DIN 17175-79 SEAMLESS STEEL TUBES FOR ELEVATED TEMPERATURES (DIN17175-79)

Sections marked with a dot (●) contain details on agreements which shall, or may be, reached at the time of ordering.

Grade	Chemical Composition (%)								
	C	Si	Mn	P	S	Ni	Cr	Mo	Others
St35.8	0.17Max	0.10~0.35	0.40~0.80	0.040Max	0.040Max	-	-	-	-
St45.8	0.21Max	0.10~0.35	0.40~1.20	0.040Max	0.040Max	-	-	-	-
17Mn4	0.14~0.20	0.20~0.40	0.90~1.20	0.040Max	0.040Max	-	0.30Max	-	-
19Mn5	0.17~0.22	0.30~0.60	1.00~1.30	0.040Max	0.040Max	-	0.30Max	-	-
15Mo3	0.12~0.20	0.10~0.35	0.40~0.80	0.035Max	0.035Max	-	-	0.25~0.35	-
13CrMo910	0.10~0.18	0.10~0.35	0.40~0.70	0.035Max	0.035Max	-	0.70~1.10	0.45~0.65	-
10CrMo910	0.08~0.15	0.50Max	0.40~0.70	0.035Max	0.035Max	-	2.00~2.50	0.90~1.20	-
14MoV63	0.10~0.18	0.10~0.35	0.40~0.70	0.035Max	0.035Max	-	0.30~0.60	0.50~0.70	V: 0.22~0.32
X20CrMoV121	0.17~0.23	0.50Max	0.40~0.70	0.030Max	0.030Max	0.30~0.80	10.00~12.50	0.80~1.20	V: 0.25~0.35

Grade	Material Number	MPa or N/mm^2		
		Min Yield Point		Tensile Strength
		WT: 16mm Max	WT: 16- 40mm	
St35.8	1.0305	235	225	360~480
St45.8	1.0405	-	245	410~530
17Mn4	1.0481	-	275	460~580
19Mn5	1.0482	-	315	510~610
15Mo3	1.5415	275	275	450~600
13CrMo910	1.7335	295	295	440~590
10CrMo910	1.7380	285	285	450~600
14MoV63	1.7715	325	325	460~610
X20CrMoV121	1.4922	490	490	690~850

1. Scope

This standard applies to seamless tubes including tubes for headers of heat-resistant steels according to Table 1 which are used in the construction of boilers, pipe-lines, pressure vessels and equipment for service up to 600℃ and at simultaneous high pressures, where the total stress and the relevant scaling conditions can raise or lower the temperature limit.

5. Designation and ordering

5.1 The code numbers for the grades of steel were formed in accordance with Sections 2.1.1.1 and 2.1.2.2 of the Explanations to DIN Normenheft 3, and the material numbers according to DIN 17007 Part 2.

5.2 The code number or the material number for the steel grade shall be appended to the symbol for the product according to the following examples:

Example 1:

Designation of a seamless steel tubes of 38mm outside diameter and 2.6mm wall thickness according to DIN 2448 of steel St 35.8, material number 1.0385:

DIN 2448 - ST 35.8 x 2.6 or DIN 2448 - 1.0305 - 38 x 2.6

5.3 The order shall not only specify the designation according to Section 5.2 but also in every case the desired total length and the desired acceptance inspection certificate and for unalloyed steel tubes also the steel grade. In addition, further details in compliance with the other Sections marked with a dot (●) can be agreed at the time of ordering.

Table1 Summary of heat-resisting steels for seamless tubes, their chemical composition (cast analysis) and color designation of tubes

Steel Grade		Chemical Composition in weight %									
Code Number	Material Number	C	Si	Mn	P	S	Cr	Mo	Ni	V	Colour designation 1)
St 35.8	1.0306	≤ 0.17	0.10 to 0.35 2)	0.40 to 0.80	0.040	0.040					white
St 45.8	1.0406	≤ 0.21	0.10 to 0.35 2)	0.40 to1.20	0.040	0.040					yellow
17Mn 4 3)	1.0481 3)	0.14 to 0.20	0.20 to 0.40	0.90 to 1.20	0.040	0.040	≤ 0.30				red and black
19Mn 5 3)	1.0482 3)	0.17 to 0.22 4)	0.30 to 0.60	1.00 to 1.30	0.040	0.040	≤ 0.30				yellow and brown
15Mn 3	1.5415	0.12 to 0.20 4)	0.10 to 0.35	0.40 to 0.80	0.035	0.035		0.25 to 0.35			yellow and carmine red

13CrMo 4 4	1.7335	0.10 to 0.18 4)	0.10 to 0.35	0.40 to 070	0.035	0.035	0.70 to 1.10	0.45 to 0.65			yellow and shades or silver
10CrMo 9 10	1.7380	0.08 to 0.15	⩽ 0.50	0.40 to 070	0.035	0.035	2.00 to 2.50	0.90 to 1.20			red and green
14MoV 6 3	1.7715	0.10 to 0.18	0.10 to 0.35	0.40 to 0.70	0.035	0.035	0.30 to 0.60	0.50 to 0.70		0.22 to 0.32	red and shades of silver
X20CrMoV 12 1	1.4922	0.17 to 0.23	⩽ 0.50	⩽ 1.00	0.030	0.030	10.00 to 12.50	0.80 to 1.20	0.30 to 0.80	0.25 to 0.35	blue

1) ● In normal practice both ends are painted with rings in the colour required. If requested it can be agreed at the time of ordering that the paint marking in the relevant colour should extend over the entire length of the tube.

