
40MW 重油发电项目 技术方案

40MW HFO Power Plant Project (RMRS)



20230409

1.概述 Overview

1.1 RMRS 建立 40MW 重油电厂,用电需求充足.电厂实施供电供热,充分回收热能,提升经济效益.

Build a 40MW heavy oil power plant in RMRS, with sufficient electricity demand. Power plant to implement power supply heating, fully recover heat energy, improve economic benefits

1.2 根据实际需求:利用原有电厂设施(油库,水池,变电站),增设组合式钢结构厂房,布置 7 台 MAN5.4MW 重油发电机组和一台调峰 3.5MW 重油发电机组,电压 11KV,频率 50Hz.

电站总容量 $7 \text{ 台} \times 5.4\text{MW} + 1 \text{ 台} \times 3.5\text{MW} = 41.3\text{MW}$. 85% 长期经济供电容量 32MW.

考虑到机组轮流保养需要以及维持电站 85% 的运行效率. 7 台 5.4 发电机组长期并机运行,运行功率 $7 \times 5.4 \times 85\% = 32\text{MW}$.

当有一台 5.4MW 机组保养时, 3.5MW 机组短期替补, $6 \times 5.4\text{MW} \times 85\% + 3.5\text{MW} = 31\text{MW}$.

保证电厂长期稳定供电 30--32MW.

8 台套发电机组布置图见附件《发电厂区总体平面布置图》.

燃料为重油和柴油。

配套控制/安全报警系统,润滑油/冷却水/压缩空气/排气系统,高低压电系统等。

According to the actual demand: use the original power plant facilities (oil depot, pool, substation), add modular steel structure workshop, install 7 MAN5.4MW heavy oil generator sets and one set peak-regulating 3.5MW heavy oil generator set, voltage 11KV, frequency 50Hz.

Total power plant capacity: $7 \text{ units} \times 5.4\text{MW} + 1 \text{ units} \times 3.5\text{MW} = 41.3\text{MW}$.

85% long-term economic power supply capacity: 32MW.

Considering the need of unit maintenance in turn and the maintenance of 85% operation efficiency of the power station, 7 sets 5.4mw generator sets run concurrently for a long time, with operation power of $7 \times 5.4 \times 85\% = 32\text{MW}$.

When there is a 5.4MW unit maintenance, 3.5MW unit short-term replacement,

$6 \text{ sets} \times 5.4\text{MW} \times 85\% + 3.5\text{MW} = 31\text{MW}$.

Ensure long-term stable power supply of 30-32MW.

For the layout of the 8 sets of generator sets, see the attached General Layout Of the Power Generation Plant.

Fuel is heavy oil or diesel.

Supporting control/safety alarm system, lubricating oil/cooling water/compressed air/exhaust system, high and low pressure electrical system, etc.

1.3 发电机组项目的主要技术参数如下:

Main technical parameters of generator set are as follows:

◆ 总发电输出功率: 41.3MW 11KV 50Hz

Total output power of generation: 41.3MW 11KV 50H

◆ 发电机组型号: 7 台 MAN10L3244 5.4MW 发电机组, 1 台 BB3345 3.5MW 发电机组

Model of the generator set: 7sets MAN 10L32444 5.4MW generator set, one sets BB3345 3.5MW generator set,

◆ 发电机组数量: 8 套

Number of generator sets: 8sets

◆ 机组输出电压: 11KV

Output voltage of the unit: 11KV

◆ 频率: 50Hz

Frequency: 50Hz

◆ 燃料: 柴油和重油

Fuel: DO /HFO

◆ 冷却方式: 压力水循环水冷形式。

Cooling method: Pressure water circulating water cooling by airing.

2. 技术方案

Technical Proposal

2.1 电站总体布置

General layout of power station

厂区内按功能划分:

主发电厂房(含发电机组, 电气设备, 监控室).

辅助室: 燃油处理/供水房, 辅助变压器区 11/0.4kv.

原留设备: 主变压器区, 油库, 水池, 道路, 绿化带.

The factory is divided according to functions:

Main power plant (including generator set, electrical equipment, monitoring room).

Auxiliary room: fuel oil treatment/water supply room, auxiliary transformer area 11/0.4KV.

Original equipment: main transformer area, oil depot, pool, road, green belt.

辅助变压器布置在厂区端头，为本厂区内的主发电厂房提供动力及照明电力供应。

主机房内,发电机组和辅助系统设备按模块化设计并分区布置，发电机组与辅助系统设备区之间以纵向贯通走道自然分隔，二者之间的连接管路采取空中高架或地沟敷设形式；相邻的两台主机组之间留出足够空间间隔形成横向通道。

纵横交错连通的走道可以使人员和零配件到达厂房内任何位置，为机组及辅助设备的日常巡视、设备检修等工作提供便利。

机房厂房内上方安装 2 台承重 20 吨以上的梁式移动吊钩，用于重量较大零部件的维修吊装。由于机组高度较高，机组两侧及发电机侧架设扶梯平台供工作人员登高操作。

Auxiliary transformers are arranged at the end of the plant to provide power and lighting power supply for the main power plant in the plant area.

In the main machine room, the generator set and auxiliary system equipment are arranged according to the modular design and partition. The natural separation between the generator set and auxiliary system equipment area is through the longitudinal walkway. The connecting pipes between the two are in the form of aerial overhead or trench laying. Leave enough space between two adjacent host groups to form a transverse channel.

The crisscross connected walkway can make personnel and spare parts to reach any position in the plant, for the unit and auxiliary equipment daily patrol, equipment maintenance and other work to provide convenience.

Two beam-type mobile hooks with a bearing capacity of more than 20 tons are installed above the machine room and workshop for maintenance and hoisting of heavy parts. Due to the high height of the unit, escalator platforms are set up on both sides of the unit and the generator side for staff to climb up and operate.

电气控制房顶部分别安装进气鼓风机、排气换气风扇，为机房及设备冷却通风和发动机燃烧提供足够的新鲜空气。厂房上方设置消防报警探头等，厂房内配备固定及移动式消防灭火装置。主厂房顶面布置排气管烟罩及排气消音器等设备,并预留余热锅炉安装位置。发电机组采用冷却塔冷却。

The electrical control roof is equipped with intake blower and exhaust ventilation fan to provide sufficient fresh air for cooling ventilation and engine combustion of the machine room and equipment. The workshop is equipped with fire alarm probes and fixed and mobile fire extinguishing devices. Exhaust chimney, exhaust muffler and other equipment are arranged on the top of the main workshop, and the installation position of waste heat boiler is reserved. The generator set is cooled by cooling tower.

电气设备及监控室分隔为高压柜室、低压柜室、主控操作室三部分。各机组的高低压电气柜布置在电气设备柜房内。

进,出线柜分别与机组主发电机及厂房外的变电/配电设施相连，实现发电的上网输出。主控操作间内设置一个集中操控台，对每个单元组的发电机组进行实时集中监视控制操作。

Electrical equipment and monitoring room are divided into three parts: high voltage cabinet room, low voltage cabinet room and main control operating room. The high and low voltage electrical cabinets of each unit are arranged in the electrical equipment cabinet room.

The inlet and outlet cabinets are respectively connected with the main generator of the unit and the substation/distribution facilities outside the plant to realize the online output of power generation. A centralized control console is set in the main control room to monitor and control the generator sets of each unit group in real time

电站储罐布置在安全的区域，将此类危险易燃易爆品集中布置在该区,并与其他区域进行隔离，便于进行管理控制，提高运行安全性。

The storage tank of the power station is arranged in a safe area, and such dangerous inflammable and explosive materials are centrally arranged in this area and isolated from other areas to facilitate management and control and improve operation safety.

2.2.设计环境

机组的环境参数：

外部环境温度-----0~55℃ (室内 0~40℃)

淡水温度-----30℃

相对湿度-----60 %

大气压强-----101.3kPa(760 毫米汞柱)

增压器的背压-----350 毫米水柱(最大 400 毫米水柱)

热交换的设计基于 30℃的淡水温度。

Design condition

The engine will be operated on Natural gas.

Capacity of the genset can be decided under the following design conditions:

Ambient temperature-----0~45℃ (Indoor 0 ~ 40 °C)

Fresh water temperature-----30℃

Relative humidity-----60%

Atmospheric pressure-----101.3kPa(760mmHg)

Back pressure of turbo-charger-----350mmAq(max 400mmAq)

Heat exchangers will be designed at fresh water temperature 30℃.

