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**Seamless Stainless Steel Tubes for Boiler and Heat  
Exchanger**

锅炉、热交换器用不锈钢无缝钢管

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# Seamless Stainless Steel Tubes for Boiler and Heat Exchanger

## 1 Scope

This document specifies the classification and code, order content, dimensions, shapes, weights, allowable deviations, technical requirements, test methods, inspection rules, packaging, marking and quality certificate of seamless stainless steel tubes for boiler and heat exchanger.

This document is applicable to seamless stainless steel tubes for boiler and heat exchanger (hereinafter referred to as steel tubes).

## 2 Normative References

The contents of the following documents constitute indispensable clauses of this document through the normative references in the text. In terms of references with a specified date, only versions with a specified date are applicable to this document. In terms of references without a specified date, the latest version (including all the modifications) is applicable to this document.

GB/T 222 Permissible Tolerances for Chemical Composition of Steel Products

GB/T 223.11 Iron, Steel and Alloy - Determination of Chromium Content - Visual Titration or Potentiometric Titration Method

GB/T 223.18 Methods for Chemical Analysis of Iron, Steel and Alloy - The Sodium Thiosulfate Separation Iodimetric Method for the Determination of Copper Content

GB/T 223.19 Methods for Chemical Analysis of Iron, Steel and Alloy - The Neocuproine-chloroform Extraction Photometric Method for the Determination of Copper Content

GB/T 223.23 Iron, Steel and Alloy - Determination of Nickel Content - The Dimethylglyoxime Spectrophotometric Method

GB/T 223.25 Methods for Chemical Analysis of Iron, Steel and Alloy - The Dimethylglyoxime Gravimetric Method for the Determination of Nickel Content

GB/T 223.26 Iron, Steel and Alloy - Determination of Molybdenum Content - The Thiocyanate Spectrophotometric Method

GB/T 223.28 Methods for Chemical Analysis of Iron, Steel and Alloy - The  $\alpha$ -benzoinoxime Gravimetric Method for the Determination of Molybdenum Content

GB/T 223.36 Methods for Chemical Analysis of Iron, Steel and Alloy - The Neutral Titration Method for the Determination of Nitrogen Content after Distillation Separation

GB/T 4340.1 Metallic Materials - Vickers Hardness Test - Part 1: Test Method

GB/T 5777-2019 Automated Full Peripheral Ultrasonic Testing of Seamless and Welded (except submerged arc-welded) Steel Tubes for the Detection of Longitudinal and / or Transverse Imperfections

GB/T 6394 Determination of Estimating the Average Grain Size of Metal

GB/T 7735-2016 Automated Eddy Current Testing of Seamless and Welded (except submerged arc-welded) Steel Tubes for Detection of Imperfections

GB/T 11170 Stainless Steel - Determination of Multi-element Contents - Spark Discharge Atomic Emission Spectrometric Method (routine method)

GB/T 17395 Dimensions, Shapes, Masses and Tolerances of Seamless Steel Tubes

GB/T 20066 Steel and Iron - Sampling and Preparation of Samples for the Determination of Chemical Composition

GB/T 20123 Steel and Iron - Determination of Total Carbon and Sulfur Content - Infrared Absorption Method after Combustion in an Induction Furnace

GB/T 20124 Steel and Iron - Determination of Nitrogen Content - Thermal Conductimetric Method after Fusion in a Current of Inert Gas (routine method)

GB/T 30062 Terminology of Steel Pipes and Tubes

YB/T 4395 Steel - Determination of Molybdenum, Niobium and Tungsten Contents - Inductively Coupled Plasma Atomic Emission Spectrometric Method

YB/T 4396 Stainless Steel - Determination of Multi-element Contents - Inductively Coupled Plasma Atomic Emission Spectrometric Method

### **3 Terms and Definitions**

The terms and definitions defined in GB/T 30062 are applicable to this document.

### **4 Classification and Code**

**4.1** In accordance with the manufacturing mode, the steel tubes are classified into two types. The categories and codes are:

- a) Hot rolled (extruded) steel tubes W-H;
- b) Cold drawn (rolled) steel tubes W-C.

