

JIS G3463 Stainless Steel for Boiler and Heat Exchanger Tubes

1. Scope

This Japanese Industrial Standard specifies the stainless steel tubes (hereafter referred to as "tubes") used for exchanging heat on the inside and outside of the tube, such as superheater tubes of boilers, and heat exchanger tubes, condenser tube, such as superheater tube of boilers, and chemical and petroleum industries, However, it is not applicable to the heating furnace tube.

Annex 1 Z1 Hardness

Annex 1 Z2 Elevated temperature yield point or proof stress.

Annex 1 Z3 Ultrasonic examination

Annex 1 Z4 Eddy current examination

Annex 1 Z6 Corrosion test

Annex 2 U-bent tube

2. The standards cited in this Standard are shown in Attached Table 9.

2. Grades and symbols

Tubes shall be classified into 35 grades, and their symbol shall be as given in Table 1.

Table 1. Symbol of grade

Classification	Symbol of grade
Austenitic tube	SUS 304TB
	SUS 304HTB
	SUS 304LTB
	SUS 309TB
	SUS 309STB
	SUS 310TB
	SUS 310STB
	SUS 316TB
	SUS 316HTB
	SUS 316LTB
	SUS 316TiTB
	SUS 317TB
	SUS 836LTB
	SUS 890LTB
SUS 317LTB	

	SUS 321TB SUS 321HTB SUS 347TB SUS 347HTB SUS XM15J1TB
Austenitic ferritic tube	SUS 329J1TB SUS 329J3LTB SUS 329J4LTB
Ferritic tube	SUS 405TB SUS 409TB SUS 409LTB SUS 410TB SUS 410TiTB SUS 430TB SUS 430LXTB SUS 430JL1LTB SUS 436LTB SUS 444TB SUS XM8TB SUS XM27TB

World standard comparative table

Grade	KS	JIS	ASTM					DIN		BS
Number	D 3577	G 3463	A268	A213 (A269)	A249	A271	A632	17455	17455	3059
Austenitic tubes	STS304TB	SUS304TB		TP304	TP304	TP304	TP304	X5Cr Ni 1810	X5Cr Ni 1810	
	STS304HTB	SUS304HTB		TP304H	TP304H	TP304H				
	STS304LTB	SUS304LTB		TP304L	TP304L		TP304L	X2Cr Ni 1911	X2Cr Ni 1911	
	STS309TB	SUS309TB		-	TP309					
	STS309STB	SUS309STB		-						

Ferritic tubes	STSM8TB	SUSXM8TB									
	STSM27TB	SUSXM27TB	TPXM27								
				TP201	TP201						
				TP202Mo17122	CFS316S59						
	STS316HTB	SUS316HTB		TP316H	TP316H	TP316H	TP316H	X2Cr Ni	Mo17132		
	STS316LTB	SUS316LTB		TP316L	TP316L		TP316L				
	STS317TB	SUS317TB		TP317	TP317		TP317				
	STS317LTB	SUS317LTB		TP317L	TP317L						
	-	SUS836LTB		-							
	-	SUS890LTB									
				TP310HCb	TP310HCb						
				TP310HCbN							
				TP310S							
				TP316N	TP316N						
				TP316LN	TP316LN						
				TP348	TP348		TP348				
				TP348H	TP348H						
				TPXM-15	TPXM-15						
					TP305 TP309H TP310S TPXM-19 TPXM-29						

			25-4-4							
			26-3-3							
			29-4-2	(TPXM-10,						
			29-4	TPXM-11,						
			18Gr2Mo	TPXM-19,						
			TPXM33	TPXM-29)						
			TP430Ti							
			TP439							
			TP446-2 ^A							
			TP405							
			TP429							
			TP443							
			TP446-1							

3. Method of manufacture

3.1 The tube shall be manufactured by seamless process, or by automatic arc welding, laser welding or electric resistance welding process.

3.2 The tube shall be heat-treated as specified in Table 2. However, heat treatments not specified in Table 2. shall be subjected to the agreement between the purchaser and supplier.

3.3 The tube shall be adequately treated to remove the oxide film that may adversely affect inspection.

Table 2. Heat treatment

Classification	Heat treatment \times C	
	Annealing	Solution treatment

SUS 304TB		1 010 min., rapid cooling
SUS 304HTB	-	1 040 min., rapid cooling
SUS 304LTB	-	1 010 min., rapid cooling
SUS 309TB	-	1 030 min., rapid cooling
SUS 309STB	-	1 030 min., rapid cooling
SUS 310TB	-	1 030 min., rapid cooling
SUS 310STB	-	1 030 min., rapid cooling
SUS 316TB	-	1 010 min., rapid cooling
SUS 316HTB	-	1 040 min., rapid cooling
SUS 316LTB	-	1 010 min., rapid cooling
SUS 316TITB	-	920 min., rapid cooling
SUS 317TB	-	1 010 min., rapid cooling
SUS 836LTB	-	1 010min., rapid cooling
SUS 890LTB	-	1 030 min., rapid cooling
SUS 317LTB	-	1 030min., rapid cooling
SUS 321TB	-	920min., rapid cooling
SUS 321HTB	-	Cold finished1 095 rapid cooling Hot finished 1 050 rapid cooling
SUS 347TB	-	980 rapid cooling
SUS 347HTB	-	Cold finished1 095 rapid cooling Hot finished1 050 rapid cooling
SUS XM15J1TB	-	1 010 rapid cooling
SUS 329J1TB	-	950 rapid cooling
SUS 329J3LTB	-	950 rapid cooling
SUS 329J4LTB	-	950 rapid cooling
SUS 405TB	700 min., air cooling or slow cooling	-
SUS 409TB	700 min., air cooling or slow cooling	-
SUS 409LTB	700 min., air cooling or slow cooling	-
SUS 410TB	700 min., air cooling or slow cooling	-
SUS 410TITB	700 min., air cooling or slow cooling	-
SUS 430TB	720 min., air cooling or slow cooling	-
SUS 430LXTB	720 min., air cooling or slow cooling	-

SUS 430J1TB	720 min., air cooling or slow cooling	-
SUS 436LTB	720 min., air cooling or slow cooling	-
SUS 444TB	700 min., air cooling or slow cooling	-
SUS XM8TB	700 min., air cooling or slow cooling	-
SUS XM27TB	700 min., air cooling or slow cooling	-

Remarks

For SUS321TB, SUS3216T1TB, and SUS345TB, stabilizing treatments may be designated. In this case, the temperature of heat treatments shall be 850 X C to 930 X C.

4. Chemical composition

Table 3. Chemical composition

symbol of grade	Chemical composition %								
	C	Si	Mn	P	S	Ni	Cr	Mo	etc
SUS 304TB	0.08 max.	1.00 max.	2.00max.	0.040 max.	0.030 max.	8.00~11.00	18.00~20.00	-	-
SUS 304HTB	0.04~0.10	0.75 max.	2.00max.	0.040 max.	0.030 max.	8.00~11.00	18.00~20.00	-	-
SUS 304LTB	0.030 max.	1.00 max.	2.00max.	0.040 max.	0.030 max.	9.00~13.00	18.00~20.00	-	-
SUS 309TB	0.15 max.	1.00 max.	2.00max.	0.040 max.	0.030 max.	12.00~15.00	22.00~24.00	-	-
SUS 309STB	0.08 max.	1.0 max.	2.00max.	0.040 max.	0.030 max.	12.00~15.00	22.00~24.00	-	-
SUS 310TB	0.15 max.	1.50 max.	2.00 ax.	0.040 max.	0.030 max.	19.00~22.00	24.00~26.00	-	-
SUS 310STB	0.08 max.	1.50 max.	2.00max.	0.040 max.	0.030 max.	19.00~22.00	24.00~26.00	-	-
SUS 316TB	0.08 max.	1.00 max.	2.00max.	0.040 max.	0.030 max.	10.00~14.00	16.00~18.00	2.00~3.00	-
SUS 316HTB	0.04~0.10	0.75 max.	2.00max.	0.030 max.	0.030 max.	11.00~14.00	16.00~18.00	2.00~3.00	-
SUS 316LTB	0.030 max.	1.00 max.	2.00 ax.	0.040 max.	0.030 max.	12.00~16.00	16.00~18.00	2.00~3.00	-
SUS 316TiTB	0.08 max.	1.00 max.	2.00max.	0.040 max.	0.030 max.	11.00~15.00	16.00~18.00	2.00~3.00	Ti 5 X C % min.
SUS 317TB	0.08 max.	1.00 max.	2.00max.	0.040 max.	0.030 max.	11.00~15.00	18.00~20.00	3.00~4.00	-
SUS 317LTB	0.030 max.	1.00 max.	2.00max.	0.040 max.	0.030 max.	11.00~15.00	18.00~20.00	3.00~4.00	-
SUS 836LTB	0.030 max.	1.00 max.	2.00max.	0.040 max.	0.030 max.	24.00~26.00	19.00~24.00	5.00~7.00	N 0.25 max.
SUS 890LTB	0.020 max.	1.00 max.	2.00max.	0.040 max.	0.030 max.	23.00~28.00	19.00~23.00	4.00~5.00-	Cu 1.00~2.00
SUS 321TB	0.08 max.	1.00 max.	2.00max.	0.040 max.	0.030 max.	9.00~13.00	17.00~19.00	-	Ti5] C% min.
SUS 321HTB	0.04~0.10	0.75 max.	2.00max.	0.030 max.	0.030 max.	9.00~13.00	17.00~20.00	-	Ti4] C%~0.60
SUS 347TB	0.08max.	1.00 max.	2.00max.	0.040 max.	0.030 max.	9.00~13.00	17.00~19.00	-	Nb10] C% min.
SUS 347HTB	0.04~0.10	1.00 max.	2.00max.	0.030 max.	0.030 max.	9.00~13.00	17.00~20.00	-	Nb8] C%~1.00
SUS XM15J1TB	0.08 max.	3.00~5.00	2.00max.	0.045 max.	0.030 max.	11.50~15.00	15.00~20.00	-	-

