Seamless steel tubes for low and medium pressure

GB 3087-1999

1. Scope

This standard stipulates the size, outline, weight, technical requirement, test method, inspection rule, package, mark and quality certificate of seamless steel tube for LP/IP boiler.

This standard is applicable to hot rolling (extruding, expanding) and cold drawing (rolling) seamless steel tube from quality carbon structure steel used for LP/IP boiler and locomotive boiler.

2. Applicable standard

The following standards constitute a part of this standard. All these standards shall be of valid edition while issuing this standard. Any standard could be revised. So the possibility to use the latest edition of following standards should be discussed by all parties using this standard.

GB/T222-1984 *Sampling method used for chemical analysis of steel and the allowable deviation for finished products chemical composition*

GB/T223.5-1997 *Chemical analysis method of iron, steel and alloy The determination of acid-soluble silicon content by reduction silicomolybdate photometric method*

GB/T 223.12-1991 *Chemical analysis method of iron, steel and*

alloy The determination of chromium by disphenyl carbazide photometric method after separation with sodium carbonate

GB/T 223.19-1989 *Methods for chemical analysis of iron, steel and alloy The determination of copper by neocuprone extraction photometric method*

GB/T 223.23-1994 *Chemical analysis method of iron, steel and alloy The determination of nickel by the dimethyl-glyoxime photometric method*

GB/T223.62-1988 *Methods for chemical analysis of iron, steel and alloy The determination of phosphorus content by butyl acetate extraction photometric method*

GB/T223.63-1988 *Methods for chemical analysis of iron, steel and alloy The determination of manganese content by sodium (potassium) periodate photometric method*

GB/T223.69-1997 *Methods for chemical analysis of iron, steel and alloy The determination of carbon by the gas content method after burning in tube-type furnace*

GB/T 223.72-1991 Methods for chemical analysis of iron, steel and alloy The determination of sulfur content by alumina chromatograph-barium sulfate gravimetric method

GB/T226-1991 Etch test for macrostructure and defect of steels

GB/T228-1987 Metallic materials-Tensile testing at ambient

GB/T241-1997 Metallic materials-Tube hydraulic test

GB/T242-1990 *Metallic materials-Tube-Drift expanding test*

GB/T244-1997 *Method for bend test on tubes of crimp*

GB/T245-1997 *Method for flanging test on tubes of metals*

GB/T246-1997 *Method for flattening test on tubes of metals*

GB/T699-1999 *Quality carbon structural steels*

GB/T2102-1998 *Checking, Packing, Marking and Quality certification of steel tube*

GB/T5777-1996 *Methods for ultrasonic testing of seamless steel tube and tubing*

GB/T7735-1995 *Eddy current testing for the compactness of steel tubes and tubes*

GB/T12606-1999 *Steel tubes-The testing method of magnetic flux leakage*

GB/T17395-1998 *Sizes, Shapes, Masses and Tolerances of seamless steel tubes*

Yb/t5222-1993 *Quality carbon steel tube blank*

3. Size, outline, weight

3.1 Outer diameter and wall thickness

3.1.1 The outer diameter, wall thickness and theoretical weight of steel tubes shall conform to the stipulation in Table1 of GB/T17395-1998. The steel tube beyond the range of the stipulation in Table1 of

GB/T17395-1998 can be supplied after agreement between supplier and buyer.

3.1.2 The allowable deviation of outer diameter and wall thickness shall conform to the stipulation in Table1.

The delivery based on high-level precision required by buyer shall be marked out in contact.

The steel tube with deviation beyond the range of the stipulation in Table 1 can be supplied after agreement between buyer and supplier and it shall be noted in contact.

