

JIS

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JAPANESE INDUSTRIAL STANDARD

**Copper and copper alloy
seamless pipes and tubes**

☎ JIS H 3300—1992

Translated and Published

by

Japanese Standards Association

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JAPANESE INDUSTRIAL STANDARD

J I S

Copper and copper alloy seamless pipes and tubes. H 3300-1992

1. Scope This Japanese Industrial Standard specifies the extended copper and copper alloy seamless pipes and tubes having a round section (hereafter referred to as the "tubes").

Remarks 1. The standards cited in this Standard are given as follows:

JIS H 0321-General rules for inspection of non-ferrous metal materials

JIS H 0501-Methods for estimating average grain size of wrought copper and copper alloys

JIS H 0502-Method of eddy current testing for copper and copper alloy pipes and tubes

JIS H 0505-Measuring methods for electrical resistivity and conductivity of non-ferrous materials

JIS H 1012-General rules for chemical analysis of copper and copper alloys

JIS H 1051-Methods for determination of copper in copper and copper alloys

JIS H 1052-Methods for determination of tin in copper and copper alloys

JIS H 1053-Methods for determination of lead in copper and copper alloys

JIS H 1054-Methods for determination of iron in copper and copper alloys

JIS H 1055-Methods for determination of manganese in copper and copper alloys

JIS H 1056-Methods for determination of nickel in copper and copper alloys

JIS H 1057-Methods for determination of aluminium in copper and copper alloys

JIS H 1058-Methods for determination of phosphorus in copper and copper alloys

JIS H 1059-Methods for determination of arsenic in copper and copper alloys

JIS H 1061-Methods for determination of silicon in copper and copper alloys

JIS H 1062-Methods for determination of zinc in copper alloys

JIS H 1291-Method for atomic absorption spectrochemical analysis of copper and copper alloys

JIS H 1292-Method for fluorescent X-ray analysis of copper alloys

JIS K 8085-Ammonia solution

JIS Z 2201-Test pieces for tensile test for metallic materials

JIS Z 2241-Method of tensile test for metallic materials

JIS Z 2245-Method of Rockwell and Rockwell superficial hardness test

2. Corresponding international standards to this Standard are given as follows.

ISO 196 : 1978	Wrought copper and copper alloys— Detection of residual stress—Mercury (1) nitrate test
ISO 274 : 1975	Copper tubes of circular section— Dimensions
ISO 426-1 : 1983	Wrought copper-zinc alloys—Chemical composition and forms of wrought products—Part 1 : Non-leaded and special copper-zinc alloys
ISO 429 : 1983	Wrought copper-nickel alloys—Chemical composition and forms of wrought products
ISO 1337 : 1980	Wrought coppers (having minimum copper contents of 99.85 %)—Chemical composition and forms of wrought products
ISO 1635 : 1974	Wrought copper and copper alloys—Round tubes for general purposes—Mechanical properties
ISO 1635-2 : 1987	Seamless wrought copper and copper alloy tube—Part 2 : Technical conditions of delivery for condenser and heat-exchanger tubes
ISO 2624 : 1973	Copper and copper alloys—Estimation of average grain size
ISO 2626 : 1973	Copper—Hydrogen embrittlement test

2. Grade, class and designation
tubes shall be as given in Table 1.

The grade, class and their designations of

Table 1. Grade, class and their designations

Grade		Class	Designation	Informative reference	
Alloy No.	Shape			Name	Specific character and examples of use
C 1020	Tube	Common grade	C 1020 T ⁽¹⁾	Oxygen free copper	Having excellent electric and heat conductivity, workability, drawability and good weldability, corrosion and weathering resistance. Free from hydrogen embrittlement heated at elevated temperature in reducing atmosphere. Applicable to heat exchanger, electrical and chemical industries, water supply, hot-water supply, etc.
		Special grade	C 1020 TS ⁽¹⁾		
C 1100	Tube	Common grade	C 1100 T ⁽¹⁾	Tough pitch copper	Having excellent electric and heat conductivity, and good drawability, corrosion and weathering resistance. Applicable to electrical parts, etc.
		Special grade	C 1100 TS ⁽¹⁾		
C 1201	Tube	Common grade	C 1201 T	Phosphorus deoxidized copper	Having good flaring and bending properties, drawability, weldability, corrosion resistance and heat conductivity. C 1220 has a property free from hydrogen embrittlement heated at elevated temperature in reducing atmosphere. C 1201 has better electric conductivity than C 1220. Applicable to heat exchanger, chemical industry, water supply, hot-water supply, gas pipe, etc.
		Special grade	C 1201 TS		
C 1220	Tube	Common grade	C 1220 T		
		Special grade	C 1220 TS		
C 2200	Tube	Common grade	C 2200 T	Red brass	Having fine gloss, good flaring and bending properties, drawability and corrosion resistance. Applicable to cosmetics case, water supply and drain pipe, joint, etc.
		Special grade	C 2200 TS		
C 2300	Tube	Common grade	C 2300 T		
		Special grade	C 2300 TS		
C 2600	Tube	Common grade	C 2600 T	Brass	Having good flaring and bending properties, drawability and suitable for plating. Applicable to heat exchanger, curtain rod, sanitary tube, parts for various apparatuses and machinery, antenna rod, etc. C 2800 has high strength.
		Special grade	C 2600 TS		
C 2700	Tube	Common grade	C 2700 T		Applicable to sugar plant, ship use, parts for various apparatuses and machinery, etc.
		Special grade	C 2700 TS		
C 2800	Tube	Common grade	C 2800 T		
		Special grade	C 2800 TS		

Table 1. (Continued)

Grade			Designation	Informative reference	
Alloy No.	Shape	Class		Name	Specific character and examples of use
C 4430	Tube	Common grade	C 4430 T	Brass for con- denser	Having good corrosion resistance, especially, C 6870, C 6871 and C 6872 have good corrosion resistance in sea water. Applicable to condenser for steam and nuclear power plant, condenser for ship, heater and water supply, distillater, oil cooler, heat exchanger for desalinator or the like.
		Special grade	C 4430 TS		
C 6870	Tube	Common grade	C6870 T		
		Special grade	C 6870 TS		
C 6871	Tube	Common grade	C 6871 T		
		Special grade	C 6871 TS		
C 6872	Tube	Common grade	C 6872 T		
		Special grade	C 6872 TS		
C 7060	Tube	Common grade	C 7060 T	Cupro- nickel for con- denser	Having good corrosion resistance, especially, good corrosion resistance in sea water, and suitable for higher temperature service. Applicable to condenser for ship, heater and water supply, chemical industry, desalinator, etc.
		Special grade	C 7060 TS		
C 7100	Tube	Common grade	C 7100 T		
		Special grade	C 7100 TS		
C 7150	Tube	Common grade	C 7150 T		
		Special grade	C 7150 TS		
C 7164	Tube	Common grade	C 7164 T		
		Special grade	C 7164 TS		

Note (1) For electric conduction use, the letter "C" shall be suffixed to the designation given in the above Table 1.

Remarks: The designation to express the temper grade shall be suffixed to the designation given in the above Table 1.

3. Quality

3.1 Appearance Tubes shall have accurate shapes, workmanlike finish, un-heterogeneity and be free from defects that are detrimental to practical use.

