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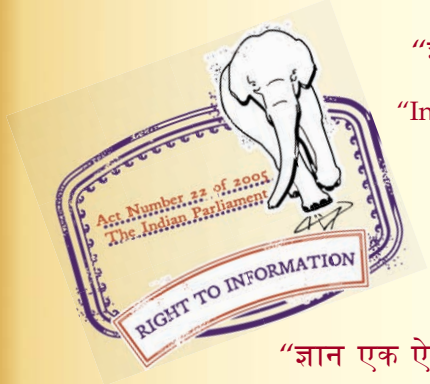
IS 2501 (1995): Solid Drawn Copper Tubes for General Engineering Purposes [MTD 8: Copper and Copper Alloys]



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"Knowledge is such a treasure which cannot be stolen"

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IS 2501 : 1995
(Reaffirmed 2006)

भारतीय मानक

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(तीसरा पुनरीक्षण)

Indian Standard

SOLID DRAWN COPPER TUBES FOR GENERAL ENGINEERING PURPOSES — SPECIFICATION

(Third Revision)

UDC 669·3 — 462

BUREAU OF INDIAN STANDARDS
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

March 1995

Price Group 3

FOREWORD

This Indian Standard (Third Revision) was adopted by the Bureau of Indian Standards, after the draft finalized by the Copper and Copper Alloys Sectional Committee had been approved by the Metallurgical Engineering Division Council.

This standard was first published in 1963 and subsequently revised in 1972 and 1985. In this revision following modifications have been made:

a) Requirements of tensile strength, percentage elongation and K value (for hydrostatic test) for half hard (HB) copper tubes have been included, as the tubes are also delivered in half hard (HB) condition;

b) One more grade Cu-DPA has been incorporated as this grade is being used for copper tubes for general engineering purposes;

c) Requirements of tensile strength, percentage elongation and K value (for hydrostatic test) for 'As drawn (HD)' and 'Annealed (O)' conditions have been modified;

d) Requirements of tolerances on eccentricity, ovality, roundness and straightness have been incorporated;

e) Hydrostatic/pneumatic/eddy current test has been made compulsory;

f) Minimum testing period of 5 seconds for hydrostatic test/pneumatic test has been specified;

g) Microscopic examination test and hydrogen embrittlement test have been included;

h) Requirements of sampling and criteria for conformity and retest have been modified;

j) Requirement of packing has been modified; and

k) Requirement for test certificate has been added.

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 : 1960 'Rules for rounding off numerical values (*revised*)'. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

Indian Standard

SOLID DRAWN COPPER TUBES FOR GENERAL ENGINEERING PURPOSES — SPECIFICATION

(Third Revision)

1 SCOPE

This standard covers the requirements of solid drawn (seamless) copper tubes for general engineering purposes.

2 REFERENCES

The Indian Standards listed in Annex A are necessary adjuncts to this standard.

3 TERMINOLOGY

3.1 For the purpose of this standard the following definitions as giver in IS 3288 (Part 3) : 1986 shall apply.

3.1.1 *Seamless Tube (Solid Drawn Tube)*

Tube produced from a tube shell by drawing.

3.1.2 *Tube Shell*

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

3.2 In addition to above following definitions shall also apply.

3.2.1 *Eccentricity*

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

where, t is wall thickness of the tube.

3.2.2 *Mean Outside Diameter*

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

3.2.3 *Mean Wall Thickness*

Half the sum of two wall thicknesses at points diametrically opposite to each other at any one cross-section of a tube.

3.2.4 *Ovality*

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

where, D is outside diameter of the tube.

NOTE — Before bending for a bent tube.

3.2.5 *Out of Roundness*

Out of roundness = $D\ Max - D\ Min$.

3.2.6 *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.

4 SUPPLY OF MATERIAL

General requirements relating to the supply of material shall be as laid down in IS 1387 : 1993.

5 GRADES

This standard covers seven grades of copper tubes, namely Cu-ETP, Cu-DHP, Cu-FRTP, Cu-DPA, Cu-ATP as specified in relevant parts of IS 191 (Parts 1 to 10) : 1980.

6 CONDITION

The tubes shall be supplied in one of the following conditions:

a) **As Drawn (HD)** — Tubes in full hard condition produced by cold drawing.

b) **Half Hard (HB)** — Tubes in half hard condition produced by cold drawing.

c) **Annealed (O).**

7 FREEDOM FROM DEFECTS

The tubes shall be reasonably clean, smooth and free from cracks, seams, slivers, scales and other defects detrimental to the intended applications.

8 DIMENSIONS AND TOLERANCES

8.1 Dimensions

The tubes shall be designated by the outside diameter and the wall thickness. The outside diameter, wall thickness and length shall be as ordered by purchaser from the rationalized sizes of tubes as specified in IS 5493 : 1981.

