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Standard for construction and acceptance of boiler installation engineering

锅炉安装工程施工及验收标准

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1 General provisions

1.0.1 This Standard is formulated to improve the construction level of boiler installation engineering, promote technological progress, ensure project quality and safety, and improve economic benefits.

1.0.2 This Standard applies to the construction and acceptance of fixed steam boilers with a rated working pressure less than or equal to 3.82 MPa for industrial, civil and district heating, fixed hot water boilers with a rated water outlet pressure greater than 0.1 MPa, and organic heat carrier furnace installation engineering. It is not applicable to the construction and acceptance of cast iron boilers, boilers for transportation vehicle and ship, nuclear power boilers, and power station boilers installation engineering.

1.0.3 Boilers whose engineering acceptance procedures have not been completed are strictly prohibited from putting into use.

1.0.4 Before and during the installation of boilers, if any quality problems are found in the pressure-bearing parts that affect safe use, the installation must be stopped and it must be reported to the construction unit.

1.0.5 In addition to complying with this Standard, the construction and acceptance of boiler installation engineering shall also comply with the provisions of relevant national standards in force.

Where: H_n – tube expansion rate of inner diameter control method;

H_w – tube expansion rate of outer diameter control method;

d_1 – actual inner diameter of the tube after expansion (mm);

d_2 – measured inner diameter of the tube when not expanded (mm);

d_3 – actual diameter of the tube hole when not expanded (mm);

d_4 – measured outer diameter of the tube close to the outer wall of the drum after expansion (mm);

δ – difference between the tube hole and the actual outer diameter of the tube when not expanded (mm).

2) The control of the expansion rate of boilers with a rated working pressure greater than 2.5 MPa shall comply with the provisions of the accompanying technical documents.

5 The expansion end and starting point should be expanded repeatedly with a distance of 10 mm ~ 20 mm.

6 The tube mouth shall be beveled; the starting point of the bevel shall be flush with the surface of the boiler drum (tube sheet). There shall be no obvious cuts or extrusion, and the bevel angle should be 12° ~ 15°.

7 After expansion, the tube ends shall not have defects such as peeling, wrinkles, cracks, cuts and extrusion.

8 The number of expander rollers should not be less than 4; the effective length of the expander cylindrical straight section shall be the drum wall thickness plus 15 mm. The expansion tube shall be measured using special tools. The surface of the expansion rod and roller shall be free of defects such as bumps, pits, and scratches. The speed of electric and pneumatic tube expanders shall not be greater than 60 r/min.

4.2.8 After the expansion work is completed, a water pressure test shall be carried out, and the tightness of the expansion joints shall be checked and the expansion joints that need to be expanded shall be determined. The expansion shall be carried out immediately after the water is released, and the number of expansions should not exceed 2 times.

4.2.9 Before expansion filling, the inner diameter of the expansion mouth shall be remeasured and the expansion filling value shall be determined. The expansion filling value shall be calculated based on the change in the measured inner diameter of the expansion mouth before and after the expansion filling. After the expansion filling, the cumulative expansion rate of the expansion mouth shall be the sum of the expansion rate before the expansion and the expansion filling rate. The cumulative expansion rate

3 The quality of the radiographic testing of the welds of the butt joints of the tubes on heated side of the organic heat carrier furnace shall not be lower than Grade II, and the quality of the ultrasonic testing shall not be lower than Grade I.

4.3.12 When adopting radiographic testing or ultrasonic testing, the number of non-destructive tests shall comply with the following provisions:

1 When the rated working pressure of the steam boiler is equal to 3.82 MPa and the nominal outer diameter is less than or equal to 159 mm, the number of non-destructive tests shall not be less than 25% of the number of welded joints; when the rated working pressure of the steam boiler is greater than 0.8 MPa and less than 3.82 MPa, and the nominal outer diameter is less than or equal to 159 mm, the number of radiographic tests shall not be less than 10% of the number of welded joints. When the rated working pressure of the steam boiler is greater than 0.8 MPa, the nominal outer diameter is greater than 159 mm or the nominal wall thickness is greater than or equal to 20 mm, the welded joints shall be subjected to 100% non-destructive testing. When the rated working pressure of the steam boiler is less than or equal to 0.8 MPa, non-destructive testing is not required.

