

CUPROCLIMA®

Technical specification for level wound copper tubes

Revision 2 – 25.11.2022

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Preamble

Cuproclima® is a protected brand name for high-quality, seamless, coiled copper tubes for refrigeration and air conditioning. Cuproclima® tubes are specially tailored to the requirements of further processing in the refrigeration and air conditioning industry. The requirements of the relevant national and international standards are fully met or exceeded.

With the cuproclima® quality standard, Wieland offers its customers maximum performance reliability. Thanks to extremely consistent processes and steadily high processing quality, the customer achieves a very long system runtime and outstanding productivity.

Of course, this cuproclima® specification supports the European Pressure Equipment Directive 2014/68/EU. Wieland's production facilities are certified according to DIN EN ISO 9001 and inspected and recognized by TÜV as a manufacturer according to PED 2014/68/EU and AD2000 W0/TRD100.

1 Scope

This specification defines the requirements, sampling, test methods and delivery conditions for seamless round tubes made of Cu-DHP and Wieland K65®, with smooth inner surface, used in the manufacture of refrigeration and air conditioning equipment, e.g. heat exchangers.

It is applicable to tubes with an outside diameter from 3.97 mm up to and including 28 mm, supplied as level-wound coils with the material Cu-DHP in the conditions light annealed, half-hard or hard, or with the material K65® in the condition annealed.

This specification covers and fulfills the requirements of European standard EN 12735-2.

For the material Wieland K65® the requirements of the European standard EN 12735-1, sections 6.1, 6.2, 9.2 are fulfilled.

2 Normative references

The following documents, which are cited in part or in their entirety in this document, are required for the application of this document. The latest edition of the referenced document applies.

EN 723 Copper and copper alloys - Combustion method for determination of the carbon content on the inner surface of copper tubes or fittings

EN 1971-1 Copper and copper alloys - Eddy current test for measuring defects on seamless round copper and copper alloy tubes - Part 1: Test with an encircling test coil on the outer surface

EN 10204 Metallic products - Types of inspection documents

EN 12735-1 Copper and copper alloys - Seamless, round tubes for air conditioning and refrigeration - Part 1: Tubes for piping systems

EN 12735-2 Copper and copper alloys - Seamless, round tubes for air conditioning and refrigeration - Part 2: Tubes for equipment

EN 15079 Copper and copper alloys - Analysis by spark optical emission spectrometry (S-OES)

EN 15605 Copper and copper alloys - Inductively coupled plasma optical emission spectrometry

EN 16090 Copper and copper alloys - Estimation of average grain size by ultrasound

EN 16117-2 Copper and copper alloys - Determination of copper content - Part 2: Electrolytic determination of copper in materials with copper content higher than 99,80 %

EN ISO 2624 Copper and copper alloys - Estimation of average grain size

EN ISO 6507-1 Metallic materials - Vickers hardness test - Part 1: Test method

EN ISO 6892-1 Metallic materials - Tensile testing - Part 1: Method of test at room temperature

EN ISO 8493 Metallic materials - Tube - Drift-expanding test

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

Level wound coil (LWC): Winding in which the turns are arranged into layers parallel to its axis such that successive turns in a given layer are next to one another.

Mean outside diameter \bar{d} (DRMAMW): Arithmetic mean of the largest and smallest outside diameter d measured on any cross section of the tube.

$$\bar{d} = \frac{d_{\max} + d_{\min}}{2}$$

Out-of-roundness UR%: Difference between the largest and smallest outside diameter in relation to the mean outside diameter, measured on any cross-section. The out-of-roundness is determined in the straight condition (straightened by hand), which corresponds to the customer's processing condition after uncoiling.

$$\text{UR}\% = \frac{(d_{\max} - d_{\min}) \cdot 2}{d_{\max} + d_{\min}} \cdot 100\%$$

Mean wall thickness \bar{s} (WDIMW): Arithmetic mean of the largest and smallest wall thickness s , measured on any cross-section of the tube.

$$\bar{s} = \frac{s_{\max} + s_{\min}}{2}$$

Production lot: Definite quantity of products of the same form, the same material condition and the same cross-sectional dimensions manufactured during the same production sequence under uniform conditions.