3.2 Chemical composition The chemical composition of tubes shall be as given in Table 2.

Table 2. Chemical composition

Alloy No.	Chemical composition %											
	Cu	Pb	Fe	Sn	Zn	Al	As	Mn	Ni	P	Si	Cu+Ni+Fe+Mn
C 1020	99.96 min.	—	—	—	—	—	—	—	—	—	—	—
C 1100	99.90 min.	—	—	—	—	—	—	—	—	—	—	—
C 1201	99.90 min.	—	—	—	—	—	—	—	—	0.004 to 0.015 excl.	—	—
C 1220	99.90 min.	—	—	—	—	—	—	—	—	0.015 to 0.040	—	—
C 2200	89.0 to 91.0	0.05 max.	0.05 max.	—	Residual	—	—	—	—	—	—	—
C 2300	84.0 to 86.0	0.05 max.	0.05 max.	—	Residual	—	—	—	—	—	—	—
C 2600	68.5 to 71.5	0.05 max.	0.05 max.	—	Residual	—	—	—	—	—	—	—
C 2700	63.0 to 67.0	0.05 max.	0.05 max.	—	Residual	—	—	—	—	—	—	—
C 2800	59.0 to 63.0	0.10 max.	0.07 max.	—	Residual	—	—	—	—	—	—	—
C 4430	70.0 to 73.0	0.05 max.	0.05 max.	0.9 to 1.2	Residual	—	0.02 to 0.06	—	—	—	—	—
C 6870	76.0 to 79.0	0.05 max.	0.05 max.	—	Residual	1.8 to 2.5	0.02 to 0.06	—	—	—	—	—
C 6871	76.0 to 79.0	0.05 max.	0.05 max.	—	Residual	1.8 to 2.5	0.02 to 0.06	—	—	—	0.20 to 0.50	—
C 6872	76.0 to 79.0	0.05 max.	0.05 max.	—	Residual	1.8 to 2.5	0.02 to 0.06	—	0.20 to 1.0	—	—	—
C 7060	—	0.05 max.	1.0 to 1.8	—	0.50 max.	—	—	0.20 to 1.0	9.0 to 11.0	—	—	99.5 min.
C 7100	—	0.05 max.	0.50 to 1.0	—	0.50 max.	—	—	0.20 to 1.0	19.0 to 23.0	—	—	99.5 min.
C 7150	—	0.05 max.	0.40 to 1.0	—	0.50 max.	—	—	0.20 to 1.0	29.0 to 33.0	—	—	99.5 min.
C 7164	—	0.05 max.	1.7 to 2.3	—	0.50 max.	—	—	1.5 to 2.5	29.0 to 32.0	—	—	99.5 min.

3.3 Items of mechanical and physical properties The items of mechanical and physical properties of tubes shall be as given in Table 3.

Table 3. Items of mechanical and physical properties

Alloy No.	Temper grade	Designation	Outside diameter mm	Items indicating mechanical and physical properties										
				Tensile strength	Elongation	Hardness	Grain size	Flaring	Flattening	Eddy current, hydrostatic, pneumatic (?)	Electric conductivity	Hydrogen embrittlement (?)	Season crack	
C 1020	O	C 1020 T-O	Up to and incl. 50	○	○	△	△	○	—	△	△	○	—	
		C 1020 TS-O	Over 50, up to and incl. 100	○	○	△	△	○	—	—	△	○	—	
	OL	C 1020 T-OL	Up to and incl. 50	○	○	△	△	○	—	△	△	○	—	
		C 1020 TS-OL	Over 50, up to and incl. 100	○	○	△	△	○	—	—	△	○	—	
	1/2H	C 1020 T-1/2H	Up to and incl. 50	○	—	△	—	—	—	△	△	○	—	
		C 1020 TS-1/2H	Over 50, up to and incl. 100	○	—	△	—	—	—	—	△	○	—	
	H	C 1020 T-H	Up to and incl. 50	○	—	△	—	—	—	△	△	○	—	
		C 1020 TS-H	Over 50, up to and incl. 100	○	—	△	—	—	—	—	△	○	—	
	C 1100	O	C 1100 T-O	Up to and incl. 50	○	○	△	—	○	—	△	△	—	—
			C 1100 TS-O	Over 50, up to and incl. 100	○	○	△	—	○	—	—	△	—	—
			Over 100	○	○	△	—	—	○	—	△	—	—	
1/2H		C 1100 T-1/2H	Up to and incl. 50	○	—	△	—	—	—	△	△	—	—	
		C 1100 TS-1/2H	Over 50	○	—	△	—	—	—	—	△	—	—	
H		C 1100 T-H	Up to and incl. 50	○	—	△	—	—	—	△	△	—	—	
		C 1100 TS-H	Over 50	○	—	△	—	—	—	—	△	—	—	
C 1201 C 1220		O	C 1201 T-O	Up to and incl. 50	○	○	△	△	○	—	△	—	△	—
	C 1201 TS-O		Over 50, up to and incl. 100	○	○	△	△	○	—	—	—	△	—	
	C 1220 T-O		Over 100	○	○	△	△	—	○	—	—	△	—	
	OL	C 1201 T-OL	Up to and incl. 50	○	○	△	△	○	—	△	—	△	—	
		C 1201 TS-OL	Over 50, up to and incl. 100	○	○	△	△	○	—	—	—	△	—	
		C 1220 T-OL	Over 100	○	○	△	△	—	○	—	—	△	—	
	1/2H	C 1201 T-1/2H	Up to and incl. 50	○	—	△	—	—	—	△	—	△	—	
		C 1201 TS-1/2H	Over 50	○	—	△	—	—	—	—	—	△	—	
		C 1220 T-1/2H												
	H	C 1201 T-H	Up to and incl. 50	○	—	△	—	—	—	△	—	△	—	
		C 1201 TS-H	Over 50	○	—	△	—	—	—	—	—	△	—	
		C 1220 T-H												
C 1220 TS-H														

Table 3. (Continued)

Alloy No.	Temper grade	Designation	Outside diameter mm	Items indicating mechanical and physical properties										
				Tensile strength	Elongation	Hardness	Grain size	Flaring	Flattening	Eddy current, hydrostatic, pneumatic (%)	Electric conductivity	Hydrogen embrittlement (%)	Season crack	
C 2200 C 2300	O	C 2200 T-O	Up to and incl. 50	○	○	△	△	○	—	△	—	—	—	
		C 2200 TS-O	Over 50, up to and incl. 100	○	○	△	△	○	—	—	—	—	—	
		C 2300 T-O	Over 100	○	○	△	△	—	○	—	—	—	—	
	OL	C 2200 T-OL	Up to and incl. 50	○	○	△	△	○	—	△	—	—	—	
		C 2200 TS-OL	Over 50, up to and incl. 100	○	○	△	△	○	—	—	—	—	—	
		C 2300 T-OL	Over 100	○	○	△	△	—	○	—	—	—	—	
	1/2H	C 2200 T-1/2H	Up to and incl. 50	○	○	△	—	—	—	△	—	—	—	
		C 2200 TS-1/2H	Over 50	○	○	△	—	—	—	—	—	—	—	
	H	C 2200 T-H	Up to and incl. 50	○	—	△	—	—	—	△	—	—	—	
		C 2200 TS-H	Over 50	○	—	△	—	—	—	—	—	—	—	
	C 2600 C 2700	O	C 2600 T-O	Up to and incl. 50	○	○	△	△	○	—	△	—	—	○
			C 2600 TS-O	Over 50, up to and incl. 100	○	○	△	△	○	—	—	—	—	○
			C 2700 T-O	Over 100	○	○	△	△	—	○	—	—	—	○
		OL	C 2600 T-OL	Up to and incl. 50	○	○	△	△	○	—	△	—	—	○
C 2600 TS-OL			Over 50, up to and incl. 100	○	○	△	△	○	—	—	—	—	○	
C 2700 T-OL			Over 100	○	○	△	△	—	○	—	—	—	○	
1/2H		C 2600 T-1/2H	Up to and incl. 50	○	○	△	—	—	—	△	—	—	○	
		C 2600 TS-1/2H	Over 50	○	○	△	—	—	—	—	—	—	○	
H		C 2600 T-H	Up to and incl. 50	○	—	△	—	—	—	△	—	—	○	
		C 2600 TS-H	Over 50	○	—	△	—	—	—	—	—	—	○	