2 When the rated outlet water temperature of the hot water boiler is greater than or equal to 120 ℃ and the nominal outer diameter is less than or equal to 159 mm, the number of radiographic testing shall not be less than 10% of the total number of circumferential seams; when the nominal outer diameter is greater than 159 mm or the wall thickness is greater than or equal to 20 mm, each weld shall be 100% non-destructively inspected; when the rated outlet water temperature of the hot water boiler is less than 120 ℃, non-destructive testing is not required.

3 For the butt joints of the pressurized organic heat carrier furnace with an outer diameter greater than or equal to 159 mm, 20% of the number of joints shall be subjected to radiographic testing; for the butt joints of the tubes with an outer diameter less than 159 mm, 10% of the number of joints shall be subjected to radiographic testing; for the condensate tank, expansion tank and storage tank, 20% of each weld shall be subjected to radiographic testing.

4 For welding joints with wall thickness less than 20 mm, the radiographic testing method shall be used; for welding joints with wall thickness greater than or equal to 20 mm, the ultrasonic testing method can be used. The ultrasonic detector should be a digital recordable instrument. When an analog ultrasonic detector is used, an additional 20% local X-ray detection shall be performed.

5 When the result of non-destructive testing is unqualified, in addition to repairing the unqualified welds, the same type of welded joints welded by the welder on the same day shall be re-inspected, and the number of re-inspections shall be twice the number of random inspections. If there are still unqualified results after re-inspection, all welding joints welded by the welder on that day shall be inspected.

4) When the rated thermal power of the gas phase organic heat carrier boiler is greater than 0.7 MW or the rated thermal power of the liquid phase organic heat carrier boiler is greater than 4.2 MW, the allowable pressure drop shall be less than or equal to 0.10 MPa;

5) When the working pressure of the steam boiler is less than or equal to 0.8 MPa, the rated outlet water temperature of the hot water boiler is less than 120 ℃, the rated thermal power of the gas-phase organic heat carrier boiler is less than or equal to 0.7 MW, and the rated thermal power of the liquid-phase organic heat carrier boiler is less than or equal to 4.2 MW, the allowable pressure drop shall be less than or equal to 0.05 MPa.

6 The test pressure shall be reduced to the rated working pressure for inspection after the holding time. The pressure shall remain unchanged during the inspection. The water pressure test is qualified when the inspection meets the following requirements:

1) There shall be no water droplets or mist on the metal wall and welds of the boiler pressure components, and no water droplets shall drip from the expansion joints;

2) There shall be no visible residual deformation after the water pressure test.

5.0.6 If the boiler fails the water pressure test, it shall be repaired. The water pressure test shall be repeated after repair.

5.0.7 After the boiler water pressure test, all water in the boiler shall be drained in time. When the water in the vertical superheater cannot be drained, anti-freeze measures shall be taken during the freezing period.

5.0.8 After the installation of the organic heat carrier furnace, a hydraulic test shall be carried out at 1.5 times the rated working pressure. When the test medium is an organic heat carrier, an air tightness test shall be carried out before the hydraulic test. When water is used as the test medium, the water in the equipment shall be drained after the water pressure test is completed, and the interior shall be blown dry with compressed air. The pressure test requirements shall comply with the relevant provisions of Subclause 5.0.5 of this Standard.

