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Seamless wrought copper and copper alloy tube —

Part 2 :

Technical conditions of delivery for condenser and
heat-exchanger tubes

Tubes sans soudure en cuivre et en alliages de cuivre corroyés —

*Partie 2 : Conditions techniques de livraison des tubes pour condenseurs et échangeurs
thermiques*

Reference number
ISO 1635-2 : 1987 (E)

Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work.

Draft International Standards adopted by the technical committees are circulated to the member bodies for approval before their acceptance as International Standards by the ISO Council. They are approved in accordance with ISO procedures requiring at least 75 % approval by the member bodies voting.

International Standard ISO 1635-2 was prepared by Technical Committee ISO/TC 26, *Copper and copper alloys*.

Users should note that all International Standards undergo revision from time to time and that any reference made herein to any other International Standard implies its latest edition, unless otherwise stated.

Seamless wrought copper and copper alloy tube —

Part 2 :

Technical conditions of delivery for condenser and heat-exchanger tubes

1 Scope and field of application

This part of ISO 1635 specifies the technical conditions of delivery of seamless wrought copper and copper alloy tube for condenser and heat-exchanger applications, currently available in commercial quantities.

For the purpose of this part of ISO 1635, the definitions for copper and copper alloys in ISO 197-1 and for tube in ISO 197-3 as well as the principles for designation in ISO 1190-1 and ISO 1190-2 apply.

For technical conditions of delivery for seamless tubes

- for water, gas and sanitation, see ISO 1635-1;¹⁾
- for general purposes, see ISO 1635-3.²⁾

2 References

2.1 Definitions

ISO 197, *Copper and copper alloys — Terms and definitions*

- *Part 1 : Materials.*
- *Part 3 : Wrought products.*

2.2 Designations

ISO 1190, *Copper and copper alloys — Code of designation*

- *Part 1 : Designation of materials.*
- *Part 2 : Designation of tempers.*

2.3 Chemical composition

ISO 426, *Wrought copper-zinc alloys — Chemical composition and forms of wrought products*

- *Part 1 : Non-leaded and special copper-zinc alloys.*
- *Part 2 : Leaded copper-zinc alloys.*

ISO 429, *Wrought copper-nickel alloys — Chemical composition and forms of wrought products.*

ISO 1337, *Wrought coppers (having minimum copper content of 99,85 %) — Chemical composition and forms of wrought products.*

2.4 Technical conditions of delivery

ISO 1635, *Seamless wrought copper and copper alloy tubes*

- *Part 1 : Technical conditions of delivery for tubes for water, gas and sanitation.³⁾*
- *Part 3 : Technical conditions of delivery for tubes for general purposes.³⁾*

2.5 Methods of test

2.5.1 Sampling

ISO 4739, *Wrought copper and copper alloy products — Selection and preparation of specimens and test pieces for mechanical testing.*

2.5.2 Tensile testing

ISO 6892, *Metallic materials — Tensile testing.*

2.5.3 Hardness testing

ISO 6507, *Metallic materials — Hardness tests — Vickers test*

- *Part 1 : HV 5 to HV 100.*

ISO 6508, *Metallic materials — Hardness test — Rockwell test (scales A — B — C — D — E — F — G — H — K).*

2.5.4 Technological testing

ISO 196, *Wrought copper and copper alloys — Detection of residual stresses — Mercury(I) nitrate test.*

1) At present at the stage of draft. (Revision of ISO 274 : 1975.)

2) At present at the stage of draft. (Revision of ISO 1635 : 1974.)

3) At present at the stage of draft.