2) The minimum silicon content is allowed to fall below 0.10%, when the steel is aluminum-killed, or vacuum-deoxidized.

3) These steels can only be considered for headers.

4) When the wall thicknesses ⩾ 30mm the carbon content is permitted to be 0.02% higher.

Table 2. Permissible deviations in the chemical composition of the sample analysis from the limits quoted in the cast analysis (see Table 1)

Element	Limits quoted in cast analysis according to Table 1 Weight %	Permissible deviation 1) of sample analysis from the limits quoted in the cast analysis according to Table 1 Weight %
C	⩽0.24	± 0.02
Si	⩽0.35 >0.35⩽0.60	± 0.03 ± 0.04
Mn	⩽1.00 >1.00⩽1.30	± 0.04 ± 0.05
P S	⩽0.040	± 0.010

Cr	⩽0.040⩽2.00 >2.00⩽2.50 ⩾1.00⩽12.50	± 0.05 ± 0.07 ± 0.15
Mo	⩽0.30 >0.30 ⩽1.20	± 0.03 ± 0.04
Ni	0.30⩽0.80	± 0.03
V	0.22⩽0.35	± 0.03
1) In a cast the deviation of an element of an element in a sample analysis is permitted to be below the minimum value or only above the maximum value of the range stipulated for the cast analysis, though not both at the same time.		

Table 3. Scope of tests for seamless tubes in both quality grades and authority for the execution of the testing.

No	Extent of testing	According to Section	Quality grade I	Quality grade II	Authority for the execution of the test 1)
1	Tensile test 2)	8.4.3	on two tubes per batch from the first two batches, on one tube from each subsequent batch	on two tubes per batch from the first two batches, on one tube from each subsequent batch	S.A.
2	Notch impact/bending test 3)	8.4.4	on tubes according to No.1	on tubes according to No.1	S.A.
3	Ring test 3)	8.4.6	on one end of the tubes acc to No.1	depending on the diameter (see Section 8.4.6) on 20% of the cut or part-lengths at one end or on 100% of the cut or part-lengths at both ends if necessary though also at one end, see Section 8.4.6.2.2.	M.W.
4	Non-destructive test	8.4.7		all tubes	M.W.
5	Visual inspection of tube surface	8.4.8	all tubes	all tubes	S.A.
6	Gauging	8.4.9	all tubes	all tubes	M.W.
7	Leakage test	8.4.10	all tubes	all tubes	M.W.
8	Grade identification test	8.4.11		all alloy tubes	M.W

9	Special tests 4) No. 9, No. 10	8.4.2	subject to agreement	subject to agreement.	M.W
10	Hot tensile test	8.4.5	unless otherwise agreed 1 sample per cast and size or 1 sample per cast and annealed batch (heat treated batch)	unless otherwise agreed 1 sample per cast and size or 1 sample per cast and annealed batch (heat treated batch)	S.A.

1) S.A = subject to agreement; M.W. = Manufacturing works.

2) 1 specimen or 1 set of specimens suffices for batch sizes of up to 10 tubes.

3) The particulars on the size range governing the application of these test in Table 14 shall be complied with.

4) ● Special tests shall be carried out only after agreement between manufacturer and customer.

Table 4. Limits governing the application of quality grades I and III

Quality	Outside diameter of tube			
	⩽ 63.5mm		> 63.5mm	
	Temperature 2) ℃	Permissible working pressure 3) bar	Temperature 2) ℃	Permissible working pressure 3) bar
I	⩽ 450	⩽ 80	⩽ 450	⩽ 32
III	> 450	> 80	> 450	> 32

1) If pressure and temperature data do not belong to the same group, the higher group applies.

2) Temperature of conveyed fluid.

3) See DIN 2401 Part 1

Table 5. Mechanical properties of seamless of heat-resistant steels at room temperature

Steel grade		Tensile strength	Yield point 1), 2) for wall thickness in mm			Elongation at fracture (Lo = 5*do)		Impact strength (DVM specimens 3) transverse
Code number	Material number	N/㎟	⩽16	>16⩽40	>40⩽50	Long	Transverse	J minimum
			N/㎟ minimum			% minimum		
St 35.8	1.0305	360 to 480	235	225	215	25	23	34
St 45.8	1.0405	410 to 530	255	245	235	21	19	27
17 Mo 4	1.0481	460 to 580	270	270	260	23	21	34
19 Mo5	1.0482	510 to 610	310	310	300	19	17	34

15 Mo 3	1.5415	450 to 600	270 4)	270	260	22	20	34
13CrMo 4 4	1.7335	440 to 590	290 4)	290	280	22	20	34
10CrMo 9 10	1.7380	450 to 600	280	280	270	20	18	34
14MoV 6 3	1.7715	460 to 610	320	320	310	20	18	41
X20CrMoV 12 1	1.4922	690 to 840	490	490	490	17	14	34 5)

1) For tubes of ≤ 30mm outside diameter and ≤ 3mm wall thickness the minimum values are by 10N/㎟ lower.

