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Alloy steel tubes for machine purposes

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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 3441** : 2016), which has been technically revised.

However, **JIS G 3441** : 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 21 February 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.

Alloy steel tubes for machine purposes

1 Scope

This Japanese Industrial Standard specifies requirements for the alloy steel tubes (hereafter referred to as tubes) used for machinery, automobiles, and other machine parts.

2 Normative references

The following standards contain provisions which, 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 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*

3 Symbol of grade

The tubes are classified into 40 grades, and the symbol of grade shall be as given in Table 1.

Table 1 Symbol of grade and symbol for manufacturing method

Classification	Symbol of grade	Symbol for manufacturing method		
		Tube manufacturing method	Finishing method	Marking
Manganese steel	SMn420TK SMn433TK SMn438TK SMn443TK	Seamless : S Electric resistance welded : E	Hot finished : H Cold finished : C As electric resistance welded : G	As given in 11 b).
Manganese chromium steel	SMnC420TK SMnC443TK			
Chromium steel	SCr415TK SCr420TK SCr430TK SCr435TK SCr440TK SCr445TK			
Chromium molybdenum steel	SCM415TK SCM418TK SCM420TK SCM421TK SCM425TK SCM430TK SCM432TK SCM435TK SCM440TK SCM445TK SCM822TK			
Nickel chromium steel	SNC236TK SNC415TK SNC631TK SNC815TK SNC836TK			
Nickel chromium molybdenum steel	SNCM220TK SNCM240TK SNCM415TK SNCM420TK SNCM431TK SNCM439TK SNCM447TK SNCM616TK SNCM625TK SNCM630TK SNCM815TK			
Aluminium chromium molybdenum steel	SACM645TK			

4 Manufacturing method

The manufacturing method shall be as follows.

a) The tubes shall be manufactured by combination of the tube manufacturing method and the finishing method which are indicated in Table 1. The symbol for manufacturing method shall be as specified in Table 1. If required, tubes may be subjected to the appropriate heat treatment.

b) If required, the purchaser may specify the heat treatment.

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

d) When tubes are manufactured by electric resistance welding, the weld beads on internal and external surfaces shall be removed to smooth the surface along the contour of the tube. Inner beads may be left as welded if so agreed between the purchaser and the manufacturer.

5 Chemical composition

The tubes shall be subjected to the test of **9.1**, and satisfy the heat analysis values given in Table 2. When the product analysis is requested by the purchaser, the test shall be performed according to **9.1**, and the obtained product analysis values shall satisfy the requirements in Table 2 within tolerances given in Table 4 of **JIS G 0321**.

6 Flattening resistance

Electric resistance welded steel tubes shall be tested in accordance with **9.2**, and the test piece shall be free from cracks on the weld when flattened until the distance between the plates is seven eighth of outside diameter. When agreed between the purchaser and the manufacturer, the specifications for flattening resistance may not be applied.

7 Dimensions and dimensional tolerances

7.1 Dimensions

The dimensions shall be as agreed between the purchaser and the manufacturer.

7.2 Dimensional tolerances

The dimensional tolerances shall be as follows.

a) The tolerances on the outside diameter and the wall thickness of tubes shall be as given in Table 3 and Table 4, respectively. For hot finished seamless steel tubes, Class 1 given in Tables 3 and 4 shall be applied. For other tubes, the category to be applied shall be determined according to the agreement between the purchaser and the manufacturer.

b) The tolerances on the length of tubes shall be $^{+50}_{0}$ mm, unless otherwise agreed between the purchaser and the manufacturer.

8 Appearance

The appearance shall be as follows.

a) The tubes shall be straight for practical purposes, and the both ends shall be at

right angles to the tube axis.

b) The tubes shall be smoothly finished and free from defects detrimental to use.

c) The tubes may be repaired by grinding, machining or other methods, provided that the wall thickness after repair still satisfies the specified tolerances on the wall thickness.

d) The surface of the repaired part shall be smooth along the contour of the tube.

e) A special request concerning the surface finishing of tubes, if any, shall be upon the agreement between the purchaser and the manufacturer.

