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Carbon steel tubes for building structure

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Foreword

This Japanese Industrial Standard has been revised by the Minister of Economy, Trade and Industry through deliberations at the Japanese Industrial Standards Committee as the result of proposal for revision of Japanese Industrial Standard submitted by The Japan Iron and Steel Federation (JISF) with a draft being attached, based on the provision of Article 12, paragraph (1) of the Industrial Standardization Act applied mutatis mutandis pursuant to the provision of Article 16 of the said Act. This edition replaces the previous edition (**JIS G 3475**:2016), which has been technically revised.

However, **JIS G 3475**: 2016 may be applied in the **JIS** mark certification based on the relevant provisions of Article 30, paragraph (1), etc. of the Industrial Standardization Act until 19 May 2022.

Attention is drawn to the possibility that some parts of this Standard may conflict with patent rights, published patent application or utility model rights. The relevant Minister and the Japanese Industrial Standards Committee are not responsible for identifying any of such patent rights, published patent application or utility model rights.

Carbon steel tubes for building structure

1 Scope

This Japanese Industrial Standard specifies requirements for the carbon steel tubes mainly used for building structures (hereafter referred to as tubes).

NOTE 1 The piles for the foundation of structures are covered by **JIS A 5525**.

NOTE 2 This Standard generally applies to tubes of outside diameter 114.3 mm to 1 000.0 mm (see **9.1**).

2 Normative references

Part or all of the provisions of the following standards, through reference in this text, constitute provisions of this Standard. The most recent editions of the standards (including amendments) indicated below shall be applied.

JIS G 0202 *Glossary of terms used in iron and steel (Testing)*

JIS G 0203 *Glossary of terms used in iron and steel (Products and quality)*

JIS G 0320 *Standard test method for heat analysis of steel products*

JIS G 0321 *Product analysis and its tolerance for wrought steel*

JIS G 0404 *Steel and steel products — General technical delivery requirements*

JIS G 0415 *Steel and steel products — Inspection documents*

JIS G 1201 *Iron and steel — General rules for analytical methods*

JIS G 1228 *Iron and steel — Methods for determination of nitrogen content*

JIS R 6010 *Coated abrasive grain sizes*

JIS Z 2241 *Metallic materials — Tensile testing — Method of test at room temperature*

JIS Z 2242 *Method for Charpy pendulum impact test of metallic materials*

JIS Z 3121 *Methods of tensile test for butt welded joints*

JIS Z 8401 *Rounding of numbers*

3 Terms and definitions

For the purpose of this Standard, the terms and definitions given in **JIS G 0202** and **JIS G 0203** apply.

4 Symbols of grade

This Standard coves tubes of three steel grades. Their symbols are shown in Table 1.

Table 1 Symbols of grade and manufacturing method

Symbol of grade	Symbols of manufacturing method		
	Tube manufacturing method	Finishing method	Marking
STKN400W	Seamless : S Electric resistance welded : E Butt welded : B Automatic arc welded : A	Hot-finished : H Cold-finished : C As electric resistance welded : G	The symbols of manufacturing method shall be in accordance with **13 c**).
STKN400B			
STKN490B			

5 Manufacturing method

The manufacturing method shall be as follows.

a) Tubes shall be manufactured by a selected combination of the tube manufacturing method and finishing method from Table 1. The manufacturing methods are designated by the symbols given in Table 1.

b) Tubes shall be supplied as manufactured (hot, warm or cold formed), or given an appropriate heat treatment.

c) Tubes shall be finished with plain ends unless otherwise specified.

6 Chemical composition

The results of heat analysis obtained according to **11.1** shall satisfy the composition given in Table 2. If a product analysis has been requested by the purchaser, the tube shall be tested in accordance with **11.1** and the analysis results shall satisfy the composition given in Table 2 within the tolerances given in Table 2 of **JIS G 0321**. The said tolerance value for product analysis does not apply to nitrogen.

Table 2 Chemical composition [a)]

Unit: %

Symbol of grade	C	Si	Mn	P	S	N [b)]
STKN400W	0.25 max.	—	—	0.030 max.	0.030 max.	0.006 max.
STKN400B	0.25 max.	0.35 max.	1.40 max.	0.030 max.	0.015 max.	0.006 max.
STKN490B	0.22 max.	0.55 max.	1.60 max.	0.030 max.	0.015 max.	0.006 max.

Note [a)] Elements not listed or without limit values (marked as "—") in this Table may be added as necessary.

Note [b)] Only applicable to tubes that are supplied as cold formed. Where the free nitrogen content is 0.006 % or under due to the addition of aluminium or other element that immobilizes nitrogen, the total nitrogen content of up to 0.009 % is permissible. The free nitrogen in this case is determined by deducting the quantitative value of nitride type nitrogen from that of the total nitrogen. The determination of nitride type nitrogen shall be in accordance with Annex A.