4 Ordering information

In order to facilitate the enquiry, order and confirmation of order procedures between the purchaser and the supplier, the purchaser shall state on its enquiry and order the following information:

- Quantity of product required
- Reference to this cuproclima® specification
- Alloy designation according to 5.1 (Cu-DHP or K65®)
- Material condition designation according to 5.2
- Nominal outside diameter and wall thickness
- Nominal coil weight according to 9.2.

In addition, the purchaser shall also state on the enquiry and order the following, if required:

- if the coils should be prepared for horizontal decoiling from center (eye to sky)
- if the coils should be delivered on cardboard spools (see 9.2)
- if there are restrictions regarding the coil dimensions or the pallet height (see 9.1/ 9.2)
- if the tubes should be marked (printed)
- if the tubes should be delivered in superclean quality (see 5.6.1)

Any additional requirements not mentioned in this specification or deviating therefrom shall be specified separately by the purchaser in the enquiry and in the order.

5 Requirements

5.1 Composition

The composition shall conform to the requirements of the respective alloy from Table 1 and Table 2:

Table 1: Composition of Cu-DHP

Material designation		Composition % (mass fraction)							
		Element	Cu ^a	Bi	O	P	Pb	Other elements (see Note)	
Symbol	Number							total	excluding
Cu-DHP	CW024A	min.	99,90	—	—	0,015	—	—	—
		max.	—	—	—	0,040	—	— ^b	
Note: The total of other elements (than copper) is defined as the sum of Ag, As, Bi, Cd, Co, Cr, Fe, Mn, Ni, O, P, Pb, S, Sb, Se, Si, Sn, Te and Zn, subject to the exclusion of any individual elements indicated.									
^a Including silver, up to a maximum of 0,015 % ^b If required, the permitted total of elements, other than silver and phosphorus, should be agreed between the purchaser and the manufacturer									

Table 2: Composition of Wieland K65®

Material designation		Composition														
		% (mass fraction)														
Symbol	Number	Element	Cu	Al	As	Cr	Fe	Mn	Ni	P	Pb	Si	Sn	Zn	Zr	Others total
CuFe2P	CW107C	min.	Rem.	—	—	—	2,1	—	—	0,015	—	—	—	0,05	—	—
		max.	—	—	—	—	2,6	—	—	0,15	0,03	—	—	0,20	—	0,2

5.2 Mechanical properties and grain size

The mechanical properties shall conform to the requirements for the respective condition from Table 3 and Table 4.

The tests shall be carried out in accordance with 7.2 and 7.4. If requested by the customer, the hardness may additionally be determined as a non-binding value according to 7.3.

Table 3: Mechanical properties and grain size of Cu-DHP

Material condition		0,2% proof strength		Tensile strength	Elongation	Grain size	
Designation according to EN 1173	common term	Rp _{0,2} MPA		R _m MPA	A %	μm	
		min.	max.	min.	min.	min.	max.
Y040	light annealed	40	90	220	48	15	35
R250	half-hard	-	-	250	30	-	-
R290	hard	-	-	290	3	-	-

Table 4: Mechanical properties of Wieland K65®

Material condition		0,2% proof strength		1,0% proof strength		Tensile strength	Elongation
Designation according to EN 1173	common term	Rp _{0,2} MPA		Rp _{1,0} MPA		R _m MPA	A %
		min.	max.	min.	max.	min.	min.
R300	annealed	140	250	160	-	300	30

5.3 Dimensions and tolerances

The geometrical properties of the tubes are defined by outside diameter and wall thickness.

5.3.1 Cu-DHP tubes

Outside diameter, wall thickness and out-of-roundness shall conform to the requirements given in Figure 1 to Figure 4. For dimensions that exactly hit a definition limit, the more stringent limit applies. Other dimensions are available on request.

In case of dispute the coil shall be straightened in an appropriate way before measurement in order to improve the accuracy when determining the maximum deviation from circular form.

