

KOREAN INDUSTRIAL STANDARD

Carbon Steel Tubes for Boiler and Heat Exchanger

1. Scope

This Korean Industrial Standard specifies the carbon steel tubes, (hereinafter referred to as "tubes") used for exchanging heat on the inside and outside of the tube, such as water tubes, smoke tubes, superheater tubes, air preheater tubes, etc., of the boiler, and heat exchanger tubes, condenser tubes, catalyser tubes, etc., used in the chemical and petroleum industries. However, it is not applicable to the steel tubes for heating furnaces and steel heat exchanger tubes for low temperature service.

- Remarks**
1. The units and numerical values given in { } in this Standard are in accordance with the international system of units (SI), and are appended for reference.
 2. The purchaser may designate in addition to the items specified in this text, by prior agreement with the manufacturer, part or all of the items in the supplementary quality requirements Z1, Z2, Z3 and Z4 specified in Appendix 1 and the item of the U-bend tube specified in Appendix 2.
- Appendix 1 Z 1 Hardness
 Appendix 1 Z 2 Elevated temperature yield point or proof stress
 Appendix 1 Z 3 Ultrasonic examination
 Appendix 1 Z 4 Eddy current examination
 Appendix 2 U-bend tube

Related Standards:

- KS A 0021** Rules for the Rounding of Numerical Values
KS B 0801 Test Pieces for Tensile Test for Metallic Materials
KS B 0802 Method of Tensile Test for Metallic Materials
KS B 0806 Method of Rockwell and Rockwell Superficial Hardness Test
KS D 0001 General Rules for Inspection of Steel
KS D 0026 Methods of High Temperature Tensile Test for Steels and Heat-Resisting Alloys
KS D 0228 Product Analysis and Tolerance for Wrought Steel
KS D 0250 Ultrasonic Examination for Steel Pipes and Tubes
KS D 0251 Eddy Current Examination of Steel Pipes and Tubes
KS D 1652 Methods for Photoelectric Emission Spectrochemical Analysis of Iron and Steel
KS D 1655 Method for X-ray Fluorescence Spectrometric Analysis of Iron and Steel
KS D 1659 Method for Absorption Spectrochemical Analysis of Iron and Steel
KS D 1802 Determination of Phosphorus in Iron and Steel
KS D 1803 Methods for Determination of Sulphur in Iron and Steel
KS D 1804 Determination of Carbon in Iron and Steel
KS D 1805 Determination of Silicon in Iron and Steel
KS D 1806 Determination of Manganese in Iron and Steel

2. Classes and Symbols

The tube shall be classified into three grades and their class symbols shall be as given in Table 1

Table 1 Class Symbols

Class symbol	Traditional symbol (Informative reference)
STBH 340	STBH 35
STBH 410	STBH 42
STBH 510	STBH 52

3. Method of Manufacture

The methods of manufacture of the tube shall be as follows.

- (1) The tube shall be made from killed steel by the seamless process or by the electric resistance welding process.
- (2) The tube shall be subjected to heat treatments specified in Table 2. The heat treatment not specified in those tables shall be agreed upon by the purchaser and the manufacturer.

Table 2 Heat Treatment

Symbol of class	Heat treatment				
	Hot finished seamless steel tube	Cold finished seamless steel tube	Electric resistance welded steel tube other than hot finished or cold finished steel tube	Hot finished electric resistance welded steel tube	Cold finished electric resistance welded steel tube
STBH 240	As manufactured	Low temperature annealing, normalizing or full annealing	Normalizing	As manufactured	Normalizing
STBH 410	As manufactured	Low temperature annealing, normalizing or full annealing	Normalizing	Low temperature annealing	
STBH 510	Normalizing				

Remarks 1. As manufactured products may be treated by low temperature annealing or normalizing by the requirements of purchaser or the state of manufacturer.

2. The cold finished electric resistance welded steel tube which has been normalized prior to cold finishing may be finished by annealing.

4. Chemical Composition

The tube shall be tested in accordance with 9.1 and the resulting ladle analysis values shall conform to Table 3.

Table 3 Chemical Composition

Symbol of Class	% Chemical Composition				
	C	Si	Mn	P	S
STBH 340	0.18Max	0.35Max	0.30 to 0.60	0.035Max	0.035Max
STBH 410	0.32Max	0.35Max	0.30 to 0.80	0.035Max	0.035Max
STBH 510	0.25Max	0.35Max	1.00 to 1.50	0.035Max	0.035Max

- Remarks** 1. When the purchaser requires product analysis, the permissible deviations for the values given above shall be as specified in Table 2 in KS D 0228 (Product Analysis and its Tolerance for Wrought Steel) for the seamless steel tube and likewise in Table 1 for the electric resistance welded steel tube.
2. Where required by the purchaser, Si may be designated as 0.10 to 0.35%.