SUS 329J1TB	0.08 max.	1.00 max.	1.50max.	0.040 max.	0.030 max.	3.00~6.00	23.00~28.00	1.00~3.00	-
SUS 329J3LTB	0.030max.	1.00 max.	1.50max.	0.040 max.	0.030 max.	4.50~7.50	21.00~26.00	2.50~4.00	N 0.08~0.30
SUS 329J4LTB	0.030 max.	1.00 max.	1.50max.	0.040 max.	0.030 max.	5.50~7.50	24.00~26.00	2.50~3.50	N 0.08~0.30
SUS 405TB	0.08 max.	1.00 max.	1.00max.	0.040max.	0.030 max.	-	11.50~14.50	-	Al 0.10~0.30
SUS 409TB	0.08 max.	1.00 max.	1.00max.	0.040max.	0.030 max.	-	10.50~11.75	-	Ti6] C%~0.75
SUS 409LTB	0.030 max.	1.00 max.	1.00max.	0.040max.	0.030 max.	-	10.50~11.75	-	Ti6] C%~0.75
SUS 410TB	0.15 max.	1.00 max.	1.00max.	0.040max.	0.030 max.	-	11.50~13.50	-	
SUS 410TiTB	0.08 max.	1.00 max.	1.00max.	0.040max.	0.030 max.	-	11.50~13.50	-	Ti6] C%~0.75
SUS 430TB	0.12 max.	0.75 max.	1.00max.	0.040max.	0.030 max.	-	16.00~18.00	-	N 0.25 max.
SUS 430LXTB	0.030 max.	0.75 max.	1.00max.	0.040max.	0.030 max.	-	16.00~19.00	-	
SUS 430J1LTB	0.025 max.	1.00 max.	1.00max.	0.040max.	0.030 max.	-	16.00~20.00	-	N 0.025 max .Nb 8X(C%+N%)~0.80 Cu 0.03~0.80
SUS 436LTB	0.025 max.	1.00 max.	1.00max.	0.040 max.	0.030 max.	-	16.00~19.00	-	Ti,Nb,Zr combination thereof 8) (C%+N%)~0.80
SUS 444TB	0.030 max.	0.75 max.	1.00max.	0.040 max.	0.030 max.	-	17.00~20.00	1.75~2.5	Ti,Nb,Zr or combination thereof 8) (C%+N%)~0.80
SUS XM8TB	0.08 max.	1.00 max.	1.00max.	0.040 max.	0.030 max.	-	17.00~19.00	-	Ti12)C%~1.10
SUS XM27TB	0.010 max.	0.40 max.	0.40max.	0.030 max.	0.020 max.	-	25.00~27.50	0.75~1.50	N 0.015 max.

Remark

1. Even when the purchaser requires product analysis, the chemical composition given above likewise applies. However, the carbon content for SUS304LTB, SUS316LTB, SUS317LTB, SUS836LTB, SUS329J3LTB, SUS329J4LTB, SUS409LTB, and SUS430LXTB shall be 0.035 % max. The carbon content for SUS430J1LTB, SUS436LTB and SUS444TB shall be 0.030 max.
 2. SUSXM15J1TB, SUS 329J1TB and SUS329J3LTB SUS329J4LTB and SUS430J1LTB, alloy elements other than those specified in Table 3 may be added.
 3. SUS 430 TB, SUS 410 TB,SUS 405TB,SUS 409 TB,SUS 410 TiTB and SUS XM8TB may contain 0.60 & max.
 4. SUS XM27TB may contain 0.50 % max. in Ni, 0.20 % max. in Cu. and 0.50 % max. in Ni + Cu.
- Further, as required, alloy element other than those given above may be added.

5. Mechanical properties**5.1 Tensile strength, yield point or proof stress, and elongation**

The tube shall be subjected to the test of 10.2, and the resulted tensile strength, proof stress, and elongation shall be as given in Table 4.

Table 4 Mechanical properties

Symbol of grade	Tensile strength kg f/Π {N/Π}	proof stress kg f/Π {N/Π}	Elongation %		
			20 mm min. in outside diameter	10 mm or over to and excl. 20 mm in outside diameter	Under 10 mm in outside diameter
			No.11 test piece No.12 test piece	No.11 test piece	No.11 test piece
SUS304TB	53{520} min.	21{206} min.	35 min.	30 min.	27 min.
SUS304HTB	53{520} min.	21{206} min.	35 min.	30 min.	27 min.
SUS304LTB	49{481} min.	18{177} min.	35 min.	30 min.	27 min.
SUS309TB	53{520} min.	21{206} min.	35 min.	30 min.	27 min.
SUS309STB	53{520} min.	21{206} min.	35 min.	30 min.	27 min.
SUS310TB	53{520} min.	21{206} min.	35 min.	30 min.	27 min.
SUS310STB	53{520} min.	21{206} min.	35 min.	30 min.	27 min.
SUS316TB	53{520} min.	21{206} min.	35 min.	30 min.	27 min.
SUS316HTB	53{520} min.	21{206} min.	35 min.	30 min.	27 min.
SUS316LTB	49{481} min.	18{177} min.	35 min.	30 min.	27 min.
SUS316TiTB	53{520} min.	21{206} min.	35 min.	30 min.	27 min.
SUS317TB	53{520} min.	21{206} min.	35 min.	30 min.	27 min.
SUS317LTB	49{481} min.	18{177} min.	35 min.	30 min.	27 min.
SUS 836LTB	53{520} min.	21{206} min.	35min.	30 min.	27 min.
SUS890LTB	49{481} min.	18{177} min.	35 min.	30 min.	27 min.
SUS321TB	53{520} min.	21{206} min.	35min.	30 min.	27 min.
SUS321HTB	53{520} min.	21{206} min.	35 min.	30 min.	27 min.
SUS347TB	53{520} min.	21{206} min.	35 min.	30 min.	27 min.
SUS347HTB	53{520} min.	21{206} min.	35 min.	30 min.	27 min.
SUSXM15J1TB	53{520} min.	21{206} min.	35 min.	30 min.	27 min.
SUS329J1TB	60{588} min.	40{392} min.	18 min.	13 min.	10 min.
SUS329J3LTB	63{618} min.	45{441} min.	18 min.	13 min.	10 min.
SUS329J4LTB	63{618} min.	45{441} min.	18 min.	13 min.	10 min.
SUS405TB	42{412} min.	21{206} min.	20 min.	15 min.	12 min.
SUS409TB	42{412} min.	21{206} min.	20 min.	15 min.	12 min.

SUS410TB	42{412} min.	21{206} min.	20 min.	15 min.	12 min.
SUS410TiTB	42{412} min.	21{206} min.	20 min.	15 min.	12 min.
SUS430TB	42{412} min.	25{245} min.	20 min.	15 min.	12 min.
SUS430LXTB	360 min.	175 min.	20 min.	15 min.	12 min.
SUS430J1LTB	390 min.	205 min.	20 min.	15min.	12 min.
SUS436LTB	41 min.	245 min.	20 min.	15 min.	12 min.
SUS444TB	42{412} min.	25{245} min.	20 min.	15 min.	12 min.
SUSXM8TB	42{412} min.	21{206} min.	20 min.	15 min.	12 min.
SUSXM27TB	42{412} min.	25{245} min.	20 min.	15 min.	12 min.

Remark

1. Exclusively for heat exchanger tube, the purchaser may, when necessary, designate the upper limit of tensile strength, which shall be the value wherein 200 N/mm is added to the value given in Table 4.
2. When the tensile test is carried out on No. 12 test piece for the tube of under 8 mm in wall thickness, the minimum value of elongation shall be calculated by subtracting 1.5 % from the values of elongation given in Table 4 for each 1 mm decrease in wall thickness, and rounding off the result to an integer in accordance with JISZ 8401.

Examples of calculation are given in Informative (reference Table).

