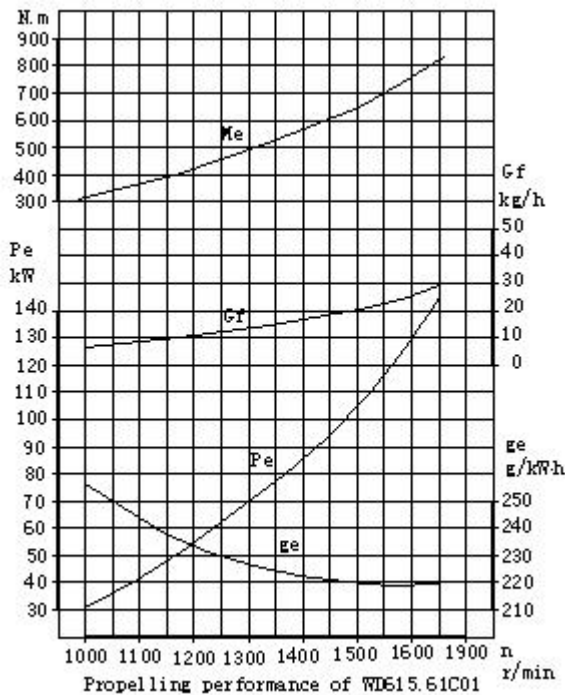
2.1 Propulsion characteristics of SINOTRUK Steyr series marine diesel engine



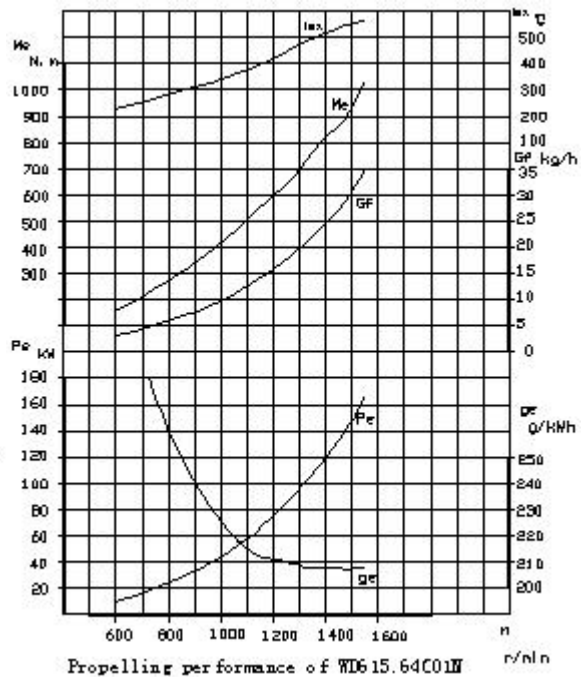
Propelling performance of WD415.16C01



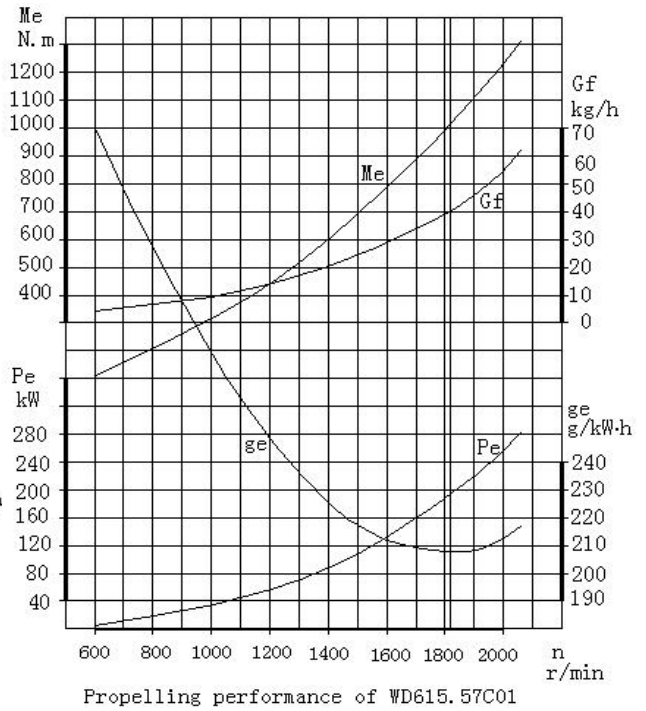
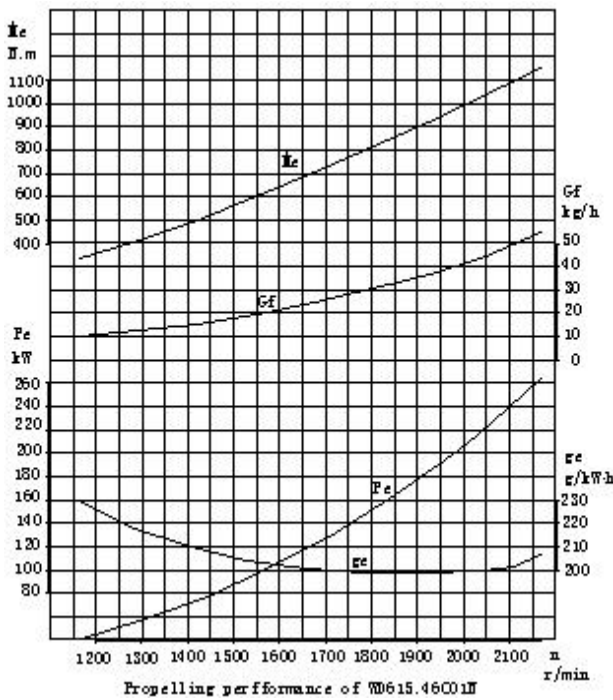
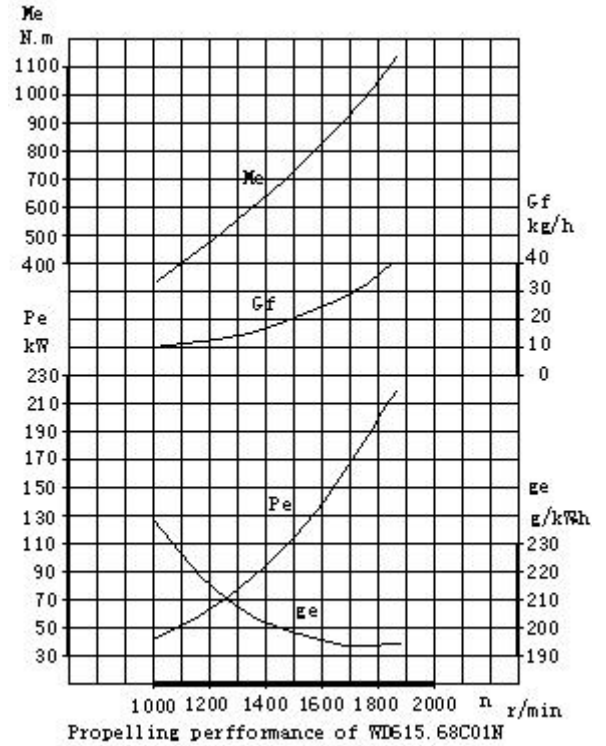
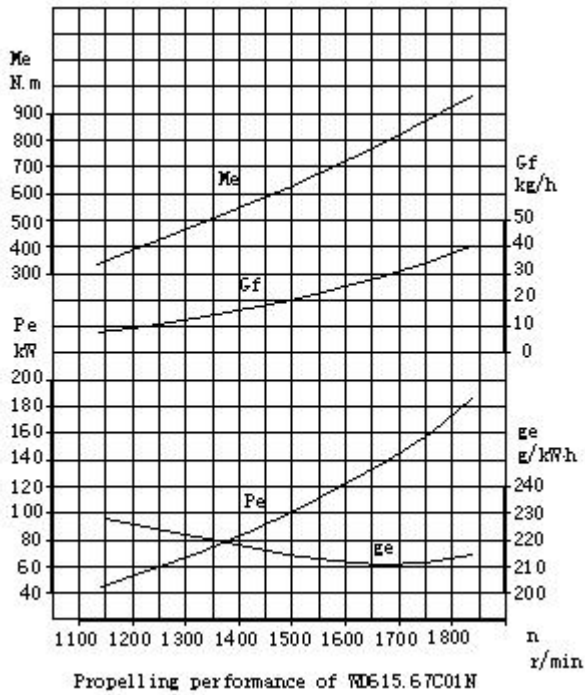
Propelling performance of WD415.24C01

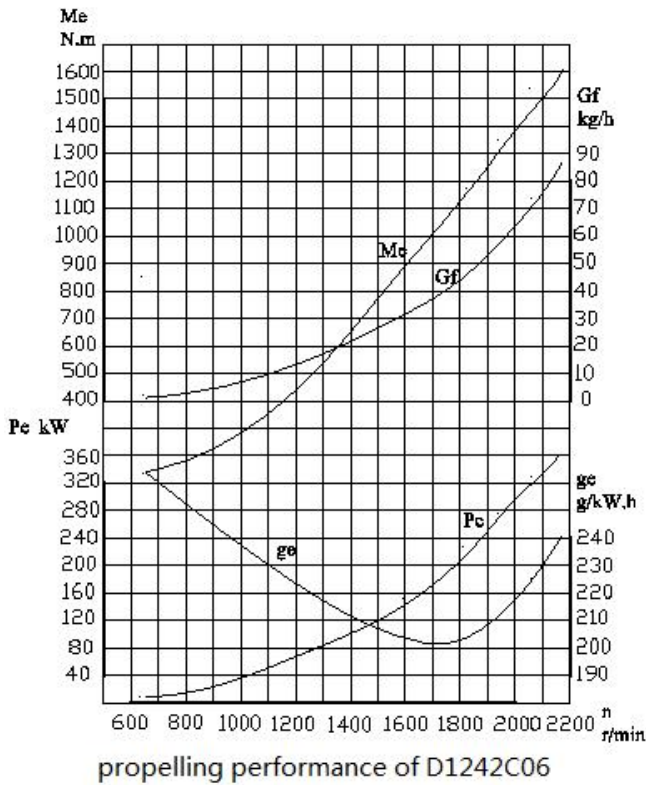
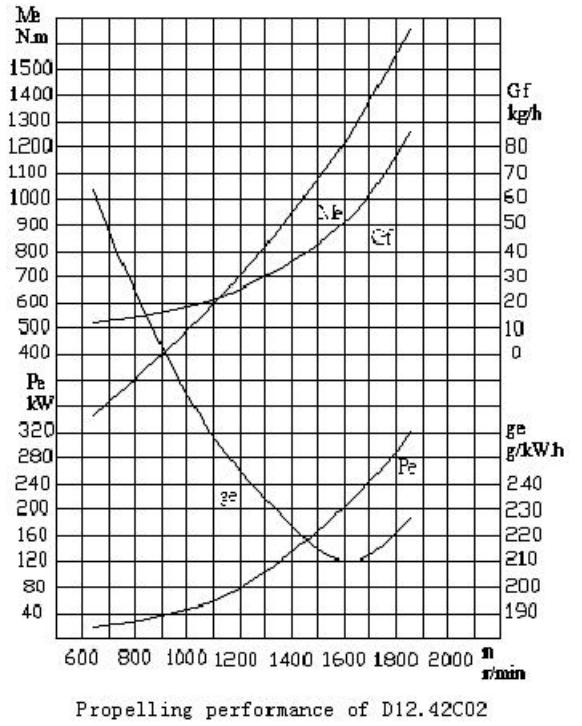
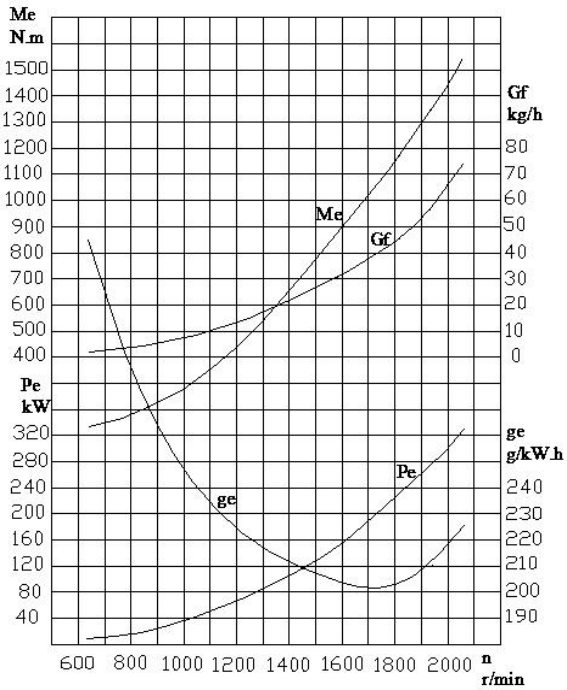