Table 2 Chemical composition

Unit: %

Symbol of grade	C	Si	Mn	P	S	Ni	Cr	Mo	Cu
SMn420TK	0.17 to 0.23	0.15 to 0.35	1.20 to 1.50	0.030 max.	0.030 max.	0.25 max.	0.35 max.	a)	0.30 max.
SMn433TK	0.30 to 0.36	0.15 to 0.35	1.20 to 1.50	0.030 max.	0.030 max.	0.25 max.	0.35 max.	a)	0.30 max.
SMn438TK	0.35 to 0.41	0.15 to 0.35	1.35 to 1.65	0.030 max.	0.030 max.	0.25 max.	0.35 max.	a)	0.30 max.
SMn443TK	0.40 to 0.46	0.15 to 0.35	1.35 to 1.65	0.030 max.	0.030 max.	0.25 max.	0.35 max.	a)	0.30 max.
SMnC420TK	0.17 to 0.23	0.15 to 0.35	1.20 to 1.50	0.030 max.	0.030 max.	0.25 max.	0.35 to 0.70	a)	0.30 max.
SMnC443TK	0.40 to 0.46	0.15 to 0.35	1.35 to 1.65	0.030 max.	0.030 max.	0.25 max.	0.35 to 0.70	a)	0.30 max.
SCr415TK	0.13 to 0.18	0.15 to 0.35	0.60 to 0.90	0.030 max.	0.030 max.	0.25 max.	0.90 to 1.20	a)	0.30 max.
SCr420TK	0.18 to 0.23	0.15 to 0.35	0.60 to 0.90	0.030 max.	0.030 max.	0.25 max.	0.90 to 1.20	a)	0.30 max.
SCr430TK	0.28 to 0.33	0.15 to 0.35	0.60 to 0.90	0.030 max.	0.030 max.	0.25 max.	0.90 to 1.20	a)	0.30 max.
SCr435TK	0.33 to 0.38	0.15 to 0.35	0.60 to 0.90	0.030 max.	0.030 max.	0.25 max.	0.90 to 1.20	a)	0.30 max.
SCr440TK	0.38 to 0.43	0.15 to 0.35	0.60 to 0.90	0.030 max.	0.030 max.	0.25 max.	0.90 to 1.20	a)	0.30 max.
SCr445TK	0.43 to 0.48	0.15 to 0.35	0.60 to 0.90	0.030 max.	0.030 max.	0.25 max.	0.90 to 1.20	a)	0.30 max.
SCM415TK	0.13 to 0.18	0.15 to 0.35	0.60 to 0.90	0.030 max.	0.030 max.	0.25 max.	0.90 to 1.20	0.15 to 0.25	0.30 max.
SCM418TK	0.16 to 0.21	0.15 to 0.35	0.60 to 0.90	0.030 max.	0.030 max.	0.25 max.	0.90 to 1.20	0.15 to 0.25	0.30 max.
SCM420TK	0.18 to 0.23	0.15 to 0.35	0.60 to 0.90	0.030 max.	0.030 max.	0.25 max.	0.90 to 1.20	0.15 to 0.25	0.30 max.
SCM421TK	0.17 to 0.23	0.15 to 0.35	0.70 to 1.00	0.030 max.	0.030 max.	0.25 max.	0.90 to 1.20	0.15 to 0.25	0.30 max.
SCM425TK	0.23 to 0.28	0.15 to 0.35	0.60 to 0.90	0.030 max.	0.030 max.	0.25 max.	0.90 to 1.20	0.15 to 0.30	0.30 max.
SCM430TK	0.28 to 0.33	0.15 to 0.35	0.60 to 0.90	0.030 max.	0.030 max.	0.25 max.	0.90 to 1.20	0.15 to 0.30	0.30 max.
SCM432TK	0.27 to 0.37	0.15 to 0.35	0.30 to 0.60	0.030 max.	0.030 max.	0.25 max.	1.00 to 1.50	0.15 to 0.30	0.30 max.
SCM435TK	0.33 to 0.38	0.15 to 0.35	0.60 to 0.90	0.030 max.	0.030 max.	0.25 max.	0.90 to 1.20	0.15 to 0.30	0.30 max.