7 Carbon equivalent or weld crack sensitivity composition

The carbon equivalent or weld crack sensitivity composition shall be as follows.

a) The carbon equivalent shall conform to Table 3. The carbon equivalent shall be calculated according to the following formula using the heat analysis values obtained according to **11.1**.

All the elements given in the formula shall be analyzed for the purpose of calculation regardless of whether or not they are intentionally added.

$$C_{eq} = C + \frac{Mn}{6} + \frac{Si}{24} + \frac{Ni}{40} + \frac{Cr}{5} + \frac{Mo}{4} + \frac{V}{14}$$

where, C_{eq}: carbon equivalent (%)

Table 3 Carbon equivalent

Unit: %

Symbol of grade	Carbon equivalent (C_{eq})
STKN400W	0.36 max.
STKN400B	
STKN490B	0.44 max.

b) Upon agreement between the purchaser and the manufacturer, the weld crack sensitivity composition may be applied instead of the carbon equivalent. In this case, the requirement in Table 4 shall be satisfied. The weld crack sensitivity composition shall be calculated according to the following formula using the heat analysis values obtained according to **11.1**.

All the elements given in the formula shall be analyzed for the purpose of calculation regardless of whether or not they are intentionally added.

$$P_{CM} = C + \frac{Si}{30} + \frac{Mn}{20} + \frac{Cu}{20} + \frac{Ni}{60} + \frac{Cr}{20} + \frac{Mo}{15} + \frac{V}{10} + 5B$$

where, P_{CM}: weld crack sensitivity composition (%)

Table 4 Weld crack sensitivity composition

Unit: %

Symbol of grade	Weld crack sensitivity composition (P_{CM})
STKN400W	0.26 max.
STKN400B	
STKN490B	0.29 max.

8 Mechanical properties

8.1 Tensile strength, yield point or proof stress, yield ratio and elongation

Tubes shall be tested in accordance with **11.2**, and their tensile strength, yield point or proof stress, yield ratio and elongation shall conform to Table 5. For a tensile test of tubes under 8 mm in wall thickness using Test piece No. 12, the elongation requirement in Table 6 shall apply.

NOTE The elongation values in Table 6 are given by deducting 1.5, for every 1 mm decrease in wall thickness from 8 mm, from the values given in Table 5 and rounding the results to a whole number according to Rule A in **JIS Z 8401**.

8.2 Flattening resistance

Seamless, electric resistance welded and butt welded tubes shall be tested in accordance with **11.2**. The test piece shall be free from cracks when flattened until the distance between the platens reaches the value given in Table 5.

NOTE See **11.2.4** for details of the flattening test.

8.3 Tensile strength of weld

Automatic arc welded tubes shall be tested in accordance with **11.2**, and the tensile strength of their weld shall be as given in Table 5.

8.4 Charpy absorbed energy

Tubes of STKN400B and STKN490B with an outside diameter of 400 mm or over and wall thickness over 12 mm shall be tested in accordance with **11.2**, and their Charpy absorbed energy shall conform to Table 5. The Charpy absorbed energy test results, obtained as the average of three test pieces, shall be judged for acceptance according to the rules described in **9.6** of **JIS G 0404**. Upon agreement between the purchaser and the manufacturer, a test temperature lower than 0 °C may be used.

Table 5　Mechanical properties

Symbol of grade	Wall thickness mm	Tensile strength N/mm²	Yield point or proof stress N/mm²	Yield ratio %	Elongation %		Charpy absorbed energy [a] J	Flattening resistance Distance between platens (H) mm	Tensile strength of weld N/mm²
					Tensile test piece	Tensile test direction			
					Test piece No. 11, No. 12 or No. 4	Parallel to tube axis			
		Tube manufacturing method							
		Seamless, electric resistance welded, butt welded and automatic arc welded						Seamless, electric resistance welded and butt welded	Automatic arc welded
STKN400W	100 or under	400 or over up to and incl. 540	235 or over	—	23 min.		—	$\frac{2}{3}D$ [d]	400 min.
STKN400B	Under 12	400 or over up to and incl. 540	235 or over	—	23 min.		27 min.	$\frac{2}{3}D$ [d]	400 min.
	12 or over up to and incl. 40		235 or over up to and incl. 385	80 max. [b] 85 max. [c]					
	Over 40 up to and incl. 100		215 or over up to and incl. 365						
STKN490B	Under 12	490 or over up to and incl. 640	325 or over	—	23 min.		27 min.	$\frac{7}{8}D$ [d]	490 min.
	12 or over up to and incl. 40		325 or over up to and incl. 475	80 max. [b] 85 max. [c]					
	Over 40 up to and incl. 100		295 or over up to and incl. 445						