5. Mechanical Properties

5.1 Tensile Strength, Yield Point or Proof Stress and Elongation

The tube shall be tested in accordance with 9.2 and the resulting tensile strength, yield point or proof stress and elongation of the tube shall comply with Table 4.

Table 4 Mechanical Properties

Symbol of Class	Tensile strength N/mm ² {kgf/mm ² }	Yield Point or proof stress N/mm ² {kgf/mm ² }	Elongation %		
			Outside diameter 20mm or over	Outside diameter 10mm or over to and excl. 20mm	Outside diameter under 10mm
			No. 11 test piece No 12 test piece	No. 11 test piece	No. 11 test piece
STBH 340	340 {35} min.	175 {18} min.	35min.	30min.	27min.
STBH 410	410 {42} min.	255 {26} min.	25min.	20min.	17min.
STBH 510	510 {52} min.	295 {30} min.	25min.	20min.	17min.

- Ramarks** 1. Exclusively for the heat exchanger tube, the purchaser may, where necessary, specify the maximum value of tensile strength, which shall be 120N/mm² {12kgf/mm²} added to the value given in Table 4.
2. When the tensile test is carried out on No. 12 test piece for the tube under 8mm in wall thickness, the minimum value of elongation shall be calculated by subtracting 1.5% from the value of elongation given in Table 4 for each 1mm decrease in wall thickness, and rounding off the result to an integer in compliance with KS A 0021 (Names of Light—Source colors). Examples of calculation are given in the reference Table.
3. In the case where the tensile test piece is taken from the electric resistance welded steel tube, No. 12 test piece shall be taken from a seamless portion.

5.2 Flattening Resistance

The tube shall be tested in accordance with 9.3 and shall be free from flaws or cracks on its wall surfaces. The distance between the flattening plates in this test shall be in accordance with the following formula.

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

where H : distance between flattening plates (mm)

t : wall thickness of tube (mm)

D : outside diameter of tube (mm)

e : constant individually decided according to the class of tube

0.09 for STBH 340

0.08 for STBH 410

0.07 for STBH 510

5.3 Flaring

When in the test of 9.4 in the tube is flared into a bell shape 1.2 times the outside diameter, no flaws shall be generated.

5.4 Reverse Flattening

When in the test of 9.5 the electric resistance welded steel tube is subjected to a reverse flattening test, flaws, cracks or the like shall not be generated on the weld.

6. Hydrostatic Characteristic or Nondestructive Characteristic

The tube shall be tested in accordance with 9.6 and the resulting hydrostatic characteristic or nondestructive characteristic shall conform to either of the following two. The preference shall be in accordance with the designation made by the purchaser or left to the discretion of the manufacturer.

6.1 Hydrostatic Characteristic

When a hydrostatic pressure specified by the purchaser or, unless otherwise specified, the pressure P [10 MPa {100kgf/cm²} at the maximum] calculated from the formula given below is applied, the tube shall withstand it without leakage. In this case, the purchaser may specify values or pressure lower or higher than pressure P .

When a hydrostatic pressure test is made in compliance with the designation of the purchaser and the test pressure exceeds either 10 MPa {100kgf/cm²} or the value P calculated from the following formula, the test pressure shall be agreed upon by the purchaser and the manu-

facturer. The designated hydrostatic test pressure shall be graduated in 0.5 Mpa for the pressure values of under 10 MPa {100kgf/cm²} and in 1 MPa for the pressure values of 10 MPa {100kgf/cm²} or over. Value P in the following formula shall be obtained by computing the unit digit and rounding off to the nearest 0.5 MPa or 1 MPa.

$$P = \frac{2st}{D}$$

where P : test pressure (MPa) {kgf/cm²}

t : wall thickness of tube (mm)

D : outside diameter of tube (mm)

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

6.2 Nondestructive Characteristic

Either an ultrasonic examination or an eddy current examination shall be made on the tube, and there shall be no signal greater than those produced by the artificial defects of the reference test block of either the division UD of the working sensitivity specified in KS D 0250 (Ultrasonic Examination for Steel Pipes and Tubes) or of the division EY of the working sensitivity specified in KS D 0251 (Eddy Current Examination of Steel Pipes and Tubes), respectively.

7. Appearance

The appearance of the tube shall be as follows:

- 7.1 The tube shall be practically straight and both its ends shall be at right angles to its axis.
- 7.2 The inside and outside surfaces of the tube shall be well—finished and free from defects injurious to use. However, in the case of electric resistance welded tube the swelling of the inside surface of the weld shall be 0.25mm or less. In this case, if necessary, the purchaser may specify the inside swelling as 0.15mm or less for the tubes 50.8mm or under in the outside diameter and at the same time 3.5mm or under in the wall thickness.

8. Dimensions, Mass and Dimensional Tolerances

8.1 Dimensions and Mass

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

Remark: The weight in this standard means mass

8.2 Dimensional Tolerances

The dimensional tolerances of the tube shall be as follows: