BUREAU OF INDIAN STANDARDS

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भारतीय मानक मसौदा

प्रशीतन और वातानुकूलन प्रयोजनों के लिए पिटवाँ ताँबे की नलिकाएँ — विशिष्टि

(आई एस 10773 *का दूसरा पुनरीक्षण*)

Draft Indian Standard

WROUGHT COPPER TUBES FOR REFRIGERATION AND AIR-CONDITIONING PURPOSES — SPECIFICATION

(*Second Revision of* IS 10773)

ICS 77.150.30

Ores and Feed Stock for Copper Industry, its Metals/ Alloys and Products Sectional Committee, MTD 08	Last date of comments **10 September 2025**

FOREWORD

(*Formal foreword clauses will be added later*)

This standard was first published in 1983 and was subsequently revised in 1995. The significant changes in this revision are as follows:

a) Scope of the standard has been modified to cover inner groove/fin tubes (*see* **1**);
b) Terminologies for inner groove tube and bottom wall thickness have been added and mean wall thickness has been modified (*see* **3**);
c) Table 1 and Table 2 have been modified;
d) Requirements of process of manufacture have been modified to cover billet and bars for drawing tubes and hard drawn condition for supply (*see* **6**);
e) Table 3, Table 4 and Table 5 have been added for dimensions and tolerances for smooth tubes (*see* **9.1**);
f) Table 6, Table 7 and Table 8 have been added for dimensions and tolerances for inner groove tubes (*see* **9.2**);
g) Flattening test and drift expanding test have been modified to cover hard drawn tubes (*see* **8**);
h) Eddy-current test, hydrostatic test, pneumatic test, microscopic examination and hydrogen embrittlement test have been modified (*see* **10**).

For the purpose of deciding whether a particular requirement of this standard is complied with the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS 2 : 2022 'Rules for rounding off numerical values (*second revision*)'. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

Draft Indian Standard

WROUGHT COPPER TUBES FOR REFRIGERATION AND AIR-CONDITIONING PURPOSES — SPECIFICATION

(*Second Revision*)

1 SCOPE

This standard covers the requirements of solid drawn (seamless) copper tubes (including inner groove/fin tubes) in straight length or coil form for air-conditioning and refrigeration purposes.

2 REFERENCES

The standards listed below contain provisions which, through reference in this text, constitute provisions of this standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent edition of these standards:

IS No.	*Title*
IS 440 : 1964	Methods for chemical analysis of copper (*revised*)
IS 1387 : 1993	General requirements for the supply of metallurgical materials (*second revision*)
IS 1608 (Part 1) : 2022/ ISO 6892-1 : 2019	Metallic materials — Tensile testing Part 1 : Method of test at room temperature (*fifth revision*)
IS 2328 : 2018/ ISO 8492 : 2013	Metallic materials — Tube — Flattening test (*third revision*)
IS 2335 : 2005/ ISO 8493 : 1998	Metallic materials — Tube — Drift expanding test (*second revision*)
IS 3288 (Part 3) : 1986	Glossary of terms relating to copper and copper alloys Part 3 Wrought forms
IS 18829 : 2024/ ISO 2624 : 1990	Copper and copper alloys — Estimation of average grain size
IS 5493 : 1981	Dimensions of wrought copper and copper alloy-tubes (*first revision*)
IS 6243 : 1985	Method for hydrogen embrittlement test for copper (*first revision*)
IS 11612 : 2004	Code of practice for eddy current testing of non-ferrous seamless pipes and tubes (*first revision*)

3 TERMINOLOGY

For the purpose of this standard, the definitions given in IS 3288 (Part 3) and the following shall apply.

3.1 Seamless Tube (Solid Drawn Tube) — Tube produced from a tube shell by drawing.

3.2 Inner Groove Tube — Tube produced from tube shell by drawing having internal enhancement or groovings to facilitate higher heat transfer rate and efficiency.

3.3 Tube Shell — A hollow cylinder produced by extrusion, rotary piercing, or casting for subsequent drawing into tube.

3.4 Bunched — A coil in which the turns are bunched and held together such that cross-section of the bunched turn is approximately circular.

3.5 Eccentricity

$$\text{Eccentricity} = \frac{t\ (Max) - t\ (Min)}{t\ (Average)}$$

where

t is wall thickness of the tube.

3.6 Level or Transverse Wound Coil — A coil in which the turns are wound into layers parallel to the axis of the coil such that successive turns in a given layer are next to one another (also called helical coil).