2) For > 60mm wall thickness, the values of tubes from the steels St 35.8, St 45.8, 17Mn 4, 19Mn 5, 15Mo 3 and 14MoV 6 3 are subject to agreement; for wall thicknesses >60 to ≤ 80mm a minimum value of 270N/㎟ or 260N/㎟ applies for tubes from the steels 13CrMo 4 4 and 10CrMo 9 10 and a minimum value of 490N/㎟ for tubes from the steel X20CrMoV 12 1.

3) When testing longitudinal specimens (see Section 8.5.3) the minimum impact strength is 14J higher.

4) A 15N/㎟ higher minimum value applies for ≤ 10mm wall thicknesses.

5) For hot extruded tubes the minimum value falls to 27J.

Table 6. Minimum 0.2% yield limit of seamless tubes at elevated temperatures.

Steel grade		Wall thickness	0.2%-yield limit at							
Code number	Material number	s mm	200℃	250℃	300℃	350℃	400℃	450℃	500℃	550℃
			N/㎟ minimum							
St 35.8	1.0305	≤ 16 16<s≤40 40<s≤60 1)	185 180 175	165 160 155	140 135 130	120 120 115	110 110 110	105 105 105	- - -	- - -
St 45.8	1.0405	≤ 16 16<s≤40 40<s≤60 1)	205 195 190	185 175 170	160 155 150	140 135 135	130 130 130	125 125 125	- - -	- - -
17Mn 4 3)	1.0481	≤ 40 40<s≤60 1)	235 225	215 205	175 165	155 150	145 140	135 130	- -	- -
19Mn 5 3)	1.0482	≤40 40<s≤60 1)	255 245	235 225	205 195	180 170	160 155	150 145	- -	- -
15Mn 3	1.5415	≤40 2) 40<s≤60 1)	225 210	205 195	180 170	170 160	160 150	155 145	150 140	- -
13CrMo 4 4	1.7335	≤ 40 2)	240	230	215	200	190	180	175	-

		40<s≤60 60<s≤80 1)	230 220	220 210	205 195	190 180	180 170	170 160	165 155	- -
10CrMo 9 10	1.7380	≤ 40 40<s≤60 60<s≤80 1)	245 235 225	240 230 220	230 220 110	215 205 195	205 195 185	195 185 175	185 175 165	- - -
14MoV 6 3	1.7715	≤ 40 40<s≤60 1)	270 260	255 245	230 220	215 205	200 190	185 175	170 160	- -
X20CrMoV 12 1	1.4922	≤ 80	430	415	390	380	360	330	290	250
1) For wall thicknesses greater than 60mm the values are subject to agreement. 2) For wall thicknesses ≤ 10mm, 15 N/㎟ higher minimum 0.2% yield limits apply at all temperatures.										

Table 7. Provisional data 1) (change in diameter) in the ring expending test.

Steel grade	Expansion 2) in ring expanding test (provisional data) For diameter ratios di/da					
	≥ 0.9	≥ 0.8 < 0.9	≥0.7 < 0.8	≥ 0.6 < 0.7	≥ 0.5 < 0.6	< 0.5
	% minimum					
unalloyed steels	8	10	12	20	25	30
alloyed steels	6	8	10	15	20	30
1) These values shall regarded as initial recommendations which are based on a series of tests and will have to be reassessed in the light of future experience. 2) The deformability of ring expanding test specimens will additionally be assessed in terms of the appearance of the fracture and fracture surfaces.						

Table 8. Permissible wall thickness deviations for orders based on the outside diameter

Permissible wall thickness deviations for outside diameters da								
da ≤ 130mm			130mm <da ≤ 320 mm			320mm <da ≤ 660mm		
≤2*Sn	≤2*Sn<s≤4*Sn	>4*Sn	≤0.05da	≤0.05da<s≤0.11da	>0.11da	≤0.05da	0.05da<s≤0.09da	>0.09da
+15% -10%	+12.5% -10%	±9%	+17.5% -12.5%	±12.5%	±10%	+22.5% -12.5%	+15% -12.5%	+12.5% -10%
Note: Sn = Nominal wall thickness according to DIN 2448								

Table 9. Permissible wall thickness deviations for orders based on the bore

Permissible wall thickness deviations for inside diameter di ⩾ 200mm to ⩽ 720mm and wall thicknesses s		
⩽ 0.05da	0.05<s⩽0.10da	>0.10 da
+22.5% -12.5%	+15% -12.5%	+12.5% -10%

Table 10. Permissible deviations on length

For orders specifying		Permissible deviations on length in mm
Production lengths		1)
Random lengths		± 500
Exact lengths		± 10 0
	from ⩽ 6m (nominal size)	
	from > 6m ⩽ 12m (nominal size)	± 15 0
	from > 12m	subject to agreement
1) The products are supplied in production lengths which differ according to diameter, wall thickness and production plant.		