Propelling performance of WD615.61C01

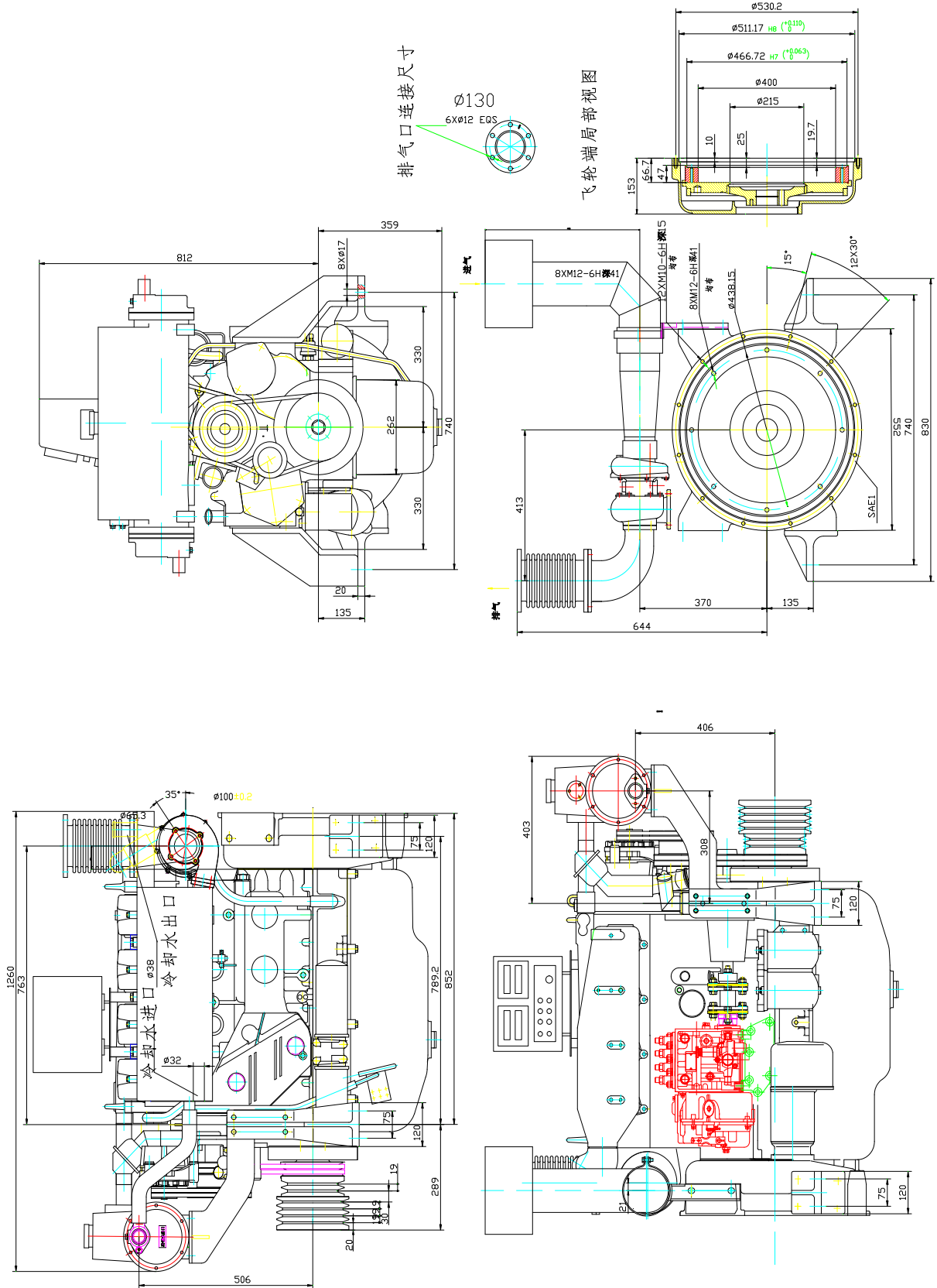


Propelling performance of WD615.64C01IV

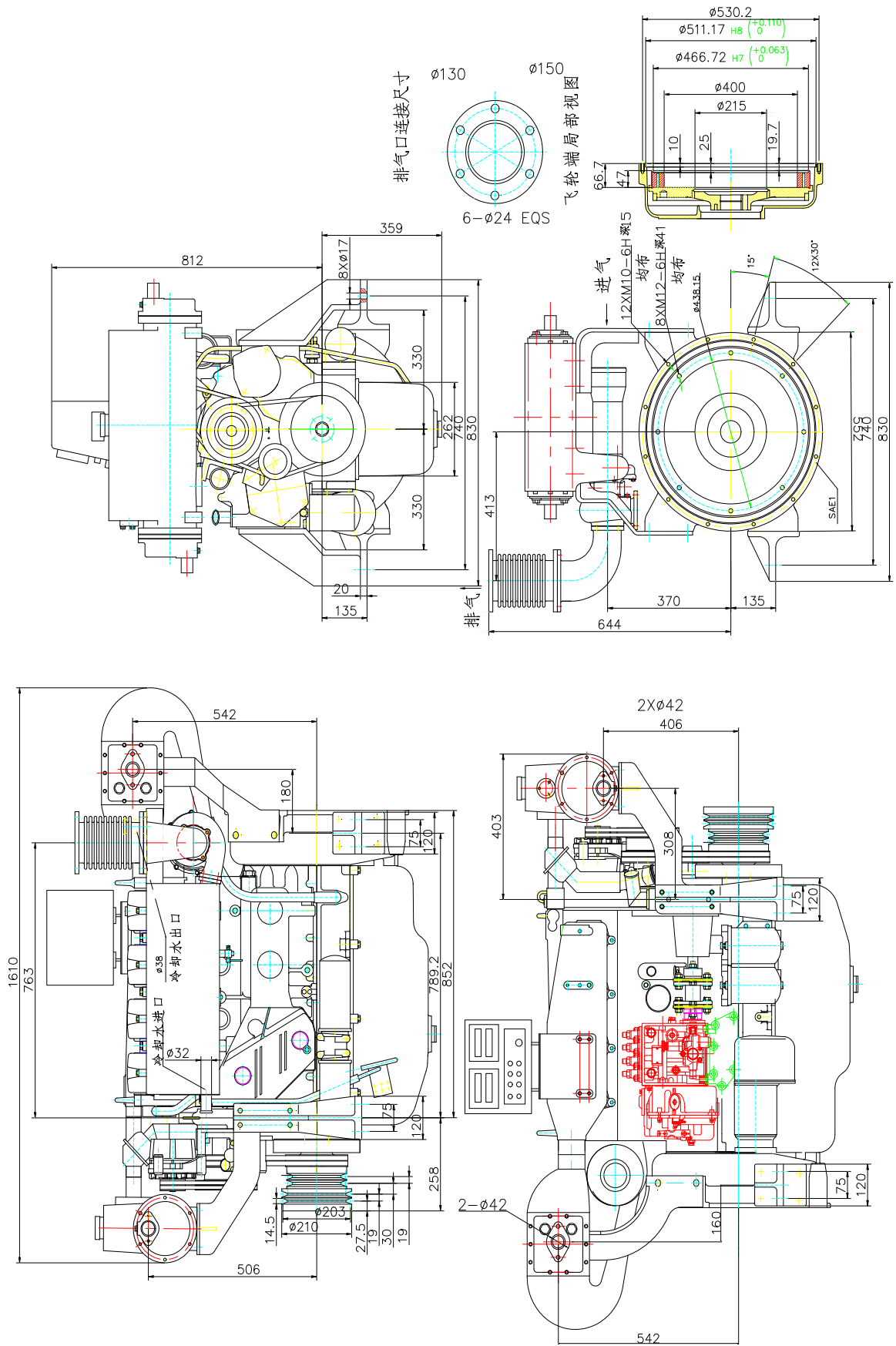




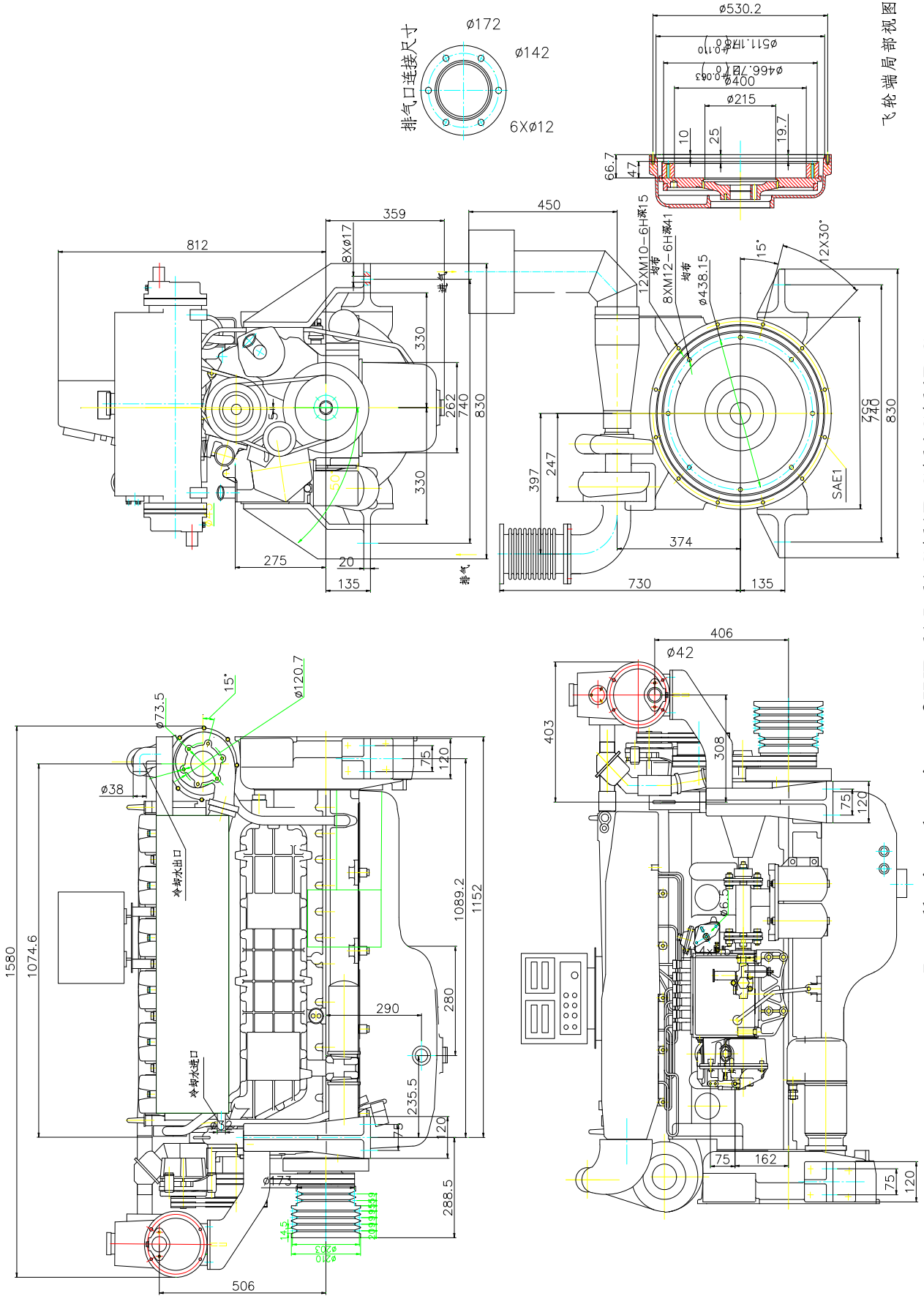
2.2 Installation drawing of Steyr diesel engine



