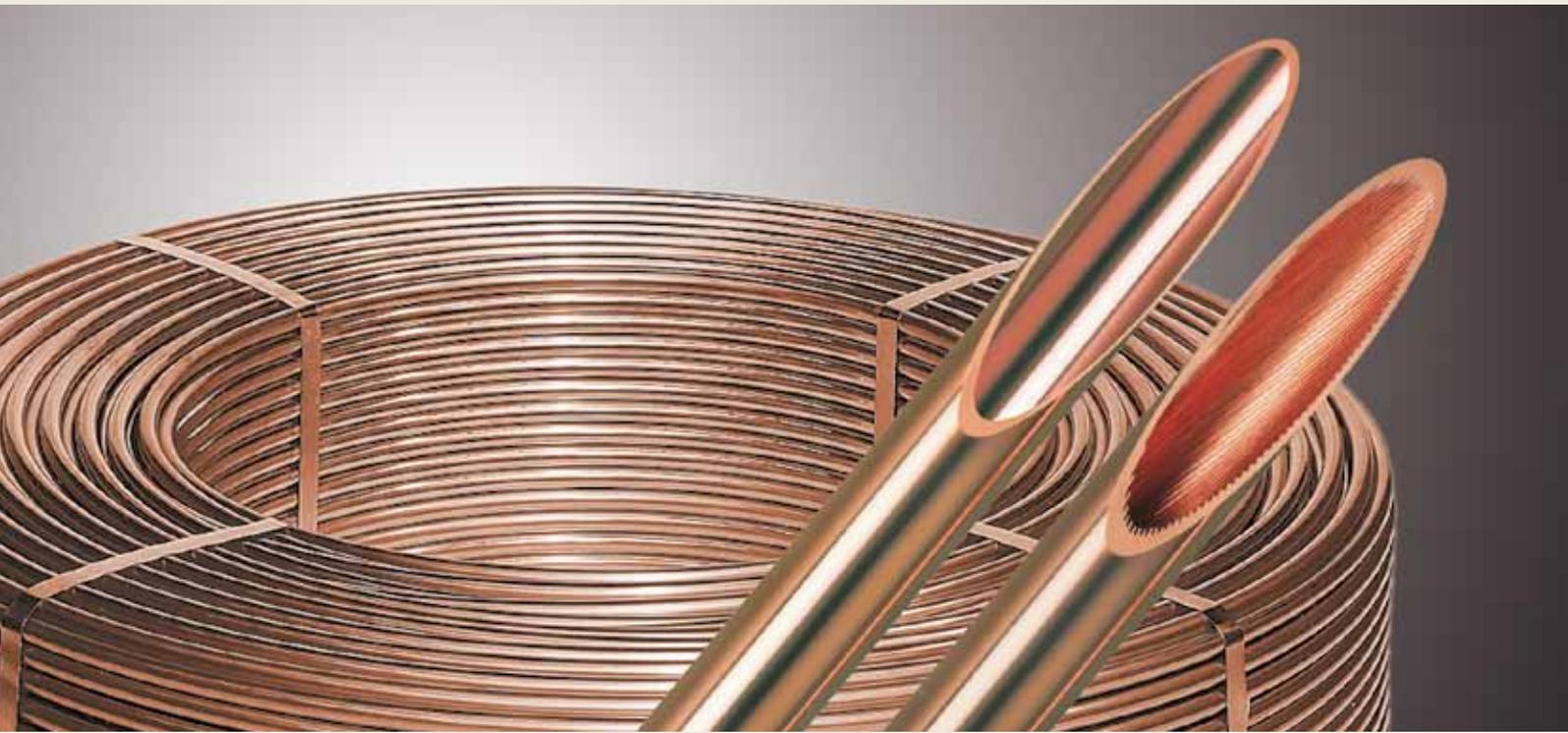
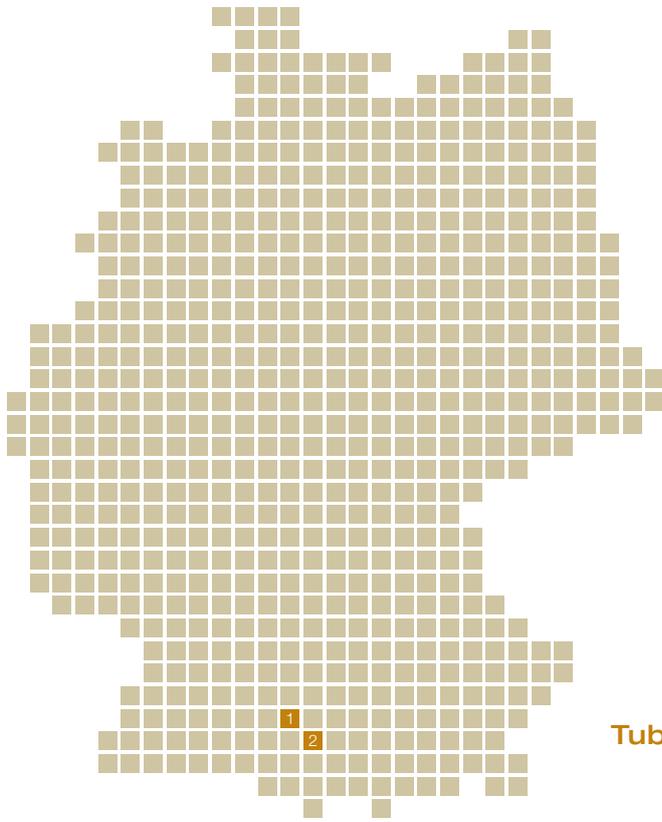