5.3.2 K65® tubes

Outside diameter and wall thickness shall conform to the requirements given in Figure 1, 3 and 4. Out of roundness shall confirm to the requirements given in Figure 2 in case of a ratio of outside diameter to wall thickness ≤ 20 . The maximum out of roundness shall be 8 % in case of a ratio of outside diameter to wall thickness > 20 .

For dimensions that exactly hit a definition limit, the more stringent limit applies. Other dimensions are available on request. In case of dispute the coil shall be straightened in an appropriate way before measurement in order to improve the accuracy when determining the maximum deviation from circular form.

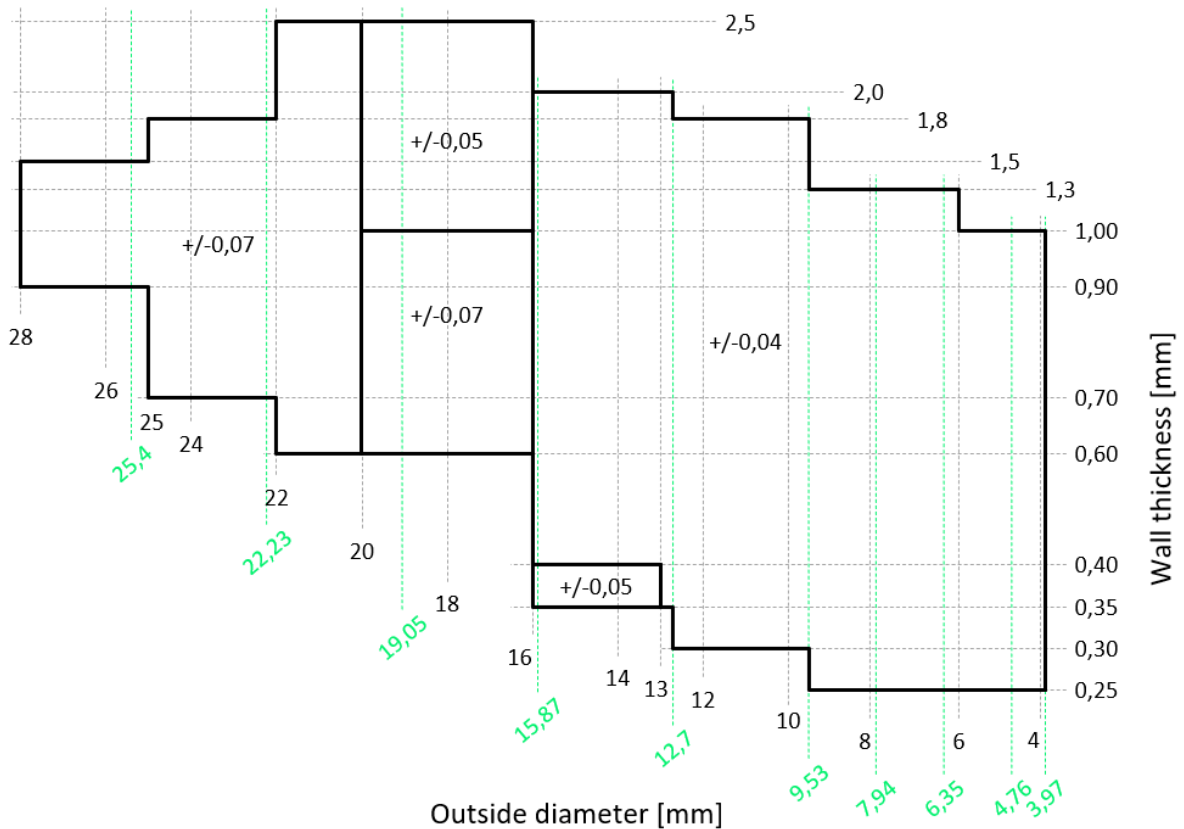


Figure 1: Tolerances on mean outside diameter in mm

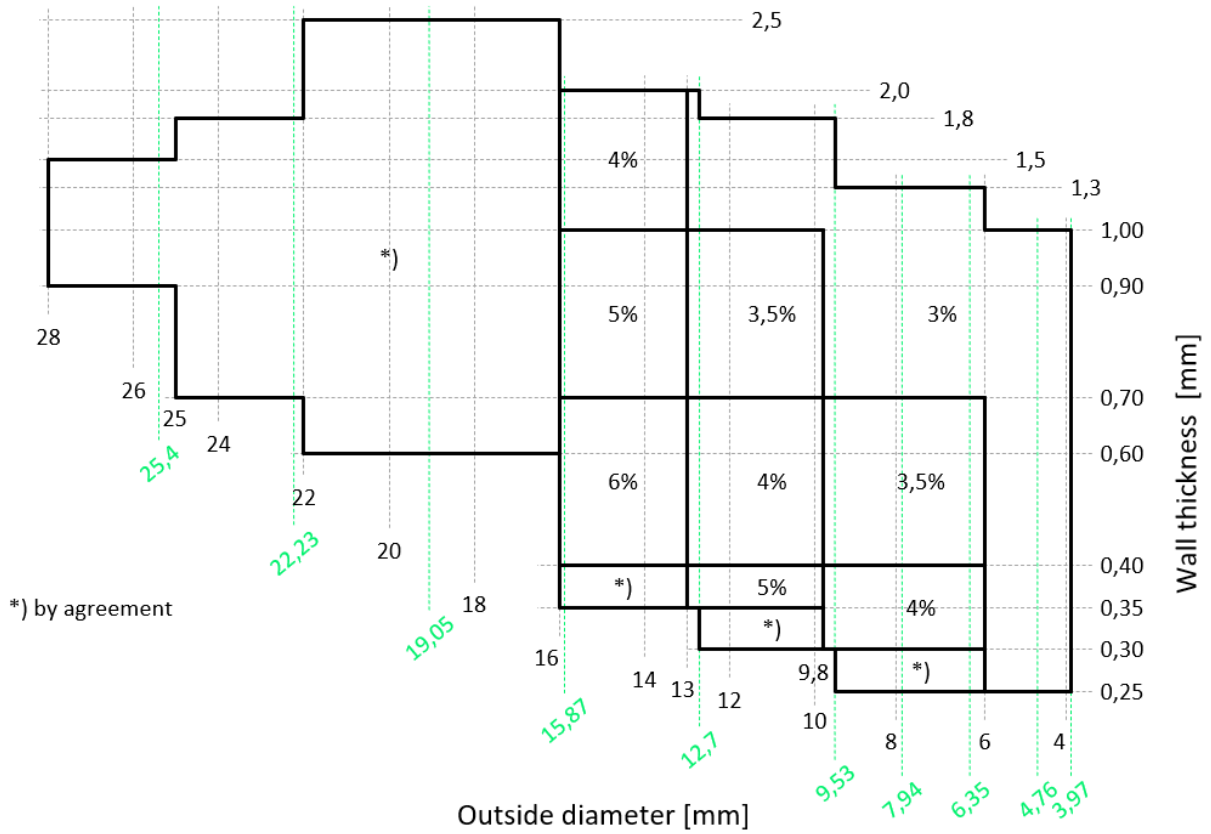


Figure 2: Maximum deviation from circular form in %