Installation drawing of WD415.16C/16DC

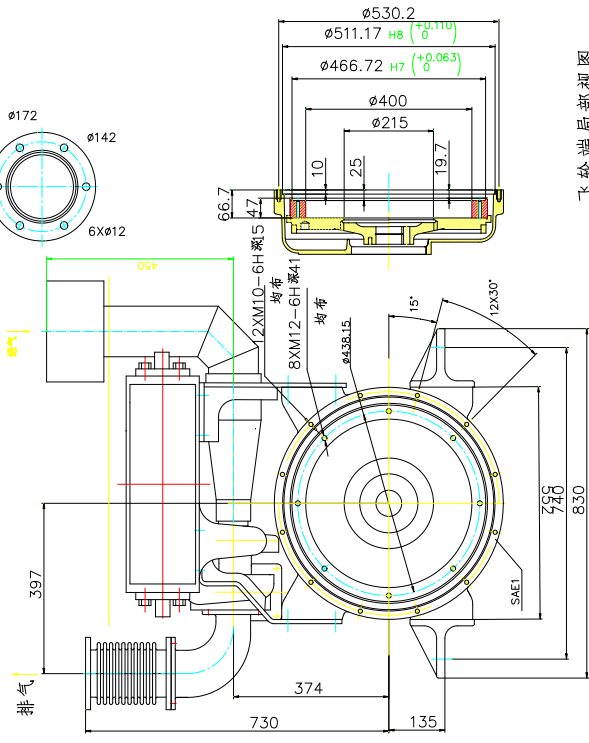
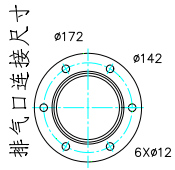
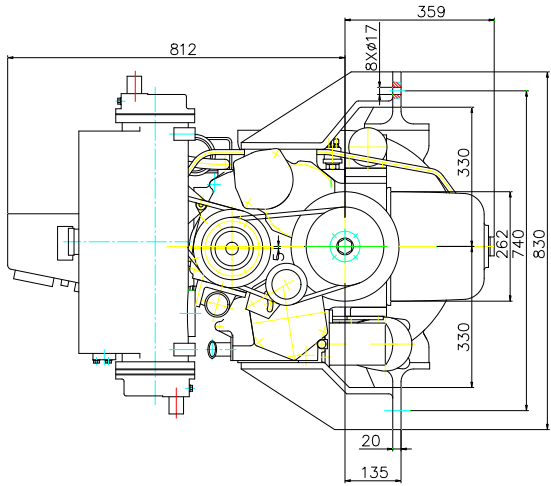
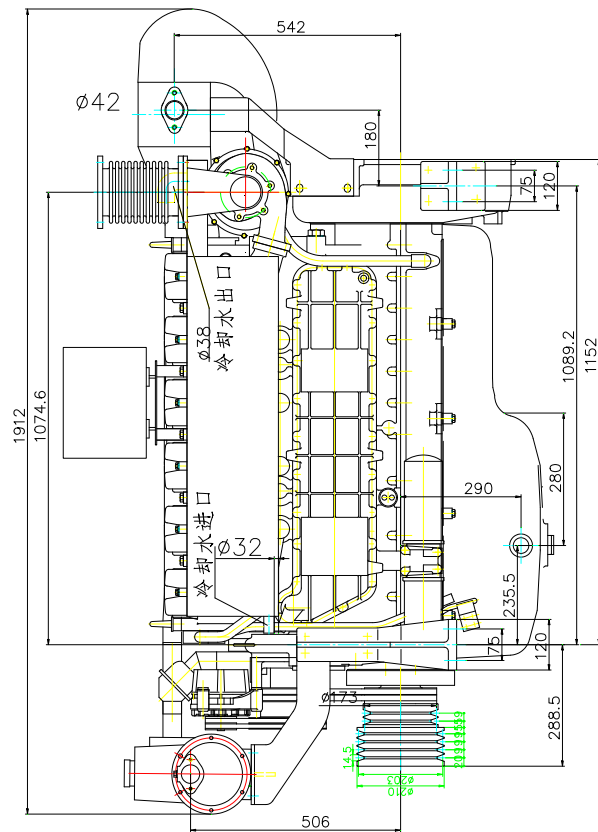


Installation drawing of WD415.24C/24DC

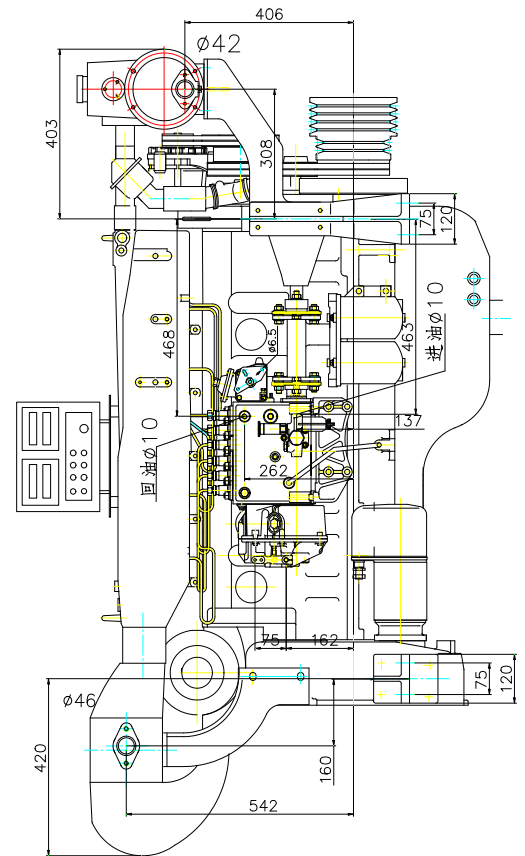


飞轮端局部视图

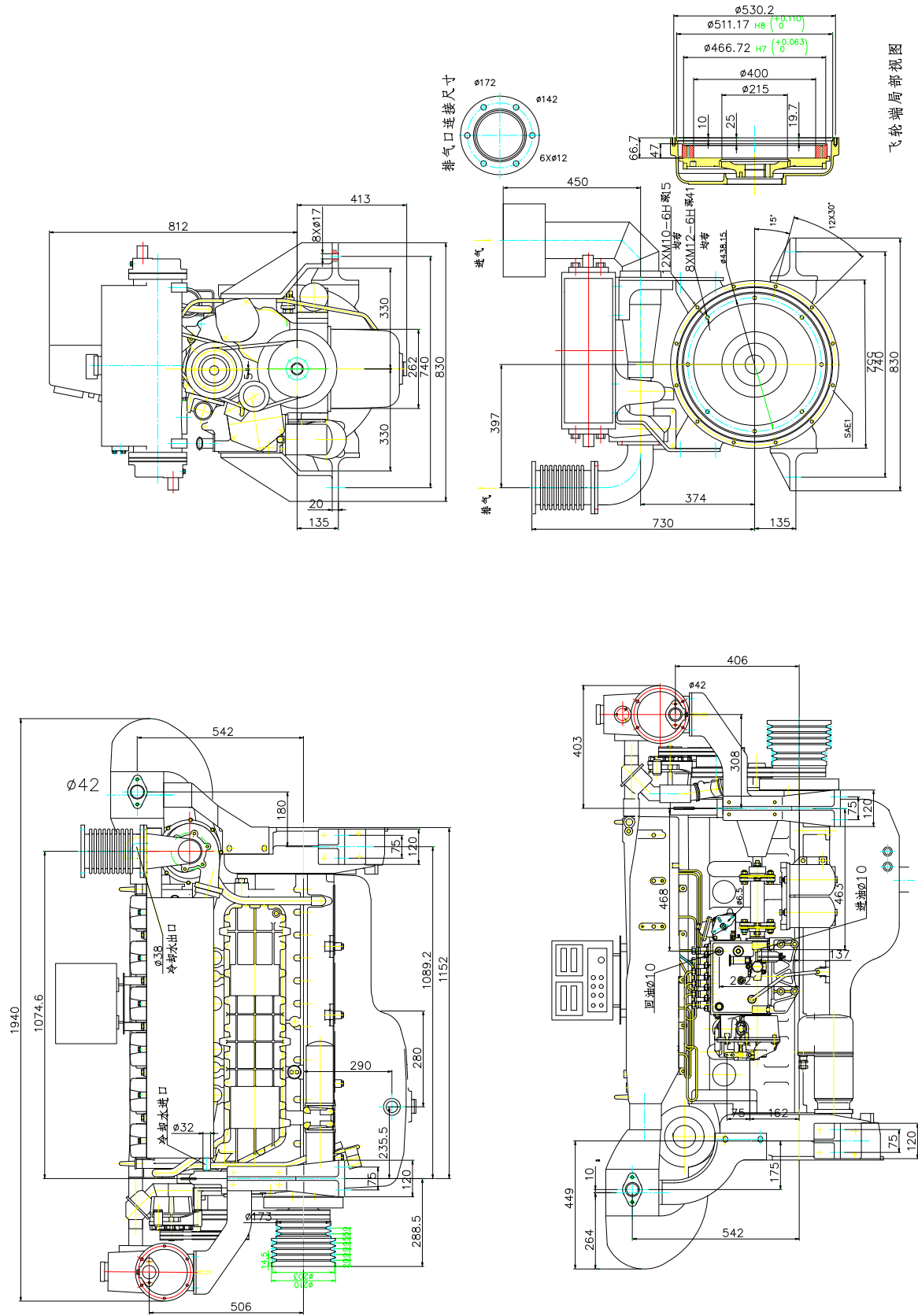
Installation drawing of WD615.61C/61DC/64C/64DC



飞轮端局部视图

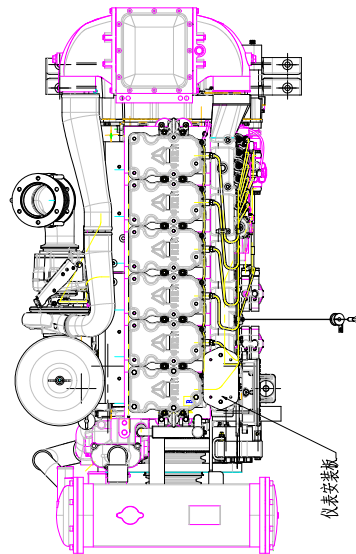
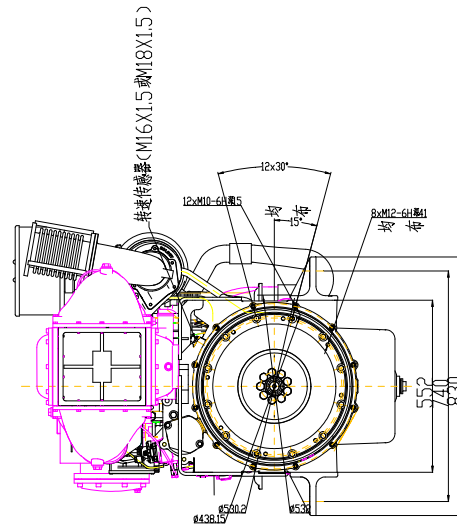
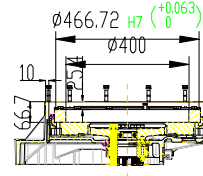
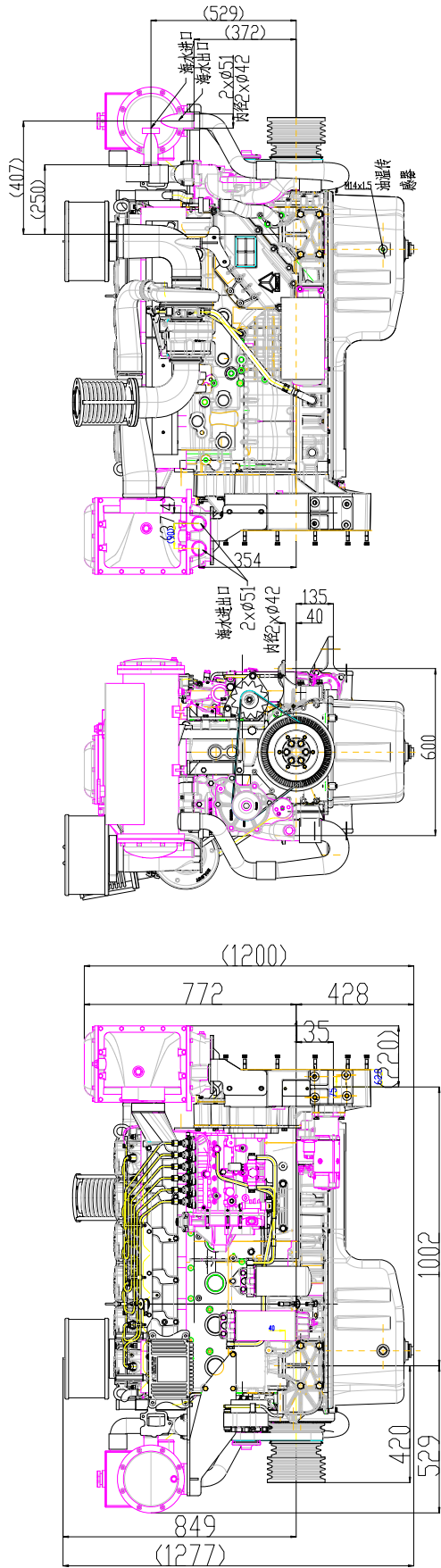