NOTE　1 N/mm² = 1 MPa
Note [a] The test temperature for Charpy impact test shall be 0 ℃.
Note [b] Applicable to seamless tubes.
Note [c] Applicable to electric resistance welded, butt welded and automatic arc welded tubes.
Note [d] D : outside diameter of tube

Table 6 Elongation of tubes under 8 mm in wall thickness, tested using Test piece No. 12 (parallel to tube axis)

Unit: %

Symbol of grade	Test piece	Wall thickness						
		Over 1 mm up to and incl. 2 mm	Over 2 mm up to and incl. 3 mm	Over 3 mm up to and incl. 4 mm	Over 4 mm up to and incl. 5 mm	Over 5 mm up to and incl. 6 mm	Over 6 mm up to and incl. 7 mm	Over 7 mm to and excl. 8 mm
STKN400W STKN400B STKN490B	Test piece No. 12	14 min.	16 min.	17 min.	18 min.	20 min.	22 min.	23 min.

9 Dimensions, unit mass and dimensional tolerances

9.1 Dimensions and unit mass

The outside diameter, wall thickness and unit mass of tubes shall conform to Table 7. Other dimensions than given in Table 7 may be used upon agreement between the purchaser and the manufacturer provided the agreed outside diameter is within the range of 21.7 mm to 1 574.8 mm, and the wall thickness is within the range of 2.0 mm to 100.0 mm. The unit mass in this case shall be calculated by the following formula assuming 1 cm^3 of steel to be 7.85 g and rounded off to three significant figures if 1 000 kg/m or smaller and to four significant figures if larger than 1 000 kg/m using the rounding Rule A of **JIS Z 8401**.

$$W = 0.024\,66\,t\,(D - t)$$

where, W: unit mass of tube (kg/m)

t : wall thickness of tube (mm)

D: outside diameter of tube (mm)

0.024 66 : conversion coefficient of unit for obtaining W

NOTE The unit mass values in Table 7 are the results of this calculation.

The values of the sectional area, moment of inertia of area, section modulus and radius of gyration of area are given in Table 7 for information.

Table 7 Dimensions and unit mass of tubes

Outside diameter mm	Wall thickness mm	Unit mass kg/m	Informative			
			Sectional area cm^2	Moment of inertia of area cm^4	Section modulus cm^3	Radius of gyration of area cm
114.3	6.0	16.0	20.41	300	52.5	3.83
165.2	5.0	19.8	25.16	808	97.8	5.67
	6.0	23.6	30.01	952	115	5.63
	7.1	27.7	35.26	1 100	134	5.60
216.3	5.8	30.1	38.36	2 130	197	7.45
	8.2	42.1	53.61	2 910	269	7.36
	10.0	50.9	64.81	3 460	320	7.30
	12.0	60.5	77.02	4 030	373	7.24
	12.7	63.8	81.23	4 230	391	7.21
267.4	6.6	42.4	54.08	4 600	344	9.22
	9.3	59.2	75.41	6 290	470	9.13
	12.7	79.8	101.60	8 260	618	9.02
318.5	6.9	53.0	67.55	8 200	515	11.0
	7.9	60.5	77.09	9 300	584	11.0
	10.3	78.3	99.73	11 900	744	10.9
	12.7	95.8	122.0	14 300	897	10.8
355.6	9.5	81.1	103.3	15 500	871	12.2
	11.1	94.3	120.1	17 800	1 000	12.2
	12.7	107	136.8	20 100	1 130	12.1
	16.0	134	170.7	24 700	1 390	12.0
	19.0	158	200.9	28 500	1 610	11.9
406.4	9.5	93.0	118.5	23 300	1 150	14.0
	12.7	123	157.1	30 500	1 500	13.9
	16.0	154	196.2	37 400	1 840	13.8
	19.0	182	231.2	43 500	2 140	13.7
450.0	19.0	202	257.3	59 900	2 660	15.3
457.2	12.7	139	177.3	43 800	1 920	15.7
	16.0	174	221.8	54 000	2 360	15.6
	19.0	205	261.6	62 900	2 750	15.5
500.0	19.0	225	287.1	83 200	3 330	17.0
	22.0	259	330.4	94 600	3 780	16.9
508.0	12.7	155	197.6	60 600	2 390	17.5
	16.0	194	247.3	74 900	2 950	17.4
	19.0	229	291.9	87 400	3 440	17.3
	22.0	264	335.9	99 400	3 910	17.2
550.0	19.0	249	317.0	112 000	4 070	18.8
	22.0	286	364.9	127 000	4 630	18.7
558.8	12.7	171	217.9	81 300	2 910	19.3
	16.0	214	272.8	101 000	3 600	19.2
	19.0	253	322.2	118 000	4 210	19.1
	22.0	291	371.0	134 000	4 790	19.0
600.0	19.0	272	346.8	146 000	4 880	20.6
	22.0	314	399.5	167 000	5 570	20.5
	25.0	354	451.6	187 000	6 230	20.3
	28.0	395	503.2	206 000	6 880	20.2
	32.0	448	571.0	231 000	7 700	20.1
	36.0	501	637.9	255 000	8 490	20.0
	40.0	552	703.7	277 000	9 240	19.8