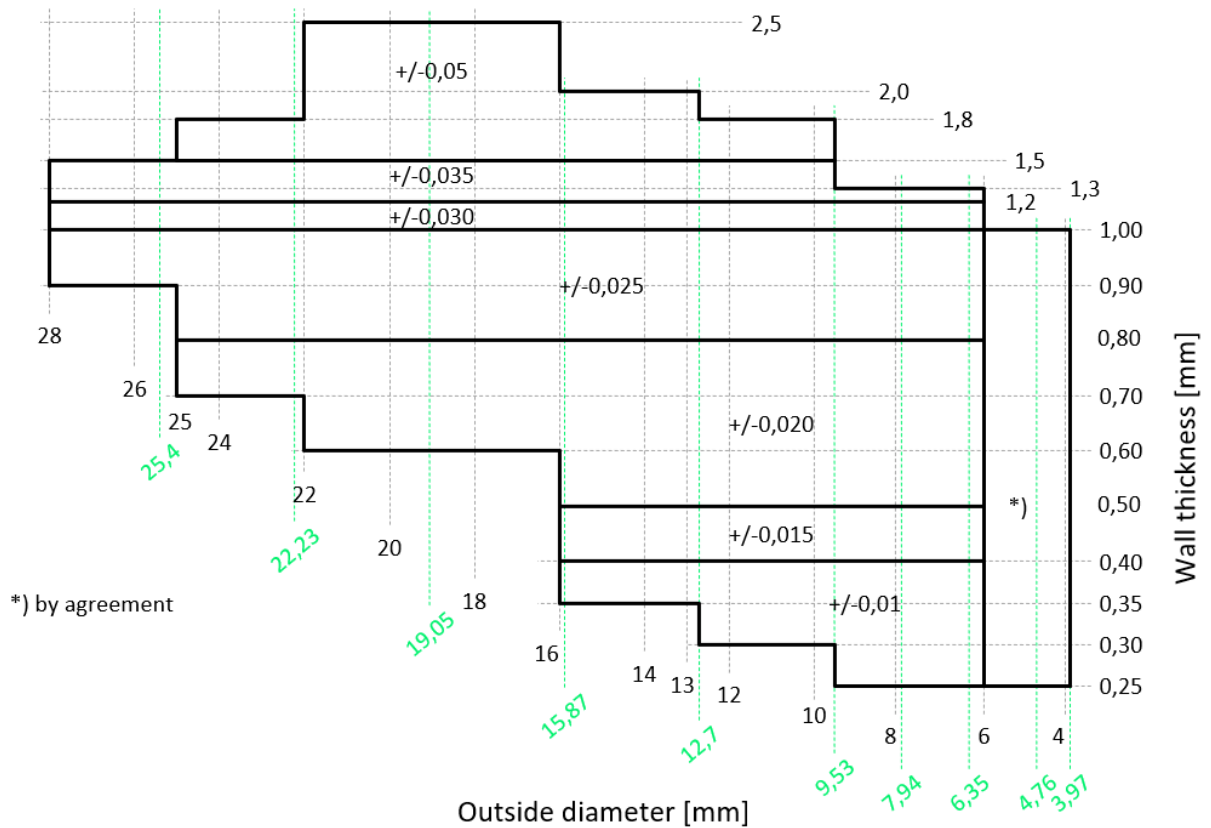


Figure 3: Tolerances on mean wall thickness in mm

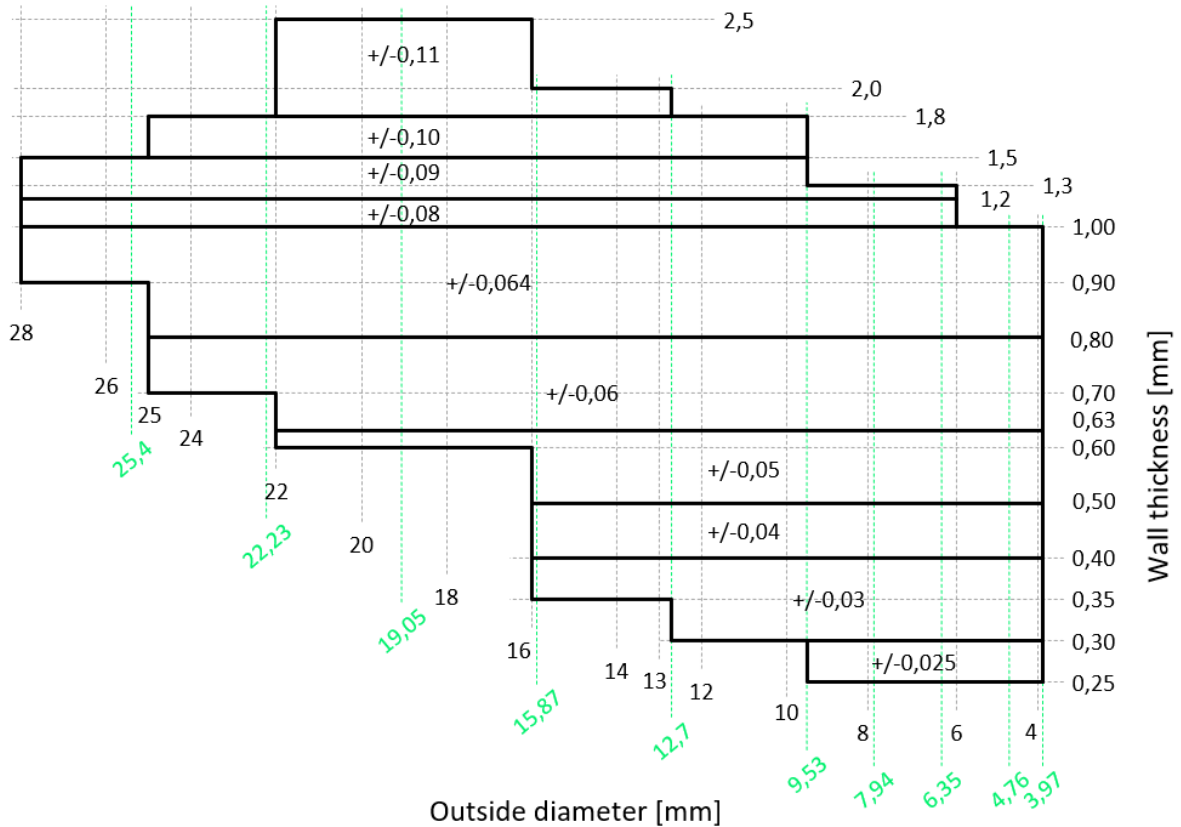


Figure 4: Tolerances on absolute wall thickness (at any point) in mm

5.4 Drift expanding behaviour

No crack, break or tearing of the metal shall be visible to the unaided eye, when tested in accordance with 7.5.

5.5 Freedom from defects

The tubes shall be free from defects that could be detrimental to their use. Each tube shall be subjected to an eddy current test according to 7.7.1 with integrated Ferromat channel for detection of ferromagnetic inclusions.

Each defect shall be marked indelibly and visibly by a method which shall not deform the tube. The permissible number of defects is proportional to the coil mass and is indicated in Table 5 as weight specific value. Any decimal values resulting from the conversion for deviating coil weights shall be rounded up.