Table 3. (Continued)

Alloy No.	Temper grade	Designation	Outside diameter mm	Items indicating mechanical and physical properties									
				Tensile strength	Elongation	Hardness	Grain size	Flaring	Flattening	Eddy current, hydrostatic, pneumatic (2)	Electric conductivity	Hydrogen embrittlement (3)	Season crack
C 2800	O	C 2800 T-O C 2800 TS-O	Up to and incl. 50	○	○	—	—	○	—	△	—	—	○
			Over 50, up to and incl. 100	○	○	—	—	○	—	—	—	—	○
			Over 100	○	○	—	—	—	○	—	—	—	○
	OL	C 2800 T-OL C 2800 TS-OL	Up to and incl. 50	○	○	△	—	○	—	△	—	—	○
			Over 50, up to and incl. 100	○	○	△	—	○	—	—	—	—	○
			Over 100	○	○	△	—	—	○	—	—	—	○
	1/2H	C 2800 T-1/2H C 2800 TS-1/2H	Up to and incl. 50	○	○	△	—	—	—	△	—	—	○
			Over 50	○	○	△	—	—	—	—	—	—	○
	H	C 2800 T-H C 2800 TS-H	Up to and incl. 50	○	—	—	—	—	—	△	—	—	○
			Over 50	○	—	—	—	—	—	—	—	—	○
C 4430 C 6870 C 6871 C 6872	O	C 4430 T-O C 4430 TS-O C 6870 T-O C 6870 TS-O C 6871 T-O C 6871 TS-O C 6872 T-O C 6872 TS-O	Up to and incl. 50	○	○	—	△	○	○	○	—	—	○
			Over 50, up to and incl. 100	○	○	—	△	○	○	—	—	—	○
			Over 100	○	○	—	△	—	○	—	—	—	○
C 7060 C 7100 C 7150 C 7164	O	C 7060 T-O C 7060 TS-O C 7100 T-O C 7100 TS-O C 7150 T-O C 7150 TS-O C 7164 T-O C 7164 TS-O	Up to and incl. 50	○	○	—	△	○	○	○	—	—	—
			Over 50, up to and incl. 100	○	○	—	△	○	○	—	—	—	—
			Over 100	○	○	—	△	—	○	—	—	—	—

Notes (2) Any one out of eddy current, hydrostatic, or pneumatic tests shall be conducted.

(3) Not applicable to C 1220.

Remarks: ○: mandatory △: upon request of the purchaser

3.4 Mechanical properties Mechanical properties (tensile strength, elongation and hardness) of tubes shall be as given in Table 4. When the hardness test is applied, however, the tests for tensile strength and elongation shall not be applied.

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Alloy No.	Temper grade	Designation	Tensile test				Hardness test			
			Outside diameter	Wall thickness	Tensile strength	Elongation	Wall thickness	Rockwell hardness		
			mm	mm	N/mm ²	%	mm	HR30T	HR15T	HRF
C 1020	O	C 1020 T-O C 1020 TS-O	4 and over, up to and incl. 100	0.25 and over, up to and incl. 30	205 min.	40 min.	0.6 min.	—	60 max.	50 max.
	OL	C 1020 T-OL C 1020 TS-OL	4 and over, up to and incl. 100	0.25 and over, up to and incl. 30	205 min.	40 min.	0.6 min.	—	65 max.	55 max.
	1/2H	C 1020 T-1/2H C 1020 TS-1/2H	4 and over, up to and incl. 100	0.25 and over, up to and incl. 25	245 to 325	—	—	30 to 60	—	—
	H	C 1020 T-H C 1020 TS-H	Up to and incl. 25	0.25 and over, up to and incl. 3	315 min.	—	—	55 min.	—	—
			Over 25, up to and incl. 50	0.9 and over, up to and incl. 4				—	—	—
			Over 50, up to and incl. 100	1.5 and over, up to and incl. 6				—	—	—
C 1100	O	C 1100 T-O C 1100 TS-O	5 and over, up to and incl. 250	0.5 and over, up to and incl. 30	205 min.	40 min.	—	—	—	—
	1/2H	C 1100 T-1/2H C 1100 TS-1/2H	5 and over, up to and incl. 250	0.5 and over, up to and incl. 25	245 to 325	—	—	30 to 60	—	—
	H	C 1100 T-H C 1100 TS-H	5 and over, up to and incl. 100	0.5 and over, up to and incl. 6	275 min.	—	—	—	—	80 min.
				Over 6, up to and incl. 10	265 min.	—	—	—	—	75 min.
C 1201 C 1220	O	C 1201 T-O C 1201 TS-O C 1220 T-O C 1220 TS-O	4 and over, up to and incl. 250	0.25 and over, up to and incl. 30	205 min.	40 min.	0.6 min.	—	60 max.	50 max.
	OL	C 1201 T-OL C 1201 TS-OL C 1220 T-OL C 1220 TS-OL	4 and over, up to and incl. 250	0.25 and over, up to and incl. 30	205 min.	40 min.	0.6 min.	—	65 max.	55 max.
	1/2H	C 1201 T-1/2H C 1201 TS-1/2H C 1220 T-1/2H C 1220 TS-1/2H	4 and over, up to and incl. 250	0.25 and over, up to and incl. 25	245 to 325	—	—	30 to 60	—	—

Table 4. (Continued)

