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National Standard of the People's Republic of China

GB 13296-xxxx
Abolishes **GB 13296 1991**

Seamless stainless steel tubes for boiler and heat exchanger

(Manuscript submitted to higher authorities for approval)

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People's Republic of China

Issued by the National Standardization Administration Committee

Foreword

This standard acts as mandatory provision articles standard, which provisions 5.2.1, 5.3, 5.4, 5.5, 6.1, 6.2.2, 6.4.1, 6.5.2, 6.5.3 act as mandatory provisions.

This standard corresponds to ASME SA-213/SA-213M (Version 2001) "Seamless Ferrite and Austenitic Alloy Steel Tubes for Boiler, Super heater and Heat Interchanger". This standard is non-equivalent to ASME SA-213/SA-213M (Version 2001) uniform degree.

With the implementation of this standard, GB 13296-1991 "Seamless Stainless Steel Tubes for Boiler and Heat Exchanger" is abolished.

This standard is comparable with GB 13296-1991, its main changes are as follows:

- The applicable scope of the standard has been revised;
- Dimension, appearance and weight of the steel pipes have been revised;
- Examples of the symbols have been deleted;
- Partial steel grades have been increased, grades 1Cr25Ti and 0Cr26Ni5Mo2 have been cancelled;
- Delivery manner of steel tubes has been defined;
- Mechanical and technological properties have been revised;
- Eddy current testing examination rank has been enhanced;
- Ultrasonic testing examination rank has been enhanced;
- Batch specification demands have been revised.

Appendix A and appendix B of this standard are its material appendixes.

This standard was proposed by China Iron and Steel Industry Association.

This standard falls under the jurisdiction of the National Steel Standardization Technical Committee.

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This standard was issued in 1988 for the first time.

All previous conditions of issuance of this standard: GB 13296-1991.

Seamless Stainless Steel Tubes for Boiler and Heat Exchanger

1. Scope

This standard specifies the classification, designation, dimension, appearance, weight, technical specification, testing methods, inspection principles, package, marking and quality certification of seamless stainless steel tubes for boilers and heat exchangers.

2. Standard Quotation Documents

Provisions in the following documents have, by the means of standard quotation, become provisions of this standard. As to all annotated dates of quotation documents, all its revisions afterwards (not including details of corrections of printing errors) or all revised versions that are inapplicable to this standard, according to the agreement based on this standard and reached by all research parties, it is yet encouraged, if it is possible, to use the newest version of these documents. As to all not annotated dates of the quotation documents, its newest version is taken as being the same as this version.

GB/T 222-1984 Steel chemistry assay law and end product chemical composition allowable deviation
GB/T 223.11 Methods for chemical analysis of iron, steel and alloy - The ammonium persulfate oxidation volumetric method for the determination of chromium content.
GB/T 223.15 Methods for chemical analysis of iron, steel and alloy - The determination of titanium by gravimetric method
GB/T 223.16 Methods for chemical analysis of iron, steel and alloy - The chromotropic acid photometric method for the determination of titanium content
GB/T 223.18 Methods for chemical analysis of iron, steel and alloy - The sodium thiosulfate separation iodimetric method for the determination of cupper 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 Methods for chemical analysis of iron, steel and alloy - The dimethylglyoxime spectrophotometric method for the determination of nickel content.
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 Methods for chemical analysis of iron, steel and alloy - The thiocyanate direct photometric method for the determination of molybdenum content.
28 GB/T 223.28 Methods for chemical analysis of iron, steel and alloy - The α-benzoinoxime gravimetric method for the determination of molybdenum content
36 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 223.37 Methods for chemical analysis of iron, steel and alloy -The indophenol blue photometric method for the determination of nitrogen content after distillation separation.