2.3.发电机组标准

Technical standards of Generator Set

机组采用标准:

Applicable standards for the unit:

- 1) . GB: 中国工业标准
- 2) GB: china Industrial Standard
- 3). ISO: 国际标准化组织标准(机组性能适用 ISO3046-1 标准)
ISO: Standards of International Standard Organization (ISO3046-1 is applicable to the performance of the unit)
- 4). IEC: 国际电工技术委员会标准(性能)
IEC: Standards of International Electrotechnical Commission (performance)

2.4. 主要技术规格参数

Main technical specifications and parameters



表 1 发电机组主要技术参数汇总表(标准条件下)
Table 11 Summary sheet of main technical parameters for generator set
(under standard conditions)

机组型号 Set model		5400GF
发电机组额定功率 Rated power of generator set	kW	5400
功率因数 Power factor		0.8
转速 Rotating speed	rpm	750

排烟温度 Exhaust gas temperature	$^{\circ}\text{C}$	420
允许的排气背压 Allowable exhaust back pressure	kPa	4.5
燃料消耗率 Fuel consumption	g/kwh	192+5%
润滑油消耗率 Lubricating oil consumption	g/kWh	0.4-0.45
缸径/冲程 Cylinder diameter/stroke	mm/mm	320/440
缸套水回水/出水温度 backwater/effluent temperature of cylinder liner water	$^{\circ}\text{C}/^{\circ}\text{C}$	74/82.5
缸套水量 Water volume of cylinder liner	m^3/h	82
输出电压 Output voltage	kV	11
频率 Frequency	Hz	50
发电机组净重 Net weight of gensets unit	T	95
发电机组外型尺寸 External dimension of gensets unit	m	12750×3635×4840 (mm) (长 x 宽 x 高)(length x width x height)

表 2 发动机技术参数表(标准条件下)
Table 2 Technical parameters of engine (under standard conditions)

项 目 Item	单 位 Unit	数 值 Value
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发动机型号 Model of engine		MAN 10L3244
发动机额定功率 Rated power of engine	kW	5600
燃气 - 热耗和燃油耗 gas heat rate and fuel consumption	g/kwhr	188+5%
气缸数量 Number of cylinder	个 Pcs.	10
缸径 Cylinder diameter	mm	320
冲程 Stroke	mm	440
排量 Discharge capacity	L	340
转速 Rotating speed	rpm	750
活塞平均速度 Mean velocity of piston	m/s	10
润滑油填充容量 Filling capacity of lubricating oil	m ³ (kg)	2.0(1600)
水填充容量 Water filling capacity	m ³ (kg)	1.2(1200)
长 Length×宽 Width×高 Height	mm	8530* 2715 *4490
净重 Net weight	kg	65000

表 3 发动机噪音指标(标准条件下)
Table 9 Noise index of engine (under standard conditions)

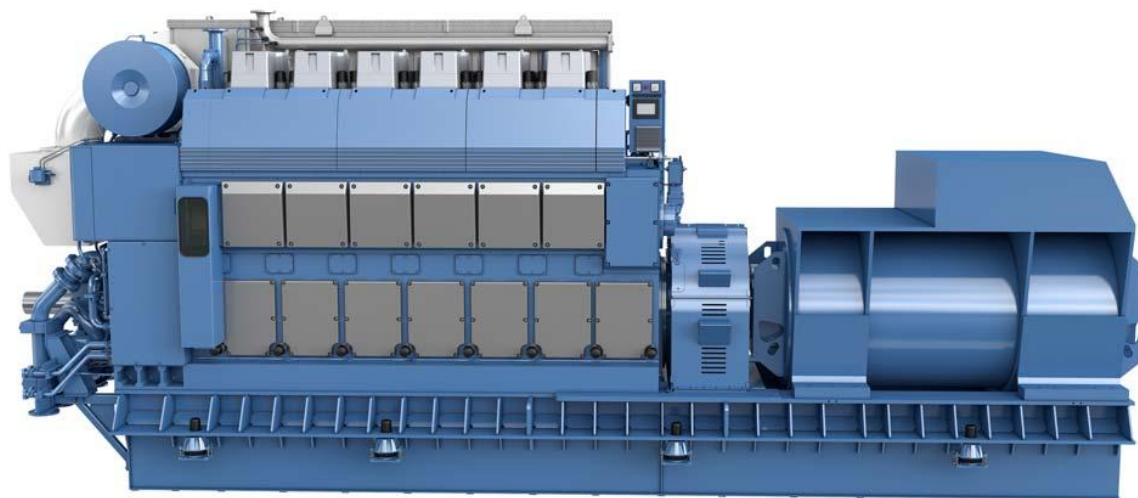
噪音频谱 Frequency spectrum of noise	Hz	32	63	125	250	500	1000	2000	4000	8000
发动机功率 Engine power	kW	5200								
进气噪音 (空气) Inflow noise (air)	dB		109	105	104	101	108	112	126	113
排气噪音 Exhaustion noise	dB	97	112	115	119	120	119	120	119	110
机组噪音 Set noise	dB	51	72	86	93	98	100	101	102	88

表 4 发电机技术数据表(标准条件下)
Table 10 Technical data sheet of electric generator (under standard conditions)

型号 ABB/TFC Model		ABB/TFC
额定功率 Rated power	kW	5400
功率因数 Power factor	COSφ	0.8
频率 Frequency	Hz	50
电压 Voltage	kV	11

转速 Rotating speed	rpm	75 0
允许超转速 Allowed overspeed	rpm	120%
效率 Efficiency	%	96
惯性矩(飞轮) Moment of inertia (flywheel)	kgm ²	590
重量 Weight	kg	16500
抗无线电干扰等级 Anti-radio jamming grade		N
结构形式 Structure type		IBM3
绝缘等级 Insulation class		F/B
防护等级 Protection class		IP23
在额定功率下允许温升 Allowable temperature rise under rated power	°C	80
最高周围环境温度 Maximum surrounding ambient temperature	°C	40
总谐波失真 Total harmonic distortion	%	3%
电抗及时间常数 Reactance and time constant		
xd 直轴同步电抗 xd direct-axis synchronous reactance	%	195.6%
xd ¹ 直轴瞬态电抗 xd ¹ direct-axis transient reactance	%	24.4%
xd''直轴次瞬态电抗	%	16%

xd'' direct-axis subtransient reactance		
Td''次瞬态电抗时间常数 Time constant of Td'' subtransient reactance	sec	0.018
Td 时间常数 Td time constant	sec	4.187



BB3345 3.5MW 发电机组技术参数

Project 项目	unit 单位	technical parameter 技术参数
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model 型号		3500GF
Cylinder arrangement 气缸排列形式		L 直列
Rated power 额定功率	kW	3500
Rated speed 额定转速	rpm	750
rated voltage 额定电压	kV	10
Rated current 额定电流	A	252.6
frequency 频率	Hz	50Hz
power factor 功率因数		0.8 (lagging)
phase 相数		3-phase

Voltage volatility 电压波动率	%	±1
Frequency volatility 频率波动率	%	±0.5
Steady state voltage regulation 稳态电压调整率	%	±2.5
Steady-state frequency regulation 稳态频率调整率	%	5
Transient voltage regulation 瞬态电压调整率	%	±20~-15
Stable time 稳定时间	s	5
Voltage regulation mode 电压调整方式		Auto AVR

Speed regulating mode of unit 机组调速方式		Electronic speed 电子调速
Frequency regulation mode 频率调整模式		Automatic or manual 自动或手动
Unit lubrication mode 机组润滑方式		Pressure, forced lubrication 压力,强制润滑
Lubricating oil type 滑油类型		SAE 4030
Start the way 启动方式		compressed air 压缩空气
Fuel oil type 燃料油类型		HFO 重油/柴油 DO
Engine cooling mode 发动机冷却方式		high and low temperature two, low temperature water close type cooling 高低温两路，低温水由闭式冷却器
Generator cooling		water cooling

发电机冷却方式		水冷
Insulation grade 绝缘等级:		(F)
Protection grade 防护等级:		IP23
Unit fuel consumption 机组燃油消耗率	g/kWh	194g/kWh+5%
Lub-Oil consumption 滑油 消耗率	g/kWh	0.6-0.8
Coupling type 联接方式		elastic coupling 弹性联轴器
Paint color according 油漆 颜色		to owner's requirement 根据业主要求
Installation method 安装方 式		common base elastic shock absorption installation 共同底座弹性减震安装
Overall dimensions 外形尺 寸	mm	9800×2500×4000
net weight of the unit 机组 净重	KG	65000

3. 发电机组及系统 Turbine Generator Set and System

3.1. 系统组成 System composition

发电机组主要由发电主机组, 机组辅助系统, 并网发电系统, 燃油系统组成。

generator set is mainly composed of generator set and auxiliary system, grid-connected power generation system, fuel system.

3.1.1. 发电机组及辅助系统 Generator set and auxiliary system

发电主机组由发动机、主发电机、公共底架及附属设施(如电动盘车、油雾探测器等)组成。

机组一侧安装的机旁柜、仪表柜可以对发动机的工作状态、报警指示等进行显示、监测, 发出指令对发动机进行实时控制。机组的启动准备、启动、同步并网、负荷控制、停机及紧急停机等操作均可在机组机旁柜上进行。

The main generator set is composed engine, main generator and common underframe and ancillary facilities (electric barring device, oil mist detector, etc.)

The side cabinet and instrument cabinet installed at the side of the set are able to display and monitor the working condition and alarm instruction of the engine as well as give orders to engine for real-time control. The startup preparation, start, synchronized grid connection, load control, shutdown and emergency shutdown of the set may carry out on the side cabinet of the set.

发动机为四冲程、L 型布置、废气涡轮增压、空气中间冷却、燃油直喷发动机。

engine is the engine with four strokes, L-type arrangement, exhaust turbine pressurization, intercooling.

发动机用压缩空气进行启动, 高压空气在主启动阀控制下依次按序进入各气缸中推动活塞运动, 实现发动机启动。

Compressed air is used for the startup of the engine, and the high pressure air enters into the cylinders successively in sequence under the control of the main starting valve to drive the piston motion and achieve the startup of the engine. By using such startup mode, sparkles possibly generated in the DC motor startup can be avoided, which is safer under the service environment of the gas.

