भारतीय मानक ब्यूरो

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भारतीय मानक मसौदा

कंडेनसर और हीट एक्सचेंजर्स के लिए तांबे और तांबे मिश्र धातु रोल्ड प्लेटों के लिए विशिष्टि

(*आईएस 8362 का पहला पुनरीक्षण*)

Draft Indian Standard

SPECIFICATION FOR COPPER AND COPPER ALLOY ROLLED PLATES FOR CONDENSERS AND HEAT EXCHANGERS

(*First Revision of IS 8362*)

ICS 77.120.30

Ores and Feed Stock for Copper Industry, its Metals/ Alloys and Products Sectional Committee, MTD 8	Last date of comment: 09/08/2023

FOREWORD

(*Formal clauses will be added later*)

This standard was originally published in 1977. This revision has been brought out to bring the standard in the latest style and format of the Indian Standards. In addition to this, references clause has been added and marking clause has been updated.

This standard has been prepared in order to make use of most suitable materials and latest production and inspection techniques in the manufacture of rolled copper and copper alloy plates for the condenser and heat exchanger equipment.

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*

SPECIFICATION FOR COPPER AND COPPER ALLOY ROLLED PLATES FOR CONDENSERS AND HEAT EXCHANGERS

(*First Revision*)

1 SCOPE

This standard specifies the requirements for rolled copper and copper alloy plates for condensers and heat exchangers.

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 editions of the standards indicated below:

IS No.	*Title*
IS 440 : 1964	Methods of chemical analysis of copper (*revised*)
IS 1387 : 1993	General requirements for the supply of metallurgical materials (*second revision*)
IS 1817 : 1961	Methods of sampling non-ferrous metals for chemical analysis
IS 1608 (Part 1) : 2022/ ISO 6892-1 : 2019	Metallic materials — Tensile testing Part 1 Method of test at room temperature (*fifth revision*)
IS 3187 : 1965	Methods of chemical analysis of copper-nickel-zinc alloys
IS 3288 (Part 1) : 1986	Glossary of terms relating to copper and copper alloys Part 1 materials (*third revision*)
IS 3685 : 1966	Methods of chemical analysis of brasses
IS 4027 (All Parts)	Methods of chemical analysis of bronzes

3 TERMINOLOGY

3.1 For the purpose of this standard, the following definition as given in IS 3288 (Part 1) shall apply.

3.2 Plate

Flat product, of exact length, over 10 mm thick and over 300 mm in width.

4 SUPPLY OF MATERIAL

General requirements relating to the supply of material shall conform to IS 1387.

5 CHEMICAL COMPOSITION AND MECHANICAL PROPERTIES

The chemical composition and mechanical properties of various rolled copper and copper alloy plates are given in Tables 1 and 2, respectively.

6 FREEDOM FROM DEFECTS

The plate shall be clean, smooth, sound and free from harmful defects.

7 CONDITION

The material shall be supplied in one of the following conditions as specified by the purchaser:

Annealed — O, and

As manufactured — M.

8 DIMENSIONS AND TOLERANCES

8.1 Width, Length or Diameter

The width, length or diameter shall be not less than that specified by the purchaser. The tolerances on width, length or diameter shall be as specified in Table 3.

8.2 Thickness

The thickness at any point shall not vary from the specified dimensions by more than the appropriate tolerance specified in Table 4.

8.3 Mass

Tolerance on mass shall be as given in Table 5.

8.3.1 For the purpose of calculating the specified mass, the following density of the alloys shall be taken:

Alloy No. (*Ref* Table 1)	Density kg/m^3
1, 2, 3, 10, 11 and 12	8938
4, 5 and 9	8426
6	8346
8	7657
7	7753
13	8586

Table 1 Chemical Composition of Rolled Copper and Copper Alloy
(Values given are the *maximum* unless shown otherwise)
(*Clause* 5.1)