Table 1 The allowable deviation of outer diameter and wall thickness

Kind of steel tube	Dismention of steel tube (mm)		Allowable deviation	
			Ordinary level	High-level
Hot rolling (extruding, expanding) pipe	Outer diameter D	≤159	± 1.0%(min. ±0.50mm)	± 0.75(min. ±0.40mm)
		>159	±1.0%	±0.90%
	Wall thickness s	≤20	+ 15.0%(min. +0.45mm) − 12.5% (min. − 0.35mm)	± 10%(min. ±0.30mm)
		>20	±12.5%	±105
		D ≥ 351hot expanding pipe	±15%	
Cold drawing (rolling) pipe	Outer diameter D	10~30	±0.40mm	±0.20mm
		>30~50	±0.45mm	±0.25mm
		>50	+1.0%	±0.75%
	Wall thickness s	1.5~3.0	+15% −10%	±10%
		>3.0	+12.5% −10%	±10%

3.2 Length

3.2.1 Common length

The common length of steel tube is specified as follows:

Hot rolling (extruding, expanding) steel tube…….4000~1200mm;

Cold drawing (rolling) steel tube……4000~10500mm.

The steel tube with length not less than 3000mm can be supplied after agreement between the buyer and supplier. But its weight shall not be more than the total weight of the said supplied lot by 5%.

3.2.2 The specified length and multiple length

The specified length and multiple length shall be within the range of common length and the allowable deviation of overall length shall be

+20 mm.
0 mm

The cut allowance shall be remained for each multiple length according to the following stipulation:

Outer diameter≤159mm……5~10mm;

Outer diameter＞159mm……...10~15mm.

3.2.3 Range length

The range length shall be within the common length.

3.3 Bending

The bending of steel tube shall not be greater than the following stipulation:

Wall thickness≤15mm……..1.5mm/m;

Wall thickness＞15mm……..2.0mm/m;

Outer diameter≥351mm hot expanding pipe……3.0mm/m.

The total bending of header tube shall not be greater than 12mm.

3.4 Shape of end

Both end face of steel tube shall be perpendicular to its axis and the burr of cut shall be removed.

3.5 The roundness and wall uniformity

The roundness and wall uniformity of same section of steel tube shall not exceed the tolerance of outer diameter and wall thickness by 80% respectively and noted in contact through the agreement between buyer and supplier based on the requirement of buyer.

3.6 Delivery weight

The delivery weight of steel tube shall conform to the stipulation in GB/T 17395, and be calculated according to density of 7.85kg/dm^3.

3.7 Example for mark

For steel tube with outer diameter 76mm and wall thickness 3.5mm made from steel 10#:

a) 10-76X3.5X3000---GB 3087-1999

that means this is the hot rolling steel tube with 3000mm multiple length and ordinary level for outer diameter and wall thickness.

b)(Cold) 10-76 (height)X3.5X5000—GB 3087-1999

that means this is cold drawing (rolling) steel tube with length 5000mm

and high-level for outer diameter and ordinary level for wall thickness.

4. Technical requirement

4.1 Steel brand and its chemical composition

4.1.1 The steel tube is made of the steel 10# or 20# and its chemical composition (smelting analysis) shall conform to the stipulation in GB/T 699. The steel tube shall be accepted according to the smelting composition.

4.1.2 In case the analysis shall be performed on ready product to request of buyer, it shall be noted in contact.

The allowable deviation of chemical composition of ready product steel tube shall conform to the stipulation in GB/T222.

4.2 Manufacturing process

4.2.1 The steel melting process

The steel shall be melted by electrical furnace, oxygen converter or Martin furnace. In case the buyer appoints certain melting process, it shall be noted in contact. The steel for pipe blanket can be made with continuous pulling technique shall be subject to refining out of furnace.

4.2.2 The manufacturing process of pipe blanket

The hot rolling technique and continuous pulling blanket or steel ingot could be adopted for manufacturing the pipe blanket. The hot rolling pipe blanket shall conform to the stipulation in YB/T 5222.

4.2.3 The manufacturing process of steel tube

The hot rolling (extruding, expanding) or cold drawing (rolling) could be adopted for manufacturing the steel tube as seamless one. In case the buyer appoints certain manufacturing method, it shall be noted in contact.

4.3 Delivery state

The steel tube shall be at hot rolling or heat treatment state during delivery. The finish rolling temperature of the steel tube at hot rolling state during delivery shall not be less than Ar3.