该发动机压力冷却水循环系统分为一次水循环(发动机内循环)和二次水循环(机组外循环), 循环系统的冷却水泵为电机驱动式齿轮泵, 冷却介质不采用防冻液, 水质要求参见所附资料。一次循环水在发动机内部进行封闭循环, 由主要冷却发动机气缸套、增压器等高温部件。

空气中冷器分为高温段和低温段两部分，其高温段由一次循环水进行冷却。从冷却塔来的二次循环水先后流经空气中冷器低温段、润滑油冷却器、一次循环水冷却器，分别对增压后的空气、润滑油、二次循环水进行冷却散热。机组循环系统中设有若干温控阀，保证水温控制在设计范围内。

The pressure cooling water circulation system of the engine is divided into the primary water circulation (internal circulation of the engine) and secondary water circulation (circulation outside the unit). The cooling water pump of the circulation system is the motor driven gear pump, and the antifreezing fluid will not be used for the cooling medium. See the water quality requirements in the attached material. Primary circulating water is in closed circulation in the engine interior, mainly for the cooling of high-temperature components, such as cylinder liner of the engine, pressurizer, etc. Air intercooler is divided into high temperature section and low temperature section, and the high temperature section is cooled by the primary circulating water. Secondary circulating water from the cooling tower will successively flow through the low temperature section of the air intercooler, lubricating oil cooler, primary circulating water cooler for the cooling and heat dissipation of supercharged air, lubricating oil and secondary circulating water. The unit circulation system is equipped with several temperature sensing valves to ensure that the water temperature is controlled within the design range.

发动机润滑油系统对发动机各运动部件的摩擦部位进行润滑减摩和冷却清洗，润滑油由发动机轴系直接驱动的齿轮润滑油泵驱动加压，通过发动机内部腔道和管路流向各润滑部位。

The friction parts of the moving components in the engine are subject to lubrication, antifriction, cooling and cleaning by the lubricating oil system of the engine. The lubricating oil is pressurized by the gear lubricating oil pump, which is directly driven by the shafting of the engine, and then flows to the oil sites through the internal camber passages and pipelines of the engine.

发动机空气进气管路上(增压器前)安装空气滤清器和进气消声器，增压器排气通过膨胀波纹管与机组排气系统相连，排气进入排气消声器和余热管路进行后续处理和利用。发动机增压器前的排气总管上还安装有排气消声器。

The air inlet pipe of the engine (in front of the pressurizer) is installed with air cleaner and intake muffler. The exhaust of the pressurizer is connected with the exhaust system of the unit by the expansion bellows, and the exhaust will be subject to follow-up treatment and utilization after entering into the exhaust muffler and waste heat pipes.

机组辅助系统为发动机提供燃油、冷却水、润滑油的供应，实现这些介质的储存、加压、过滤、加热、冷却等功能。机组辅助系统主要包括以下系统：燃油燃气系统、冷却水系统、润滑油系统、压缩空气系统、进排气系统等。

Unit auxiliary system for the engine to provide fuel, cooling water, lubricating oil supply, to achieve these media storage, pressure, filtration, heating, cooling and other functions. Unit auxiliary system mainly includes the following systems: fuel gas system, cooling water system, lubricating oil system, compressed air system, intake and exhaust system, etc.

3. 1.2 Lube oil treatment system

Diesel engine adopts wet oil sump arrangement, diesel engine's lubricating system adopts engine interior integral arrangement. Generator's lube oil is feed to every lubricating position by means of built on pump.

Generator lubricating system includes:

- generator lube oil cooler
- lube oil thermostat
- lube oil duplex strainer
- pipe by pass centrifugal strainer
- lube oil pre lubricating pump
- lube oil pressure regulating valve

Power plant is equipped with one lube oil separator for every 4 generators as one unit block, that is used to periodically purify lube oil of generator running on heavy fuel oil. Among generators, it takes system pipeline valves to change over.

润滑油处理系统

柴油机采用湿式油底壳布置，柴油机的润滑系统采用发动机内整体布置。发电机的润滑油通过在泵上建立，以满足每一个润滑位置。

发电机润滑系统包括:

-发电机润滑油冷却器

——润滑油恒温器

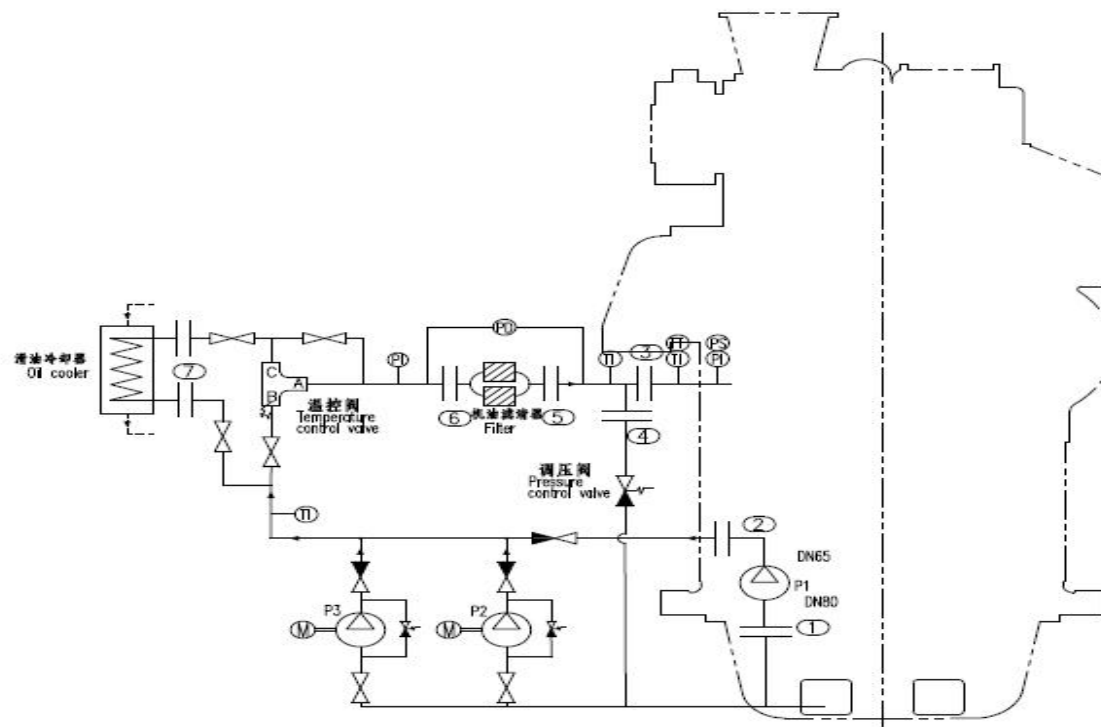
-润滑油双联滤器

管式离心过滤器

润滑油预润滑油泵

-润滑油压力调节阀

动力装置发电机都配有一个润滑油分离器，作为一个单位块，用来定期的净化在重油中运行的发电机润滑油。在发电机中，它需要系统管道阀门来改变。



3.1.3 Compressed air system

The generator is started by the compressed air. Compressed air from the air receivers will, after reduced pressure and filtered through pressure reducing valve set fitted on engine, drive air motor to engage flywheel gear ring and start generator.

The system includes:

- CZ20/30 air compressor 1 sets
- 500L 3.0MPa air bottle
- pressure reducing valve
- air purifying filter
- start solenoid set
- manual starting valve

Power plant black start can be realized by adding one diesel engine driven air compressor (option).

压缩空气系统

由压缩空气启动发电机。压缩空气通过空气接收装置，在降低压力后，通过安装在发动机上的压降阀进行过滤，使空气马达与飞轮齿轮环接触，启动发电机。

该系统包括:

