

# **PGS Series Coil Steam Boiler**

## **Installation&Use Manual**

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Jiangsu , China

## Preface

- ◆ As a special equipment, the state has formulated relevant laws and regulations and standards for the design, manufacture, installation, use, inspection, repair and modification of boilers . To ensure the safe, reliable and economical operation of the boiler, please strictly follow the regulations.
- ◆ In addition to this manual, the special manuals provided with the product should also be read carefully and implemented according to their requirements.
- ◆ If users encounter problems that cannot be solved by themselves during actual operation, please consult our after-sales service department, local office or agent in time.
- ◆ Please keep the original copy of this manual and other technical information in a safe place .

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## 1. Standard

The design, manufacture, installation, use and maintenance of this series of boilers must strictly comply with the following standards:

TSG 11 "Boiler Safety Technical Regulations"

TSG 91 "Technical Regulations for Energy Saving and Environmental Protection of Boilers"

NB/T10936 "Technical Regulations for Electric Heating Boilers"

NB/T47034 "Technical Requirements for Industrial Boilers"

GB/T16508 "Shell Boiler"

GB/T1576 "Industrial Boiler Water Quality"

GB50273 "Construction and Acceptance Standards for Boiler Installation Projects"

GB50231 "General Regulation for Construction and Acceptance of Mechanical Equipment Installation Projects"

JB/T2379 《Metallic tubular heating elements》

GB50235 "Industrial Metal Pipeline Engineering Construction Regulations"

GB50236 "Construction Regulations for Field Equipment and Industrial Pipeline Welding Engineering"

GB50126 "Construction Regulations for Thermal Insulation Engineering of Industrial Equipment and Pipelines"

GB50041 "Boiler Room Design Standard 》

**Installation requirements: The boiler must be installed by a company approved and certified by the State Council's special equipment safety supervision and management department , and operated by a boiler operator certified by the quality and technical supervision department. Pressure piping components should be products produced by certified company. Before installation, you should read the "Installation and Operation Manual" and related general drawings, instrument drawings and other installation-related drawings.**

## 2. Structure introduction

The coil steam boiler is designed with a vertical structure + air-cooled smoke box + air-cooled shell + external high-efficiency economizer + external high-efficiency condenser integrated structure . The high-temperature flue gas generated by the full combustion of fuel in the furnace is discharged into the atmosphere through the furnace → two-pass enhanced convection tube bundle → three -pass enhanced convection tube bundle → high-efficiency economizer→ high-efficiency condenser → chimney. At the same time, the boiler feed water enters the boiler through the condenser → economizer → boiler body.

## 3. Boiler characteristics

3.1 Integrated structure, vertical layout, small footprint

3.2 The water volume is small, and compared with the one-through boiler, the steam production speed is fast, the steam production time is increased by more than 1 times, and steam can be produced in 1 minute after ignition at the fastest .

3.3 Coil structure, wide pressure applicability, meeting the needs of industries with high pressure levels .

3.4 Condensing design, compared with one-through boiler, the thermal efficiency is increased by 5 % , saving fuel.

3.5 Especially suitable for fire fighting industry, steam fire extinguishing .

3.6 The boiler is highly efficient (thermal efficiency exceeds 100%), environmentally friendly, and complies with national energy conservation and emission reduction policies. In order to further reduce the boiler exhaust temperature, make full use of fuel heat energy. A high-efficiency low-temperature condenser (low-temperature water supply preheater) using silicon-magnesium-aluminum alloy (resistant to sulfuric acid dew point corrosion better than 09CrCuSb (ND steel)) finned tubes at the outlet of the economizer uses low-temperature water supply (20°C) to cool the flue gas. The exhaust gas temperature drops to <60°C (lower than the saturation temperature corresponding to the partial pressure of water vapor in the flue gas, that is, the water dew point temperature). Maximize the absorption and utilization of the sensible heat of the flue gas and the latent heat of vaporization released during the condensation process of the combustion product water vapor in the flue gas. The energy-saving effect is very significant. Calculated based on the low calorific value of the fuel, its comprehensive thermal efficiency exceeds 100%, which minimizes the user's fuel costs. At the same time, harmful components (CO<sub>2</sub>, SO<sub>2</sub>, NO<sub>x</sub>) in the flue gas are dissolved in the condensed water and then discharged to the treatment pool through the drainage pipe, effectively reducing atmospheric emissions in the flue gas.

## 4. Water quality requirements

Water quality requirements (according to GB/T 1576 "Industrial Boiler Water Quality ")

