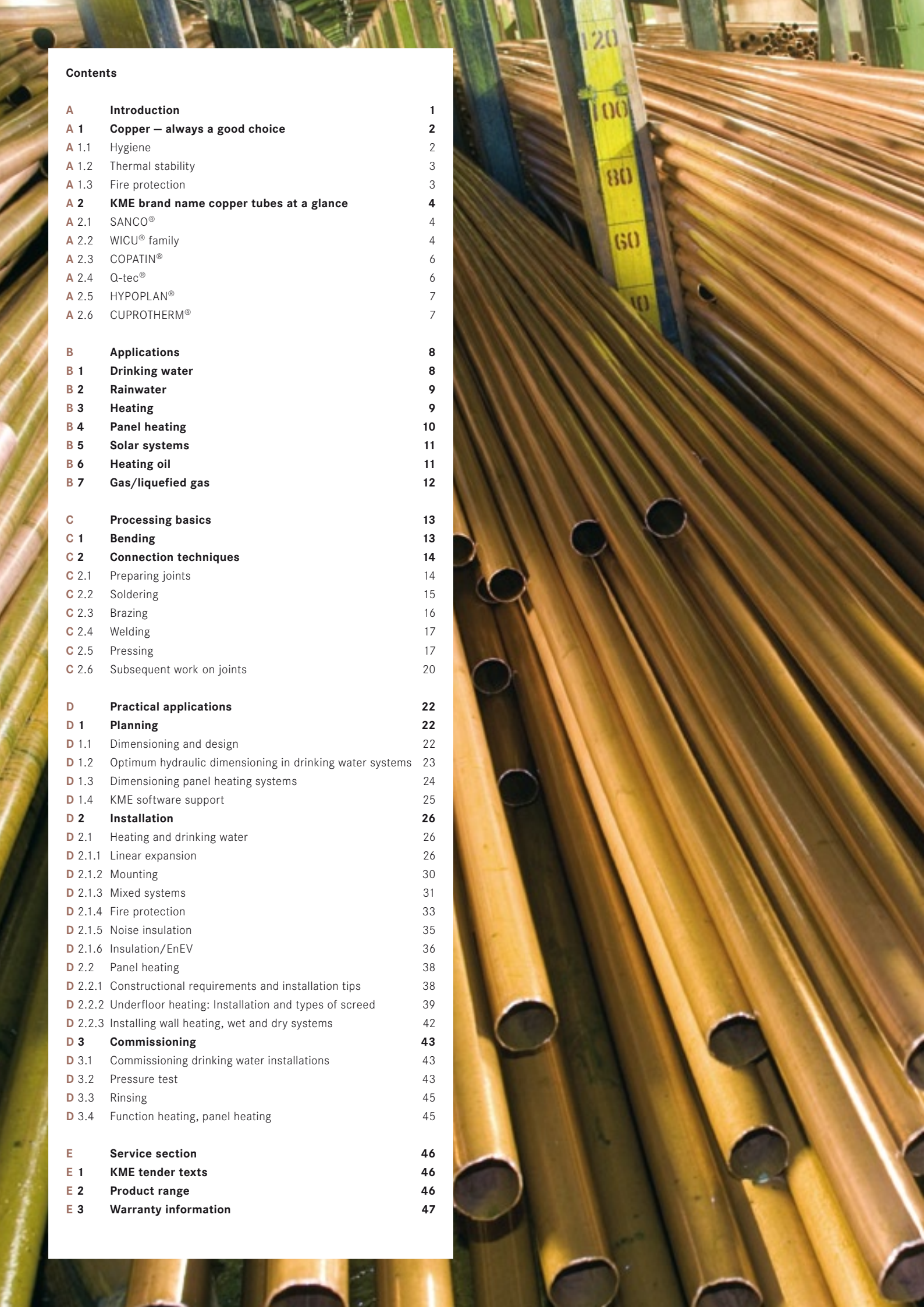
Plumbing Tubes

Planning and Installation with KME Brand Name Copper Tubes

KME Germany AG & Co. KG
Plumbing Tubes
[GB]

Member of the KME Group



Contents

A Introduction

This application brochure contains the most important planning and processing information you need to use KME brand name copper tubes and systems. The concise, clear presentation ensures that you find what you really need at a glance. If you need any further information, the latest data and online features of KME Germany AG & Co. KG are available. The enclosed CD-ROM features a selection of documents you might find useful, and you can download further documents at www.kme-tube-systems.com. Each section contains the corresponding references.

KME product and system solutions fulfil all the relevant quality standards and are also extremely reliable and easy to work with. With a comprehensive range of services, KME Germany AG & Co. KG is the competent partner at your side.

A 1 Copper — always a good choice

Wherever you need tubes for domestic plumbing, KME brand name tubes are always the right choice. As opposed to other installation materials, they can be used in all domestic plumbing applications. As a natural material, copper has the broadest range of applications of all tube materials. It has many benefits:

- **impervious to oxygen diffusion and UV-resistant.**
- **low thermal linear expansion**
- **proven resistance to ageing and corrosion**
- **high mechanical resistance**
- **versatile, simple processing and connection techniques that have been tried and tested over generations**
- **environmentally friendly and fully recyclable**

The metal proves its worth under extreme stress and also fulfils the highest reliability and durability requirements. No wonder that more than 60 per cent of German household plumbing installations are made from copper. The consistent in-house and external monitoring of production at KME and our DIN ISO 9001 quality management system guarantee the constant high quality of our brand name tubes.

A 1.1 Hygiene

Copper also has many advantages when it comes to hygiene. This is especially important in drinking water systems. Copper's ability to withstand high temperatures allows preventative measures against legionella to be carried out especially efficiently. For instance, hot water circulation systems can regularly be flushed with hot water (> 70 °C) and/or a continuous low dose of chlorine. According to recent studies, the material has additional benefits compared to stainless steel and plastic. At 25 °C copper tube installations have much lower concentrations of legionella and, as opposed to other materials, no legionella could be found at 55 °C.

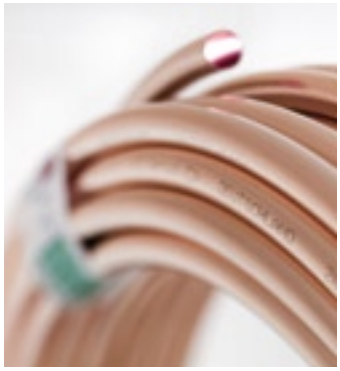
A 1.2 Thermal stability

Because of their extreme thermal stability, copper tubes can be used at all permitted operating temperatures in domestic installations. They also have a comfortable safety factor in case of overheating in the heating system, for example due to faults in the controls. Copper also has low thermal expansion during of temperature fluctuations, which keeps the expense of installing suitable compensation measures within reasonable limits.

A 1.3 Fire protection

Copper tubes are not flammable and do not form toxic gases in the event of fire. This is especially important where the focus is on minimising fire loads – for example, in preventive fire protection in hotels or high-rise public buildings. Copper tubes are an economical way of meeting LAR specifications (tubing system guidelines) of the individual federal states in Germany.

A 2 KME brand name copper tubes



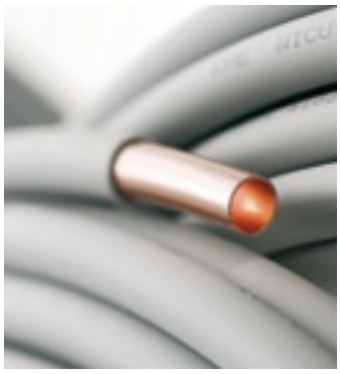
A 2.1 SANCO®

SANCO® can be used in all domestic plumbing applications – in drinking water systems and rainwater systems, for heating and solar systems and for oil and gas lines. Plumbing, heating and air conditioning suppliers have 23 outer diameters from 6 x 1 to 267 x 3 mm to choose from at wholesalers who stock the full range of products. As a standardised product it can be used with fittings and connection techniques from many different manufacturers. No other tube offers this service spectrum or the system openness, which is another important reason why SANCO® is so popular with wholesalers and contractors.

With its patented manufacturing process, which guarantees extreme durability and corrosion resistance, SANCO® has become the leading brand for domestic installation in all European markets. It is by far Europe's leading bright copper plumbing tube.

A 2.2 WICU®-Family

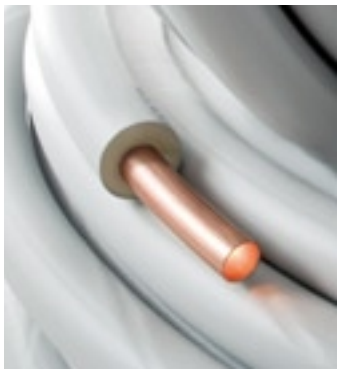
With the WICU® system KME offers contractors a ready covered, thermally insulated brand name copper tube as well as a selection of suitable preformed parts and accessories. Many requirements for the installation system – such as thermal and sound insulation – are fulfilled during the manufacturing process in the factory. This saves contractors planning and installation time. The range includes tubes for drinking water, rainwater, heating systems and oil and gas lines.



The WICU® system includes the following tubes and system components:
WICU® Tube • WICU® Eco • WICU® Eco preformed parts • WICU® Flex • WICU® Frio • WICU® Clim

WICU® Tube

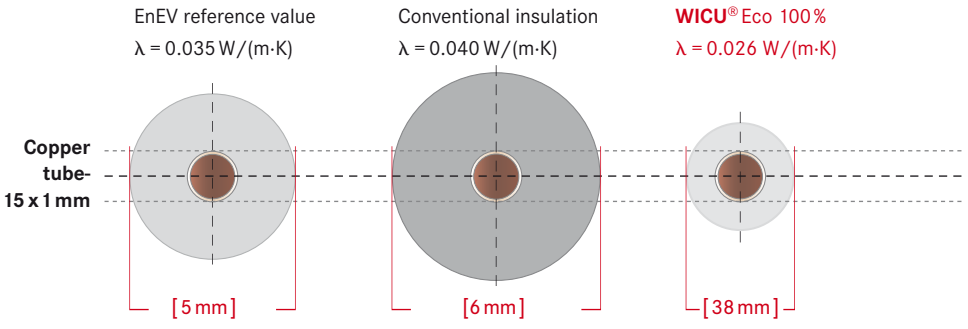
The plastic covered WICU® Tube is suitable for all domestic plumbing applications with no heat insulation requirements. The plastic coating protects the tube against external effects and prevents sound transmission and condensation. WICU® Tube is available in coils and 5 m lengths, it is easy to bend and can be processed with all conventional fittings. Among other things, it is suitable for installation under plaster, in rooms with an aggressive atmosphere and installations with exposed exteriors above or below ground (e.g. liquefied gas).



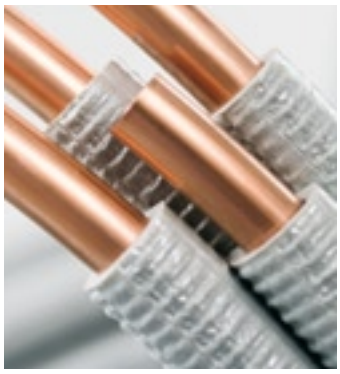
WICU® Eco

The energy-saving WICU® Eco tube for distribution lines in heating and hot water systems comes with particularly efficient thermal insulation. This ensures that the insulation specifications of the German energy saving regulation (EnEV) are complied with at every point in the domestic plumbing installation. The tube is available with two insulation thicknesses. This allows you to fulfil the 100 % or 50 % requirements of the EnEV.

The insulation material has an extremely low heat conductivity factor of λ = 0.026 W/(m·K). With the same insulation effect, heating and hot water installations with WICU® Eco have a much smaller outer diameter than tubes that are insulated in the conventional manner. No space is wasted.



Suitable preformed parts (90° bend, T-piece, hose) which complement the system are available to insulate and cover WICU® Eco joints.



WICU® Flex

WICU® Flex is a thermally insulated copper tube coil with an especially flexible, adjustable insulation sheath. This saves the time that is normally needed to insulate joints afterwards, which in turn saves costs. There are added processing benefits especially at the joints, as the insulation material does not have to be stripped and replaced afterwards. The tube also has good thermal and sound insulation properties. This effectively supports measures to improve structure-borne sound insulation according to DIN 4109, supplementary sheet 2. WICU® Flex is suitable for connecting radiators and in distribution lines for hot and cold domestic water systems where no energy saving regulation (EnEV) requirements have to be considered.

WICU® Solar/WICU® Solar Duo

The WICU® Solar/WICU® Solar Duo tube bundle from KME offers a complete solution for simple installation to connect solar collectors and heat exchangers. The hot and cold lines are in one string, come with optimum insulation and are easy to install. The control line between the temperature sensor and the solar control system is also integrated. This considerably reduces the installation time for solar power systems.

The tube bundle is protected by an extremely durable, UV-stable outer sheath made from soft polyethylene (PE-LD). The tube bundle also comes complete with all the required installation accessories.

WICU® Frio and WICU® Clim

WICU® Frio and WICU® Clim tubes were especially developed to transport refrigerants and cooling gases – for example in split-cycle air conditioning systems. The core copper tube is manufactured according to EN 12735-1 and, in accordance with the standard, has a particularly clean and metallic smooth inner surface. This protects the entire cooling circulation system. The flexible sheath, made from HFC/CFC-free foamed polyethylene, prevents condensation and reduces cold losses. A PE film with a high resistance to steam diffusion prevents condensation entering the insulation, which ensures the long-term insulating effect of the flexible PE sheath.
WICU® Frio air conditioning tubes are supplied in metric sizes and are especially suitable for air conditioning systems from German and European manufacturers with the respective connections. They are available in the dimensions 10 x 1 mm to 18 x 1 mm in 50 m coils and 22 x 1 mm in 25 m coils.

The WICU® Clim tubes are available in inch sizes. They allow air conditioning units from Asian or US manufacturers to be installed without the need for adapters. These tubes are available in the sizes 1/4" to 1/2" in 50 m coils and 5/8" to 7/8" in 25 m coils.

A 2.3 COPATIN®

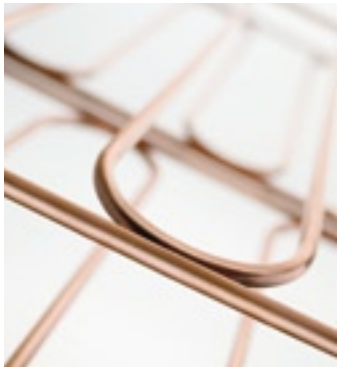
COPATIN® is the premium tube from KME for all drinking water and rainwater systems. It can also be used in heating technology and as a gas pipe. The seamlessly extruded copper tube has internal, high-quality tin plating. The inner surface is refined (tin). This guarantees constant drinking water quality at the tap and ensures excellent corrosion protection. According to DIN 50930, Part 6, tin-plated copper tubes are expressly suitable for all drinking water properties according to the German drinking water regulations. Consequently, when COPATIN® is used, no drinking water analysis is required. COPATIN® tubes can be connected with press fittings or capillary fittings (soldered). In the system, COPATIN® tubes are cold pressed with the specially designed COPATIN® press fittings from Viega. With the extensive range of press fittings that is available, joints, bends and connections in a drinking water system can be installed very quickly, reliably and economically. The COPATIN® system is also approved for gas lines according to the TRGI rules.