8.2 Tolerances

8.2.1 The relevant tolerances on mean outside diameter, wall thickness, straightness, length and roundness as specified in IS 5493 : 1981 shall be applicable for respective sizes.

8.2.2 The tolerances on ovality and eccentricity shall be as agreed to between the purchaser and the supplier. However no tolerance on ovality shall be specified for tubes of wall thickness up to and including 0·4 mm.

8.2.3 The tolerances on ovality, roundness and eccentricity are applicable HB and HD tempers only. If the tubes are supplied in O condition the tolerances should be verified before heat-treatment.

9 CHEMICAL COMPOSITION

9.1 The chemical composition shall comply with the requirement of relevant grade of copper as specified in IS 191 (Parts 1 to 10) : 1980.

9.2 The chemical composition shall be determined either by the method specified in IS 440 : 1964 or any other established instrumental/chemical method. In case of dispute, the procedure specified in IS 440 : 1964 shall be referee method.

10 PHYSICAL PROPERTIES

10.1 Mechanical Properties

10.1.1 *Tensile Test*

A piece of tube selected for test, suitably plugged or flattened sufficiently for gripping or a strip cut from a tube, when tested in accordance with IS 2655 : 1964 shall conform to the requirements as given in Table 1.

Table 1 Tensile Strength and Constant for Hydrostatic Test (K)

(*Clause* 10.1.1 *and* 10.4.2)

Condition	Tensile Strength, MPa	Percentage Elongation on Gauge Length $5{\cdot}65\sqrt{So}$	K
	Min	*Min*	
(1)	(2)	(3)	(4)
As Drawn (HD)			113
i) As such	280	—	
ii) Strip cut from tube	250	—	
Half Hard (HB)			99
i) As such	235	25	
ii) Strip cut from tube	225	25	
Annealed (O)			85
i) As such	205	40	
ii) Strip cut from tube	195	45	

10.2 Flattening and Doubling-Over Test

10.2.1 *For Tubes not Exceeding 100 mm in Outside Diameter or 3 mm in Wall Thickness*

10.2.1.1 The tubes shall be annealed before testing if supplied in HD or HB condition.

10.2.1.2 A piece of tube shall be flattened down until the interior surfaces of the tube meet as shown in Fig. 1 and then doubled over on itself, that is bent through 180°, the bend being at right angles to the axis of the tube as shown in Fig. 2.

10.2.2 *For Tubes Over 100 mm in Outside Diameter or Exceeding 3 mm in Wall Thickness or Both*

10.2.2.1 A strip of 25 mm cut from the tubes longitudinally parallel to the axis, shall be capable of undergoing test both when cold and and red-hot without showing either crack or flaw on the outside of either bend.

10.2.2.2 The test piece after flattening, shall be bent through an angle of 180° in opposite directions as shown in Fig. 3 and double-up close. The edges of the test piece shall be carefully rounded and smoothed longitudinally.

10.3 Drift Expanding Test

10.3.1 The drift expanding test shall be carried out as per IS 2335 : 1985 for tubes not exceeding 100 mm in outside diameter and less than 3 mm in wall thickness. The test pieces of HB and HD tempers shall be annealed before testing and shall comply with the requirements specified in **10.3.2** without further annealing.

10.3.2 The tube shall be capable of undergoing drifting by means of a taper drift having an included angle of 45° as shown in Fig. 4, without showing either crack or flaw until the outside diameter of the expanded end measures at least 25 percent more than the original diameter of the tube.

10.4 Non-Destructive Testing

10.4.0 All tubes shall meet the requirements eddy-current or hydrostatic/pneumatic test as desired by the purchaser.

10.4.1 *Eddy-Current Test*

10.4.1.1 Each tube shall be subjected to the eddy-current test in accordance with IS 11612 : 1984. Tubes shall be tested in HD condition prior to the final annealing, unless otherwise agreed upon by the supplier and the purchaser.