Table 5: Eddy current testing – calibration tube and permissible number of defects

Outside diameter (nominal value) mm		Drill hole diameter mm	Permissible number of defects per 100 kg
from	to	max.	max.
≥ 3,97	6	0,4 ^{a)} 0,6 ^{b)}	5 ^{c)} 3 ^{d)}
> 6	9,53	0,4 ^{a)} 0,6 ^{b)}	3
> 9,53	20	0,6	3
> 20	28	0,7	3
a) Wall thickness (nominal value) ≤ 0,35 mm		b) Wall thickness (Nominal value) > 0,35 mm	
c) Wall thickness (Nominal value) ≤ 0,28 mm		d) Wall thickness (Nominal value) > 0,28 mm	

By agreement, the test for freedom from defects with rotating probe (so-called circograph test) according to 7.7.2 may additionally be carried out for particularly thin-walled tubes. The permissible number of defects shall be agreed separately between Wieland and the customer.

5.6 Surface quality

The outer and inner surfaces of the tubes shall be clean and smooth. The inner surface of the tubes shall be checked according to 7.6.

5.6.1 Cu-DHP tubes in condition Y040

The lubricant residues as total carbon content on the inner surface of the tubes shall not exceed 0,25 mg/dm² for an outside tube diameter of ≥ 6 mm.

By request, the tubes may be ordered in superclean quality with particularly high internal cleanliness. In this case, the total carbon content on the inner surface of the tubes shall not exceed 0,20 mg/dm².

superclean

For tubes with an outside diameter < 6 mm, the total carbon content on the inner surface of the tubes shall not exceed 0,38 mg/dm².

5.6.2 K65® tubes in condition R300

The lubricant residues as total carbon content on the inner surface of the tubes shall not exceed 0,38 mg/dm².