-20-30 空气压缩机 1 套

-500L 3.0 MPa 空气瓶

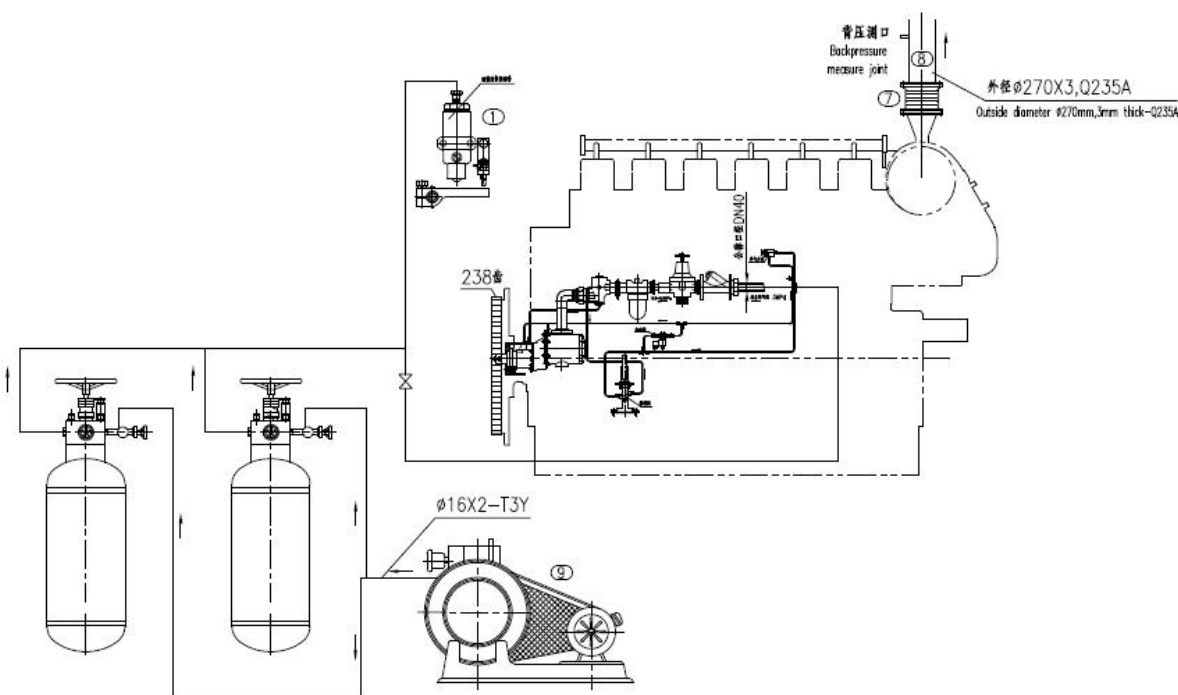
——减压阀

——空气净化过滤器

——启动电磁阀组

——手动起动阀

通过添加一个柴油机驱动的空气压缩机(选项)，可以实现电厂的黑启动。



3. 1. 4. Cooling water system

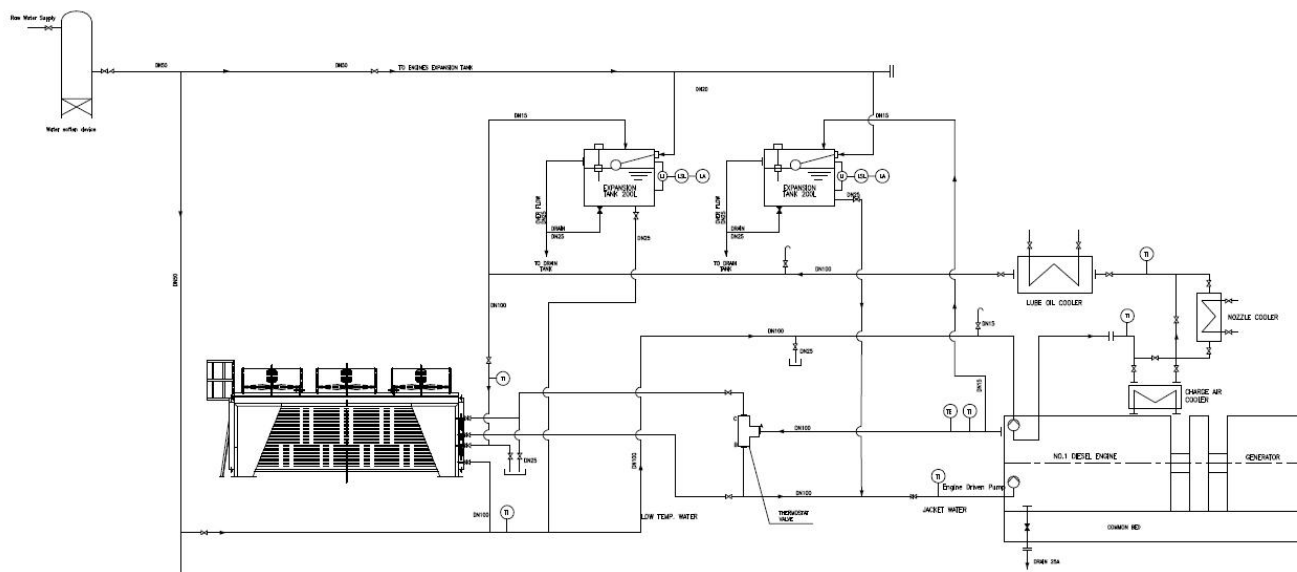
The generator adopts two loops cooling type, that is low temperature water circuit and high temperature water circuit. Both of the two systems' heat will emit through radiator.

The generator's cooling water will be circulated by water pump built on diesel engine, both of the two systems are fitted with high positioned expansion water tank for cooling water making up and deaeration.

冷却水系统

该发电机采用了两种循环冷却式，即低温水回路和高温水回路。两个系统的热量都会通过散热器散发。

该发电机的冷却水将由柴油发动机上的水泵循环使用，这两种系统都装有高定位膨胀水箱，用于冷却水。



Cooling water system include:

200m³ countercurrent closed cooling tower for cooling water (circulating water flows from top to bottom and air flows from bottom to top)

Size 5 * 2.2 * 2.75 m.

-The metal outer plate is durable and has strong anticorrosion ability.

- large cooling area,

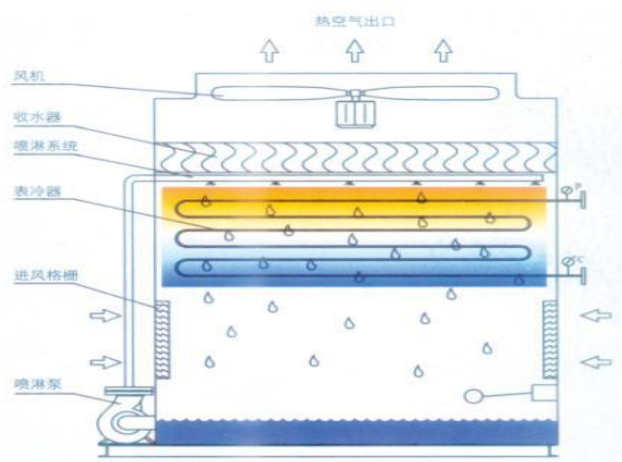
- suitable for high and low temperature cooling

冷却水采用 200m³ 逆流闭式冷却塔（循环水自上而下流动，空气自下而上逆向流动）

尺寸 5*2.2*2.75m.

-金属外板坚固耐用,防腐能力强..

- 冷却面积大,
- 适用于高,低温冷却



3.1.5. Intake and exhaust system

Packaged generator air intake adopts container forced ventilation mode, fans at engine turbocharger end will draw fresh air outside into container, part of the air will enter diesel engine combustion after charged by turbocharger and afterwards emit to the atmosphere through exhaust turbine and silencer, the rest of the air will be drawn out by axial fan by means of convection.

Intake and exhaust system includes:

- container axial fan
- exhaust expansion joint
- exhaust silencer

-exhaust boiler

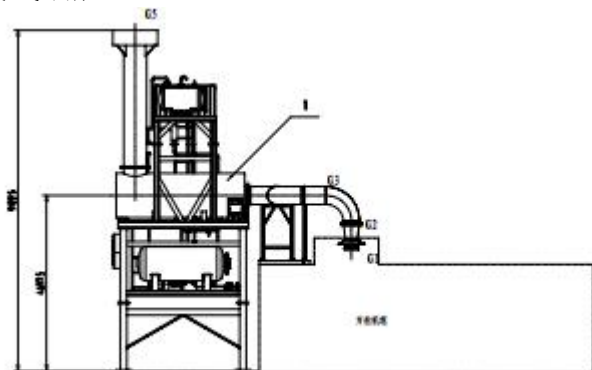
进排气系统

发电机进气采用容器强制通风模式,在发动机涡轮增压器将新鲜空气进入容器,空气的一部分将进入柴油机燃烧后收取的涡轮增压器,然后排放到大气中通过排气涡轮和消音器,其余轴流式通风机的空气将通过对流。

进气和排气系统包括:

容器轴流式通风机

排气伸缩接头
—排气消声器
—废气锅炉



3.1.6. 电气系统 Electric system

本发电站，共 8 台发电机组,按并网发电和电气控制子系统和一个电站总控室进行方案设计。

This power station, a total of 8 generator sets, according to the grid generation and electrical control subsystem and a power station control room for the scheme design.

发电单元电气主要由高压供电系统、主发电机、发电机组控制系统、操作站、单元公共控制系统，安全监控系统。发电单元电气系统结构框图见附图资料。

The electric system of generating units mainly consists of high-voltage grid connection and power supply system, main generator, generator set control system, generating unit operating station, public unit control system and safety supervision system. The structured diagram for the electric system of generating units is shown in the attached diagram.

高压并网及供电系统

High-voltage grid connection and power supply system

发电单元高压并网及供电系统主要由 8 台机组并网柜、两台出线柜、1 台 PT 柜、壹台联络柜、1 台站用开关柜,共 8 面高压开关柜、控制元件及电力电缆组成。安装在电站发电单元高压控制室。主要负责发电机组并网合闸电力功给和主发电机保护及线路保护，以及给发电单元用电设备供电。

The high-voltage grid connection and power supply system for generating units are mainly composed of 8 grid-connected unit cabinets, 2 outgoing cabinets, 1 PT cabinets, 1 contact cabinets and 1 station switch cabinet. total of 8 high-voltage switch cabinets, control elements as well as power cables. It is installed at the high-voltage generating unit control room of the power station. It is mainly used to supply grid-connected closing power to generator sets, protect the main generator and lines, and supply power to electrical equipment in generating units.