Attached Table 6. Dimensions and mass of SUS XM27TB Unit: kg/m

Outside diameter (mm)	Wall thickness (mm)	1.2	1.6	2.0	2.3	2.6	2.9	3.2	3.5	4.0	4.5	5.0	5.5	6.0	6.5	7.0	8.0	9.5	11.0	12.5
15.9		0.425	0.551	0.670	0.754	0.833	0.909													
19.0		0.515	0.671	0.819	0.926	1.03	1.13													
21.7		0.593	0.775	0.950	1.08	1.20	1.31	1.43												
25.4		0.700	0.918	1.13	1.28	1.43	1.57	1.71	1.85											
27.2		0.752	0.987	1.21	1.38	1.54	1.70	1.85	2.00	2.24										
31.8		0.885	1.16	1.44	1.64	1.83	2.02	2.21	2.39	2.68	2.96									
34.0			1.25	1.54	1.76	1.97	2.17	2.38	2.57	2.89	3.20	3.49								
38.1			1.41	1.74	1.98	2.22	2.46	2.69	2.92	3.29	3.64	3.99	4.32							
42.7				1.96	2.24	2.51	2.78	3.05	3.31	3.73	4.14	4.54	4.93	5.31						
45.0				2.07	2.37	2.66	2.94	3.22	3.50	3.95	4.39	4.82	5.24	5.64	6.03					
48.6				2.25	2.57	2.88	3.19	3.50	3.80	4.30	4.78	5.25	5.71	6.16	6.59	7.02				
50.8				2.35	2.69	3.02	3.35	3.67	3.99	4.51	5.02	5.52	6.00	6.48	6.94	7.39	8.25	9.46	10.6	11.5
54.0				2.51	2.87	3.22	3.57	3.92	4.26	4.82	5.37	5.90	6.43	6.94	7.44	7.93	8.87	10.2	11.4	12.5

57.1			2.66	3.04	3.41	3.79	4.16	4.52	5.12	5.70	6.28	6.84	7.39	7.93	8.45	9.47	10.9	12.2	13.4
60.3			2.81	3.21	3.62	4.01	4.40	4.79	5.43	6.05	6.66	7.26	7.85	8.43	8.99	10.1	11.6	13.1	14.4
63.5				3.39	3.82	4.24	4.65	5.06	5.74	6.40	7.05	7.69	8.31	8.93	9.53	10.7	12.4	13.9	15.4
65.0				3.48	3.91	4.34	4.77	5.19	5.88	6.56	7.23	7.89	8.53	9.16	9.78	11.0	12.7	14.3	15.8
70.0				3.75	4.22	4.69	5.15	5.61	6.36	7.10	7.83	8.55	9.25	9.95	10.6	12.0	13.9	15.6	17.3
76.2				4.10	4.61	5.12	5.63	6.13	6.96	7.78	8.58	9.37	10.2	10.9	11.7	13.1	15.3	17.3	19.2
82.6							6.12	6.67	7.58	8.47	9.35	10.2	11.1	11.9	12.8	14.4	16.7	19.0	21.1
88.9							6.61	7.20	8.18	9.15	10.1	11.1	12.0	12.9	13.8	15.6	18.2	20.7	23.0
101.6								8.27	9.41	10.5	11.6	12.7	13.8	14.9	16.0	18.0	21.1	24.0	26.8
114.3									10.6	11.9	13.2	14.4	15.7	16.9	18.1	20.5	24.0	27.4	30.7
127.0									11.9	13.3	14.7	16.1	17.5	18.9	20.2	22.9	26.9	30.8	34.5
139.8												17.8	19.3	20.9	22.4	25.4	29.8	34.1	38.3

Remark

1. The numerical value of mass shall be calculated according to the following formula by taking the mass of 1 cm of steel as 7.67 g, and rounded off to three significant figures in accordance with JIS Z 8401.

$$W=0.02410 t (D-t)$$

Where

W: unit mass of tube(kg/m)

t: wall thickness of tube (mm)

D: outside diameter of tube(mm)

2 .In dealing, the unit mass of the tube shall be increased by 15% for hot finished seamless tube, and by 10 % for cold finished seamless tube, automatic arc welded tube, laser welded tube, and electric resistance welded tube. The increased unit mass shall be used as standard unit mass.

3. When the tensile test piece is taken from the automatic arc welded tube, laser welded tube, and electric resistance welded tube, No. 12 test piece shall be taken from a seamless portion.

5.2 Flattening resistance

The tube shall be tested in accordance with 10.3 and free from flaws or cracks on its wall surface. The distance between the flat plates in this test shall be in accordance with the following formula.

$$H = \frac{(1 + e)t}{e + \frac{t}{D}}$$

Where

H: distance between the flat plates(mm)

t: wall thickness of tube (mm)

D: outside diameter of tube (mm)

e: constant individually defined for each grade of tube

0.09 for austenitic tube

0.07 for austenitic-ferritic tube and ferritic tube

5.3 Flaring resistance

When the austenitic tube is flared to 1.2 times the outside diameter, and the austenitic-ferritic tube or the ferritic tube to 1.14 times the outside diameter subjected to the test in 10.4, no flaws shall be generated.

5.4 reverse flattening resistance

When the automatic arc welded tube, laser welded tube, and electric resistance welded tube are subjected to the test of 10.5, they shall be free from flaws, cracks, etc. in the weld zone.

6. Austenite grain size

When the tube of SUS321HTB is subjected to the test of 10.6, its austenite average grain size shall be No. 7 or coarser.

7. Hydraulic test characteristic or nondestructive examination characteristic

When the tube is subjected to the test of 11.7, its hydraulic test characteristic or nondestructive examination characteristic shall conform to either of the following. The preference shall be in accordance with the designation made by the purchaser or left to the discretion of the manufacturer.

7.1 Hydraulic test characteristic

When the hydraulic pressure is designated by the purchaser, apply designated pressure; or, in its absence, the pressure P calculated from the formula below (10 MPa max.) is applied, the tube shall withstand it without leakage.

In this case, the purchaser may designate values of pressure lower or higher than the pressure P.

When a hydraulic test is made in accordance with the designation by the purchaser and the test pressure exceeds either the value P or 10 MPa, the test pressure shall be subjected to the agreement between the purchaser and supplier. In this case, the designated hydraulic test pressure shall be expressed in the nearest 0.5 MPa for under 10 MPa, and in the nearest 1 MPa calculated from the following formula and rounded off likewise to the nearest 0.5 MPa or 1 MPa.

$$P = 2st / D$$

Where

P: test pressure (MPa)

t: wall thickness of tube (mm)

D: outside diameter of tube (mm)

s: 60% of the minimum value of proof stress specified in Table 4. (N/mm²)

7.2 Nondestructive examination characteristic

Either an ultrasonic examination or an eddy current examination shall be made on the tube, and there shall be no signal equal to or greater than those produced by the working sensitivity in JIS G 0582 or the division EY of the working sensitivity specified in JIS G 0583, respectively.

8. Appearance

- 8.1 The tube shall be practically straight and its both ends shall be at right angles to the axis of the tube.
- 8.2 The inside and outside surfaces of the tube shall be well-finished and free from defects in jurious to use.

9. Dimensions, mass, and dimensional tolerances

9.1 Dimensions and mass

The outside diameter, wall thickness, and mass of the tube shall be as specified in Attached Table to 8 unless otherwise specified.

Table 1, Table 2, Table 3, Table 4, table5, Table 6.

Attached Table 1. Dimensions and mass of SUS 304 TB, SUS 304 HTB, SUS 304 LTB, SUS 321 and TBSUS 321 HTB Unit: kg/m

Outside diameter (mm)	Wall thickness (mm)	1.2	1.6	2.0	2.3	2.6	2.9	3.2	3.5	4.0	4.5	5.0	5.5	6.0	6.5	7.0	8.0	9.5	11.0	12.5	
15.9		0.439	0.570	0.692	0.779	0.861	0.939														
19.0		0.532	0.693	0.847	0.957	1.06	1.16														
21.7		0.613	0.801	0.981	1.11	1.24	1.36	1.47													
25.4		0.723	0.949	1.17	1.32	1.48	1.63	1.77	1.91												
27.2		0.777	1.02	1.26	1.43	1.59	1.76	1.91	2.07	2.31											
31.8		0.915	1.20	1.48	1.69	1.89	2.09	2.28	2.47	2.77	3.06										
34.0			1.29	1.59	1.82	2.03	2.45	2.46	2.66	2.99	3.31	3.61									
38.1			1.45	1.80	2.05	2.30	2.54	2.78	3.02	3.40	3.77	4.12	4.47								
42.7				2.03	2.31	2.60	2.88	3.15	3.42	3.86	4.28	4.70	5.10	5.49							
45.0				2.14	2.45	2.75	3.04	3.33	3.62	4.09	4.54	4.98	5.41	5.83	6.23						
48.6				2.32	2.65	2.98	3.30	3.62	3.93	4.44	4.94	5.43	5.90	6.37	6.82	7.25					
50.8				2.43	2.78	3.12	3.46	3.79	4.12	4.66	5.19	5.70	6.21	6.70	7.17	7.64	8.53	9.77	10.9	11.9	
54.0				2.59	2.96	3.33	3.69	4.05	4.40	4.98	5.55	6.10	6.64	7.17	7.69	8.20	9.17	10.5	11.8	12.9	
57.1				2.75	3.14	3.53	3.92	4.30	4.67	5.29	5.90	6.49	7.07	7.64	8.19	8.74	9.78	11.3	12.6	13.9	
60.3				2.90	3.32	3.74	4.15	4.55	4.95	5.61	6.25	6.89	7.51	8.12	8.71	9.29	10.4	12.0	13.5	14.9	
63.5					3.51	3.94	4.38	4.81	5.23	5.93	6.61	7.29	7.95	8.59	9.23	9.85	11.1	12.8	14.4	15.9	