Table 11. Permissible deflection f

b in mm	⩽ 100	>100⩽ 200	>200⩽ 300	> 300
f in mm	⩽ 0.75	⩽ 1	⩽ 1.5	⩽ 2

Table 12. Reference data for hot forming, normalizing and hardening and tempering of high-temperature seamless tube steels 1)

Steel grade		Hot forming	Normalizing	Hardening and tempering	
Code number	Material number	℃	℃	Hardening temperature 2) ℃	Tempering temperature ℃
St 35.8	1.0305	between 1100 and 850 3)	900 to 930	-	-
St 45.8	1.0405		870 to 900	-	-
17Mn 4 3)	1.0481		880 to 910	-	-
19Mn 5 3)	1.0482		880 to 910	-	-

15Mn 3	1.5415		910 to 940	-	-
13CrMo 4 4	1.7335		-	910 to 940	660 to 730
10CrMo 9 10	1.7380		-	900 to 960	700 to 750
14MoV 6 3	1.7715		-	950 to 980	690 to 730
X20CrMoV 12 1	1.4922		-	1020 to 1070	730 to 780

1) The work pieces must attain the specified temperature over the entire cross-section. Provided this has definitely been done further holding at these temperatures is unnecessary when normalizing and hardening.

The temperatures laid down for tempering shall be held for approximately 30minutes minimum for the steels 13CrMo 4 4 and 10CrMo 9 10 and for 1 hour minimum for the steels 14MoV 6 3 and X20CrMoV 12 1, with the annealing time being counted from the moment when the lower limit of the given temperature range is reached.

2) Cooling in air or controlled atmosphere. Accelerated cooling e.g in liquid, can become necessary at greater wall thicknesses.

3) The temperature can drop to 750℃ during processing.

4) In addition to given quenching and tempering treatment the following sequence of treatment can be considered for the steel:

900℃ to 960℃/furnace to 700℃ ≥1 hour 700℃/air.

Table 13. Welding methods and data for the heat-treatment after welding

Steel grade		Welding methods	Annealing temperatures 1) and holding time 2), 3) at the required heat-treatment after welding ℃
Code number	Material number		
St 35.8	1.0305	All fusion welding methods and flash butt-welding	520 to 600
St 45.8	1.0405		520 to 600
17Mn 4 3)	1.0481		520 to 580
19Mn 5 3)	1.0482		520 to 580
15Mn 3	1.5415		530 to 620
13CrMo 4 4	1.7335		600 to 700
10CrMo 9 10	1.7380		650 to 750
14MoV 6 3	1.7715	All fusion welding methods, except gas fusion welding	690 to 730
X20CrMoV 12 1	1.4922		720 to 780

1) If required (see Section 7.3) these temperatures apply also to annealing treatments after cold forming.

2) The holding time for the specified temperatures depends on the thickness of the work pieces. A minimum holding time of 15minutes is recommended for a thickness ≤ 15mm, a minimum holding time of 30minutes, for thicknesses > 15 to≤30mm and a minimum holding time of 60minutes for thicknesses >30mm.

At thicknesses >30mm a minimum holding time of 90 minutes is required for 10CrMo 9 10. Furnace anneals should be performed in the mid-range of the specified temperatures. For local anneals the external surface shall be at the maximum temperature.

3) The annealing treatment shall also comply with the instructions f the manufacturer of the filter metals.

4) Judging from the experience gained up t nw, repeated annealing treatments shall not exceed a total holding time of 10 hours, with the subsequent annealing treatments being performed in the lower temperature range when the material is in the air-hardened condition.

5) Welding shall be followed by cooling below 150℃ (though for thick-walled tubes not below 100℃).

The following holding times are recommended:

≤8mm thickness 30minutes minimum

>8≤30mm thickness 60minutes minimum

>30≤60mm thickness 120minutes minimum

>60mm thickness 180minutes minimum

Table 14. Size ranges for the application of mechanical and technological methods for testing tubes in both qualities

Tube diameter mm		Nominal wall thickness of the tubes				
external	internal	<2mm	≥2mm≤16mm	>16mm≤30mm	>30mm≤40mm	>40mm
≤21.3	≤15	Tensile test Ring flattening test	Tensile test Ring flattening test	-	-	-
> 21.3 ≤ 148	>15	Tensile test Ring flattening test	Tensile test Notch impact/bending test 1) Ring expanding test	Tensile test Notch impact/bending test 1) Ring expanding test	Tensile test Notch impact/bending test 1) Ring expanding test	Tensile test Notch impact/bending test 1) Ring expanding test
> 146 3)			Tensile test Notch impact/bending test 1) Ring tensile test	Tensile test Notch impact/bending test 1) Ring tensile test 2)	Tensile test Notch impact/bending test 1) Ring tensile test 2)	Tensile test Notch impact/bending test

1) Only for tubes manufactured from steels 14MoV 6 3 and X20CrMoV 12 1 in nominal thicknesses > 10mm and for tubes manufactured from steel 15Mo 3 in nominal thicknesses >20mm.