5.0.9 The gas phase furnace air tightness test of organic heat carrier furnace shall comply with the following provisions:

1 During the air tightness test, safety accessories shall be fully installed;

2 The ambient temperature of the air tightness test shall not be lower than 5 ℃. When the ambient temperature is lower than 5 ℃, anti-freezing measures shall be taken;

3 The gas used for air tightness test shall be dry, clean air, nitrogen or other inert gas, and the temperature of the test gas shall not be lower than 5 ℃;

6 Tap, instrumentation, valves, soot blower and auxiliaries

6.1 Tap

6.1.1 The installation of tap and primary instruments on pressure piping and equipment shall comply with the following provisions:

1 Mechanical processing methods shall be used for tapping in pressure piping and equipment;

2 The material, structural dimensions and installation location of taps shall comply with the requirements of the design documents;

3 The tapping and welding of taps shall be carried out before corrosion and pressure tests.

6.1.2 The installation of temperature taps shall comply with the following provisions:

1 The temperature measuring element shall be installed in a place where the medium temperature changes sensitively and is representative;

2 The material of the thermometer socket shall be the same as that of the tube;

3 The compensation resistance of the external circuit of the temperature instrument shall meet the specified value of the instrument; the allowable deviation of the circuit resistance is ±0.2 Ω for thermocouples and ±0.1 Ω for thermal resistors;

4 When the device is installed horizontally or at a position that is susceptible to strong impact from the measured medium, when the insertion depth is greater than 1 m, or when the measured temperature is greater than 700 ℃, anti-bending measures shall be taken;

5 When installed at the bend of the pipeline, it should be installed against the flow direction of the medium, and the axis of the tap shall coincide with the axis of the pipeline;

6 When installed at an inclined angle to the pipeline, it should be installed against the flow direction of the medium, and the axis of the tap shall intersect with the axis of the pipeline;

7 When installed perpendicularly to the pipeline, the axis of the tap shall intersect the axis of the pipeline perpendicularly;

8 When the temperature tap and the pressure tap are installed on the same pipe section, the pressure tap component shall be installed upstream of the temperature tap, and the spacing should not be less than 200 mm.

6.1.3 The installation of pressure measurement tap shall comply with the following provisions:

1 The pressure measuring point shall be selected in the straight section of the pipeline where the medium flow is stable, and the end of the pressure taking device shall not extend into the inner wall of the pipeline.

2 When detecting the pressure of turbid materials such as dust, solid particles or sediment, the tap shall be installed tilted upward on vertical and inclined equipment and pipelines, and should be installed at an acute angle along the material flow on horizontal pipelines.

3 When installing pressure tap on inclined and horizontal tube sections, the setting of pressure points shall comply with the following regulations:

1) When measuring steam, the pressure point should be selected in the upper and lower parts of the pipeline within the range of 0° ~ 45° with the horizontal center line of the pipeline;

2) When measuring gas, the upper part of the pipeline shall be selected;

3) When measuring liquid, the angle between the lower half of the pipeline and the horizontal center line of the pipeline shall be within the range of 0° ~ 45°.

4 When the medium temperature measured by the local pressure gauge is greater than 60 °C, a U-shaped or annular tube shall be installed in front of the secondary door.

5 When the local pressure gauge measures pressure with severe fluctuations, a buffer device shall be installed behind the secondary door.

6.1.4 The installation of flow tap shall comply with the following provisions:

1 The installation of flow devices shall comply with the provisions of the design documents.

2 No other taps or temperature measuring elements shall be installed within the specified minimum length of the straight tube section.

3 When the throttling device is installed on a horizontal or inclined pipeline, the orientation of the pressure tapping port shall comply with the following provisions:

1) When measuring gas flow, it shall be in the upper half of the pipeline;

2) When measuring liquid flow, it shall be in the lower half of the pipeline and form an angle of 0° ~ 45° with the horizontal center line of the pipeline;

3) When measuring steam flow, it shall be in the upper half of the pipeline and form an angle of 0° ~ 45° with the horizontal center line of the pipeline.