Installation drawing of WD615.67C/68C/68DC



飞轮端局部视图

Installation drawing of WD615.46C/46DC



Installation drawing of D12.42C/42DC

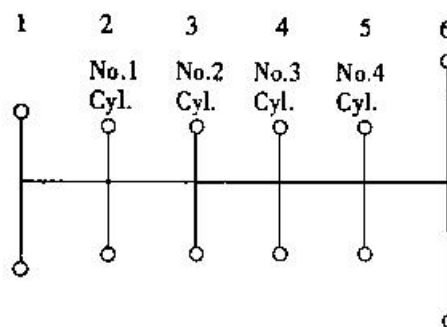
3 Shafting torsional parameters of marine diesel engine

3.1 Shafting torsional parameters of WD415 marine diesel engine

3.1.1 Basic parameters

Content		WD415.16C
Model		WD415.24C
Bore size	mm	126
Stroke	mm	130
Number of cylinders		4
Weight of reciprocating parts	kg	4.83
Length of connecting rod	mm	219
Crank radius	mm	65
Firing order		1-3-4-2
Crankshaft material		42CrMo(A)
Mechanical efficiency %		84

3.1.2 Equivalent calculate diagram of Shafting torsional vibration



3.1.3 Calculate data table of Shafting torsional vibration

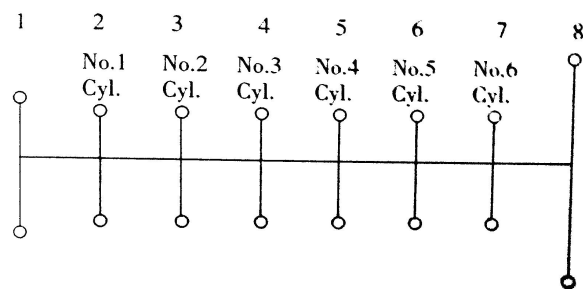
Sequence number	Name	Moment of inertia (kgm ²)	Rigidity (kNm/rad)	Diameter (mm)
1	Belt pulley+shock absorber	0.2487	2717.37	—
2	No.1 Cyl	0.081	2492	82/0
3	No.2 Cyl	0.081	2492	82/0
4	No.3 Cyl	0.081	2492	82/0
5	No.4 Cyl	0.081	2703	82/0
6	Flywheel+flange	1.8122	—	—

3.2 Shafting torsional parameters of WD615 marine diesel engine

3.2.1 Basic parameters

Content Model	WD615.61C WD615.64C WD615.67C		WD615.46C WD615.68C	
	Bore size	mm	126	
Stroke	mm	130		
Number of cylinders		6		
Weight of reciprocating parts	kg	4.83		
Length of connecting rod	mm	219		
Crank radius	mm	65		
Firing order		1-5-3-6-2-4		
Crankshaft material		45-GB699		42CrMo(A)
Mechanical efficiency %		84		

3.2.2 Equivalent calculate diagram of Shafting torsional vibration



3.2.3 Calculate data table of Shafting torsional vibration

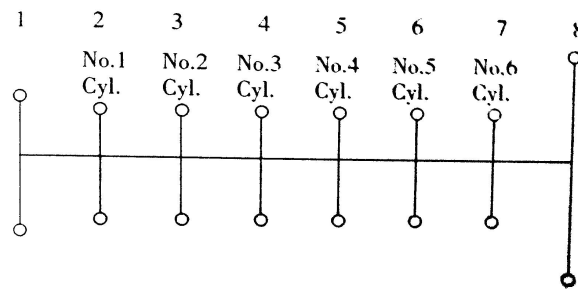
Sequence number	Name	Moment of inertia (kgm ²)	Rigidity (kNm/rad)	Diameter (mm)
1	Belt pulley+shock absorber	0.2382	2717.37	—
2	No.1 Cyl	0.0766	2413.26	82/0
3	No.2 Cyl	0.0766	2413.26	82/0
4	No.3 Cyl	0.0766	2413.26	82/0
5	No.4 Cyl	0.0766	2413.26	82/0
6	No.5 Cyl	0.0766	2413.26	82/0
7	No.6 Cyl	0.0766	3511.98	82/0
8	Flywheel+flange	1.8122	—	—

3.3 Shafting torsional parameters of WD615.57 marine diesel engine

3.3.1 Basic parameters

Model	Content	WD615.57C
Bore size	mm	126
Stroke	mm	130
Number of cylinders		6
Weight of reciprocating parts	kg	4.83
Length of connecting rod	mm	219
Crank radius	mm	65
Firing order		1-5-3-6-2-4
Crankshaft material		42CrMo(A)
Mechanical efficiency %		84

3.3.2 Equivalent calculate diagram of Shafting torsional vibration



3.3.3 Calculate data table of Shafting torsional vibration

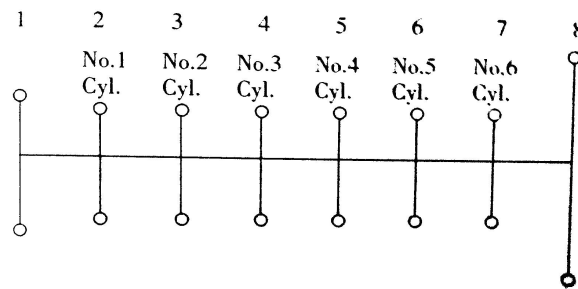
Sequence number	Name	Moment of inertia (kgm ²)	Rigidity (kNm/rad)	Diameter (mm)
1	Belt pulley+shock absorber	0.2487	2717.37	—
2	No.1 Cyl	0.081	2492	82/0
3	No.2 Cyl	0.081	2492	82/0
4	No.3 Cyl	0.081	2492	82/0
5	No.4 Cyl	0.081	2492	82/0
6	No.5 Cyl	0.081	2492	82/0
7	No.6 Cyl	0.081	2492	82/0
8	Flywheel+flange	1.8122	—	—

3.4 Shafting torsional parameters of D12 marine diesel engine

3.4.1 Basic parameters

Content Model		D12.42C	D12.42DC
Bore size	mm	126	
Stroke	mm	155	
Number of cylinders		6	
Weight of reciprocating parts	kg	5.05	
Length of connecting rod	mm	253	
Crank radius	mm	77.5	
Firing order		1-5-3-6-2-4	
Crankshaft material		42CrMo(A)	
Mechanical efficiency %		88	

3.4.2 Equivalent calculate diagram of Shafting torsional vibration



3.4.3 Calculate data table of Shafting torsional vibration

Sequence number	Name	Moment of inertia (kgm ²)	Rigidity (kNm/rad)	Diameter (mm)
1	Belt pulley+shock absorber	0.257	3103	—
2	No.1 Cyl	0.10807	2552	82/0
3	No.2 Cyl	0.10807	2552	82/0
4	No.3 Cyl	0.10807	2552	82/0
5	No.4 Cyl	0.10807	2552	82/0
6	No.5 Cyl	0.10807	2552	82/0
7	No.6 Cyl	0.10807	2552	82/0
8	Flywheel+flange	2.07	—	—

4. Assembly and Operation Requirements

4.1 Points for attention in installing the marine diesel engine

4.1.1 Before you install the engine, you must read the concerned documents and information carefully to learn about the construction and installation requirements of the engine;

4.1.2 The installation personnel must be experienced mechanics and electricians;

4.1.3 If the actual installation is different greatly with the information provided by the manufacturing plant, the installation should be done under the instruction of the concerned personnel of the manufacturing plant;

4.1.4 In order to ensure the engine's normal operation, there should be ventilation equipment in the engine cabin.

It is the most effective measure for air exchange to fit air suction fan and air exhaust fan. When you fit the air suction fan and the air exhaust fan, you should do your best to avoid the air convection between the outlet of the air suction fan and the inlet of the air exhaust fan, so there should be a distance between them.

4.1.5 Under the standard state, the air flow amount can be calculated according to the formula below:

$$C = 4.79 \frac{Q}{\Delta T} \times 10^{-7} m^3 / \text{min}$$

C—— Air flow amount m^3/min

Q——Quantity of heat amount J/min

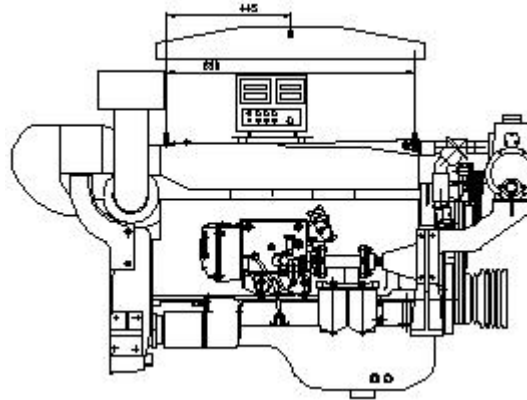
$$Q=600,000 \text{ J}/\text{min}$$

ΔT —— allowed temperature-increasing $^{\circ}\text{C}$

As for the general installation, the air flow amount should be bigger than the estimated value. If it is possible, the ventilation system should be designed to be an adjustable system for the air volume.

4.1.6 When you install the engine, there should be enough room above the engine cabin and before and after the engine to facilitate the operation and maintenance of the engine.

4.1.7 When lifting the engine, you can use an engine lifting ring screw to lift it. Meanwhile keep the engine shaft horizontal and use the structural lifting tool as shown in the figure below. The angle between two steel wire ropes should less than 40° if you use them to lift the engine. The lift hook and the steel wire ropes should be strong enough to bear the engine.



Structural lifting tool of the engine

4.1.8 The Steyr series marine diesel engine can be integrated with 120C, 135, MB270, MB242 (D12 with MB270A, 300, D300A, HC200) etc. marine gear case and then be mounted on the same common base. The articulated locating bolts are used at the support location for fastening. If the housing is not positioned by the means of a spigot, you should correct its axial line's axiality to ensure that the axiality error between the input coupler of the gear case and engine flywheel is not more than $\Phi 0.2\text{mm}$, and the user should measure and correct the axiality routinely. The axiality error between the push coupler and the output coupler of the gear case should be not more than $\Phi 0.1\text{mm}$, otherwise the set will vibrate excessively, causing abnormal wear and tear on the bearing and the elastic straight pin, even loosening the fixed part and damaging the marine body or engine etc..

4.1.9 The engine is allowed to be installed by a pitch angle, but the pitch angle shall not be more than 10° ; when you operate the engine from a distance, you can drive the reversing handle on the gear case by using the steel wire rope. When adjusting it, you must ensure the reversing valve a correct and reliable working position for its rotation; when you refit it with the handle taken down, the reversing valve shaft cannot be shifted to other position along the shaft.

4.1.10 The output pulley on the front end of the engine can drive miniature machines such as water pump, steering machine hydraulic pump and generator and so on, and the pulleys must be laid on the two sides of the engine symmetrically to avoid the possibility that the engine crankshaft bears the one-way tensile force. If it is necessary to drive a big machine like net hauler etc., they must be connected by using an elastic coupling, and be mounted according to the different alignment precision requirements of the different couplers; you must check the coaxial precision routinely since you begin to use the coupler, and ensure that the coupler's axiality is correct; its axiality and end run out must be less than 0.2mm , otherwise the engine parts will be damaged.

