



JAPANESE
INDUSTRIAL
STANDARD

Translated and Published by
Japanese Standards Association

JIS G 3462 : 2019

(JISF)

Alloy steel tubes for boiler and heat exchanger

ICS 23.040.10;27.060.30;77.140.75

Reference number : JIS G 3462 : 2019 (E)

Date of Establishment: 1962-03-01

Date of Revision: 2019-11-20

Date of Public Notice in Official Gazette: 2019-11-20

Investigated by: Japanese Industrial Standards Committee
Standards Board for ISO area
Technical Committee on Metal and Inorganic
Materials

JIS G 3462:2019, First English edition published in 2020-04

Translated and published by: Japanese Standards Association
Mita MT Building, 3-13-12, Mita, Minato-ku, Tokyo, 108-0073 JAPAN

In the event of any doubts arising as to the contents,
the original JIS is to be the final authority.

© JSA 2020

All rights reserved. Unless otherwise specified, no part of this publication may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying and microfilm, without permission in writing from the publisher.

Printed in Japan

Contents

	Page
Introduction	1
1 Scope	1
2 Normative references	1
3 Symbol of grade	2
4 Manufacturing method	2
5 Chemical composition	3
6 Mechanical properties	4
6.1 Tensile strength, yield point or proof stress, and elongation	4
6.2 Flattening resistance	5
6.3 Flaring property	5
6.4 Reverse flattening resistance	5
7 Hydraulic test characteristics or non-destructive test characteristics	5
8 Dimensions, unit masses and dimensional tolerances	6
8.1 Dimensions and unit masses	6
8.2 Dimensional tolerances	7
9 Appearance	9
10 Supplementary quality requirements and U-bent tubes	10
11 Tests	10
11.1 Chemical analysis	10
11.2 Mechanical tests	10
11.3 Hydraulic test or non-destructive test	12
12 Inspection and reinspection	13
12.1 Inspection	13
12.2 Reinspection	13
13 Marking	13
14 Report	14
Annex JA (normative) Supplementary quality requirements	15
Annex JB (normative) U-bent tubes	17
Annex JC (informative) Comparison table between JIS and corresponding International Standards	20

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 3462:2016**), which has been technically revised.

However, **JIS G 3462:2016** 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 November 2020.

This **JIS** document is protected by the Copyright Act.

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.

NOTE Based on Article 9 of the Supplementary Provisions to the Unfair Competition Prevention Act etc., any submission of proposal, or employment of procedures such as deliberation by the Japanese Industrial Standards Committee under the previous Industrial Standardization Act shall be deemed to have been conducted pursuant to the provision of Article 12, paragraph (1) of the revised Industrial Standardization Act.

Alloy steel tubes for boiler and heat exchanger

Introduction

This Japanese Industrial Standard has been prepared based on **ISO 9329-2:1997**, Edition 1, and **ISO 9330-2:1997**, Edition 1, with some modifications of the technical contents.

In addition to the specification items in the main body, the supplementary quality requirements to be applied upon agreement between the purchaser and the manufacturer, and the requirements for U-bent tubes that are applied when specified by the purchaser, are given in Annex JA and Annex JB, respectively. The vertical lines on both sides and dotted underlines indicate changes from the corresponding International Standards. A list of modifications with the explanations is given in Annex JC.

1 Scope

This Standard specifies requirements for the alloy steel tubes (hereafter referred to as tubes) used for exchanging heat between the inside and outside of the tube, such as water tubes, smoke tubes, superheater tubes and air preheater tubes, etc. of boilers, and heat exchanger tubes, condenser tubes and catalyser tubes, etc. used in chemical and petroleum industries. It is not applicable to the steel tubes for fired heater and steel heat exchanger tubes for low temperature service.

This Standard is generally applicable to tubes of outside diameters 15.9 mm to 139.8 mm.

NOTE The International Standards corresponding to this Standard and the symbol of degree of correspondence are as follows.

ISO 9329-2:1997 *Seamless steel tubes for pressure purposes—Technical delivery conditions—Part 2: Unalloyed and alloyed steels with specified elevated temperature properties*

ISO 9330-2:1997 *Welded steel tubes for pressure purposes—Technical delivery conditions—Part 2: Electric resistance and induction welded unalloyed and alloyed steel tubes with specified elevated temperature properties (overall evaluation: MOD)*

In addition, symbols which denote the degree of correspondence in the contents between the relevant International Standard and **JIS** are **IDT** (identical), **MOD** (modified), and **NEQ** (not equivalent) according to **ISO/IEC Guide 21-1**.