6.2.2 After calibration, instruments and control devices shall meet the following requirements:

1 The variation of the instrument shall meet the technical requirements of the instrument;

2 The pointer shall move smoothly throughout the entire stroke, without any abnormal phenomena such as jitter, needle jam or jump. The balance of the pointer of the moving coil instrument shall comply with the provisions of the accompanying technical documents;

3 Adjustable parts such as potentiometers or adjusting screws shall have adjustment margin;

4 The damping of the instrument shall comply with the provisions of the accompanying technical documents;

5 The calibration records shall be complete and any corrections shall be noted in the records;

6 After passing the calibration, the instrument shall be sealed with lead. The date of the next calibration shall also be indicated on the instruments that are inspected regularly.

6.2.3 The installation of pressure gauges shall comply with the following provisions:

1 The pressure gauge installed on site shall not be fixed on equipment and pipelines with strong vibration;

2 The installation height of the pressure gauge or transmitter should be consistent with the height of the pressure taking point;

3 A red line indicating the rated working pressure of the boiler drum shall be drawn on the dial of the boiler drum pressure gauge;

4 A three-way stopcock or needle valve shall be installed between the pressure gauge and the liquid storage elbow. The pressure gauge shall be installed in a location that is easy to observe and purge.

6.2.4 The installation of flow detection instruments shall comply with the following provisions:

1 The throttling device of the flow detection instrument shall be installed after the pipeline is flushed. The medium inlet and outlet direction shall be checked before installation. The side with the "+" sign on the ring chamber shall be the medium inlet direction. The end face of the throttling device shall be perpendicular to the pipeline axis, and the deviation shall not be greater than 1°. The sharp edge of the orifice plate or the curved surface of the nozzle shall face the flow direction of the measured liquid;

2 When installing a differential pressure gauge or differential pressure transmitter, check the positive and negative pressure chambers, and ensure that the connections with the measuring tube and accessories are correct. The installation of the lead-out tube and its accessories shall comply with the provisions of the accompanying technical documents.

6.2.5 The installation of analytical samplers shall comply with the following provisions:

1 The installation of the analysis and sampling system shall comply with the requirements of the design documents. The vent pipe of the analyzed sample shall be connected to the main vent pipe, and the main vent pipe shall be led to a safe outdoor location;

2 The installation position of the combustible gas detector shall be determined according to the density of the detected gas; when the density is greater than that of air, the detector shall be installed at a distance of 200 mm ~ 300 mm from the ground; when the density is less than that of air, the detector shall be installed above the leakage area.

6.2.6 The installation of liquid level detection instruments shall comply with the following provisions:

1 The allowable deviation between the elevation of the glass tube and plate water level gauge and the normal water level line of the boiler drum shall be ±2 mm, and "highest water level", "lowest water level" and "normal water level" shall be marked on the water level gauge;

2 The guide tube or other guide device of the internal float level gauge and the float ball level gauge shall be installed vertically, and the liquid in the guide tube shall flow smoothly. The flange short tube connection shall ensure that the float ball can move freely within the entire range;

3 The electric contact water level gauge shall be installed vertically, and the design zero point shall coincide with the normal water level of the boiler drum;

4 Before installing the boiler drum water level balance container, the manufacturing dimensions and the tightness of the internal pipelines shall be checked. It shall be installed vertically; the positive and negative pressure pipes shall be led out horizontally, and the design zero position of the balancer shall coincide with the normal water level line.

6.2.7 The installation of electric actuators shall comply with the following provisions:

1 The rotating arms of the electric actuator and the regulating mechanism shall move in the same plane, the transmission part shall move flexibly, and there shall be no idle travel or jamming. When the opening is 1/2, the rotating arm should be perpendicular to the connecting rod;

	1.12 times the working pressure, and shall not be less than the working pressure plus 0.10

6.3.8 The safety valve of the organic heat carrier furnace shall be installed vertically and a discharge pipe shall be installed. The diameter of the discharge pipe shall be consistent with the discharge diameter of the safety valve. The discharge pipe shall be connected to a water-cooled surface condenser and then to a separate organic heat carrier storage tank. The discharge pipe shall be provided with anti-freezing measures.