ISO 2624, *Copper and copper alloys — Estimation of average grain size.*

ISO 8493, *Metallic materials — Tube — Drift expanding test.*¹⁾

ISO 6957, *Copper and copper alloys — Ammonia test for stress corrosion resistance.*¹⁾

3 Ordering information

The purchaser shall state on his inquiry and order the following information :

- a) quantity;
- b) designation of the material and temper required (see tables 1 and 2);
- c) the mandatory properties : hardness and expansion or mechanical properties (see table 2 and 4.2);
- d) in case of hardness, whether Vickers or Rockwell hardness is mandatory;
- e) whether the tubes are required to be suitable for welding (see table 1);
- f) dimensions, i.e.
 - outside diameter (see table 3) (if all minus tolerance is required, this shall be stated),
 - wall thickness (either average or minimum) (see 4.3.2),
 - length (see table 4);
- g) whether it is the purchaser's intention to inspect the tubes at the supplier's works;
- h) the tests to be carried out, including those to be agreed upon, for example technological tests (see clause 6);
- i) whether a certificate of compliance is required.

4 Requirements

4.1 Chemical composition

The chemical composition shall comply with the requirements as specified in ISO Standards referred to in table 1.

Table 1 — Chemical composition

Material designation	Chemical composition in accordance with
Cu-DHP	ISO 1337
CuZn20Al2 CuZn28Sn1 CuZn30As	ISO 426-1
CuNi10Fe1Mn ¹⁾ CuNi30Mn1Fe ¹⁾ CuNi30Fe2Mn2 ¹⁾	ISO 429

1) If the tube is for subsequent welding applications and so specified by the purchaser, the restrictions for P, S and C apply as indicated in ISO 429.

4.2 Mandatory properties

4.2.1 This part of ISO 1635 embodies the principle that either

- hardness and drift expanding or
- mechanical properties

are generally sufficient to define the condition of the material. Exact conversion between tensile strength and hardness is not possible.

At the option of the purchaser, mandatory properties of the tube may be either

- hardness and drift expanding or
- mechanical properties,

but not both.

In case of hardness, it shall be indicated whether the Vickers or the Rockwell hardness test method is mandatory.

In case of drift expanding, all tubes selected for test shall withstand a minimum expansion of outside diameter without exhibiting cracks visible to the unaided eye.

If mandatory properties are not specified by the purchaser, the supplier may choose to meet either

- hardness and drift expanding or
- mechanical properties.

Mechanical properties are specified in table 2.

4.2.2 All heat-treated copper-alloy tube selected for test shall have an average grain size of 0,01 to 0,05 mm.

4.2.3 Subject to agreement between the purchaser and the supplier, copper-zinc alloy tube may be supplied in the stress-relieved condition and be subject to the stress corrosion test. Test pieces subjected to this test shall not crack.

Should a lot of material fail the test, the supplier shall have the option to restress relieve the lot and to resubmit it to all the relevant tests.

4.3 Dimensions and tolerances

4.3.1 Diameter

At no point shall the outside diameter of the tube (including circularity) exceed the tolerances specified in table 3.

4.3.2 Wall thickness

Unless otherwise specified, average wall thickness shall be supplied.

1) At present at the stage of draft.

4.3.2.1 Average wall thickness

The average wall thickness shall not vary from the specified thickness by more than $\pm 10\%$ (including concentricity) when measured at any point at the ends (see table 3).

4.3.2.2 Minimum wall thickness

If a minimum wall thickness is specified, the wall thickness at any point shall not be less than the specified thickness. The maximum deviation from the specified wall shall not exceed twice the plus tolerance stated in table 3.

4.3.3 Length

Tubes ordered to be a specified length shall not vary from that length by more than the tolerances specified in table 4, when measured at ambient temperature.

4.3.4 Straightness

The tubes shall be such straight as to easily slip them into tube plate.

5 Surface quality

The tubes shall be clean, smooth, and free from harmful defects and deleterious films in the bore. Heat-treated tubes may have a superficial, dull, iridescent oxide film on both the inside and outside surfaces. Drawn temper tubes may have a superficial film of drawing lubricant on the surfaces.

6 Methods of test**6.1 Sampling**

Sampling shall be carried out in accordance with the procedures in ISO 4739.

The lot size for sampling shall be 600 tubes or 2 000 kg, whichever is greater. If not otherwise specified, the rate of sampling for condenser shall be two individual tubes per lot for each of the tests referred to in 6.2 to 6.6, as appropriate.