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	<i>Standard test method for heat analysis of steel products</i>
JIS G 0321	<i>Product analysis and its tolerance for wrought steel</i>
JIS G 0404	<i>Steel and steel products—General technical delivery requirements</i>
JIS G 0415	<i>Steel and steel products—Inspection documents</i>
JIS G 0416	<i>Steel and steel products—Location and preparation of samples and test pieces for mechanical testing</i>
JIS G 0567	<i>Method of elevated temperature tensile test for steels and heat-resisting alloys</i>
JIS G 0582	<i>Automated ultrasonic examination of steel pipes and tubes</i>
JIS G 0583	<i>Automated eddy current examination of steel pipes and tubes</i>
JIS Z 2241	<i>Metallic materials—Tensile testing—Method of test at room temperature</i>
JIS Z 2245	<i>Rockwell hardness test—Test method</i>
JIS Z 8401	<i>Rounding of numbers</i>

3 Symbol of grade

Tubes shall be classified into 8 grades, and their symbols shall be as given in Table 1.

Table 1 Symbols of grade and symbols for manufacturing method

Symbol of grade		Symbol for manufacturing method		
		Tube manufacturing method	Finishing method	Marking
Molybdenum steel tube	STBA12	Seamless: S Electric resistance welded: E	Hot-finished: H Cold-finished: C As electric resistance welded: G	As given in 13 b).
	STBA13			
Chromium molybdenum steel tube	STBA20			
	STBA22			
	STBA23			
	STBA24			
	STBA25			
STBA26	Seamless: S	Hot-finished: H Cold-finished: C		

4 Manufacturing method

The manufacturing method shall be as follows.

- Tubes shall be manufactured by a combination of the tube manufacturing method and the finishing method which are given in Table 1. Symbols indicating the manufacturing method shall be as given in Table 1.
- Tubes shall be subjected to the heat treatment given in Table 2. Other heat treatments may be applied upon agreement between the purchaser and the manufacturer.
- Tubes shall be finished with plain ends unless otherwise specified.

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

Table 2 Heat treatment

Symbol of grade	Heat treatment ^{a)}
STBA12 STBA13	Low temperature annealing, isothermal annealing, full annealing, normalizing or normalizing followed by tempering
STBA20 STBA22	Low temperature annealing, isothermal annealing, full annealing or normalizing followed by tempering
STBA23 STBA24 STBA25 STBA26	Isothermal annealing, full annealing or normalizing followed by tempering ^{b)}
Notes ^{a)} Low temperature annealing shall not be applied to the electric resistance welded steel tube. ^{b)} The tempering temperature for STBA23, STBA24, STBA25 and STBA26 shall be 650 °C or higher.	

5 Chemical composition

Tubes shall be tested in accordance with 11.1 and the obtained heat analysis values shall satisfy the requirements given in Table 3. Where necessary, other alloy elements than given in Table 3 may be added. When the product analysis is requested by the purchaser, the tube shall be tested in accordance with 11.1, and the obtained product analysis values shall satisfy the requirements given in Table 3.

Table 3 Chemical composition

Unit: %

Symbol of grade	C	Si	Mn	P	S	Cr	Mo
STBA12	0.10 to 0.20	0.10 to 0.50	0.30 to 0.80	0.035 max.	0.035 max.	— ^{a)}	0.45 to 0.65
STBA13	0.15 to 0.25	0.10 to 0.50	0.30 to 0.80	0.035 max.	0.035 max.	— ^{a)}	0.45 to 0.65
STBA20	0.10 to 0.20	0.10 to 0.50	0.30 to 0.60	0.035 max.	0.035 max.	0.50 to 0.80	0.40 to 0.65
STBA22	0.15 max.	0.50 max.	0.30 to 0.60	0.035 max.	0.035 max.	0.80 to 1.25	0.45 to 0.65
STBA23	0.15 max.	0.50 to 1.00	0.30 to 0.60	0.030 max.	0.030 max.	1.00 to 1.50	0.45 to 0.65
STBA24	0.15 max.	0.50 max.	0.30 to 0.60	0.030 max.	0.030 max.	1.90 to 2.60	0.87 to 1.13
STBA25	0.15 max.	0.50 max.	0.30 to 0.60	0.030 max.	0.030 max.	4.00 to 6.00	0.45 to 0.65
STBA26	0.15 max.	0.25 to 1.00	0.30 to 0.60	0.030 max.	0.030 max.	8.00 to 10.00	0.90 to 1.10
Alloy elements not specified in this table and the element for which dashes ("—") are entered in this table may be added as necessary. Note ^{a)} Addition of Cr is permitted to a level where chemical composition of the grade concerned remains distinguishable, after the addition of Cr, from those of all other grades.							