A 2.4 Q-tec®

The Q-tec® brand name tube system is especially good value for money and can be used in virtually every domestic plumbing application. It is made from particularly thin-walled and lightweight copper tube with a polyethylene sheath. This combination produces a sturdy but also very flexible copper tube. It uses two thirds less copper than traditional copper tube rings.

Q-tec® has considerable benefits when is comes to flexibility – for example, in drinking water distribution systems, to connect radiators or in panel heating systems. With SANCO® inside where the tubes come into contact with water, they are especially suitable for the hygienically safe transport of drinking water.

The applications also include panel cooling systems, outdoor heating and ground source absorbers. Because of the tight, non-positive connection with a sturdy plastic covering, it is also suitable for concrete core activation.



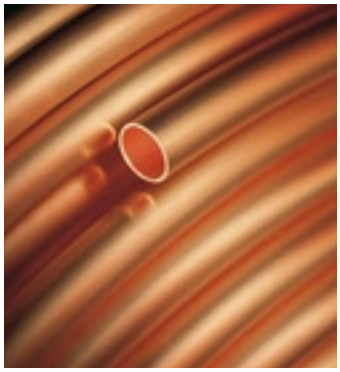
A 2.5 HYPOPLAN®

The HYPOPLAN® wall heating system from KME saves energy and is maintenance free, creates a healthy room climate and allows you to design the room without having to worry about the position of radiators. The heat is radiated via mineral plaster on the wall or ceiling in which copper tube registers are embedded. With just six types of register, the system can be installed virtually anywhere. The preformed wall heating modules, made from 10 mm high-quality copper tubes, can be combined in many different ways. Because of their especially thin design, the HYPOPLAN® wall heating systems can be installed in normal plaster thicknesses of 17 to 20 mm. The heat registers can also be installed in dry constructions with systems such as plasterboard. In this case, the heat registers are fixed to the wall panels with self-adhesive thermal baffle plates. With the corresponding add-on technology, the system can also be used to cool room in summer with no unpleasant draughts.

A 2.6 CUPROTHERM®

CUPROTHERM® copper tubes have been used successfully in domestic plumbing for many years. Once they have been installed, you can forget about them – the only way you notice the panel heating system is as a comfortable source of heat. Copper in its purest form, Cu-DHP, has proven to be an ideal tube material to ensure trouble-free continuous operation. The CUPROTHERM® tubes have the highest thermal conductivity rating of all plumbing materials.

For the CUPROTHERM® systems with wet and dry screeds the heating tubes have a protective sheath that protects the copper tube against mechanical damage during shipping, installation, and handling on the building site. It also protects the copper tube against external chemical effects (e.g. aggressive building materials in combination with moisture or swimming pool water containing chlorine). It allows the copper tube to expand without restriction, which happens when the hot water temperature rises.



The bright copper tube

No other material is more suitable for use in mastic asphalt screeds than high-quality copper. The most important component for long term operation of the CUPROTHERM® panel heating system – the copper tube – is ideal for embedding in mastic asphalt because of its thermal stability. For this application bright CUPROTHERM® heating tubes in the sizes 12 x 0.7 mm or 14 x 0.8 mm are used.

B Applications

	SANCO®	WICU® Tube	WICU® Eco	WICU® Flex	WICU® Frio	WICU® Clim	COPATIN®	Q-tec®	HYPOPLAN®	CUPROTHERM®	OSNASOL®
Drinking water/rainwater											
Basement/riser lines	X	X	X[1)]	X[2)]			X				
Distribution system	X	X	X[1)]	X[2)]			X	X			
Heating											
Basement/riser lines	X	X	X[1)]	X[2)]			X				
Connecting radiators	X	X	X[1)]	X[2)]			X	X			
Panel heating/cooling											
Floor								X		X	
Wall									X		
Open areas								X		X	
Solar power systems	X						X				X
Heating oil	X	X									
Natural gas	X	X					X				
Liquefied gas	X	X									
Sprinkler	X	X					X				
Extinguishing water	X	X					X				
Refrigeration					X	X					
Other											
Ground source absorber								X		X	
Concrete core activation								X		X	

1) Thermally insulated for hot water and heating installations according to EnEV
2) Flexibly and sound insulated for cold water and hot water lines as well as heating tubes with no particular thermal insulation requirements according to EnEV

B 1 Drinking water

The KME brand name copper tubes SANCO®, WICU® and Q-tec® are DVGW-certified for use in drinking water systems. They can be used for all drinking water that complies with the provisions of DIN 50930-6. Accordingly, they can be used if

- the pH is at least pH 7.4, or
- if the pH is between pH 7.0 and pH 7.4, the TOC value is no higher than 1.5 mg/l.

This is the case in almost all water supply regions in Germany, apart from a few exceptions. According to DIN 50930-6, COPATIN® tubes with internal tin plating, which are also DVGW-certified, can be used for all drinking water with no restrictions.

Evaluating water analyses:
The water utilities must provide the latest analysis data for the drinking water that is needed to evaluate the areas of application on request. KME Germany AG will provide assistance in the evaluation of water analyses and will inform you about the use of its brand name copper tubes in drinking water installations:

Fax hotline (in Germany): +49 (0)541 321-4320

In drinking water installations copper tubes not only have advantages in terms of hygiene (see Section A1). They are also very durable, can withstand high pressures and are completely recyclable. With the extensive KME product range it is possible to realise complete drinking water installations using the versatile, durable material, copper. From the house connection filter to the tap – we have a wide range

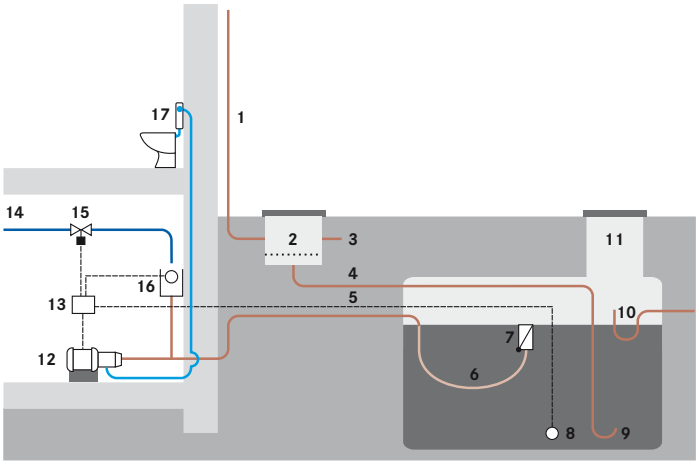
of brand name copper tubes with ideal installation properties. For example, rising mains made with SANCO® can be combined with Q-tec® distribution tubes to create a complete, economic and installation friendly system.

B 2 Rainwater

Applications for rainwater include toilet flushing, washing machines, cleaning and watering the garden. Rainwater is not only used in private households, it is also used in many public and commercial areas.

Water from rainwater harvesting systems is not drinking water. Consequently, the usage criteria of DIN 50930-6 for the use of copper pipes are not applicable in this area. Planning and installation are carried out according to DIN 1989 and EN 1717. According to DIN 1989-1 "rainwater harvesting systems", the tube systems certified by DVGW for drinking water installations are also approved for rainwater utilisation.

Hence, the KME brand name copper tubes SANCO®, WICU®, Q-tec® and COPATIN® can be used without restriction. The main specification for rainwater harvesting systems is that a separate tube system, absolutely separated from the drinking water system, is installed. The tubing system is dimensioned in accordance with DIN 1988.



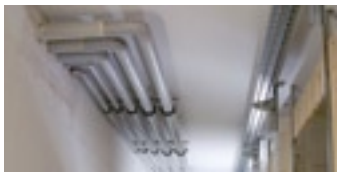
Basic design of a rainwater harvesting system, with underground storage facility

1 Rainwater pipe
2 Filter
3 Seepage or sewage system
4 Rainwater feed
5 Suction and control lines
6 Floating withdrawal line
7 Non-return valve
8 Level sensor
9 Stabilised feed
10 Overflow siphon with connection to the seepage or sewage system
11 Pump
12 Controller
13 Cold water
14 Tank for water backfeed
15 Inspection shaft
16 Motor-operated valve
17 Consumer

B 3 Heating

KME brand name copper tubes in heating systems are not only corrosion resistant and age-proof, they are also not affected by high hot water temperatures. Even if the hot water temperature rises uncontrollably (if the control system breaks down, for example) you do not have to worry about the tube being damaged. In addition, copper tubes are absolutely diffusion proof; steel components such as boilers or distributors are thus protected against corrosion. And, last but not least, because of their low thermal expansion coefficient, copper tubes offer ideal requirements for installation and operation.

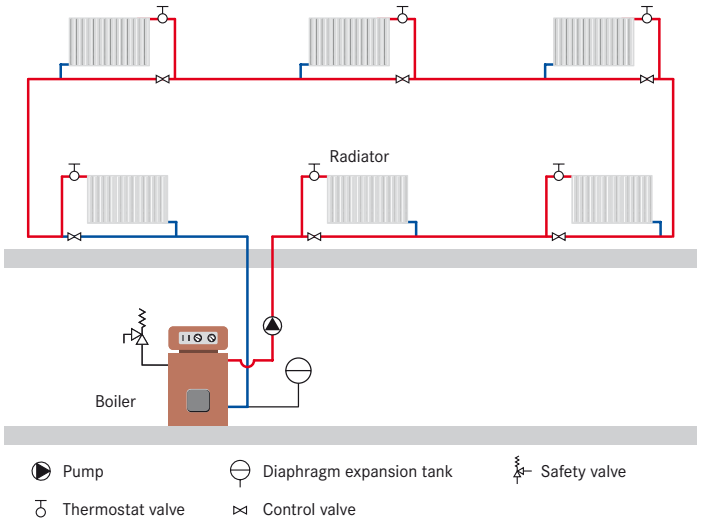
Depending on how the water flows in the tubing system on the various floors, we distinguish between one and two tube systems. The simplest and cheapest design is single tube heating with the radiators connected in series, in which case the heating water circulates through all the radiators in turn. However, the most common system of heat distribution is the two-tube system. Each radiator is connected to the feed and return lines and has the same flow temperature. The heating output is controlled by thermostat valves.



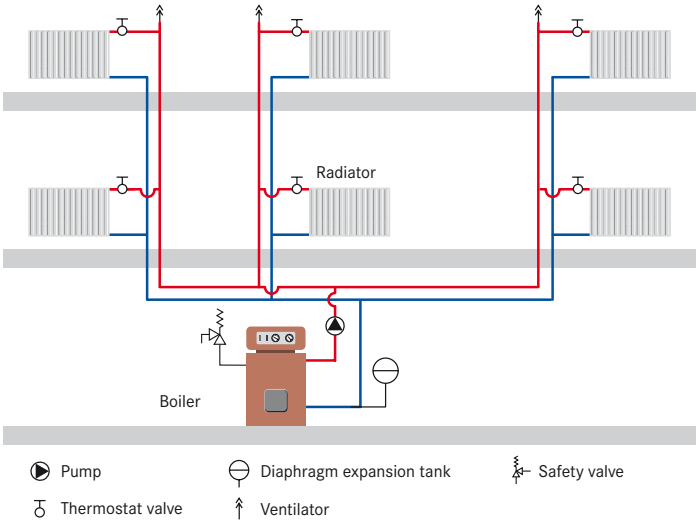
In two-tube heating systems the following variants are available:
- Central heat distributor
- T-piece installation (distribution via T-pieces or cross fittings)
- Distribution below the skirting board

Besides the classic bright SANCO® copper tube, the KME brand name copper tube range has many other options that are ideal for contractors. For example, the WICU® system includes pre-insulated copper tubes. When these are used, they can considerably reduce planning and installation time. The especially effective insulating layer of our WICU® Eco energy saving tubes also saves a lot of space, as the required insulation effect is achieved with a particularly small outer diameter. Radiators can be connected with the especially lightweight and flexible Q-tec® tubes, an economic alternative with the added advantage that the tubes are also very easy to work with.

Single tube heating



Two tube heating



B 4 Panel heating

The pleasant radiated warmth and energy-saving design are the main reasons why more and more house owners and renovators are choosing panel heating. Panel heating systems are especially suitable for the low feed temperatures of modern condensing boiler central heating systems, but also for operation with innovative heat generators, such as solar power or heat pump systems. The average feed temperatures are 30 to 40 °C, which is well below that of radiator heating systems.

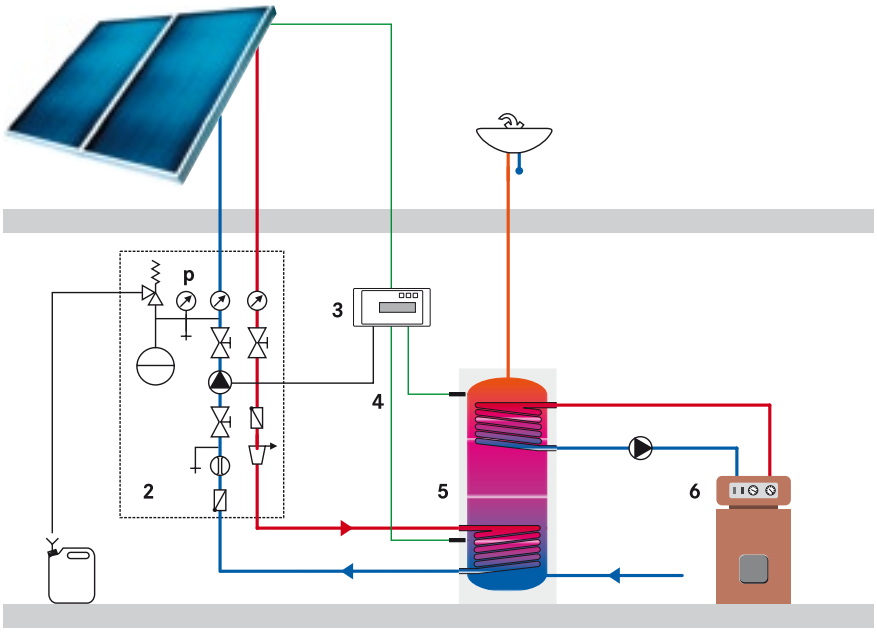
Copper tubes also provide unbeatable benefits in panel heating systems. They have the highest level of heat conductivity of all plumbing materials, which ensures an especially high heat output. The extreme temperature stability and the fact that copper tubes are resistant to oxygen diffusion help guarantee many years of uninterrupted operation. The material is also exceptionally age-proof, while the soldered or pressed joints provide reliability for many, many years. The low linear expansion of copper is yet another advantage. Plastic materials can expand up to twelve times more than copper at the same temperature.

The HYPOPLAN® system is ideal for wall heating and also for wall and ceiling panel cooling systems. Underfloor heating systems can be implemented quickly, easily and inexpensively with Q-tec® or CUPROTHERM® and the corresponding KME system accessories.

B 5 Solar systems

These days, in solar power systems the tubing is almost exclusively copper. This is because the material is also suitable for high temperatures. It remains stable at temperatures of 150 °C and higher and also at extremely cold temperatures in winter. Compared to other materials copper tubes exhibit a low degree of thermal expansion, which is particularly important in view of the high temperature differences the tubes are exposed to. Besides, they can also be installed quickly and easily. All copper tubes according to DIN EN 1057 can be used.

SANCO® brand name copper tubes are often used to connect the solar collectors and storage units. Alternatively, for the collectors KME also has the brand name product OSNASOL® – a completely enclosed and thermally insulated tube bundle. The unit consists of the feed and return lines and an integrated measuring cable.