2) Tubes ≤ 100mm inside diameter shall baring flattening-tested instead of ring tensile-tested.

3) This limit applies also for tube, orders for which are based on the inside diameter, provided the nominal outside diameter > 146mm.

Appendix A

The following Table gives tentative figures for the long time high temperature strength of the steels used for seamless tubes. The figures listed are mean values for the scatter ranger representing results so far available. These mean values will be examined from time to time and amended where necessary as further results become available. From the data so far available from long time creep tests it can be assumed that the bottom limit of this scatter range at the stated temperatures for the steel grades listed is about 20% lower than the mean value quoted.

Table A.1.

Steel grade Code number	Temperature ℃	1%-time yield limit 1), 2)		Creep strength 2), 3) for		
		10 000h N/㎟	100 000h N/㎟	10 000h N/㎟	100 000h N/㎟	200 000h N/㎟
St 37.8 St 42.8	380	164	118	229	165	145
	390	150	106	211	148	129
	400	136	95	191	132	115
	410	124	84	174	118	101
	420	113	73	158	103	89
	430	101	65	142	91	78
	440	91	57	127	79	67
	450	80	49	113	69	57
	460	72	42	100	59	48
	470	62	35	86	50	40
	480	53	30	75	42	33
17Mn 4 19Mn 5	380	195	153	291	277	206
	390	182	137	266	203	181
	400	167	118	243	179	157
	410	150	105	221	157	135
	420	135	92	200	136	115
	430	120	80	180	117	97
	440	107	69	161	100	82

	450 460 470 480 490	93 83 71 63 55	59 51 44 38 33	143 126 110 96 84	85 73 63 55 65 47	70 60 52 44 37
	500	49	29	74	41	30
15 Mo 3	450 460 470 480 490	216 199 182 166 149	167 146 126 107 89	298 273 247 222 196	245 209 174 143 117	228 189 153 121 96
	500 510 520 530 540	132 115 99 84 (70)	73 59 46 36 (28)	171 147 125 102 (82)	93 74 59 47 (38)	75 57 45 36 (28)
	550	(59)	(24)	(64)	(31)	(25)

1) This being the stress referred to the original cross-section which leads to a permanent elongation of 1% after 10000 or 100000 hours (h).

2) A bracket denotes that the steel should preferably no longer be used for continuous service t the relevant temperature.

3) This being the stress referred to in the original cross-section which results in rupture after 10 000, 100 000 or 200 000 hours (h).

Table A.1. (continued)

Steel grade Code number	Temperature ℃	1%-time yield limit 1), 2)		Creep strength 2),3) for		
		10 000h N/㎟	100 000h N/㎟	10 000h N/㎟	100 000h N/㎟	200 000h N/㎟
13CrMo 4 4	450 460 470 480 490	245 228 210 193 173	191 172 152 133 116	370 348 328 304 273	285 251 220 190 163	260 226 195 167 139

	500	157	98	239	137	115
	510	139	83	209	116	96
	520	122	70	179	94	76
	530	106	57	154	78	62
	540	90	46	129	61	50
	550	76	36	109	49	39
	560	64	30	91	40	32
	570	53	24	76	33	26
10CrMo 9 10	450	240	166	306	221	201
	460	210	155	286	205	186
	470	200	145	264	188	169
	480	180	130	241	170	152
	490	163	116	219	152	136
	500	147	103	196	135	120
	510	132	90	176	118	105
	520	119	78	156	103	91
	530	107	68	138	90	79
	540	94	58	122	78	68
	550	83	49	108	68	58
	560	73	41	96	58	50
	570	65	35	85	51	43
	580	57	30	75	44	37
	590	50	26	68	38	32
	600	44	22	61	34	28
14MoV 6 3	480	243	177	299	218	182
	490	219	155	268	191	163
	500	195	138	241	170	145
	510	178	122	219	150	127
	520	161	107	198	131	109
	530	146	94	179	116	91
	540	133	81	164	100	76

	550	120	69	148	85	61
	560	109	59	134	72	48
	570	(98)	(48)	(121)	(59)	(37)
	580	(88)	(37)	(108)	(46)	(28)

For footnotes 1), 2) and 3) see page 18

Table A.1. (continued).