SCM440TK	0.38 to 0.43	0.15 to 0.35	0.60 to 0.90	0.030 max.	0.030 max.	0.25 max.	0.90 to 1.20	0.15 to 0.30	0.30 max.
SCM445TK	0.43 to 0.48	0.15 to 0.35	0.60 to 0.90	0.030 max.	0.030 max.	0.25 max.	0.90 to 1.20	0.15 to 0.30	0.30 max.
SCM822TK	0.20 to 0.25	0.15 to 0.35	0.60 to 0.90	0.030 max.	0.030 max.	0.25 max.	0.90 to 1.20	0.35 to 0.45	0.30 max.
SNC236TK	0.32 to 0.40	0.15 to 0.35	0.50 to 0.80	0.030 max.	0.030 max.	1.00 to 1.50	0.50 to 0.90	a)	0.30 max.
SNC415TK	0.12 to 0.18	0.15 to 0.35	0.35 to 0.65	0.030 max.	0.030 max.	2.00 to 2.50	0.20 to 0.50	a)	0.30 max.
SNC631TK	0.27 to 0.35	0.15 to 0.35	0.35 to 0.65	0.030 max.	0.030 max.	2.50 to 3.00	0.60 to 1.00	a)	0.30 max.
SNC815TK	0.12 to 0.18	0.15 to 0.35	0.35 to 0.65	0.030 max.	0.030 max.	3.00 to 3.50	0.60 to 1.00	a)	0.30 max.
SNC836TK	0.32 to 0.40	0.15 to 0.35	0.35 to 0.65	0.030 max.	0.030 max.	3.00 to 3.50	0.60 to 1.00	a)	0.30 max.
SNCM220TK	0.17 to 0.23	0.15 to 0.35	0.60 to 0.90	0.030 max.	0.030 max.	0.40 to 0.70	0.40 to 0.60	0.15 to 0.25	0.30 max.
SNCM240TK	0.38 to 0.43	0.15 to 0.35	0.70 to 1.00	0.030 max.	0.030 max.	0.40 to 0.70	0.40 to 0.60	0.15 to 0.30	0.30 max.
SNCM415TK	0.12 to 0.18	0.15 to 0.35	0.40 to 0.70	0.030 max.	0.030 max.	1.60 to 2.00	0.40 to 0.60	0.15 to 0.30	0.30 max.
SNCM420TK	0.17 to 0.23	0.15 to 0.35	0.40 to 0.70	0.030 max.	0.030 max.	1.60 to 2.00	0.40 to 0.60	0.15 to 0.30	0.30 max.
SNCM431TK	0.27 to 0.35	0.15 to 0.35	0.60 to 0.90	0.030 max.	0.030 max.	1.60 to 2.00	0.60 to 1.00	0.15 to 0.30	0.30 max.
SNCM439TK	0.36 to 0.43	0.15 to 0.35	0.60 to 0.90	0.030 max.	0.030 max.	1.60 to 2.00	0.60 to 1.00	0.15 to 0.30	0.30 max.
SNCM447TK	0.44 to 0.50	0.15 to 0.35	0.60 to 0.90	0.030 max.	0.030 max.	1.60 to 2.00	0.60 to 1.00	0.15 to 0.30	0.30 max.
SNCM616TK	0.13 to 0.20	0.15 to 0.35	0.80 to 1.20	0.030 max.	0.030 max.	2.80 to 3.20	1.40 to 1.80	0.40 to 0.60	0.30 max.
SNCM625TK	0.20 to 0.30	0.15 to 0.35	0.35 to 0.60	0.030 max.	0.030 max.	3.00 to 3.50	1.00 to 1.50	0.15 to 0.30	0.30 max.
SNCM630TK	0.25 to 0.35	0.15 to 0.35	0.35 to 0.60	0.030 max.	0.030 max.	2.50 to 3.50	2.50 to 3.50	0.50 to 0.70 b)	0.30 max.
SNCM815TK	0.12 to 0.18	0.15 to 0.35	0.30 to 0.60	0.030 max.	0.030 max.	4.00 to 4.50	0.70 to 1.00	0.15 to 0.30	0.30 max.
SACM645TK	0.40 to 0.50	0.15 to 0.50	0.60 max.	0.030 max.	0.030 max.	0.25 max.	1.30 to 1.70	0.15 to 0.30	0.30 max.