高压开关柜安装在高压控制室，采用按国标标准设计生产的 KYN28A-12(Z)中置式高压开关柜，真空断路器，微机保护，电流互感器，电压互感器及其它电气元件均采用国内知名品牌(用户也可选装)。高压开关柜主要有柜体和手车两大部分。柜体分断路器室、母线室、电缆室和低压室，各功能单元室相互独立，并有可靠接地装置。高压室上方有压力释放装置，进出线采用地沟进出方式，机房为高压柜正面和背面留有足够空间，安装、调试和维护可方便地从正面和背面进行。

The high-voltage switch cabinet is installed in the high-voltage control room, and is of KYN28A-12(Z) central-positioned type designed and produced based on the international standard, in which the vacuum circuit breaker, microcomputer protection, current transformer, voltage transformer and other electric elements are of famous domestic brands (they can also be selectively installed according to the user's instructions). The high-voltage switch cabinet mainly consists of two parts, body and handcart. In the cabinet body, the sub-circuit breaker chamber, busbar chamber, cable chamber, low voltage chamber and various functional module chambers are independent from each other and are equipped with reliable earthing devices. There is a pressure release device above the high voltage chamber, incoming and outgoing lines are set in trenches, and sufficient spaces are reserved in the machine room for the front and back of high voltage cabinet, so that installation, debugging and maintenance can be conveniently carried from the front and back.

主要保护有：

Main protections are:

- 1). 发电机组差动保护
Differential protection for generator set
- 2). 定子接地保护
Stator ground protection
- 3). 机组逆功保护
Reverse power protection for the unit
- 4). 机组过电流、过电压保护
Overcurrent and overvoltage protection for the unit
- 5). 超频、低频保护
Overfrequency and under frequency protections
- 6). 三相电压过低或过高。

Too high or low three-phase voltage

7). 电流、电压不均衡。

Current and voltage imbalance

8). 励磁回路接地/失磁。

Excitation circuit grounded/excitation loss

9). 定子线圈接地

Stator coil grounded

主发电机 Main generator

发电机组主发电机发电机为同步、直驱、6 抽头、紧密耦合型、低数量旋转零件、永磁式、无刷旋转磁场发电机。Generators are synchronous, direct-driven, 6-tap, tightly coupled, low-number rotating parts, permanent magnet, brushless rotating magnetic field generators.

发电机与发动机是紧密耦合，主转子通过半弹性驱动磁盘固定在发动机飞轮上，保证持久校直。发电机采用防滴式设计和防护，按照 IEE、NEMAMG-1-22 标准组装，双排轴承、凸极、旋转磁场。旋转磁场线圈为湿式、精密分层绕制，每层磁性导线涂有环氧材料。发电机由三相永磁型发电机组向励磁器提供励磁电源，增加了非线性负载的承受能力，保证了在短路状况发生时可以承受 10 秒的 250% 的额定电流。发电机上配备一个主端子扩展箱，安装发电机的导线、端子扩展母线，调压器和必须的 CT 和 PT。发电机上装有一个 220V 的空间加热器，加热器上嵌有温度探测器，加热器可以保证发电机组的绕组在非运行状态下保持干燥。

The generator is tightly coupled with the engine, and the main rotor is fixed on the flywheel of the engine through a semi-flexible magnetic driver disk to guarantee enduring alignment. The generator is drip proof in design and protection, is assembled as per IEE and NEMAMG-1-22, and is equipped with double-row bearings, salient poles and rotary magnetic fields. The rotary magnetic field is of wet type and wound in layers precisely, and each layer of magnetic conductor is smeared with epoxy materials. In the generator, the three-phase permanent magnetic generator set is set to provide excitation sources to the exciter, enhancing the bearing capacity of nonlinear load and guaranteeing that 250% of the rated current can be born for 10 seconds in case of a short circuit. A main terminal extension box is provided on the generator, in which the generator conductor, terminal extension busbar, voltage regulator and necessary CT and PT are mounted. A 220V space heater is mounted on the generator, on which a temperature detector is embedded. The heater can guarantee that the windings of generator set can be dry all the time, in the non-operating state.

调压器为数字式调压器，具有自动电压调节，功率因数调节，无功功率调节三种调节模式，可根据需要进行设置。

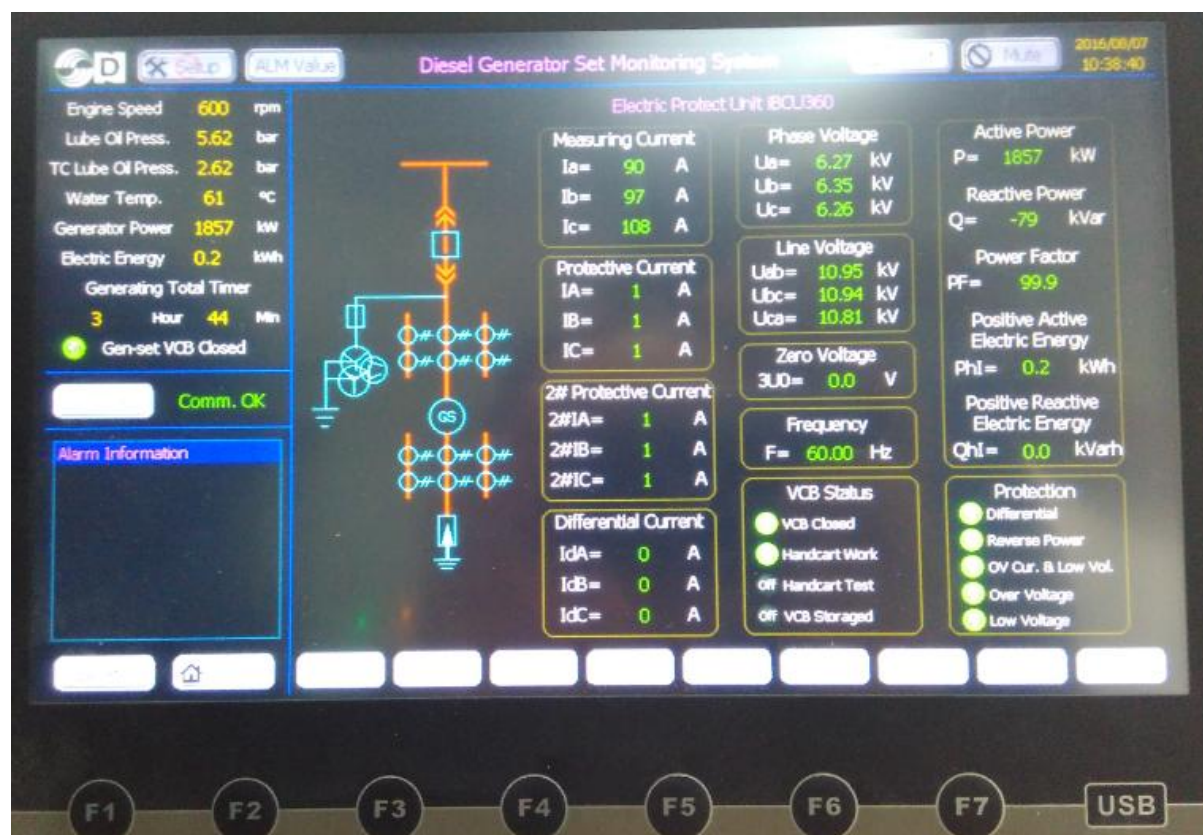
The voltage regulator is a digital voltage regulator having three regulating modes of automatic voltage regulation, power factor regulation and reactive power regulation. It can be set as required.

电压调节器具有发电机过电压、发电机低电压、失励磁、瞬间磁场过电流、过励磁、传感失效、三极管故障监测、内部监测器故

障、内部存储器故障等功能。

The voltage regulator has functions including generator overvoltage, generator low voltage, excitation loss, instant magnetic field overcurrent, overexcitation, sensing failure, triode failure monitoring, internal monitor failure, internal memory failure, etc.

发电机组控制系统主要由发电机组控制面板，发动机旁控制面板，机组辅助控制面板组成。机组控制系统示意图如下：
generator set control system mainly consists of the generator set control panel, control panel aside the engine and auxiliary control panel for the unit. The diagram of the unit control system is as follows:



发电机组控制面板

Generator set control panel

发电机组控制面板主要由可编程控制器(PLC), 人机界面、数字式自动并机并网模块、负载分配模块、控制按钮、指示灯、控制电源、小型断路器、继电器组成。功能描述如下:

The generator set control panel mainly consists of the programmable controller (PLC), human-computer interface, digital automatic unit and grid connection module, load distribution module, control button, indicator light, control power supply, small circuit breaker and relay unit. The functions are described as follows:

- 1) 控制功能: 自动/手动起动, 延时停机, 手动停机, 转速控制, 同步并机并网控制,有功功率控制, 无功功率控制, 可编程逻辑控制等。

Control function: automatic/manual start, delay shutdown, manual shutdown, speed control, synchronous unit and grid connection control, active power control, reactive power control, programmable logic control, etc.

- 2) 数字显示功能: 发动机转速、排温, 发动机工作小时, 机油压力, 冷却水温, 直流电压, 机组电压, 电流, 频率, 实际输出功率, 无功功率, 视在功率, 电度计量, 功率百分数, 功率因数, 故障代码显示。

Digital display function: display engine speed and discharging temperature, engine working hours, engine oil pressure, cold water temperature, direct voltage, unit voltage, current, frequency, actual output power, reactive power, apparent power, measurement of electricity degree, power percent, power factor and fault code.