Table 7 (continued)

Outside diameter mm	Wall thickness mm	Unit mass kg/m	Informative			
			Sectional area cm^2	Moment of inertia of area cm^4	Section modulus cm^3	Radius of gyration of area cm
609.6	12.7	187	238.2	106 000	3 480	21.1
	16.0	234	298.4	132 000	4 310	21.0
	19.0	277	352.5	154 000	5 050	20.9
	22.0	319	406.1	176 000	5 760	20.8
650.0	16.0	250	318.7	160 000	4 930	22.4
	19.0	296	376.6	188 000	5 770	22.3
	22.0	341	434.0	214 000	6 590	22.2
	25.0	385	490.9	240 000	7 390	22.1
	28.0	429	547.1	265 000	8 160	22.0
	32.0	488	621.3	297 000	9 150	21.9
	36.0	545	694.4	328 000	10 100	21.7
	40.0	602	766.6	358 000	11 000	21.6
660.4	22.0	346	441.2	225 000	6 820	22.6
	28.0	437	556.3	279 000	8 440	22.4
	36.0	554	706.2	345 000	10 500	22.1
700.0	16.0	270	343.8	201 000	5 750	24.2
	19.0	319	406.5	236 000	6 740	24.1
700.0	22.0	368	468.6	270 000	7 700	24.0
	25.0	416	530.1	302 000	8 640	23.9
	28.0	464	591.1	334 000	9 550	23.8
	32.0	527	671.5	375 000	10 700	23.6
	36.0	589	751.0	415 000	11 900	23.5
	40.0	651	829.4	453 000	13 000	23.4
711.2	22.0	374	476.3	283 000	7 960	24.4
	25.0	423	538.9	318 000	8 930	24.3
	28.0	472	601.0	351 000	9 880	24.2
750.0	16.0	290	368.9	249 000	6 630	26.0
	19.0	343	436.3	292 000	7 780	25.9
	22.0	395	503.2	334 000	8 900	25.8
	25.0	447	569.4	375 000	9 990	25.6
	28.0	499	635.1	414 000	11 100	25.5
	32.0	567	721.8	466 000	12 400	25.4
	36.0	634	807.5	516 000	13 800	25.3
	40.0	700	892.2	564 000	15 000	25.1
762.0	16.0	294	375.0	261 000	6 850	26.4
	22.0	401	511.5	350 000	9 200	26.2
	28.0	507	645.7	435 000	11 400	26.0
800.0	16.0	309	394.1	303 000	7 570	27.7
	19.0	366	466.2	356 000	8 890	27.6
	22.0	422	537.7	407 000	10 200	27.5
	25.0	478	608.7	457 000	11 400	27.4
	28.0	533	679.1	507 000	12 700	27.3
	32.0	606	772.1	570 000	14 300	27.2
	36.0	678	864.1	632 000	15 800	27.0
	40.0	750	955.0	691 000	17 300	26.9
812.8	19.0	372	473.8	373 000	9 190	28.1
	22.0	429	546.6	428 000	10 500	28.0
	25.0	486	618.7	480 000	11 800	27.9

Table 7 (concluded)

Outside diameter	Wall thickness	Unit mass	Informative			
			Sectional area	Moment of inertia of area	Section modulus	Radius of gyration of area
mm	mm	kg/m	cm^2	cm^4	cm^3	cm
850.0	22.0	449	572.3	491 000	11 500	29.3
	25.0	509	648.0	552 000	13 000	29.2
	28.0	568	723.1	611 000	14 400	29.1
	32.0	646	822.3	689 000	16 200	28.9
	36.0	703	896.1	745 000	17 500	28.8
	40.0	799	1 018.0	837 000	19 700	28.7
900.0	19.0	413	525.9	510 000	11 300	31.2
	22.0	476	606.8	585 000	13 000	31.1
	25.0	539	687.2	658 000	14 600	30.9
	28.0	602	767.1	730 000	16 200	30.8
	32.0	685	872.6	823 000	18 300	30.7
	36.0	767	977.2	913 000	20 300	30.6
	40.0	848	1 081.0	1 000 000	22 300	30.4
1000.0	28.0	671	855.0	1 010 000	20 200	34.4
	32.0	764	973.1	1 140 000	22 800	34.2
	36.0	856	1 090.0	1 270 000	25 400	34.1
	40.0	947	1 206.0	1 390 000	27 800	34.0