10.4.1.2 The hole size shall be as agreed in between the supplier and the purchaser.

FIG. 1 FLATTENING TEST

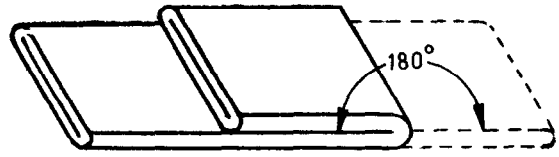

FIG. 2 DOUBLING-OVER TEST

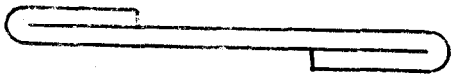

FIG. 3 DOUBLE BEND TEST

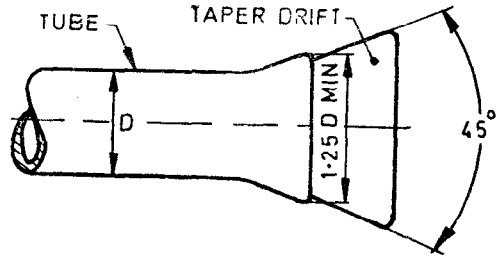

FIG. 4 DRIFT EXPANDING TEST

10.4.1.3 The tubes which do not actuate the signalling device of the eddy-current tester shall be considered as conforming to the requirements of this test. Tubes with discontinuities indicated by the testing unit may, at the option of the manufacturer, be re-examined or retested to determine whether the discontinuity should be the cause for rejection. Signals that are found to have been caused by minor mechanical damage, soil or moisture shall not be the cause for rejection provided dimensions are still within the prescribed limits and the tube is suitable for the intended application.

10.4.2 *Hydrostatic Test*

Each tube 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 = a constant as specified in Table 1,

t = nominal wall thickness of the tube in mm, and

D = nominal outside diameter of the tube in mm.

10.4.3 *Pneumatic Test*

Each tube shall be tested to a minimum internal air pressure of 40 N/cm² for a minimum period of 5 seconds without showing any sign of leakage while immersed in water.

10.5 Microscopic Examination (for O Condition Only)

10.5.1 Samples in longitudinal direction of tubes selected for the test shall be subjected to microscopic examination in accordance with IS 4748 : 1988 at a magnification of 75 × and shall show uniform and complete recrystallization with an average grain size of 0 025 to 0·050 mm. Maximum grain size shall not exceed 0·050 mm.

10.5.2 Examination of unetched specimen shall show reasonable freedom from dirt, slag or foreign matter.

10.6 Hydrogen Embrittlement Test (for Cu-DHP and Cu-DPA Grades)

Test specimen of tubes shall be capable of meeting the requirements of hydrogen embrittlement test as per IS 6243 : 1985.

11 SAMPLING AND CRITERIA FOR CONFORMITY

11.0 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.

11.1 Lot

In any consignment tubes of the same grade, size, thickness and condition shall be grouped together to constitute a lot of 300 tubes or 1 000 kg (whichever is higher) or part thereof.

11.2 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.

11.3 Chemical Composition and Mechanical Properties

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

11.4 Hydrostatic/Pneumatic/Eddy-Current Test

Each tube shall be tested for hydrostatic/pneumatic/eddy-current test as prescribed in **10.4.**

11.5 Microscopic Examination/Hydrogen Embrittlement Test

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

11.6 Retest

11.6.1 *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.

11.6.2 *Mechanical Properties*

If the test result on any sample for mechanical test (tensile test, drift expanding test, flattening test) fails to satisfy the requirement for any of the mechanical properties two more samples shall be retested for that test only. If both the test results satisfy the relevant requirements, the lot shall be considered as conforming to specification; otherwise not.

11.6.3 *Microscopic Examinatian/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 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 shall not exceed 1 000 kg (gross). The bottom of the packing case shall be rigid to enable the tubes to maintain straightness.

13 MARKING

13.1 Boxes containing tubes shall be suitably marked with the following details:

a) Lot number,
b) Grade,
c) Condition,
d) Size and thickness, and
e) Indication of the source of manufacture.

13.2 Standard Marking

13.2.1 The material may also be marked with the Standard Mark.

The use of the Standard Mark is governed by the provisions of the Bureau of Indian Standards Act, 1986 and the Rules and Regulations made thereunder. The details of conditions under which the licence for the use of Standard Mark may be granted to manufacturers or producers may be obtained from the Bureau of Indian Standards.

14 TEST CERTIFICATE

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

ANNEX A

(*Clause* 2)

LIST OF REFERRED INDIAN STANDARDS

IS No.	*Title*	*IS No.*	*Title*
191 (Parts 1 to 10) : 1980	Copper (*third revision*)	4748 : 1988	Method for estimating average grain size of metals (*first revision*)
440 : 1964	Methods of chemical analysis of copper (*revised*)	5493 : 1981	Dimensions of wrought copper and copper alloy tubes (*first revision*)
1387 : 1993	General requirements for the supply of metallurgical materials (*second revision*)	6243 : 1985	Method of hydrogen embrittlement test of copper (*first revision*)
2335 : 1985	Method for drift expanding test for metallic tubes (*first revision*)	11612 : 1984	Code of practice for eddy-current testing of non-ferrous seamless pipes and tubes (*first revision*)
2655 : 1964	Method for tensile testing of copper and copper alloy tubes		
3288 (Part 3) : 1986	Glossary of terms relating to copper and copper alloys: Part 3 Wrought forms		

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Amendments Issued Since Publication

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