Wieland

Level-wound coils





Tube production in Germany

2 Vöhringen plant



1 Ulm plant



Lagengespulte Coils



The Wieland Group

The Wieland Group with headquarters in Ulm, Germany, is one of the world's leading manufacturers of semi-finished and special products in copper and copper alloys. These include strip, sheet, tube, rod, wire and sections as well as slide bearings, finned tubes and heat exchangers.

The Wieland Group comprises manufacturing companies, slitting centres and trading subsidiaries in many European countries as well as in the USA, in South Africa, Singapore and China.

Wieland supplies customers in numerous markets with over 100 different copper materials which are primarily used in the electrical and electronic industries. Other important customer sectors include domestic installations, air conditioning and refrigeration, heating and the automotive industry.

Copper tubes

Wieland is one of the leading European manufacturers of copper tubes. Production is located in Vöhringen, Germany, and in Austria at buntmetall amstetten Ges.m.b.H, a subsidiary of Wieland-Werke AG. Copper tubes are also manufactured by Wieland Copper Products in Pine Hall, North Carolina, USA.

Manufacture and quality assurance at all locations are certified according to ISO 9001:2000. The plant in Vöhringen is validated to the environmental standards EN 14001 and EMAS. An in-house laboratory accredited according to EN 17025 ensures continuous quality control. Numerous inspection certificates and product approvals by well-known organisations demonstrate the high quality of Wieland's copper tubes.

Level-wound coils

Seamless drawn round copper tubes in level-wound coils (LWC) are a particularly cost-effective pre-material for the manufacture of heat exchangers, tube bends, fittings, electrical water heaters, solar collectors, and cable lugs. Long lengths and the resulting coil weights of up to 300 kg provide the consumer with several advantages: Little scrap, higher manufacturing flexibility and optimisation of machine times.

Production

The production of tubes begins with continuously cast billets. They are first heated to the hot forming temperature of approx. 950 °C and then extruded to become redraw tubes for further processing. They subsequently undergo a number of cold-forming drawing operations on either spinner blocks or drawing benches. Round dies and mandrels serve to reduce diameter and wall thickness. These operations are repeated until the final dimension is reached.

Copper requires no intermediate annealing due to its excellent forming properties. When the tube has been drawn to or close to the required size, heat treatment may be necessary depending on the temper requested by the customer. Inner grooves are produced with a grooving plug (cuprofin). Finally, the tubes are level wound.



Level-wound coils in copper (furnace behind)



De-coiling process

Material

Wieland-K20 and **Wieland-K21** are phosphorus deoxidized grades of copper. They correspond to Cu-DHP, Material No. CW024A according to EN 12735-2 with a minimum copper content of 99.9 % and a residual phosphorus content between 0.015 and 0.40 %.

Wieland-K10 (Cu-OFE), **Wieland-K12** (Cu-HCP) and **Wieland-K30** (Cu-ETP, Cu-OF) according to DIN EN 13600 or EN 12449 are the copper grades with the highest electrical conductivity.

Wieland-K65 (CuFe2P) is a high-strength copper-iron alloy which is used in high-pressure applications.

Moreover, Wieland offers inner-grooved tubes in **Wieland-L10** (CuNi10Fe1Mn) for sea water applications.

For example Wieland-L10 is defined in the EN 12451 which is harmonized with the Pressure Equipment Directive 97/23/EC (PED).

Tempers

Copper tubes in level-wound coils are available in different tempers. Tubes in annealed temper are normally specified with “Y040 light annealed”, less frequently with “Y035 soft annealed” according to EN 12735-2. In case of high demands on strength the tubes can also be supplied in hard as drawn as per Wieland specification R-1001. This version corresponds to the temper “R360” according to EN 12449. Also a half-hard temper (R250 according to EN 12451) is available on request for several dimensions.

Physical properties

Nominal values for Cu-DHP	
Thermal conductivity (at 20 °C)	344 W/(m·K)
Coefficient of thermal expansion (20 to 300 °C)	17.7·10 ⁻⁶ /K
Thermal capacity (at 20 °C)	0.385 J/(g·K)
Modulus of elasticity	132 kN/mm ²
Mass density	8.94 g/cm ³

The mechanical and physical properties of Wieland-K10, Wieland-K12 and Wieland-K30 meet the requirements of EN 13600. These tubes are available in soft, half hard and hard as drawn temper. The alloy K65 is included in EN 12449. For the design of pressure vessels there is a VdTÜV material data sheet (No. 567).