GB/T 223.40 Methods for chemical analysis of iron, steel and alloy - The anion-exchange separation-sulphochlorophenol S photometric method for the determination of niobium content
GB/T 223.41 Methods for chemical analysis of iron, steel and alloy - The anion-exchange separation-pyrogallol photometric method for the determination of tantalum content
GB/T 223.42 Methods for chemical analysis of iron, steel and alloy - The anion-exchange separation-bromopyrogallol red photometric method for the determination of tantalum content
GB/T 223.60 Methods for chemical analysis of iron, steel and alloy - The perchloric acid dehydration gravimetric method for the determination of silicon content.
GB/T 223.62 Methods for chemical analysis of iron, steel and alloy - The butyl acetate extraction photometric method for the determination of phosphorus content
GB/T 223.63 Methods for chemical analysis of iron, steel and alloy - The sodium (potassium) periodate photometric method for the determination of manganese content
GB/T 223.68 Methods for chemical analysis of iron steel and alloy - The potassium iodate titration method after combustion in the pipe furnace for the determination of sulphur content.
GB/T 223.69 Methods for chemical analysis of iron, steel and alloy - The gas-volumetric method after combustion in the pipe furnace for the determination of carbon content.
GB/T 228 Metallic materials - Tensile testing at ambient temperature. **(GB/T 228-2002, eqv ISO 6892: 1998)**
GB/T 230.1 Metallic Rockwell hardness test - Part1: Test method (scales A、B、C、D、E、F、G、H、K、N、T) (GB/T 230.1—2004, ISO 6508-1:1999, MOD)
GB/T 231.1 Metallic materials - Brinell hardness test - Part 1: Test method. **(GB/T 231.1-2002, eqv ISO 6506-1: 1999)**
GB/T 241 Metal tubes - Hydrostatic pressure testing.
GB/T 242 Metal tubes - Drift expanding test. **(GB/T 242-1997, eqv ISO 8493: 1986)**
GB/T 246 Metal tubes - Flattening test. **(GB/T 246-1997, eqv ISO 8492: 1986)**
GB/T 2102 Acceptance, packing, marking, and certification of steel tubes.
GB/T 2975 Steel and steel products - Location and preparation of test pieces for mechanical testing. **(GB/T 2975-1998, eqv ISO 377: 1997)**
GB/T 4334.5 Stainless steels - Method of copper sulfate-sulfuric acid test
GB/T 4338 Metallic materials - Tensile testing at elevated temperature（GB/T 4338—1995, eqv ISO 738:1989）
GB/T 4340.1 Metallic Vickers hardness test-Part 1: Test method (GB/T 4340.1—1999, eqv ISO 6507-1:1997)
GB/T 5777 Seamless steel tubes - Methods for ultrasonic testing. **(GB/T 5777-1996, eqv ISO 9303: 1989)**
GB/T 6394 Metal - Methods for estimating the average grain size
GB/T 7735. Steel tubes - The inspection method on eddy current test. **(GB/T 7735-1995, eqv ISO 9304: 1989)**
GB/T 11170 Method for photoelectric emission spectroscopic analysis of stainless steel.
GB/T 17395-1998 Dimensions, shapes, weight and tolerances of seamless steel tubes. **(neq ISO 1127: 1992, ISO 4200: 1991, ISO 5252: 19991)**

3. Classification, Designation

Seamless steel tubes in this standard are divided according to the product manufacturing method into two categories; categories and designations are:

a) Hot-rolled (extrusive, expanding) steel tubes— **WH**;
b) Cold-drawn (rolled) steel tubes— **WC.**

4. Order Content

According to this standard, steel tubes order contract or order form must include following information:

a) Standard serial number;
b) Name of the product;
c) Steel grade;
d) Dimension norms (outer diameter x wall thickness, millimetre as unit);
e) Quantity ordered;
f) Manufacturing methods;
g) Special requirements.

5. Dimension, Appearance and Weight

5.1. Outer Diameter and Wall Thickness

5.1.1. Regular dimension of the outer diameter of the steel tubes: 6 mm ~ 159 mm, wall thickness: 1.0 mm ~ 14 mm, steel tubes dimensions shall conform to specifications set in GB/T 17395-1998 Table 3. According to the acquirer's request and supplying and requisitioning parties' mutual agreement, steel tubes with other outer diameters and wall thickness may be supplied.