1 Collector field
2 Solar station
3 Solar controller
4 Sensor and control line
5 Solar storage unit
6 Heating boiler

Safety valve
Pump
Pressure gauge
Gravity braking system
Thermometer
Central ventilation system
Diaphragm expansion tank
Flow meter
KFE tap
Collector tank
Valve
Temperature sensor

B 6 Heating oil

Dimensions for the installation of heating oil lines of certified WICU® and SANCO® copper tubes

R220 soft in coils in mm	**R250 half-hard in str. lengths** in mm
6 x 1.0	
8 x 1.0	
10 x 1.0	
12 x 1.0	12 x 1.0
15 x 1.0	15 x 1.0
18 x 1.0	18 x 1.0
22 x 1.0	22 x 1.0
	28 x 1.0

Sizes of 12 x 1.0 mm and larger also have the DVGW inspection mark.

EL heating oil (extra-light) according to DIN 51603, Part 1 is a flammable liquid which is also hazardous with water. SANCO® and WICU® copper tubes are especially suitable for this demanding area. Coils and half-hard straight lengths of copper tubing may be used.

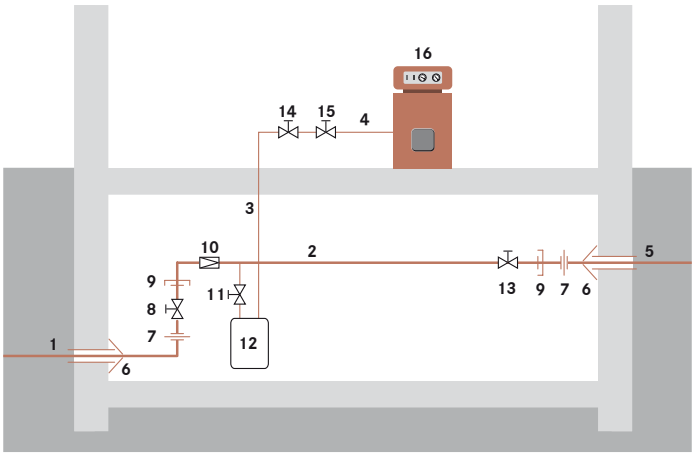
The connection lines from the oil tank to the oil burner can be installed as single or two-line systems. Because of the lower installation effort, the single-line system is most popular these days. A pump sucks the heating oil from the tank through a single line and feeds it to the oil burner.

B 7 Gas/Liquefied gas

Copper tubes have been used for many years as connection lines between the central gas supply and the gas appliances and warm water heaters, but also for the increasingly popular gas sockets. They remain gasproof, even after many years, are not flammable and do not produce toxic gases in the event of a fire. They can also be installed and joined quickly and easily in this area of application. Besides our brand name copper tubes, SANCO® and WICU®, COPATIN® (our tube with the internal tin plating) also bear the DVGW inspection mark for gas installation.

Copper tubes can be installed for natural gas and liquefied gas inside and also outside the house, above or below ground. Outside lines must be protected against external corrosion. For this WICU® tubes from KME are supplied with a suitable corrosion protection sheath.

The WICU® plastic sheath fulfils the requirements for external corrosion protection according to DIN 30672, stress class B (corrosive soils) in the following points: freedom from pores, sheath resistance, indentation resistance, impact resistance, elongation at tear and tensile strength.



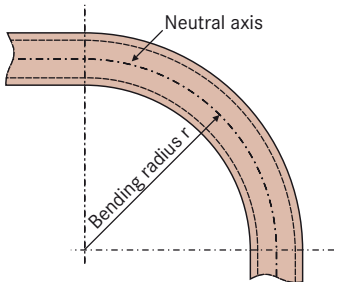
Tube system
1 House connection
2 Distribution line for unmetered gas
3 Consumer line for metered gas
4 Device connection line
5 Underground outside line

Components
6 Pull-out protection
7 Insulation
8 Service valve
9 Detachable connection
10 Gas pressure control device
11 Gas meter valve
12 Gas meter
13 Valve
14 Device connection fitting
15 Thermally triggered valve
16 Gas device

C 1 Bending

Because of their good ductility, copper tubes can be bent cold. Hot bending, especially filling the tubes with sand and bending them hot, is seldom used these days.

Hence, we will only describe bending cold tubes, with and without tools here. With small tube sizes cold bending enables changes in direction to be made quickly and can be used for all hardness levels. This is especially easy with soft copper coils, as they can be bent by hand without any tools. This means, for example with radiator connections, that there is no need for the time and cost consuming use of preformed parts. But time and material costs can also be saved during installation by bending half-hard and hard straight lengths.



Bending KME brand name copper tubes

Strength level	Without tools	With tools
SANCO®, WICU®, COPATIN® soft R220 coils	All	All
SANCO® half-hard R250 straight lengths		up to 28 x 1.5
SANCO® hard R290 straight lengths		up to 10 x 1
WICU®, COPATIN® hard R290 straight lengths		up to 18 x 1
Q-tec® coils	All	All

Where the tube is bent there must be no narrowing of the cross section and no folds or kinks. This also applies to tubes that are bent using tools. Consequently, when copper tubes are bent, a minimum bending radius must be adhered to. The bending radius refers to the centre line of the tube, the so-called neutral axis, and depends on the tube diameter and the process used for bending.

Bending without tools

Soft SANCO®, WICU® and COPATIN® tubes in coils can be bent by hand. Larger bending radiuses are also created when changing direction simply by installing the tube from the coil. The bending radius when tubes are bent without tools depends on the outer diameter of the tube and, as experience has shown, is six to eight times the outer diameter.

Bending with tools

To make smaller bending radiuses, contractors have a range of tools from well-known manufacturers available. The regulations relating to soft copper tubes contain no specifications for the minimum bending radius. The following minimum bending radiuses apply to hard and half-hard straight lengths of SANCO®, WICU® and COPATIN®:

	Radius of the neutral axis in mm	
Tube dimension	hard R 290	half-hard R 250
6 x 1.0	30.0	-
8 x 1.0	35.0	-
10 x 1.0	40.0	-
12 x 1.0	45.0	45.0
15 x 1.0	55.0	55.0
18 x 1.0	70.0	70.0
22 x 1.0	-	77.0
28 x 1.5	-	114.0

With the thermally insulated WICU® Eco tube coils, the sheath must be removed from the bending area before you bend the tube with a tool. After the tube has been bent, the bend is covered with a WICU® Eco preformed part (hose).

To bend WICU® Flex tubes, you slide the sheath back where the bend is to be made and hold it in place with a clamp. When the bend has been made, the sheath is simply pushed back in place again.

Because of their thinness, Q-tec® tubes can be bent easily by hand or also with a bending spring or bending tool. The following minimum bending radiuses apply:

	Bending radiuses (minimum) mm	
Tube dimension	**By hand**	**With tool**
14 x 2.0	70.0	50.0
16 x 2.0	80.0	55.0
20 x 2.0	140.0	80.0

C 2 Connection Techniques

All copper tube connections must remain sealed even under changing operating conditions (e.g. fluctuations in temperature and pressure). Permanent joints can be made by soldering, brazing, welding or pressing the tubes together. The following list shows which connection techniques are permitted in the different areas:

	Drinking water/ Rainwater	**Heating**	**Solar**	**Oil**	**Gas/liquefied gas**
Soldering	X	X[1)]			
Brazing	X[2)]	X	X	X	X
Welding	X[3)]	X[3)]	X[3)]	X[3)]	X[3)]
Pressing	X[4)]	X	X[4)]	X[4)]	X[4)]
Insertion*					

1) To 110 °C
2) From 35 x 1.5 mm
3) Welded joints can be used in all installations where the wall thickness is at least 1.5 mm, in drinking water systems from 35 mm outer diameter.
4) For pressed joints only press fittings with a special sealing element may be used – suitable for the respective application.

Exceptions apply to the KME brand name copper tubes COPATIN® and Q-tec®. Here, press fittings are used in the respective areas of application (see Pressing).

* *Insert fittings are standardised in prDIN 1254-6 (draft). The permitted applications are certified by the manufacturer or by a DVGW inspection mark.*

C 2.1 Preparing joints

Note: The sheath must be removed from WICU® Tube and WICU® Eco before the tubes are joined. Pay attention to the following lengths of sheath that must be stripped.

Tube dimension	**Soldering**	**Brazing**	**Pressing**
8 x 1 up to 22 x 1	80 mm	120 mm	40 mm
28 x 1.5 up to 35 x 1.5	120 mm	160 mm	40 mm
42 x 1.5 up to 54 x 2	120 mm	200 mm	50 mm

1.
Deburr the inside and outside of the tube

2.
With soft tubes calibrate the ends of the tube with a suitable calibration tool (ring and mandrel)

With WICU® Flex this is not necessary. Here, the flexible insulation layer is slid back and held in place with clamps; when the joint is complete, the clamp is removed and the sheath is then pushed back in place. Any visible areas of tube are covered with a piece of insulation and the joints are sealed with Coroplast (the Section Subsequent work, p. 20).

Otherwise, proceed as shown opposite.

C 2.2 Soldering

Soldered joints can be used in cold and hot water installations and in heating systems with operating temperatures up to 110 °C. Gas, liquefied gas and oil lines may not be soldered. As temperatures in excess of 110 °C can occur in thermal solar systems, these lines are also not soldered.

1.
Preparations for making joints

Clean the areas to be soldered

Soldering is generally performed with copper capillary solder fittings (Cu-DHP) or gunmetal (G-CuSn5ZnPb), which, depending on the material, is available for outer tube dimensions of up to 108 mm.

2.
Preparations for making joints

Apply solder paste or flux

Soldered joints are made with the help of a flux or solder paste, which comprises a mixture of flux and pulverised solder. The solid solder wire must have the same alloy as the solder in the solder paste.

In drinking water systems, only solders according to DVGW, worksheet GW 2, may be used. A tip to make the job simpler and prevent confusion is to use the same solders also for soldered joints in heating systems.

3.
Attach the fitting

Soldered joints must always be made with flux or solder paste, which comprises a mixture of flux and pulverised solder.

4.
Connection process

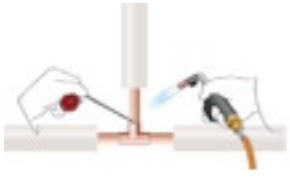
Preheat the fitting and tube evenly with a neutral flame

Solder additives

Solders according to DIN EN 29453 and DVGW, worksheet GW 2	S-Sn97Ag3	S-Sn97Cu3
Melting interval (°C)	221 – 230	230 – 250
Flux according to DIN EN 29454-1	Type 2.1.2, Type 3.1.1 oder Type 3.1.2	
Solder paste according to DVGW, worksheet GW 2	Min. metal content 60 % by weight Solid solder wire must have the same alloy as the solder in the solder paste.	

5.
Melt the solder or welding additive

Without torch flame



6.
Clean the joint

1.
Preparations for the connection process

Clean the areas to be soldered

2.
Preparations for making joints

With gunmetal fittings flux must also be used in brazing.

3.
Attach the fitting

4.
Connection process

Preheat the fitting and tube evenly with a neutral flame.

5.
Melt the solder or welding additive in the torch flame.

6.
Clean the joint

C 2.3 Brazing

Compared to soldered joints, brazed joints have more temperature stability and also a higher shear resistance.

Brazing can be used in heating, oil, gas and liquefied gas systems and also for thermal solar power systems. According to DVGW, worksheet GW 2, tubes used in drinking water and rainwater systems may be brazed only if they are larger than 28 x 1.5 mm.

For brazing, the same copper capillary solder fittings (Cu-DHP) or gunmetal (G-CuSn5ZnPb) as are used in soldering can be used. Special fittings for brazed joints are also available.

As opposed to soldering, in brazing a flux is not always needed. In drinking water systems, only the types listed in DVGW worksheet GW 2 may be used in brazing.

Brazing Additions

Brazing metal according to DIN EN 1044	AG 106	AG 203	AG 104	CP 105	CP 203
Melting interval (°C)	630 – 730	675 – 735	640 – 680	645 – 825	710 – 890
Working temperature (°C)	710	730	670	740	760
Flux according to DIN EN 1045	FH 10	FH 10	FH 10	Without*	Without*

** If brass or gunmetal fittings are brazed, the brazing metals CP 105 and CP 203, which contain phosphorous, may be used only in combination with flux (FH 10).*

1.
Fitting
Clip or crimp fitting

Crimping

2.
Melt off solder or sulpur additive

3.
Clean connection

Remove scales

C 2.4 Welding

Welding copper tubes with and without fittings is an economic connection alternative, especially with larger tube sizes. No capillary solder fittings are available for tubes with an outer diameter larger than 108 mm, which means that these lines are joined preferably by welding anyway. But welding is often a rational alternative even with smaller sizes.

Welded joints can be used in all installations where the wall thickness of the copper tube is at least 1.5 mm, in drinking water systems from 35 mm outer diameter. All welding work on gas lines or systems that must be officially accepted must be performed by a certified welder with a welding certificate according to DIN EN ISO 9606-3. Various welding processes may be used, such as oxy-acetylene welding, TIG welding (tungsten inert gas) and MIG welding (metal inert gas).

Fittings in accordance with DIN 2607 with the same wall thickness as the tubes to be joined are used. If no fittings are used, butt joints are used to weld copper tubes (according to DIN 8552, Part 3). Angles and T-branches can be created with fittings or collars.

Welding additives

Welding additives	SG-CuAg	SG-CuSn
Melting interval (°C)	1070 – 1080	1020 – 1050
Preferred use	Oxy-acetylene welding	WIG, MIG

No flux is needed for welding; however, a boron-based flux may be used (FH 21 or FH 30).

C 2.5 Pressing

A simple and fast alternative to traditional connection techniques has become popular in many areas of installation – press fittings made from copper or gunmetal. As opposed to soldered joints, there is no fire risk, and in addition, press fittings save a lot of time and, thus, money for each joint.

Press fittings up to 103 mm are available from several manufacturers in various designs for different media in domestic plumbing installations. Only press fittings that are approved for the specific medium may be used. The main difference between the press fittings for different applications is the seal element that is used. The applications range from hot water distribution systems to gas installations. Special designs with FPM seal elements may also be used for oil lines, district heating systems and solar power systems.

Safety press fittings have become established on the market. These fittings ensure that unpressed joints become visible with leaking water and also exhibit a drop in pressure during pressure tests with water. When they have been pressed, the joints are durable, leak proof and safe.

COPATIN® tubes are cold pressed with fully tin-plated COPATIN® press fittings (DVGW worksheet GW 2). These also have the same safety feature.

1.
Preparations for the connection process

Make sure that the seal element is in the correct position.

2.
Attach or tack the fitting

Mark the insertion depth.

3.
Connection process

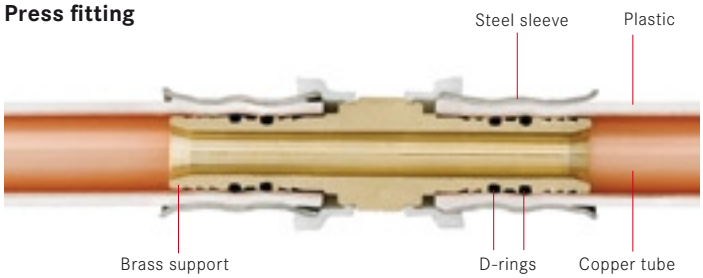
When pressed joints are made it is very important that the ends of the tubes are deburred. By doing this you make sure that the seal element of the press fitting is not damaged when the tube is inserted. This also eliminates any contraction that could have occurred when the tube was cut to size. Contractions could cause turbulence in the flow, which could result in additional losses in pressure.

The sequence of pictures opposite shows the process for pressing KME brand name copper tubes SANCO® WICU®, COPATIN®, CUPROTHERM® and HYPOPLAN®.

Press fittings are also used with Q-tec® copper installation tubes. Q-tec® system press fittings with a double EPDM seal are available. The pressed connection is based on the metal on metal seal, which guarantees a high level of security and reliability. A very high level of pull-out force is guaranteed, regardless of the temperature of the respective medium.

In most cases existing pressing tools can be used to press the joints, assuming they are compatible with the normal TH contours. Q-tec® clamp connections and adapters can be used for connections to heating systems, drinking water distribution systems and control valves.

Press fitting



Joining Q-tec® copper tubes

Cutting to length

The tubes can be cut to length at a right angle with the Q-tec® tube shears, which are available as an accessory, or with a fine-toothed hacksaw.

Deburring and calibration

Before the Q-tec® press fitting is inserted the cut end of the tube must be deburred and calibrated in one process with the Q-tec® tube shears.

If the tube is to be bent directly behind the joint, keep a gap of at least 5 cm from the joint to the bend.

Joints

Q-tec® copper tubes and press fitting must be joined in a straight line as far as they can be pushed together. There must be no sealing or lubrication materials (oil, grease) on the components.

Pressing

The Q-tec® copper tube and press fittings are joined with standard pressing tools and pressing jaws with the TH contour.

C 2.6 Subsequent work on joints

The sheath or insulation on the WICU® system is interrupted by joints. Hence, they have to be reworked after the joint has been made if the regulations for the respective domestic plumbing application specify sheaths or insulation.

Thermal insulation with WICU® Eco preformed parts

Preformed parts (90° bend, T-pieces and hoses) made of foamed polyethylene as well the associated outer shells are available for the subsequent insulation of thermally insulated installations with WICU® Eco tubes. They are easy to bend and keep their shape. The process is shown below using a T-piece.

1.
WICU® preformed parts are used for the subsequent insulation of T-pieces up to 28 mm

Cut the preformed part

2.
Attach the preformed part

3.
Cut the outer shell of the preformed part

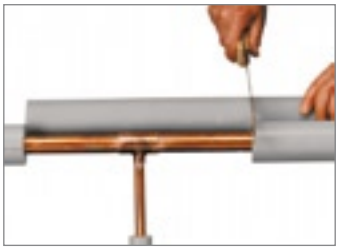
4.
Attach the outer shell of the preformed part

5.
You can also fix the joints with plastic rivets

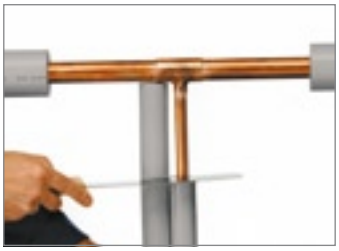
6.
Or seal them, with Coroplast.

Outdoor gas installations:
If the covered WICU® tube for outdoor natural or liquefied gas installations is used, joints have to be protected against corrosion. Consequently, they are covered with corrosion protection type or shrink-wrap hoses according to DIN 30672, paying attention to the processing instructions of the respective manufacturer.

Joint covered in shrink-wrap foil



1.
To subsequently insulate T-pieces larger than 28 mm the joint is insulated with WICU® hose.



2.
Cutting to size

3.
Attaching the short hose

4.
Cutting a hole with the punch

5.
Cutting the outer shell to size

6.
Sealing the joints

D Practical applications
D 1 Planning

D 1.1 Dimensioning and design

Planning and dimensioning domestic plumbing installations is carried out according to the acknowledged rules. To plan hydraulically reliable tube systems you need the material-related, so-called R value (pressure loss caused by friction, given in mbar/m) of the tubing systems. KME provides comprehensive pressure loss tables – based on tube dimension, medium in the tube, temperature and flow rate – and diagrams to make calculations in the different areas of domestic plumbing. They can be found on the enclosed CD-ROM for the various KME brand name copper tubes.

It can be assumed that the rules themselves are known by approved plumbing, air conditioning and heating specialists. The following is a brief overview:

Drinking water:
- *DIN 1988 (parallel in some cases to DIN EN 806)*
  Technical rules for drinking water installations
- *DVGW, worksheet W 551*
  Domestic water heating and drinking water tubing systems; technical measures to reduce legionella growth; planning, installation, operation and modernisation of drinking water installations
- *DVGW, worksheet W 553*
  Dimensions of circulation systems in central drinking water heating systems
- *VDI 6023*
  Hygiene for drinking water supply systems

Rainwater:
- *DIN 1988 (parallel in some cases to DIN EN 806)*
  Technical rules for drinking water installations
- *DIN 1989*
  Rainwater harvesting systems
- *DVGW, worksheet W 555*
  Utilisation of rainwater (roof drainage water) in the household

Heating:
- *VDI 2035*
  Preventing damage in hot water heating systems
- *DIN EN 12828*
  Heating systems in buildings
  Planning hot water heating systems
- *ATV VOB Part C / DIN 18380*
  Heating systems and central water heating systems

Underfloor heating:
- *DIN EN 1264-1 to -4*
  Underfloor heating

Panel heating:
- *DIN EN 1264-5 (in preparation)*
  Heating and cooling panels in floors, ceilings and walls

Solar power systems:
- *VDI 6002*
  Solar domestic water heating

Oil installations:
- *TRbF 50*
  Technical rules for flammable liquids – tubing
- *DIN EN 12514*
  Oil supply systems for oil burners

Gas installations:
- *TRGI DVGW worksheet G600*
  German technical rules for gas installations (TRGI)
- *DIN 18381*
  Gas, water and drainage systems inside buildings
- *TRF*
  German technical rules for liquefied gas

D 1.2 Optimum hydraulic dimensioning in drinking water systems

In drinking water systems wrongly dimensioned tubes and hydraulic problems not only cause operating problems, they also put the supply of hygienically safe drinking water at risk. If the tubing is calculated according to DIN 1988 Part 3 (differentiated method), this provides the requirements for a hydraulically reliable drinking water system. Over-dimensioning should be avoided.

Preventing stagnation

From a hygienic aspect the main aim is to prevent stagnation. Consequently, the tubing systems should be designed so that taps that are not used so often are not supplied via long lines. As stagnated water – regardless of the raw material – can no longer be classified as drinking water, the amount of stagnating water must be kept to an absolute minimum.

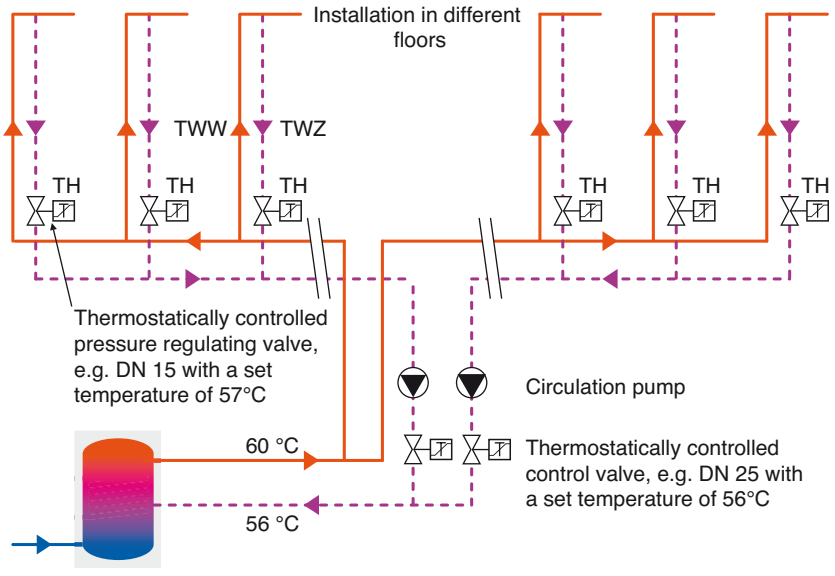
Circulation systems in central water heating systems

In general, contamination through microbial growth, such as legionella, is to be avoided. According to the DVGW worksheets all large systems containing more than 400 l and/or more than 3 l in each line between the water heater and the tap must be fitted with a circulation system.

In regard to drinking water hygiene, DVGW worksheet W553 redefines the dimensioning of circulation systems as set out in DIN 1988, Part 3. Now, according to DVGW worksheet W551, the water temperature in the circulating hot water system may not be more than 5 K below the outlet temperature of the water heater. Besides, for large systems the temperature limit for the operation of circulation systems was set at a minimum of 55 °C. Hence, only DVGW worksheet W 553 should be used to dimension circulation systems with SANCO®, WICU®, Q-tec® and COPATIN®.

Flow rate

To facilitate the hydraulic equalisation of the system, it may be practical to dimension the circulation lines near the pump with higher rates of 0.5 m/s to 1.0 m/s and the lines further away from the pump with lower rates, up to 0.5 m/s. Hydraulic equalisation is performed with pressure regulating valves to ensure the circulation flow rate and temperature differences specified in the plan.



Example of the installation position of control valves

D 1.3 Dimensioning panel heating systems

Underfloor heating:

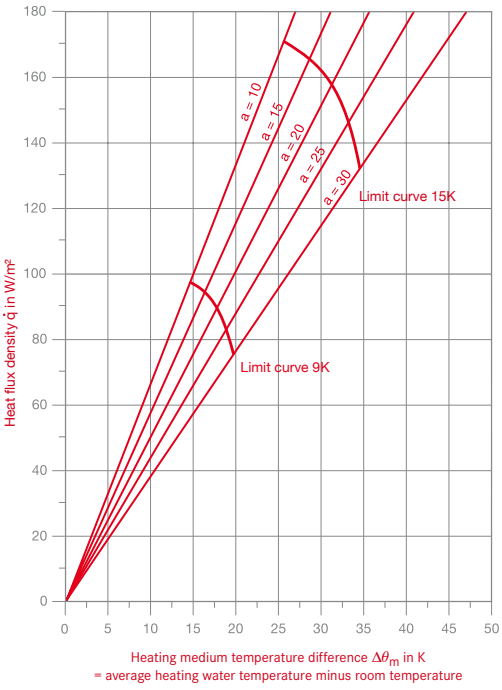
Underfloor heating systems are planned and designed according to DIN EN 1264. Accordingly, for residential and recreational rooms a floor covering with $R_\lambda = 0.10\,m^2K/W$ should be assumed. For bathrooms, toilets, etc, the value is $R_\lambda = 0.0\,m^2K/W$.

However, in practice all types of floor covering are possible. But the limit value of $R_\lambda = 0.15\,m^2K/W$ must not be exceeded.

Another criterion to be considered is the maximum permitted surface temperature:

Area	$\theta_{Fb,max}$
Living area	≤ 29 °C
Border zones (1m deep)	≤ 35 °C
Bathrooms/showers	≤ θ_i + 9 K

For the heating capacity that can be achieved with Q-tec® or CUPROTHERM® in underfloor heating systems KME has commissioned an independent test institute to draw up detailed output diagrams in accordance with DIN EN 1264. You will find them on the enclosed CD-ROM. The diagrams contain the characteristics for the installation gaps 10, 15, 20, 25 and 30 cm. For dry screeds, the installation gaps are taken as 12.5 and 25 cm.



Examples of a diagram::
Top covering groups for wet screeds
valid for 14 x 2 mm, 16 x 2 mm and 20 x 2 mm.
45 mm overlap

To determine the heat output, choose the average heating medium temperature difference (= average heating water temperature minus the room temperature) on the horizontal, determine the installation gap and go to the vertical on the left. There you can see the heat flux density.

For underfloor heating with wet screeds you will also find an interactive output calculator in MS Excel format on the enclosed CD-ROM. On the basis of the system temperatures and the installation gaps between the Q-tec® heating tubes, you can see the heat output (W/m^2) for various floor coverings. You will find extensive information about Q-tec® in underfloor heating systems in the Q-tec® planning documentation for panel heating systems. You can obtain this from KME or download it from the Internet: *www.q-tec.eu.com -> Downloads -> Brochures.*
There you can also obtain the output calculator described above in Excel format.

Wall heating

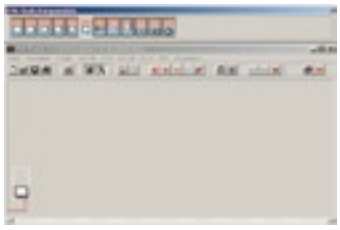
HYPOPLAN® wall heating can be operated with feed temperatures of up to 55 °C; however, the optimum feed temperature is in the range of 40 – 50 °C. This low feed temperature enables the use of conventional low-temperature and condensing boilers as well as regenerative energies, such as solar power and heat pump technology.

At present there are no binding standards for wall heating planning; in the medium term this will be a component of DIN EN 1264. At the same time, HYPOPLAN® wall heating can be designed quickly and easily according to physical principles with the help of the quick design tables which KME has developed for both wet and dry systems. You will also find them on the enclosed CD-ROM.

KME also offers extensive planning aids, which allow precise and reliable planning on the basis of the heating load calculation. Easy-to-understand tables provide precise data for each register type, such as the output at different heading medium temperatures. They can be obtained from KME or downloaded from the Internet at:
www.kme-tube-systems.com -> Service -> Downloadcenter -> Brochures -> HYPOPLAN® Planning documentation

When the positions and arrangement of the heating areas have been decided, the required registers can be assembled on the basis of the planning documents – in relation to the planned feed temperature and the required room temperature.

The tube registers can be connected either in series or according to Tichelman. The latter variant is especially suitable when a lot of heat registers have to be connected. The advantage is that each part of the heating wall has the same pressure losses; hence the temperature and heat output are the same at every point. You will find detailed information about this in the HYPOPLAN® planning material.



D 1.4 KME software support

To assist plumbing, heating and air conditioning contractors and planners, KME offers complete software solutions to calculate tubing systems in drinking water and heating installations and also to plan underfloor heating systems.

KME-Planfix

The intuitive KME Planfix calculates tubing for drinking water and heating systems in compliance with the relevant standards and regulations in no time at all. In just a few steps, users get exact sizes and tubing dimensions. The program operates in a diagram oriented manner with a building block system of various symbols. The computer also draws plumbing and heating diagrams.

Detailed, VOB-compliant material lists with all the required installation tubes, fittings and accessories are also printed out. The insulation requirements according to EnEV are also stored and are displayed for the individual tube sections. The lists can then be exported into commercial software or MS Excel via interfaces.

HT 2000 planning software

KME provides the latest version of HT 2000 planning software when its brand name copper tubes, Q-tec® or CUPROTHERM® are used. This considerably simplifies dimensioning and planning of Q-tec® underfloor heating systems for planners and the plumbing, heating and air conditioning trades.
The software can also be used to create quotations and tenders.

The software is designed to handle the system variants that can be used with Q-tec®, such as wet and dry screeds and industrial panel heating. The software solution also contains a CAD application. In combination with easy-to-operate floor area entry, such as with a scanner, users obtain exact installation plans with just a few steps. The KME software is compatible with the "Willms HT 2000" program package and has GAEB and ZVSHK/UGS interfaces.