ALLOY No.	ALLOY	PERCENT																		Remarks
		Cu	Sn	P	Zn	Ni	Fe	As	Mn	S	Pb	C	Sb	Al	Si	Mg	Bi	Oxygen	Total Impurities	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)
1.	Tough pitch arsenical copper	99.20 *Min*	—	—	—	—	0.02	0.20-0.50	—	—	0.02	—	0.01	—	—	—	0.005	0.10	—	IS 191 ATP Se + Te = 0.030 *Max*
2.	Phosphorised deoxidised arsenical copper	99.20 *Min*	0.01	0.02-0.10	—	—	0.03	0.20-0.50	—	—	0.01	—	0.01	—	—	—	0.003	—	0.07	IS 191 DPA Se + Te = 0.030 *Max*
3.	Phosphorised deoxidised non-arsenical copper	99.80 *Min*	0.01	0.02-0.10	—	—	0.03	0.05	—	—	0.01	—	0.005	—	—	—	0.003	—	0.06	IS 191 DHP-1 Se + Te = 0.030 Max
4.	Naval Brass (A)	61.0-64.0	1.0-1.5	—	Remainder	—	—	—	—	—	—	—	—	—	—	—	—	—	0.75	
5.	Naval Brass (B)	59.0-62.0	0.50-1.0	—	Remainder	—	0.10	—	—	—	0.20	—	—	—	—	—	—	—	0.50	
6.	Aluminium brass	76.0-79.0	—	—	Remainder	—	0.06	0.02-0.10	—	—	0.07	—	—	1.8-2.5	—	—	—	—	0.30	
7.	7 percent aluminium bronze	Remainder	—	—	—	—	1.5-3.5	—	1.0	—	—	—	—	6.0-8.0	—	—	—	—	0.50	Cu + Fe + Ni + Mn + Al = 99.5 *Min*
8.	10 percent aluminium bronze	Remainder	—	—	0.5	4.0-7.0	1.5-3.5	—	0.5-2.0	—	0.05	—	—	8.5-10.5	0.25	0.05	—	—	0.50	Cu + Zn + Ni + Fe + Mn + Al = 99.5 *Min*
9.	Leaded muntz metal	58.0-61.0	0.25	—	Remainder	—	0.15	—	—	—	0.4-1.0	—	—	—	—	—	—	—	0.50	
10.	90/10 copper-nickel-iron	86.5 *Min*	—	—	1.0	9.0-11.0	1.0-2.0	—	0.30-0.8	0.03	0.05	—	—	—	—	—	—	—	0.30	Cu + Ni + Fe + Zn + Mn = 99.5 *Min*
11.	95/5 copper-nickel-iron	91.20 *Min*	—	—	1.0	4.8-6.2	1.3-1.7	—	0.30-0.80	—	0.05	—	—	—	—	—	—	—	0.30	Cu + sum of the elements mentioned = 99.5 *Min*
12.	70/30 copper-nickel-iron	65.0 *Min*	—	0.02	1.0	29.0-33.0	0.40-0.70	—	0.40-1.0	0.02	0.05	—	—	—	—	—	—	—	0.30	Cu + sum of the elements mentioned = 99.5 *Min*
13.	Copper-silicon	94.80 *Min*	—	—	1.5	—	0.8	—	0.5-1.5	—	0.05	—	—	—	2.8-3.8	—	—	—	0.50	Cu + sum of the elements mentioned = 99.5 *Min*

NOTE 1 — In the above alloys where nickel is not an intentional alloying element, a maximum of 0.7 percent be considered as copper.
NOTE 2 —Silver, if incidentally present, should be considered as copper.
NOTE 3 —Sometimes, in some alloys the purchaser wants deliberate addition of either P, As or Sb to a certain extent. In such cases, these additions in the limits should not be considered as impurities.

NOTE 4 —By agreement between the purchaser and the manufacturer, the Bi content in copper may be increased beyond this limit. If, however, should these alloys be required to undergo severe fabrication in the temperature ranges from 400°C to 700°C, this fact shall be indicated by the purchaser and in such cases, it is desired that Bi content should be 0.0015 percent (*Max*).

Table 2 Mechanical Properties of Rolled Copper and Copper Alloy Plates

(*Clause* 5.1)

ALLOY NO.	ALLOY	CONDITION	THICKNESS		TENSILE STRENGTH *Min*	ELONGATION ON GAUGE LENGTH $5.65\sqrt{A}$, PERCENT *Min*
			Over	Up to and Including		
			mm	mm		
(1)	(2)	(3)	(4)	(5)	(6) N/mm^2 (kgf/mm^2)	(7)
1.	Tough pitch arsenical copper	M or O	10	—	220 (22.5)	30
2.	Phosphorised deoxidised arsenical copper	M or O	10	—	210 (21.5)	30
3.	Phosphorised deoxidised non-arsenical copper	M or O	10	—	210 (21.5)	30
4.	Naval brass (A)	M	10	25	360 (36.5)	18
			25	125	340 (34.5)	18
			125	—	310 (31.5)	18
5.	Naval brass (R)	M	10	20	315 (32.0)	20
			20	—	305 (31.0)	20
6.	Aluminium brass	M	10	—	280 (28.5)	36
7.	7 percent aluminium bronze	M	10	50	480 (49.0)	30
			50	—	450 (46.0)	30
8.	10 percent aluminium bronze	M	10	90	590 (60.0)	8
			90	—	550 (56.0)	8
9.	Leaded muntz metal	M	10	20	345 (35.0)	16
			20	50	315 (32.0)	16
			50	—	275 (28.0)	16
10.	90/10 copper-nickel-iron	M	10	65	275 (28.0)	25
11.	95/5 copper-nickel-iron	M	10	—	230 (23.5)	27
12.	70/30 copper-nickel-iron	M	10	—	310 (31.5)	27
13.	Copper-silicon	M	10	—	340 (34.5)	31