Water	Rated steam pressure/MPa		p≤1.0		1.0<p≤1.6		1.6<p≤2.5		2.5<p<3.8		
	Feed water type		Softened water	Desalted water	Softened water	Desalted water	Softened water	Desalted water	Softened water	Desalted water	
Feed water	Turbidity/FTU		≤5.0								
	Hardness/(mmol/L)		≤0.03						≤5×10 <sup>-3</sup>		
	pH(25℃)		7.0~10.5	8.5~10.5	7.0~10.5	8.5~10.5	7.0~10.5	8.5~10.5	7.5~10.5	8.5~10.5	
	Conductivity(25℃)/(μS/cm)				≤5.5×10 <sup>2</sup>	≤1.1×10 <sup>3</sup>	≤5.0×10 <sup>2</sup>	≤1.0×10 <sup>3</sup>	≤3.5×10 <sup>2</sup>	≤80.0	
	Dissolved oxygen*/(mg/L)		≤0.10			≤0.050					
	Oil/(mg/L)		≤2.0								
	Iron/(mg/L)		≤0.30					≤0.10			
Boiler water	Total alkalinity/(mol/L)	No superheater	4.0~26.0	≤26.0	4.0~24.0	≤24.0	4.0~16.0	≤16.0	≤12.0		
		With superheater				≤14.0		≤12.0			
	Phenolphthalein Alkalinity/(mmol/L)	No superheater	2.0~18.0	≤18.0	2.0~16.0	≤16.0	2.0~12.0	≤12.0	≤10.0		
		With superheater				≤10.0					
	pH(25 °C)							10.0~12.0		9.0~12.0	9.0~11.0
	Conductivity (25 °C)/(μS/cm)	No superheater	≤6.4×10		≤5.6×10		≤4.8×10		≤4.0×10		
		With superheater			≤4.8×10		≤4.0×10		≤3.2×10		
	Dissolved solids/(mg/L)	No superheater	≤4.0×10		≤3.5×10 <sup>3</sup>		≤3.0×10 <sup>3</sup>		≤2.5×10		
		With superheater			≤3.0×10		≤2.5×10		≤2.0×10		
	Phosphate/(mg/L)							10~30		5~20	
	Sulfite/(mg/L)					10~30				5~10	
Relative		≤0.25 -									

alkalinity
<p>Note 1: For boilers with a rated evaporation capacity of less than or equal to 4 t/h and a rated steam pressure of less than or equal to 1.0 MPa, the conductivity and dissolved solids index can be implemented in Table 2.</p> <p>Note 2: For steam boilers with a rated steam pressure of less than or equal to 2.5 MPa, the feed water is desalted and the feed water conductivity is less than 10 <math>\mu\text{S}/\text{cm}</math>. The lower limit of the boiler water pH value (25 °C) can be controlled to be no less than 9.0, and the lower limit of phosphate can be controlled to be no less than 5 mg/L.</p>
<p>For boiler feed water supplying steam to steam turbines, the dissolved oxygen should be less than or equal to 0.050 mg/L.</p> <p>For boilers with low steam quality requirements and no superheater, the upper limit of boiler water alkalinity can be appropriately relaxed, but the pH (25 °C) of the boiler water after relaxation should not exceed the upper limit.</p>

## 5. Automatic adjustment and protection of boiler

### ( 1 ) Water level regulation and protection

The boiler is equipped with two water feed pumps (one for use and one for backup )

Maintaining a normal water level is the operator's primary responsibility. If the water level is too low, the boiler heating surface will overheat and burst ; if the water level is too high, it will affect the steam-water separation effect. In addition to the advanced water supply device, the boiler is also equipped with a flat water level gauge for the boiler operator to observe the changes in the boiler water level during operation. The water level gauge should be flushed every shift to determine its true water level.

For water level protection, the water level control of this series of boilers is controlled by the following three methods.

#### 1. Visual water level gauge

According to the size of boiler, there are generally two types of water level gauges: one is single color; the other is two colors.

2. Electrode type variable frequency water level controller (can also be equipped with double chamber balance container or capacitive sensor according to the contract)

The feed water pump uses the frequency signal given by the electrode-type frequency conversion controller to control the water level within a certain range to achieve automatic continuous water supply (continuous regulation ) When the boiler water level drops below the normal water level, the water pump motor operating frequency is automatically increased to replenish water. When the water level rises above the normal water level, the water pump motor operating frequency is automatically reduced to reduce water replenishment. This is repeated, and the boiler water level is controlled to change within the set range.

#### 3. Extreme low water level interlock

This series of boilers are equipped with an independent limit water level probe. Using the conductive on-off principle, when the water level drops to the limit value and the water supply device fails to replenish water in time due to a fault, it will immediately perform interlock protection, cut off the heating device , sound and light alarm, and shut down according to the corresponding procedures.

For the normal water level, the highest safe water level and the lowest safe water level, please refer to the specific boiler general drawing. (II)

## **(2) Pressure protection**

### **1. Steam pressure protection**

When the boiler pressure exceeds the set value, it needs to be adjusted or interlocked for protection, which is achieved by shutting down one or more heating components . By reducing the steam production, the steam pressure is reduced to ensure the safe operation of the boiler. If the steam pressure rises further and reaches the overpressure interlock set pressure value, the boiler will automatically perform interlock protection, cut off the heating device , sound and light alarm, and shut down according to the corresponding procedures.

The steam pressure protection of the boiler is the same as the water level, which adopts multiple protections. Our company's boilers use the following pressure protections:

#### ① Visual inspection of the pressure gauge

Two pressure gauges are installed on the boiler body .

#### ② Pressure control sensor

This series of boilers generally use a pressure controller and a pressure transmitter (sensor ) The pressure controller is used for overpressure alarm and interlock protection, and the pressure transmitter is used to control the regulation of the heating device . It is a mechanical-electrical conversion device that converts pressure signals into electrical signals . Its function is to output high and low pressure signals as electrical signals, and automatically adjust the heating through an external control circuit.