38.1		1.46	1.81	2.06	2.31	2.56	2.80	3.04	3.42	3.79	4.15	4.50							
42.7			2.04	2.33	2.61	2.89	3.17	3.44	3.88	4.31	4.73	5.13	5.52						
45.0			2.16	2.46	2.76	3.06	3.35	3.64	4.11	4.57	5.01	5.45	5.87	6.27					
48.6			2.34	2.67	3.00	3.32	3.64	3.96	4.47	4.98	5.47	5.94	6.41	6.86	7.30				
50.8			2.45	2.80	3.14	3.48	3.82	4.15	4.69	5.22	5.74	6.25	6.74	7.22	7.69	8.58	9.84	11.0	12.0
54.0			2.61	2.98	3.35	3.72	4.08	4.43	5.01	5.58	6.14	6.69	7.22	7.74	8.25	9.23	10.6	11.9	13.0
57.1			2.76	3.16	3.55	3.94	4.32	4.70	5.32	5.93	6.53	7.11	7.69	8.25	8.79	9.85	11.3	12.7	14.0
60.3			2.92	3.34	3.76	4.17	4.58	4.98	5.65	6.30	6.93	7.56	8.17	8.77	9.35	10.5	12.1	13.6	15.0
63.5				3.53	3.97	4.41	4.84	5.26	5.97	6.66	7.33	8.00	8.65	9.29	9.92	11.1	12.9	14.5	16.0
65.0				3.62	4.07	4.51	4.96	5.40	6.12	6.83	7.52	8.20	8.87	9.53	10.2	11.4	13.2	14.9	16.5
70.0				3.90	4.39	4.88	5.36	5.84	6.62	7.39	8.15	8.89	9.63	10.3	11.1	12.4	14.4	16.3	18.0
76.2				4.26	4.80	5.33	5.86	6.38	7.24	8.09	8.92	9.75	10.6	11.4	12.1	13.7	15.9	18.0	20.0
82.6							6.37	6.94	7.88	8.81	9.73	10.6	11.5	12.4	13.3	15.0	17.4	19.7	22.0
88.9							6.88	7.49	8.51	9.52	10.5	11.5	12.5	13.4	14.4	16.2	18.9	21.5	23.9
101.6								8.61	9.79	11.0	12.1	13.3	14.4	15.5	16.6	18.8	21.9	25.0	27.9
114.3									11.1	12.4	13.7	15.0	16.3	17.6	18.8	21.3	25.0	28.5	31.9
127.0									12.3	13.8	15.3	16.8	18.2	19.6	21.1	23.9	28.0	32.0	35.9
139.8												18.5	20.1	21.7	23.3	26.4	31.0	35.5	39.9

Remark

1. The numerical value of mass shall be calculated according to the following formula by taking the mass of 1 cm of steel as 7.98g, and rounded off to three significant figures in accordance with JIS Z 8401.

$$W=0.024 50t (D-t)$$

Where

W: unit mass of tube (kg/m)

t: wall thickness of tube (mm)

D: outside diameter of tube(mm)

2. In dealing, the unit mass of the tube shall be increased by 15% for hot finished seamless tube, and by 10 % for cold finished seamless tube, automatic arc welded tube, laser welded tube, and electric resistance welded tube. The increased unit mass shall be used as standard unit mass.

Outside diameter (mm)	Wall thickness (mm)	1.2	1.6	2.0	2.3	2.6	2.9	3.2	3.5	4.0	4.5	5.0	5.5	6.0	6.5	7.0	8.0	9.5	11.0	12.5			
15.9		0.432	0.561	0.681	0.766	0.847	0.924																
19.0		0.523	0.682	0.833	0.941	1.04	1.14																
21.7		0.603	0.788	0.965	1.09	1.22	1.34	1.45															
25.4		0.711	0.933	1.15	1.30	1.45	1.60	1.74	1.88														
27.2		0.764	1.00	1.23	1.40	1.57	1.73	1.88	2.03	2.27													
31.8		0.900	1.18	1.46	1.66	1.86	2.05	2.24	2.43	2.72	3.01												
34.0			1.27	1.57	1.79	2.00	2.21	2.41	2.62	2.94	3.25	3.55											
38.1			1.43	1.77	2.02	2.26	2.50	2.74	2.97	3.34	3.70	4.05	4.39										
42.7				1.99	2.28	2.55	2.83	3.10	3.36	3.79	4.21	4.62	5.01	5.39									
45.0				2.11	2.41	2.70	2.99	3.28	3.56	4.02	4.47	4.90	5.32	5.73	6.13								
48.6				2.28	2.61	2.93	3.25	3.56	3.87	4.37	4.86	5.34	5.81	6.26	6.70	7.13							
50.8				2.39	2.73	3.07	3.40	3.73	4.06	4.59	5.10	5.61	6.10	6.59	7.05	7.51	8.39	9.61	10.7	11.7			
54.0				2.55	2.91	3.27	3.63	3.98	4.33	4.90	5.46	6.00	6.54	7.06	7.56	8.06	9.02	10.4	11.6	12.7			
57.1				2.70	3.09	3.47	3.85	4.23	4.60	5.20	5.80	6.38	6.95	7.51	8.06	8.59	9.62	11.1	12.4	13.7			
60.3				2.86	3.27	3.68	4.08	4.48	4.87	5.52	6.15	6.77	7.38	7.98	8.57	9.14	10.3	11.8	13.3	14.6			
63.5					3.45	3.88	4.31	4.73	5.15	5.83	6.50	7.17	7.82	8.45	9.08	9.69	10.9	12.6	14.1	15.6			
65.0					3.53	3.97	4.41	4.85	5.27	5.98	6.67	7.35	8.02	8.67	9.32	9.95	11.2	12.9	14.6	16.1			
70.0					3.81	4.29	4.77	5.23	5.70	6.47	7.22	7.96	8.69	9.41	10.1	10.8	12.2	14.1	15.9	17.6			
76.2					4.16	4.69	5.21	5.72	6.23	7.08	7.90	8.72	9.53	10.3	11.1	11.9	13.4	15.5	17.6	19.5			
82.6										6.22	6.78	7.70	8.61	9.51	10.4	11.3	12.1	13.0	14.6	17.0	19.3	21.5	
88.9										6.72	7.32	8.32	9.31	10.3	11.2	12.2	13.1	14.0	15.9	18.5	21.0	23.4	
101.6											8.41	9.56	10.7	11.8	12.9	14.1	15.1	16.2	18.3	21.4	24.4	27.3	
114.3												10.8	12.1	13.4	14.7	15.9	17.2	18.4	20.8	24.4	27.8	31.2	
127.0													12.1	13.5	14.9	16.4	17.8	19.2	20.6	23.3	27.3	31.3	35.1
139.8															18.1	19.7	21.2	22.8	25.8	30.3	34.7	39.0	

Remark

1. The numerical value of mass shall be calculated according to the following formula by taking the mass of 1 cm of steel as 7.80 g, and rounded off to three significant figures in

accordance with JIS Z 8401.

$$W=0.024 50t (D-t)$$

Where

W: unit mass of tube (kg/m)

t: wall thickness of tube (mm)

D: outside diameter of tube (mm)

2 .In dealing, the unit mass of the tube shall be increased by 15% for hot finished seamless tube, and by 10 % for cold finished seamless tube, automatic arc welded tube, laser welded tube, and electric resistance welded tube. The increased unit mass shall be used as standard unit mass.

Attached Table 4. Dimensions and mass of SUS 430 TB and SUSXM8TB Unit: kg/m

Outside diameter (mm)	Wall thickness (mm)	1.2	1.6	2.0	2.3	2.6	2.9	3.2	3.5	4.0	4.5	5.0	5.5	6.0	6.5	7.0	8.0	9.5	11.0	12.5
15.9		0.427	0.553	0.672	0.757	0.836	0.912													
19.0		0.517	0.673	0.822	0.929	1.03	1.13													
21.7		0.595	0.778	0.953	1.08	1.20	1.32	1.43												
25.4		0.702	0.921	1.13	1.29	1.43	1.58	1.72	1.85											
27.2		0.755	0.991	1.22	1.39	1.55	1.70	1.86	2.01	2.24										
31.8		0.888	1.17	1.44	1.64	1.84	2.03	2.21	2.40	2.69	2.97									
34.0			1.25	1.55	1.76	1.97	2.18	2.38	2.58	2.90	3.21	3.51								
38.1			1.41	1.75	1.99	2.23	2.47	2.70	2.93	3.30	3.66	4.00	4.33							
42.7				1.97	2.25	2.52	2.79	3.06	3.32	3.74	4.16	4.56	4.95	5.33						
45.0				2.08	2.38	2.67	2.95	3.24	3.51	3.97	4.41	4.84	5.26	5.66	6.05					
48.6				2.25	2.58	2.89	3.21	3.51	3.82	4.32	4.80	5.27	5.73	6.18	6.62	7.04				
50.8				2.36	2.70	3.03	3.36	3.68	4.00	4.53	5.04	5.56	6.03	6.50	6.97	7.42	8.28	9.49	10.6	11.6
54.0				2.52	2.88	3.23	3.58	3.93	4.28	4.84	5.39	5.93	6.45	6.97	7.47	7.96	8.90	10.2	11.4	12.5
57.1				2.67	3.05	3.42	3.80	4.17	4.54	5.14	5.73	6.30	6.87	7.42	7.96	8.48	9.50	10.9	12.3	13.5
60.3				2.82	3.23	3.63	4.03	4.42	4.81	5.45	6.07	6.69	7.29	7.88	8.46	9.03	10.1	11.7	13.1	14.5
63.5					3.40	3.83	4.25	4.67	5.08	5.76	6.42	7.08	7.72	8.35	8.96	9.57	10.7	12.4	14.0	15.4
65.0					3.49	3.92	4.36	4.78	5.21	5.90	6.59	7.26	7.92	8.56	9.20	9.82	11.0	12.8	14.4	15.9