6.3.9 An organic heat carrier gas phase furnace shall be equipped with at least two fully-open spring safety valves without handles. A bursting disc shall be installed on the short pipe connecting the safety valve to the cylinder, and a stop valve shall be installed on the short pipe connecting the bursting disc to the boiler drum or header. When the organic heat carrier gas phase furnace is in operation, the stop valve must be in the fully open position.

6.3.10 The opening and closing pressure difference of the safety valve shall be 4% ~ 7% of the set pressure, and the maximum shall not exceed 10%. When the set pressure is less than 0.3 MPa, the opening and closing pressure difference shall not be greater than 0.03 MPa.

6.3.11 After passing the inspection, the boiler safety valve shall be locked or sealed.

6.3.12 The installation of fixed soot blower and its pipelines shall comply with the following provisions:

1 The allowable deviation between the installation position and the design position is ±5 mm;

2 The horizontal deviation of the nozzle shall not exceed 3 mm over the entire length;

3 Each nozzle shall be located in the middle of the gap between the pipes;

4 The soot blower pipeline shall be installed with a slope greater than or equal to 0.2%, without dead points for deposited condensed water, and shall meet pipeline expansion requirements. No additional stress shall be placed on the soot blower body, and the steam pipeline shall be insulated.

6.3.13 The installation of heat expander for organic heat carrier furnace shall comply with the following provisions:

1 The expander of the organic heat carrier furnace shall not be installed directly above the organic heat carrier furnace, and the vertical distance between its bottom and the top of the organic heat carrier furnace shall not be less than 1.5 m;

2 The regulating volume of the expander shall not be less than 1.3 times the volume increase of the organic heat carrier in the liquid phase furnace and the pipeline network due to thermal expansion at the working temperature.

7.1.7 The cold test run of the stroker should be carried out before the furnace is built and shall comply with the following provisions:

1 The cold test run time of the chain stroker shall not be less than 8 hours; the reciprocating stroker shall not be less than 4 hours. The chain stroker test run speed shall not be less than two levels. During the adjustment stage from low speed to high speed, the protection mechanism of the transmission device shall be checked;

2 The stroker shall rotate smoothly without abnormal noise, blocking, shaking or deviation;

3 The stroker bar shall be able to turn over freely without any bulge;

4 The roller shall rotate flexibly and mesh smoothly with the sprocket without any jamming;

5 The stroker tension device shall have adjustment margin.

7.1.8 The cooling device of the coal gate and stroker bearing shall be checked for water flow and maintained at a pressure of 0.4 MPa for 2 minutes without leakage.

7.1.9 The joint between the coal hopper and the furnace wall shall be tight, the coal gate shall be flexible to lift and lower, and the opening shall meet the design requirements. The distance deviation between the lower edge of the coal gate and the stroker surface shall not be greater than 5 mm.

7.1.10 The wind shield door, stroker air duct and its flange joints, each section of the air chamber, ash drop door, etc. shall be flat and well-sealed. The baffle shall open flexibly.

7.1.11 The gap between the side sealing block and the stroker shall meet the design requirements and prevent the stroker from getting stuck, leaking coal and air.

7.1.12 The slag stopper shall fit neatly on the stroker surface and shall not be stuck or overturned when the stroker is in operation.

7.2 Spreader

7.2.1 The allowable deviation of the spreader elevation shall be ±5 mm.

7.2.2 The allowable deviation of the distance between two adjacent spreaders shall be ±3 mm.

7.2.3 When the spreader adopts series transmission, the allowable deviation of the coaxiality of the blade rotor shafts of two adjacent spreaders shall be 3mm. The allowable coaxiality deviation between the transmission device and the shaft of the first spreader shall be 2 mm.

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