(continuous signal) or implement interlock protection (switch signal ) To keep the boiler pressure stable within the set range.

#### ③ Safety valve

The safety valve is the last line of defense in boiler protection. When the boiler exceeds the limit pressure, the steam is exhausted and the pressure is relieved according to the pressure set by the safety valve to ensure the normal operation of the boiler. The safety valve is adjusted and approved by the special equipment supervision and inspection department where the boiler is installed. The boiler is not allowed to be put into operation before the safety valve is adjusted and approved.

④ Once the set value of the pressure controller and the set value of the safety valve are set and approved by the special equipment supervision and inspection department, they are not allowed to be changed at will.

### **(3) Power failure self-locking protection**

In case of a sudden power outage, the running boiler will immediately stop and self-lock. If the circuit is powered on again, it will not start even if the button is pressed. It must be reset to release the self-locking function before it can be re-ignited and started.

## **6. Boiler start and stop program control**

See the electrical control system operating instructions

## **7. Boiler room layout safety and requirements**

The boiler room design should be undertaken by a professional design company with design qualifications. The design of oil and gas boiler rooms should be approved by the relevant competent authorities. The boiler room design should comply with the provisions of GB50041 "Boiler Room Design Standard". Users have the right and obligation to monitor the designed boiler room according to relevant standards to



ensure that the boiler room is installed in accordance with regulations.

### **1. Civil Engineering**

Boilers should generally be installed in a separately built boiler room. Boiler rooms should not be located directly in rooms where many people gather (such as public bathrooms, classrooms, restaurants, waiting rooms, etc.) or above, below, adjacent to or on both sides of the main evacuation exits. Newly built boiler rooms should not be connected to residential buildings. When boiler rooms are adjacent to other buildings, the adjacent walls should be fire walls. The floor of the boiler room should be flat without steps, and water accumulation should be prevented. When the boiler room is located in the basement, forced ventilation measures should be taken to ensure normal combustion of fuel.

The number of entrances and exits of a single-story boiler room should not be less than 2. The door leading to the outside of the boiler room should open outwards and must not be locked or bolted during operation.

The boiler room must not be connected to Class A, B or Class C fire hazardous buildings using flammable liquids. When the boiler room is connected to other production plants, it must be separated by a fire wall.

The boiler room belongs to Class D production plant. The fire resistance level of boiler room with a capacity of more than 4t/h shall not be lower than Class II, and that of boiler room with a capacity of  $\leq 4$ t/h may be Class III. The outer wall or roof of the boiler room shall have a pressure relief area (such as glass windows, skylights, weak walls, etc. equivalent to at least 10% of the area of the boiler room). The pressure relief point shall not be adjacent to rooms and passages where many people gather.

### **2. Process layout**

The clearance height of boiler operating location and passage shall not be less than 2m and shall meet the requirements of operating height of lifting equipment.

The high and low points of the hot water, steam and condensate pipes should be equipped with air release valves and water drain valves respectively; valves should be installed on the branches of the hot water, steam and condensate pipes leading to each user, and valves may not be installed when the length of the branch pipe is less than 20m.

The boiler feed water tank should be installed at a height that allows the boiler feed water pump to have sufficient filling head.

Steam boiler 1-4t/h, hot water boiler 0.7-2.8MW, should not be less than 3m; steam boiler 6-20t/h, hot water boiler 4.2-14MW, should not be less than 4m;

Clear distance of passages at the sides and rear of the boiler:

For steam boilers of 1-4 t/h and hot water boilers of 0.7-2.8 MW, the height should not be less than 0.8 m; for steam boilers of 6-20 t/h and hot water boilers of 4.2-14 MW, the height should not be less than 1.5 m.

### **3. Supporting Facilities**

The fire resistance level and fire protection requirements of boiler room buildings shall comply with the requirements of GB50016 "Code for Fire Protection Design of Buildings". Class C and Class A production plants for fuel oil and gas in boiler rooms shall be equipped with foam, steam and other fire extinguishing devices, and indoor fire water supply shall be provided. If the boiler room building is of the first or second level fire

resistance level, indoor fire water supply may not be provided. The number of fire extinguishers is generally 50 One is configured per square meter, but there must be no less than two in the boiler room.

For boiler rooms located in the basement, ground floor, top floor or combined construction of buildings, in addition to fire extinguishers, automatic fire alarm facilities and automatic fire extinguishing facilities should also be installed.

Laboratory should be set up in the boiler room . If the following conditions are met, only a laboratory site can be set up to conduct simple water quality analysis such as hardness, alkalinity, pH value, dissolved oxygen, etc .:

① Steam boilers with a rated evaporation capacity less than 6t/h or a total evaporation capacity less than 10t/h .

② The company has a central laboratory or other testing department that can prepare chemical reagents for water quality analysis for the boiler room and can test other items that need to be tested regularly in the boiler room.