70.0				3.77	4.24	4.71	5.17	5.63	6.39	7.13	7.86	8.58	9.29	9.98	10.7	12.0	13.9	15.7	17.4
76.2				4.11	4.63	5.14	5.65	6.16	6.99	7.80	8.61	9.41	10.2	11.0	11.7	13.2	15.3	17.3	19.3
82.6							6.15	6.70	7.61	8.50	9.39	10.3	11.1	12.0	12.8	14.4	16.8	19.1	21.2
88.9							6.63	7.23	8.21	9.19	10.1	11.1	12.0	13.0	13.9	15.7	18.2	20.7	23.1
101.6								8.31	9.44	10.6	11.7	12.8	13.9	15.0	16.0	18.1	21.2	24.1	26.9
114.3									10.7	12.0	13.2	14.5	15.7	16.0	18.2	20.6	24.1	27.5	30.8
127.0									11.9	13.3	14.8	16.2	17.6	18.0	20.3	23.0	27.0	30.9	34.6
139.8												17.9	19.4	21.0	22.5	25.5	29.9	34.3	38.5

Remark

1. The numerical value of mass shall be calculated according to the following formula by taking the mass of 1 cm of steel as 7.70 g, and rounded off to three significant figures in accordance with JIS Z 8401.

$$W=0.02419 t (D-t)$$

Where

W: unit mass of tube (kg/m)

t: wall thickness of tube (mm)

D: outside diameter of tube (mm)

2. In dealing, the unit mass of the tube shall be increased by 15% for hot finished seamless tube, and by 10 % for cold finished seamless tube, automatic arc welded tube, laser welded tube, and electric resistance welded tube. The increased unit mass shall be used as standard unit mass.

Attached Table 5. Dimensions and mass of SUS 405 TB, SUS 409 TB, SUS 410 TB, SUS 410TiTB, SUS 444 TB, SUSXM 15 J 1 TB Unit: kg/m

Outside diameter (mm)	Wall thickness (mm)	1.2	1.6	2.0	2.3	2.6	2.9	3.2	3.5	4.0	4.5	5.0	5.5	6.0	6.5	7.0	8.0	9.5	11.0	12.5	
15.9		0.430	0.557	0.677	0.762	0.842	0.918														
19.0		0.520	0.678	0.828	0.935	1.04	1.14														
21.7		0.599	0.783	0.960	1.09	1.21	1.33	1.44													
25.4		0.707	0.927	1.14	1.29	1.44	1.59	1.73	1.87												
27.2		0.760	0.997	1.23	1.39	1.56	1.72	1.87	2.02	2.26											
31.8		0.894	1.18	1.45	1.65	1.85	2.04	2.23	2.41	2.71	2.99										
34.0			1.26	1.56	1.78	1.99	2.20	2.40	2.60	2.92	3.23	3.53									
38.1			1.42	1.76	2.00	2.25	2.49	2.72	2.95	3.32	3.68	4.03	4.37								
42.7				1.98	2.26	2.54	2.81	3.08	3.34	3.77	4.19	4.59	4.98	5.36							

19.0	0.515	0.671	0.819	0.926	1.03	1.13														
21.7	0.593	0.775	0.950	1.08	1.20	1.31	1.43													
25.4	0.700	0.918	1.13	1.28	1.43	1.57	1.71	1.85												
27.2	0.752	0.987	1.21	1.38	1.54	1.70	1.85	2.00	2.24											
31.8	0.885	1.16	1.44	1.64	1.83	2.02	2.21	2.39	2.68	2.96										
34.0		1.25	1.54	1.76	1.97	2.17	2.38	2.57	2.89	3.20	3.49									
38.1		1.41	1.74	1.98	2.22	2.46	2.69	2.92	3.29	3.64	3.99	4.32								
42.7			1.96	2.24	2.51	2.78	3.05	3.31	3.73	4.14	4.54	4.93	5.31							
45.0			2.07	2.37	2.66	2.94	3.22	3.50	3.95	4.39	4.82	5.24	5.64	6.03						
48.6			2.25	2.57	2.88	3.19	3.50	3.80	4.30	4.78	5.25	5.71	6.16	6.59	7.02					
50.8			2.35	2.69	3.02	3.35	3.67	3.99	4.51	5.02	5.52	6.00	6.48	6.94	7.39	8.25	9.46	10.6	11.5	
54.0			2.51	2.87	3.22	3.57	3.92	4.26	4.82	5.37	5.90	6.43	6.94	7.44	7.93	8.87	10.2	11.4	12.5	
57.1			2.66	3.04	3.41	3.79	4.16	4.52	5.12	5.70	6.28	6.84	7.39	7.93	8.45	9.47	10.9	12.2	13.4	
60.3			2.81	3.21	3.62	4.01	4.40	4.79	5.43	6.05	6.66	7.26	7.85	8.43	8.99	10.1	11.6	13.1	14.4	
63.5				3.39	3.82	4.24	4.65	5.06	5.74	6.40	7.05	7.69	8.31	8.93	9.53	10.7	12.4	13.9	15.4	
65.0				3.48	3.91	4.34	4.77	5.19	5.88	6.56	7.23	7.89	8.53	9.16	9.78	11.0	12.7	14.3	15.8	
70.0				3.75	4.22	4.69	5.15	5.61	6.36	7.10	7.83	8.55	9.25	9.95	10.6	12.0	13.9	15.6	17.3	
76.2				4.10	4.61	5.12	5.63	6.13	6.96	7.78	8.58	9.37	10.2	10.9	11.7	13.1	15.3	17.3	19.2	
82.6								6.12	6.67	7.58	8.47	9.35	10.2	11.1	11.9	12.8	14.4	16.7	19.0	21.1
88.9								6.61	7.20	8.18	9.15	10.1	11.1	12.0	12.9	13.8	15.6	18.2	20.7	23.0
101.6								8.27	9.41	10.5	11.6	12.7	13.8	14.9	16.0	18.0	21.1	24.0	26.8	
114.3									10.6	11.9	13.2	14.4	15.7	16.9	18.1	20.5	24.0	27.4	30.7	
127.0									11.9	13.3	14.7	16.1	17.5	18.9	20.2	22.9	26.9	30.8	34.5	
139.8												17.8	19.3	20.9	22.4	25.4	29.8	34.1	38.3	

Remark

1. The numerical value of mass shall be calculated according to the following formula by taking the mass of 1 cm of steel as 7.67 g, and rounded off to three significant figures in accordance with JIS Z 8401.

$$W=0.02410 t (D-t)$$

Where

W: unit mass of tube (kg/m)

t: wall thickness of tube (mm)

D: outside diameter of tube (mm)

2 .In dealing, the unit mass of the tube shall be increased by 15% for hot finished seamless tube, and by 10 % for cold finished seamless tube, automatic arc welded tube, laser welded tube, and electric resistance welded tube. The increased unit mass shall be used as standard unit mass.

9.2 Dimensional tolerances

The dimensional tolerances of the tube shall be as follows.

(1) Tolerances on the outside diameter of the tube shall be as given in Table 5

Table 5 Tolerances on outside diameter Unit :mm

Division of outside diameter	Tolerances on outside diameter		
	Hot finished seamless tube	Cold finished seamless tube	Automatic arc welded tube Laser welded tube and Electric resistance welded tube
Under 40	+0.4 -0.8	[0.25	[0.25
40 or over to and excl. 50		[0.25	[0.25
50 or over to and excl. 60		[0.25	[0.25
60 or over to and excl. 70		[0.30	[0.30
80 or over to and excl.90		[0.40	[0.40
100 or over to and excl. 110	+0.4 -1.2	+0.40 -0.60	+0.40 -0.60
120 or over to and excl. 160		+0.40 -0.80	+0.40 -0.80
160 or over to and excl. 200	+0.4 -1.8	+0.40 -1.20	+0.40 -1.20
200 or over		+0.40 -1.60	+0.40 -1.60

Remark

1. The tolerances on the outside diameter of ferritic cold finished seamless tube, automatic arc welded tube, and electric resistance welded tube shall be [0.10 mm for outside diameter of under 25mm, [0.15 mm for outside diameter of 25 mm or over to and excluding 40 mm, and [0.20 mm for outside diameter of 40 mm or over to and excluding 50 mm.

2. The purchaser may specify the tolerances on the outside diameter of cold finished seamless tube, automatic arc welded tube, laser welded tube, and electric resistance welded tube of under 40 mm in outside diameter as [0.20mm.

(2) The tolerances on the wall thickness and the eccentricity shall be as specified in Table 6.