Steel grade Code number	Temperature ℃	1%-time yield limit 1), 2)		Creep strength 2),3) for		
		10 000h N/㎟	100 000h N/㎟	10 000h N/㎟	100 000h N/㎟	200 000h N/㎟
X20CrMoV 12 1	470	324	260	368	309	285
	480	299	236	345	284	262
	490	269	213	319	260	237
	500	247	190	294	235	215
	510	227	169	274	211	191
	520	207	147	253	186	167
	530	187	130	232	167	147
	540	170	114	213	147	128
	550	151	98	192	128	111
	560	135	85	173	112	96
	570	118	72	154	96	81
	580	103	61	136	82	68
	590	90	52	119	70	58
	600	75	43	101	59	48
	610	64	36	87	50	40
	620	53	30	73	42	33
	630	44	25	60	34	27
	640	36	20	49	28	22
	650	29	17	40	23	18

For footnotes 1), 2) and 3) see page 18

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

ASTM Standard	UNS NO.	KOREA/JAPANES			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 106 Seamless C-Steel Pipe for High Temperature Service																	
Grade A	K02501	SPHT 38 / STPT 370	D3570 / G3456	(16)(30)	St 35.8	17175	1.0305		3602	HFS 360		TU 37C	A49-213		C 14	5462	
Grade B	K03006	SPHT 42 / STPT 410	D3570 / G3456	(16)(30)	St 45.8	17175	1.0405		3602	HFS 410		TU 42C	A49-213		C 18	5462	

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

ASTM Standard	UNS NO.	GERMAN				BRITISH			BELGIAN			FRENCH			ITALIAN		
		DIN Type	DIN Number	Material Number	Remarks	B.S Number	B.S Grade	Remarks	NBN Type	NBN Grade	Remarks	AFNOR Type	NF Number	Remarks	UNI Type	UNI Number	Remarks
A 179 Seamless Cold Drawn Low-C Steel Heat Exchanger and Condenser Tubes	K01200	St 35.4	1629	1.0309		3606	CFS 320		D 37-2	629	(3b)	TU 37 C	A49-215	(3a)	C 14	5462	
		St35.8	17175	1.0305	Plus DIN 2391 (18) Gutegard C.NBK												

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

ASTM Standard	UNS NO.	KOREA/JAPANES			GERMAN				BRITISH			BELGIAN			FRENCH			ITALIAN		
		KS/JIS Symbol	KS/JIS Number	Remarks	DIN Type	DIN Number	Material Number	Remarks	B.S Number	B.S Grade	Remarks	NBN Type	NBN Grade	Remarks	AFNOR Type	NF Number	Remarks	UNI Type	UNI Number	Remarks
A 192 Seamless C-Steel Boiler Tube for High	K01201	STBH 340 / STB 340	D3563 / G3461	(30)	St35.8	17175	1.0305		3059	320	(27)(30)	D45	837	(27)	TU 7C	A49-213	(27)	C14	5462	(27)

Pressure Service																				

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

ASTM Standard	UNS NO.	KOREA/JAPANES			GERMAN				BRITISH			BELGIAN			FRENCH			ITALIAN		
		KS/JIS Symbol	KS/JIS Number	Remarks	DIN Type	DIN Number	Material Number	Remarks	B.S Number	B.S Grade	Remarks	NBN Type	NBN Grade	Remarks	AFNOR Type	NF Number	Remarks	UNI Type	UNI Number	Remarks
A 199 Seamless Cold Drawn Intermediate Alloy Steel Heat Exchange and Condenser Tubes																				
T5	K41545	STHA 24 / STBA 25	D3572 / G3462	(35)	12CrMo 19 5		1.7362	(3a)	3606	CFS 625	(35)	X 12 Cr Mo 5	837	(35)	Z 12 CD 5.05		(3a)			(3); dalmine 234
T11	K11597	STHA 22 / STBA 23	D3572 / G3462	(35)	13CrMo 44	17175	1.7335	(8)	3606	CFS 621	(35)				10 CD 5.05		(3a)			(3); dalmine 227(10)
T22	K21590	STHA 23 / STBA 24	D3572 / G3462	(35)	10CrMo 9 10	17175	1.7380		3606	CFS 622	(35)	10 Cr Mo 9 10	837	(35)	10 CD 9.10		(3a)	12CrMo 9 10	5462	(10)0

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

ASTM Standard	UNS NO.	KOREA/JAPANES			GERMAN				BRITISH			BELGIAN			FRENCH			ITALIAN		
		KS/JIS Symbol	KS/JIS Number	Remarks	DIN Type	DIN Number	Material Number	Remarks	B.S Number	B.S Grade	Remarks	NBN Type	NBN Grade	Remarks	AFNOR Type	NF Number	Remarks	UNI Type	UNI Number	Remarks
A 200 Seamless Intermediate Alloy Steel																				