- 3) 故障保护停机功能: 机油低压力停机保护, 高水温停机保护, 超速保护, 超速起动保护, 紧急停机保护, 低电压或高电压保护, 低频率或高频率保护, 过电流保护, 逆功率保护。各种预报警和报警信号指示。

Fault containment shutdown function: engine oil low pressure shutdown protection, high water temperature shutdown protection, over-speed protection, over-speed start protection, emergency shutdown protection, low or high voltage protection, low or high frequency protection, over-current protection, reverse power protection. Various pre-alarm and alarm signal indications.

发动机旁控制面板

Control panel aside the engine

发动机机旁控制面板主要负责发动机启动、停机控制、发动机转速控制,发动参数监控、报警、数据上传等功能。

The control panel aside is the engine mainly used for engine start and shutdown control, engine speed control, monitoring, alarm and upload of engine parameters, etc.

机组辅助控制面板

Auxiliary control panel for the unit

辅助控制系统主要负责发动机滑油系统、冷却水系统, 空气压缩系统等辅助设备的电源和控制。

The auxiliary control system mainly is used for power supply and control of auxiliary equipment including engine lubricating oil system, cooling water system, etc.

机组控制系统特点

Characteristics of unit control system

- 1) 发动机燃烧控制、机组功率控制、机组并网控制都使用 woodward 最新的控制器，机组核心控制器采用 Netmation 控制器，具有极高可靠性，技术先进，功能强大。可对发电机组进行各种工作状态的监测，控制和保护可以保证机组长时间稳定高效的运行。控制器操作简单，可以在面板上进行参数设置，控制机组的启动、运转和停车，也可通过计算机在远端监控中心对控制器进行设置，监测机组各种参数，控制机组的启动、运转和停机。

The latest woodward controller shall be adopted in engine combustion control, unit power control and unit grid connection control, and the Netmation controller manufactured shall be used as the unit core controller, with extreme high reliability, advanced technology and powerful features. Various kinds of operating conditions of a generator set can be monitored and control and protection can ensure stable and efficient operation of the generator set for a long time. The controller is easy to operate and its parameters can be set via the panel to control startup, operation and shutdown of the controller unit, and the controller also can be set through the remote monitoring center of computer to monitor the unit parameters of different kinds and control startup, operation and shutdown of the unit.

- 2) 机组机旁柜和并网柜都配置了液晶屏，可让用户随时了解机组的运行状况。在系统设计上，保证用户不做任何操作就可以清晰完整看到机组所有运行状态和运行参数。

Both of the cabinet next to the unit and the grid-connection cabinet shall be equipped with LCDs, so that the users can understand the operating condition at all times. The system design can ensure that the users, without any operation, can see all operating conditions and parameters clearly and completely.

- 3) 系统硬件构架充分考虑了可扩展性，使用户可以自由地把机组进行分组管理，包括异地机组都可以进行统一管理。

The system hardware architecture has taken into full account extendibility so that the users can group the units into different parts for management at their disposal and the units located in different places also can be managed in a unified mode.

- 4) 辅助设备控制配置 PLC 模块，根据机组工作的需求逻辑，对发电机组的冷却水、润滑油的手动/自动预热，润滑油，燃气的手动/自动预供等进行控制，保证机组可以随时和长期的正常运行。

PLC module shall be provided for the auxiliary machinery control, and according to the logic of operating demands of units, manual/automatic preheating of cooling water and lubricating oil and manual/automatic supplying of lubricating and gas for a generator set shall be controlled to ensure the unit can normally and long operate at any time.

- 5) 机组并网和并网安全保护由控制系统全自动实现。当发动机满足条件，系统会自动启动并网程序，完成自动并网功能。当触发脱网条件，程序控制自动脱网。

The unit grid connection and grid-connection safety protection can be realized automatically through the control system. When the engine meets the required conditions, the system will automatically start the grid connection procedure and then complete the automatic grid connection function. If the grid-disconnected condition is triggered, the procedure control will be disconnected from the grid.

- 6) 多机组可以实现功率自动分配和功率自动转移。功率分配和功率转移的策略可以根据用户预设方案执行。

The multi-unit can realize the automatic power distribution and the automatic power transfer. The strategies of power distribution and

transfer can be carried out based on the user presetting scheme.

- 7) 发动机自动控制。发动机所有运行过程和参数都在控制系统监控之中，当任何一个参数触发报警，系统都会启动预设的报警处理。

The engine can be controlled automatically. All operating processes and parameters of the engine can be monitored and controlled by the control system, and when any one of these parameters triggers an alarm, the system will start the preset alarm processing.

- 8) 供气系统的安全防护的自动控制。

The safety protection of gas supply system can be controlled automatically.

- 9) 发动机参数，机组参数的采集传输：排温、油水温度压力、转速、各控制点状态、所有的电参数都可以实现遥测功能。

Acquisition and transmission of engine parameters and unit parameters: discharge temperature, temperature and pressure of oil and water, rotational speed, status of each control point and all electrical parameters can realize the function of telemetering.

- 10) 系统采用以太网方式组成通信网络，这样就让系统具备了灵活的可扩展性和可远程访问的功能，可以通过网络连接，就可以授权查询机组状态，对机组进行控制。具体组网的方式不受限制，可以有线网络、无线网络、以及 internet 网络。

The system adopts the Ethernet mode to form a communication network, so that the system can be provided with the functions of flexible extendibility and remote access and connected via the network, and the system can be authorized to query the unit status and control the unit. The specific networking methods are not limited, including wired network, wireless network and internet network.

3.1.7 系统安全保护措施

System safety protection measure

- 1) 系统对机组提供了完善的安全保护措施，当出现用户预定的状况，系统会按照预定程序实施系统保护，降功率、脱网、停机组等程序，保证人员和设备的安全。

The system has been designed with complete safety protection measure for unit . When designed situation happens, the system will activate protection according to preset procedures, reducing the power, disconnecting the network, shutting down the unit, so as to guarantee personnel and equipment safety.

对于机组并网系统，除了控制系统提供保护之外，机组电气控制系统整套完善的自动保护功能配置。

As for unit networking system, apart from being protected via control system, unit electrical system also has a complete set of automatic protection function,

包括：

Including

输出电压过高/过底告警保护停机

Alarming and shutting down by over-voltage/under-voltage

频率过高/过低告警保护停机

Alarming and shutting down by over-frequency/under-frequency

逆功率保护

Reverse-power protection

差动保护

Differential protection

接地故障保护

Grounding fault protection

输出过载或短路告警保护停机

Alarming and shutting down by over-load or short circuit

水温过高告警保护停机

Alarming and shutting down by water over-temperature

发电机绕组温度过高告警

Alarming by generator winding over-temperature

发电机轴承温度过高告警

Alarming by generator bearing over-temperature

对于控制系统，软件本身也提供了防护措施，机组控制系统和机组数据，都提供了多重安全防护功能。

For the control system, software protection measure is adopted to protect the safety of generator unit control system and data.

附件1 标准随机备件清单list of standard spare parts,标准随机工具 list of standard tools

1-1 标准随机备件清单annex 1-1 the list of standard spare parts

序号 No.	中文名称 Designation	英文名称 Designation	单位 Unit	每平台数量 Qty/Plat	备注 Remark
1	进气阀	Inlet valve cone, plasma-nitrided	件(PIECE)	2	
2	排气阀	Exhaust valve cone, plasma-nitrided	件(PIECE)	2	
3	气阀导套	Valve guide	件(PIECE)	4	
4	气阀内弹簧 8×51×178	Pressure spring 8×51×178	件(PIECE)	4	
5	气阀外弹簧 12×81×193	Pressure spring 12×81×193	件(PIECE)	4	
6	进气阀座	Inlet valve seat ring	件(PIECE)	2	
7	排气阀座	Outlet valve seat ring	件(PIECE)	2	
9	转阀机构（进气）	Valve rotating device	套(SET)	2	
10	转阀机构（排气）	Axial bearing	套(SET)	2	
11	气阀卡块	Valve cone piece two-part	套(SET)	2	
12	起动阀及安装组件	Assembly starting valve	套(SET)	1	
13	密封圈 38×3.2	Set of gaskets	件(PIECE)	6	

15	O 型密封圈 56.52×5.33	Round seal ring	件(PIECE)	18	
16	O 型 密 封 圈 72.62×3.53 Q/SC362-1979-MS29513/233-F 105	Round seal ring 72.62×3.53	件(PIECE)	30	
17	O 型密封圈 94.92×2.62 Q/SC362-1979-MS29513/154-F 105	Round seal ring 94.92×2.62	件(PIECE)	12	
18	O 型密封圈 59.69×5.33 Q/SC361-1979-AN35-F105	Round seal ring 59.69×5.33	件(PIECE)	12	
19	O 型密封圈 23.40×3.53 Q/SC361-1979-AN18-F105	Round seal ring 23.40×3.53	件(PIECE)	24	
20	O 型 密 封 圈 405.26×5.33 Q/SC362-1979-MS29513/385-F 105	Round seal ring 405.26×5.33	件(PIECE)	12	
21	O 型密封圈 18.64×3.53 Q/SC361-1979-AN15-F105	Round seal ring 18.64×3.53	件(PIECE)	6	
25	O 型密封圈 354.97×5.33 Q/SC362-1979-MS29513/383-F 105	Round seal ring 354.97×5.33	件(PIECE)	24	
26	O 型密封圈 37.47×5.33	Round seal ring	件(PIECE)	24	