5.1.2. Allowable deviation of the nominal outer diameter and nominal wall thickness of the steel tubes shall conform to specifications set in Table 1. According to acquirer's request and supplying and requisitioning parties' mutual agreement, and if clearly indicated in the contract, steel tubes with other allowable deviation dimensions than those specified in Table 1 may be supplied.

Table 1 Allowable Deviations of the Outer Diameter and Wall Thickness

Classification and Designation of Steel Tubes	Nominal Dimensions of the Steel Tubes		Allowable Deviations
Hot-rolled (extrusive, expanding) steel tubes WH	Outer Diameter (D)	≤140	±1.25%D
		>140	±1%D
	Wall thickness (S)	≤3	$^{+40}_{0}$ %S
		>3～4	$^{+35}_{0}$ %S
		>4～5	$^{+33}_{0}$ %S
		>5	$^{+28}_{0}$ %S
Cold-drawn (rolled) steel tubes WC	Outer Diameter (D)	6～30	$^{+\ 0.15}_{-\ 0.20}$
		>30～50	±0.30
		>50	±0.75%D
	Wall Thickness [a] (S)	D≤38	$^{+20}_{0}$ %S
		D>38	$^{+22}_{0}$ %S

[a] According to supplying and requisitioning parties' mutual agreement, in case of unchanged tolerance range, allowed wall thickness deviance of the cold-drawn (rolled) steel tubes for heat exchanger with outer diameter not bigger than 38 mm may be delivered according to ±0.10%S; allowed wall thickness deviance of the cold-drawn (rolled) steel tubes for heat exchanger with outer diameter bigger than38 mmmay be delivered according to ±0.11%S.

5.2. Length

5.2.1. Regular Length

The regular length of steel tubes for boiler is 4000 mm~12000 mm.

The regular length of steel tubes for heat exchanger and other steel tubes is 3 000 mm ~ 12 000 mm.

5.2.2. Specified Length and Multiple Length

According to acquirer's request and supplying and requisitioning parties' mutual agreement, and if clearly indicated in the contract, specified length and multiple length or over length steel tubes may be supplied. Total length of specified and multiple lengths shall be in regular length scope, overall length allowable deviation is 100+mm.

Each multiple length shall set aside incision allowance 5 mm ~ 10 mm.

5.3. Bending

5.2.3 Every meter of hot-rolled (extrusive, expanding) steel tubes camber should be ≤2.0mm/m.

5.2.4 Every meter of cold-drawn (rolled) steel tubes camber shall be ≤1.5 mm/m.

5.3 Non-circularity and Wall Thickness Disproportionation

The non- circularity and wall thickness disproportionation difference of steel tubes should not surpass **80%** of the outer diameter and wall thickness tolerance.

5.4. Nosetip Dimensions

Surface of the two ends of the steel tubes should be vertical with the steel tube axis; incision burr should be eliminated.

5.5 Weight

Steel tubes shall be delivered according to their actual weight. According to acquirer's request and supplying and requisitioning parties' mutual agreement, delivery may also be made according to their theoretical weight. Theoretical weight per meter of steel tubes supplied according to average/mean wall thickness is calculated according to formula (1).

$$W = \frac{\pi}{1000}(D - S)S \cdot \rho \qquad \cdots\cdots(1)$$

Notes:
W—theoretical weight of every meter of steel tubes, kilogram per meter (kg/m) as unit;
π— 3.1416 ;
D—nominal outer diameter of steel tubes, millimetre (mm) as unit;
S—nominal wall thickness of steel tubes, millimetre (mm) as unit;
P—steel density, kilogram per dekalitre (kg/dm3) as unit, see Table 3.

As to the theoretical weight of steel tubes supplied according to the smallest wall thickness, value calculated according to formula (1) increases 15% for hot-rolled (extrusive, expanding) steel tubes, value calculated according to formula (1) increases 10 % for cold-drawn (rolled) steel tubes, these values stand for the standard quantity.?

6. Technical Specifications

6.1. Steel Grade and Chemical Composition of Steel

6.1.1. Steel grade and chemical composition of steel (smelting analyses) should conform to stipulations specified in Table 2, steel tubes are inspected and accepted according to the smelting analyses.