Measurement of mechanical properties

Mechanical properties

Temper for Cu-DHP			Yield strength		Tensile strength R _m (MPa)	Elongation A ₅ (%)	Brinell hardness		Grain size	
			R _{p0.2} (MPa)				HB		(mm)	
			min.	max.	min.	min.	min.	max.	min.	max.
soft	R200	EN 12449	–	110	200	40	35	60	–	–
hard	R360	EN 12449	320	–	360	–	105	–	–	–
light annealed	Y040	EN 12735-2	40	90	220	40	–	–	0.015	0.040
soft annealed	Y035*	EN 12735-2	35	80	210	40	–	–	0.030	0.060
soft	(light annealed) cuproclima		50	90	230	40	–	–	0.015	0.035
dead soft	(soft annealed*) cuproclima		35	80	210	40	–	–	0.030	0.060

* Y035 and soft annealed only for dimensions with wall thickness >0.5 mm

Industrial tubes



Industrial tubes are available in sizes from approx. 4 mm to 28 mm depending on the wall thickness.

There are national and international standards for copper tubes in level-wound coils. Tubes for the refrigeration and air-conditioning industry are usually manufactured according to EN 12735-2 or to the Wieland standard "cuproclima". Otherwise the EN 12449 is being used but there is no statement regarding the requirements for copper tubes in level-wound coils.

Wieland has therefore drawn up its own standards based on the characteristics of level-wound coils:

Company standard	Application
R-1000	Plain copper tubes (soft) in level-wound coils
R-1001	Plain copper tubes (hard) in level-wound coils
R-0001	"super clean" quality (in conjunction with R-1000; not possible for R-1001)

These company standards cover the common international standards such as ASTM B68 and ASTM B743 as well as EN 13600 and EN 12735-2. Furthermore, R-1000 and R-1002 support the European Pressure Equipment Directive 97/23/EC.

Copper tubes in level-wound coils for industrial applications are used in a number of industries to manufacture products with a long life expectancy. Good processing characteristics are of paramount importance as the tubes are decoiled, and often straightened, bent or undergo an additional forming process at the customers.

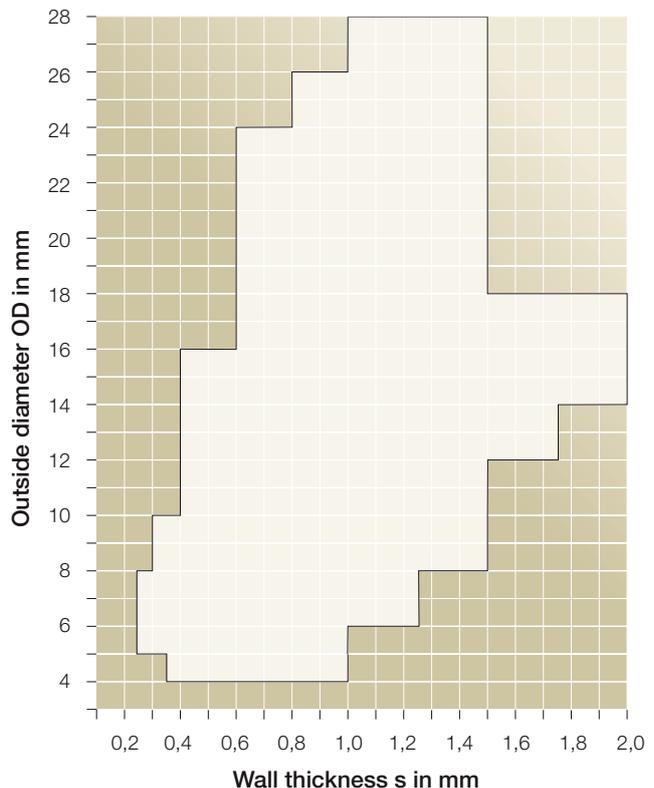
Various tempers can be used for different applications depending on the requirements:

- Hard temper copper tubes are used – for example - in the manufacture of solar heat absorbers
- Tubes in half-hard temper are suitable for special requirements in terms of high-strength material, but also improved formability of the material.
- Annealed tubes are supplied to manufacture products where they must be formed to a high degree and where fittings and bends demand tight radii.

Wieland's R&D Division is continuously working to further develop the processing quality of their copper tubes, for example improving the cleanliness of the tube's inner and outer surface.

For further information please refer to page 9.

Sizes available



ACR tubes



ACR (ACR – air conditioning and refrigeration) tubes are level-wound, seamless copper tubes (LWCs) for refrigeration and air conditioning.

- internally smooth tubes
- inner-grooved tubes

cuproclima tubes

The cuproclima trademark stands for high-grade, seamless, internally smooth copper tubes in level-wound coils for refrigeration and air conditioning. They have a cleaner inner surface than industrial tubes. The quality requirements for cuproclima tubes exceed those specified in EN 12735-2.