Alloy No.	Temper grade	Designation	Tensile test				Hardness test			
			Outside diameter	Wall thickness	Tensile strength	Elongation	Wall thickness	Rockwell hardness		
			mm	mm	N/mm ²	%	mm	HR30T	HR15T	HRF
C 1201 C 1220	H	C 1201 T-H C 1201 TS-H C 1220 T-H C 1220 TS-H	Up to and incl. 25	0.25 and over, up to and incl. 3	315 min.	—	—	55 min.	—	—
			Over 25, up to and incl. 50	0.9 and over, up to and incl. 4				—	—	—
			Over 50, up to and incl. 100	1.5 and over, up to and incl. 6				—	—	—
			Over 100, up to and incl. 200	2 and over, up to and incl. 6	275 min.	—	—	—	—	—
			Over 200, up to and incl. 350	3 and over, up to and incl. 8	255 min.	—	—	—	—	—
C 2200	O	C 2200 T-O C 2200 TS-O	10 and over, up to and incl. 150	0.5 and over, up to and incl. 15	225 min.	35 min.	Up to and incl. 1.1	30 max.	—	—
							Over 1.1	—	—	70 max.
	OL	C 2200 T-OL C 2200 TS-OL	10 and over, up to and incl. 150	0.5 and over, up to and incl. 15	225 min.	35 min.	Up to and incl. 1.1	37 max.	—	—
							Over 1.1	—	—	78 max.
	1/2H	C 2200 T-1/2H C 2200 TS-1/2H	10 and over, up to and incl. 150	0.5 and over, up to and incl. 6	275 min.	15 min.	—	38 min.	—	—
	H	C 2200 T-H C 2200 TS-H	10 and over, up to and incl. 100	0.5 and over, up to and incl. 6	365 min.	—	Over 0.5, up to and incl. 6	55 min.	—	—
	O	C 2300 T-O C 2300 TS-O	10 and over, up to and incl. 150	0.5 and over, up to and incl. 15	275 min.	35 min.	Up to and incl. 1.1	36 max.	—	—
							Over 1.1	—	—	75 max.
C 2300	OL	C 2300 T-OL C 2300 TS-OL	10 and over, up to and incl. 150	0.5 and over, up to and incl. 15	275 min.	35 min.	Up to and incl. 1.1	39 max.	—	—
							Over 1.1	—	—	85 max.
	1/2H	C 2300 T-1/2H C 2300 TS-1/2H	10 and over, up to and incl. 150	0.5 and over, up to and incl. 6	305 min.	20 min.	—	43 min.	—	—
	H	C 2300 T-H C 2300 TS-H	10 and over, up to and incl. 100	0.5 and over, up to and incl. 6	390 min.	—	Over 0.5, up to and incl. 6	65 min.	—	—

Table 4. (Continued)

Alloy No.	Temper grade	Designation	Tensile test				Hardness test			
			Outside diameter mm	Wall thickness mm	Tensile strength N/mm ²	Elongation %	Wall thickness mm	Rockwell hardness		
								HR30T	HR15T	HRF
C 2600	O	C 2600 T-O C 2600 TS-O	4 and over, up to and incl. 250	0.3 and over, up to and incl. 15	275 min.	45 min.	Up to and incl. 0.8	40 max.	—	—
							Over 0.8	—	—	80 max.
	OL	C 2600 T-OL C 2600 TS-OL	4 and over, up to and incl. 250	0.3 and over, up to and incl. 15	275 min.	45 min.	Up to and incl. 0.8	60 max.	—	—
							Over 0.8	—	—	90 max.
	1/2H	C 2600 T-1/2H C 2600 TS-1/2H	4 and over, up to and incl. 100	0.3 and over, up to and incl. 6	375 min.	20 min.	—	53 min.	—	—
			Over 100, up to and incl. 250	2.0 and over, up to and incl. 10	355 min.					
	H	C 2600 T-H C 2600 TS-H	4 and over, up to and incl. 100	0.3 and over, up to and incl. 6	450 min.	—	Over 0.5, up to and incl. 6	70 min.	—	—
			Over 100, up to and incl. 250	2.0 and over, up to and incl. 10	390 min.					
C 2700	O	C 2700 T-O C 2700 TS-O	4 and over, up to and incl. 250	0.3 and over, up to and incl. 15	295 min.	40 min.	Up to and incl. 0.8	40 max.	—	—
							Over 0.8	—	—	80 max.
	OL	C 2700 T-OL C 2700 TS-OL	4 and over, up to and incl. 250	0.3 and over, up to and incl. 15	295 min.	40 min.	Up to and incl. 0.8	60 max.	—	—
							Over 0.8	—	—	90 max.
	1/2H	C 2700 T-1/2H C 2700 TS-1/2H	4 and over, up to and incl. 100	0.3 and over, up to and incl. 6	375 min.	20 min.	—	53 min.	—	—
			Over 100, up to and incl. 250	2.0 and over, up to and incl. 10	355 min.					
	H	C 2700 T-H C 2700 TS-H	4 and over, up to and incl. 100	0.3 and over, up to and incl. 6	450 min.	—	Over 0.5, up to and incl. 6	70 min.	—	—
			Over 100, up to and incl. 250	2.0 and over, up to and incl. 10	390 min.					

Table 4. (Continued)

Alloy No.	Temper grade	Designation	Tensile test				Hardness test			
			Outside diameter mm	Wall thickness mm	Tensile strength N/mm ²	Elongation %	Wall thickness mm	Rockwell hardness		
								HR30T	HR15T	HRF
C 2800	O	C 2800 T-O C 2800 TS-O	10 and over, up to and incl. 250	1 and over, up to and incl. 15	315 min.	35 min.	—	—	—	—
	OL	C 2800 T-OL C 2800 TS-OL	10 and over, up to and incl. 250	1 and over, up to and incl. 15	315 min.	35 min.	Up to and incl. 0.8	60 max.	—	—
							Over 0.8	—	—	90 max.
	1/2H	C 2800 T-1/2H C 2800 TS-1/2H	10 and over, up to and incl. 250	1 and over, up to and incl. 6	375 min.	15 min.	—	55 min.	—	—
	H	C 2800 T-H C 2800 TS-H	10 and over, up to and incl. 100	1 and over, up to and incl. 6	450 min.	—	—	—	—	—
C 4430	O	C 4430 T-O C 4430 TS-O	5 and over, up to and incl. 250	0.8 and over, up to and incl. 10	315 min.	30 min.	—	—	—	—
C 6870 C 6871 C 6872	O	C 6870 T-O C 6870 TS-O C 6871 T-O C 6871 TS-O C 6872 T-O C 6872 TS-O	5 and over, up to and incl. 50	0.8 and over, up to and incl. 10	375 min.	40 min.	—	—	—	—
			Over 50, up to and incl. 250	0.8 and over, up to and incl. 10	355 min.	40 min.				
C 7060	O	C 7060 T-O C 7060 TS-O	5 and over, up to and incl. 250	0.8 and over, up to and incl. 5	275 min.	30 min.	—	—	—	—
C 7100	O	C 7100 T-O C 7100 TS-O	5 and over, up to and incl. 50	0.8 and over, up to and incl. 5	315 min.	30 min.	—	—	—	—
C 7150	O	C 7150 T-O C 7150 TS-O	5 and over, up to and incl. 50	0.8 and over, up to and incl. 5	365 min.	30 min.	—	—	—	—
C 7164	O	C 7164 T-O C 7164 TS-O	5 and over, up to and incl. 50	0.8 and over, up to and incl. 5	430 min.	30 min.	—	—	—	—

Remarks 1. The mechanical properties of tubes having a dimension exceeding the range of the specified dimensions shall be as agreed upon between the purchaser and supplier.

2. For those alloys that are doubly specified in the hardness, either one of the hardness tests may be dispensed with on an agreement between the purchaser and supplier.

3.5 Grain size The grain size of tubes shall be as given in Table 5. However, this requirement shall be applied only when requested by the purchaser. In this case, Table 4 shall not be applied.

Table 5. Grain size

Unit: mm

Alloy No.	Temper grade	Designation	Grain size
C 1020	O	C 1020 T, TS-O	0.025 to 0.060
C 1201		C 1201 T, TS-O	
C 1220		C 1220 T, TS-O	
	OL	C 1020 T, TS-OL	0.040 max.
		C 1201 T, TS-OL	
		C 1220 T, TS-OL	
C 2200	O	C 2200 T, TS-O	0.025 to 0.060
C 2300		C 2300 T, TS-O	
C 2600		C 2600 T, TS-O	
C 2700		C 2700 T, TS-O	
	OL	C 2200 T, TS-OL	$\alpha^{(4)}$ to 0.035
		C 2300 T, TS-OL	
		C 2600 T, TS-OL	
		C 2700 T, TS-OL	
C 4430	O	C 4430 T, TS-O	0.010 to 0.045
C 6870		C 6870 T, TS-O	
C 6871		C 6871 T, TS-O	
C 6872		C 6872 T, TS-O	
C 7060		C 7060 T, TS-O	
C 7100		C 7100 T, TS-O	
C 7150		C 7150 T, TS-O	
C 7164		C 7164 T, TS-O	

Note ⁽⁴⁾ The grain size of α is the minimum to those of recrystallized.