Any alloy elements not given in this table shall not be intentionally added for other purposes than finishing the heat. Boron may be added upon agreement between the purchaser and the manufacturer. If added, the B content shall be not more than 0.005 0 %, and the designation B shall be suffixed to the symbol of grade.

The limit of Al of SACM645TK shall be 0.70 % to 1.20 %.

Notes a) As necessary, Mo may be added. When added, the Mo content shall be less than 0.15 %.

b) The lower limit of Mo of SNCM630TK may be 0.30 % upon agreement between the purchaser and the manufacturer.

Table 3 Tolerances on outside diameter [a)]

Category	Outside diameter mm		Tolerances on outside diameter
Class 1		Under 50	±0.5 mm
	50 or over		±1 %
Class 2		Under 50	±0.25 mm
	50 or over		±0.5 %
Class 3		Under 25	±0.12 mm
	25 or over to and	excl. 40	±0.15 mm
	40 or over to and	excl. 50	±0.18 mm
	50 or over to and	excl. 60	±0.20 mm
	60 or over to and	excl. 70	±0.23 mm
	70 or over to and	excl. 80	±0.25 mm
	80 or over to and	excl. 90	±0.30 mm
	90 or over to and	excl. 100	±0.40 mm
	100 or over		±0.50 %
Class 4 [b)]		Under 13	±0.25 mm
	13 or over to and	excl. 25	±0.40 mm
	25 or over to and	excl. 40	±0.60 mm
	40 or over to and	excl. 65	±0.80 mm
	65 or over to and	excl. 90	±1.00 mm
	90 or over to and	excl. 140	±1.20 mm
	140 or over		[c)]

Notes
a) For local repaired parts, the tolerances on outside diameter in this table shall not apply.
b) For the tolerances on the outside diameter of quenched and tempered tubes, values of Class 4 shall usually apply.
c) The tolerance on the outside diameter shall be as agreed between the purchaser and the manufacturer.

Table 4 Tolerances on wall thickness

Category	Wall thickness mm	Tolerances on wall thickness
Class 1	Under 4	+0.6 mm –0.5 mm
	4 or over	+15 % –12.5 %
Class 2	Under 3	±0.3 mm
	3 or over	±10 %
Class 3	Under 2	±0.15 mm
	2 or over	±8 %

9 Tests

9.1 Chemical analysis

9.1.1 General requirements and sampling method

General requirements for chemical analysis and sampling method for heat analysis shall be in accordance with Clause 8 of JIS G 0404. When the product analysis is requested by the purchaser, the sampling method shall be in accordance with Clause 4 of JIS G 0321.

9.1.2 Analytical method

The heat analysis shall be in accordance with JIS G 0320. The product analysis shall be in accordance with JIS G 0321.

9.2 Flattening test

9.2.1 General

General requirements for flattening test shall be in accordance with Clauses 7 and 9 of JIS G 0404.

9.2.2 Sampling method

The samples subjected to the flattening test shall be in accordance with Class A in 7.6 of JIS G 0404, and its sampling method shall be as given in Table 5.

Table 5 Sampling method

Outside diameter	Sampling method
65 mm or under	Take one sample from each 2 000 m and its fraction of tubes of the same dimensions [a] and the same heat treatment batch [b] [c].
Over 65 mm up to and incl. 100 mm	Take one sample from each 1 000 m and its fraction of tubes of the same dimensions [a] and the same heat treatment batch [b] [c].
Over 100 mm up to and incl. 200 mm	Take one sample from each 500 m and its fraction of tubes of the same dimensions [a] and the same heat treatment batch [b] [c].
Over 200 mm	Take one sample from each 250 m and its fraction of tubes of the same dimensions [a] and the same heat treatment batch [b] [c].
Notes [a] "Same dimensions" refer to the same outside diameter and the same wall thickness. [b] Applicable to heat-treated tubes. The "same heat treatment batch" in the case of using continuous furnace refers to a unit of tubes from continuous furnace operation under the same heat treatment conditions, and tubes which are heat treated after any stop of furnace operation do not belong to the same heat treatment batch. [c] In the case of sampling from a unit of tubes from the same cast, the tubes in the unit may be of the same heat treatment conditions, instead of being from the same heat treatment batch.	

9.2.3 Test pieces

Take one test piece of length 50 mm or longer from each sample. For tubes of wall thickness 15 % or over of the outside diameter, C-shaped test piece prepared by removing a part of the circumference of a ring-shaped test piece may be used. The part to be removed shall be as shown in Figure 2.

9.2.4 Test method

Place the test piece at ordinary temperature (5 °C to 35 °C) between two flat plates, compress to flatten until the distance between the plates H is decreased to seven eighth of the outside diameter or less, and then examine for cracks on the weld of test pieces. Place the weld, as shown in Figure 1, such that the line connecting the centre of the tube and the weld is perpendicular to the direction of compression. In the case of C-shaped test piece, see Figure 2.