**4.2** The following codes are applicable to this document:

$D$	nominal outer diameter (unit: mm);
$S$	nominal wall thickness (unit: mm);
$S_{\min}$	minimum wall thickness (unit: mm);
$S_c$	average wall thickness (the average value of the maximum and minimum wall thickness calculated based on the minimum wall thickness and its allowable deviation, unit: mm).

## 5 Order Content

The contract or order for steel tubes based on this document includes, but is not limited to the following contents:

- a) Serial No. of this document;
- b) Product name;
- c) Steel designation;
- d) Dimensions and specifications (outer diameter  $\times$  wall thickness, unit: mm);
- e) The quantity ordered (total weight, total length or quantity);
- f) Manufacturing method;
- g) Other special requirements.

## 6 Dimensions, Shapes, Weights and Allowable Deviations

### 6.1 Outer Diameter and Wall Thickness

**6.1.1** Unless otherwise specified in the contract, the steel tubes shall be delivered in accordance with the nominal outer diameter ( $D$ ) and minimum wall thickness ( $S_{\min}$ ). In accordance with the requirements of the demand-side, through negotiation between the supply-side and the demand-side, the steel tubes can be delivered in accordance with the nominal outer diameter and nominal wall thickness ( $S$ ).

**6.1.2** The dimensions and specifications of the steel tubes shall comply with the stipulations of GB/T 17395. In accordance with the requirements of the demand-side, through negotiation between the supply-side and the demand-side, steel tubes of other dimensions other than those specified in GB/T 17395 can be supplied.

**6.1.3** When the steel tubes are delivered in accordance with the nominal outer diameter and minimum wall thickness, the allowable deviations of the nominal outer diameter and minimum wall thickness shall comply with the stipulations of Table 1. When the steel tubes are delivered

The steel tubes shall be manufactured using hot rolled (extruded) or cold drawn (rolled) seamless method.

### 7.3 Delivery State

**7.3.1** The steel tubes shall be heat treated and acid-pickled for delivery. The heat treatment system of the steel tubes shall comply with the stipulations of Table 4. Steel tubes that have been integrally ground, bored or heat treated in a protective atmosphere can be delivered without acid-pickling.

**7.3.2** In accordance with the requirements of the demand-side, through negotiation between the supply-side and the demand-side, and statement in the contract, steel tubes containing titanium (Ti) or niobium (Nb) stabilizing elements can be subjected to stabilizing heat treatment after solid solution heat treatment. The stabilizing heat treatment system is determined by the supply-side and the demand-side through negotiation.

### 7.4 Mechanical Properties

**7.4.1** The room-temperature longitudinal tensile properties of heat-treated steel tubes shall comply with the stipulations of Table 4.

**7.4.2** In accordance with the requirements of the demand-side, through negotiation between the supply-side and the demand-side, and statement in the contract, steel tubes with a wall thickness of not less than 1.7 mm can be tested for Brinell hardness, Rockwell hardness or Vickers hardness, and the value shall comply with the stipulations of Table 5.

**7.4.3** In accordance with the requirements of the demand-side, through negotiation between the supply-side and the demand-side, and statement of test temperature in the contract, steel tubes with designations 07Cr19Ni10, 07Cr19Ni11Ti and 07Cr18Ni11Nb can be subjected to high-temperature tensile test, and their specified plastic elongation strength ( $R_{p0.2}$ ) value at high temperatures shall comply with the stipulations of Appendix A. When the demand-side requires high-temperature tensile strength ( $R_m$ ) value, the value shall be determined by the supply-side and the demand-side through negotiation.