4.4 Mechanical properties

4.4.1 The longitudinal mechanical properties of steel tube during delivery state shall conform to the stipulation in Table2.

Table 2 Longitudinal mechanical properties of steel tube

Brand	Wall thickness mm	Tensile strength	Yield point σ_s MPa	Elongation δ_5 %
			≥	
10	ALL	335~475	195	24
20	＜15	410~550	245	20
	≥15		225	

4.4.2 The high temperature transient performance ($\sigma_{0.2}^{T}$) of steel tube used for superheat in IP boiler shall conform to the stipulation in Table 3. The buyer shall note the application of steel tube in contact.

The buyer could provide the actual data for high temperature transient performance of steel tube while the test temperature is noted in contact

after the agreement between buyer and supplier according to the buyer's requirement.

Table 3 Min. value ($\sigma_{0.2}^{T}$) of yield strength for steel tube under high temperature MPa

Brand of steel	Test pieces state	Temperature ℃					
		200	250	300	350	400	450
10	Delivery state	165	145	122	111	109	107
20450		188	170	149	137	134	132

4.5 Process test

4.5.1 Hydraulic test

The hydraulic test shall be performed for the steel tube one by one. The max. test pressure shall be calculated according the formula (1) (7MPa for steel 10# be, and 10MPa for steel 20#). The test shall last at least 5_s.The leakage shall not appear for the steel tube under the test pressure.

$$P=2S\cdot R/D \quad \text{.....(1)}$$

Where: P--test pressure, MPa;

S—nominal wall thickness of steel tube,mm;

D—nominal outer diameter of steel tube,mm;

R—allowable stress equal to 60% the yield point stipulated in Table 2.

The eddy current testing can be used instead of hydraulic test by the buyer. The ultrasonic test or magnetic flux leakage test can be also used instead of hydraulic test after agreement between supplier and buyer. The A level hole in GB/T 5777-1996 shall be adopted during eddy

current testing; The depth level of longitudinal notch groove at external surface of comparison sample shall conform to the stipulation in C8 of GB/T 5777-1996 during ultrasonic test; The longitudinal notch groove with min. depth 0.5mm and max. depth 1.5mm at external surface of comparison sample shall conform to the stipulation in N12.5 of GB/T 12606-1999 during magnetic flux leakage testing.

4.5.2 Flattening test

The flattening test shall be performed for the steel tube with the outer diameter more than 22mm up to 400mm and wall thickness not greater than 10mm, The distance between flat plate after the steel tube flattening shall be calculated according to formula (2):

$$H=(1+\alpha)S/\alpha+S/D \cdots\cdots (2)$$

Where: H---distance between flat plate,mm;

S---nominal wall thickness of steel tube, mm;

D---nominal outer diameter of steel tube, mm;

α —0.08 (deformation factor of unit length) or 0.07 while S/D≥0.125.

The flaw or crack shall not appear on test piece after flattening test.

4.5.3 Flanging test

The flanging test can be performed for the pipe made by steel 10# after agreement between buyer and supplier according to the requirement of buyer and it shall be noted in contact.

The width (measured from inner wall) of flanging shall not be less than the nominal inner diameter by 12% and also not less than 1.5times nominal wall thickness with flanging angle 90°. The flaw or crack shall not appear at the flanging area after the flanging test.

4.5.4 Flaring test

The flaring test can be performed for the steel tube with wall thickness not greater than 8mm after agreement between buyer and supplier. according to the requirement of buyer. The center taper can be 30°, 45° or 60°. The flaw or crack shall not appear at the test pieces after flaring.

The flaring rate at outer diameter of test pieces after flaring shall conform to the stipulation in Table 4.

Table 4 The flaring rate at outer diameter of steel tube

Brand	Flaring rate at outer diameter of steel tube, %		
	Inner diameter/outer diameter		
	≤0.6	>0.6~0.8	>0.8
10	20	15	19
20	10	12	17

4.5.5 Bending test

The bending test shall be performed for the steel tube with the outer diameter not greater than 22mm and bending angle 90, and the mandrel radius is 6 times the outer diameter of steel tube. The flaw or crack shall not appear on the bending position.