	Q/SC361-1979-AN28-F105	37.47×5.33			
27	火焰环	Fire land ring	件(PIECE)	1	
28	O 型 密 封 圈 405.26×5.33 Q/SC362-1979-MS29513/385-F 105	Round seal ring 405.26×5.33	件(PIECE)	12	
29	密封环 H=10	Seal ring H=10	件(PIECE)	1	
31	曲轴轴承(上瓦)	Upper bearing shell	件(PIECE)	1	
32	曲轴轴承(下瓦)	Lower bearing shell	件(PIECE)	1	
33	横向拉紧螺柱 M42×3	Stud screw M42×3	件(PIECE)	2	
34	螺母 M42×3	Nut M42×3	件(PIECE)	2	
35	止推块	Stop piece	件(PIECE)	2	
36	螺钉 M24×280	Hexagon bolt M24×280	件(PIECE)	2	
37	螺钉 M24×560	Hexagon bolt M24×560	件(PIECE)	2	
38	螺母 M24 GB/T6177.1-2000-M24-10	Hexagon nut M24	件(PIECE)	4	
39	圆柱销 12m6×32 GB/T119.2-2000-A12m6×32-钢	Cylinder pin 12m6×32	件(PIECE)	2	
40	螺栓 M24×180 GB/T5782-2000-M24×180-8.8	Hexagon bolt M24×180	件(PIECE)	24	
41	螺栓 M12×80 GB/T5782-2000-M12×80-8.8	Hexagon bolt M12×80	件(PIECE)	4	

42	止推轴承	Thrust bearing ring	件(PIECE)	2	
43	螺栓 M20×180 GB/T5782-2000-M20×180-8.8	Hexagon bolt M20×180	件(PIECE)	8	
44	螺母 M48×3	Nut M48×3	件(PIECE)	8	
45	垫片	Gasket	件(PIECE)	6	
47	O 型密封圈 55×3	Round seal ring	件(PIECE)	12	
48	O 型密封圈 126.59×3.53	Round seal ring	件(PIECE)	6	
49	喷油嘴总成	Injection nozzle	套 (SET)	1	.
51	O 型密封圈 59.92×3.53	Round seal ring	件(PIECE)	30	
52	密封环	seal ring	件(PIECE)	12	
53	高压油管总成	Fuel injection pipe covered	套 (SET)	1	

附件12 标准随机工具清单 annex 1-2 the list of standard tools

序号 NO.	中文名称 Designation	英文名称 Designation	每船数量 Qty/Plat	备注 Rem ark
1	027 部件专用工具	Tools for sub-assembly 027	1 套 SET	
2	连杆 030 部件专用工具	Tools for sub-assembly 030 connecting rod	1 套 SET	
4	曲轴 021 部件专用工具	Tools for sub-assembly 021 crankshaft	1 套 SET	
5	曲轴 020 部件专用工具	Tools for sub-assembly 020 crankshaft	1 套 SET	
7	连杆 030 部件专用工具	Tools for sub-assembly 030 connecting rod	1 套 SET	
8	缸盖 055 部件专用工具	Tools for sub-assembly 055 cylinder head	1 套 SET	
9	缸套 050 部件专用工具	Tools for sub-assembly 050 cylinder line	1 套 SET	
10	活塞 034 部件专用工具	Tools for sub-assembly 034 piston	1 套 SET	
11	高压油管 434 部件专用工具	Tools for sub-assembly 434 injection pipe	1 套 SET	
12	起动阀 161 部件专用工具	Tools for sub-assembly 161 starting valve	1 套 SET	
14	喷油泵 200 部件专用工具	Tools for sub-assembly 200 injection pump	1 套 SET	
15	示功阀 419 部件专用工具	Tools for sub-assembly 419 indicator vale	1 套 SET	
16	进排气阀 113/114 部件专用工具	Tools for sub-assembly 113/114 inlet/out	1 套 SET	
17	喷油器 221 部件专用工具	Tools for sub-assembly 221 injection valve	1 套 SET	
20	爆压表 419 部件专用工具	Tools for sub-assembly 419 ignition pressure	1 套 SET	

Annex2 Selective catalytic reduction (SCR)

Introduction

2.0.1

The Selective catalytic reduction process utilizes the conversion reaction of nitrogen oxide (NO_x) and ammonia (NH₃) to nitrogen (N₂) and water (H₂O) on the surface of a catalytic active substance. Ammonia is provided by the injection of a diesel exhaust fluid (DEF) as reducing agent forming ammonia and carbon dioxide (CO₂) after vaporizing and decomposing in the hot exhaust gas.

The NO_x reduction of the SCR system (not taking the exhaust gas temperature as general go/no-go criteria for the urea injection into account) is mainly depending on the urea injection rate and the available surface area of the catalyst. In general (w/o active use of a NO analyser unit), the urea injection is based on a mapping of the engine-out NO_x emissions (NO_x vs. load/speed) in which the injection rate is subject to a optimization process between NO_x reduction, urea consumption and emission of secondary pollution like ammonia slip. Without any injection of urea, the NO_x reduction capability of the SCR system will be marginal (<5%).

DEF/urea

2.1

DEF is usually an aqueous urea solution with 40% urea and 60% deionised water. DEF is hereafter referred to as urea. 32,5% AdBlue solution can also be used if the DEF injection strategy is modified or adjusted.

In general, marine SCR systems operate with a 40% aqueous urea solution as the reducing agent. Properties as well as quality requirements of the 40% urea-water solution are given in Table 4.

System overview

2.2

The SCR system (shown in Figure 3) consists of the following main components:

- SCR housing with catalyst elements (8)
- Static mixer(11)
- Urea injector / injection lance(10)
- SCR control cabinet (3)
- Dosing unit(5)
- Urea pump unit(4)
- Pressure & temperature sensors(6)

Additionally, the following items (not being a part of the general scope of supply by itself) are required for a fully operational system:

- Urea main storage tank(1)
 - Piping and wiring for system fluids (air, urea)
 - Mixing/Injection pipe(9)
-

Finally, the below-mentioned components and system design features of the SCR system are available optionally:

- NO analyzer unit incl. analyzer probes(2,7)
- Soot blowing system(12)
- Integrated silencer
- Internal bypass

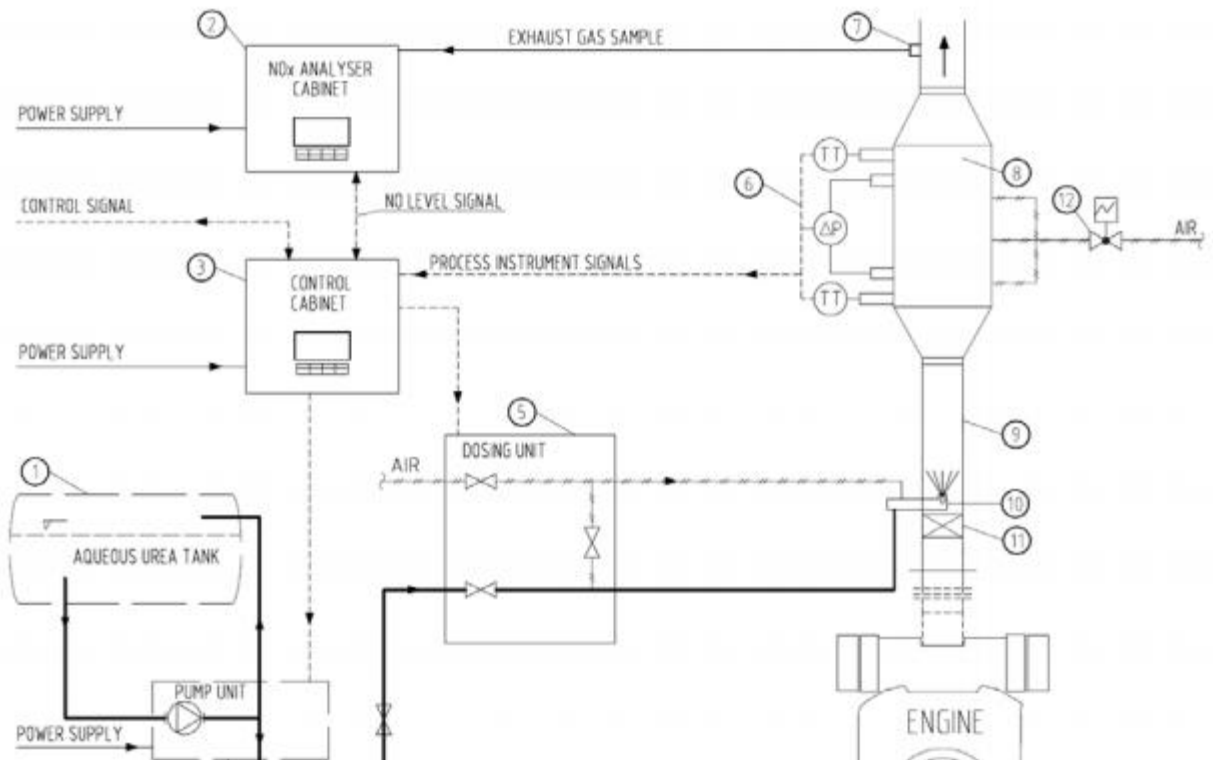


Fig 3: SCR system principal drawing

2.3 Catalyst housing

For each engine that is to be fitted with an SCR system, one separate catalyst housing is to be placed in the exhaust pipe line. The catalyst housing is a steel casing (steel grade part dependent) whose actual configuration depends on system design parameters such as NOx reduction, pressure drop or total installation space. It can generally be installed in both vertical and horizontal orientation and is typically equipped with the following elements:

Supporting elements for catalyst modules

- *Access hatches.*
- *Dust blowing system.*
- *Inlet and outlet cone with flange connections.*
- *Mounting feet.*
- *Connections for thermocouples and differential pressure transmitters.*
- *Thermal insulation at the outside.*
- *Internal exhaust by-pass (optional design feature upon request).*
- *In-line configuration with standard silencer for sound attenuation up to 35 dB(A) (optional design feature upon request).*

2.4 Catalyst

The catalyst typically has a square cross-section and is of the fully extruded type with a homogeneous dispersion of the active material (mainly vanadium-pentoxide and titanium oxide). The actual material specification (e.g. vanadium content and pitch) is mainly based on engine and project specific information like the exhaust gas flow, temperature and NOx emission level, and the type of fuel used. Thus, an optimized solution with respect to NOx reduction, system backpressure and other application and project criteria can be provided.