5.7 Printing

By request, the tubes can be individually marked (printed) by black ink, for example with the nominal dimensions, the production date and the production lot number.

6 Sampling

For the purposes of demonstrating conformity to the requirements of this standard in Clause 5, the sampling rate to be taken at random shall be at least one sampling unit for each 3 000 kg.

Results may be used from analyses carried out at an earlier stage of manufacturing the product, e.g. from the melt immediately before casting, if product identity is maintained during production.

7 Test methods

7.1 Analysis

The analysis for the determination of the composition shall be carried out on test pieces obtained from test samples according to Clause 6. Chemical or spectrographic analytical methods according to EN 15079, EN 15605 or EN 16117 shall be used.

7.2 Tensile test

The tensile test shall be carried out according to EN ISO 6892-1 on test pieces, prepared from the test samples obtained in accordance with Clause 6.

7.3 Hardness test

When required, hardness tests shall be performed using the Vickers method according to EN ISO 6507-1 on test pieces prepared from the test samples taken in accordance with Clause 6.

7.4 Estimation of average grain size

For Cu-DHP tubes, the average grain size shall be determined by the methods given in EN ISO 2624 on test pieces prepared from the test samples obtained in accordance with Clause 6. Alternatively, the grain size may be determined by the method described in DIN EN 16090.

7.5 Drift expanding test

The drift expanding test shall be carried out in accordance with EN ISO 8493 on test pieces prepared from the test samples obtained in accordance with Clause 6. The outside diameter of the tube end shall be expanded using a conical mandrel with an angle of 45°

7.5.1 Cu-DHP tubes in condition Y040

The outside diameter shall be expanded by minimum 40 %.

7.5.2 K65® tubes in condition R300

The outside diameter shall be expanded by minimum 30 %.

7.6 Carbon content test

The determination of lubricant residues as total carbon content shall be carried out according to the procedure described in EN 723 on test pieces prepared from the test samples obtained according to Clause 6.

7.7 Freedom from defects test (eddy current test)

7.7.1 Testing by stationary probe

The test shall be carried out after the final drawing step over the entire tube length according to EN 1971-1 using systems with encircling solenoid coils.

The maximum diameters of the drill holes for the production of the calibration tubes for the determination of the response threshold for local inhomogeneities (defects) are given in Table 5.

Local inhomogeneities which generate signals equal to or stronger than the response threshold shall be marked according to 5.5.

Non-local inhomogeneities that produce more than 3 signals that are equal to or stronger than the second, lower selected response threshold per 300 mm tube length shall be evaluated as 1 defect and marked according to 5.5.

The value of the lower selected response threshold shall be $\leq 30\%$ of the response threshold for local inhomogeneities. If the usual basic interference level of a product does not permit compliance with this specification, the lower response threshold may be increased to such an extent that eddy current testing is possible without defect signals from the basic interference level.

For the detection of ferromagnetic inclusions, only test devices with a Ferromat channel shall be used. These shall be calibrated according to the manufacturer's experience. Each Ferromat signal shall be evaluated as a defect and marked according to 5.5.

7.7.2 Testing by rotating probe

This optional test shall be performed with an eddy current testing apparatus with rotating probe (so-called circograph).

The calibration tube shall be made from a defect-free tube with the same test characteristics as the tube to be tested. The calibration tube shall be provided with an approximately rectangular longitudinal groove running parallel to the longitudinal axis of the calibration tube. The depth and width of this groove are 0.1 mm each. The sorting limit results from the smallest amplitude generated by the defect signal of the groove in the calibration tube.

7.8 Retests

If a test sample does not meet the requirements, all tubes of the lot from which the test sample originates shall be blocked for delivery.

Further test samples shall be taken from the blocked tubes, at a sampling rate four times higher than specified in Section 6. If all retested test samples meet the requirements, the tubes from which the retested sample sections were taken shall be deemed to meet the requirements of this specification. Otherwise, the tubes in question shall be rejected.

7.9 Alternative test methods

At the customer's request, it may be deviated from the test methods listed in Clause 7. In this case, alternative test methods shall be agreed between Wieland and the customer.