These two programs are easy to learn. KME also offers regular seminars at its training centre in Osnabrück, Germany. You can find more information in the Internet at:
www.kme-tube-systems.com -> Service -> Training

D 2 Installation

D 2.1 Heating and drinking water

D 2.1.1 Linear expansion

Every material expands when the temperature rises. With copper tube, linear expansion is exactly 0.017 millimetres per meter of tube when the temperature rises by 1 Kelvin. This so-called expansion coefficient applies regardless of the wall thickness and tube diameter and also for smooth and covered copper tubes.

When high-temperature tubing is being installed, the temperature-related linear changes have to be carefully taken into consideration.

- Linear expansion must be adequately considered.
- Every tubing section must be able to expand.
- A free expansion possibility must be created between two fixed points. This can be done by changing the direction or by using compensators.

The linear expansion of a tube section between two fixed points can be calculated on the basis of the total length and the material expansion coefficient. The following formula applies:

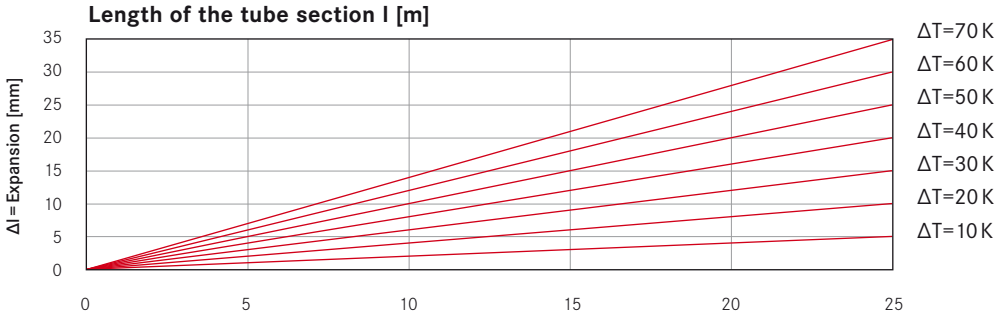
$\Delta l = a \bullet l \bullet \Delta T$

Where:

Δl Expansion of the tube section [mm]
a Expansion coefficient (copper tube 0.017 mm/(m•K))
l Length of the tube section [m]
ΔT Temperature difference between (minimum) ambient temperature and (maximum) operating temperature in the tubing system [K]

Example: When the temperature increases from 20 °C to 60 °C (maximum operating temperature), a twelve metre long copper riser becomes roughly eight millimetres longer (40 K x 12 m x 0.017 mm/(m•K) = 8.16 mm).

The linear expansion can be seen on the diagram below. Based on the total length of the tube section, the linear expansion can be seen at the point where the temperature difference lines intersect.



The temperature-related linear expansion can be absorbed by:

- the correct arrangement and choice of tube fixing methods (fixed points, sliding mounts, slip-in brackets)
- favourable tubing design (avoid long, straight sections of tube)
- expansion compensation, such as expansion bends or axial compensators.

Fixed points

Assemble fixed point clamps according to the manufacturer's specifications. In covered and thermally insulated tubes in the WICU® system (WICU® Tube, WICU® Eco, WICU® Flex) the fixed point clamp must be fitted directly on the copper tube. At this point, the tube sheath must be removed to the width of the clamp.

Slip-in brackets

Horizontal tubes are guided eg by pendulum suspensions. Sliding mounts can be used vertically and horizontally for this purpose.

Change of direction

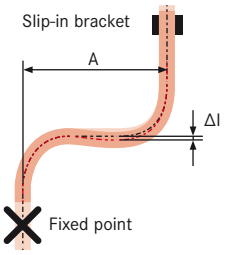
Expansion can be balanced out easily by changing the direction of the tube and installing branches. If the leeway for movement is not sufficient, additional elements, such as expansion bends or compensators must be installed.

If changes of direction are used to absorb expansion, the mounts – also slip-in brackets and sliding mounts – must be sufficiently far away from bends or T-pieces. The minimum gap A is not only based on the calculated linear expansion of the tube section between the bend and the next fixed point, but also on the diameter. Larger nominal widths need bigger gaps. Choose the dimension A in relation to the diameter so that the calculated expansion of the respective tube section can be absorbed. It is calculated according to the formula below:

A = 61 • (d • ΔI) • 0.5

Where:

A Construction dimension [mm] (see drawing)
d outer diameter [mm]
ΔI Expansion of the tube section [mm]



For construction dimension A (in mm) the following table can be used for orientation:

Outer Ø [mm]	**Expansion compensation ΔI** [mm]											
	5	**10**	**15**	**20**	**25**	**30**	**35**	**40**	**45**	**50**	**55**	**60**
12	473	668	818	945	1057	1157	1250	1336	1418	1494	1567	1637
14[1)]	510	722	884	1021	1141	1250	1350	1444	1531	1614	1693	1768
15	528	747	915	1057	1181	1294	1398	1494	1585	1671	1752	1830
16[1)]	546	772	945	1091	1220	1336	1444	1543	1637	1725	1810	1890
18	579	818	1002	1157	1294	1418	1531	1637	1736	1830	1919	2005
20[1)]	610	863	1057	1220	1364	1494	1614	1725	1830	1929	2023	2113
22	640	905	1108	1280	1431	1567	1693	1810	1919	2023	2122	2216
28	722	1021	1250	1444	1614	1768	1910	2041	2165	2282	2394	2500
35	807	1141	1398	1614	1804	1977	2135	2282	242	2552	2676	2795
42	884	1250	1531	1768	1977	2165	2339	2500	2652	2795	2932	3062
54	1002	1418	1736	2005	2241	2455	2652	2835	3007	3170	3324	3472

[1)] *only Q-tec®*

Expansion bends

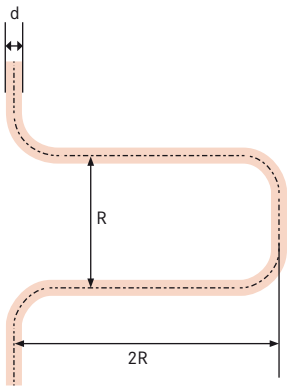
Often, in long, straight sections of tubing, such as risers or lines in suspended ceilings, larger linear changes have to be compensated for. The easiest and least expensive method is to create U-shaped expansion bends.

The calculation also depends on the linear expansion of the tube section and the nominal width. The following formula can be used to calculate U-tube compensators:

R = 16.25 • (d • ΔI) • 0.5

Where:

R Construction dimension [mm] (see drawing)
d Outer diameter [mm]
ΔI Expansion of the tube section [mm]



For construction dimension R (in mm) the following table can be used for orientation:

Outer Ø [mm]	**Expansion compensation ΔI** [mm]											
	10	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**	**125**	**150**
12	178	252	308	356	398	436	471	503	534	563	629	689
14[1)]	192	272	333	385	430	471	509	544	577	608	680	745
15	199	281	345	398	445	488	527	563	597	629	704	771
16[1)]	206	291	356	411	460	503	544	581	617	650	727	796
18	218	308	378	436	488	534	577	617	654	689	771	844
20[1)]	230	325	398	460	514	563	608	650	689	727	813	890
22	241	341	417	482	539	590	638	682	723	762	852	933
28	272	385	471	544	608	666	719	769	816	860	961	1053
35	304	430	527	608	680	745	804	860	912	961	1075	1177
42	333	471	577	666	745	816	881	942	999	1053	1177	1290
54	378	534	654	755	844	925	999	1068	1133	1194	1335	1463

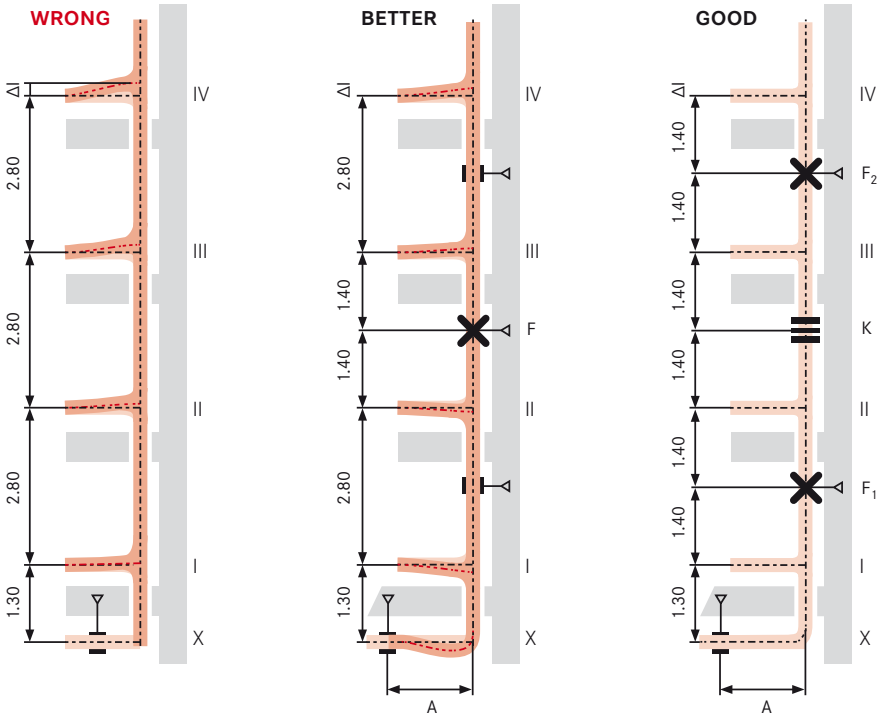
[1)] *only Q-tec®*

Compensators

Instead of expansion bends – especially if there is a lack of space – axial compensators can also be used. As the expansion compensation depends on the type of construction and the manufacturer, you will find the respective data in the manufacturer's instructions. When compensators are being installed, it must be ensured that they can be reached at all times after the system has been put into operation.

Risers with branches

Linear expansion in risers and its effects on branched lines can be shown by the example of a system that covers four floors.



Example 1:
The suspension clamp directly at the base of the riser prevents downward compensation. This causes the entire thermal expansion to work upward, which causes severe deformation in the top branches/ tube systems. The mounting at coordinate X acts like a fixed point for the riser.

Example 2:
An improvement is achieved by pushing the last tube clamp of the basement distribution away from base point X of the riser by distance A and creating a fixed point F between the branches II and III. The thermal expansion is distributed upward and downward. The expansion ratios at the branches are considerably improved.

Example 3:
Further improvement is achieved by installing an axial compensator K between branches II and III and from fixed points F1, F2 between branches I and II and between III and IV.

In all three examples, the respective floor branches must be cushioned so that the thermal expansion of the riser is taken into account at this point. When choosing the distance between the tube clamps from base point X, the minimum section lengths A according to the above table must be considered.

Installation below plaster

When WICU® tubes are installed below plaster, the expansion points must not be plastered over so that they cannot move. Under plaster expansion possibilities must be created by cushioning the tubes with elastic materials. For example, this prevents the expansion movements of a riser being prevented by a plastered branch line.

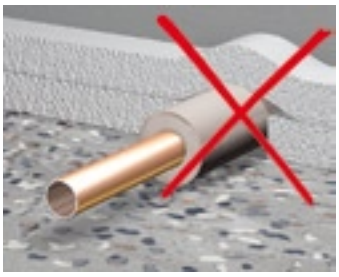
Screeds: Preventing "tube cracking"

Preventing this requires close cooperation between the plumbing, heating and air conditioning contractors and the screed contractor. When these tubes are laid directly on the raw concrete floor, according to DIN 18560, Part 2 a levelling layer must be installed to prevent isolated or linear increases in height and, thus, differences in the thickness of the screed.

Since according to DIN 4108 thermal insulation is always required, generally thermal and impact sound insulation materials are used as a levelling layer – of course, this insulation must be suitable for floating screeds. Different layer thicknesses are required depending on the area of application – apartment separation floors or basement floors against unheated rooms or against the soil or outside air. It must be ensured that in this step the screed layer leaves sufficient space to the side and also above the tube and the insulation material so as not to prevent the tubes expanding. In this connection WICU® Eco tubes offer particular benefits because of their very small overall outer diameter.

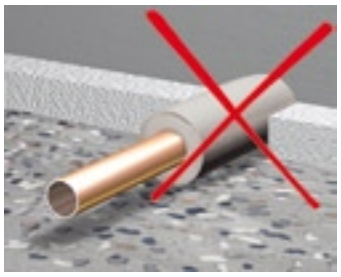
When the insulation material has been installed properly, an even surface must be created to take another layer of insulation or the screed. It is fully adequate to cover the gaps in the insulation material for the tubes with a strip of corrugated cardboard.

Proper installation of WICU® tubes on raw concrete floors by creating an even surface and adequate gaps for expansion movements



Incorrect floor design:

Tube projects into the insulation



Tube projects into the screed

Tube size [mm]	Max. fixing distance [m]
6 x 1.0	1.00
8 x 1.0	1.00
10 x 1.0	1.00
12 x 1.0	1.25
15 x 1.0	1.25
18 x 1.0	1.50
22 x 1.0	2.00
28 x 1.0	2.15
28 x 1.5	2.25
35 x 1.5	2.75
42 x 1.5	3.00
54 x 2.0	3.50
64 x 2.0	4.00
76.1 x 2.0	4.25
88.9 x 2.0	4.75
up 108 x 2.5 to 267 x 3.0	5.00

D 2.1.2 Mounting

The maximum mounting distances for copper tubes used to transport water are defined in DIN 1988. For gas and liquefied gas lines TRGI and TRF contain the distances between mounting devices. The values opposite apply for the KME brand name copper tubes SANCO®, WICU® and COPATIN®:

The following values apply to Q-tec® brand name copper tubes:

Tube size [mm]	Max. fixing distance [m]	
	Horizontal on plaster	Vertical on plaster
14 x 2	1.20	1.55
16 x 2	1.20	1.55
20 x 2	1.30	1.70

Q-tec® copper tubes installed on a bearing surface (raw concrete floor) are fixed with plastic hook bolts every 1.0 m and also before and after bends.

In general, high-temperature tubing systems must be arranged and fixed so that thermal linear expansion is not hindered (see previous section).

Clamps for tubes that transport water must always have sound insulation, such as a rubber insert. For gas lines with SANCO® and WICU® tubes the mounts, such as clamps, must also have elastic inserts (sound insulation). The tubing systems must never be used to carry loads or be attached to other lines.

If several lines are being installed for different media, the tubes which are at risk of developing condensation must be installed below the other lines. This rule also applies to copper tubes, although they are not affected by condensation.

Fixing gas lines

Special safety precautions must be taken with gas lines. The bearing part of the tube mounts must be made from non-flammable materials. At joints the components on which the tubes are fixed must comply with the following specifications:

- in low buildings (for the definition, see the respective state building laws) fire resistance class F 30, and
- in other buildings fire resistance class F 90 according to DIN 4102

The fixing components (such as anchors) must also be made from non-flammable materials. The tubes must be fixed to that they remain stable even in case of fire. The tubes must not slip out of the mounts. In this way there can be no open tube sections from which gas can escape.

D 2.1.3 Mixed systems

A mixed system exists if several metals are used in a drinking water system, such as copper and zinc coated steel tube. To prevent damaging electrochemical processes caused by the oxygen dissolved in drinking water, it is important in cases such as this that the so-called "flow rule" is observed. This rule says that: In drinking water systems with several metals the non-noble metal must be installed before the noble metal in the flow direction. In practice this means zinc coated steel tube or steel tanks (non-noble) and copper tubes and fittings made from copper alloys such as brass or gunmetal (noble). COPATIN® copper tubes with internal tin plating are treated as normal copper tubes.