3.6 Flareability and flattenability For temper grade O and OL, tubes shall be free from cracks when either flaring test or flattening test is conducted as specified in 5.5 and 5.6, respectively. Both of these tests, however, shall be applied to C 4430, C 6870, C 6871, C 6872, C 7060, C 7100, C 7150 and C 7164.

3.7 Non-destructive test result When any one of those tests — eddy current test in 5.7, hydrostatic test as in 5.8, pneumatic test as in 5.9 — is applied to tubes not more than 50 mm outside diameter, they shall be free from defects that are detrimental to practical use.

These tests may be applied to tubes before annealing. However, these tests shall be applied to those excluding C 4430, C 6870, C 6871, C 6872, C 7060, C 7100, C 7150 and C 7164, and also only when specially requested by the purchaser.

3.8 Electric conductivity The electric conductivity of tubes shall be as given in Table 6. This test, however, shall be applied only when requested by the purchaser.

Table 6. Electric conductivity

Alloy No.	Temper grade	Designation	Wall thickness mm	Electric conductivity % (20°C)
C 1020 C 1100	O OL	C 1020 T-O, OL C 1020 TS-O, OL C 1100 T-O, OL C 1100 TS-O, OL	Up to and incl. 2	100 min.
			Over 2	100 min.
	1/2 H	C 1020 T-1/2H C 1020 TS-1/2H C 1100 T-1/2H C 1100 TS-1/2H	Up to and incl. 2	97 min.
			Over 2	98 min.
	H	C 1020 T-H C 1020 TS-H C 1100 T-H C 1100 TS-H	Up to and incl. 2	96 min.
			Over 2	97 min.

3.9 Hydrogen embrittlement When the hydrogen embrittlement test specified in 5.11 is carried out, tubes of C 1020, C 1201 shall be free from amounts of blowholes or open grain structures characteristic of hydrogen embrittlement at the vicinity of grain boundaries. However, for those grade C 1201, this test shall be applied only when requested by the purchaser.

3.10 Season cracking When the season cracking test specified in 5.12 is carried out for tubes of C 2600, C 2700, C 2800, C 4430, C 6870, C 6871 and C 6872, tubes shall be free from cracking on the surface. This test, however, may be omitted by agreement with the purchaser.

4. Dimensions and tolerances

4.1 Dimensions specification To specify the dimensions for tubes, any two out of outside diameter, inside diameter or wall thickness and as well as length shall be indicated.

4.2 Preferred dimension The preferred dimensions for tubes should be as given in Tables 7 (1) to 7 (3).

Table 7 (1). Preferred dimensions for tubes
(C 1020 · C 1100 · C 1201 · C 1220 · C 2200 · C 2300 · C 2600 · C 2700 · C 2800)
Unit : mm

Outside diameter	Wall thickness																				
	0.25	0.3	0.35	0.4	0.5	0.6	0.7	0.8	1	1.2	1.5	2	2.5	3	3.5	4	4.5	5	6	8	10
4											—	—	—	—	—	—	—	—	—	—	—
5						○					—	—	—	—	—	—	—	—	—	—	—
6	○	○	○	○	○	○	○	○	○		—	—	—	—	—	—	—	—	—	—	—
6.35	○	○	○	○	○	○	○	○	○		—	—	—	—	—	—	—	—	—	—	—
8	○	○	○	○	○	○	○	○	○	○	○		—	—	—	—	—	—	—	—	—
9.52	○	○	○	○	○	○	○	○	○	○	○		—	—	—	—	—	—	—	—	—
10				○	○	○	○	○	○	○	○		—	—	—	—	—	—	—	—	—
12				○	○	○	○	○	○	○	○		—	—	—	—	—	—	—	—	—
12.7	—	—	—	○	○	○	○	○	○	○	○		—	—	—	—	—	—	—	—	—
14	—	—	—	—		○	○	○	○	○			—	—	—	—	—	—	—	—	—
15	—	—	—	—		○	○	○	○	○	○		—	—	—	—	—	—	—	—	—
15.9	—	—	—	—	○	○	○	○	○	○	○		—	—	—	—	—	—	—	—	—
16	—	—	—	—	○	○	○	○	○	○				—	—	—	—	—	—	—	—
18	—	—	—	—	—			○	○	○				—	—	—	—	—	—	—	—
19.1	—	—	—	—	—	○	○	○	○	○	○	○		—	—	—	—	—	—	—	—
20	—	—	—	—	—				○	○				—	—	—	—	—	—	—	—
22	—	—	—	—	—			○	○	○	○			—	—	—	—	—	—	—	—
22.2	—	—	—	—	—		○	○	○	○	○				—	—	—	—	—	—	—
25	—	—	—	—	—				○	○		○			—	—	—	—	—	—	—
25.4	—	—	—	—	—	○	○	○	○	○	○	○			—	—	—	—	—	—	—
28	—	—	—	—	—				○	○					—	—	—	—	—	—	—
31.8	—	—	—	—	—	○	○	○	○	○	○				—	—	—	—	—	—	—
32	—	—	—	—	—			○	○	○					—	—	—	—	—	—	—
35	—	—	—	—	—				○						—	—	—	—	—	—	—
38.1	—	—	—	—	—	○	○	○	○	○					—	—	—	—	—	—	—
40	—	—	—	—	—	—	—										—	—	—	—	—
45	—	—	—	—	—	—	—	—				○					—	—	—	—	—
50	—	—	—	—	—	—	—	—				○							—	—	—
50.8	—	—	—	—	—	—	—	—				○							—	—	—
75	—	—	—	—	—	—	—	—	—	—	—										
100	—	—	—	—	—	—	—	—	—	—	—	—	—								
125	—	—	—	—	—	—	—	—	—	—	—	—	—								
150	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—						
200	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—				
250	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—				

Remarks: Bold-faced lines show the range of manufacture, and ○ mark shows the preferred dimensions.

Table 7 (2). Dimensions of copper tubes for ordinary piping
(C 1020 · C 1220)

Nominal diameter		Outside diameter mm		Wall thickness mm		
(A)	(B)	Standard diameter	Tolerance	Type K	Type L	Type M
8	1/4	9.52	±0.03	0.89	0.76	—
10	3/8	12.70	±0.03	1.24	0.89	0.64
15	1/2	15.88	±0.03	1.24	1.02	0.71
—	5/8	19.05	±0.03	1.24	1.07	—
20	3/4	22.22	±0.03	1.65	1.14	0.81
25	1	28.58	±0.04	1.65	1.27	0.89
32	1 1/4	34.92	±0.04	1.65	1.40	1.07
40	1 1/2	41.28	±0.05	1.83	1.52	1.24
50	2	53.98	±0.05	2.11	1.78	1.47
65	2 1/2	66.68	±0.05	—	2.03	1.65
80	3	79.38	±0.05	—	2.29	1.83
100	4	104.78	±0.05	—	2.79	2.41
125	5	130.18	±0.08	—	3.18	2.77
150	6	155.58	±0.08	—	3.56	3.10

- Remarks
1. For the nominal diameter, either (A) or (B) shall be used. However, as necessarily, the letter A for (A) series and the letter B for the (B) series shall be suffixed to each digit expressing the nominal diameter to identify.
 2. The term tolerance is defined as the allowable limit on the difference between the mean value of maximum and minimum diameter measured at arbitrary cross section of the tube and the standard outside diameter.
 3. Type K and L are mainly used for piping service of medicine.
 4. Type L and M are mainly used for water supply and drainage, hot water supply, cooling of warm water and town gas transmission.
 5. For the tolerances on ratio of out-of-roundness, those for the special grade in Table 10 shall be applied. However, the tolerances on average outside diameter and ratio of out-of-roundness shall not be applied to temper grade O and OL.