## **8. Boiler installation and acceptance**

The installation of boilers should be undertaken by qualified professional installation company. Construction company that install boilers must be reviewed and approved by the boiler and pressure vessel safety supervision agencies of provinces, autonomous regions, and municipalities directly under the central government. The professional installation company invited should hold a boiler installation license that matches the boiler level and installation type. Before installing the boiler, the professional installation company must also submit the installation company qualification certificate, a full set of boiler information, boiler room review opinions, etc. to the local boiler and pressure vessel safety supervision agency for review and approval, otherwise construction will not be allowed.

The boiler installation quality section acceptance and water pressure test shall be conducted jointly by the boiler installation company and the user. In addition to the boiler installation company and the user, the safety supervision agency shall also send personnel to participate in the overall boiler acceptance. After the boiler installation acceptance is qualified, the installation company shall hand over the technical documents and construction quality certification materials of the installed boiler to the user and store them in the boiler technical file.

### **1. Boiler Installation Precautions**

This series of electric steam boilers are delivered as a whole, easy to place and install, and have good quick installation. The placement, installation, water, electricity and other connections of the boiler should still be carried out according to the boiler room layout drawing. The specific layout of the boiler room should comply with TSG 11 "Boiler Safety Technical Regulations" and GB50041 "Boiler Room Design Standards". The installation and construction acceptance of boilers shall comply with the relevant technical provisions of GB50273 "Boiler Installation Engineering Construction and Acceptance Standards" and GB50235 "Industrial Metal Pipeline Engineering Construction Specifications" and GB50236 "On-site Equipment, Industrial Pipeline Welding Engineering Construction Specifications".

### **2. General requirements for boiler installation technology**

#### **(1) Accuracy**

The first is the accuracy of geometric dimensions such as center position (or positioning position ) verticality, elevation, level, and gap value, and the error should be controlled within the

allowable deviation value; the second is the accuracy of the installation process, and it should be arranged what to install first and what to install later.

(2) The thermal system is unobstructed and clean

First, it is required to remove dirt, oxide layers, debris, etc. left in the system before the installation process, during manufacturing or transportation; second, it is required that during the construction process, no new residues or pollution sources should re-enter the system to ensure the smooth and clean system.

(3) Flexible thermal expansion and low thermal stress

Since the boiler installation work is carried out under normal temperature conditions, and the boiler operates under normal parameters, different parts are heated differently and made of different materials.

The expansion direction is different, and there is a certain internal stress during welding, and the expansion is very complicated. Therefore, sufficient clearance should be left for the expansion part to ensure that it can flexibly expand freely during expansion or return to the expansion value position of the corresponding temperature conditions during contraction. In addition, during welding, it is not allowed to force the assembly to reduce the internal stress of welding.

(4) Rigorousness

Through the installation process, eliminate the water leakage, steam leakage, oil leakage, air leakage, ash leakage, smoke leakage, air leakage, etc. existing in the equipment or caused by construction. To ensure the tightness of the boiler.

(5) Reliability

The reliability of the original design should be ensured during installation. The strength and rigidity of the boiler's pressure-bearing and supporting components should not be weakened, nor should the bearing surfaces and points that transmit force be deformed due to installation reasons, so as to maintain the reliability of the bearing force.

(6) Economical

After installation, the operating technical and economic indicators specified under the design conditions must be maintained. For example, the insulation should meet the design requirements and the surface should not overheat to prevent increased heat loss.

### 3. Installation Instructions

(1) This boiler is shipped as a whole. Before installation, the user needs to check whether the equipment is damaged during transportation. Check the instruments, valves, accessories, spare parts and related technical data, auxiliary machine technical manuals, etc. specified in the "Packing List". If any are missing, immediately report it to our sales department for proper handling.

(2) When unloading or lifting the boiler, the boiler lifting ears must be hooked, and wire ropes cannot be tied to other parts for lifting to prevent personal injury and equipment accidents.

(3) The boiler room layout should comply with TSG 11 "Boiler Safety Technical Regulations" and GB50041 "Boiler Room Design Standards".

(4) The boiler foundation should be built in accordance with the technical drawings and technical requirements provided by the boiler manufacturer. The concrete layer should be burned. The pre-buried pits for the anchor bolts should be reserved. After the boiler company is aligned and in place, the auxiliary equipment, valves, instruments, electrical equipment, sewage, etc. should be installed. The elbows, fasteners, steam water supply pipes other than the main valve, steam delivery pipes, instrument pipes, valves, and thermal insulation materials other than those specified in the "Packing List" shall be prepared by the user. They must be fully prepared according to the drawings before installation for installation.

(5) The discharge pipe of the safety valve of the boiler body should be connected to a safe

place and no valve should be installed on the discharge pipe. The installation should be firm to prevent vibration . The discharge pipes of two safety valves should not be connected. The air discharge pipe on the steam cylinder should be led to a safe area outside the boiler room. The boiler sewage pipe and drain pipe should be connected to the sewage ditch.

(6) The installation of the entire system lines such as water, electricity, and control cabinets should be carried out according to the process flow or line layout diagram of the design department, and the operation method should be installed and operated according to the equipment random information and instruction drawings.

4. Water pressure test (a water pressure test should be carried out when the boiler is used for the first time or when it is put into operation for the first time after a major or medium overhaul)

4.1 After the boiler is installed, an overall hydraulic test must be carried out. The hydraulic test should comply with TSG 11 "Boiler Safety Technical Regulations"

4.5.6 , the test pressure is shown in the following table:

**Boiler hydraulic test pressure**

Name	Boiler drum (shell) working pressure	Test pressure
Boiler body	<0.8MPa	1.5 times the working pressure of the drum (shell) , but not less than 0.2MPa
Boiler body	0.8~1.6MPa	Boiler drum (shell) working pressure plus 0.4MPa
Boiler body	> 1.6MPa	1.25 Times the working pressure of the drum (shell)

4.2 When the boiler is undergoing a hydraulic pressure test, the water pressure should be raised and lowered slowly. When the water pressure reaches the working pressure, the pressure should be raised and checked for leaks.

Then increase the pressure to the test pressure, keep the boiler at the test pressure for 20 minutes, then reduce it to the working pressure for inspection , and the pressure should remain unchanged during the inspection.

4.3 The water pressure test should be carried out when the ambient temperature is above 5°C . Anti-freeze measures must be taken when the temperature is below 5°C. The water temperature used for the water pressure test should be kept higher than the ambient dew point temperature to prevent condensation on the boiler surface. However, the temperature should not be too high to prevent vaporization and excessive temperature difference stress. It is generally 20-70°C.

**5. Boiling-out**

5.1 The boiler can be boiled after all parts of the boiler are installed, the system is normal, the water pressure test is qualified, and all parts can be safely started and operated. The purpose of boiling the boiler is to remove debris and oil stains inside the boiler. When boiling the boiler, appropriate drugs should be added to the boiler to remove oil stains and other substances. Boiling the boiler can use drugs such as soda ash or trisodium phosphate. The former is 5 kg and the latter is 3 kg per cubic meter of boiler volume. The above drugs used for boiling the boiler should be prepared into a concentration of 20%. A uniform solution is not allowed to add solid drugs directly into the boiler.

5.2 Inject the treated soft water into the boiler slowly, and the water inlet temperature is generally not higher than 40°C. When the water level is at the lowest level, close the water supply valve and observe whether the boiler water level is stable. When adding boiler water, open the air valve on the drum to exhaust the air in the furnace. After the water is added, check the boiler hand hole cover, flange joint surface, and sewage for leakage.

5.3 The boiler is started and starts with a small load. The boiler is supposed to maintain no pressure within 12 hours. Then the pressure is gradually raised to 0.4MPa and maintained for 12 hours. Then the combustion is stopped and the pressure is gradually reduced to 0.1MPa. When the water temperature is lower than 70°C, the drain valve is opened to drain all the boiler water.

5.4 When the pressure drops to 0MPa and the boiler cools down, you can open the hand hole and rinse the inside of the boiler with clean water. When you check that there is no grease or dirt, the boiler is considered to be boiled. Otherwise, light the fire for no less than 3 hours according to the above-mentioned dosing requirements and boil the boiler again.

## 6. Pipeline tightness test and trial operation

After the boiler has passed the boiling test, the following steps should be followed for tightness test and trial operation.

6.1 Start to increase the pressure to 0.1-0.3MPa, and tighten the connecting bolts or connecting threads of flanges, valves, instruments, etc. within the boiler range in a hot state.

6.2 Continue to increase the pressure to the rated working pressure and further check the tightness of the joints such as flanges, valves, and instruments.

6.3 If the tightness test is passed, the starting pressure of the safety valve should be finally adjusted and the adjusted safety valve should be locked or sealed immediately.

6.4 After the safety valve is adjusted, the boiler should run continuously under load for 4 to 24 hours. Normal operation is considered qualified, and then the overall acceptance procedures for the project can be carried out.

## 7. Acceptance

The intermediate acceptance and water pressure test of boiler installation quality shall be carried out jointly by the boiler installation company and the user. During the overall acceptance of the boiler, in addition to the boiler installation company and the user, the local boiler and pressure vessel safety supervision agency shall generally also send personnel to participate.

After the boiler installation is accepted, the installation company shall hand over the technical documents and construction quality certification materials of the installed boiler to the user company and store them in the boiler technical file. **It is strictly forbidden to put the boiler into use without overall acceptance of the project.**

## 8. Boiler room system installation safety confirmation items

8.1 Whether the boiler operator holds a boiler operator certificate issued by the labor department.

8.2 Whether the boiler room design company holds a professional design qualification certificate; whether the boiler room installation company (team) holds an installation qualification certificate issued by the labor department. Whether the boiler user has completed the boiler registration and use procedures.

8.3 Whether the boiler room has sufficient light and good ventilation, whether it is open to the outside, and whether the exits and passages are unobstructed.

8.4 Whether the window area and pressure relief vent of the boiler room is not less than 10% of the area of the boiler room.

8.5 The water treatment soft water tank uses a stainless steel water tank, a plastic water tank or

a carbon steel water tank lined with resin; whether a water filter and a water pressure gauge are installed on the water inlet side of the water softener ; whether a water filter is installed on the water pump inlet side, etc.