6.2 Hardness test**6.2.1 Vickers hardness**

The test shall be made in accordance with ISO 6507-1.

6.2.2 Rockwell hardness

The test shall be made in accordance with ISO 6508.

6.3 Estimation of average grain size

The estimation shall be made in accordance with ISO 2624.

6.4 Draft expanding test

The test shall be made in accordance with ISO 8493.

6.5 Tensile test

The test shall be made in accordance with ISO 6892.

6.6 Stress corrosion test

If required, the test is only carried out on copper-zinc alloys as listed in table 2.

The method shall be the mercury(II) nitrate test according to ISO 196. By agreement between supplier and purchaser, an ammonia test according to ISO 6957 may be specified instead of the mercury(II) nitrate test.

6.7 Non-destructive tests

Each tube shall be subjected to an eddy current test. The test shall be performed on the tubes either in the final drawn or annealed temper. The method of test and levels of calibration shall be agreed between supplier and purchaser until such time as an International Standard covering this test is published. By agreement between purchaser and supplier, a hydrostatic or pneumatic test may be specified as an alternative to the eddy current test.

6.8 Retests

6.8.1 If both test pieces which were originally taken from a lot fail to meet the specification for any reason, the lot shall be deemed not to comply with this part of ISO 1635.

6.8.2 If one of the two test pieces taken originally from the lot fails to meet the specification for any reason, two further test pieces shall be taken. One of these two test pieces shall be taken from the plate, sheet or strip from which the failed test piece was originally taken, unless that plate, sheet or strip has been withdrawn from the lot by the supplier. The other test piece shall be taken from another sample from the same lot. All appropriate tests shall be carried out.

6.8.3 Should both new test pieces pass the tests, the lot represented by the test pieces shall be deemed to comply with this part of ISO 1635. Should either of the additional test pieces fail, then the lot represented by the test pieces shall be deemed not to comply with this part of ISO 1635.

Table 2 — Hardness and mechanical properties

Designation		Hardness		Minimum expansion of diameter %	Mechanical properties		
Alloy	Temper	Vickers HV 5	Rockwell		$R_{p0,2}$ N/mm ²	R_m N/mm ²	A_5 %
Cu-DHP	HA	70 to 100	F 60 to 83	25	160 to 250	min. 250	min. 25
CuZn30As	OS-25	80 to 105	F 65 to 85	25	150 to 240	min. 320	min. 40
CuZn28Sn1	OS-25	80 to 105	F 70 to 85	25	150 to 240	min. 320	min. 40
	OS-35	65 to 90	F 65 to 80	30	120 to 180	min. 310	min. 50
CuZn20Al2	OS-25	85 to 110	B 45 to 65	25	160 to 250	min. 370	min. 40
CuNi10Fe1Mn	OS-35	75 to 110	B 25 to 60	25	100 to 230	min. 300	min. 30
	HA	100 to 130	B 60 to 75	20	240 to 310	min. 320	min. 20
CuNi30Mn1Fe	OS-35	90 to 120	B 40 to 70	25	120 to 250	min. 370	min. 30
CuNi30Fe2Mn2	OS-35	100 to 130	B 40 to 72	25	150 to 260	min. 420	min. 30

Table 3 — Dimensions and tolerances

Outside diameter			Wall thickness	
over	Size range mm up to and incl.	Tolerance ¹⁾ including circularity mm	Size range mm	Tolerance mm
—	12	± 0,07	from 0,7 up to and incl. 2,5	± 10 % (including concentricity)
12	18	± 0,10		
18	25	± 0,12		
25	35	± 0,15		
35	50	± 0,18		

1) Minus tolerances instead of plus and minus tolerances can be supplied by agreement between purchaser and supplier. When all minus tolerances are specified, they shall be twice the minus tolerance stated in the table.

Table 4 — Tolerances on length

Length		Tolerance mm
Specified length mm over	up to and including	
—	5,0	+ 3 0
5,0	6,5	+ 4 0
6,5	10	+ 5 0
10	20	+ 9 0
20	30	+ 12 0