The bending test shall be performed for the steel tube used for locomotive boiler after agreement between supplier and buyer according to the requirement of buyer. The bending angle and the mandrel radius shall be agreed by both parties.

4.6 Macroscopic test

The buyer shall ensure the pickling macrostructure test pieces taken from the cross section of steel tube or its blanket free of white flake, cinder inclusion, dirt, spilliness, lamination and blistering, in case the steel tube is made of continuous pulling blanket or steel ingot.

4.7 Surface quality

Any crack, fold, backfin, mill streak, tongue and lamination shall be removed on the inner/external surface of steel tube. The depth of removal shall not exceed the negative deviation of nominal wall thickness and the actual wall thickness at the removing area shall not be less than the min value of allowable wall thickness.

The allowable defect depth of straight portion of tube is as follows:

max. depth 0.3mm but not greater than the wall thickness by 4% for cold drawing (rolling) steel tube.

max. depth 0.5mm but not be greater than the wall thickness by 5% for hot rolling (extruding, expanding) steel tube.

The rest defect is allowed if its depth is not greater than the negative deviation of wall thickness, and the residual wall thickness is not less

than the min allowable value.

4.8 NDT

The NDT shall be performed for the steel tube one by one after agreement between buyer and supplier according to the requirement of buyer and shall be noted in contact. The depth level of longitudinal notch groove on the external surface of comparison sample shall conform to the stipulation in C8 of GB/T 5777-1996.

5. Test method

5.1 The size of steel tube shall be measured by gauge with specified accuracy.

5.2 The visual inspection shall be performed for the inner/external surface of steel tube one by one.

5.3 The other inspection item of steel tube shall conform to the stipulation in Table 5.

Table 5 Inspection item, sample quantity and test method of steel tube

No.	Inspection item	Test method	Sample quantity
1	Chemical analysis	GB/T222 GB/T223	One for each furnace (can)
2	Tensile test	GB/T228	Each one for two tubes from each lot
3	Hydraulic test	GB/T241	One by one
4	Flattening test	GB/T246	Each one for two tubes from each lot
5	Flanging test	GB/T245	Each one for two tubes from each lot
6	Flaring test	GB/T242	Each one for two tubes from each lot
7	Bending test	GB/T244	Each one for two tubes from each lot
8	Macroscopic test	GB/T226	Each one for two tubes from

			each lot
9	Ultrasonic test	GB/T5777	One by one
10	Eddy current testing	GB/T7735	One by one
11	Magnetic flux leakage test	GB/T12606	One by one

6. Inspection regulation

6.1 Inspection and acceptance

The inspection and acceptance of steel tube shall conform to the stipulation in GB/T 2102.

6.2 Grouping method

The inspection and acceptance shall be performed for steel tube lot by lot. Each lot shall consist of tube with the same steel brand, same furnace (can) number, same specs and same heat treatment régime (heat No.).

All pipe section taken from multiple seamless steel tubes shall be regard as one piece.

The quantity of each lot steel tube shall not exceed the following stipulation:

For the outer diameter not greater than 76mm and wall thickness not greater than 3mm……400 pieces

For the outer diameter greater than 351mm……500 pieces

For steel tube with other size ……..200 pieces

The residual steel tubes shall be regard as a separate lot while its quantity not less than the above stipulation by 50%; or contained into the adjacent lot with same brand, same furnace (can) No, same specs and same heat

treatment regime (heat No.) while its quantity greater than the above stipulation by 50%.

6.3 Sampling quantity

The sampling quantity of each lot of steel tube for various inspection items shall be according to the stipulation in GB/T2102.

6.4 Re-test and judging regulation

The retest and judging regulation of steel tube shall conform to the stipulation in GB/T 2102.

7. Package, mark and quality certificate

The package, mark and quality certificate of steel tube shall conform to the stipulation in GB/T 2102.