Table 3 Tolerances on Width, Length and Diameter

(*Clause* 8.1)

WIDTH, LENGTH OR DIAMETER, mm		PERMISSIBLE TOLERANCE ON WIDTH, LENGTH OR DIAMETER, mm
Over	Up to and Including	
—	1500	±1.5
1500	2500	±2.5
2500	3500	±3.0
3500	5000	±3.5
5000	—	±4.0

Table 4 Thickness Tolerances

(*Clause* 8.2)

THICKNESS IN mm		THICKNESS TOLERANCE, PLUS AND MINUS BOR DIAMETERS OR WIDTHS				
Over	Up to and Including	Up to 1500 mm	Up to 1500 mm Up to and Including 2500 mm	Up to 2500 mm Up to and Including 3500 mm	Up to 3500 mm Up to and Including 5000 mm	Over 5000 mm
(1)	(2)	(3)	(4)	(5)	(6)	(7)
10	15	0.60	0.70	0.80	0.90	1.00
15	20	0.70	0.80	0.90	1.00	1.10
20	25	0.80	0.90	1.00	1.10	1.20
25	40	0.90	1.00	1.10	1.20	1.30
40	60	1.20	1.30	1.50	1.70	1.90
60	—	1.50	1.70	1.90	2.20	2.50

NOTE — When tolerances are specified as all plus or all minus, double the values given here shall apply.

Table 5 Tolerance on Mass

(*Clause* 8.3)

SPECIFIED WIDTH OR DIAMETER, mm		TOLERANCES ON CALCULATED SPECIFIED MASS, PERCENT
Over	Up to and	

	Including	
—	2500	±7.5
2500	—	±10.0

8.4 Flatness (Depth of Arc)

The deviation from flatness of the plate shall not exceed the values given in Table 6, when measured by placing the plate on a flat-surface table with the sidemarked 'Flat side' up, applying a 2-m straight edge when the size permits or a shorter one equal to the dimensions to be inspected, and measuring the depth of arc between the straight edge and the plate.

Table 6 Tolerance on Flatness

ALLOY No. (Ref Table)	FLATNESS TOLERANCE (DEPTH OF ARC) IN mm FOR DIAMETER, LENGTHS OR WIDTHS		
	Up to 1500	Over 1500 up to and Including 2500	Over 2500 up to and Including 6000
1, 2, 3, 4, 6, 9, 11, & 13	1.3	1.4	1.5
7, 8, 10, & 12	1.5	2.0	2.5

9 SELECTION OF TEST SAMPLES

9.1 Mechanical Tests

Test samples may be taken from the scrap margins of the plates. By special arrangement, separately prepared test samples may be used provided they are taken from the same cast of metal, and treated throughout in a similar manner to the plate they represent. The number of samples to be taken in respect of each order shall be subject to agreement between the supplier and the purchaser.

9.1.1 The test samples shall not be annealed or mechanically worked (except that they may be machined to the shape of the test piece) before being tested.

9.2 Gassing or Hydrogen Embrittlement Test

When this test is required, the selection of test samples and the number of tests to be made shall be agreed to between the supplier and the purchaser.

9.3 Samples for Chemical Analysis

Samples for chemical analysis shall be taken in accordance with IS 1817 for determination of chemical composition. The lot size, portion size and selection of pieces shall be as given in **9.4** and **9.5**.

9.4 Lot Size

9.4.1 *Thickness of Plates 42 mm or under* — A lot shall consist of not more than 2500 kg or the mass of a single plate in excess of this amount.

9.4.2 *Plates Over 40 mm in Thickness* **—** A lot size shall consist of not more than 5000 kg or the mass of a single plate in excess of this amount.

9.5 Portion Size

9.5.1 Pieces from four individual lengths of finished product shall be taken. If the lot consists of less than the number of lengths indicated in the portion size, a piece shall be taken from each individual length.

9.5.2 Minimum mass of composite sample of 150 g shall be divided into three equal parts.

10 TESTS (INCLUDING PREPARATION OF TEST PIECES)

10.1 The following tests shall be made on test pieces prepared from test samples, selected as specified in **9**.

10.2 Tensile Test for Thickness up to and Including 15 mm

The tensile test shall be made on a test piece of full thickness of the plate provided that this does not exceed the width, and machined to conform to the dimensions as given in Table 7 (*see* Appendix A) (*see* 1608 (Part 1) for details on tensile test).