Table 7 (3). Preferred dimensions of copper alloy tubes for heat exchanger
(C 4430 · C 6870 · C 6871 · C 6872 · C 7060 · C 7100 · C 7150 · C 7164)

Unit: mm

Outside diameter	Wall thickness												
	0.9	1	1.2	1.4	1.6	1.8	2	2.1	2.5	2.6	2.8	3	3.7
10	—	○	—	—	—	—	○	—	—	—	—	—	—
12	—	○	—	—	—	—	—	—	—	—	—	—	—
15	—	○	○	—	—	—	○	—	○	—	—	—	—
16	—	○	○	○	○	—	—	—	—	—	—	—	—
19	—	○	○	○	○	○	○	—	—	—	—	—	—
20	—	—	—	○	—	—	○	—	—	—	—	○	—
22.2	—	—	○	—	—	—	—	—	—	—	—	—	—
25	—	○	○	—	—	—	—	—	—	—	—	—	—
25.4	○	—	○	—	—	—	—	○	—	—	○	—	—
28.2	—	—	—	—	○	—	—	—	—	○	—	—	—
28.6	—	—	○	—	—	—	—	—	—	—	—	—	—
31.8	○	—	○	—	—	—	—	—	—	—	—	—	—
40.9	—	—	—	—	—	—	○	—	—	—	—	—	○
44.4	—	—	○	—	—	—	—	—	—	—	—	—	—

4.3 Diameter tolerance The tolerances on diameter for tubes shall be as given in Tables 8 (1) and (2).

Table 8 (1). Tolerances on average diameter⁽⁵⁾

Unit: mm

Outside diameter or inside diameter	Alloy number Class	C 1020 · C 1100 · C 1201 · C 1220 · C 2200 · C 2300 · C 2600 · C 2700 · C 2800		C 4430 · C 6870 · C 6871 · C 6872 · C 7060 · C 7100 · C 7150 · C 7164	
		Common grade	Special grade	Common grade	Special grade
4 and over, up to and incl. 15		±0.08	±0.05	—	—
Over 15, up to and incl. 25		±0.09	±0.06	—	—
Over 25, up to and incl. 50		±0.12	±0.08	—	—
Over 50, up to and incl. 75		±0.15	±0.10	±0.15	±0.10
Over 75, up to and incl. 100		±0.20	±0.13	±0.20	±0.13
Over 100, up to and incl. 125		±0.27	±0.15	±0.27	±0.15
Over 125, up to and incl. 150		±0.35	±0.18	±0.35	±0.18
Over 150, up to and incl. 200		±0.50	—	±0.50	—
Over 200, up to and incl. 250		±0.65	—	±0.65	—
Over 250, up to and incl. 350		±0.40%	—	±0.40%	—

Note ⁽⁵⁾ The term average diameter is defined as the mean value either obtained from the maximum and minimum outside diameter or obtained from the maximum and minimum inside diameter measured at arbitrary cross section of the tube.

- Remarks 1. When the tolerance is specified by only either plus or minus side, the value in the above table shall be doubled.
2. The tolerance for tubes having a dimension exceeding the range of specified dimensions shall be as agreed upon between the purchaser and supplier.

Table 8 (2). Tolerances on diameter
(C 4430 · C 6870 · C 6871 · C 6872 · C 7060 · C 7100 · C 7150 · C 7164)

Unit: mm

Class Outside diameter	Tolerance		
	Common grade	Special grade	
		Up to and incl. 1.1 in thickness	Over 1.1 in thickness
5 and over, up to and incl. 10	$\begin{matrix} 0 \\ -1.5\% \end{matrix}$	$\begin{matrix} 0 \\ -0.10 \end{matrix}$	$\begin{matrix} 0 \\ -0.10 \end{matrix}$
Over 10, up to and incl. 20		$\begin{matrix} 0 \\ -0.20 \end{matrix}$	$\begin{matrix} 0 \\ -0.17 \end{matrix}$
Over 20, up to and incl. 30		$\begin{matrix} 0 \\ -0.30 \end{matrix}$	$\begin{matrix} 0 \\ -0.22 \end{matrix}$
Over 30, up to and incl. 50		$\begin{matrix} 0 \\ -0.40 \end{matrix}$	$\begin{matrix} 0 \\ -0.30 \end{matrix}$

Remarks: The tolerances for tubes having a dimension exceeding the range of specified dimensions shall be as agreed upon between the purchaser and supplier.

4.4 Thickness tolerance The tolerances on wall thickness for tubes shall be as follows:

- (1) For tubes excepting the alloy tubes for heat exchanger (C 4430 · C 6870 · C 6871 · C 6872 · C 7060 · C 7100 · C 7150 · C 7164), Table 9 (1) applies to the common grade, and Table 9 (2) applies to the special grade.
- (2) For the alloy tubes for heat exchanger (C 4430 · C 6870 · C 6871 · C 6872 · C 7060 · C 7100 · C 7150 · C 7164), it is $\pm 10\%$.

Table 9 (1). Tolerances on wall thickness (Common grade)

Unit: mm

Wall thickness Outside diameter	Tolerance									
	0.25 and over, up to and incl. 0.4	Over 0.4, up to and incl. 0.6	Over 0.6, up to and incl. 0.8	Over 0.8, up to and incl. 1.4	Over 1.4, up to and incl. 2	Over 2, up to and incl. 3	Over 3, up to and incl. 4	Over 4, up to and incl. 5.5	Over 5.5, up to and incl. 7	Over 7
4 and over, up to and incl. 15	±0.06	±0.07	±0.10	±0.13	±0.15	±0.18	—	—	—	—
Over 15, up to and incl. 25	±0.07	±0.08	±0.10	±0.15	±0.18	±0.20	±0.30	±0.40	±0.45	—
Over 25, up to and incl. 50	—	±0.09	±0.11	±0.15	±0.18	±0.20	±0.30	±0.40	±0.45	±8 %
Over 50, up to and incl. 100	—	—	±0.15	±0.18	±0.22	±0.25	±0.30	±0.40	±0.45	±8 %
Over 100, up to and incl. 175	—	—	—	±0.22	±0.25	±0.30	±0.35	±0.42	±0.45	±9 %
Over 175, up to and incl. 250	—	—	—	—	±0.30	±0.35	±0.40	±0.45	±0.50	±9 %

- Remarks 1. When the tolerance is specified by only either plus or minus side, the value in the above table shall be doubled.
2. When the inside diameter is specified, the above table shall be so applied that the outside diameter equals the inside diameter plus twice the wall thickness.
3. The tolerances for tubes having a dimensions exceeding the range of the specified dimensions shall be as agreed upon between the purchaser and supplier.