6 Mechanical properties

6.1 Tensile strength, yield point or proof stress, and elongation

Tubes shall be tested in accordance with 11.2.3, and the tensile strength, yield point or proof stress, and elongation shall be as given in Table 4. When the tensile test is carried out on Test piece No. 12 for the tube under 8 mm in wall thickness, the elongation shall be in accordance with Table 5.

Table 4 Tensile strength, yield point or proof stress, and elongation

Symbol of grade	Tensile strength ^{a)}	Yield point or proof stress	Elongation %				
			Outside diameter				
			Under 10 mm	10 mm or over to and excl. 20 mm	20 mm or over	All outside diameters	
			Tensile test piece				
			Test piece No. 11	Test piece No. 11	Test piece No. 11 Test piece No. 12	Test piece No. 4	Test piece No. 14A
			Tensile test direction				
				N/mm ²	N/mm ²	Parallel to tube axis	Parallel to tube axis
STBA12	380 min.	205 min.	22 min.	25 min.	30 min.	24 min.	21 min.
STBA13	410 min.						
STBA20							
STBA22							
STBA23							
STBA24							
STBA25							
STBA26							
NOTE 1 N/mm ² = 1 MPa							
Note ^{a)} Exclusively for the heat exchanger tubes, the purchaser may, where necessary, specify the maximum value of tensile strength. In this case, the maximum tensile strength value shall be the value obtained by adding 150 N/mm ² to the value in this table.							

Table 5 Elongation for Test piece No. 12 of tube under 8 mm in wall thickness (direction parallel to tube axis)

Unit: %

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
Elongation	21 min.	22 min.	24 min.	26 min.	27 min.	28 min.	30 min.
NOTE The elongation values in this table are calculated by subtracting 1.5 % from the elongation value given in Table 4 for each 1 mm decrease of tube wall thickness from 8 mm, and by rounding the result to an integer according to Rule A of JIS Z 8401.							

6.2 Flattening resistance

Tubes shall be tested in accordance with **11.2.4**. When flattened until the distance H between two platens reaches the value obtained by Formula (1), the test piece shall be free from cracks.

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

where, H : distance between platens (mm)
 t : wall thickness of tube (mm)
 D : outside diameter of tube (mm)
 e : constant 0.08

NOTE For the detailed procedure for flattening test, see **11.2.4**.

6.3 Flaring property

Tubes shall be tested in accordance with **11.2.5**. When flared into a trumpet shape until the outside diameter is enlarged 1.14 times the original size, the test piece shall be free from cracks. For tubes of outside diameter exceeding 101.6 mm, this requirement shall apply when the flaring test is requested by the purchaser.

NOTE For the detailed procedure for flaring test, see **11.2.5**.

6.4 Reverse flattening resistance

Electric resistance welded steel tubes shall be tested in accordance with **11.2.6** and the test piece shall be free from cracks in the weld.

NOTE For the detailed procedure for reverse flattening test, see **11.2.6**.

7 Hydraulic test characteristics or non-destructive test characteristics

Tubes shall be tested in accordance with **11.3**, and their hydraulic test characteristics or non-destructive test characteristics shall conform to either of the following. The decision on which characteristics to test shall be left to the discretion of the purchaser. If not specified, it shall be left to the discretion of the manufacturer.

a) **Hydraulic test characteristics** Hydraulic test characteristics shall be as follows.

- 1) When a hydraulic test pressure is not specified by the purchaser, the tube shall be subjected to the minimum hydraulic test pressure P calculated by Formula (2) (10 MPa if P exceeds 10 MPa), and shall withstand the pressure without leakage.

$$P = \frac{2st}{D} \dots\dots\dots (2)$$

where, P : test pressure (MPa)
 t : wall thickness of tube (mm)
 D : outside diameter of tube (mm)
 s : 60 % of the specified minimum value of yield point or proof stress given in Table 4 (N/mm²)