10.3 For Material Over 15 mm Thick

A machined test piece conforming to the dimensions of the standard proportional round test piece as specified in Table 8 (*see* Appendix A) (*see* IS 1608 (Part 1) for details on tensile test).

10.4 Chemical Analysis

The chemical composition of the material shall be determined in accordance with IS 440, IS 3187, IS 3685 or IS 4027(relevant parts).

10.5 Gassing and Hydrogen Embrittlement Test (for Alloys No. 2 and 3)

10.5.1 The gassing and hydrogen embrittlement test shall be carried out as given in **10.5.2.**

10.5.2 The edges of the test pieces shall be carefully rounded and smoothened longitudinally. After being exposed to an atmosphere of hydrogen for 30 minutes at 800°C to 875°C and subsequently cooled, the test pieces shall be subjected to a close bend test as described in **10.5.3** and **10.5.4.**

10.5.3 The test piece *AB* is bent by steadily applied pressure, or a succession of blows, at right angles to the length *AC* and flattened close until *A* assumes the position indicated by *D* (*see* Fig. 1).

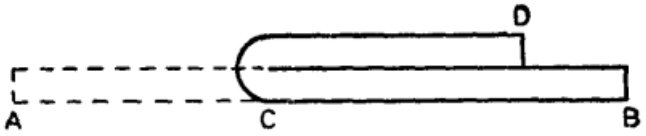

FIG. 1 CLOSE BEND TEST

10.5.4 The convex surface of the bent portion shall not reveal any cracks, openings or porosity.

10.6 For the purpose of this test, one piece of plate shall be selected from each hundred pieces, or part thereof in the consignment or order, and the test pieces taken from the pieces so selected.

11 RETESTS

11.1 Should any one of the test pieces first selected by the purchaser or his representative fail to pass any of the prescribed tests, two further samples from the same batch shall be selected for testing, one of which shall be taken from the plate from which the original test sample was taken.

11.2 Should the test pieces from both these additional samples pass, the batch represented by the test samples shall be deemed to comply with this standard. Should the test pieces from either of these additional samples fail, the batch represented by the test samples shall be deemed not to comply with this standard.

NOTE — Due to one or other reason, if the manufacturer and the purchaser find any necessity of deleting or modifying some tests, test values and/or tolerances, it may be done so by mutual agreement.

12 MARKING

12.1 The material shall be identified by such marking as shall ensure full identification of the material.

12.2 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**.**

APPENDIX A

(*Clauses* 10.1 *and* 10.2)

DIMENSIONS OF TENSILE TEST PIECES

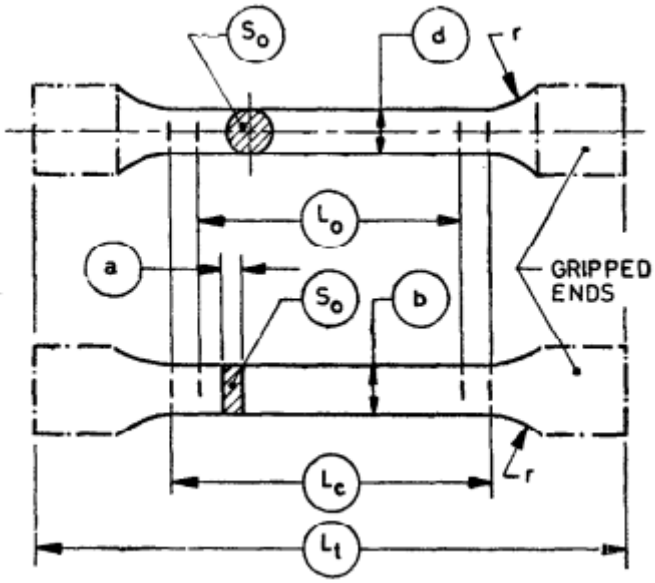

FIG. 2 TEST PIECE OF CIRCULAR AND RECTANGULAR CROSS SECTION

Table 7 Dimensions of Rectangular Cross Section

(*Clause* 10.1)

WIDTH *Max*	GAUGE LENGTH	PARALLEL LENGTH *Min*	RADIUS OF SHOULDER *Min*	TOTAL LENGTH (APPROX)
b	L_o	L_e	*r*	L_t
mm	mm	mm	mm	mm
40	200	225	25	450

Table 8 Dimensions of Circular Cross Section

(*Clause* 10.2)

CROSS SECTIONAL AREA	DIAMETER	GAUGE LENGTH	MINIMUM PARALLEL LENGTH	MINIMUM RADIUS AT SHOULDER
S_o	*d*	L_o	L_e	*r*
mm^2	mm	mm	mm	mm
150	14	70	76	13