3.7 Mean Outside Diameter — Half the sum of two diameters measured in the mutually perpendicular directions at any one cross-section of a tube.

3.8 Mean Wall Thickness — In case of smooth/plain copper tubes mean wall thickness is defined as half the sum of two wall thicknesses at points diametrically opposite to each other at any one cross-section of a tube.

3.9 Bottom Wall Thickness — In case of inner groove/fin tubes bottom wall thickness defined as the wall thickness at the root of groove/fin.

3.10 Ovality

$$\text{Ovality} = \frac{D\ (Max) - D\ (Min)}{D\ (Average)}$$

where

D is outside diameter of the tube.

NOTE — Before bending for a bent tube.

3.11 Out of Roundness

Out of roundness = *D (Max) – D (Min)*

3.12 Pipe/Tube — A hollow wrought product of uniform cross-section with only one enclosed void along its whole length and with a uniform wall thickness.

3.13 Single or Double Layer Flat Coil — A coil in which the turns are spirally wound into disk like single or double layer (also known as pancake coil or single/double layer spirally wound coil).

4 SUPPLY OF MATERIAL

General requirements relating to the supply of material shall be as laid down in IS 1387.

5 CHEMICAL COMPOSITION

5.1 The chemical composition shall comply with the requirements as given in Table 1.

5.2 The chemical composition shall be determined either by the method specified in IS 440 or any other established instrumental/chemical method. In case of dispute the procedure specified in IS 440 shall be the referee method.

Table 1 Chemical Composition
(*Clause* 5.1)
(Composition limit are in percent maximum unless shown otherwise)

Sl No.	Grade	Cu + Ag *Min*	Pb	Sn	Fe	Al	Mn	As	Ni	Zn	P	O
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
i)	Cu-OF	99.95	—	—	—	—	—	—	—	—	—	10 ppm
ii)	Cu-DLP	99.90	—	—	—	—	—	—	—	—	0.004 to 0.015	—
iii)	Cu-DHP	99.90	—	—	—	—	—	—	—	—	0.015 to 0.040	—

6 MANUFACTURE

6.1 The tube shall be manufactured from tube shell, billet, bars by drawing.

6.2 The tubes shall be supplied either in soft-annealed, light annealed, light drawn or hard drawn condition.

6.3 The tube shall be cut to size in coil or straight length, duly drafted and sealed at both ends.

6.4 Tubes shall not be manufactured from used tubes.

7 FREEDOM FROM DEFECTS

The tubes shall be clean, smooth, free from cracks, seams, slivers, scales and other harmful defects.

8 MECHANICAL PROPERTIES

8.1 Tensile Test

A piece of tube selected for test, suitably plugged or flattened sufficiently at the ends for gripping or a strip cut from a tube, shall be tested in accordance with IS 1608 (Part 1) and shall conform to the requirements of tensile properties as given in Table2.

Table 2 Tensile Properties
(*Clause* 8.1)

Sl No.	Condition	Tensile Strength MPa		Percentage Elongation on Gauge Length of 50 mm
		Min	*Max*	*Min*
(1)	(2)	(3)	(4)	(5)
i)	Soft annealed	210	—	40
ii)	Light annealed	220	—	40
iii)	Light drawn	245	—	20
iv)	Hard drawn	245	—	—

8.2 Flattening Test

8.2.1 The flattening as per IS 2328 test shall be carried out on test pieces selected from any part of the tubes in soft annealed condition. The light annealed, light drawn and hard drawn tubes shall be soft-annealed before testing.

8.2.2 The test piece shall not crack when close flattened until the interior surfaces of the tube meet as shown in Fig. 1.

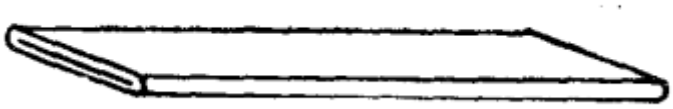

FIG. 1 FLATTENING TEST

8.3 Drift Expanding Test

8.3.1 The drift expanding test shall be carried out as per IS 2335 on tubes in soft annealed condition. The light annealed, light drawn and hard drawn tubes shall be soft annealed before testing**.**

8.3.2 The tube shall be capable of undergoing drifting by means of a taper drift having an included angle of 60^{o} as shown in Fig. 2, without showing either crack or flaw until the outside diameter of the expanded end measures at least 40 percent more than the original diameter of the tube. The test piece shall be examined with eyes having normal vision with or without spectacles.