4.1.11 The base on which the engine is mounted must possess enough rigidity and good planeness (the planeness $\leq 0.25\text{mm}$).

4.1.12 When you mount the engine, it is strictly forbidden to let the dust, scrap iron and welding slag etc. enter into the air intake and exhaust pipes of the engine.

4.1.13 Air intake system and ventilation of the engine cabin

The function of the air intake system is to provide the engine with sufficiently clean and dry and fresh air within a proper temperature range. If the intake air cannot reach the requirement, it will be difficult to run the engine and the maintenance costs will be increased.

4.1.13.1 The air inlet of the engine should be laid outside the engine cabin or the air inlet of the engine cabin. When you fit the air filter and the whole air intake pipeline, don't use elbow pipe as far as possible and adopt big rounded corner at the pipe turning position, and the effective pipe diameter of the air intake pipeline should not be less than $\Phi 110\text{mm}$.

4.1.13.2 In the design for laying the air inlet of the air filter, and for the air intake pipeline and for the engine cabin ventilation, you should ensure that the temperature at the air inlet of the engine (measured at the connector between the air intake pipe and the turbocharger) is not above the ambient temperature out of the engine cabin by 17°C .

4.1.13.3 You must keep the whole air intake pipeline system in a good leak proof state without any possible crack or any leak. Adopting the smooth welded steel pipe and rubber connector is recommended to ensure that it is fixed unflinchingly.

Because the temperature and the moisture of the air that enters the engine have great effect on the performance and service life of the engine, and in order to ensure that the intake air meets the requirement for the engine, you can adopt engine cabin natural ventilation or engine cabin force ventilation, or inhale the fresh air through pipe from outside the engine cabin accordingly.

There must be an opening that is big enough on the cabin, which adopts natural ventilation, and the opening must be located at the position, which ensures that enough air can be supplied to the engine, and the heat emitted by the machine in the cabin can be rejected within a certain temperature range.

The air inlet of the cabin should be kept away from various heat sources like air exhaust pipe, silencer, and heat exchanger etc.. As for a low-speed marine engine, in order to keep a proper temperature in the cabin, an exhaust fan should be fitted on the upper part of the engine to reject the heat air in the cabin.

If the engine that adopts natural ventilation cannot meet the ambient requirement of the engine, it should adopt force ventilation in the cabin, inhaling the air from outside the cabin by the fan. You should choose the positions for the fans, the air inlet and outlet of the cabin so that the engine can be supplied with enough fresh air and the heat air in the cabin can be rejected.

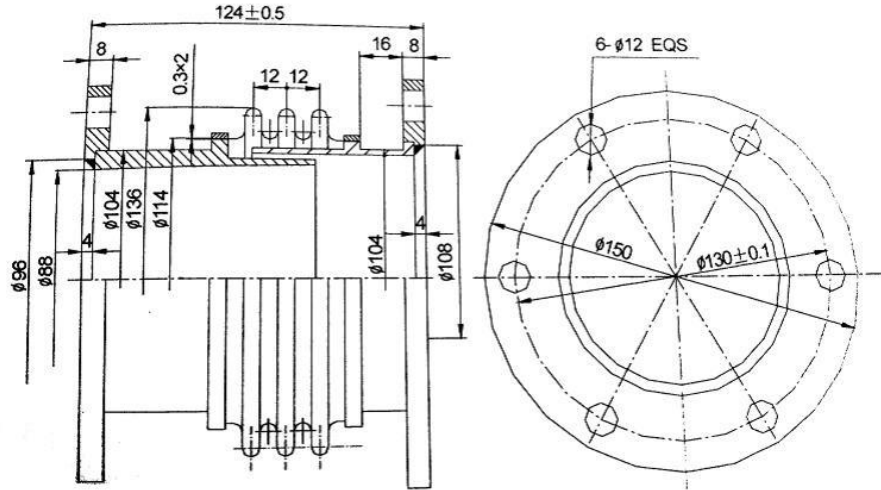
Moreover, you can extend the air intake pipe out of the cabin to inhale the fresh air and send it into the inlet of the air filter. The inlet of the air intake pipe should be kept far away from various heat

sources, at the same time, you should prevent the exhaust gas emitted by the air exhaust pipe from returning to the air intake pipe, and a cap and a dust cover should be fitted over the air inlet to prevent the rain and the dirty matter from entering into the pipe.

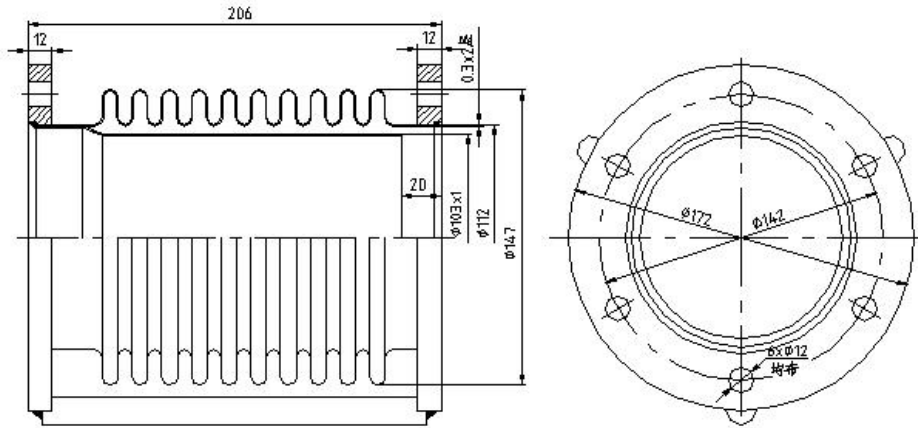
4.1.14 Air exhaust system and safety protection

The air exhaust system rejects the exhaust gas produced by engine out of the cabin through the air exhaust pipe, and has the functions of decreasing the noise, controlling emission and removing heat.

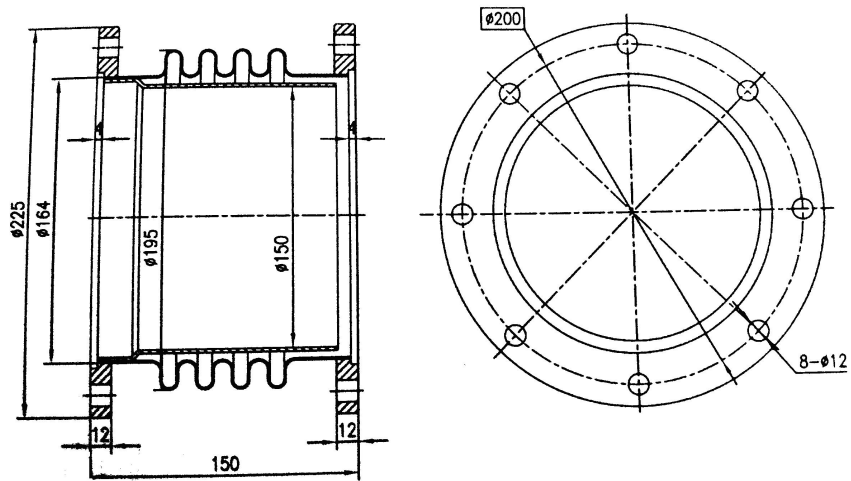
- a) After the air exhaust pipe is fitted, to be not more than 10kPa is required of the back pressure of the air exhaust, otherwise, the engine power and the fuel economy will be reduced, and the exhaust air will overheat, therefore it is better for the air exhaust pipe extended to outside to be as short as possible and the use of elbow joint should not be reduced as far as possible. The use of a sharp elbow joint should be avoided, and the inner diameter of the air exhaust pipe connected to outside should not be more than $\Phi 110\text{mm}$ (D12 $\Phi 150\text{mm}$).
- b) An elastic bellows should be fitted between the external air exhaust pipe and the turbocharger to eliminate the distortion as a result of the heat expansion of the air exhaust pipe. When you fit the bellows, you should keep the bellows at a free state, and make it possess certain flexibility. If you fit the bellows inappropriately, it will be damaged easily.
- c) The material of the external air exhaust pipe should be the same as that of the air intake pipe, like welded seam steel tube or seamless steel tube; the external air exhaust pipe and the silencer should be supported fixedly to avoid adding excessive load on the turbocharger connecting flange, otherwise the turbocharger flange will produce the bending moment that will affect the normal function of the turbocharger.
- d) There should not be any combustibles around the air exhaust pipe. In order to reduce the temperature in the cabin, a heat-shielding device or a water-cooling device should be fitted out of the air exhaust pipe.
- e) If more than two engines are fitted together, and only one external air exhaust pipe is used, some troubles will appear. Under these circumstances, if these engines don't work at the same time, the exhaust gas will be condensed into water and then enter the engine which doesn't work. Therefore, every engine should be equipped with the air exhaust pipe extended to outside separately.
- f) As for the profile and the structure of the bellows of the Steyr series engine, see the figure below.



Profile drawing of WD 415 marine engine bellows



Profile drawing of WD 615 marine engine bellows



Profile drawing of D12 marine engine bellows

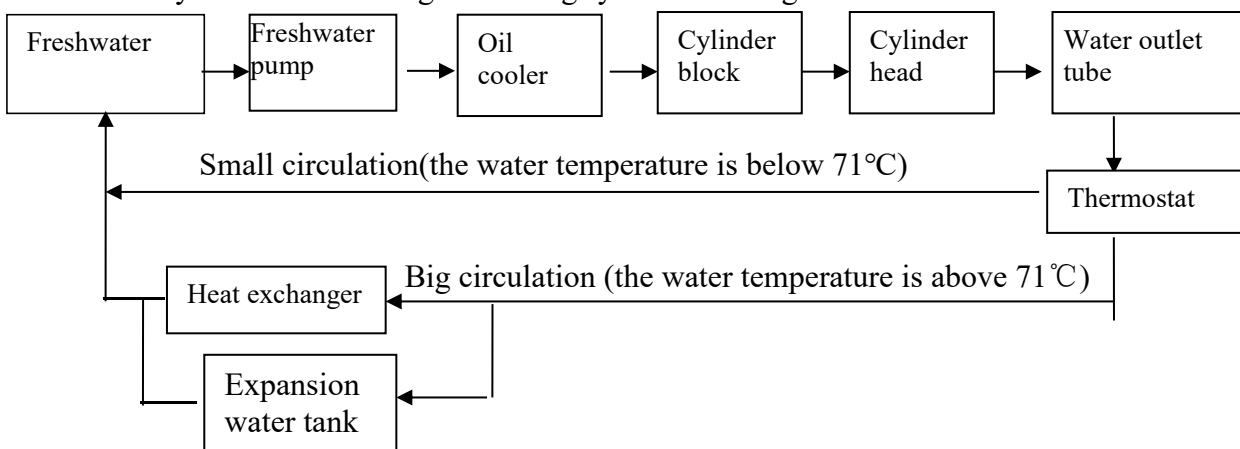
4.1.15 Cooling system

Whether the cooling system is fitted correctly or not has direct effect on the engine performance and service life; the marine engine adopts freshwater and seawater double-cycled cooling system, among the cycles the freshwater one is of closed-cycle and the seawater one is of open cycle, and the system is composed of freshwater pump, seawater pump, and heat-exchanger etc..

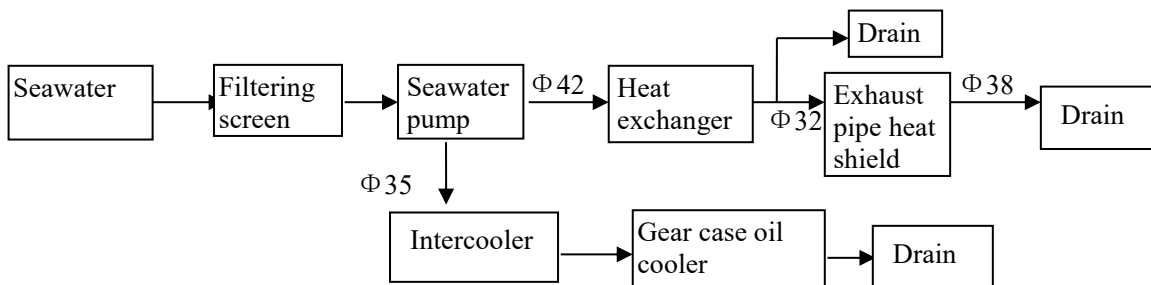
Note: In the closed-cycle it is forbidden to use seawater, because that will make the cylinder block and cylinder head etc. rust early and become rejects with the result that they can't be overhauled.