Recommended cuproclima tube sizes*									
Outside diameter OD		Wall thickness s							
Inch	mm	0.011 in. 0.28 mm	0.012 in. 0.30 mm	0.014 in. 0.35 mm	0.016 in. 0.40 mm	0.018 in. 0.45 mm	0.020 in. 0.50 mm	0.025 in. 0.635 mm	0.028 in. 0.70 mm
5/16	7.94	•	•	•					
3/8	9.52	•	•	•	•		•		•
1/2	12.70			•	•		•	•	•
5/8	15.87				•	•	•	•	•
	22**								

* other dimensions on request

** wall thickness to be agreed

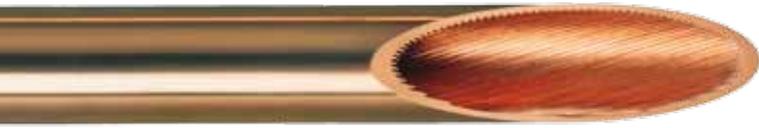
Tolerances on diameter and roundness of cuproclima tubes					
Wall thickness s (mm)	Tolerance on	Outside diameter OD			
		from 6 to 9.52 mm	over 9.52 to 13 mm	over 13 to 16 mm	over 16 to 22 mm
≤ 0.40	Average diameter	± 0.04 mm		± 0.05 mm	***
> 0.40		± 0.04 mm		± 0.05 mm	
≤ 0.40	Roundness	4 %	5 %	7 %	
from 0.40 to 0.70		3.5 %	4 %	6 %	***
> 0.70		3 %	3.5 %	5 %	***

*** by agreement

Zulässige Abweichungen der Wanddicke von cuproclima-Rohren												
Außendurchmesser d _a (mm)	Toleranz auf	Wanddicke s										
		von 0,25	über 0,30	über 0,35	über 0,40	über 0,50	über 0,63	über 0,80	über 1,00	über 1,20	über 1,50	über 1,80 bis 2,00
von 6 bis 16	Gesamtabweichung der Wanddicke****	± 0,025	± 0,03		± 0,04	± 0,05	± 0,06	± 0,07	± 0,08	± 0,09	± 0,10	± 0,11
von 6 bis 9,52	mittlere Wanddicke	± 0,01		± 0,015		± 0,02	± 0,025	± 0,03	± 0,035	± 0,05		
über 9,52 bis 13	auf Anfrage											
über 13 bis 16												
über 16 bis 28												

**** including eccentricity

**** einschließlich Ungleichwandigkeit



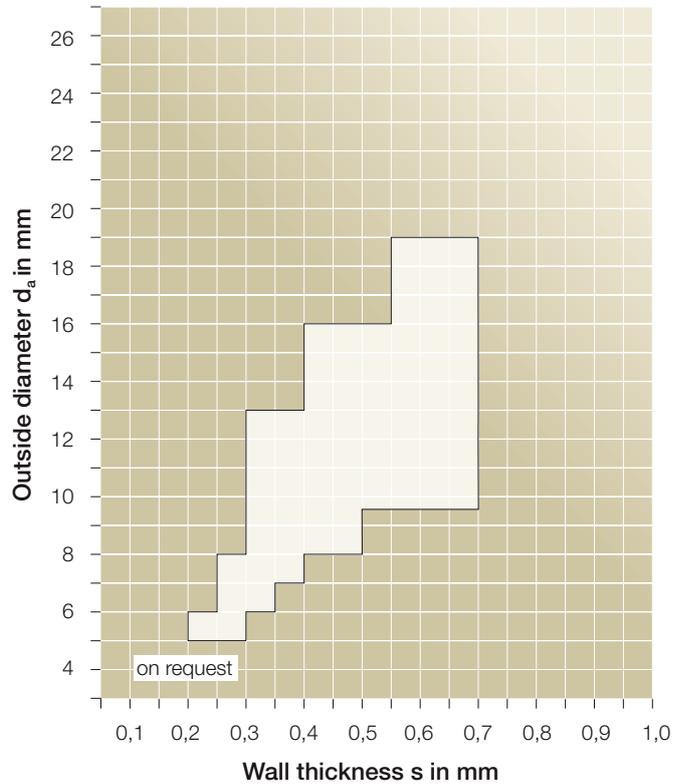
cuprofin – seamless inner-grooved tubes

Cuprofin tubes have a smooth outer and a grooved inner surface. They are used in heat exchangers where the refrigerant is either evaporated or condensed inside the tubes.

The technical demands on cuprofin tubes increase constantly. The main requirement is the maximum heat transfer coefficient on the inside of the tube at a low pressure drop. A sophisticated test rig enables to further develop fin configurations and determine appropriate measurement results. The available types of tubes and their thermal properties are described in the data sheets. After the finning process, the tubes are usually level-wound and soft annealed. In this condition the tubes can easily be cut to straight lengths or “hair pin” bent to suit the customers’ applications.

The tubes can also be supplied cut to length ready to install.

Wieland seamless cuprofin tubes are manufactured in a cold forming operation, with the fins shaped from the wall of a smooth tube. This forming technology requires the most sophisticated technical equipment, tools and test devices. Measuring equipment has been specially designed for this purpose which, in conjunction with the EDP system, records and monitors data during the manufacturing process.