8.6 Check whether the exhaust pipe of the safety valve is connected to a safe place outdoors.

## 9. Inspection before boiler operation

### ( 1 ) Water supply system inspection

1. Check all parts of the automatic water supply device and confirm that there is no abnormality in each part and it meets the normal operating conditions.
2. hole of the water pump to exhaust the air, turn the switch of the water pump to manual and check whether the rotation direction of the motor is correct.
3. Open all the valves at the inlet and outlet of the water pump.
4. Check the opening of the boiler feed water valve or electric feed water valve.
5. Check the water level gauge and observe whether the cock is flexible and unobstructed.
6. Flush the water level gauge and observe whether the water level returns to normal after the cock is drained and closed. If there is any abnormality, immediately check whether the system and cock are blocked.
7. Check whether the check valve, stop valve and other valves in the automatic water supply system are opened or closed correctly.

### ( 2 ) Boiler body inspection

1. The body is normal without leakage, and the outer skin is normal without damage.
2. Check whether the boiler's safety accessories are normal: whether the pressure gauge indication is normal, whether the water level gauge indication is correct, whether the safety valve is normal, and whether the discharge is unobstructed.

### ( 3 ) Steam system inspection

1. Check whether the pressure gauge pipeline and valve are unobstructed and flexible. If the pressure surface glass is dirty, wipe it clean with dilute hydrochloric acid.
2. Check whether the safety valve has any abnormality and whether the exhaust pipe is firmly supported.
3. The main steam valve opens easily and the air valves are in normal condition.
4. The pressure controller has been adjusted and is in normal automatic control state.
5. Check whether the pressure before the valve group is normal.

### ( 4 ) Electrical system

Check the operation and automatic components inside and outside the control panel , and whether the protective switches for each operation are closed or in the stop position. Also check whether the electrical equipment related to the boiler, the electrical equipment of the combustion system and the automatic components are normal. Finally, turn on the main switch of the power circuit in the control panel to complete the operation preparation.

### ( 5 ) Safety valve setting

The safety valve should be adjusted during the initial pressure increase.

The set pressure of the safety valve of the steam boiler drum (shell) and superheater should be based on TSG 11 Adjust and verify according to the requirements of Table 5-3 of Boiler Safety

## Technical Regulations .

Rated steam pressure ( MPa)	Safety valve set pressure	
	Minimum value	Highest value
$P \leq 0.8$	Working pressure 0.03MPa	Working pressure 0.05MPa
$0.8 < P \leq 5.9$	1.04 times working pressure	1.06 times working pressure
$5.9 < P$	1.05 times working pressure	1.08 times working pressure

Note: ① There must be a safety valve on the boiler, which should be set according to the lower starting pressure in the table;

② The working pressure in the table refers to the working pressure of the components directly connected to the safety valve;

③ All safety valves cannot be changed after being calibrated and sealed.

④ It is strictly forbidden to put the boiler into operation before the safety valve is calibrated.

## 10. Boiler operation

- **The boiler may be put into operation only after being registered with the local boiler and pressure vessel safety supervision agency and obtaining a use permit .**
- **The boiler operator must undergo training and pass the examination and obtain a certificate before he can operate independently.**
- **Before operation, boiler operators and related personnel must be very familiar with safety regulations and equipment .**
- **During the operation of this series of boilers, the connecting pipes of the sewage outlet should be connected to the drainage ditch respectively. The drainage pipes should be kept unobstructed during on-site installation and no valves should be installed.**

### 1. Water supply system

Boiler feed water needs to be treated and the water quality must comply with GB/T1576 standards.

Pay attention to the water level changes of steam boilers. After being put into automatic operation, the water level rises and falls smoothly. Regardless of automatic or manual operation, the boiler water level must not be higher than the highest safe water level or lower than the lowest safe water level. The boiler should sound an alarm under automatic control. At the lowest safe water level, the combustion is automatically cut off and the boiler is stopped. The boiler can only be restarted after the water level returns to normal and is manually reset.

If the water level gauge has abnormal phenomena when the water surface is still, the reasons are as follows:

- a) The water level gauge or its connecting pipe is blocked internally;
- b) The water supply pipe is blocked by scale;
- c) The cock or valve leaks too much;
- d) The water supply device fails or the electrode point controller is short-circuited;
- e) The valve in the water level gauge and boiler connecting pipe is operated incorrectly.

### 2. Blowdown

- ① Blowdown is to make the boiler water alkalinity not exceed a certain concentration, meet the

boiler water alkalinity requirements, and discharge the boiler water sediment at the same time. Blowdown should be carried out when the boiler is under low load, and the amount of blowdown can be determined based on the results of boiler water chemical analysis.

② In addition to regular blowdown, large-capacity boilers can be equipped with continuous blowdown according to user requirements. This can remove salt, foam, oil and other impurities near the surface of the boiler water to prevent steam-water azeotropy, which affects the steam quality.

③ When doing the blowdown please note:

a) When two or more boilers use the same blowdown pipe at the same time, it is strictly prohibited for the two boilers to discharge blowdown at the same time.

b) If a boiler is under maintenance, it should be isolated from the main pipe.

c) When discharging wastewater, the boiler should be placed at low load, the boiler water level should be raised, and the change of water level should be closely monitored during the discharging process. If there is any abnormal situation, the discharging of wastewater should be stopped immediately. Usually, the most suitable water level of the boiler drum should be lowered by 25 to 40 mm each time the wastewater is discharged .