Strictly speaking, combinations of copper/gunmetal or copper/brass are also mixed systems. However, as gunmetal and brass consist mainly of copper, they can be combined with each other in any ratio. By the way, combinations of copper and copper alloy with copper tubes with internal tin plating also cause no problems whatsoever.

The flow rule does not apply in heating systems. This is a closed system with no feed of oxygen. Hence, the different materials can be combined in any sequence.

Mixed systems in new buildings

In new buildings the combination of zinc coated steel and copper is generally avoided. Usually the use of shut-off valves made from gunmetal or brass in sections of zinc-plated steel piping causes no problems and can be regarded as state of the art. The small surface of the nobler material in relation to the less noble material has a risk minimising effect. Nevertheless, special care must be taken. Experiences with the materials used at the specific site must be considered. In case of doubt, contact the local water utility, the tube manufacturer or other installation companies that are familiar with the respective water supply in the region.

Cold water systems

If basement distribution lines and risers are made from zinc coated steel, only the upstream lines in higher floors to the taps can be implemented in copper. Recirculation from the copper sections to the zinc coated steel sections must be excluded.

Hot water systems

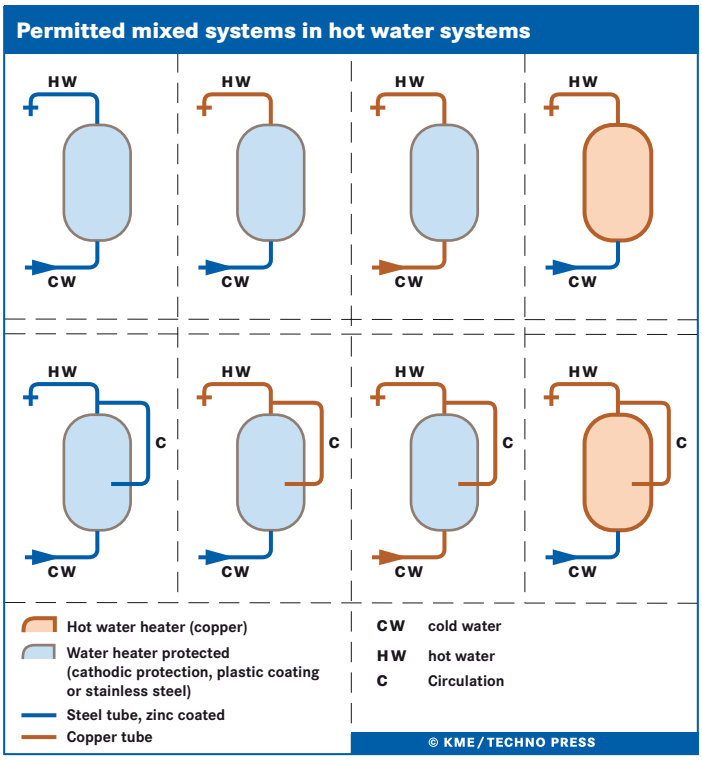
In hot water systems copper tubes may also be used after tubing or tanks made from zinc coated steel. However, this applies only in systems with no circulation lines. In circulation systems, if copper tubes are used, the steel water heater must be protected against corrosion with an internal coating and a sacrificial anode.

Mixed systems in older buildings

In older buildings, the same rules apply as in new buildings. If zinc coated steel tubes or steel tanks are in use and parts are being renewed with copper tubes, there must be no intermediate sections of zinc coated steel.

It is also possible to carry out a partial conversion limited to the zinc coated steel drinking water system. However, all the flow channels in the system must be known to exclude problematic material combinations.

Permitted mixed systems in hot water systems



D 2.1.4 Fire protection

Preventive fire protection is a particularly complex topic in the planning and installation of domestic plumbing systems. Depending on the type of building very strict demands are placed on wall and ceiling penetrations for tubing. The different regional tubing system guidelines are applicable.

KME brand name copper tubes are classified as follows:

		Fire classification according to guideline (LAR/RbALei) for the factory-side scope of delivery		
Tube type	Fire resistance classification according to DIN 4102 and DIN EN 13501-1	*Section 3* Necessary corridors, outdoor exits, necessary stairways	*Section 4.2* Relief according to LAR/RbALei	*Section 4.1* With ABP/ABZ in R30- to R90-grades
SANCO®	A1 (non-flammable)	Non-flammable	Non-flammable	Non-flammable
COPATIN®	A1 (non-flammable)	Non-flammable	Non-flammable	Non-flammable
WICU® Tube	*B2 according to DIN 4102* *E according to DIN EN 13501-1* Non-flammable tube + Flammable sheath 2)	Flammable Non-flammable tube + Flammable sheath 2)	Non-flammable Because sheath ≤ 3 mm thick 1)2)	Penetration in R30- / R90-Qualität Corresponds to system approval incl. flammable sheath 2)
WICU® Flex	*B2 according to DIN 4102* *E according to DIN EN 13501-1* Non-flammable tube + Flammable flexible sheath 3)	Flammable Non-flammable tube + Flammable flexible sheath 3)	Flammable Non-flammable tube + Flammable flexible sheat 3)	Penetration in R30- / R90-grade Corresponds to system approval incl. flexible sheath 3)
WICU® Eco	*B2 according to DIN 4102* *E according to DIN EN 13501-1* Non-flammable tube + Flammable insulation 4)	Flammable Non-flammable tube + Flammable insulation 4)	Flammable Non-flammable tube + Flammable insulation 4)	Penetration in R30- / R90-grade Corresponds to system approval incl. flammable insulation 4)
Q-tec®	*B2 according to DIN 4102* *E according to DIN EN 13501-1* Non-flammable tube + Flammable sheath 2)	Flammable Non-flammable tube + Flammable sheath 2)	Non-flammable Because sheath ≤ 3 mm thick 1) 2)	Penetration in R30- / R90-grade Corresponds to system approval incl. flammable sheath 2)

1) Corresponding to the comment on MLAR 03/2000 [1] the sheath may be ≤ 3 mm if the sheath consists of low flammable materials (B1).

2) Flammable sheath as external protection and as corrosion protection if bedded in mortar, e.g. for gas installations.

3) Flexible sheath to decouple structure-borne sound in case of direct bedding in mortar as thermal insulation according to DIN 1988-2, Table 9.

4) Flammable insulation with WLG 025 for extremely thin insulation thicknesses according to EnEV.

Explanation of fire protection terms

Fire resistance classes (Germany)

F 30 Fire resistance for at least 30 minutes = fire resisting
F 60 Fire resistance for at least 60 minutes = highly fire resisting
F 90 Fire resistance for at least 90 minutes = fire retarding
F 120 Fire resistance for at least 120 minutes = highly fire retarding

Flammability of materials according to DIN 4102

A 1 non flammable. e.g. copper, SANCO® tube
A 2 non flammable with a small amount of flammable components, e.g. aluminium coated insulation for condensation protection in cold lines/discharge lines

B 1 flame retardant, e.g. PVC
B 2 normal flammable, e.g. PE, PP, PE-x plastic composite tubes or composite building materials, such as WICU® Tube

Classification — comparison between DIN EN 13501-1 and DIN 4102

New Euroclasses according to DIN EN 13 501-1		Old material classes acc. to DIN 4102
Euro-classes	**Time to "flash-over" in "room corner test"**	
Euroclass A1	No flash-over; calorific value ≤2 MJ/kg	A 1
Euroclass A2	No flash-over; calorific value ≤2 MJ/kg	A 2
Euroclass B	No flash-over	B 1
Euroclass C	10 – 20 min	B 1
Euroclass D	2 – 10 min	B 2
Euroclass E	0 – 2 min	B 2
Euroclass F	No performance criteria	B 3

The tubing system guidelines in the different German states differ in the specifications for tube applications, particularly in regard to building types and tubing type or medium. Specific requirements apply to the different building types.

- Free-standing house or semi-detached house
- Town house
- Low buildings with more than two flats
- Medium height buildings
- High-rise buildings
- Special-use buildings
- Industrial buildings and building complexes

There are also special requirements for special rooms in buildings (e.g. boiler rooms, garages) and also for escape and rescue routes.

In the tubing types and media distinctions are made between

- plumbing tubes
- heating tubes
- tubes for gases and dust
- fire extinguishing and sprinkler tubes
- tubes for non flammable gases and dust

Some of the requirements for fire protection are closely linked to thermal and noise insulation.

More details can be found on *Fire protection guideline for regular detailed planning with KME domestic installation tubes* (Fire protection guidelines for proper installation planning in conformity with legal stipulations wherever KME installation tubes are used), on the enclosed CD-ROM. It explains the relationships between the ordinances, guidelines, standards and regulations, not only in terms of fire protection rules but also noise and thermal insulation.

The following are described:

- Preventive fire protection according to BauO and the German tubing system guideline (Guideline for conducting systems)
- Noise insulation according to DIN 4109/A1
- Thermal insulation according to EnEV and DIN 1988-2
- Interfaces to the building

D 2.1.5 Noise insulation

The basic standard for noise insulation is DIN 4109 (noise insulation in building construction), in which three different noise insulation levels are defined. The maximum permitted noise level for residential buildings (living rooms and bedrooms) is 30 dB (A). This basic requirement applies to drinking water and drainage systems and to other domestic systems such as heating and ventilation systems. In addition to this standard level the other noise levels are 27 dB (A) – "additional" and 24 dB(A) – "comfort".

VDI 4100	DIN 4109
Noise insulation level I 35 dB (A)*	Standard 30 dB (A)
Noise insulation level II 30 dB (A)	Additional 27 dB (A)
Noise insulation level III 25 dB (A)	Comfort 24 dB (A)

** Since October 1988 no longer state of the art*

Flow noises can be transmitted to other building components via the tubes. Consequently, plumbing and heating systems should be isolated from other materials. If specific noise insulation measures are taken when the tubes are being installed, the noise transmission is minimised.

- When tubes are being installed, attention should be paid that the copper tubes do not touch walls or ceilings directly at any point.
- Tube mounts should always have a noise insulation insert.
  Clamp manufacturers offer solutions for fixed points.
- Even when the covered WICU® Tube or thermally insulated WICU® Eco is installed on plaster, the tube mounts should all have insulated inserts.
- Tubing should be especially covered with insulation material in wall and ceiling penetrations Depending on the building type and the type of tubing, in addition to the noise insulation specifications the fire protection regulations specified by the different German states and the thermal insulation guidelines according to EnEV may also apply. Also ensure that no noise bridges are created when holes are filled in again with mortar.
- Tubing in brickwork and under the floor must be insulated against structure-borne sound transmission and must not affect the impact sound insulation of the floor. Especially suitable for such applications are the covered and insulated WICU® Tube, WICU® Eco and WICU® Flex. We have an expert opinion regarding noise insulation from the Fraunhofer Institute for Building Physics.
- Noise bridges can also be avoided when fittings are fixed to the wall. The fitting manufacturers provide solutions for this, such as sound insulated fitting connections.

In addition, many planners and contractors regard it as important that the individual components make an effective contribution towards fulfilling the additional noise insulation requirements of DIN 4109. This requirement is fulfilled by the flexible, thermally insulated WICU® Flex copper tube. An expert opinion from the Fraunhofer Institute for Building Physics confirms an average lower noise level of 18.1 dB compared to uncovered copper tube.

D 2.1.6 Insulation/EnEV

The German regulations on energy saving (EnEV 2007), which came into force on 1 October 2007, contain detailed requirements for insulation in hot tubes in high-temperature heating and drinking water systems. Uncontrolled heat losses in unheated areas are to be prevented.

Requirements for domestic plumbing tubes – where do I find what?

EnEV Section 12
Distribution facilities and hot water systems

Paragraph 5
If you are installing heat distribution or hot water tubes and fittings in buildings for the first time or replacing existing tubes or fittings, you must limit the heat output according to Appendix 5.

Appendix 5
Describes the requirements to limit heat output of heat distribution and hot water tubing systems and fittings. Heat output must be limited with insulation. The requirements for minimum insulation thickness according to Appendix 5 relate to a thermal conductivity level for the insulation of 0.03 W/(m•K) (WLG 035).

Comparison of insulation thicknesses for copper tubes according to Appendix 5 (EnEV)

EnEV requirements	Tube outer Ø	Reference value acc. to EnEV λ = 0.035 W/(m•K)		Conventional insulation λ = 0.040 W/(m•K)		WICU® Extra λ = 0.026 W/(m•K)	
		Insulation thickness	Total outer diameter	Insulation thickness	Total outer diameter	Insulation thickness	Total outer diameter
Lines 1-4 100 %	12	20	52	27	66	11.0	34
	15	20	55	27	69	11.5	38
	18	20	58	26	70	12	42
	22	20	62	26	74	11.5	45
	28	30	88	38	104	17.5	63
	35	30	95	38	111	18.0	71
	42	39	120	51	144	24.0	90
	54	50	154	–	–	27.5	109
Lines 5-6 50 %	12	10	32	13	38	7.0	26
	15	10	35	13	41	7.0	29
	18	10	38	13	44	7.0	32
Line 7	12	6	24	9	30	7.0	26
	15	6	27	9	33	7.0	29
	18	6	30	9	36	7.0	32

The WICU® Eco thermally insulated energy saving tube according to EnEV is a suitable solution which minimises research and planning expenditure. The following tables show the requirements of EnEV and indicate the most suitable product solution from the WICU® system.

Heating

Type of tubing system		EnEV requirements	Product solution
Single house	*Apartment building*		
• Tubing systems on plaster in unheated or infrequently heated rooms (e.g. basements) • Tubing systems in parts of the building that border the outside air, the soil or unheated rooms		Appendix 5 Table 1 Lines 1 – 4	WICU® Eco 100 %
	• Tubing systems that supply several users	Appendix 5 Table 1 Lines 1 – 4	WICU® Eco 100 %
• Tubing and fittings in wall and ceiling penetrations, where lines cross, where lines connect, in central distribution systems		Appendix 5 Table 1 Line 5	WICU® Eco 50 %
	• Tubing systems in areas between heated rooms with different users	Appendix 5 Table 1 Line 6	WICU® Eco 50 %
	• Tubing systems in the floor between heated rooms with different users	Appendix 5 Table 1 Line 7	WICU® Eco 50 %
• Tubing systems in heated rooms • Tubing systems in areas between heated rooms of one user, if their heat output can be affected by un-insulated valves		No requirement	WICU® Flex WICU® Tube

Hot water

Type of tubing system		EnEV requirements	Product solution
Single house	*Apartment building*		
• Tubing systems on plaster in unheated or infrequently heated rooms (e.g. basements) • Tubing systems in parts of the building that border the outside air, the soil or unheated rooms		Appendix 5 Table 1 Lines 1 – 4	WICU® Eco 100 %
	• Circulation lines (all lines in the circulation system)	Appendix 5 Table 1 Lines 1 – 4	WICU® Eco 100 %
	• Tubing systems in the floor between heated rooms with different users	Appendix 5 Table 1 Line 7	WICU® Eco 100 %
• Tubing systems in flats, up to an inner diameter of 22 mm, which are neither included in the circulation system nor fitted with electrical heating		No requirement	WICU® Flex WICU® Tube

With WICU® Eco, the thermal insulation values demanded in the EnEV can be fulfilled up to tube dimensions of 54 mm simply, reliably and with no subsequent insulation effort. This saves planners and installers having to calculate the insulation thickness for subsequent insulation depending on the material properties of the insulation cover. In apartment buildings the EnEV specifies only half the insulation requirements for systems in areas between heated rooms of different users. Here, the use of WICU® Eco 50 % is a considerable benefit because of its especially small outer diameter compared to other insulation materials. In addition, this tube (up to and including 15 x 1 mm) is the only product available on the market that can be embedded in standard floors for intermediate storeys – i.e. with 30 mm insulation.