9.2 Dimensional tolerances

The dimensional tolerances shall be as follows.

a) The tolerances on outside diameter of tubes shall be as given in Table 8, and those on wall thickness of tubes, as given in Table 9 or 10.

b) For the length tolerance, tubes shall be equal to or longer than the specified length unless otherwise specified.

Table 8 Tolerances on outside diameter

Outside diameter	Tolerance
Under 50 mm	±0.5 mm
50 mm or over [a) b)]	±1 %

Note [a)] For electric resistance welded and automatic arc welded tubes over 350 mm in outside diameter, the tolerance on outside diameter at the tube end shall be ±0.5 %.

Note [b)] For tubes over 350 mm in outside diameter, the circumferential length (l) may be measured and the outside diameter (D) calculated from conversion according to the following formula:

$$D = l / \pi$$

where, D: outside diameter (mm)
l : circumferential length (mm)
π : 3.141 6

Table 9 Tolerances on wall thickness (for seamless tubes)

Wall thickness	Tolerance
Under 6 mm	+0.9 mm −0.5 mm
6 mm or over	+20 % −0.5 mm

Table 10 Tolerances on wall thickness (for other than seamless tubes)

Wall thickness	Tolerance
Under 6 mm	+0.9 mm −0.5 mm
6 mm or over	+15 % −0.5 mm

10 Appearance

The appearance shall be as follows.

a) The tube shall be straight, and its ends at right angles to its axis for practical purposes

b) The internal and external surfaces of the tube shall be finished smoothly and free from defects detrimental to use. Harmful defects, if found, may be removed by grinding, machining or other means of surface treatment, or repaired by welding on the following conditions.

1) For grinding, machining or other surface treatment

— The tube after repair shall remain within the specified wall thickness tolerance.

— The repaired surface shall be smooth along the contour of the tube.

2) For repair by welding

— Repair shall only be performed on the base metal of automatic arc welded, electric resistance welded and butt welded tubes, and on the weld of automatic arc welded tubes.

— Any harmful defects on the tube shall be removed thoroughly by chipping, grinding or other suitable means prior to welding. The depth of the removed part shall be 20 % or under of the nominal wall thickness of the tube. The total conditioned area on the external surface of the tube shall not exceed 2 % of the external surface area of the tube, and that on the internal surface shall not exceed 2 % of the internal surface area of the tube.

— The repair by welding shall be carried out by a suitable means according to the type of the steel product, or according to the characteristics of the weld if the repair is on the weld.

— The welded part shall be free from undercuts or overlaps around the fringe of

the weld. The weld reinforcement shall be built at least up to the rolled surface, and then removed by chipping, grinding or other suitable means so that it merges smoothly with the adjacent tube surfaces, or with the original weld bead if the repair is on the weld.

— For heat treated tubes, the tube body shall receive another run of the given heat treatment after repair by welding.

c) If requested, other specific surface finish and coating may be applied upon agreement between the purchaser and the manufacturer.

11 Tests

11.1 Chemical analysis

11.1.1 General requirements and sampling method

General requirements for chemical analysis and the sampling method for heat analysis shall be in accordance with Clause **8** of **JIS G 0404**. If a product analysis is requested by the purchaser, the sampling method for product analysis shall be in accordance with Clause **4** of **JIS G 0321**. Alternatively, a ruptured test piece after tensile test may be used as a sample for the product analysis.

11.1.2 Analysis method

The heat analysis shall be in accordance with **JIS G 0320**, and the product analysis, in accordance with **JIS G 0321**.

11.2 Mechanical tests

11.2.1 General

General requirements for mechanical tests shall be in accordance with Clauses **7** and **9** of **JIS G 0404**. For sampling method, Class A specified in **7.6** of **JIS G 0404** shall apply.

11.2.2 Sampling method and number of test pieces

The sampling method and the number of test pieces shall be as given in Table 11.