6.1.2 The allowable deviation of chemical composition of the steel tubes end product should conform to stipulations specified in Table 3 of GB/T 222-1984.

Table 2 Steel Grade and Chemical Composition

Type	No.	Steel Grade	Chemical Composition of Steel (mass fraction), %									
			C	Si	Mn	P	S	Ni	Cr	Mo	Ti	Other
Austenite	1	0Cr18Ni9	≤0.07	≤1.00	≤2.00	≤0.035	≤0.030	8.00～11.00	17.00～19.00	—	— —	
	2	1Cr18Ni9	≤0.15	≤1.00	≤2.00	≤0.035	≤0.030	8.00～10.00	17.00～19.00	—	— —	
	3	1Cr19Ni9	0.04～0.10	≤1.00	≤2.00	≤0.035	≤0.030	8.00～11.00	18.00～20.00	—	—	—
	4	00Cr19Ni10	≤0.030	≤1.00	≤2.00	≤0.035	≤0.030	8.00～12.00	18.00～20.00	—	—	—
	5	0Cr18Ni10Ti	≤0.08	≤1.00	≤2.00	≤0.035	≤0.030	9.00～12.00	17.00～19.00	—	≥5C	—
	6	1Cr18Ni11Ti	0.04～0.10	≤0.75	≤2.00	≤0.030	≤0.030	9.00～13.00	17.00～20.00	—	4×C～0.60	—
	7	0Cr18Ni11Nb	≤0.08	≤1.00	≤2.00	≤0.035	≤0.030	9.00～13.00	17.00～19.00	—	—	Nb+Ta：10×C～1.00
	8	1Cr19Ni11Nb	0.04～0.10	≤1.00	≤2.00	≤0.035	≤0.030	9.00～13.00	17.00～20.00	—	—	Nb+Ta：8×C～1.00
	9	0Cr17Ni12Mo2	≤0.08	≤1.00	≤2.00	≤0.035	≤0.030	11.00～14.00	16.00～18.00	2.00～3.00	—	—
	10	1Cr17Ni12Mo2	0.04～0.10	≤0.75	≤2.00	≤0.030	≤0.030	11.00～14.00	16.00～18.00	2.00～3.00	—	—
	11	00Cr17Ni14Mo2	≤0.030	≤1.00	≤2.00	≤0.035	≤0.030	12.00～15.00	16.00～18.00	2.00～3.00	—	—
	12	0Cr18Ni12Mo2Ti	≤0.08	≤1.00	≤2.00	≤0.035	≤0.030	11.00～14.00	16.00～19.00	1.80～2.50	5C～0.70	—
	13	1Cr18Ni12Mo2Ti	≤0.12	≤1.00	≤2.00	≤0.035	≤0.030	11.00～14.00	16.00～19.00	1.80～2.50	5(C-0.02)～0.80	—
	14	0Cr18Ni12Mo3Ti	≤0.08	≤1.00	≤2.00	≤0.035	≤0.030	11.00～14.00	16.00～19.00	2.50～3.50	5C～0.70	—
	15	1Cr18Ni12Mo3Ti	≤0.12	≤1.00	≤2.00	≤0.035	≤0.030	11.00～14.00	16.00～19.00	2.50～3.50	5(C-0.02)～0.80	—
	16	1Cr18Ni9Ti	≤0.12	≤1.00	≤2.00	≤0.035	≤0.030	8.00～11.00	17.00～19.00	—	5(C-0.02)～0.80	—
	17	0Cr19Ni13Mo3	≤0.08	≤1.00	≤2.00	≤0.035	≤0.030	11.00～15.00	18.00～20.00	3.00～4.00	—	—