WICU® Eco tubes also have particular system benefits when older buildings are being refurbished. In older buildings the installation shafts, especially for distribution lines and risers, are often not designed according to the conventional, very thick thermal insulation layers based on the EnEV. Among other things, this would necessitate costly constructional corrections. In many cases, the much smaller space requirements of WICU® Eco tubes can make a decisive difference.

Insulating cold water lines

According to DIN 1988, cold drinking water lines must be installed far enough away from heat sources (e.g. warm tubes, chimneys, heating systems) so that they do not become warm. If this is not possible, the tubes must be insulated so that the water quality is not negatively affected by being heated.

Guiding values for minimum insulation thicknesses for drinking water tubes (cold)

Installation situation	Insulation thickness at $\lambda = 0.040\ W/(m \cdot K)$* mm
Open tubing in unheated room (e.g. basement)	4
Open tubing in heated room	9
Tubing in duct, with no high-temperature tubing	4
Tubing in duct, beside high-temperature tubing	13
Tubing in brickwork chase, riser	4
Tubing in wall chase, beside high-temperature tubing	13
Tubing on concrete floor	4

** For other thermal conductivity values the insulation thickness must be calculated accordingly on the basis of a diameter of d = 20 mm.*

D 2.2 Panel heating

As underfloor and wall heating systems have a relatively high proportion of radiation in terms of heat output (approx. 60 – 75 %), the room air temperature can be set lower than with other heating systems. This produces a system-related energy saving of roughly 6 – 12 %, as the building's ventilation and transmission heat losses are reduced.

D 2.2.1 Constructional requirements and installation recommendations

Underfloor heating

Sub-structure/raw concrete floor

The load-bearing structure must be sufficiently dry to take the floor construction and satisfy the static engineering requirements (load and imposed load). Raised areas, tubing or similar that could cause sound bridges and/or differences in the height of the screed are not allowed. Otherwise, a levelling layer according to DIN 18560, Part 2 is required.

Height/evenness

The height and evenness tolerances for the surface of the load-bearing structure must comply with the requirements of DIN 18202.

Sealing buildings

Rooms that border the soil must be sealed according to DIN 18195. The architect will decide whether this is actually necessary. Generally, PVC or bitumen seals are used. If polystyrene thermal and impact sound insulation is to be installed on top of this, a separation layer must be installed (e.g. PE foil) to prevent plasticizer migration.

Edge insulation strips

For the screed to fulfil sound insulation and thermal insulation requirements it is necessary that the edge insulation strips are laid carefully. They must allow 5 mm movement around the screed after it has hardened.

Wall heating

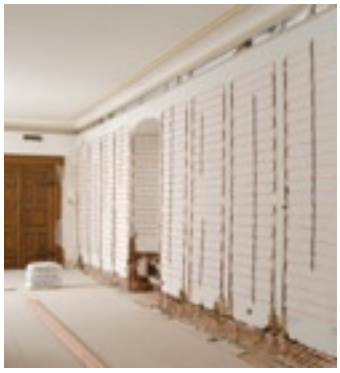
The HYPOPLAN® tube register can be installed on inside and outside walls. Basically, a wall in which HYPOPLAN® wall heating is to be installed must fulfil the following requirements:

- Compliance with the evenness tolerances according to DIN 18202
- The wall surface must be obviously dry
- The wall surface must be free of any loose particles (plaster residue, etc.)

When installing the system on outside walls, it must be ensured that the U-values according to the EnEV are not exceeded.

- New building: U-value ≤ 0.35 W/(m•K)
- Older building: U-value ≤ 0.45 W/(m•K)

If the maximum U-value of the outside wall is higher, thermal insulation is required. In case of wall heating systems on walls bordering other houses, the temperature lag of the entire construction must be at least $R_\lambda \geq 0.75\,m^2K/W$.



For additional inside thermal insulation cellulose panels, cork or HERAKLIT panels can be used in combination with the corresponding plaster systems. The thermal insulation is fixed to the wall by mechanical means or adhesion (see the manufacturer's instructions) and thus forms a stable base for the plaster.

Basically, the moisture conditions of the building element (wall) according to DIN 4108-3 (climate-related moisture protection, requirements, calculation method and instructions for planning and implementation) must be adhered to and a moisture barrier must be put in place if necessary.

If the panels are installed using a wet system, the base must be suitable for mineral plasters, must be able to bear the weight, be structurally stable and be free of dust and grease. This should be checked before the heat register is put in place. The plaster base many have to be treated beforehand (e.g. primer, adhesion promoter, coarse plaster) by the contracted plasterer.

D 2.2.2 Underfloor heating: Installation and types of screed

For underfloor heating bifilar (spiral) installation is recommended. The alternating position of feed and return beside each other gives a very even floor surface temperature in the entire room. The 90° bends required for bifilar installation can be created easily by hand during installation (no tools required). 180° bends can also be bent by hand. With the installation gaps of 100 and 150 mm it is advisable to make a pear-shaped deflection.

Laying a heating circulation system over an expansion joint

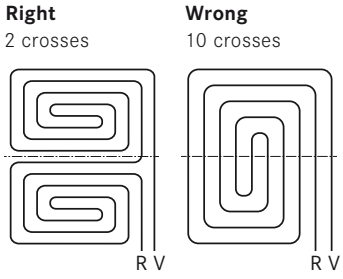
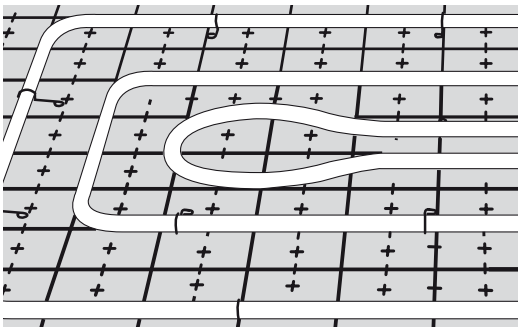


Diagram of the reverse loop



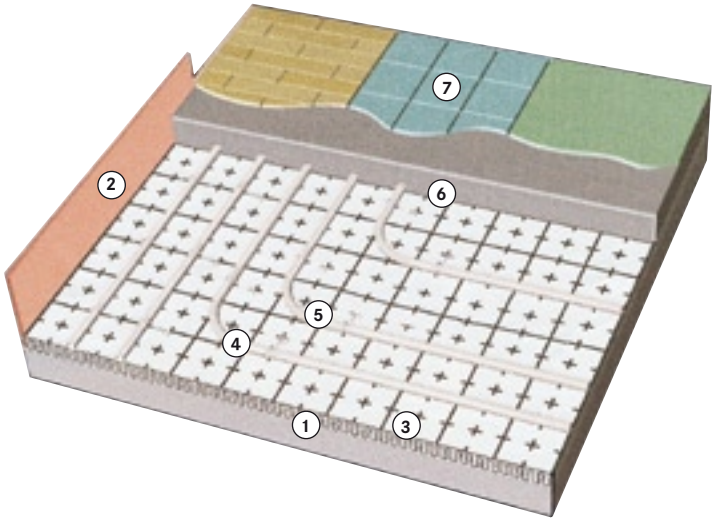
Dimensions	Bending radiuses (minimum) mm
Q-tec®	By hand
14 x 2	70
16 x 2	80
20 x 2	140
CUPROTHERM®	By hand
10 x 0.6	80
12 x 0.7	100
14 x 0.7	120

Three variants are possible for the installation of underfloor heating with Q-tec®.

Construction with a wet screed

With wet screeds the copper tube is laid out on a layer of insulation in accordance with the insulation regulations of DIN EN 1264-4 and is then embedded directly in the screed. The screed covers the tubes directly, which is good for heat transmission.

Diagram of construction with wet screed



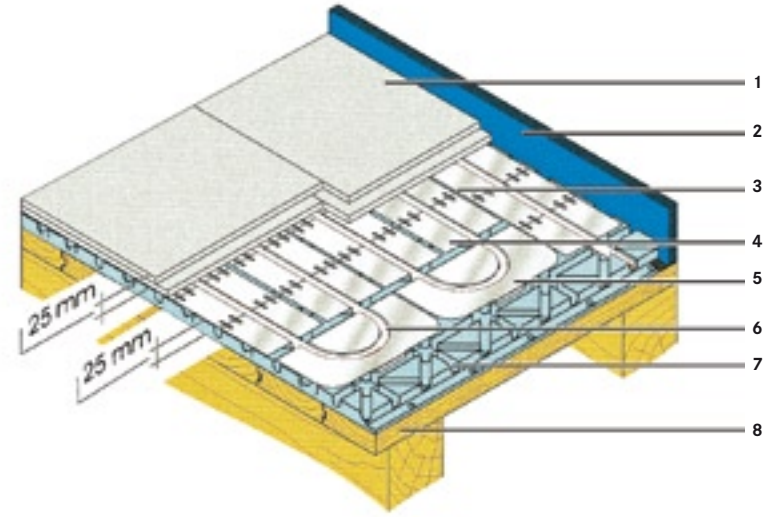
1. Concrete floor
2. Edge insulation strips
3. Composite sheet 30 – 2 mm
4. Heating tube
5. Anchors
6. Screed
7. Floor covering (various choices)

Construction with a dry screed

Especially in older buildings where the floor height can be very low, Q-tec® or CUPROTHERM® underfloor heating systems can be used with dry screeds. In this case the tubes lie inside the insulation and the heat is transmitted 180° upward by heat conducting channels and bends. Dry screed elements are then laid on top of this construction. The installation height is just 50 mm.

Diagram of construction with dry screed

Wooden rafter floor with dry screed elements



1. Dry screed elements
   (read the manufacturer's instructions)
2. Edge insulation strips
3. Covering foil
4. Heat conducting channel
5. Heat conducting bend 180°
6. Heating tube
   14 x 2 mm
7. System sheet,
   $R_\lambda = 0.56\,m^2\,K/W$
8. Ensure that the wooden floor is even,
   DIN 18202

Additional insulation by agreement

Underfloor heating – with mastic asphalt

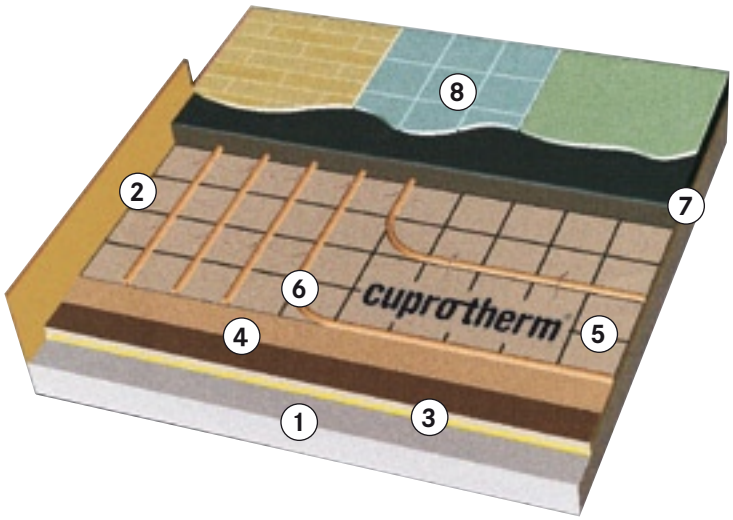
Building is always a struggle against time. Building moisture and the long drying times delay progress. Mastic asphalt is the best and quickest solution in this situation. As opposed to conventional screed, it is manufactured without any hydraulic binding agent. This means that no additional moisture is introduced to the building. On the contrary: The temperature at which it is installed, 240 °C, helps drive out the existing moisture in the building. The underfloor heating can be put into operation as soon as the asphalt has cooled and the desired floor covering has been laid.

The benefits are obvious

- No drying time
- Lowest height of 40 mm
- Laid without joints
- Insensitive to moisture
- Permitted rated load up to 5 kPa
- Ecological building material

The most important component of the CUPROTHERM® underfloor panel heating systems, the copper tube, is ideal for mastic asphalt because of its heat stability. For this application bright CUPROTHERM® heating tubes in the sizes 12 x 0.7 mm or 14 x 0.8 mm are used.

Diagram of construction with mastic asphalt

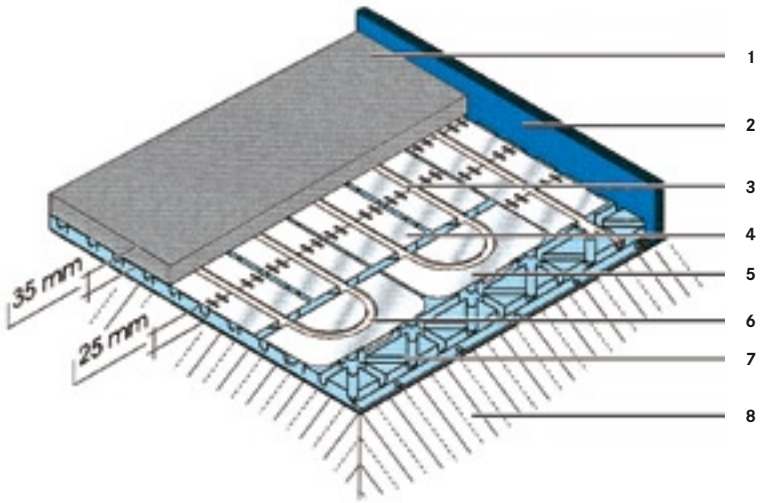


1. Concrete floor
2. CUPROTHERM®-edge insulation strips
3. CUPROTHERM®-FESCO-ETS 36/34 mm
4. CUPROTHERM®-felted woollen board
5. CUPROTHERM®-raster foil
6. CUPROTHERM® bright heating tube
7. Mastic asphalt screed 40 – 50 mm
8. Floor covering

Construction with wet screed (dry construction basis)

On the basis of the dry construction system it is also possible to use a calcium sulphate screed.

Diagram of construction with wet screed (dry construction basis)
Concrete floor with calcium sulphate screedh

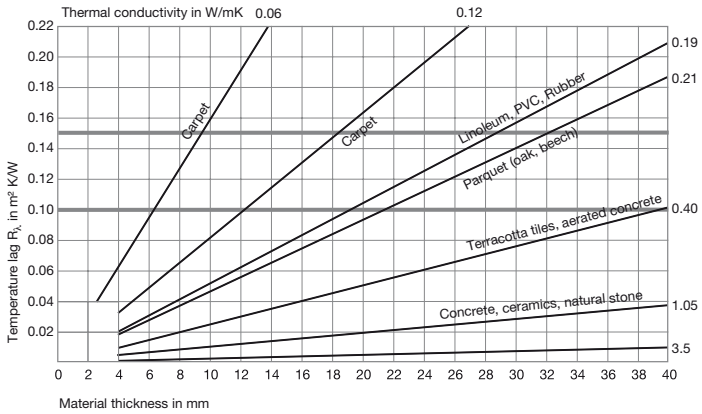


1. Heat screed approx. 35 – 40 mm, according to DIN 18560, Part 2 (read manufacturer's instructions)
2. Edge insulation strips
3. Covering foil
4. Heat conducting channels
5. Heat conducting bend 180°
6. Heating tube 14 x 2 mm
7. System sheet, R_λ = 0.56 m² K/W
8. Concrete floor, dimensional tolerance according to DIN 18202, see "Installation conditions"

Additional insulation by agreement

Overview

Temperature lag R_λ of various floor coverings



Floor coverings

Basically, all floor coverings are suitable for underfloor heating systems. The decisive criterion is the temperature lag. According to DIN EN 1264 it may not exceed 0.15 m^2 K/W.