Table 9 (2). Tolerances on wall thickness (Special grade)

Unit: mm

Wall thickness Outside diameter	Tolerance						
	0.25 and over, up to and incl. 0.4	Over 0.4, up to and incl. 0.6	Over 0.6, up to and incl. 0.8	Over 0.8, up to and incl. 1.4	Over 1.4, up to and incl. 2	Over 2, up to and incl. 3	Over 3, up to and incl. 4
4 and over, up to and incl. 15	±0.03	±0.05	±0.06	±0.08	±0.09	±0.10	—
Over 15, up to and incl. 25	±0.04	±0.05	±0.06	±0.09	±0.10	±0.13	±0.15
Over 25, up to and incl. 50	—	±0.06	±0.08	±0.09	±0.10	±0.13	±0.18
Over 50, up to and incl. 100	—	—	±0.10	±0.13	±0.15	±0.18	±0.20

- Remarks 1. When the tolerance is specified by only either plus or minus side, the value in the above table shall be doubled.
2. When the inside diameter is specified, the above table shall be so applied that the outside diameter equals the inside diameter plus twice wall thickness.
3. The applicable tolerances for tubes having a dimension exceeding the range of specified dimensions shall be those for common grade.

4.5 Tolerance on roundness The tolerances on ratio of out-of-roundness for tubes shall be as given in Table 10. However, the ratio of out-of-roundness shall not be applied to tubes of temper grade O and OL, tubes in coil form, alloy tubes for heat-exchangers, and tubes under 0.4 mm in wall thickness.

The term ratio of out-of-roundness is defined as the proportion of the specified outside diameter against the difference between the longest and shortest diameter measured at arbitrary cross section of the tube.

Table 10. Tolerances on ratio of out-of-roundness

Wall thickness/ outside diameter	Class	Tolerance	
		Common grade	Special grade
0.01 and over, up to and incl. 0.03		3 % max. of outside diameter	1.5 % max. of outside diameter
Over 0.03, up to and incl. 0.05		2 % max. of outside diameter	1.0 % max. of outside diameter
Over 0.05, up to and incl. 0.10		1.5 % max. ⁽⁶⁾ of outside diameter	0.8 % max. ⁽⁷⁾ of outside diameter
Over 0.10		1.5 % max. ⁽⁶⁾ of outside diameter	0.7 % max. ⁽⁷⁾ of outside diameter

Notes ⁽⁶⁾ The tolerance in the case of 0.1 mm or under the calculated value shall be 0.1 mm.

⁽⁷⁾ The tolerance in the case of 0.05 mm or under the calculated value shall be 0.05 mm.

Remarks: The tolerance of the tube of which the ratio of wall thickness to outside diameter is outside the specified range shall be as agreed upon between the purchaser and supplier.

4.6 Length tolerance The length tolerances for tubes shall be as given in Tables 11 (1) to 11 (3).

Table 11 (1). Length tolerances for straight tubes

(C 1020 · C 1100 · C 1201 · C 1220 · C 2200 ·
C 2300 · C 2600 · C 2700 · C 2800)

Unit: mm

Length	Outside diameter	Tolerance		
		Up to and incl. 25	Over 25, up to and incl. 100	Over 100
Up to and incl. 600		+ 2 0	+ 3 0	+ 3 0
Over 600, up to and incl. 1800		+ 3 0	+ 3 0	+ 6 0
Over 1800, up to and incl. 4200		+ 6 0	+ 6 0	+ 6 0
Over 4200, up to and incl. 9000		+10 0	+10 0	+10 0

Remarks: The tolerances for straight tubes having a dimension exceeding the range of specified dimensions shall be as agreed upon between the purchaser and supplier.

Table 11 (2). Length tolerances of copper alloy straight tubes for heat exchanger

(C 4430 · C 6870 · C 6871 · C 6872 ·
C 7060 · C 7100 · C 7150 · C 7164)

Unit: mm

Length	Tolerance
Up to and incl. 9000	+ 5 0
Over 9000, up to and incl. 18000	+10 0
Over 18000, up to and incl. 30000	+15 0

Remarks: The tolerances for copper alloy straight tubes having a dimension excepting the range of specified dimensions shall be as agreed upon between the purchaser and supplier.

Table 11 (3). Length tolerances for tubes in coil form

Unit: mm

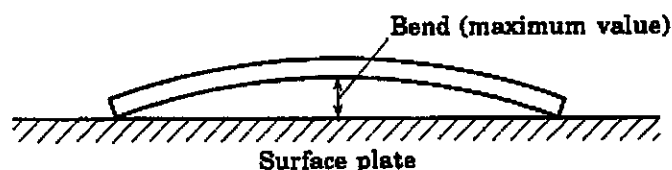
Length	Outside diameter	Tolerance
		Up to and incl. 50
Up to and incl. 15000		+ 300 0
Over 15000, up to and incl. 30000		+ 600 0
Over 30000		+ 3 0 %

Remarks: The tolerances for tubes in coil form having a dimension excepting the range of specified dimensions shall be as agreed upon between the purchaser and supplier.

4.7 Maximum permissible bend The maximum permissible value on bend for tubes⁽⁸⁾ shall be as given in Table 12. However, the permissible maximum value on bend shall be applied to straight tube with an outside diameter 6 mm or over up to and including 90 mm, and shall not be applied to those of temper grade O and OL.

Table 12. The permissible maximum value on bend⁽⁸⁾
Unit: mm

Length	Maximum value
1000 and over, up to and incl. 2000	5
Over 2000, up to and incl. 2500	8
Over 2500, up to and incl. 3000	12



Note ⁽⁸⁾ The term bend is the depth of the arc for the full length.

- Remarks 1. The permissible maximum value on bend for the tube with a length over 3000 mm shall be 12 mm or under in any 3000 mm in length instead of full length.
2. The permissible maximum value for tubes having a dimension exceeding the range of specified dimensions shall be as agreed upon between the purchaser and supplier.

5. Test

5.1 Chemical analysis The analytical method of chemical composition shall conform to any one of the following standards:

JIS H 1012	JIS H 1055	JIS H 1061
JIS H 1051	JIS H 1056	JIS H 1062
JIS H 1052	JIS H 1057	JIS H 1291
JIS H 1053	JIS H 1058	JIS H 1292
JIS H 1054	JIS H 1059	

5.2 Tensile test The tensile test shall conform to JIS Z 2241. The test piece, in this case, shall be No. 11 test piece specified in JIS Z 2201.

In case No. 11 test piece is unable to take, either No. 12 or No. 14 C test piece shall be substituted.