Table 2 continue

Type	No.	Steel Grade	Chemical Composition of Steel (mass fraction), %									
			C	Si	Mn	P	S	Ni	Cr	Mo	Ti	其他
Austenite	18	00Cr19Ni13Mo3	≤0.030	≤1.00	≤2.00	≤0.035	≤0.030	11.00～15.00	18.00～20.00	3.00～4.00	—	—
	19	00Cr18Ni10N	≤0.030	≤1.00	≤2.00	≤0.035	≤0.030	8.50～11.50	17.00～19.00	—	—	N：0.10～0.16
	20	0Cr19Ni9N	≤0.08	≤1.00	≤2.00	≤0.035	≤0.030	7.00～10.50	18.00～20.00	—	—	N：0.10～0.16
	21	0Cr23Ni13	≤0.08	≤1.00	≤2.00	≤0.035	≤0.030	12.00～15.00	22.00～24.00	—	—	—
	22	2Cr23Ni13	≤0.20	≤1.00	≤2.00	≤0.035	≤0.030	12.00～15.00	22.00～24.00	—	—	—
	23	0Cr25Ni20	≤0.08	≤1.00	≤2.00	≤0.035	≤0.030	19.00～22.00	24.00～26.00	—	—	—
	24	2Cr25Ni20	≤0.25	≤1.50	≤2.00	≤0.035	≤0.030	19.00～22.00	24.00～26.00	—	—	—
	25	0Cr18Ni13Si4	≤0.08	3.00～5.00	≤2.00	≤0.035	≤0.030	11.50～15.00	15.00～20.00	—	—	—
	26	00Cr17Ni13Mo2N	≤0.030	≤1.00	≤2.00	≤0.035	≤0.030	10.50～14.50	16.00～18.50	2.0～3.0	—	N：0.12～0.22
	27	0Cr17Ni12Mo2N	≤0.08	≤1.00	≤2.00	≤0.035	≤0.030	10.00～14.00	16.00～18.00	2.0～3.0	—	N：0.10～0.22
	28	0Cr18Ni12Mo2Cu2	≤0.08	≤1.00	≤2.00	≤0.035	≤0.030	10.00～14.50	17.00～19.00	1.20～2.75	—	Cu:1.00～2.50
	29	00Cr18Ni14Mo2Cu2	≤0.030	≤1.00	≤2.00	≤0.035	≤0.030	12.00～16.00	17.00～19.00	1.20～2.75	—	Cu:1.00～2.50
Ferrite	30	1Cr17[a]	≤0.12	≤0.75	≤1.00	≤0.035	≤0.030	—	16.00～18.00	—	—	
	31	00Cr27Mo[b]	≤0.010	≤0.40	≤0.40	≤0.030	≤0.020	—	25.00～27.50	0.75～1.50	—	N≤0.015

Note: 1Cr18Ni9Ti type of steel is not recommended for usage.

[a]Ni permissible content is not bigger than 0.60%;
[b]Ni permissible content is not bigger than 0.50%, Cu is not bigger than 0.20%, however Ni+Cu should be not bigger than 0.50%.

6.2. Manufacturing Method

6.2.1. Steel Smelting Method

For steel smelting, electric arc furnace plus secondary steelmaking processes or electroslag remelting processes should be employed.

According to acquirer's request and supplying and requisitioning parties' mutual agreement, other smelting methods may be employed.

6.2.2 Steel Tubes Manufacturing Method

For steel tubes, hot-rolled (extrusive, expanding) and cold-drawn (rolled) seamless manufacturing methods should be employed**.**

6.3. Conditions of Delivery

6.3.1 Steel tubes should be delivered after having undergone heat treatment and acid cleaning. For steel tubes recommended heat treating regime see Table 3, heat treating regime should be stipulated in the quality certificate. According to acquirer's request and supplying and requisitioning parties' mutual agreement, and if clearly indicated in the contract, other heat treating regimes for steel tubes than those stipulated in Table 3 may be employed.

6.3.2 All steel tubes that have undergone overall scrub or special atmosphere heat treatment may be delivered without having undergone acid cleaning.