You will find extensive information about floor constructions, including impact sound and thermal insulation and about Q-tec® in underfloor heating systems in the Q-tec® planning documentation for panel heating systems. You can obtain this from KME or download it from the Internet:
www.q-tec.eu.com -> Downloads -> Brochures

D 2.2.3 Installation of wall heating in wet and dry systems

The HYPOPLAN® wall heating modules are supplied ready to connect, including the required mounting material. Because of the mounting straps on the stable registers, only four to six mounts are needed (wet system), depending on the size of the heat register.

In the wet variant (plaster) the mineral plaster is subsequently applied by a plastering contractor. All mineral plasters made from gypsum, cement and lime or combinations according to DIN 18550 can be used. The plaster is processed wet in wet (two layers). It should be approx. 17 to 20 millimetres thick, it is sufficient if the tubes are covered to a thickness of roughly seven millimetres. Any surface finish can be chosen; all the coatings generally used in interior finishing, such as finishing resin, wallpaper or paints, are suitable.

The heat registers can also be installed in dry constructions with systems like plasterboard. Self-adhesive copper heat conducting channels are available for such applications. On the one hand, these are used to fix the heat registers to the plasterboard quickly and on the other, they improve the heat transmission to the dry construction element and, consequently, the system's overall heat output.

The tube registers can be connected either in series or according to the Tichelman system. The latter variant is especially suitable when a lot of heat registers have to be connected. This ensures that the same pressures exist in the entire system, which guarantees even and almost simultaneous heating of all surfaces – even in large wall heating systems.

D 3 Commissioning

D 3.1 Commissioning drinking water installations

For hygienic reasons and also in regard to operating safety, the commissioning of a drinking water system is very important. It is generally done in the following steps:

1. Install the fine filter (according to DIN EN 13443)
2. Fill the tubing with filtered drinking water and completely ventilate the system
3. Perform a pressure and leak test according to DIN 1988, Part 2 or according to the ZVSHK information leaflet "Dichtheitsprüfungen von Trinkwasser-Installationen mit Druckluft, Inertgas oder Wasser" [Leak tests of drinking water systems with compressed air, inert gas or water]
4. Flush the system with filtered drinking water directly after the pressure test.
5. Immediately put the drinking water system into operation

D 3.2 Pressure test

New tubing systems may only be put into operation when the specified pressure test has been carried out with no problems. No leaks may exist.

Drinking water systems

The latest ZVSHK information leaflet "Leak tests for drinking water installations using air pressure, inert gas or water" applies to drinking water systems. Because of the new drinking water regulations hygienic requirements must be considered when choosing the leak test method. If long inactive periods (stagnation) are to be expected between the leak test and when the system is actually put into operation, a dry test with compressed air or an inert gas should be performed. For hygienic reasons, a test with drinking water where the system is subsequently emptied must be avoided.

A detailed description of leak tests with compressed air or inert gas can be found in the brochure
• Q-tec® Technical Information.
You can obtain this from KME or download it from the Internet:
www.q-tec.eu.com -> Downloads -> Brochures

On the enclosed CD-ROM you will find the respective pressure test log for drinking water:
• with compressed air or inert gas
• with water

Heating systems

Leak tests on heating systems are to be performed according to DIN 18380. According to the standard the plumbing, heating, or air conditioning contractor must carry out a pressure test on the system after installation but before wall slits and wall or ceiling penetrations are closed. Before this, a visual check should be carried out to make sure that the joints are pressed correctly.

Hot water systems must be tested with a pressure of 1.3 times the total pressure at each point of the system, but at least 1 bar. Immediately after the cold water test has been performed the system is heated to its maximum temperature; in other words, the highest calculated hot water temperature, and the system is checked again for leaks. The system should then be put into operation immediately if there is a risk of frost, otherwise other suitable measures must be taken to prevent the system freezing.

Underfloor heating systems are leak tested according to DIN 18380 VOB, Part C.
This test is carried out for 1 hour at a pressure of 10 bar.

The enclosed CD-ROM contains a pressure test log for heating systems.

Solar power systems

Depending to the type approval a water pressure test must be performed for most solar power system collectors. This must be carried out at a minimum pressure according to information provided by the collector manufacturer. When the system is kept at a constant temperature, the pressure should not drop during the test period; however, there is no precise specification for the time required for the pressure test.

Gas installations

TRGI specifies clear instructions for the load and leak tests and also for filling and decommissioning systems that are no longer required – these instructions must be adhered to. The test results must be reported to the local gas utility.

Test methods	Reason			
	Newly installed system	Decommissioned system	System taken out of service	System after a short interruption
Preliminary test (1 bar)	X	–	–	–
Main test (110 bar)	X	X	X	–
Combined load and leak test (3 bar)	X	X	X	–
Test of connections and joints up to 1 bar	X	–	–	–
Pressure test	X	X	X	X
Suitability test	–	–	X	X

Heating oil systems

After installation, all oil transporting tubes, including valves, are subjected to a pressure test. This is done with air or inert gas at 1.1 times the operating pressure or, if liquid is used, at 1.3 times the operating pressure, but at least 5 bar. The system is deemed leak proof when after 10 minutes waiting time for the temperature to balance out the test pressure does not fall during the subsequent 1 hour test period.

D 3.3 Flushing

According to DIN 1988, Part 2, regardless of the material used, drinking water systems must be thoroughly rinsed after they have been completed. The objectives are:

- ensuring the quality of the drinking water
- cleaning the inner surfaces of the tubes
- preventing faults in fittings and apparatus

These requirements are met by two flushing methods:

- Flushing with water (ZVSHK information leaflet)
- Flushing with an air-water mixture (DIN 1988, Part 2, Section 11.2)

Both flushing methods can be used if required. The contractual provisions, the requirements of the system operator, manufacturer's instructions and the installer's experience should all be considered.

Putting a system back into service after it has been unused for a long period

If long periods are to be expected between completion and the system being put into operation, after the pressure and leak tests and flushing the tube systems should be filled and sealed.

To ensure hygienic conditions when the system is put in to service, the stagnated water is flushed out with drinking water. If the inactive period is during the frost season, the building must be heated to prevent frost damage in the tubing system. If this is not possible, the system must be completely emptied. The planner must ensure that there is a suitable facility for emptying the system.

But in many cases, the building is not heated and the system cannot be completely emptied.
Then, if there is a risk of frost, the system must be tested with a dry pressure and leak test method, with oil-free compressed air or an inert gas such as nitrogen.

D 3.4 Function heating, panel heating

According to DIN EN 1264, Part 4 to commission and check the functions of an underfloor heating system, so-called function heating is performed. The contractor must keep a log of this. The log can be found on the enclosed CD-ROM or in the Q-tec® Technical Information brochure. You can obtain this from KME or download it from the Internet:
www.q-tec.eu.com -> Downloads -> Brochures

Function heating may not be carried out for at least 21 days on cement screeds or 7 days for calcium sulphate screeds. Depending on the screed supplier and the use of various additives, these values may deviate considerably from the guideline. Read the manufacturer's instructions. If the function heating has created suitable conditions for laying floor covering, this can be laid. If not, the floor must be heated to prepare for the floor covering.

With wall heating you can start function heating when the plaster is completely dry. This process commences with a feed temperature of 25 °C, which is maintained for three days. Then the maximum feed temperature is set and kept for four days. The heating system installer must keep a log of this function heating process.

Here, too, you will find the respective log on the enclosed CD-ROM

E Service Section

E 1 KME Tender texts

You will find the latest texts for tenders for KME brand name copper tubes on the Internet:
www.kme-tube-systems.com -> Service -> Download Center -> Tender documents

E 2 Product ranges

SANCO® Copper tube according to DIN EN 1057 and DVGW-GW 392 with the RAL quality mark and the DVGW mark, Cu-DHP, protected against pitting, for all domestic plumbing applications
Availability from 6.0 x 1.0 to 267 x 3.0

• 50 m coils	R220 (soft)	6.0 x 1.0 to 15.0 x 1.0
• 25 m coils	R220 (soft)	18.0 x 1.0 to 22.0 x 1.0
• 5 m straight lengths	R250 (halfhard)	12.0 x 1.0 to 28.0 x 1.5
• 5 m straight lengths	R290 (hard)	6.0 x 1.0 to 10.0 x 1.0 and 35.0 x 1.5 up to 267 x 3.0

WICU® Tube Copper tube according to DIN EN 1057 and DVGW-GW 392 with the RAL quality mark and the DVGW mark, Cu-DHP, protected against pitting and with plastic sheath applied in the factory.
External corrosion protection for gas tubes according to TRGI, TRF and drinking water systems according to DIN 1988, Part 7. Protection against condensation according to DIN 1988, Part 2. Fire resistance: DIN 4102-B2 or DIN EN 13501-1 Class E
Availability from 6.0 x 1.0 to 54 x 2.0

• 50 m coils	R220 (soft)	6.0 x 1.0 to 18.0 x 1.0
• 25 m coils	R220 (soft)	6.0 x 1.0 to 22.0 x 1.0
• 5 m straight lengths	R290 (hard)	12.0 x 1.0 to 54 x 2.0

WICU® Eco Thermally insulated copper tube according to DIN EN 1057 and DVGW-GW 392 with the RAL quality mark and the DVGW mark, Cu-DHP, protected against pitting and with insulation layer according to EnEV applied in the factory (thermal conductivity: λ = 0.026 W/(m•K)) made from polyurethane foam (PUR), 100 % HFC/CFC free and protective sheath made from hard PVC for high temperature drinking water and heating systems. Fire resistance: DIN 4102-B2 or DIN EN 13501-1 Class E
Availability from 12.0 x 1.0 to 54 x 2.0

• 25 m coils	R220 (soft)	12.0 x 1.0 to 18.0 x 1.0 (50 % EnEV)
• 5 m straight lengths	R290 (hard)	12.0 x 1.0 to 54 x 2.0 (100 % EnEV)

WICU® Flex Copper tube according to DIN EN 1057 and DVGW-GW 392 with the RAL quality mark and the DVGW mark, Cu-DHP, protected against pitting and with plastic insulation sheath made from HFC/CFC free polyethylene (PE) and a PE structure foil applied in the factory. For drinking water systems according to DIN 1988, Part 2, Table 9, in the requirements up to 4 mm and for heating systems without insulation requirements according to the EnEV Fire resistance: DIN 4102-B2 or DIN EN 13501-1 Class E
Availability from 12.0 x 1.0 to 22 x 1.0

• 50 m coils	R220 (soft)	12.0 x 1.0 to 18.0 x 1.0
• 25 m coils	R220 (soft)	12.0 x 1.0 to 22.0 x 1.0

WICU® Frio Copper tube according to DIN EN 12735-1, Cu-DHP, R 220 with clean and metallic bright inner surface and with grey sheath made from 100 % HFC/CFC free, closed-cell PE foam with protective PE film.
Average vapor diffusion resistance η = 13000
Fire resistance: DIN 4102-B2 or DIN EN 13501-1 Class E
Suitable for transporting refrigerant and coolants as well as water-glycol mixtures.
Availability from 10.0 x 1.0 to 22 x 1.0

• 50 m coils	R220 (soft)	10.0 x 1.0 to 18.0 x 1.0
• 25 m coils	R220 (soft)	22.0 x 1.0

WICU® Clim Copper tube according to DIN EN 12735-1, Cu-DHP, R 220 with clean and metallic bright inner surface and with white sheath made from 100 % HFC/CFC free, closed-cell PE foam with protective PE film.
Average vapor diffusion resistance η = 14000
Fire resistance: DIN 4102-B2 or DIN EN 13501-1 Class E
Suitable for transporting refrigerant and coolants as well as water-glycol mixtures.
Availability from 1/4“ bis 7/8“
- 50 m coils R220 (soft) 1/4“, 3/8“ and 1/2“
- 25 m coils R220 (soft) 5/8“, 3/4“ and 7/8“

COPATIN® Copper tube with internal tin plating for drinking water systems with DVGW inspection mark, DVGW registration no. DW-7210AS2096, copper tube according to DIN EN 1057, DVGW worksheet GW 392 and the quality conditions of Gütegemeinschaft Kupferrohr e. V.
Availability from 12.0 x 1.0 to 108 x 2.5
- 25 m coils R220 (soft) 12 x 1.0 up to 22 x 1.0
- 5 m straight lengths R290 (hard) 12 x 1.0 up to 108 x 2.5

Q-tec® Copper tube (SANCO® INSIDE) according to DVGW-VP 652, copper Cu-DHP, soft R220 with firmly attached plastic sheath; inside surface according to DIN EN 1057
Fire class B2 according to DIN 4102 or DIN EN 13501-1 Class E
Sheath colour white for drinking water, heating and panel heating
Availability
- 100 m coils 14 x 2 mm and 16 x 2 mm
- 50 m coils 20 x 2 mm
- Extensive range of system accessories for underfloor heating systems and a range of press fittings for plumbing and heating applications

HYPOPLAN® Copper wall heating system
- Heat registers for wet and dry construction systems
- Heat conducting channels for dry construction
- Heating plaster
- Heating group distributors
- Single room controls

CUPROTHERM® Copper panel heating system for use in the system variants:
- Wet screed
- Dry construction
- Mastic asphalt.

Consisting of copper tubes according to DIN EN 1057. Strength soft (R220) with the following product range:
- 50 m coils R220 (soft) CUPROTHERM® Plus 10 x 0.6/12 x 0.7/14 x 0.8 mm with plastic sheath
- 50 m coils R220 (soft) CUPROTHERM® Blank 12 x 0.7/14 x 0.8 mm for mastic asphalt applications

OSNASOL® Tube bundles for solar power systems
- Copper tube with outer diameter 15 or 18 mm (other sizes possible)
- Outer diameter stainless steel corrugated tube DN 16 (other sizes possible)
- Control lines: Silicon lines, temperature range -50 °C to +180 °C, short term +200 °C

OSNASOL® is protected by an extremely durable, seamlessly extruded outer sheath made from soft polyethylene
Availability up to 500 m coiled on drums

E 3 Warranty information

KME Germany AG provides contractors with a high degree of security when they use its brand name copper tubes. In addition to a liability assumption statement between KME and the German Central Association Plumbing, Heating, and Air Conditioning (ZVSHK), there is also a liability assumption statement for work contracts between KME and the Federal Industrial Association for Heating, Air Conditioning and Sanitary Engineering/Technical Buildings Systems (BHKS). Both agreements cover the brand name copper tubes produced by KME, SANCO®, WICU®, COPATIN®, Q-tec®, CUPROTHERM® and HYPOPLAN®. This means that long-term warranty and compensation regulations are provided – just in case.

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