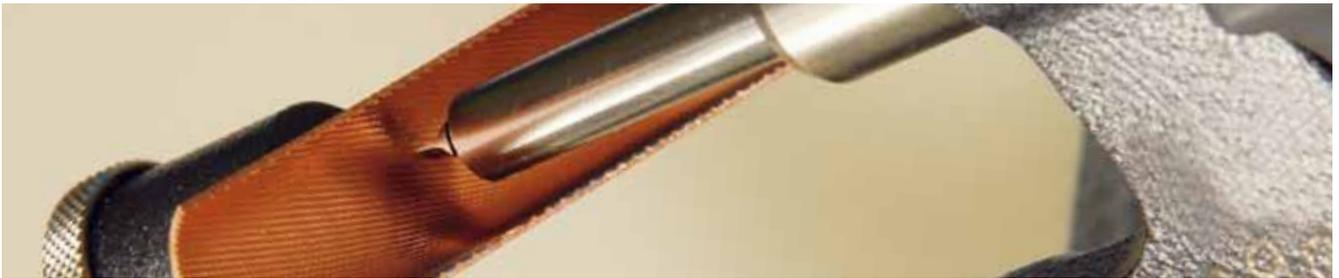


microgroove

The trend for the design of fin coil heat exchangers is towards core tubes with smaller diameters. This enables to reduce the refrigerant charge, to save material and to increase the energy efficiency. microgroove designates smallest inner-grooved tubes with an outer diameter of usually 5 mm.

Beside standard structures Wieland also offers high-efficient and weight-reduced variants. Wieland will be pleased to assist you with the selection of the optimum product for your application.





Special qualities of level-wound coils

Depending on the application and requirements Wieland offers special qualities with enhanced product properties and particularly high inside and outside cleanliness of the tubes. Thus our customers are provided with the right quality for the respective application conditions to optimise their manufacturing processes.

superclean – ultraclean inner surface for the refrigeration and air-conditioning industry

Thanks to a special cleaning process superclean tubes are clearly below the limit of relevant standards for carbon residues. Thus the soluble residual carbon which gets into the refrigerant is significantly reduced.

cuproclean – corrosion resistance for oxygen-containing water

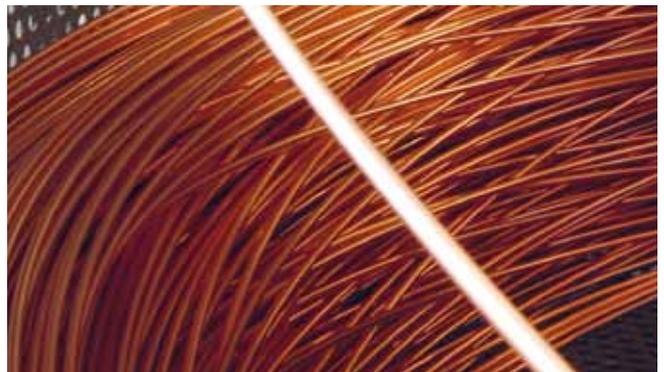
Due to a sophisticated cleaning process exclusively developed by Wieland cuproclean tubes are free from carbon deposits on the inner side of the tube. Therefore, they can also be safely installed in applications containing water even if there is oxygen diffusion into the tube system.

cuproform – exceptional forming properties

For cuproform the manufacturing parameters have been further optimised to achieve constant and extremely high forming properties of the material. During the flaring test for tubes in cuproform Wieland ensures a possible expansion of 80 % for each order. For this test, usual standards only require 40 %.

solarclean – optimised qualities for the production of solar absorber

The solarclean copper tubes and their super clean outer surface offer the appropriate quality for various joining technologies such as ultrasonic and laser welding in the manufacture of solar thermal collectors. Wieland has developed further solarclean variants with additional special properties for applications like evacuated tube collectors and for the bending of meander shapes.



Packaging and form of delivery

Level-wound coils are supplied with or without cardboard reels. The latter helps to reduce the amount of throw-away packaging.

Decoiling adaptors for processing coils supplied without reels can be obtained from Wieland.

LWCs without reels are strapped in four places with copper or nylon strip and stacked on wooden pallets with cardboard discs between the coils.

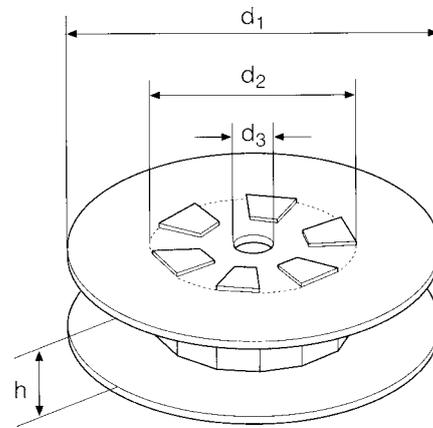
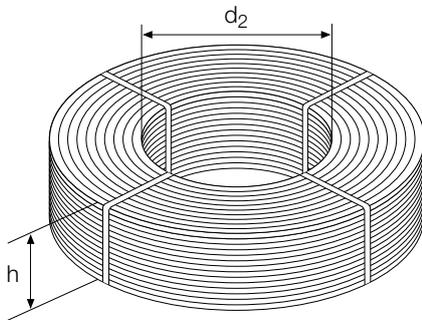
The loaded pallet is shrink-wrapped in biodegradable PE foil.