Table 3 Recommended Heat Treating Regime and Mechanical Properties

Type	No.	Steel Grade	Recommended Heat Treating Regime		Mechanical Properties			Density ρ kg/cm³
					Tensile [a] Strength R_m N/mm²	Proof strength at Non-proal Extension $R_{p0,2}$ N/mm²	Elongation after Fracture A %	
					Not smaller than			
Austenite	1	0Cr18Ni9	1010℃～1150℃	Rapid Cooling	520	205	35	7.93
	2	1Cr18Ni9	1010℃～1150℃		520	205	35	7.90
	3	1Cr19Ni9	1010℃～1150℃		520	205	35	7.93
	4	00Cr19Ni10	1010℃～1150℃		480	175	35	7.93
	5	0Cr18Ni10Ti	920℃～1150℃		520	205	35	7.95
	6	1Cr18Ni11Ti	Cold-rolled≥1095℃ Hot-rolled≥1050℃		520	205	35	7.93
	7	0Cr18Ni11Nb	980℃～1150℃		520	205	35	7.98
	8	1Cr19Ni11Nb	Cold-rolled≥1095℃ Hot-rolled≥1050℃		520	205	35	8.00
	9	0Cr17Ni12Mo2	1010℃～1150℃		520	205	35	7.98
	10	1Cr17Ni12Mo2	≥1040℃		520	205	35	7.98
	11	00Cr17Ni14Mo2	1010℃～1150℃		480	175	40	7.98
	12	0Cr18Ni12Mo2Ti	1000℃～1100℃		530	205	35	8.00
	13	1Cr18Ni12Mo2Ti	1000℃～1100℃		540	215	35	8.00
	14	0Cr18Ni12Mo3Ti	1000℃～1100℃		530	205	35	8.10
	15	1Cr18Ni12Mo3Ti	1000℃～1100℃		540	215	35	8.10
	16	1Cr18Ni9Ti	920℃～1150℃		520	205	40	7.90
	17	0Cr19Ni13Mo3	1010℃～1150℃		520	205	35	7.98
	18	00Cr19Ni13Mo3	1010℃～1150℃		480	175	35	7.98
	19	00Cr18Ni10N	1010℃～1150℃		515	205	35	7.90
	20	0Cr19Ni9N	1010℃～1150℃		550	240	35	7.90
	21	0Cr23Ni13	1030℃～1150℃		520	205	35	7.98
	22	2Cr23Ni13	1030℃～1150℃		520	205	35	7.98
	23	0Cr25Ni20	1030℃～1180℃		520	205	35	7.98
	24	2Cr25Ni20	1030℃～1180℃	Rapid Cooling	520	205	35	7.98
	25	0Cr18Ni13Si4	1010℃～1150℃		520	205	35	7.98
	26	00Cr17Ni13Mo2N	1010℃～1150℃		515	205	35	8.00
	27	0Cr17Ni12Mo2N	1010℃～1150℃		550	240	35	7.80
	28	0Cr18Ni12Mo2Cu2	1010℃～1150℃		520	205	35	7.98
	29	00Cr18Ni14Mo2Cu2	1010℃～1150℃		480	180	35	7.98
Ferrite	30	1Cr17	780℃～850℃	Air-cooling or Slow Cooling	410	245	20	7.70
	31	00Cr27Mo	900℃～1050℃	Rapid Cooling	410	245	20	7.70

[a] Tensile strength of hot extrusive steel tubes may be reduced to 20 N/mm².

6.4. Mechanical Properties

6.4.1 Longitudinal mechanical properties of heat treated steel tubes should conform to specification set in Table 3.

6.4.2 According to acquirer's request and supplying and requisitioning parties' mutual agreement, and if clearly indicated in the contract, steel tubes with wall thickness ≥2 mm may be put to one kind of hardness test among HBW, HRB and HV, hardness value of the steel tubes should be in accordance with stipulations set in Table 4.

Table 4 Hardness

Type	Steel Grade	Hardness		
		HBW	HRB	HV
Austenite	00Cr18Ni10N、0Cr19Ni9N、00Cr17Ni13Mo2N、0Cr17Ni12Mo2N	≤217	≤95	≤220
	0Cr18Ni13Si4	≤207	≤95	≤218
	Other	≤187	≤90	≤200
Ferrite	1Cr17	≤183	—	—
	00Cr27Mo	≤219	—	—

6.4.3 For the smallest value of proof strength at non-proportional extension ($R_{p0.2}$) under the condition of high temperature of finished steel tubes used for boilers with grade 1Cr18Ni9 and 1Cr19Ni11Nb and 100 000 h endurance strength recommended data see Appendix A (material appendix) and Appendix B (material appendix). According to acquirer's request and supplying and requisitioning parties' mutual agreement, and if the testing temperature is clearly indicated in the contract, supplier may provide numeral value reference of steel tubes proof strength at non-proportional extension ($R_{p0.2}$) under the condition of high temperature.