Table 11 Sampling method and number of test pieces

Outside diameter	Sampling method	Number of test pieces
100 mm or under	Take one sample from each 5 000 m and its fraction of tube of the same heat and same dimensions [a].	Take the following number of test pieces from one sample. Tensile test piece : one Tensile test piece of weld : one Flattening test piece: one Charpy impact test piece : one set (three test pieces)
Over 100 mm up to and incl. 200 mm	Take one sample from each 2 500 m and its fraction of tube of the same heat and same dimensions [a].	
Over 200 mm up to and incl. 350 mm	Take one sample from each 1 250 m and its fraction of tube of the same heat and same dimensions [a].	
Over 350 mm	Take one sample from each 1 250 m and its fraction of tube of the same heat and same dimensions [a]. Where the total of calculated mass of tubes is over 100 t, further take one sample from each 100 t or its fraction of tube.	
Note [a] Tubes of the same dimensions are those manufactured to the same outside diameter and wall thickness.		

11.2.3 Tensile test

The tensile test piece and test method shall be as follows.

a) **Test piece**

1) Test piece No. 11, No. 12 (No. 12A, No. 12B or No. 12C) or No. 4 specified in **JIS Z 2241**, taken parallel to the tube axis, shall be used. Test piece No. 12 shall not contain the weld. Test piece No. 4 shall be taken such that its centre is at a quarter-thickness position from the outer surface. If taking from this position is impossible, the test piece shall be taken at a closest possible position to it.

2) For the tensile test of weld of automatic arc welded tubes, flatten a sample taken from a tube, machine the weld reinforcement until flush with the sheet surface, and take Test piece No. 1 specified in **JIS Z 3121** from this.

b) **Test method** The test method shall be in accordance with **JIS Z 2241**.

11.2.4 Flattening test

The flattening test piece and test method shall be as follows.

For seamless tubes, this test may be omitted [1] unless it is specified by the purchaser. For electric resistance welded tubes over 300 mm in outside diameter or those over 30 mm in wall thickness, this test may be omitted upon the agreement between the purchaser and the manufacturer.

Note [1] The test may be omitted at the discretion of the manufacturer, but even in this case, the tube shall satisfy the specified flattening resistance.

a) **Test piece** The test piece shall have a length of 50 mm or greater.

b) **Test method** In an environment at the ordinary temperature (5 °C to 35 °C), flat-

ten the test piece between two platens until the distance *H* between the platens reaches the value specified in Table 5, and examine the test piece for cracks. The test piece of electric resistance welded and butt welded tubes shall be placed such that the central line across the tube cross-section passing through the weld is perpendicular to the compression direction as shown in Figure 1.

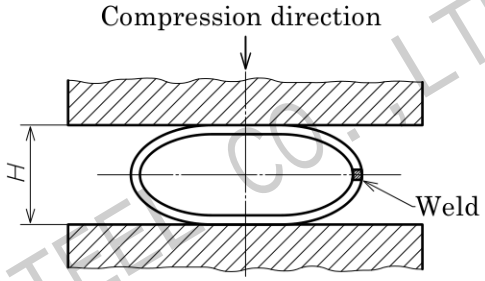

Figure 1 Flattening test

11.2.5 Charpy impact test

The Charpy impact test piece and test method shall be as follows.

a) **Test piece** The V-notch test piece specified in **JIS Z 2242** taken parallel to the tube axis such that its centre is at a quarter-thickness position from the outer surface shall be used. The notch shall be given with its length direction being perpendicular to the tube axis. If taking from the said position is impossible, the test piece shall be taken at a closest possible position to it.

b) **Test method** The test method shall be in accordance with **JIS Z 2242**. A striker with a 2 mm radius shall be used.

NOTE Instead of the tests specified in this Standard, non-destructive tests of tube or weld specified in Japanese Industrial Standards may be carried out upon agreement between the purchaser and the manufacturer, in which case the test piece sampling, test method, acceptance criteria and other necessary requirements shall be previously agreed between the purchaser and the manufacturer.

12 Inspection and reinspection

12.1 Inspection

The inspection shall be as follows.

a) The general requirements for inspections are specified in **JIS G 0404**.

b) The chemical composition shall conform to the requirements of Clause **6**.

c) The carbon equivalent or weld crack sensitivity composition shall conform to the requirements of Clause **7**.

d) The mechanical properties shall conform to the requirements of Clause **8**.

e) The dimensions shall conform to the requirements of Clause **9**.

f) The appearance shall conform to the requirements of Clause **10**.

12.2 Reinspection

Tubes having failed the mechanical tests may be subjected to a retest according to **9.8** of **JIS G 0404** for further acceptance judgement.

13 Marking

Each of the tubes having passed the inspection shall be marked with the following information. Where this is difficult due to a small tube diameter, or where the purchaser has so requested, the marking may be given on each bundle of tubes by a suitable means. The order of the markings is not specified. Part of the particulars may be omitted as long as the product is identifiable.

a) Symbol of grade

b) Heat number or inspection number

c) Symbol of manufacturing method

The symbols of manufacturing method shall be as follows. The dashes before the symbols may be replaced with a blank.