Specific steps:

Slightly open the blowdown valve to preheat the blowdown pipe. After the pipe is preheated, slowly open the valve and close the blowdown valve immediately after draining. When blowdown, if there is an impact sound in the blowdown pipe, immediately close the blowdown valve until the impact disappears, and then slowly open the valve. Blowdown should not be continuous for a long time to avoid affecting the boiler water circulation.

### 3. Emergency shutdown

During boiler operation, if one of the following situations occurs, the boiler should be stopped immediately:

3.1 The boiler water level is lower than the lowest visible edge of the water gauge; the feed water pump or automatic water supply system fails and cannot supply water to the boiler.

3.2 Water level gauge or safety valve fails.

3.3 The pressure gauge or pressure controller fails.

3.4 The boiler components are damaged and endanger the safety of the operating personnel.

3.5 Other abnormal conditions endanger the safe operation of the boiler.

① General routine inspection

a) To ensure the normal operation of safety valves and pressure gauges, they must be calibrated regularly;

b) To reduce sudden load changes;

c) Keep the air pressure and water level within the normal range;

d) Carry out water quality analysis and supervision on feed water, boiler water and steam in each shift;

e) Maintain the normal operation of the water supply or circulating water system;

f) The automatic control devices should be checked and adjusted regularly to ensure the normal operation of the unit.

② Daily inspection contents of boiler body

a. Check the water level gauge and rinse the glass panel once a day to keep the water level normal;



- b) Pay attention to whether there is leakage in the water supply and medium delivery valve pipelines;
- c) Check the indications of each meter cyclically to see if the displayed data is normal;
- d) Check the temperature and lubricating oil level of the rotating parts and bearings every shift to see if they are normal;
- e) Each shift should keep operation records and establish a handover record transfer system.
- f) When the boiler is shut down, before checking the inside of the drum (shell), the working pressure of the boiler should be reduced to 0MPa and the water temperature should be reduced to below 50°C. The external closed handhole and manhole can be opened only after the boiler has cooled down.

### ③ Electrical control system

- a) Check if the pressure gauge indicates any abnormality, once a day;
- b) Check the power supply current meter for any abnormalities, once a day;
- c) Motor running current, temperature and sound, once a day; Check the electric heater once a week;
- e) Check the control panel and the insulation of the movable parts once a week;
- f) Check each contact, switch and other components once a month.

### ④ Water supply system

- a) When cooperating with boiler maintenance, regularly dismantle and inspect the water level device and water level regulating valve;
- b) Check the water level device inlet and outlet pipes and steam pipes for scale, blockage and abnormality. Deal with them immediately to ensure smooth flow of pipes;
- c) Prevent the water pump from running idle, which may cause equipment wear. When starting the water pump, it is strictly forbidden to suck air into the water pipe.

### ⑤ Electrical system

- a) Regularly check whether the performance of automatic control equipment is perfect, and pay attention to immediate handling of certain abnormalities, boiler water shortage alarm and shutdown, and test whether its performance is normal.
- b) Once a day, test the automatic water supply regulator and the low water level interlock probe under extremely low water level conditions to confirm whether its performance is normal.
- c) Once a day, test the pressure controller under overpressure conditions to confirm whether its performance is normal.
- d) Check the over-temperature alarm and temperature regulator, automatic switch performance and whether its control performance is normal when the oil temperature is over-temperature.

## 11. Boiler economic operation

### **Boiler economic operation should follow GB/T 17954 "Economic Operation of Industrial Boilers" Related Requirements**

- ◆ Industrial boiler users should use boilers and supporting auxiliary products that comply with relevant regulatory requirements such as safety technology, environmental protection, and energy conservation.
- ◆ The design, layout and construction of industrial boiler rooms shall comply with the requirements of GB50041.
- ◆ The installation of industrial boilers should comply with the provisions of GB50273 and

meet the design requirements.

- ◆ To properly treat boiler water, water treatment facilities should comply with the provisions of GB/T16811, and the quality of feed water and boiler water should comply with the requirements of GB/T 1576.

- ◆ The insulation of industrial boilers and their ancillary equipment and thermal pipelines should comply with the requirements of GB/T4272

- ◆ The auxiliary equipment of newly installed industrial boilers should be high-efficiency energy-saving products that meet the latest national standards or industry standards; the auxiliary equipment of the original industrial boilers, if it is an obsolete product announced by the state, should be replaced with energy-saving products in a timely manner.

- ◆ During the operation of industrial boilers, the load conditions should be adjusted and the pressure, temperature and water level should remain relatively stable.

- ◆ When the load of an industrial boiler changes during operation, the boiler operation should be monitored and adjusted in time. Industrial boilers should not be overloaded.

- ◆ When industrial boilers are in operation, the flue gas side of the heating surface should be cleaned regularly to keep it clean. The steam and water side of the heating surface should be regularly checked for corrosion and scaling, and anti-corrosion and descaling should be carried out. When using chemical agents such as cleaning agents, anti-corrosion agents, and descaling agents, safety, environmental protection, and effectiveness should be ensured.