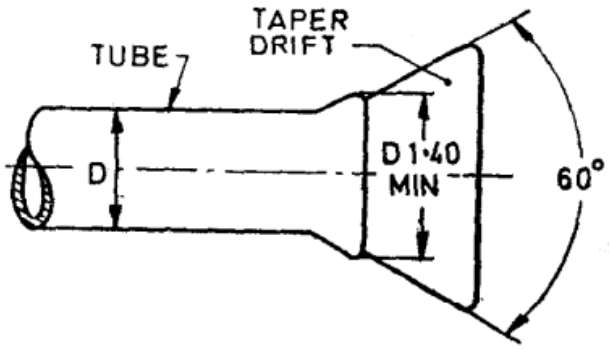

FIG. 2 DRIFT EXPANDING TEST

9 DIMENSIONS AND TOLERANCES

9.1 Dimensions and Tolerance for Smooth Tubes

9.1.1 The tubes shall be designated by the outside diameter and the wall thickness. The outside diameter, wall thickness and length shall be as per the mutual agreement between purchaser and the supplier, however, certain standard sizes along with wall thickness tolerances and outer diameter tolerances of tubes are specified in Table 3 and Table 4 respectively.

Table 3 Dimensions for Smooth Tubes
(*Clause* 9.1.1)

Sl No.	Wall Thickness(mm)	Outside Diameter (mm)						
		0.8 < OD ≤ 3.0	**3.0 < OD ≤ 16**	**16 < OD ≤ 25**	**25 < OD ≤ 50**	**50 < OD ≤ 100**	**100 < OD ≤ 180**	**180 < OD ≤ 250**
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
i)	0.25 < WT ≤ 0.40	± 0.03	± 0.03	± 0.04	± 0.05	—	—	—
ii)	0.40 < WT ≤ 0.60	± 0.05	± 0.05	± 0.05	± 0.06	—	—	—
iii)	0.60 < WT ≤ 0.90	± 0.06	± 0.06	± 0.06	± 0.08	± 0.10	—	—
iv)	0.90 < WT ≤ 1.5	± 0.08	± 0.08	± 0.09	± 0.09	± 0. 10	± 0.20	—
v)	1.5 < WT ≤ 2.0	—	± 0.09	± 0.10	± 0.10	± 0.15	± 0.20	± 0.25
vi)	2.0 < WT ≤ 3.0	—	± 0.10	± 0.10	± 0.10	± 0.20	± 0.20	± 0.25

Table 4 Tolerance for Smooth Tubes
(*Clause* 9.1.1)

Sl No.	Specified Diameter (mm)	Tolerance (mm)
(1)	(2)	(3)
i)	0.8 < OD ≤ 3.0	± 0.05
ii)	3.0 < OD ≤ 16	± 0.05
iii)	16 < OD ≤ 25	± 0.06
iv)	25 < OD ≤ 50	± 0.08
v)	50 < OD ≤ 75	± 0.10
vi)	75 < OD ≤ 100	± 0.12
vii)	100 < OD ≤ 125	± 0.15
viii)	125 < OD ≤ 150	± 0.18
ix)	150 < OD ≤ 200	± 0.20
x)	200 < OD ≤ 250	± 0.25

9.1.2 Tolerance on length of tubes supplied in straight length shall be as given in Table 5.

Table 5 Tolerance on Length of Tubes
(*Clause* 9.1.2)

Sl No.	Length (mm)	Tolerance (mm)
(1)	(2)	(3)
i)	$l \leq 600$	+ 1.6 − 0
ii)	$600 < l \leq 2\,000$	+2.0 − 0
iii)	$2\,000 < l \leq 4\,000$	+5.0 − 0
iv)	$4\,000 < l \leq 7\,000$	+8.0 − 0

Sl No.	Length (mm)	Tolerance (mm)
(1)	(2)	(3)
v)	7 000 < *l*	+10.0 − 0

9.2 Dimensions and Tolerance for Inner Groove Tubes

9.2.1 The Inner groove tubes shall be designated by the outside diameter and the bottom wall thickness, groove/fin height, number of grooves/fins and shape of fin. The outside diameter, bottom wall thickness shall be as per the mutual agreement between purchaser and the supplier, however, certain standard sizes along with wall thickness tolerances and outer diameter tolerances of tubes are specified in Table 6 and Table 7 respectively.