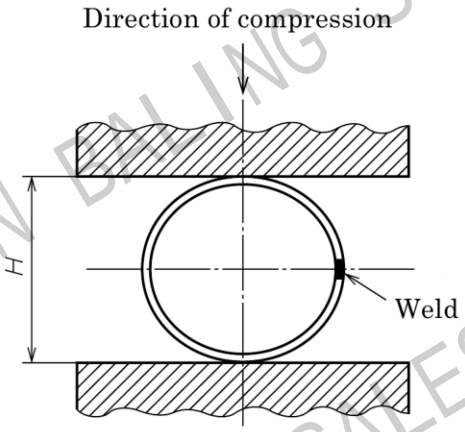

Figure 1 Flattening test (using ring-shaped test piece)

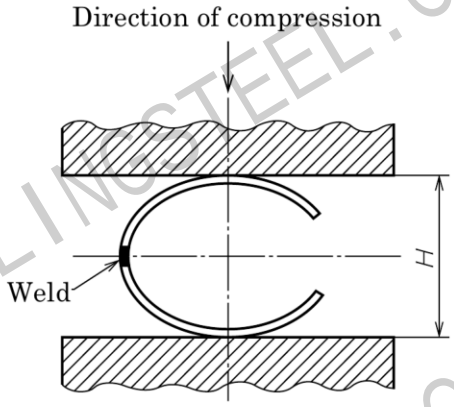

Figure 2 Flattening test (using C-shaped test piece)

NOTE The examples of test to be applied by the agreement between the purchaser and the manufacturer are given in Annex A for reference.

10 Inspection and reinspection

10.1 Inspection

The inspection shall be as follows.

a) General requirements for inspection shall be in accordance with **JIS G 0404**.

b) Chemical composition shall conform to the requirements of Clause **5**.

c) Flattening resistance shall conform to the requirements of Clause **6**.

d) Dimensions shall conform to the requirements of Clause **7**.

e) Appearance shall conform to the requirements of Clause **8**.

10.2 Reinspection

The tubes having failed in the flattening test may be subjected to the retest accord-

ing to 9.8 of JIS G 0404 for further acceptance judgement.

11 Marking

Each tube having passed the inspection shall be marked with the following items. When the marking on tube is difficult because its outside diameter is small or when so requested by the purchaser, the marking may be given on each bundle of tubes by a suitable means. In this case, the order of marking is not specified. Any information among the following not essential for identification of the product may be omitted upon agreement between the purchaser and the manufacturer.

a) Symbol of grade

b) Symbol for manufacturing method. The symbol for manufacturing method shall be as follows. A dash may be replaced with a blank.

   1) Hot finished seamless steel tube : –S–H

   2) Cold finished seamless steel tube : –S–C

   3) As electric resistance welded steel tube : –E–G

   4) Hot-finished electric resistance welded steel tube : –E–H

   5) Cold-finished electric resistance welded steel tube : –E–C

c) Dimensions. Dimensions shall be marked by outside diameter and wall thickness.

d) Manufacturer's name or abbreviation

e) Designation for boron (B) added. When boron (B) is added, the designation B shall be suffixed to the symbol of grade.

12 Report

Unless otherwise specified, 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.

When boron (B) is added by the agreement between the purchaser and the manufacturer, and when molybdenum (Mo) is added as necessary, the content shall be described in the inspection document.

Annex A (informative)

Examples of test to be applied by the agreement between the purchaser and the manufacturer

The examples of test to be applied by the agreement between the purchaser and the manufacturer are given in Table A.1 for reference. When the test is applied according to the agreement between the purchaser and the manufacturer, the previous agreement is required on matters such as the test frequency, sampling method, test method and acceptance criteria.

Table A.1 Examples of test to be applied by the agreement between the purchaser and the manufacturer

Name of test	Test method
Tensile test	JIS Z 2241 *Metallic materials — Tensile testing — Method of test at room temperature*
Charpy pendulum impact test	JIS Z 2242 *Method for Charpy pendulum impact test of metallic materials*
Brinell hardness test	JIS Z 2243-1 *Brinell hardness test — Part 1 : Test method*
Vickers hardness test	JIS Z 2244-1 *Vickers hardness test — Part 1 : Test method*
Rockwell hardness test	JIS Z 2245 *Rockwell hardness test — Test method*
Grain size test	JIS G 0551 *Steels — Micrographic determination of the apparent grain size*
Non-metalic inclusion test	JIS G 0555 *Microscopic testing method for the non-metallic inclusions in steel*
Determination test of depth of decarburization	JIS G 0558 *Steels — Determination of depth of decarburization*
Hardenability test	JIS G 0561 *Method of hardenability test for steel (End quenching method)*
Ultrasonic examination	JIS G 0582 *Automated ultrasonic examination of steel pipes and tubes*
Eddy current examination	JIS G 0583 *Automated eddy current examination of steel pipes and tubes*

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