Data for LWCs without reels can be found in the table below.

LWCs on corrugated cardboard reels are also supplied on wooden pallets and shrink-wrapped in biodegradable PE foil. The reel of the customary non-returnable coils comprises a core with two round flanges.

Characteristic dimensions:

- d_1 flange diameter
- d_2 outside core diameter / coil inside diameter
- d_3 diameter of receiving bore
- h clearance between flanges / reel height



Coreless LWCs		
Coil weight (kg)	h^* (mm)	d_2 (mm)
300	max. 480	600 + 10/-0
150	max. 400	600 + 10/-0
100	to approx. 320	600 + 10/-0

* coil height depends on tube OD;
tolerance on coil height is +5/-10 mm

LWCs on reel		
Coil weight (kg)	Reel sizes*	
	h (mm)	d_1 (mm)
150	320	1060 1150
	280	1060 1150
	240	1060 1150
	200	1060
100	240	1060 1150
	200	1060

* d_2 approx. 600 mm, d_3 130 mm

Quality and quality assurance

Wieland copper tube is produced on high-performance, state-of-the-art automatic facilities using the extensive know-how gathered during many years of experience in this field.

For many years, customers all over the world have been relying on Wieland for consistent high-level quality. Wieland products are subject to stringent control throughout the production process, beginning with the raw material and ending with shipment of the finished product.

Products are carefully inspected at every stage of their production according to documented procedures and schedules to ensure that the specified quality requirements are met. Work schedules and test results are stored and available when needed. The quality assurance system of Wieland-Werke AG is certified according to EN ISO 9001.

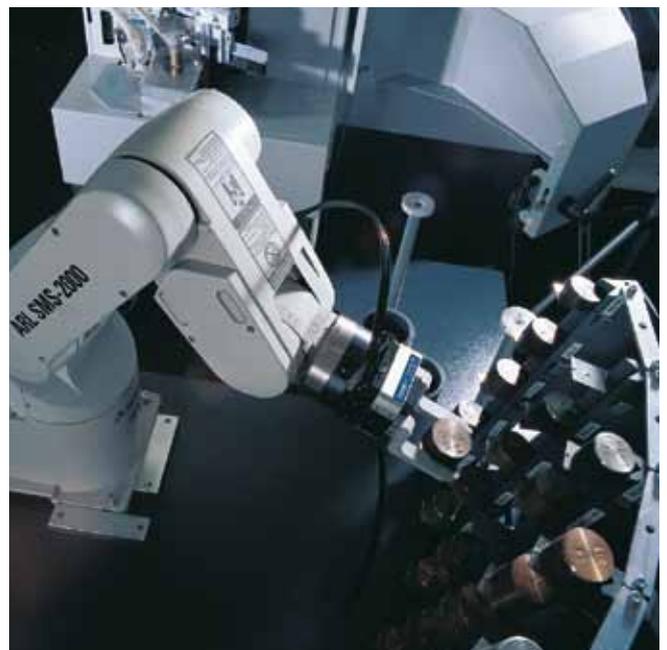
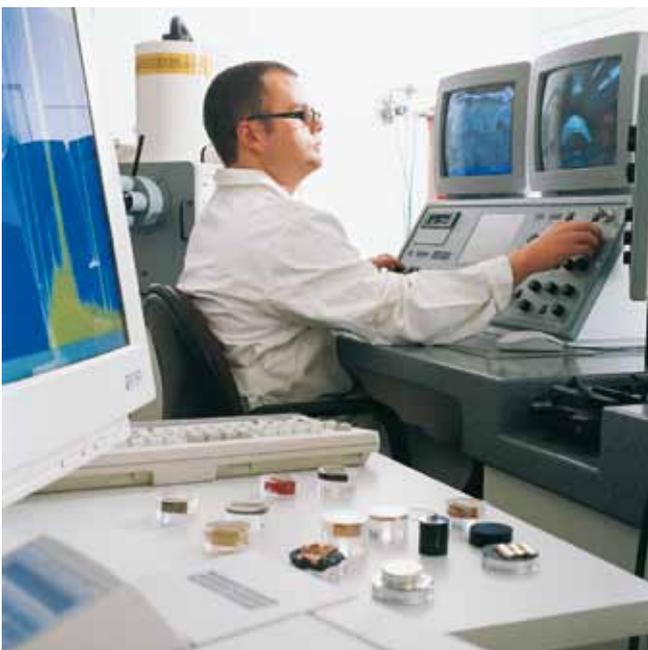
Eddy current testing

Each level-wound coil undergoes eddy current testing according to EN 1971, i.e. the tube wall is checked continuously for defects. A test according to ASTM E 243 is possible on demand. Defects detected in the tube wall are automatically marked with black ink. They are easily recognizable during further processing at the customers and can be sorted out.