1) Hot-finished seamless tube –S–H

2) Cold-finished seamless tube –S–C

3) Hot-finished electric resistance welded tube –E–H

4) Cold-finished electric resistance welded tube –E–C

5) As electric resistance welded tube –E–G

6) Butt welded tube –B

7) Automatic arc welded tube –A

Example Hot-finished seamless tube of STKN400W : STKN400W–S–H

d) Dimensions, marked by outside diameter and wall thickness.

e) Name of manufacturer or identifying brand

14 Report

The manufacturer shall submit an inspection document to the purchaser. The report shall be in accordance with Clause **13** of **JIS G 0404**. Unless otherwise specified in the order, the type of the inspection document to be submitted shall be in accordance with **5.1** of **JIS G 0415**.

The report shall also include analysis results of elements used for calculation of carbon equivalent or weld crack sensitivity composition, and those of alloy elements added outside Table 2.

Annex A (normative)
Determination of nitride type nitrogen

A.1 Scope

This Annex specifies the method for determining the content of nitride type nitrogen in steel products that is used to obtain the free nitrogen content. It should be noted that the specified method does not determine silicon nitride as nitride type nitrogen.

A.2 General

General requirements for analytical methods shall be in accordance with **JIS G 1201**.

A.3 Summary

After decomposition of iron, which is the matrix in the sample, by a suitable method, the residue is filtered and captured by a polycarbonate membrane filter. The captured residue is decomposed with sulfuric acid and potassium sulfate. The nitrogen in this solution is then determined by the method specified in Annex 1, 2 or 3 of **JIS G 1228**.

A.4 Reagents

The following reagents shall be used.

A.4.1 Sulfuric acid

A.4.2 Potassium sulfate

A.4.3 Methanol

A.4.4 Methyl acetate

A.4.5 Bromine-methanol solution

Measure 135 ml of methanol in a measuring cylinder, and transfer to an Erlenmeyer flask (300 ml). Add 15 ml of bromine to this using a measuring cylinder or a conical liquidometer, and stir. These measured quantities and total quantity may be changed depending on the amount needed for testing, provided they are in the same ratio as above. Prepare this solution immediately before use.

A.4.6 Bromine-methyl acetate solution

Measure 135 ml of methyl acetate in a measuring cylinder, and transfer to an Erlenmeyer flask (300 ml). Add 15 ml of bromine to this using a measuring cylinder or a conical liquidometer, and stir. These measured quantities and total quantity may be changed depending on the amount needed for testing, provided they are in the same ratio as above. Prepare this solution immediately before use.

A.4.7 Iodine-methanol solution

Weigh 42 g of iodine and transfer to a beaker (300 ml). Add methanol and stir to

make the total quantity 300 ml. These measured quantities and total quantity may be changed depending on the amount needed for testing, provided they are in the same ratio as above. Prepare this solution immediately before use.

A.4.8 Tetramethylammonium chloride (TMAC)-acetylacetone-methanol electrolyte

Weigh 5 g of TMAC ($[(CH_3)_4N]Cl$) using a scale and measure 50 ml of acetylacetone using a measuring cylinder or a conical liquidometer, and transfer these to a beaker (500 ml). Add methanol and stir to make the total quantity 500 ml. Prepare this solution immediately before use.

A.5 Procedure

A.5.1 Separation of nitride type nitrogen

Separation of nitride type nitrogen shall be performed by one of the following methods.

a) **Iodine-methanol method**

1) Weigh 1 g to 5 g of sample to the nearest 1 mg, transfer to a dry Erlenmeyer flask with interchangeable ground joint (500 ml), and add 50 ml of iodine-methanol solution (**A.4.7**) per 1 g of sample. The amount of sample to be weighed shall be such that the nitrogen amount calculated from the expected content of nitride type nitrogen is within the applicable range of the nitrogen determination method specified in **JIS G 1228**. Mount a dry coiled condenser with interchangeable ground joint on the flask, and heat to 60 ℃ in a water bath. During the heating, stir the solution with ultrasonic equipment or a magnetic stirrer. If precipitation occurs during the decomposition, increase the amount of iodine-methanol solution (**A.4.7**). When the decomposition of the base metal is complete, remove the flask from the water bath and allow to cool.

2) Suction-filter the solution by using a polycarbonate membrane filter (47 mm in diameter and 0.2 μm in pore diameter) to collect the insoluble residue on the filter. Wash with methanol until colouration of the filter is no longer observed.