Tubes for Refinery Service																				
T 5	K41545	STHA 24 / STBA 25	D3572 / G3462	(32)	12CrMo 19 5		1.7362	(3a)	3604	625	(30)(32)	X12CrMo	837	(32)	TU Z 12 CD	A49-213	(32)			Dalmine 234(3b)
T 11	K11597	STHA 22 / STBA 23	D3572 / G3462	(32)	13CrMo 44	17175	1.7335	(8)	3604	621	(30)(32)				5.05	A49-213	(32)			Dalmine 227(3b)
T 22	K2159	STHA 23 / STBA 24	F3572 / G3462	(32)	10CrMo 9 10	17175	1.7380		3606	622	(30)(32)	10CrMo 9 10	837	(32)	TU 10 CD 5.05	A49-213	(32)	12CrMo 9 10	5462	(3b)
															TU 12 CD 9.10					

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

ASTM Standard	UNS NO.	KOREA/JAPANES			GERMAN				BRITISH			BELGIAN			FRENCH			ITALIAN		
		KS/JIS Symbol	KS/JIS Number	Remarks	DIN Type	DIN Number	Material Number	Remarks	B.S Number	B.S Grade	Remarks	NBN Type	NBN Grade	Remarks	AFNOR Type	NF Number	Remarks	UNI Type	UNI Number	Remarks
A 210 Seamless Medium-Carbon Steel Boiler and Superheater Tube																				
Grade A-1	K02707	STHA 410 / STB 410	D3563 / G3461	(30)(24)	St45.8	17175	1.0405		3059	320	(30)	D45	837	(13)	TU A42-C	A49-213	(6)(13)	C 18	5462	(38)

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

ASTM Standard	UNS NO.	KOREA/JAPANES			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)	12CrMo 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)	13CrMo 44	17175	1.7335	(8)(32)	3606	621	(30)	5.05		(3b)(32)			Dalmine 227(3b)
Grade T 12	K11562	STHA 21 / STBA 22	D3572 / G3462	(30)(24)	13CrMo 44	17175	1.7335	(32)	3606	620	(30)	TU 10 CD 5.05					
Grade T 22	K21590	STHA 23 / STBA 24	D3572 / G3462	(30)(24)	10CrMo 9 10	17175	1.7380	(32)	3606	622	(30)(32)			(3a)(32)	12 CrMo 9 10	5462	Dalmine 235(3b)
TP 304	S30400	STS 304 TB / SUS 304 TB	D3577 / G3463	(30)(24)	X5 CrNi 18 9	17440	1.4301	(3b)	3606	304S25	(30)	TU 10 CD 9.10	A49-218	(3b)	X5 CrNi 18 10	6904	(3b)
TP 304L	S31403	STS 304LTB / SUS 304LTB	D3577 / G3463	(30)(24)	X2CrNi 18 9	17440	1.4306	(3b)	3606	304S22	(30)	Z 6 CN 18.09	A49-218	(3b)	X2 CrNi 18 11	6904	(3b)
TP 310	S31000	STS 310STB/SUS 210STB	D3577 / G3463	(30)(24)	X12CrNi 2528		1.4845	WBL-470(3b)			(3)	Z 2 CN 18.09		(3)	X22CrNi 25 20	6904	(3b)(11)
TP 316	S31600	STS 316TB / SUS 316TB	D3577 / G3463	(30)(24)	X5CrNiMo 18 10	17440	1.4401	(3b)	3606	316S30	(30)		A49-218	(3b)	X5 CrNiMo 17 12	6904	(3b)
TP 316L	S211603	STS 316LTB /SUS 316LTB	D3577 / G3463	(30)(24)	X2CrNiMo 18 10	17440	1.4404	(3b)	3606	316S29	(30)	Z 6 CND 17.12	A49-218	(3b)	X2 CrNiMo 17 12	6904	(3b)
TP 321	S32100	STS 312TB/SUS 321TB	D3577 / G3463	(30)(24)	X10CrNiTi 18 9	17440	1.4541	(3b)	3606	321S22	(30)	Z2 CND 17.13	A49-218	(3b)	X6 CrNiTi 18 11	6904	(3b)
TP 347	S34700	STS 347TB / SUS 347TB	D3577 / G3463	(30)(24)	X10CrNiNb 18 9	17440	1.4550	(3b)	3606	347S17	(30)	Z6 CNT 18.11	A49-218	(3b)	X6 CrNiNb	6904	(3b)

															18 11		
												Z 6 CNNb 18.11					

JIS Number and Corresponding Foreign Standards

JIS			ASTM			BS			DIN			NF			ISO			Index Number
Standard Number	Grade	Tube	Standard Number	Grade	Tube	Standard Number	Grade	Tube	Standard Number	Grade	Tube	Standard Number	Grade	Tube	Standard Number	Grade	Tube	
G3456		C	A106	GrA	C	3602	HFS360	C	17175	St35.8	C	A49-211	TU37b	C	2604/2	TS5	C	C004
	STPT370					"	CFS360	C	17177	St37.8	C	A49-213	TU37c	C	2604/3	TW9H	C	
	(STPT38)					"	ERW360	C				A49-243	TU37c	C				
						"	CEW360	C										
		C	A106	GrB	C	3602	HFS410	C	17175	St45.8	C	A49-211	TU42b	C	2604/2	TS9H	C	
	STPT410					"	CFS410	C	17177	St42.8	C	A49-213	TU42c	C				
	(STPT42)					"	ERW410	C				A49-243	TU42c	C				
						"	CEEW410	C										
		C	A106	GrC	C	3602	HFS460	C				A49-211	TU48b	C	2604/2	TS14	C	
	STPT480					"	CFS460	C				A49-213	TU48c	C				
	(STPT42)					"	ERW460	C										
						"	CEEW460	C										