Internal cleanliness of copper tubes in LWC

The maximum content of soluble and insoluble substances remaining on the inner surface of the tubes is defined in accordance with applicable standards. Testing is carried out in accordance with EN 723.

Different qualities with various cleanliness grades are available according to the requirements of the customers (see page 9).



Advice for working

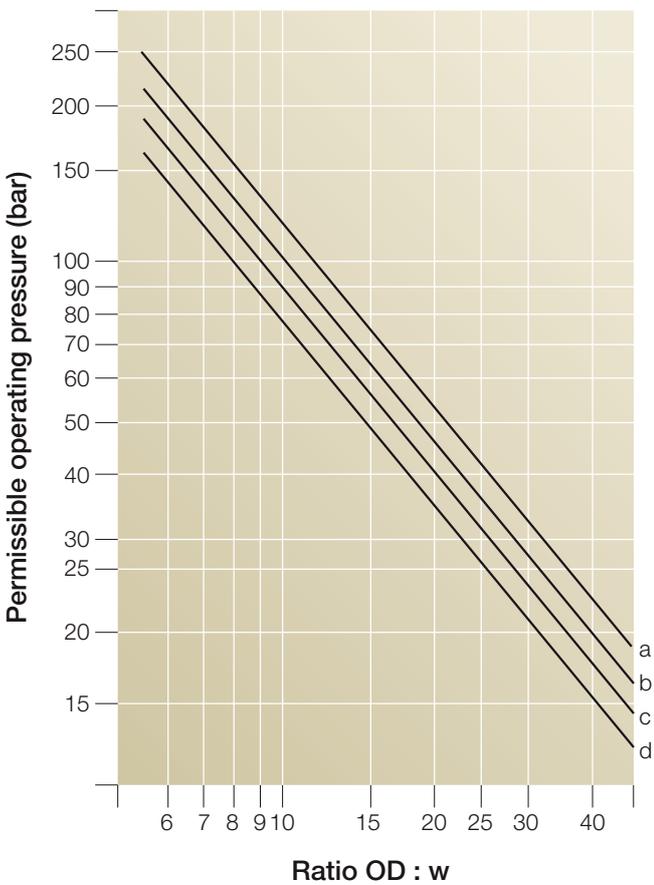
Operating pressure

The diagram below depicts the permissible operating pressure P_B at various operating temperatures for seamless drawn copper tubes of Wieland-K20/K21 in soft temper. For this purpose, the ratio between outside diameter and wall thickness OD : s has to be calculated according to the formula

$$P_B = 20 \cdot s / (OD - s) \cdot K/S \quad \text{in bar}$$

- K characteristic strength value in MPa
- S safety coefficient (no dimension)
- OD outside diameter in mm
- s wall thickness in mm
- K/S permissible stress in MPa

The permissible stress K/S is taken from the AD data sheet 6/2. The stress given for operating temperatures in excess of 100 °C is based on 100,000 operating hours. A loss of strength as a result of the heat effect of brazing operations has been taken into account.



Permissible operating pressures at various operating temperatures for seamless drawn Wieland-K20/K21 copper tubes in soft temper R220, thermally treated according to the regulation AD2000.

Processing

Copper is a highly ductile material. A drawn copper tube in soft temper can be easily bent, expanded, reduced, swaged or beaded. It can be bent around mandrels with very small radii with no or only minimal creases in the tube wall on the inside of the bend. The rule of thumb is $r \geq 1.3 OD$, where r is the radius of curvature referred to the axis of the tube and OD is the outside diameter and applies to a tube in soft temper with a ratio of $OD : s \leq 30$. Extremely high degrees of deformation of at least 80 % (guaranteed by a specially developed flaring test by Wieland) can be ensured for the cuproform quality.

The level-wound tube tends to retain a so-called coil set when it is decoiled. It is, therefore, recommended to calibrate the coiled tubes before feeding them into the actual processing equipment and to straighten them.

Line	Operating temperature	Permissible stress K/S
a	≤ 100 °C	55 MPa
b	150 °C	49 MPa
c	200 °C	43 MPa
d	250 °C	36 MPa

Decoiling of copper tubes

The following are proposals for decoiling copper tubes supplied without cardboard packing.

Decoiling from wooden decoiling device

By means of a lifting strap the level wound coils are individually mounted on a wooden decoiling device (available from Wieland) and decoiled vertically or horizontally.



Decoiling from the coil core

Very simple and economic method of decoiling copper tubes. The level wound coils normally remain on the pallets as delivered. The equipment is not offered by Wieland. But we will be pleased to advise you.



Decoiling from the pallet with a decoiling device

The so-called pallet decoiling device is an innovative system to unwind coils from the pallet. It has been developed by Wieland in cooperation with a manufacturer of special machines.