5.3 Hardness test The hardness test shall be conducted on the inside surface of tubes in accordance with JIS Z 2245.

5.4 Grain size test The grain size test shall be conducted on the longitudinal section in accordance with JIS H 0501.

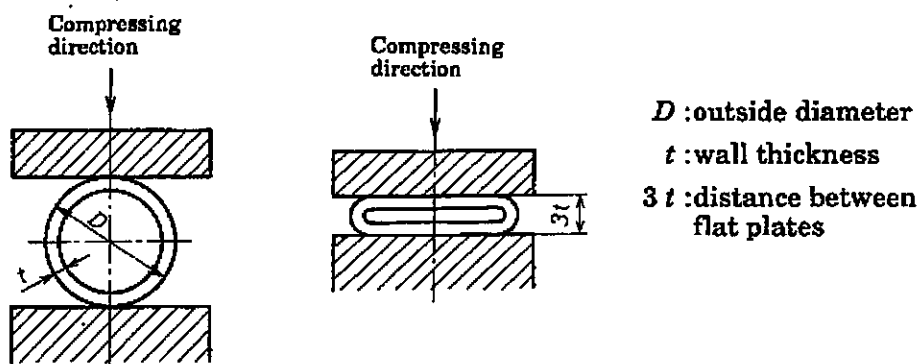
5.5 Flaring test The flaring test shall be conducted by thrusting a conical wedge having a vertical angle of 60° into any one end of the test piece taken from one end of a tube with an adequate length until its outside diameter extends and the ratio reaches as given in Table 13.

Table 13. Flaring ratio

Alloy No.	Outside diameter, wall thickness	Flaring ratio	
		Up to and incl. 20 mm in outside diameter, and also over 0.5 mm in wall thickness	Over 20 mm up to and incl. 100 mm in outside diameter, or up to and incl. 0.5 mm in wall thickness
C 1020 · C 1100 · C 1201 · C 1220		1.4	1.3
C 2200 · C 2300 · C 2600 · C 2700 C 2800		1.2	1.15
C 4430 · C 6870 · C 6871 · C 6872 C 7060 · C 7100 · C 7150 · C 7164		1.25	

5.6 Flattening test The flattening test shall be conducted by placing the test piece taken from one end of a tube with a length approximately 100 mm as given in Figure 1, and pinching it between two flat plates and flattened until the distance between the plates becomes equal to 3 times the wall thickness of the tube.

Fig. 1



5.7 Eddy current test The eddy current test shall conform to JIS H 0502. In this case, the size of reference defects shall be as given in Table 14.

Table 14. Size of reference defects (Diameter of drill hole)
Unit: mm

Alloy No. Outside diameter	C 1020 · C 1100 C 1201 · C 1220	Others
4 and over, up to and incl. 10	0.9	0.7
Over 10, up to and incl. 20	1.0	0.8
Over 20, up to and incl. 30	1.1	0.9
Over 30, up to and incl. 40	1.3	1.1
Over 40, up to and incl. 50	1.5	1.3

Remarks: The diameter of drill hole for tubes exceeding the range of specified dimensions shall be as agreed upon between the purchaser and supplier.

5.8 Hydrostatic test In the hydrostatic test, pressures computed by the following formula shall be applied.

$$P = \frac{2S \times t}{D - 0.8t}$$

where, P : test hydrostatic pressure (MPa)

t : wall thickness of tube (mm)

D : outer diameter of tube (mm)

S : allowable stress of material as given in Table 15 (N/mm²)

Unless specifically specified, this pressure P does not need to exceed 6.85 MPa.

Table 15. Allowable stress of materials

Alloy No.	Value of S N/mm ²
C 1100 · C 1020 · C 1201 · C 1220	41
C 2200 · C 2300 · C 2600 · C 2700 · C 2800 · C 4430 · C 6870 · C 6871 · C 6872 · C 7060 · C 7100 · C 7150 · C 7164	48

5.9 Pneumatic test The pneumatic test shall be conducted in water by using an air pressure of 395 to 785 kPa.

5.10 Electric conductivity test The electric conductivity test shall conform to JIS H 0505.

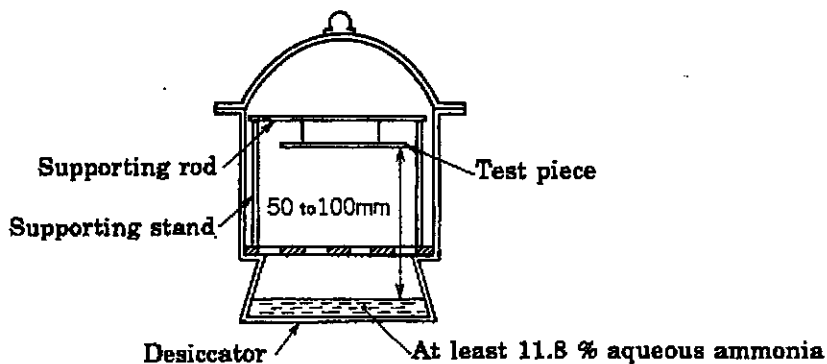
5.11 Hydrogen embrittlement test The hydrogen embrittlement test shall be conducted by heating the test piece in a hydrogen gas current at $850 \pm 25^\circ\text{C}$ for 30 min followed by polishing and etching, and then examined by means of a microscope of 75 magnifications to 200 magnifications.

5.12 Season cracking test The season cracking test shall be conducted conforming to either one of the following by means of visual examination.

- (1) **Method A** The test piece with a length not less than 75 mm cut from a tube shall be degreased and dried, and be kept in the ammonia atmosphere for 2 h at ordinary temperature by putting the test piece in the desiccator containing aqueous ammonia specified in JIS K 8085, of 11.8 % and over which is diluted by equal amount of pure water, and the test piece away from the liquid surface with a distance of 50 mm to 100 mm (see Informative Reference Fig. 1).

This test piece shall be rinsed with 10 % sulphuric acid solution and polished the surface or for tubes of temper grade O and OL, they may be flattened until one diameter becomes 50 % to 60 % of original outside diameter. However, for the tube with an outside diameter not more than 6 times the wall thickness, the test piece shall be flattened until one diameter becomes 3 times the wall thickness.

Informative Reference Fig. 1



- (2) **Method B** The test piece with a length of not less than 75 mm shall be cut from a tube, and shall be immersed into a mercurous nitrate solution for 15 min. Thereafter cracking is judged.

The mercurous nitrate solution to be used shall contain 100 g of mercurous nitrate and 13 ml of nitric acid (1.42 of specific gravity) per litre.

6. Inspection The inspection shall be carried out as follows.

- (1) Tubes shall be inspected on appearance and dimensions in addition to the tests conforming to the requirements of 5., and their results shall comply with the specifications of 3. and 4.
- (2) One representative tube for the tensile test, hardness test, grain size test, flaring test, flattening test, electric conductivity test, hydrogen embrittlement test and season crack test shall arbitrarily be, as a rule, taken from every 100 tubes (if the mass of 100 tubes being less than 2000 kg, take the number of tubes to 2000 kg) or the fraction, of each lot consisting of tubes of the same grade, class, and temper grade rolled to the same sectional dimensions. And the test piece shall be made from the tube mentioned above.
- (3) Eddy current test, hydrostatic test or pneumatic test shall be conducted on the tube taken arbitrarily from a lot consisting of the same grade, class, and temper grade rolled to the same sectional dimensions. Then number of tubes to be tested shall be 0.2 % of whole quantity. However, those tests shall be conducted on each tube of C 4430, C 6870, C 6871, C 6872, C 7060, C 7100, C 7150 and C 7164.

Those tests may be applied to as-worked condition prior to the final heat treatment.

- (4) When the product belongs to the same lot as tested already, the result of electric conductivity test carried out by the manufacturer may be considered as the representative value for the lot.
- (5) Other general requirements shall comply with JIS H 0321.

7. Marking Tubes shall be marked with the following items on each package, on each bundle, or on each tube by a suitable means.

- (1) Grade, class, temper grade or their designation
- (2) Dimensions
- (3) Manufacturing number
- (4) Manufacturer's name or its abbreviation

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