JIS Number and Corresponding Foreign Standards

JIS			ASTM			BS			DIN			NF			ISO			Index Number
Standard Number	Grade	Tube	Standard Number	Grade	Tube	Standard Number	Grade	Tube	Standard Number	Grade	Tube	Standard Number	Grade	Tube	Standard Number	Grade	Tube	
G3461	STB340	C	A161	LC	C	3059	HFS320	C				A49-245	TS34e	C				C010
	(STB35)		A192	-	C	"	CFS320	C				"	TS34c	C				

			A226	-	C	"	ERW320	C										
			A556	GrA2	C	"	CEW320	C										
			A557	GrA2	C	"	S1 360	C										
						"	S2 360	C										
						"	ERW 360	C										
						"	CEW360	C										
						3606	ERW320	C										
						"	CEW320	C										
						"	CFS320	C										
	STB410	C	A179	GrC	C	3059	S1 440	C	17175	St45.8	C	A49-213	TU42c	C	2604/2	TS9H	C	
	(STB42)		A210	GrA1	C	"	S2 440	C	17177	St42.8	C	A49-215	TU42c	C	"	TW9H	C	
			A556	GrB2	C	"	ERW 440	C				A49-243	TS42c					
			A557	GrB2	C	"	CEW 440	C				A49-245	TS42c					
						3602	HFS 410	C				"	TS42c					
						"	CFS 410	C										
						"	ERW 410	C										
						"	CEW 410	C										
						3606	ERW 440	C										
						"	CEW 440	C										
						"	CFS 440	C										
STB510	C							C	17175	19Mn5	C	A49-213	TU52C	C	2604/2	TS18	C	
(STB52)								C				A49-248	TU52C	C				

JIS Number and Corresponding Foreign Standards

JIS			ASTM			BS			DIN			NF			ISO			Index Number
Standard Number	Grade	Type	Standard Number	Grade	Type	Standard Number	Grade	Type	Standard Number	Grade	Type	Standard Number	Grade	Type	Standard Number	Grade	Type	

G3462	STBA12	Mo	A209	T1	Mo	3606	ERW245	Mo										C011
			A250	T1	Mo	"	CEW245	Mo										
						"	CFS245	Mo										
	STBA13	Mo	A209	T1-A	Mo													
			A250	T1-a	Mo													
			A629	-	Mo													
	STBA20	CrMo	A213	T2	CrMo													
	STBA22	CrMo	A213	T12	CrMo	3059	S1 620	CrMo	17175	13CrMo44	CrMo							
						"	S2 620	CrMo										
						3059	ERW620	CrMo										
						"	CEW620	CrMo										
						3604	HFS620-460	CrMo										
						"	CFS620-460	CrMo										
						"	ERW620-460	CrMo										
						"	CEW620-460	CrMo										
						"	HFS620-440	CrMo										
						"	CFS620-440	CrMo										
						"	ERW620-440	CrMo										
						"	CEW620-440	CrMo										
						3606	ERW620	CrMo										
						"	CEW620	CrMo										
						"	CFW620	CrMo										
	STBA23	CrMo	A199	T11	CrMo	3604	HF621	CrMo				A49-213	TU10CD	CrMo				
			A213	T11	CrMo	"	CFS621	CrMo				A49-215	TU10CD5.05	CrMo				
						"	ERW621	CrMo										
						"	CEW621	CrMo										

						3606	ERW621	CrMo										
						"	CEW621	CrMo										
						"	CFS621	CrMo										
	STBA24	CrMo	A199	T22	CrMo	3059	S1-622-440	CrMo	17175	10CrMo910	CrMo	A49-213	Tu10CD9.10	CrMo				
			A213	T22	CrMo	"	S2-622-440	CrMo				A49-215	Tu10CD9.10	CrMo				
						"	S1-622-490	CrMo										
						"	S2-622-490	CrMo										
	STBA25	CrMo	A199	T5	CrMo	3604	HFS625	CrMo							260 4/2	TS37	CrMo	
			A213	T5	CrMo	"	CFS625	CrMo										
						3606	CFS625	CrMo										
	STBA26	CrMo	A199	T9	CrMo	3059	S1-629-470	CrMo				A49-213	TUZ10CD9	CrMo				
			A213	T9	CrMo	"	S2-629-470	CrMo				A49-215	TUZ10CD9	CrMo				
						"	S1-629-470S2-629-590	CrMo										
						"	S2-629-590	CrMo										
						3604	HFS629-470	CrMo										