Table 6 Dimensions for Inner Groove Tubes
(*Clause* 9.2.1)

Sl No.	Wall Thickness (mm)	Outside Diameter (mm)		
		0.8 < OD ≤ 3.0	**3.0 < OD ≤ 16**	**16 < OD ≤ 25**
(1)	(2)	(3)	(4)	(5)
i)	0.25 < WT ≤ 0.40	± 0.020	± 0.025	± 0.040
ii)	0.40 < WT ≤ 0.60	± 0.025	± 0.050	± 0.050

Table 7 Tolerance for Inner Groove Tubes
(*Clause* 9.2.1)

Sl No.	Specified Diameter (mm)	Tolerance (mm)
(1)	(2)	(3)
i)	0.8 < OD ≤ 3.0	± 0.040
ii)	3.0 < OD ≤ 16	± 0.050
iii)	16 < OD ≤ 25	± 0.060

9.2.2 Tolerance on length of inner groove tubes supplied in straight length shall be as given in Table 8.

Table 8 Tolerance on Length of Inner Groove Tubes
(*Clause* 9.2.2)

Sl No.	Length (mm)	Tolerance (mm)
(1)	(2)	(3)
i)	*l* ≤ 600	+ 1.6 − 0
ii)	600 < *l* ≤ 2 000	+2.0 − 0
iii)	2 000 < *l* ≤ 4 000	+5.0 − 0
iv)	4 000 < *l* ≤ 7 000	+8.0 − 0
v)	7 000 < *l*	+10.0 − 0

9.2.3 *Tolerance on Groove/Fin Height, Number of Grooves/Fins and Shape of Fin*

The tolerances on groove/fin height, number of grooves/fins and shape of fin shall be as per the mutual agreement between purchaser and the supplier.

9.3 Tolerance on Ovality and Eccentricity

The tolerances on ovality and eccentricity shall be as agreed to between the purchaser and the supplier.

The tolerances on ovality, roundness and eccentricity are applicable for light drawn and hard drawn tubes only. If the tubes are supplied in soft/light annealed conditions, the tolerances should be verified before heat-treatment.

9.4 Roundness Tolerances

The roundness tolerances on the outside diameters of tubes shall be as given below:

t/D	*Tolerance, percent*
Upto 0.03	1.5
Over 0.03 to 0.05	1.1
Over 0.05 to 0.l0	0.8 or 0.5 mm, whichever is more
Over 0.10	0.7 or 0.05 mm, whichever is more

where

t = nominal wall thickness of tube, and
D = nominal outside diameter of tube.

10 NON-DESTRUCTIVE TEST

10.1 Eddy-Current Test

Each tube shall be subjected to the Eddy-current test in accordance with IS 11612. Tubes shall be tested in as drawn condition prior to the final annealing or heat treatment. Tubes that are not of a size suitable for eddy current test (OD > 50 mm) shall be tested by hydrostatic or pneumatic test.

10.1.1 The hole size shall be as agreed to between supplier and purchaser.

10.2 Hydrostatic Test

For tubes supplied in straight length, one sample from each lot shall be subjected to an internal hydrostatic test pressure of 7 MPa or the value given by the following formula, whichever is less, unless otherwise agreed to between the purchaser and the supplier. When subjected to the test for a minimum period of 5 seconds, the tube shall not show any sign of weeping or leaking.

$$P = \frac{Kt}{D}$$

where

P = internal hydrostatic test pressure in MPa,
K = 130,
t = nominal wall thickness of the tube in mm, and

D = nominal outside diameter of the tube in mm.

10.3 Pneumatic Test

For tubes supplied in coils, one sample from each lot shall be subjected to a minimum internal air pressure of 0.45 MPa for a minimum period of 5 seconds without showing any sign of leakage while immersed in water. This test may also be carried on tubes supplied in straight length as an alternative to hydrostatic test.

10.3 Microscopic Examination

Samples in longitudinal direction of tubes selected for the test shall be subjected to microscopic examination in accordance with IS 18829 at a magnification of 75 X and shall show uniform and complete recrystallization with an average grain size as below:

Temper	*Grain Size*
Light annealed	0.015 mm to 0.040 mm
Soft annealed	0.040 mm, *Min*

10.4 Hydrogen Embrittlement Test

This test is only applicable to Cu-OF grade tubes. Test specimen of tubes shall not show any gassing or open grain structure, when examined under a microscope in accordance with IS 6243.