6.5 Technological Properties

6.5.1 Hydrostatic Pressure Test

Steel tubes should one by one undergo the hydrostatic pressure test; test pressure is calculated according to formula (2). The highest test pressure is 20 MPa, under the test pressure, steel tubes must not show leakage phenomenon during stable pressure period not smaller than 5 s.

$$P = 2SR/D \qquad \cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots(2)$$

Notes:
P------test pressure, mega Pascal (Mpa) as unit;
S—nominal wall thickness of steel tubes, millimetre (mm) as unit;

D ——nominal outer diameter of steel tubes, millimetre (mm) as unit;
R-----permissible stress, mega Pascal (Mpa) as unit[1]. For ferrite steel tubes, 60% of the minimum value according to proof strength at non-proportional extension listed in Table 3, for austenite steel tubes 50% of the minimum value according to proof strength at non-proportional extension listed in Table 3.

The supplier may employ the eddy current test to replace the hydrostatic pressure test. If the eddy current test is employed, contrasting test cylinder artificial defects should conform to acceptance inspection scale B of GB/T 7735 provisions.

6.5.2 Flattening Test

Steel tubes with wall thickness not bigger than 10 mm should perform the flattening test, after the sample flattening test, no cracks or brakes on the sample are allowed. Outer wall distance H after the sample flattening test is calculated according to formula (3):

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

Notes:
H—— outer wall distance after flattening, millimetre (mm) as unit;
α——coefficient of unit length deformation. 0.09 for austenite steel tubes, 0.08 for ferrite steel tubes;
S——nominal wall thickness of steel tubes, millimetre (mm) as unit;
D ——nominal outer diameter of steel tubes, millimetre (mm) as unit.

6.5.3 Expansion Test

Steel tubes with wall thickness not bigger than 10 mm, should perform the expansion test. Top core taper of the expansion test is 60°, outer diameter flaring rate of the sample after the expansion should be divided into: 15 % for the ferrite steel tubes, 18% for the austenite steel tubes. After the expansion test, no cracks or brakes on the sample are allowed.

6.6 Corrosion Test

Non-corrosive steels with grades 2Cr23Ni13 and 2Cr25Ni20 may not undergo the Huey test, other corrosive austenite steel tubes should undergo the Huey test. Huey test method is carried out according to GB/T 4334. According to acquirer's request and supplying and requisitioning parties' mutual agreement, and if clearly indicated in the contract, supplier may specify the employment of other corrosion testing methods.

6.7 Grain Size

[1] : 1 N/mm2=MPa.

1Cr19Ni9、1Cr17Ni12Mo2、1Cr18Ni11Ti、1Cr19Ni11Nb steel tubes mean grain size should be 4～7 grade.

6.8 Ultrasonic Flaw Test

Steel tubes should one by one undergo the ultrasonic flaw detecting. Level of depth of the contrast test cylinder surface longitudinal notch should be C5. According to acquirer's request and supplying and requisitioning parties' mutual agreement, and if clearly indicated in the contract, ultrasonic flaw detecting may employ other inspection and acceptance levels.

6.9 Surface Quality

On the outer and inner surface of steel tubes no cracks, folds, rolling brakes, abscission layers and scars are allowed. These flaws should be completely eliminated and surface of the steel tubes on the place where the flaw was eliminated should be smooth with no edges or corners, moreover the actual wall thickness of the cleared place should not be smaller than the minimal permitted value of the wall thickness.

Permitted depth of cut of chute should be in accordance with following stipulations:

a) Cold-drawn (rolled) steel tubes: not bigger than 4% of the wall thickness, maximum 0.2 mm;

b) Hot-rolled (extrusive, expanding) steel tubes: not bigger than 5% of the wall thickness, maximum 0.4 mm.