3) Detach the filter from the suction filter and dry it at room temperature.

b) **Bromine-methyl acetate method**

1) Weigh 1 g to 5 g of sample to the nearest 1 mg, transfer to a dry Erlenmeyer flask with interchangeable ground joint (300 ml), and add 150 ml of bromine-methyl acetate solution (**A.4.6**). The amount of sample to be weighed shall be such that the nitrogen amount calculated from the expected content of nitride type nitrogen is within the applicable range of the nitrogen determination method specified in **JIS G 1228**. Mount a dry coiled condenser with interchangeable ground joint on the flask, and decompose at room temperature. During the decomposition, stir the solution with ultrasonic equipment or a magnetic stirrer.

2) Suction-filter the solution by using a polycarbonate membrane filter (47 mm in diameter and 0.2 μm in pore diameter) to collect the insoluble residue on the filter. Wash with methyl acetate until colouration of the filter is no longer observed.

3) Detach the filter from the suction filter and dry it at room temperature.

c) **Bromine-methanol method**

1) Weigh 1 g to 5 g of sample to the nearest 1 mg, transfer to a dry Erlenmeyer flask with interchangeable ground joint (300 ml), and add 150 ml of bromine-methanol solution (**A.4.5**). The amount of sample to be weighed shall be such that the nitrogen amount calculated from the expected content of nitride type nitrogen is within the applicable range of the nitrogen determination method specified in **JIS G 1228**. Mount a dry coiled condenser with interchangeable ground joint on the flask, and decompose at room temperature. During the decomposition, stir the solution with ultrasonic equipment or a magnetic stirrer.

2) Suction-filter the solution by using a polycarbonate membrane filter (47 mm in diameter and 0.2 μm in pore diameter) to collect the insoluble residue on the filter. Wash with methanol until colouration of the filter is no longer observed.

3) Detach the filter from the suction filter and dry it at room temperature.

d) **Controlled potential electrolysis method**

1) Using an abrasive paper (P120 to P400 in grain size, specified in Clause **3** of **JIS R 6010**), polish the surface of a sample cut out to an appropriately sized block, ultrasonically wash it in methanol, dry, and weigh.

2) In an electrolytic bath containing 500 ml of TMAC-acetylacetone-methanol electrolyte (**A.4.8**), previously set up the sample as an anode by hanging with a platinum wire or fixing with a magnet and set up platinum or copper as a cathode. Electrolyze and dissolve the sample under a specific electric potential by using a controlled potential electrolytic equipment. The dissolved amount of the sample shall be about 1 g [1)].

Note [1)] One hour of electrolysis at 100 mA dissolves about 0.1 g of sample.

3) Upon completion of the electrolysis, remove the sample from the electrolytic bath, transfer to a dry beaker (200 ml), pour methanol to fully submerge, and ultrasonically wash to shake off the attached insoluble residue. Suction-filter the washings of the sample and the electrolyte by using a polycarbonate membrane filter (47 mm in diameter and 0.2 μm in pore diameter) to collect the insoluble residue on the filter. Wash with methanol until colouration of the filter is no longer observed.

4) Detach the filter from the suction filter and dry it at room temperature.

5) Wash the sample thoroughly with methanol, dry, and weigh. Subtract this mass from the mass determined in **1)** to take it as the dissolved amount of sample.

A.5.2 Decomposition of insoluble residue

Transfer the residue obtained in **A.5.1 a)**, **A.5.1 b)**, **A.5.1 c)** or **A.5.1 d)** to an Erlenmeyer flask (300 ml) together with the polycarbonate membrane filter, and add 10 g of potassium sulfate (**A.4.2**) and 20 ml of sulfuric acid (**A.4.1**). Gently heat this solution to vaporize moisture, mount a funnel on the mouth of the flask, heat, and let white fumes

of sulfur trioxide evolve for about an hour to decompose the insoluble residue. After allowing to cool to room temperature, add gradually 100 ml of water and boil for a while to eliminate sulfur dioxide. Cool to room temperature.

A.5.3 Determination of nitrogen

The nitrogen content in the solution obtained in **A.5.2** shall be determined by one of the followings.

a) **Ammonia distillation separation amidosulfuric acid titration**, according to Annex 1 of **JIS G 1228**.

b) **Ammonia distillation separation bis (1-phenyl-3-mehtyl-5-pyrazolone) absorptiometry**, according to Annex 2 of **JIS G 1228**.

c) **Ammonia distillation separation indophenol blue absorptiometry**, according to Annex 3 of **JIS G 1228**.

Errata for **JIS** (English edition) can be downloaded in PDF format at Webdesk (purchase information page) of our website (https://www.jsa.or.jp/).

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