Table 6. Tolerances on thickness and on eccentricity

division of tolerance	Division of wall thickness mm		Hot finished seamless tube		Cold finished seamless tube		Automatic arc welded tube Electric resistance welded tube	
	Division of wall thickness mm	Division of outside diameter mm	Under 100	100 or over	Under 40	40 or over	40 or over	40 or over
Tolerances on wall thickness %	Under 2		-	-	+0.4mm 0		+0.4mm 0	
	2 or over to and excl. 2.4		+40 0	-				
	2.4 or over to and excl. 3.8		+35 0	+35 0	+20 0	+22 0	+20 0	+22 0
	3.8 or over to and excl. 4.6		+33 0	+33 0				
	4.6 or over		+28 0	+28 0				
Tolerances on eccentricity %			22.8 max. of wall thickness					

Remark

The eccentricity means the ratio of the difference between maximum and minimum of measured wall thickness in the same section to the specified wall thickness and this is not applicable to the tube of under 5.6 mm wall thickness.

(3) Tolerances to the tube of the tube shall be as specified in Table 7.

Table 7. Tolerances on length

Division		Tolerance on length
30 mm or under in outside diameter	7 m or under in length	+0.7mm 0
	Over 7 m in length	Add 3 mm to the plus side tolerances given above for an increase of every 3 m or its fraction in length. However, the maximum value shall be 15 mm.

Over 50 mm in outside diameter	7 m or under in length	+10mm 0
	Over 7 m in length	Add 3 mm to the plus side tolerances given above for an increases of every 3 m or its fraction in length. However, the maximum value shall be 15 mm.

Remarks

When an accurate length is particularly required, the tolerances shall be subjected to the agreement between the purchaser and supplier.

10. Stainless steel boiler and heat exchanger tubes

Stainless steel boiler and heat exchanger tubes

Outside diameter (O.D)	Wall thickness (W.T)	Weight kg/M													
		304(L)	316(L)	20n	100n	150n	200n	250n	300n	350n	400n	t ^{calc}	O.D/I.D	m	
6	1	0.125	0.125	390	306	275	256	242	230	219	211	0.800	1.36	1.00	≤
6.35	0.89	0.121	0.122	309	242	218	203	192	182	174	167	0.690	1.28	1.00	≤
6.35	1.24	0.158	0.159	496	389	350	326	308	292	276	269	1.040	1.49	1.00	≤
8	1	0.174	1.175	281	221	199	185	175	166	159	153	0.800	1.25	1.00	≤
8	1.5	0.243	0.244	492	385	347	323	305	290	277	266	1.300	1.48	1.00	
9.53	0.89	0.192	0.193	198	155	139	130	123	117	111	107	0.690	1.17	1.00	≤
9.53	1.24	0.256	0.257	310	243	219	204	193	183	175	168	1.040	1.28	1.00	≤
9.53	1.65	0.324	0.326	455	357	321	299	282	268	256	246	1.450	1.44	1.00	≤
10	1	0.224	0.225	220	173	155	145	137	130	124	119	0.800	1.19	1.00	≤
10	1.5	0.318	0.319	379	297	267	249	235	223	213	205	1.300	1.35	1.00	≤
10	2	0.399	0.400	556	436	392	366	345	328	313	301	1.800	1.56	1.00	
12	1	0.274	0.275	181	142	128	119	112	107	102	98	0.800	1.15	1.00	≤
12	1.5	0.392	0.394	308	241	217	202	191	181	173	167	1.300	1.28	1.00	≤
12	2	0.498	0.500	447	351	315	294	278	264	252	242	1.800	1.43	1.00	≤
12.7	0.89	0.262	0.263	146	114	103	96	90	86	82	79	0.690	1.12	1.00	≤
12.7	1.24	0.354	0.356	226	177	159	149	140	133	127	122	1.404	1.20	1.00	≤
12.7	1.65	0.454	0.456	327	256	230	215	203	192	184	177	1.0450	1.30	1.00	≤
14	1	0.324	0.325	154	120	108	101	95	91	86	83	0.800	1.13	1.00	≤

15	1	0.349	0.350	143	112	101	94	89	84	80	77	0.800	1.12	1.00	≤
15	1.5	0.504	0.507	240	189	170	158	149	142	135	130	1.300	1.21	1.00	≤
15	2	0.648	0.651	345	271	244	227	215	204	195	187	1.800	1.32	1.00	
15.88	1.24	0.452	0.454	178	139	125	117	110	105	100	96	1.040	1.15	1.00	≤
16	1.5	0.542	0.544	225	176	158	147	139	132	126	121	1.300	1.19	1.00	≤
16	2	0.697	0.701	321	252	266	211	199	189	181	174	1.800	1.29	1.00	≤
18	1.5	0.617	0.619	197	155	139	130	122	116	111	107	1.300	1.17	1.00	≤
18	2	0.797	0.801	281	221	199	185	175	166	159	153	1.800	1.25	1.00	≤
19.05	1.24	0.550	0.553	146	115	103	96	91	86	82	79	1.040	1.12	1.00	
19.05	1.65	0.717	0.789	209	164	147	137	130	123	118	113	1.450	1.18	1.00	≤
19.05	2.11	0.890	0.979	280	220	198	185	174	165	158	152	1.899	1.25	1.00	≤
20	1.5	0.691	0.694	176	138	124	116	109	104	99	95	1.300	1.15	1.00	
20	2	0.897	0.901	251	196	177	165	156	148	141	136	1.800	1.22	1.00	≤
20	2.5	1.090	1.097	321	252	226	211	199	189	181	174	2.250	1.29	1.00	
20	3	1.270	1.28	395	310	279	260	246	233	223	214	2.700	1.37	1.00	
22	1.5	0.766	0.769	159	125	112	105	99	94	90	86	1.300	1.13	1.00	
22	2	0.996	1.00	226	177	159	149	140	133	127	122	1.800	1.20	1.00	≤
25	2	1.146	1.15	197	154	139	129	122	116	111	107	1.800	1.17	1.00	≤
25	2.5	1.401	1.14	251	196	177	165	156	148	141	136	2.250	1.22	1.00	≤
25	3	1.644	1.65	307	241	216	202	190	181	173	166	2.700	1.28	1.00	
25	4	2.092	2.10	426	334	301	280	265	251	240	231	3.600	1.40	1.00	
25.4	1.65	0.976	1.08	153	120	108	101	95	90	86	83	1.450	1.13	1.00	≤
25.4	2.11	1.224	1.35	205	161	144	135	127	121	115	111	1.899	1.18	1.00	≤
28	1.5	0.990	0.995	123	97	87	81	77	73	69	67	1.300	1.10	1.00	
28	2	1.295	1.30	174	136	123	115	108	103	98	94	1.800	1.15	1.00	≤
28	2.5	1.588	1.60	221	174	156	146	137	130	125	120	2.250	1.19	1.00	
30	2	1.395	1.40	162	127	114	106	100	95	91	88	1.800	1.14	1.00	
30	2.5	1.713	1.72	205	161	145	135	128	121	116	111	2.250	1.18	1.00	
30	3	2.018	2.03	251	196	177	165	156	148	141	136	2.700	1.22	1.00	
30	4	2.591	2.60	345	271	244	227	215	204	195	187	3.600	1.32	1.00	

30	5	3.114	3.13	447	351	315	294	278	264	252	242	4.500	1.43	1.00	
35	2	1.644	1.65	137	108	97	90	85	81	77	74	1.800	1.11	1.00	≤
35	2.5	2.024	2.03	174	136	123	115	108	103	98	94	2.250	1.15	1.00	
35	3	2.391	2.40	212	166	149	139	132	125	119	115	2.700	1.18	1.00	≤
42	3	2.914	2.93	174	136	123	115	108	103	98	94	2.700	1.15	1.00	≤

11. Test

11.1 Chemical analysis

11.1.1 Chemical analysis

General matters common to chemical analysis and sampling of analysis samples shall be as specified in 3. of JIS G 0303.

11.1.2 Method of analysis

The method of analysis shall be in accordance with any one of the following standards

JIS G 1211, JIS G 1212, JIS G 1213, JIS G 1214, JIS G 1215, JIS G 1216

JIS G 1217, JIS G 1218, JIS G 1219, JIS G 1223, JIS G 1228, JIS G 1232

JIS G 1237, JIS G 1253, JIS G 1256, JIS G 1257

11.2 Number of product analysis samples

The number of product analysis samples shall be subjected to the agreement between the purchaser and supplier.

11.2.1 Test piece

The test piece shall be any one of No. 11, No. 12A, No.12B, or No. 12C test piece specified in JIS Z 2201 and sampled from the longitudinal direction of the tube.

11.3 Flattening test

11.3.1 Sampling of specimen and number of test piece

The sampling of a specimen and the number of test pieces shall be as given in 10.2.1. Test piece

A test piece of 50 mm or over in length shall be cut off from the end of a tube to serve as a test piece. For the tube whose wall thickness is 15% or over of outside diameter, a C-shaper test piece made by removing a part of the circumference of a ring-shaped test piece may be used.

11.3.2 Test method

The test piece shall be placed at ordinary temperature between two flat plates and flattened by compression until the distance H between the plates come to the specified value, and checked for occurrence of flaws or cracks on its wall surface.

For the automatic arc welded tube, laser welded tube, and electric resistance welded tube, the weld zone shall be placed at right angles to the direction of compression as shown in Fig. or the C-shape test piece shall be placed as shown in Fig. 2.