- ◆ During the operation of industrial boilers, the boiler electrical control system, steam-water system, instruments, valves and insulation structure should be checked regularly to ensure they are tight and intact.

- ◆ Industrial boilers should be equipped with electric energy metering devices, steam or water flow meters, pressure gauges, thermometers, and other instruments and meters that can indicate the economic operation status of the boiler. The instruments and meters in use should be calibrated or verified regularly as required.

- ◆ Industrial boiler users should implement the "Management Measures for Special Equipment Operators", and operators should undergo training and assessment on safe and economical operation, and hold a certificate before taking up their posts. For industrial boiler rooms with a total capacity of more than 10t/h , full-time professional technicians should be deployed.

- ◆ Industrial boiler users should establish and improve safety and technical files for boilers in use to ensure that the equipment is in good condition. In addition to complying with the relevant provisions of the "Regulations on Safety Supervision of Special Equipment", the content of the safety and technical files should also include installation and commissioning acceptance records, technical transformation files, energy-saving and environmental protection monitoring files, etc.

- ◆ The original records of the operation of industrial boilers in use should be kept. The main items of the original records of the operating conditions should comply with the following regulations

#### Main record items

A : Steam pressure and flow rate;

B: water supply pressure, temperature and flow; sewage discharge;

C : Water treatment test data

D : Running time

Note 1 : For areas above 2000m above sea level , records of local atmospheric pressure, humidity and temperature should be added.

Note 2: Items for which the recording time is not specified shall be recorded at least once per shift.

## 12. Boiler maintenance

### 1. Quarterly maintenance

- Check whether the circuits of electrical instruments are loose and clean up the dust;
- Check whether all boiler valves are in good condition and clean them;
- Clean the water pump inlet filter or oil and gas filter.
- Test various protection and interlocking operations to see if they are normal.
- Check whether there is scaling and corrosion inside the boiler drum.
- Whether the auxiliary systems (dosing system, water supply system, etc.) are normal.
- Check whether the safety accessories on the boiler body, such as safety valve, water level gauge and pressure gauge, are intact and working properly.

### 2. Annual maintenance

In addition to implementing the items in the seasonal repair and maintenance one by one, the following items should also be done

- For repair and maintenance of the electrical control system , please refer to the electrical installation manual;

- Check the corrosion of boilers and pipelines;
- Check the insulation of motors, electrical appliances and circuits;
- Check the correctness of instrument indications.

### 3. Boiler maintenance

When the boiler is shut down for a long time, maintenance must be carried out to prevent corrosion of the boiler heating surface. The maintenance method can be wet maintenance:

- Wet maintenance

Wet maintenance is to fill the boiler with alkaline liquid to prevent corrosion.

After the boiler is shut down, drain the water, clean the internal dirt, inject clean water, and then dissolve the solid chemicals ( such as trisodium phosphate  $\text{Na}_3\text{PO}_4$  ) into a 0.1-0.2% concentration of liquid and inject it into the boiler drum to make the boiler water alkaline at PH = 10-12 to prevent metal corrosion.

## 13. Common faults and troubleshooting

If a fault occurs, you must first check the root cause of the fault: 1. Circuit; 2. Water (gas) supply line; 3. Interlocking control device , etc.

Fault conditions	Causes	Treatment
Operation button does not start	1) The pressure controller switch is cut off 2) The boiler water level drops to a low level 3 ) The pressure controller circuit is disconnected	1 ) Wait until the steam pressure drops before starting 2) Wait until the water level is reset before restarting 3) From the pressure controller circuit, detect the broken wire according to its circuit sequence
Starting and stopping at pressures different from the pressure controller setpoint	1 ) The pressure controller is defective 2) The pressure pipe, cock and pressure controller are blocked.	1 ) Correct the pressure controller installation to be vertical 2 ) Clean the dirt on the pressure controller and cock pressure pipe .
Low water level	1 ) The low water level controller is	1 ) Perform low water level test every day to

alarm does not sound, but the pump keeps running.	not working properly 2 ) The line is bad or the connector controller is broken.	keep the controller in normal working condition 2 ) Check whether the circuit and controller contacts are short-circuited
The pump is running but no water is supplied	1 ) No water in the water tank 2 ) Pipes and joints are rusted and blocked 3 ) Check valve is damaged or installed upside down 4 ) Air enters the water pump	1 ) Water supply 2 ) Inspection 3 ) Replacement and correction 4 ) Loosen the water pump bleed screw
Water level electrode fault alarm	1 ) Water level probe failure 2 ) Circuit failure	1 ) Check or replace 2 ) Check or replace
Water level fault alarm	1 ) Water level is too high 2 ) Water level is extremely low	1 ) Drain to normal water level 2 ) Add water to normal water level
Safety valve keeps discharging steam	1 ) Working pressure is higher than the opening pressure of the safety valve 2 ) Safety valve failure	1 ) Maximum working pressure $\leq$ rated working pressure 2 ) Maintenance

## 14. Boiler related technical parameters and requirements

See to delivery attached documentation and general drawings.