8 Declaration of conformity and inspection documentation

For each production lot, Wieland issues a test certificate 3.1 in accordance with EN 10204, which contains the determined test results that shall comply with this specification. In this test certificate, Wieland also confirms conformity with the European Pressure Equipment Directive 2014/68/EU.

9 Packaging, marking and form of delivery

9.1 Packaging and Marking

The coils are stacked on pallets and packed in such a way that they are effectively protected under the usual conditions of transport and handling.

The tube ends are sealed by default.

Wieland determines the stacking height according to transport considerations. If there are restrictions on the part of the customer in the maximum stacking height or in the maximum pallet weight, this must be explicitly communicated by the customer.

Each coil is provided with a label containing the following information:

- Reference to this cuproclima®-specification
- Material designation according to 5.1
- Nominal sizes: Outside diameter x wall thickness
- Material condition according to 5.2
- Net weight
- Approximative coil length
- Number of black marks
- Order number
- Material number
- Production lot number
- Packing piece number

9.2 Form of delivery

The level wound coils can be supplied with a nominal weight between 100 kg and 530 kg, depending on the manufacturing plant. The minimum permissible coil weight is 50% of the nominal weight, with a maximum of 20% of the coils in a delivery weighing less than 70% of the nominal weight. If required, the maximum permissible coil weight shall be agreed separately between Wieland and the customer.

The core diameter of the coils is 600_{-0}^{+10} mm. Coil outer diameter and coil height depend on coil weight, outer diameter and wall thickness of the tubes. The maximum coil outer diameter is 1.130 mm (or 1.200 mm for a coil with 530 kg nominal weight), and the maximum coil height is 500 mm. See also Figure 5.

If there are any restrictions on the part of the customer regarding the maximum outside diameter or coil height, this shall be explicitly communicated to Wieland.

By agreement, the coils may be prepared for horizontal decoiling from the center (eye to sky).

The coils are delivered without cardboard spools by default. By agreement, the coils may be supplied on cardboard spools.

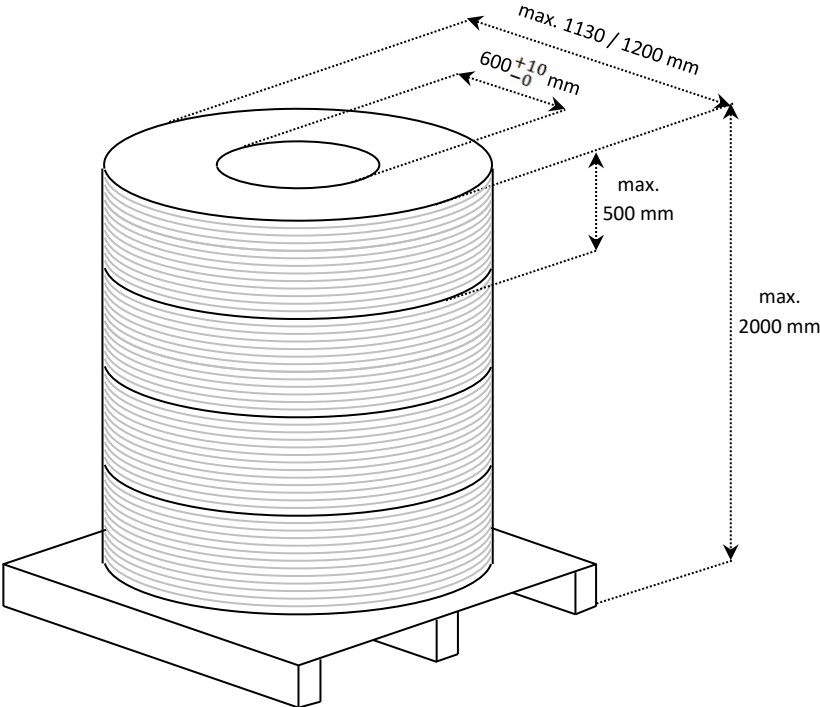


Figure 5: Coil and pallet dimensions