Other local flaws that do not surpass permitted negative deviance of the wall thickness are allowed to exist.

7 Testing Methods

7.1. For size and dimension of steel tubes, tube by tube measurement should be employed, in accordance with accuracy specifications.

7.2. Outer and inner surface of steel tubes should be inspected tube by tube under sufficient lighting conditions.

7.3. Other inspection items, inspection methods and sample quantity of the steel tubes should be in accordance with stipulations set in Table 5.

Table 5 Steel Tubes Testing Items. Sampling Quantity, Sampling Methods

and Testing methods

No.	Testing Items	Testing Methods	Sampling Methods	Sampling Quantity
1	Chemical Composition	GB/T 223 GB/T 11170	GB/T 222	From each furnace (cask) 1 sample is taken
2	Tensile Test	GB/T 228	GB/T 2975	Each batch respectively takes 1 sample of two steel tubes
3	Tensile Test under High Temperature	GB/T 4338	GB/T 2975	Each batch respectively takes 1 sample of two steel tubes
4	Hardness Test	GB/T 230.1 GB/T 231.1 GB/T 4340.1	GB/T 2975	Each batch respectively takes 1 sample of two steel tubes
5	Hydrostatic Pressure Test	GB/T 241	—	Tube by tube
6	Eddy Current Test	GB/T 7735	—	Tube by tube
7	Flattening Test	GB/T 246	GB/T 246	Each batch respectively takes 1 sample of two steel tubes
8	Expansion Test	GB/T 242	GB/T 242	Each batch respectively takes 1 sample of two steel tubes
9	Intergranular Corrosion	GB/T 4334.5	GB/T 4334.5	Each batch respectively takes 1 sample of two steel tubes
10	Grain Fineness Number	GB/T 6394	GB/T 6394	Each batch respectively takes 1 sample of two steel tubes
11	Ultrasonic Flaw Test	GB/T 5777	—	Tube by tube

8 Testing Principles

8.1 Examination, Checking and accepting
Examination, checking and accepting is carried out by the supplier's technical supervising department.

8.2 Batch Forming Principles

Steel tubes are examined, checked and accepted according to batches. Each

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batch should consist of steel tubes that have identical steel grade, identical furnace (cask) number, identical specifications and identical heat treating regime (melt). Each steel tubes batch quantity should not surpass following stipulations:

a) outer diameter $\leqslant$ 76 mm, and wall thickness $\leqslant$ 3 mm: 400 tubes;
b) other specifications, 200 tubes

8.3 Quantity of Samples

Quantity of samples for testing of each batch of steel tubes should be in accordance with stipulations set in Table 5.

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8.4. Recheck and Determination Principles

Recheck and determinations principles of steel tubes should be in accordance with provisions GB/T 2102.

9 Packing, Marking and Quality Certification

Packing, marking and quality certification of steel tubes should be in accordance with provisions GB/T 2102.

Appendix A

(Material Appendix)

Table A The Smallest Value of the Proof Strength at Non-proportional Extension（Rp0.2） under the Condition of High Temperature (N/mm²)

Newton on Millimetre as Unit

No.	Steel Grade	Temperature, ℃										
		100	150	200	250	300	350	400	450	500	550	600
1	1Cr18Ni9	171	155	144	136	128	124	119	115	111	106	—
2	1Cr19Ni11Nb	239	227	216	207	200	195	191	190	189	188	—

Appendix B
(Material Appendix)

Table B 100 000 h Endurance Strength Recommended Data

Newton on Millimetre as Unit

Endurance Strength / Test Temperature℃ / No. / Steel Grade	100 000 h Endurance Strength,															
	600	610	620	630	640	650	660	670	680	690	700	710	720	730	740	750
1 1Cr18Ni9	95	88	81	74	68	63	57	52	48	43	40	36	33	31	28	26
2 1Cr19Ni11Nb	132	121	110	100	91	82	74	66	60	54	48	43	38	34	31	28