**7.4.4** See Appendix B for the recommended 100,000 h endurance strength data of steel tubes with designations 07Cr19Ni10, 07Cr19Ni11Ti and 07Cr18Ni11Nb.

$$H = \frac{(1 + \alpha)S}{\alpha + S/D} \dots\dots\dots ( 3 )$$

Where,

*H*---the distance between two plates, expressed in (mm);

*α*---deformation coefficient per unit length, for austenitic steel tubes, *α* is 0.09, for other steel tubes, *α* is 0.07;

*S*---the nominal wall thickness or average wall thickness (when delivered in accordance with the minimum wall thickness) of the steel tubes, expressed in (mm);

*D*---the nominal outer diameter of the steel tubes, expressed in (mm).

## 7.6.2 Flaring

Steel tubes with an outer diameter not greater than 150 mm and a wall thickness not greater than 10 mm shall undergo a flaring test. The top core taper of the flaring test is 60°. The flaring rate of the outer diameter of the specimen after flaring shall respectively be: 18% for austenitic steel tubes and 15% for other steel tubes; after flaring, the specimen shall not manifest any cracks or cracking.

## 7.7 Corrosion

**7.7.1** Steel tubes with designations 07Cr19Ni10, 16Cr23Ni13, 20Cr25Ni20, 07Cr17Ni12Mo2, 07Cr19Ni11Ti and 07Cr18Ni11Nb do not need to undergo intergranular corrosion test, and other austenitic steel tubes shall undergo intergranular corrosion test. The intergranular corrosion test is performed in accordance with Method E in GB/T 4334-2020. After the test, the specimen shall not manifest a tendency of intergranular corrosion.

**7.7.2** Through negotiation between the supply-side and the demand-side, and statement in the contract, the demand-side may specify other test methods for corrosion.

## 7.8 Grain Size

The grain size level of steel tubes 07Cr19Ni10, 07Cr17Ni12Mo2, 07Cr19Ni11Ti and 07Cr18Ni11Nb shall be Level-4 ~ Level-7.

## 7.9 Non-destructive Testing

**7.9.1** The steel tubes shall be subjected to ultrasonic testing one by one in accordance with the stipulations of GB/T 5777-2019, and the acceptance level shall be U2.

**7.9.2** In accordance with the requirements of the demand-side, through negotiation between the supply-side and the demand-side, and statement in the contract, other non-destructive testing methods and acceptance levels can be used.

## 7.10 Surface Quality

**7.10.1** There shall be no cracks, folds, crimps, delamination and scarring on the inner and outer surfaces of the steel tubes. These defects shall be completely removed. The surface of the steel tubes where the defects are removed shall be round and smooth, without edges and corners, and the actual wall thickness at the position of removal shall not be less than the minimum allowable wall thickness.

**7.10.2** The allowable depth of straight tracks on the inner and outer surfaces of the steel tubes shall comply with the following stipulations:

- a) For cold drawn (rolled) steel tubes: not greater than 4% of wall thickness, and not greater than 0.2 mm;
- b) Hot rolled (extruded) steel tubes: not greater than 5% of wall thickness, and not greater than 0.4 mm.

**7.10.3** Other local defects not exceeding the lower deviation of wall thickness are allowed to exist.

## 8 Test Methods

**8.1** The chemical composition analysis and sampling of the steel tubes shall comply with the rules of GB/T 20066. Generally speaking, the chemical composition analysis complies with GB/T 11170, GB/T 20123, GB/T 20124 or other universal methods. During arbitration, the stipulations of GB/T 223.11, GB/T 223.18, GB/T 223.19, GB/T 223.23, GB/T 223.25, GB/T 223.26, GB/T 223.28, GB/T 223.36, GB/T 223.37, GB/T 223.40, GB/T 223.59, GB/T 223.60, GB/T 223.63, GB/T 223.84, GB/T 223.85, GB/T 223.86, YB/T 4395 and YB/T 4396 shall be followed.

**8.2** The dimensions and shapes of the steel tubes shall be measured one by one using a measuring tool that complies with the accuracy requirements.

**8.3** The inner and outer surfaces of the steel tubes shall be visually inspected one by one under sufficient illumination conditions. The depth of the straight track shall be measured with a measuring tool that complies with the accuracy requirements.

**8.4** The sampling methods and test methods for other inspection items of the steel tubes shall comply with the stipulations of Table 6.



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