Adopting a special and long-effective anti-freeze fluid in the closed-cycle is recommended.

See the Steyr series marine engine cooling system in the figure below:



Freshwater closed-cycle figure



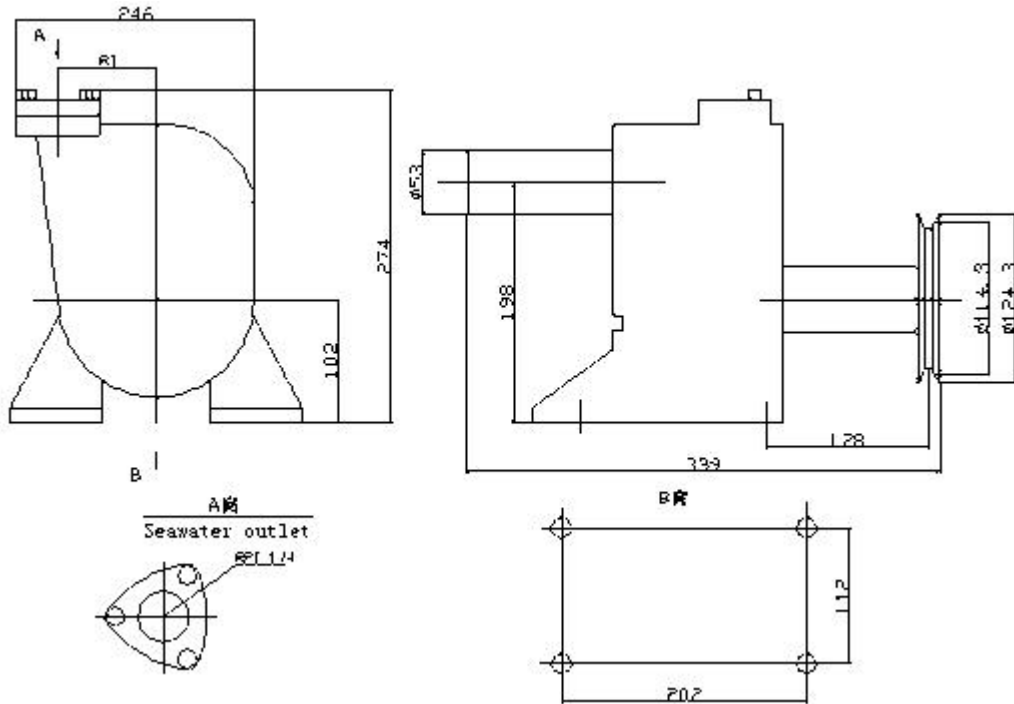
Seawater open cycle figure

The seawater inlet should be positioned at the lowest part of the ship body, and it should be shielded by coarse screen to prevent sundries from entering it. There should be a check valve fitted in the water inlet tube to prevent seawater from pouring in backwards. The seawater tube line should adopt as few the elbows as possible, and the inner diameters of the tubes should not be less than those of the connectors of relevant parts, otherwise the resistance will be increased in the tube line, and the flow quantity will be reduced in the water pump, resulting in the increase of the water and oil temperature. All the seawater tube lines should adopt copper tube or zinc-coated iron tube to prevent themselves from being rusted by seawater.

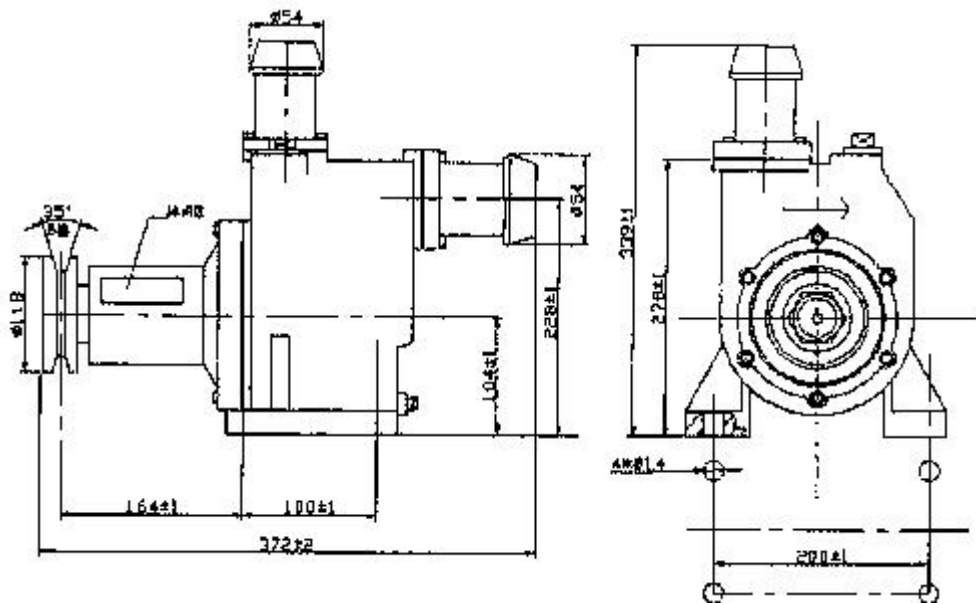
a) Seawater pump

The WD615C series marine engine adopts the ZL135 self-priming seawater pump or the centrifugal self-priming seawater pump. The seawater pump is driven directly through “B” type V-belt by engine crankshaft belt pulley, and the centrifugal water pump is fixed on the timing gear case before the cylinder block front end. The water pump scroll case and the water outlet are cast integrated with the timing gear case. See the shape figure below for assembling seawater pump.

When $n=2800r/min$, then flow quantity $Q=15m^3/h$ and delivery lift $H \geq 15m$ (D12 $H \geq 20$).



Installment drawing of seawater pump



Installment drawing of D12 series seawater pump

Before the seawater pump is used, its chamber should be filled with water fully, and use the pump to turn the belt pulley several turns to make the seal faces matched together normally. If the seizing between the parts appears, you should dismantle and check the pump, after the trouble is removed, use it again. When the pump is running, the water cut-off interval should not exceed 2 minutes lest the water seal ring should be damaged. In the seawater pump lubricating grease should be injected once a month after it is used to ensure that the gears will be lubricated.

b) Heat exchanger

The Steyr series marine engine adopts the model LQ1.8, LQ1.8, LQ2.2 heat exchanger (LQ3 for D12) separately, and these exchangers mainly consists of the fresh water cooler, expansion water tank and lower water cistern etc. as a whole component. Fitted near the front end of the engine, the position in which the heat exchanger is fitted should be higher slightly than that where the fresh water outlet is. The heat radiant core of the fresh water cooler is fin-and-tube type. The seawater is flowing in the tube while the fresh water flows outside the tube round about. There is zinc bar fitted on the cover of the heat radiant core end to weaken the corrosion of the exchanger caused by seawater. After a period of usage, the zinc bar will produce a layer of deposit, so it should be cleaned often, otherwise, its anti-corrosion function will fail. If the zinc bar itself is corroded, replace it. There are water filling inlet and cover of the breath valve, and water overflow pipe above the expansion water tank.

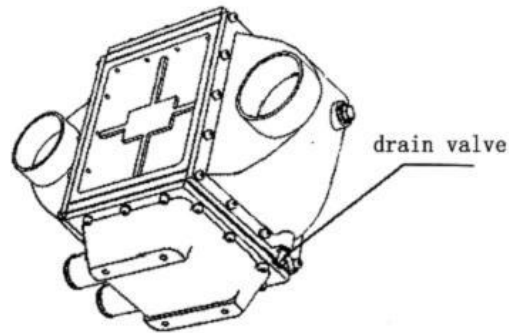
c) Intercooler

The air-cooling device (the intercooler) has the function to reduce the air temperature compressed by the turbocharger, increasing the air intake density of the engine, as a result the output power will be heightened further, but the air exhaust temperature will not be too high. When it is running, the seawater flows in the tube of the intercooler, and the air is cooled out of the tube by the seawater through the radiating fin. After long time running, it is easy to have dust deposit or be contaminated by dust; therefore, it should be cleaned and be blown dry regularly. Otherwise, the engine's performance will be affected, and the power will be reduced and the air exhaust temperature will be heightened. The intercooler adopted by the Steyr series marine engine is the rectangle fin-and-tube air cooler mounted above the flywheel housing.

The air will produce very high quantity of heat after high compression ratio press when passes through the turbocharger, result in the air expansion, density decreased, therefore the air must cooling before the hot air get into the cylinder .If the air humidity and water vapor content is higher, the water in the air will be dew because the temperature is reduced, and then form liquid attached to the radiating fin, especially in wet weather, when the exhaust temperature is lower than the air dew point or shutdown cooling, there will be more water condensed. If it contains too much water in the

oil, will cause the lubricating oil emulsification, and then affects the safe operation of the machine, so it must be timely drain condensated water.

When drain condensated water, the engine should be stopped, fully cooled, and condensed water is fully precipitation, such as before starting in morning. Slowly open the drain water switch, until no water flows, close the switch.



Drain valve position

d)daily maintenance of heat exchanger and intercooler

Because the marine diesel engine always used in harsh environment, it should open the cover, cleaning the cooling pipe and replace the zinc block each quarter among intercooler and sea water heat exchanger. If the intercooler and heat exchanger are not maintain for a long term , will result the block zinc corrosion, the cooling pipe damage, and then cooling effect is reduced, also reduce the use effect of diesel engine.

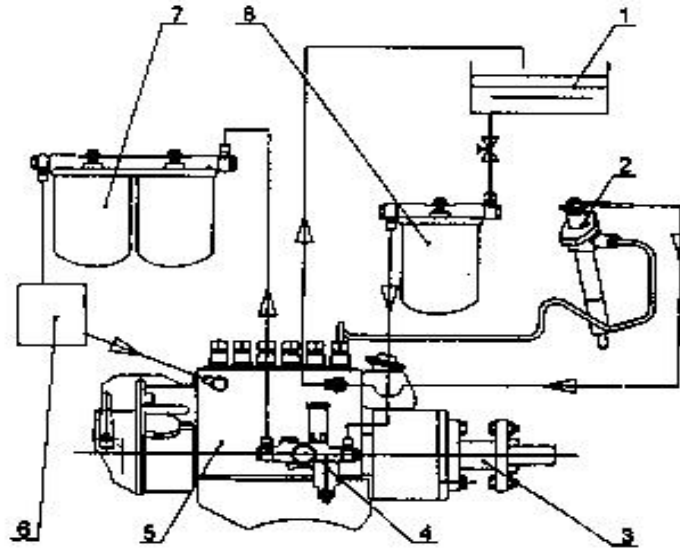
4.1.16 Fuel supply system

The function of the fuel supply system is to provide engine with clean fuel without water and air.

Where the main fuel tank is positioned is very important, and the simplest method is to position the tank near the engine, and make the top of the tank level with the inlet of the fuel pump.

If the main fuel tank is positioned inevitably lower than the horizontal centerline of the fuel pump inlet, in order to keep full fuel in the suction pip line all the time and to reduce the time needed for restart, we recommend that a non-return valve should be fitted in the inline to avoid the fuel returning to the fuel tank because of its own weight.

If the main fuel tank bottom is below the fuel pump inlet centerline by 1m or more, a supplementary fuel tank should be fitted, and a transfer pump is needed to transfer the fuel into the supplementary tank, which is positioned just lower than the inlet centerline of the fuel pump. All the supplementary tanks must have air port and overflow pipe.



Fuel supply system

1. Fuel tank 2. Fuel injector assembly 3. Coupling assembly
 4. Fuel supply pump 5. Injection pump
 6. Electromagnetic valve 7. Fuel filter 8. Coarse fuel filter

If the main fuel tank is positioned above the fuel pump inlet, a cut-off valve should be fitted in the inline to make it convenient for cutting off the fuel when replacing the fuel filter. At the same time, that the fuel returning resistance is not too big must be taken into account, otherwise, it will be difficult for the engine to return the fuel and the normal work of the engine will be affected.