11 RESIDUE TEST OR CLEANLINESS TEST

11.1 The inside of tube with sealed ends shall be sufficiently clean so that when the interior of tube is washed with trichloroethylene, carbon tetrachloride or any other suitable organic solvent, the residue remaining after evaporation of the solvent shall not exceed 0.038 g/m^2 of Each tube shall be tested for hydrostatic/ interior surface.

11.2 To perform the test, a determined quantity of the solvent shall be taken through a tube in to a flask, which is, in turn attached to an aspirator or vacuum pump. The solvent then transferred to a weighed container (crucible, evaporating dish or beaker). The solvent in the container shall be evaporated to dryness on a low temperature hot plate or sand bath. Over heating of the container should be avoided to prevent charring of the residue. The container shall then be dried in an oven at 100 °C to 110 °C for 10 minutes, cooled in a dessicator and weighed. A blank determination shall be run on the same determined quantity of solvent and the gain in weight for the blank shall be subtracted from the weight of the residue sample.

11.3 In performing the test, care shall be exercised to clean the outside surface of the end of the sample to be immersed in the solvent. The sample shall be prepared in such a manner as to prevent the inclusion in the residue of copper chips or dust resulting from the cutting of the sample.

12 SAMPLING AND CRITERIA FOR CONFORMITY

12.1 Unless otherwise agreed to between the purchaser and the supplier, the following procedure of sampling and criteria for conformity should be followed for acceptance of a lot.

12.2 Lot

In any consignment tubes of the same grade, size, thickness and temper shall be grouped together to constitute a lot of 300 tubes or 4 500 kg (whichever is lower) or part thereof.

12.3 Dimensional Tolerances

From each lot, ten tubes shall be selected at random and tested for length, outside diameter and wall thickness. No failure shall occur if the lot is to be accepted under this clause.

12.4 Chemical Composition, Mechanical Properties, Flattening Test and Drift Expanding Test

From the lot found acceptable for dimensions, one test shall be conducted for each of chemical composition, mechanical properties, flattening test and drift expanding test requirements given in the specification. The lot shall be accepted if the samples tested meet all the requirements of these tests.

12.5 Hydrostatic/Pneumatic/Eddy-Current Test

Each tube shall be tested for Eddy-current test as prescribed in **10.1** and one sample from each lot shall be tested for hydrostatic/pneumatic test as prescribed in **10.2** and **10.3** respectively.

12.6 Microscopic Examination/Hydrogen Embrittlement Test/Residue Test

One sample from each lot shall be tested for above tests.

12.7 Retest

12.7.1 *Chemical Composition*

If a test, result of chemical analysis fails to satisfy the requirements for any of the elements, two more tests for that element shall be done on the same sample in order to confirm that the analysis has been done properly. If both the test results satisfy the relevant requirements the lot shall be considered as conforming to the specification; otherwise not.

12.7.2 *Mechanical Properties, Flattening Test and Drift Expanding Test*

If the test results on any sample tested for mechanical test (tensile test), flattening test, drift expanding test, fail to satisfy the requirements for any of these tests given in the specification, two more sample shall be tested for that test. If both the test results satisfy the relevant requirement, the lot shall be considered as conforming to specification; otherwise not.

12.7.3 *Microscopic Examination/Hydrogen Embrittlement Test*

Should any specimen fail under above tests, all the tubes represented by the sample shall stand rejected. However, they may be resubmitted for inspection after stress-relieving treatment.

12.7.4 *Residue Test*

The procedure for retest shall be as agreed to between supplier and purchaser.

13 PACKING

The tubes shall be suitably covered with a polyethylene sheet and packed to avoid movements and rubbing. The tube ends shall be protected by proper inserts to avoid damage during handling and transit. Each package shall be of convenient weight for ease of handling and net and gross weight shall be agreed between manufacturer and purchaser. The bottom of the packing case shall be rigid to enable the tubes to maintain straightness.

14 MARKING

14.1 Boxes/packages containing tubes shall be suitably marked with the following details:

a) Lot number;
b) Grade;
c) Temper;
d) Size (diameter, thickness and length);
e) Number of tubes in the box/package;
f) Date of manufacture; and
g) Name and address of manufacturer.

14.2 BIS Certification Marking

The product(s) conforming to the requirements of this standard may be certified as per the conformity assessment schemes under the provisions of the *Bureau of Indian Standards Act*, 2016 and the Rules and Regulations framed thereunder, and the products may be marked with the Standard Mark.

15 TEST CERTIFICATE

The manufacturer/supplier should provide test certificate for each consignment giving information like lot number, grade, temper, size, thickness and corresponding chemical composition and physical properties.