A complete pallet with LWC can be placed onto the device and be easily decoiled. Non-productive machine times are considerably reduced due to easy and fast set up. Furthermore, the risk of damages due to the handling of the coils is significantly reduced and the safety is increased because the coils remain on the pallet. Thus, dimensions can be changed quickly and easily. Thanks to a compact design only little space is required. The storage of the material is combined with the decoiling system.



Applications

Main applications for industrial copper tubes

Heating, refrigeration, air conditioning, solar technology, fittings, plant and machinery, vehicle components, electrical parts, metal goods as well as sanitary fittings.



Heat exchanger



Fin coil for air conditioning and refrigeration units

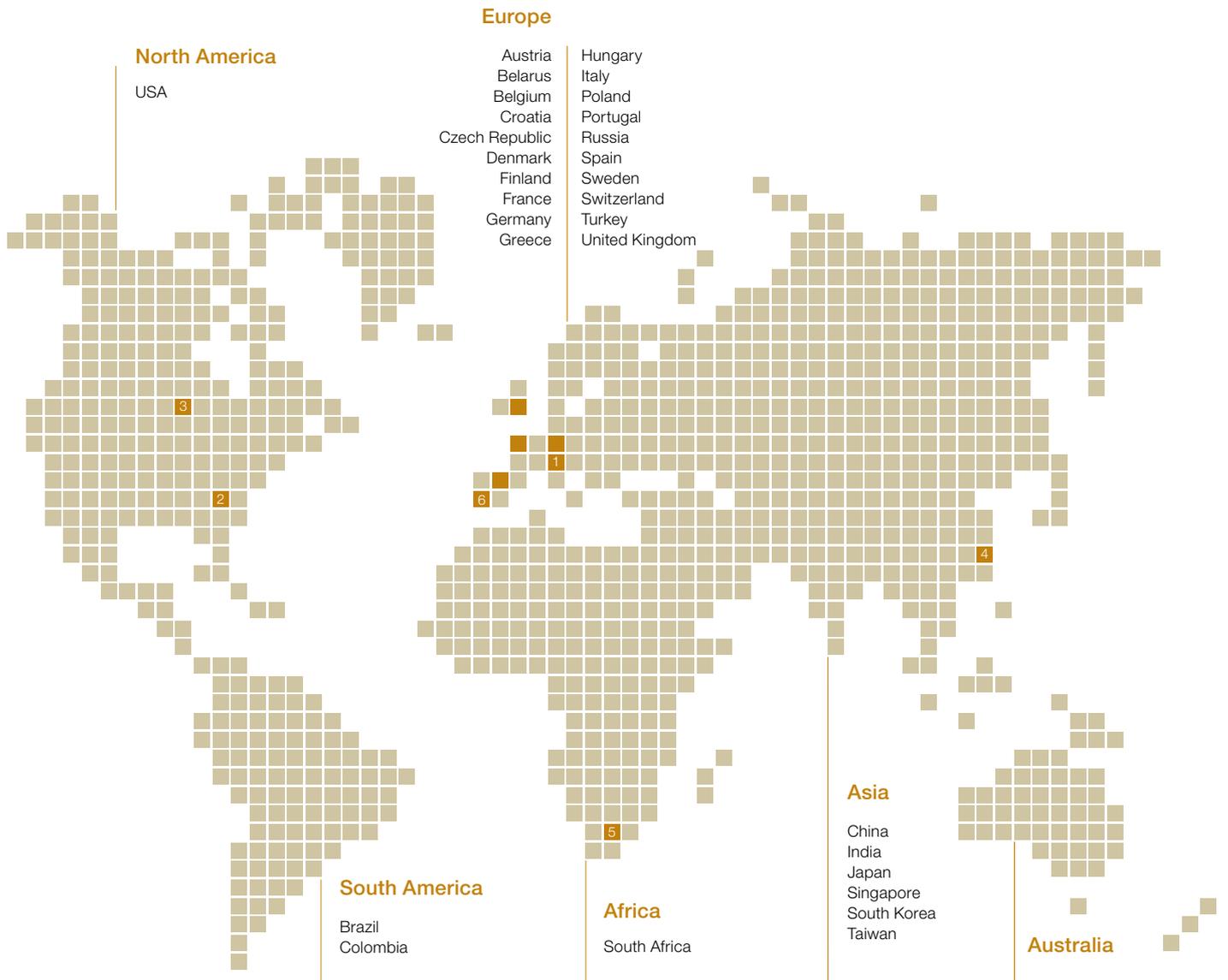


Fittings



Solar heat absorber

Locations of the Wieland Group and its trading agencies



Tube production worldwide



- 1 *buntmetall amstetten Ges.m.b.H., Amstetten, Austria*
- 2 *Wieland Copper Products, LLC, Pine Hall, USA*
- 3 *Wieland Metals, Inc., Wheeling, USA*
- 4 *Wieland Thermal Solutions (Shanghai) Co., Ltd., China*
- 5 *Wieland (South Africa) (Pty.) Ltd., Edenvale, South Africa*
- 6 *Wieland Thermal Solutions Lda., Esposende, Portugal*

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