The fuel tube often adopts a kind of braided rubber tube of good quality. When steel pipe is adopted for the fuel tube, there should be a length of rubber tube to joint the engine and the pipe, thus some relative movement between the pipe line and the engine is allowed. The material of the pipe should adopt black iron pipe and neither copper nor zinc-plated pipe is acceptable, for the diesel oil will dissolve the copper and zinc. The resistance of the fuel inlet and return of the fuel tube should not be more than 13.6kPa, so the inner diameter, length, bending of the tube and the connector for it should be taken into account when you fit the pipe. At the time, the maintenance of each fuel filter should be done regularly.

4.1.17 Electric system

4.1.17.1 Buildup of meter, monitoring and protective system

The WD615 series marine engine adopts a fully automatic engine electric monitoring system controlled by advanced microcomputer, which can monitor accurately the engine and display the rotating speed, fuel pressure, fuel temperature and water temperature with digit; when the engine's parameters exceed the limit, the system will send out the sound-optical warning signal and stop signal with the function of starting and stopping the engine.

The meters of the marine engine is divided into two parts, the first is the main instrument fitted on the engine, and the second is the long distance transfer instrument connected to the cab through the long distance transfer cable. The long distance transfer instrument can control the engine's starting and stopping from a distance, and display each parameter of the engine simultaneously, furthermore, when the engine's parameters exceed the limit, it will send out the sound-optical warning signal and engine stop signal.

a The meter's parameter of the engine

Sequence number	Parameter displayed	Value for warning	Value for stopping (connected to the fuel cutoff electromagnet)
1	Rotating speed	110% of the rated rotating speed	115% of the rated rotating speed
2	Oil pressure	$\leq 0.06\text{Mpa}$	$\leq 0.045\text{Mpa}$
3	Oil temperature	115°	118°
4	Water temperature	97°	99°
5	Fuel leak	Leaking	—

b The installation hole dimension for the long distance transfer displayer (see the *Instrument instruction* attached to the instrument)

c The installation dimensional drawing for the long distance transfer instrument (see the *Instrument instruction* attached to the instrument)

4.1.17.2 Technical requirements

The meter should be supplied with power by storage battery, and the voltage of battery is DC24V.

4.2 Usage of the marine engine

Before the engine is used, the operator should read carefully the concerned information like the usage and maintaining instruction etc.. Be conscientious to do every piece of work well, especially engine's regular maintenance.

4.2.1 Before the engine is started, check the levels of the coolant, oil and fuel to see if they meet the requirements; check and see if the mechanical connection points is firm, and if the fuel supply system, lubricating system, and cooling system of the engine and each pipe connector leak air, water or oil; and wipe every part of the engine to clean out part of dust and dirt. After confirming that they are firm, put the operating handle on the "Stop" position to start the main engine, at first, the main engine should be run-in at the lowest steady rotating speed (600r/min). If there is no reading on the oil pressure indicator after the engine is started, stop the engine and check it to find out the cause and remove the failure and it is forbidden to run the engine under the condition of lacking of oil. When the oil pressure is established, raise the main engine speed to the rated rotating

speed, and check the oil pressure to see if it is within the stipulated range, if the oil pressure is normal or it has been adjusted to the normal range, run the engine 5~10min unceasingly.

Reversing 2~3 times at 50% rated rotating speed, and the oil pressure ascending time when you check reversing should be 2~3S, after reversing, the oil pressure should reach stipulated value.

Check and see if there is abnormal noise or an oil and water leak.

When you want to reverse the main engine normally, its speed should be reduced to 50% rated rotating speed or so, and the forward rotation should go on at “stop” position for 2~3S, then you can reverse it.

4.2.2 The duration of the engine’s idle running should not be less than 5 min before the engine stops.

Let the lubricating oil and cooling water take away the heat of the combustion chamber and shaft etc.. It makes more sense for the turbocharged engine to do so. Because the bearing and the oil seal are affected by high-temperature exhaust air; when the engine is running, the heat is taken away by the circulating oil, but if the engine stops abruptly, the turbocharger temperature will be raised to too high, as a result, the bearing will stick or the oil seal will fail.

But the engine’s long-time idle running is not allowed, for it is disadvantageous for the engine; if the combustion chamber temperature is too low, and the fuel cannot be burned completely, there will be deposits in the oil injection nozzle orifice or on the piston ring. When the engine is running at idle speed, the pressure in the air compressor outlet and the turbo inlet is very small, and the oil is easy to leak from the seal ring at both ends. Therefore, you should avoid running engine for a long time at the idle speed.

4.2.3 The engine can steadily run for a long time within the continuous power (rotating speed is continuous speed) and the lowest steady power range. The accumulated running time of the engine under overload working condition cannot exceed 10% of the all running time. The engine’s long-time running under overload working condition is not allowed.

4.2.4 The running-in of the new engine and the overhauled engine

How to use the new engine within initial 100h working time is very critical, for it has direct effect on the service life of the engine and of its parts; although the engine had run for several hours on the test bed for dynamometry before it left the factory, it is absolutely necessary for the operator to run the engine according to the requirements below within the initial 100h running-in period.

4.2.4.1 The engine’s long-time idle running should be avoided, and the duration of the engine’s running under overload working condition cannot exceed 5min.

4.2.4.2 Form the habit to pay close attention to the fuel and meters when you operate the engine, if the oil temperature reaches 120° or the coolant temperature 92° , throttle down.

4.2.4.3 During the running-in period, check the oil level once every 10h.

4.2.5 Protective measures in cold weather

1) As to the engine working in cold weather, we recommend using the long-effective anti-freezing solution to prevent the engine from being damaged out of frost and to facilitate starting.

2) When the engine stops, drain the water from the engine and its accessories thoroughly, otherwise there will be serious damage such as breakage of cylinder head and cylinder block out of frost, etc. In order to drain the water out of the cylinder block and cylinder head completely, turn on the water proof switch or water drain screw plug in the cylinder block, thermostat, water pump water inlet connector, sea water pump, water heat insulating cover, oil cooler of the marine gearbox.

3) Logbook and report

If the marine diesel engine operator wants to obtain the most satisfactory use effect, he must keep the engine in the perfect mechanical state. Daily logbook and report favour trouble removal and maintenance.

The following items should be recorded in the report:

- | | |
|--|--|
| a) The pressure of the lubricating oil is insufficient | b) Water temperature is abnormal. |
| c) The noise of diesel engine is abnormal. | d) Smoke is too heavy. |
| e) There is difficulty in starting the engine. | f) The diesel fuel supply is insufficient. |
| g) Too much fuel is consumed. | h) Too much lubricating oil is consumed. |
| i) The marine gearbox is too hot. | j) Vibration is abnormal. |
| k) The idle speed is unstable. | |

4.3 Maintenance of marine diesel engine

The maintenance is the key to reducing the cost of the marine engine usage. The engine needs maintenance according to stipulations to keep it in a good state. The protective maintenance is the simplest and the most economical one, therefore it is necessary to carry out this work in time.

4.3.1 The main work that must be done during the engine checkup and maintenance is shown in table 3.

Table 4-1 Maintenance period of diesel engine

Item	Maintenance period
First check	After 30~50 hours
Routine check (P)	Every 150 hours
First level maintenance (WD1)	Every 300 hours
Second level maintenance (WD2)	Every 600 hours
Third level maintenance (WD3)	Every 1,200 hours
Forth level maintenance (WD4)	Every 2,400 hours

Table 4-2 Maintenance procedures of diesel engine

Item	First check	P	WD1	WD2	WD3	WD4
Change oil (Once per year at least)	●	●	●	●	●	●
Change oil filter or filter cartridge	●	Every time changing oil				
Check and adjust valve clearances	●		●	●	●	●
Check and adjust opening pressure of injectors					●	●
Check fuel filter cartridge			●	●	●	●
Clean coarse fuel filter or change cartridge			●	●	●	●
Check coolant level and fill it up	●	●	●	●	●	●
Change coolant	Every 24 months					
Tighten water pipe clamps	●					
Tighten intake pipe and hose connections and flanges	●		●	●	●	●
Check the maintenance warning indicator of air filter			●	●	●	●
Clean the dust cup of air filter. (excluding the self-scavenging type)		●	●	●	●	●
Clean air filter	Every 250 hours					
Check and tighten V-belts	●	●	●	●	●	●
Check clearances of turbocharger bearing						●
Check and calibrate injection pump on test bench					●	●
Check and adjust clutch play and steel cable	●	●	●	●	●	●
Reset idle speed	●					
Note: The sign ● indicates that maintenance is needed						

4.3.2 Items of monthly checkup

After stopping engine, check the remaining amount of various kinds of oil and fluids (including lubricating oil, coolant, fuel). Check and clean the air filters often and drain the water out of the fuel filters. After every 200 hours' running check on the status of lubrication of the sea water pump and the fresh water pump. Add calcium base grease through bearing body to the pumps. After rotating

for one hour or more than one hour all the new belts will become loose, therefore readjust them according to the requirements of “belt tensioning grades”. Check and see if there is a leak or damage in the air intake and exhaust system, if yes, remove the troubles in time.

4.3.3 Maintenance of intercooler

Because the cooling function of the intercooler can exert a direct influence on the performance and service life of the engine. The inner core of the intercooler must be cleaned regularly. In assembling and dismantling the intercooler the following points must be taken into account:

- a) Prevent the intercooler from falling to ground and striking against it, so that the inner core will not be damaged and the plane of the air outlet will not be scratched.
- b) The connection of engine to the air inlet, air outlet, water inlet and water outlet must be sealed and firm to avoid a water leak and an air leak. Cleaning the sea water pipe line of the intercooler can adopt the method for descaling, namely the method of flushing the intercooler with acid or alkaline fluid.

5 Troubleshooting

Diesel engine troubles may result from various causes, only one of them will cause the engine working abnormally in many different ways, while a trouble may be the result of complicated situations. Different methods, such as watching, listening, feeling and smelling, etc .can usually be used to find out and evaluate the troubles, from shooting simple to complicated troubles, from shooting external to internal troubles .When you are removing the faults, a comprehensive analysis of the abnormal phenomena should be made in compliance with the failure features and failure nature , so that the interrelations can be found out ,and it should be done from analyzing simple to difficult interrelations and by following clues to track down the cause , to find the true causes of trouble ,then to solve the problems according to its categories .If the cause of a trouble cannot be found out in a short time, keep the diesel engine working at low speed and observing it on precondition that no big accident is sure to occur .It is not allowed to dismantle the engine blindly and replace the concerned parts ,otherwise the problem will be complicated . The following are the introductions of the typical troubles, their causes and the ways to remove them.

5.1 Engine fails to start or starts with difficulty

4.1.1 Insufficient battery voltage or the loose connectors will cause the starter to work with difficulty, the diesel engine to work at low speed and not be started .Charge the battery or tighten the connectors.

5.1.2 The starter fails to work.

5.1.3 Because the ambient temperature is too low, the viscosity of the oil is high and the oil is high resistant, the temperature of water and oil diesel fuel is approaching freezing point, the engine can hardly be ignited and started .If so, warm up water and oil to start the engine.

5.1.4 Check and see whether the right diesel fuel has been chosen.

5.1.5 The trouble of fuel system

a) Check and see whether the strainer of the intake filter of the fuel supply pump is blocked up, whether there is dust in the suction valve of the fuel supply pump and whether the valve surface is flat or not, and whether the fuel pipe is blocked up, if so, remove the trouble.

b) Check and see whether there is air in the fuel system .Loose the connector of the injection pump pipe, and pump the hand fuel pump to drain the air in the fuel pipe and pump until no air bubble can be seen in the overflowing diesel . That means that air is exhausted completely. At that time, if you pump the hand fuel pump, you can feel a certain pressure, and then tighten the connector of the fuel return pipe.

c) Check and see whether the pressure of the spill valve of the injection pump is too low. The set value is 1.0-1.2 100kpa .If it is low, the diesel pumped by the fuel supply pump out of the tank

will flow through the spill valve back to the tank, so that the low pressure fuel chamber cannot hold the fuel out of too low pressure .During engine maintenance adjustment can be done or the defect spring can be replaced.

d) Clean or replace the filter cartridge if the diesel filter is blocked up.

e) Check and see if the fuel supply advanced angle is right one, if not ,adjust it .

f) Check the atomizing of the nozzle and see whether there is serious carbon deposit, biting and the pressure is normal.

g) Examine and adjust the fuel pump assembly on a test bench to find out whether the starting fuel amount is too small, the plunger is seriously worn or seized , whether there is a leak in the valve or the spring is broken , etc .