The catalyst elements are packed in canned modules by using expansion mats, ensuring the position of the catalyst blocks in the canisters and preventing them from damage due to vibrations and mechanical stress. The modules are typically placed in two or three layers inside the housing.

2.5 Urea injection and mixing

The injector unit is attached to the injection pipe with a flange connection positioning the nozzle in the injection pipe centre line. The injector is a dual media type using air for both cooling the urea solution inside the injector and improving the atomization of the small urea solution droplets at the nozzle outlet. Moreover, flushing the nozzle tip with air after stopping the urea injection prevents the crystallization of urea and with it the clogging of the nozzle.

There is one static mixer mounted inside the exhaust gas piping, ensuring a good mixing of ammonia with the exhaust in order to obtain optimum system performance. The mixer is mounted in the exhaust piping just prior to the injector unit, and the injected urea is thereby mixed with the exhaust immediately after injection. The mixer and injector must be installed in a straight pipe, as the injection pipe is positioned just after the injector. The injection pipe is generally a straight stainless steel pipe (to prevent corrosion from urea) that is required for complete mixing of the injected reducing agent. Dimensions of the mixer as well as injection pipe length and diameter are based on project specific information like exhaust- and urea flow and back-pressure requirements.

2.6 Urea distribution and control system

The urea supply to the SCR system(s) is ensured by one common pump unit, which is also responsible for maintaining the pressure in the urea distribution system. The most important part of the pump unit is the automatically operated main pump, and the distribution box which is connected to the SCR control unit. The pump unit starts the urea supply for the SCR system(s) automatically, and delivers the urea to a pressure control- and distribution unit, which adjusts the system pressure and distributes the urea to the dosing unit(s).

The dosing unit includes a flow meter and the automatic main dosing valve which enables accurate dosing of urea. In addition the dosing unit consists of other equipment needed for functions such as urea flow on/off and providing air for injection and for rinsing the urea injector. From the dosing unit the correct amount of urea and air is delivered to the two phase injector, which is mounted on the exhaust pipe upstream of the injection pipe. Each engine that is equipped with an SCR reactor has a separate dosing unit, which is connected to the common SCR control unit via a distribution box.

The function of the SCR control unit is to regulate and control the amount of urea that is delivered to the injector, as well as controlling other functions such as start/stop of urea and air at the dosing unit and controlling the urea pump unit. It consists of the PLC (Programmable logic controller) and the HMI (Human-machine interface), thus, all communication (like alarms, starting/stopping the urea injection process or viewing the actual and historical process data) with the PLC can be done via the HMI. The PLC allows for both digital and analogue inputs and outputs. In case of an alarm, the cause for the alarm and possible actions will be indicated on the HMI.

The function between urea consumption, engine load and NO_x is recorded as a curve in the PLC. Control of the urea injection rate is thereby carried out automatically, based on an engine load signal to the control system, enabling accurate and delay free urea dosing.

As illustrated in the figure below two possible control unit configurations can be chosen, depending on application requirements. The control unit can be configured as a common control unit for control of up to 8 engines. Alternatively one control unit per engine is possible by integrating the control unit on the dosing unit panel.

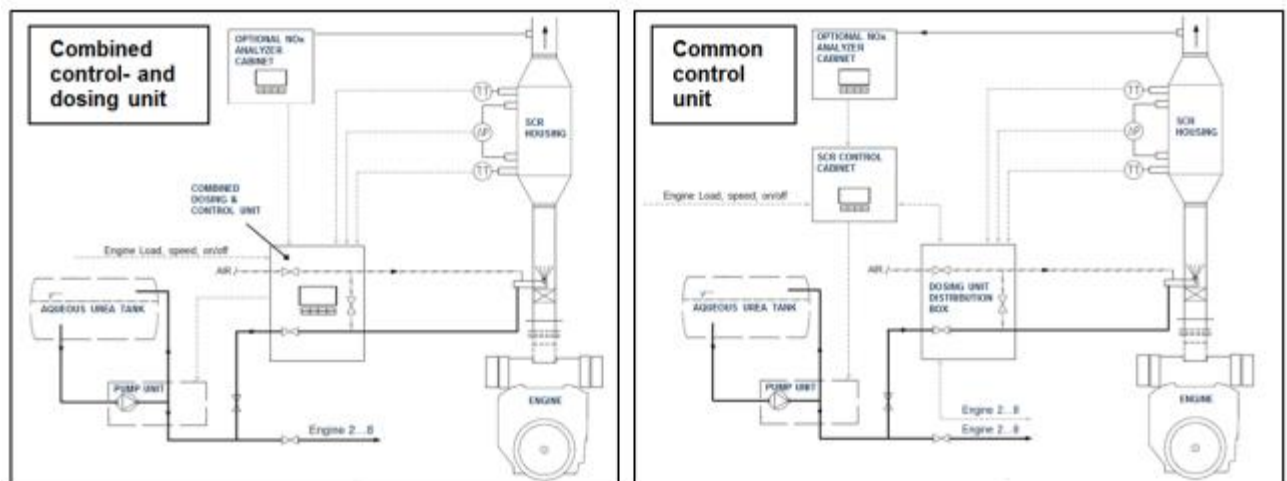


Fig 4: Principal layout of SCR control and urea distribution system. (1) Drawing on left side is configuration with control unit mounted on dosing unit. (2) Drawing on right side is for one common SCR control cabinet for up to 8 engine

2.7 Optional system components

The following features/components can be supplied with the SCR system on demand:

Internal by-pass:

In cases where the SCR system is applied to a single propulsion engine, a by-pass mechanism is mandatory. Thereby, the exhaust gas is guided past the outside of the catalyst material. As an optional feature, the by-pass can enable undisturbed operation in the case of clogging or blocking of the catalyst.

Integrated silencer:

The catalyst housing can be integrated with a silencing function for sound attenuation in-line with a standard silencer. This results in a decrease in the space requirements as well as the total system pressure drop. In addition, the standard silencer may in such cases be omitted.

NO analyzer:

The NO analyzer system consists of an analyzer cabinet, the analyzer probe and the sampling system. It can be applied for both monitoring the system performance (NOx concentration after the catalyst) and providing an additional control function for the DEF dosing by adjusting the injection rate based on the deviation between the actual, measured NOx value and the set point. An alarm will be given if the deviation exceeds a given, pre-defined limit and with it indicating a system malfunction.

Soot blowing system:

The soot blowing system consists of several nozzles positioned below each catalyst layer as well as pipes and valves to control the air flow. Compressed air (>7 bar) is required to operate the system. It is activated by an increase of the differential pressure over catalyst elements above a predefined set point. Applying a soot blowing system is required in case of running on HFO, and is optional when applying distillate fuel oils (MDO and MGO) with sulphur content below 0.5% m/m.

2.8 Design parameters

An overview of SCR system characteristic data including consumables and the dimensions of the most important components is given in Table 2. However, this information is for reference only, as for each individual project the system will be designed based on project specific information such as required NOx reduction efficiency, space requirements and the like.

Table 2: SCR system design parameters (for reference only)

Engine	Catalyst housing				Mixing pipe		Consumables	
Rated power	Width	Depth	Length	Weight, including catalyst elements	Diameter	Length	Air	Electricity
<i>kW</i>	<i>mm</i>	<i>mm</i>	<i>mm</i>	<i>kg</i>	<i>DN</i>	<i>mm</i>	<i>l/h</i>	<i>kW</i>
1920 - 2000	1030	1350	2400	1730	500	1800	18- 19	4 - 5
2560 - 3000	1350	1350	2400	2250	700	2300	24-27	4 - 5
3600 - 4000	1680	1520	2500	2980	8000	2500	28-34	4 - 5

Table 2: SCR system design parameters (for reference only)

Engine	Catalyst housing	Weight, catalyst	Mixing pipe including elements	Diameter Electricity	Consumables Length	Air
Rated power	Width Length	Depth				
4320 - 4800	1680 40-45	1680 4 - 5	2700	3310	800	2800
5400 - 6000	2000 47-50	1850 4 - 5	2700	4180	900	3200
7200	2170 54	2000 4 - 5	3000	4750	1000	3500
7680 - 8000	2330 65-67	2000 4 - 5	3000	5200	1100	3800