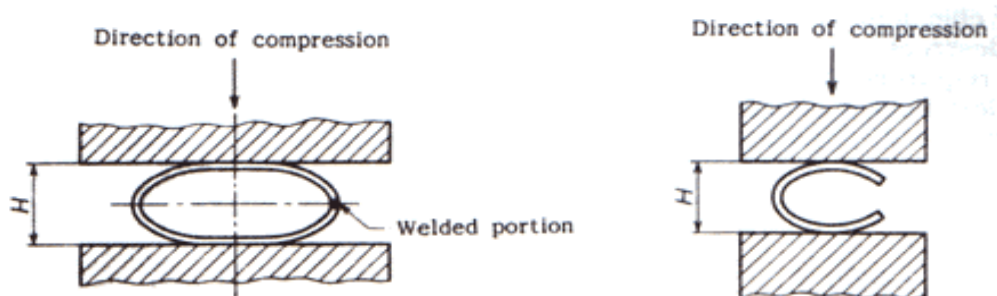


Fig.1 Flattening test (for ring-shaped test piece)

Fig.2 Flattening test (for C-shape test piece)

11.4 Flaring test

11.4.1 Test piece

An adequate length of a tube shall be cut off from one end of a tube to serve as a test piece.

11.4.2 Test method

The test piece shall be split in the direction of a tube axis at the opposite side of a welded line, opened up, flattened and the checked for any flaws, cracks or other defects injurious to use that may have occurred in the weld zone

11.5 Reverse flattening test

11.5.1 Test piece

A 100 mm length of a tube shall be cut off from one end of a tube to serve as a test piece.

11.5.2 Test method

The test piece shall be split in the direction of a tube axis at the opposite side of a welded line, opened up, flattened and then checked for any flaws, cracks or the defects injurious to use that may have occurred in the weld zone.

11.6 Austenite grain size test

11.6.1 Test piece

An about 20 mm length of a tube shall be cut off from one end of a tube to serve as a test piece.

11.6.2 Test method

The test method shall be as specified in JIS G 0551.

11.7 Hydraulic test or nondestructive examination

11.7.1 Hydraulic test

When a hydraulic pressure is applied to a tube and kept at designated or specified pressure for 5 s or longer, whether the tube withstands that without leakage shall be examined.

11.7.2 Nondestructive examination

the test method shall be as specified in JIS G 0582 or JIS G 0583.

Either the hydraulic test or nondestructive examination shall be carried out on each one tube.

12. Inspection

12.1 Inspection

The inspection shall be as follows.

(1) General matters common to the inspection shall be as specified in JIS G 0303.

(2) The chemical composition shall conform to the requirements specified in 4.

(3) The mechanical properties shall conform to the requirements specified in 5.

(4) The austenite grain size of SUS321HTB shall conform to the requirements specified in 6.

(5) The hydraulic test characteristic or nondestructive examination characteristic shall conform to the requirements specified in 7.

However, the nondestructive examination may be substituted by an appropriate nondestructive examination other than that given in 10.7.3 subject to the agreement between the purchaser and supplier.

(6) The dimensions shall conform to the requirements specified in 8.

(7) The appearance shall conform to the requirements specified in 9.

(8) When the special quality requirements given in Annex 1 or the U-bent tube of Annex 2 is designated subject to the agreement between the purchaser and supplier, the results of inspection shall conform to the relevant requirements specified in Z1, Z2, Z3, Z4, Z6 of Annex 1 and in Annex 2.

12.2 Reinspection

The tube may be determined for acceptance or rejection by carrying out a retest specified in 4.4 of JIS G 0303.

13. Marking

Tubes having passed the inspection shall be marked with the following items on each tube. However, the order of suitable method on each bundle.

Further, in the case of either small tubes or a request from the purchaser, the tubes may be bundled and marked by a suitable method on each bundle.

When approved by the purchaser, a part of the items may be omitted.

(1) Symbol of grade

(2) Symbol indicating the method of manufacture ().

(3) Dimensions ()

(4) Manufacturer's name or abbreviation

(5) Symbol Z indicating the designation of special quality requirements

Notes () Symbols indicating the method of manufacture shall be as follows.

However, the sign of dash may be replaced by a space.

13. Reinspection

The tube may be determined for acceptance or rejection by carrying out a retest specified in 4.4 of JIS G 0303

14. Marking

Tubes having passed the inspection shall be marked with the following items on each tube. However, the order of arranging the items is not specified.

- (1) Symbol of grade
- (2) Symbol indicating the method of manufacture (2)
- (3) Dimensions (3)
- (4) Manufacturer's name or abbreviation
- (5) Symbol Z indicating the designation of special quality requirements

Note (2) Symbols indicating the method of manufacture shall be as follows.

However, the sign of dash may be replaced by a space

Hot finished seamless tube -S-H

Cold finished seamless tube -S-C

Automatic arc welded tube -A

Cold finished automatic arc welded tube -A-C

Cold finished electric resistance welded tube -E-C

15. Report

The manufacturer shall, as a rule, submit to the purchaser a detained statement concerning to the test results, method of manufacture, ordered dimensions, quantity, a work number traceable to the history of manufacture, etc.

Annex 1. Special quality requirements

The special quality requirements shall apply when requested by the purchaser and the manufacturer shall execute the designated items on the straight tube.

Z1 Hardness.

Z 1.1 The hardness of the tube shall be as specified in Annex 1 Table 1.

Annex 1.table 1. Hardness

Symbol of grade	Rockwell hardness (mean value of there points)	
	HRB	HRC
SUS 304 TB, SUS 304 HTB SUS 304 LTB, SUS309 TB SUS 309 STB, SUS 310 TB SUS 310 STB, SUS 316 TB	90 max.	-

SUS 316 HTB, SUS 316 LTB SUS 316TiTB, SUS 317 TB, SUS 317 LTB SUS 321 TB, SUS 321 HTB SUS 347 TB, SUS 347 HTB		
SUS 839LTB, SUS 409LTB, SUS 410TiTB, SUS 430LXTB, SUS 430J1LTB, SUSXM8TB, SUSXM27TB	90 max.	
SUS 329 J 1TB, STS 329 J 2LTB	-	29 max.
SUS 410 TiTB, SUS 430 TB SUS XM 8 TB, SUS XM 27 TB	90 max.	-
SUS 890LTB, SUS 405TB, SUS 409TB SUS 410TB, SUS 444TB SUS XM15 J1TB	95 max.	-

Z 1.2 A suitable length of a tube shall be cut off from one of the tube to serve as a test piece.

Z 1.3 The test method shall be in accordance with JIS Z 2245 and the hardness on the cross section or inside surface of the test piece shall be measured at three points for each test piece.

Further, a tube of 2 mm or under in wall thickness shall not be tested. As for the automatic arc welded tube, laser welded tube and electric resistance welded tube. the test shall be carried out in the portion other than the weld and the heat-affected zones.

Z 1.4 The hardness shall comply with the requirement specified in Annex 1 Table 1.

Z 1.5 The sampling of a specimen and the number of test pieces shall be as specified for the tensile test in 10.2.1 of the text.

Z 1.6 Reinspection

Retest for tube may be carried out to determine acceptance or rejection according to 4.4 of JIS G 0303.

Z 2 Elevated temperature yield point or proof stress

The elevated temperature yield point or proof stress shall be as follows

Z 2.1 The value of elevated temperature yield point or proof stress and the testing temperature of the tube shall be subjected to the agreement between the purchaser and supplier.

Z 2.2 The test piece and the test method shall be as specified in JIS G 0576,

However, when it is practically difficult to take the test piece of the shape specified in JIS G 0576, the shape of the test piece shall be subjected to the agreement between the purchaser and supplier.

Z 2.3 For sampling of a specimen and the number of test pieces, one specimen shall be sampled from each lot of the same cast steel, and one test piece shall be sampled there

from for each test temperature.

Z 3 Ultrasonic examination

The ultrasonic examination shall be as follow:

Z 3.1 The criteria of working sensitivity in the ultrasonic examination shall be the division UA or UC specified in JIS G 0582 and there shall be no signal equal to or greater than the signal from an artificial flaw of reference test piece.

Z 3.2 The method of the ultrasonic examination shall be in accordance with JIS G 0582

Z 3.3 The ultrasonic examination shall be performed on each tube and the result shall comply with the requirements specified in (1).

Z 4 Eddy current examination

The eddy current examination shall be as follows:

Z 4.1 The criteria of working sensitivity in the eddy current examination shall be the division EV, EW, or EX specified in JIS G 0583 and there shall be no signal equal to or greater than the signal from an artificial flaw in the reference test piece.

Z 4.2 The method of the eddy current examination shall be in accordance with JIS G0583

Z 4.3 The eddy current examination shall be carried out on each tube and the result shall conform to the requirements specified in (1).

Z 6 Corrosion test

Test corrosion test shall be as follows

Z 6.1 Corrosion resistance

The corrosion resistance by the intergranular corrosion test of the tube shall comply with the following requirements.

In this case, the intergranular corrosion test to be applied shall be subjected to the agreement between the purchaser and supplier.

(1) Evaluation by etch structure obtained in the 10 % oxalic acid etch test shall be as specified in Annex 1 Table 2.

Annex 1 Table 2 Evaluation by 10 % oxalic acid etch test

Symbol of grade	Condition	Structure for ferric sulfate-sulfuric acid test	Structure for 65% nitric acid test	Structure for nitric-hydrofluoric acid test	Structure for copper sulfate-sulfuric acid test
SUS 304 TB	As delivered (solution treatment)	Ditch structure	Ditch structure End grain pitting II	-	Ditch structure
SUS 316 TB			-	-	
SUS 317 TB			-	-	
SUS 304LTB	Sensitization	Ditch structure	Ditch structure End grain pitting II	-	Ditch structure
SUS 316LTB			-	Ditch structure	
SUS 317LTB			-	-	
SUS 321 TB			-	-	

SUS 347 TB					
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(2) The mass loss by ferric sulfate-sulfuric acid test shall be as specified in Annex 1 Table 3.

Symbol of grade	Condition	Mass loss g/(m h)
SUS 304TB SUS 316TB SUS 317TB	As delivered (solution treatment)	Subject to the agreement between the purchaser and supplier.
SUS 304LTB SUS 316LTB SUS 317LTB	Sensitization	Subject to the agreement between the purchaser and supplier.

(3) The mass loss by 65 % nitric acid test shall be as specified in Annex 1 Table 4.

Annex 1 Table 4. Mass loss by 65% nitric acid test

Symbol of grade	Condition	Mass loss g/(m ² h)
SUS 304TB	As delivered (solution treatment)	Subject to the agreement between the purchaser and supplier.
SUS 304LTB	Sensitization	Subject to the agreement between the purchaser and supplier.

(4) The corrosion rate ratio by nitric-hydrofluoric acid test shall be as specified in Annex 1 Table 5.

Annex 1 Table 5. Corrosion rate ratio by nitric-hydrofluoric acid test

symbol of grade	Corrosion rate ratio
SUS 316TB SUS 317TB	1.5 max. 1.5 max.
SUS 316LTB SUS 317LTB	1.5 max. 1.5 max.

(5) The state of the bent surface by copper sulfate-sulfuric acid test shall be as specified in Annex 1 Table 6.

Annex 1 Table 6. State of bent surface by copper sulfate-sulfuric acid test

Symbol of grade	Condition	State of bent surface
SUS 304TB SUS 316TB SUS 317TB	As delivered (solution-treatment)	Intergranular corrosion crack shall not be generated.
SUS 304LTB	Sensitization	Intergranular corrosion crack shall not be generated.

SUS 316LTB		
SUS 317LTB		
SUS 321TB		
SUS 347TB		

Z 6.2 A suitable length of a tube shall be cut off from one end of the tube to serve as a test piece.

Z 6.3 The test method shall be in accordance with any one of the following standards.

JIS G 0571, JIS G 0572, JIS G 0573JIS, G 0574JIS, G 0575Z

6.4 The test results shall conform to the requirements specified in (1).

Z 6.5 The sampling of a specimen and the number of test pieces shall be as specified for the grain size test in 10.6.1 of the text. If requested, the test piece mentioned above shall be sampled for each lot of the tubes of the same cast steel processed under the simultaneous heat treatment.

Annex 2. U-bent tube

The U-bent tube shall apply when requested by the purchaser and shall be executed by the manufacturer

1.Method of manufacture

The method of manufacture shall be as follows:(see Annex 2 Fig)

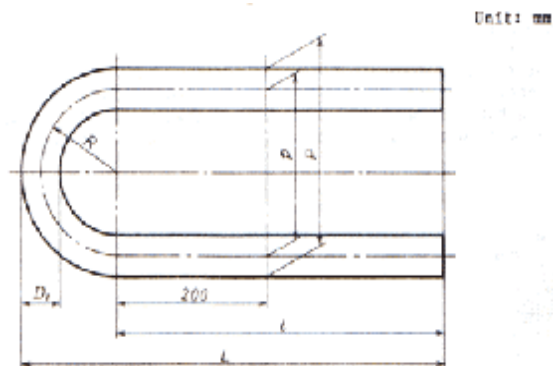
(1) The U-bent tube shall be manufactured by cold bending process and the bend radius shall be at least 1.5 times the outside diameter of the tube.

(2)The bent portion of the tube shall, as a rule, not be heat-treated. However, when requested by the purchaser, a heat treatment may be agreed upon.

2. The bent portion shall be free from defect injurious to use.

3. Dimensional tolerances on the bent portion shall be as specified in Annex2. Table 1, and tolerances on the length after bending shall be as specified in Annex 2 Table 2.

Annex 2 Fig. 1 Unit: mm



R: bend radius

D1: outside diameter of bent portion

t1: minimum wall thickness of bent portion

Dn: nominal outside diameter

tn: nominal wall thickness

p: pitch

P: $p+D_n$

ラ: length of straight portion

L: $ラ+R+D_n/2$

Annex 2 Table 1. Dimensional tolerances on bent portion

Variation rate of outside diameter $D_1-D_n / D_n \times 100\%$		Reduction rate of wall thickness $t_n-t_1 / t_n \times 100\%$	Tolerances on pitch (p) or P mm
Short radius side	Long radius side		
$D_n / 4R \times 100$ max. Where, the minimum value of D-Dn is 0.5mm	$D_n / 8R \times 100$ max. Where, the minimum value of D -Dn is 0.5 mm	$D_n / 2.5R \times 100$ max.	[1.5

Annex 2 Table 2. Tolerances on length of U-bent tube

Division of length	Tolerances on length (l or L) mm
7 m max. in length of straight portion after bending	+7 0
Over 7 m in length of straight portion after bending	+10 0

4. In order to measure the dimensions of the bent portion, one specimen shall be sampled from the U-bent tube with the smallest bending radius among tubes of the same dimensions bent simultaneously. The outside diameters in two directions at 90° C to the bent portion and the wall thickness at four points on the circumference shall be measured to obtain the variation rate of outside diameter and the reduction rate of wall thickness.

Material Comparison Tables (ASTM, KS, JIS, DIN, BS, NBN, NF, UNI)

ASTM Standard	UNS NO.	KOREA/JAPANESE			GERMAN				BRITISH			FRENCH			ITALIAN		
		KS/JIS Symbol	KS/JIS Number	Remarks	DIN Type	DIN Number	Material Number	Remarks	B.S Number	B.S Grade	Remarks	AFNOR Type	NF Number	Remarks	UNI Type	UNI Number	Remarks
A 213 Seamless Alloy Steel Boiler and Heat Exchanger Tubes																	
Grade T 5	K41545	STHA 24 / STBA 25	D3572 / G3462	(30)(24)	12 CrMo 19 5		1.7362	(3a)	3606	625	(30)	TUZ12C	A49-213	(3a)(32)			Dalmine 234(3b)
Grade T 11	K11597	STHA 22 / STBA 24	D3572 / G3462	(30)(24)	13 CrMo 44	17175	1.7335	(8)(32)	3606	621	(30)	5.05		(3b)(32)			Dalmine 227(3b)

for General Service														
Type 405	S40500			(3)	X7 CrAl	17440	1.4002	(3b)				(3b)		
Type 410	S41000	STS 405 TB / SUS 405 TB	D3577 / G3463		X10 Cr13	17440	1.4006	(3b)				(3b)		(3)

Material Comparison Tables (ASTM, KS, JIS, DIN, BS, NF, UNI)

ASTM Standard	UNS NO.	KOREA/JAPANES			GERMAN				FRENCH			ITALIAN		
		KS/JIS Symbol	KS/JIS Number	Remarks	DIN Type	DIN Number	Material Number	Remarks	AFNOR Type	NF Number	Remarks	UNI Type	UNI Number	Remarks
A 269 Seamless and Welded Austenitic Stainless Steel Tubing for General Service														
Type 304	S30400	STS 304TB / SUS 304TB	D3577 / G3463		X5 CrNi 18 9	17740	1.4301	(3b)	TU26 CN 18-10	A49-230		X5 CrNi 18 10	6904	(3b)
Type 304L	S30403	STS 304LTB/ SUS 304LTB	D3577 / G3463		X2 CrNi 18 9	17740	1.4306	(3b)	TU22 Cn 18-09	A49-230		X2 CrNi 18 11	6904	(3b)
Type 316	S31600	STS 316TB / SUS 316TB	D3577 / G3463		X5 CrNiMo 18 10	17740	1.4401	(3b)	TU26CND17-11	A49-230		X5 CrNiMo 17 12	6904	(3b)
Type 316L	S31603	STS 316LTB / SUS 316LTB	D3577 / G3463		X2CrNiTi 18 9	17740	1.4404	(3b)	TU22CND17-12	A49-230		X2 CrNiMo 17 12	6904	(3b)
Type 317	S31700	/SUS 317TB	D3577 / G3463					(3)						
Type 321	S32100	STS 321TB / SUS 321TB	D3577 / G3463		X10 CrNiTi 18 9	17740	1.4541	(3b)	TU26CNT18-10	A49-230		X6 CrNiTi 18 11	6904	(3b)
Type 347	S34700	STS 347TB / SUS 347TB	D3577 / G3463		X 10 CrNiNb 18 9	17740	1.4550	(3b)				X6 Cr Ni Nb 1 11	6904	(3b)