5.1.6 The serious worn-off of liner , piston and piston ring ,too small valve clearance and leak of valve or that the two splits of the upper and lower gas rings face the same direction and are parallel , will lead to the insufficiency of pressure in the cylinder ,which results in the fact that the diesel engine is difficult to start .

5.1.7 The flywheel gear ring is loose or there is a tooth break.

5.1.8 The air filter is blocked up and the intake air volume is insufficient. The air intake and exhaust pipes are blocked up.

5.2 Power insufficiency of the diesel engine

Power insufficiency means that the diesel engine cannot reach the set output power. Apart from the above mentioned troubles in the fuel system, there are some more common causes;

5.2.1 Fuel tap is not opened completely or air hole is blocked up.

5.2.2 Check and see if there is a leak in the fuel pipe, or the fuel is of good quality.

5.2.3 The active speed of the governor is low, put the fuel pump on the test bench to check and adjust the governor.

5.2.4 There is air in the fuel system.

5.2.5 The injection pump injects fuel insufficiently.

5.2.6 The incorrect valve clearance, leak, incorrect valve timing or advance angle of fuel supply can lead to incomplete diesel combustion. If so, make adjustment or perform repair.

5.2.7 Air intake and exhaust system: Check and see whether the air filter or the intake manifold is blocked up, resulting in insufficiency of air. Check and see whether the leak of intake and exhaust manifold decreases the working efficiency of the turbo charger, resulting in insufficiency of air in the cylinder and incomplete diesel combustion.

5.2.8 If the spring seal ring or the floating bearing in the turbocharger is burnt out, there will be a leak in the connecting parts in the spiral casing or block-up of the pipe, making the turbocharger work abnormally with poor intake air. Wash or change the concerned parts.

5.2.9 There is dirt in the intercooler, which affects intake air amount.

5.2.10 The broken piston ring, the worn-out liner or piston, or the scoring will lead to too large piston skirt clearance, insufficient pressure in the cylinder and incomplete combustion. Change the parts and perform repair.

5.3 Engine stops soon after being started

5.3.1 The air goes into the fuel system. Check and repair it.

5.3.2 The diesel fuel filter is blocked up. Clear the internal dirt, wash or change the filter.

5.3.3 Check and see whether the idle speed has been adjusted to too low level.

5.3.4 Wash the strainer, check or change the fuel supply pump if the strainer of the pump's filter bowl is blocked up, or there is a seized piston or a broken spring.

5.3.5 The opening pressure of the spill valve of the injection pump is too low, adjust the valve or change the concerned parts and repair the valve.

5.3.6 The delivery valve is damaged, change the parts and repair the valve.

5.4 Abnormal smoke colour

The smoke is colourless or light, if there is complete diesel combustion; it is dark black, if there is incomplete combustion, white smoke can be seen, if there is too much water or part of gas is exhausted unburnt and the exhaust is blue, if the oil goes up and burns.

5.4.1 Black smoke

Black smoke comes out mainly because of insufficiency of intake air or too much fuel supply.

- 1) The quality of the diesel fuel is poor.
- 2) Check and see whether the air filter is blocked up, the intake air connecting hose is flat through suction and the intake and exhaust pipe is leaky to lower the working efficiency of the turbocharger, resulting in insufficiency of intake air.
- 3) If the spring seal ring or the floating bearing in the turbocharger is broken, there will be leakage at the connecting parts in the spiral casing or blockage of the pipes, making the turbocharger work abnormally with poor intake air.
- 4) The valve clearance is too big, which results in insufficiency of intake air or incomplete air exhausting. Poor sealing of the valve and the valve-seat ring will lead to a leak. Adjust the clearance, repair or replace the valve and valve-seat ring.

- 5) If there is too much carbon deposit on the piston ring, and sealing is poor, or the cylinder liner is seriously worn out and the air blows by downward, resulting in insufficiency of pressure in the cylinder and incomplete combustion. Replace the liner and piston ring.
- 6) The advance angle is small, that means delayed fuel supply, which causes a lag of combustion of part of fuel.
- 7) Adjust the injection pump at the test bench, if the fuel quantity is excessive.
- 8) The injection pressure of the nozzle is low, atomization is poor or the nozzle is sticky or dripping. All these can lead to incomplete combustion. Replace the nozzle and restore the engine to normal conditions.
- 9) The diesel engine runs under overload.
- 10) The cooler is broken or there is an air leak.

5.4.2 White smoke

- 1) The diesel is of poor quality with too much water in it.
- 2) The coupler of nozzle is not sealed well, resulting in fuel dripping, leaking, low injection pressure and poor atomization.
- 3) Check and see if the air or the water temperature is too low.
- 4) The injector copper bushing is not sealed well, resulting in water leaking into the cylinder.
- 5) The clearance between the rocker arm and the valve is too small or there is no clearance between them, and the sealing of the valve is poor.
- 6) Low pressure diesel enters into the cylinder directly due to the faulty electromagnetic valve.

5.4.3 Blue smoke

- 1) Wear-in between the piston rings and the cylinder liner is not ended. Continue to carry it out.
- 2) A too high oil level in the oil sump brings on high pressure in the crankcase and oil going-up. The oil should be filled till the oil level reaches the marked line of the dipstick.
- 3) The piston of the oil gas separator is seized and clogged by dirt, resulting in bring on too high pressure in the compressor to burn oil. Wash, check and repair the faulty parts.
- 4) The engine is made to run at high speed immediately after being started, or it is stopped at high speed, leaving the turbocharger to rotate at 80,000-110,000 rpm to undergo dry friction, which will result in damaging the sealing ring and the floating bearing.
- 5) Replace the cylinder liner when it is seriously worn out or it is too much worn out by the piston.
- 6) The oil seal of the valve is damaged, or the valve and the guide are both worn out badly, resulting in the fact that oil entered into the cylinder.
- 7) Too much negative pressure in the gas compressor causes oil sucked into the cylinder due to clogging of the air filter of the turbocharger.

5.5 Oil consumption is too high

Oil dripping down and oil burnt in the exhaust manifold are the common phenomena expressing high oil consumption. Two other causes are listed below, apart from those mentioned above where there is blue smoke.

5.5.1 Check and see if there is a leak in the sealed places such as the oil pipe connectors, the oil seal in front of and behind the crankshaft, etc.

4.5.2 There is a leak of oil from the exhaust manifold due to worn out piston ring and worn out liner of the air compressor. Replace them and restore the compressor to normal conditions.

5.6 The oil level in the oil sump is raised.

The raising level is generally caused by the entry of diesel into the oil sump. The pressure adjusting spring of the injector is broken and ceases to be in effect, and the nozzle pin is stuck tight in the opened condition. Too low pressure of the nozzle causes poor diesel atomization and diesel dripping. It follows that an excessive amount of non-atomized diesel fuel goes into the cylinder, part of which is not burned out, and then goes along the clearances in the wall and through the piston ring gaps into the oil sump.

There is a leak inside the steering pump and the hydraulic oil goes down into the oil sump. Replace the parts and restore the pump to normal conditions.

The plunger of the injection pump is seriously worn out and the sealing O-ring of the plunger is damaged. When the lever of the fuel supply pump is seriously worn out, the fuel is caused to leak into the under part of pump and to go into the oil sump with oil together.

5.7 The oil pressure is too low.

5.7.1 Check and see if the correct oil is being used.

5.7.2 The oil pressure sensor plug and the pressure meter are damaged.

5.7.3 Check the oil level and refill oil, if there is few left and the oil level is too low.

5.7.4 The oil will go bad and becomes thinner after being used for a long time.

5.7.5 Check and see if there is a leak in the oil pipe, and if there is any damaged gasket for the oil cooler core, pickup screen, etc. , or if the inner and exterior oil pipe are broken. Check and see if the gasket for the oil pump or pickup screen is clogged due to disalignment.

5.7.6 The oil temperature is too high and the viscosity is decreasing.

5.7.7 Too much diesel goes into the oil and the oil is diluted.

5.7.8 There is a leak in the limit valve for the main oil passage or the pressure adjusting spring fails to work, etc..

5.7.9 No oil can be sucked out due to the clogged oil strainer.

5.7.10 No oil can be supplied due to the jammed gears of the oil pump or the sliding of the driving gears.

5.7.11 The seriously worn-out main bearing liner and connecting rod bearing will lead to a too large clearance between the bearings, which, together with the bearing burning due to lack of oil and scoring due to polluted oil, makes it difficult to build up oil membrane and brings on oil leaking and pressure decreasing.

5.8 The mixture of oil and water

The failure of mixture of oil and water can be divided into two kinds:

First, there is water in the oil sump, the causes of which are listed below:

5.8.1 The series diesel engine adopts dry liners; they fit the cylinder bores in a transitional way. If the engine is used incorrectly, there will be cracks on the cylinder liner bore due to big temperature difference of the engine and quick change of temperature and the cooling water will go through the cracks into the oil sump.

5.8.2 The cooling water flows into the oil sump due to a leak in the $\phi 40\text{mm}$ bowl shape core plug in the cylinder block. The check method is : dismantle the cylinder head and look through the valve tappet case and find out where there is rust, there is the ineffective bowl shape core plug. Replace the bowl shape core plug and restore the engine to normal conditions.

5.8.3 There is a flaw or a hole in the cylinder head or there is a leak in the injector copper bushing for cooling. Check or replace the defect part.

5.8.4 The cylinder head gasket is broken or there is a leak in the gasket.

Secondly, there is oil in the water tank. The main causes are: The core of the oil cooler is damaged and its gasket is broken. There are sand holes in the main oil gallery and the oil pressure is higher than the cooling water, which makes the oil flow into the water pipe. Replace the defect part and restore the engine to normal conditions.

5.9 The water temperature is too high

Under the control of a thermostat the water temperature should be generally stable. If the temperature is too high ($>95^{\circ}\text{C}$), the following causes should be taken into account.

5.9.1 Check and see if there is too little cooling water left in the thermostat.

5.9.2 Check the water pump to find out whether the belt is sliding or too loose, or there is a leak in the water seal.

5.9.3 Check and see if there is vapour-lock in the cooling system.

5.9.4 Check and see if the thermostat is ineffective.

5.9.5 If the fuel supply advance angle is small and the fuel supply is delayed, the period of after combustion of engine is extended with more thermal load.

5.9.6 High temperature air goes into the water pipe due to the damaged cylinder gasket.

5.9.7 The engine runs for a long time with overload.

5.9.8 There is too much carbon deposit in the combustion chamber, and the clearance of the air exhaust is clogged up.

5.9.9 The heat-exchanger is clogged up.

5.9.10 The sea water pump works abnormally.

5.9.11 The water inlet of the sea water pump is blocked up.

According to some requirements, the cooling water for diesel engine should be treated to some extent and some antirust additive should be added to. If there appears some water scale after the cooling water has been used for a long time, make use of descaling agent.

Note of quality feedback

In order to analyze product quality and the damage reason, and provide more high-quality products available to users, sincerely welcome users to reflect the problem in the application. The company will give answers to these questions; help repair or compensation. Some items for users reflecting the problems:

- (1) Fill out the feedback form of use of diesel, send the company technical-service department.
- (2) Fault and the appearance should be narrated in detail as far as possible, damaged parts should be kept intact, in order to analyze the reasons.
- (3) If the fault indeed caused by the quality problem of production factory, and should compensate for damaged parts, and the damaged parts should be sent to our company. If you need to invite the company representatives to observe and analyze on-site, you should contact technical-services department of the company or subsidiaries, offices in location within three days.
- (4) If the diesel faults resulted from improper use and the users' improper repair, it should be the user's responsibility, but we can help repair.
- (5) The quality problems of outsourcing parts can also be reflected directly to its manufacturing plant.

The user's information and feedback card

User Name		Tel	
Company Name		Fax	
Detail Address		Post Code	
Vehicle Type Code		Engine Code	
Use Condition	Work kM(h)	Use Circumstance	
Fault Occur Time	Fault Appearance	Fault Reason	Troubleshooting

Comments and Suggestions: