COPPER PRESSURE PIPING SYSTEMS

Copper tube for domestic water services at temperatures up to 110°C is manufactured to EN 1057. However, 110°C is not the maximum temperature to which copper can be subjected in service. Indeed, copper tube, (EN 12449) and copper alloys, correctly installed and jointed, are ideal materials to use for all the following industrial and marine pressure piping systems:

- steam boiler, feed and hot water;
- hydraulic (water or oil);
- oil fuel;
- pneumatic and gas;
- refrigeration and cryogenic;

at temperatures from -200°C to +200°C where required.

Table 1 Design stress values (N/mm 2) for solid drawn copper tubes (See BS 1306 for copper alloy tubes)

Material	Designation (BS 6017)	EN 12449 (Formerly BS2871-2)	Condition	Tensile strength (min.)	Values of design stress for metal temperatures not exceeding				
					-200 to +50 C	100 C	150 C	175 C	200 C
Copper	Cu-DHP	2	Annealed O	200	41	40	34	26	18
		2	Light drawn 1/2H	250	62	59	55	34	18
		2	As drawn M	280	70	69	55	34	18

The specification for copper and copper alloy pressure piping systems is BS 1306. This standard covers the design, installation and inspection of the systems mentioned above.

Design pressure

To determine the required wall thickness for a particular diameter of straight tube, the formula is:

$$t = \frac{pd}{p+20F}$$

Where:
t is the minimum tube wall thickness (mm);
p is the design pressure (bar);
d is the outside diameter of the tube (mm);
F is the design stress (N/mm²), at the maximum working temperature, and is obtained from Table 1.

It should be noted, however, that tube manufacturers' tolerances irrespective of wall thickness generally allow for a variance of ±10% of any specified wall thickness.

Where copper tube is to be used for steam or condenser water services at temperatures of up to 205°C and working pressures of up to 17bar, suitable thicknesses are shown in Table 2.

Joints

Tube can be joined by welding, brazing, soldering or mechanical methods, provided the type of joint used is suitable for the tube material, pipeline fluid carried, its pressure and temperature, and has the mechanical strength required under service conditions.

Brazing is often used where the maximum working temperature does not exceed 200°C. Socket type capillary joints and flanges made from copper alloy are brazed with EN 1044 group AG silver brazing alloys as the filler metal. This requires the use of a suitable flux. Where both fittings and tube are made from copper, EN 1044 group CP copper-phosphorus brazing alloys can be used. These do not require the use of a flux as the phosphorus content will remove the oxide film. If 1/2H, or as drawn M, condition tube is heated to temperatures >600°C during fabrication or jointing the annealed, O condition values for design stress should be used.

Table 2 Copper tube for steam services with plain ends EN12449 (Formerly BS 2871-2)

Size of tube (mm)	Low pressure range (Table 5)	High pressure range (Table 6)
	Working pressure up to and including 7 bar, max working temperature 205℃	Working pressure up to and including 17 bar, max working temperature 205℃
	Thickness (mm)	Thickness (mm)
6	0.8	0.8
8	0.8	0.8
10	0.8	0.8
12	0.8	0.8
15	1.0	1.0
18	1.0	1.0
22	1.2	1.2
28	1.2	1.5
35	1.5	2.0
42	1.5	2.0
54	2.0	3.0
67	2.0	3.5
76.1	2.0	4.0
108	2.5	5.0

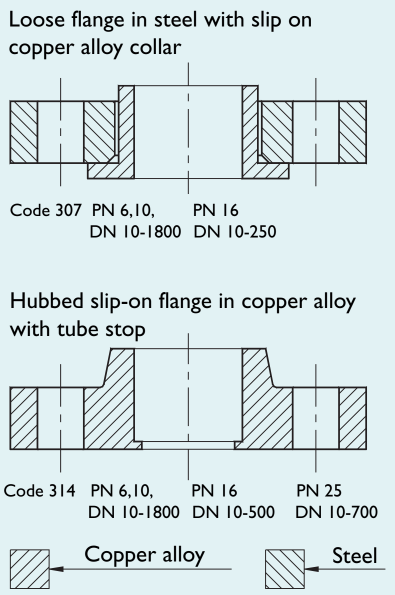

Figure 1 Typical flanges for brazing

Jointing refrigeration tubing

Oil, water and dirt should be kept out of the bore of all pipelines during installation. This is especially important in the case of refrigeration (and oxygen) pipelines. The tube used should be specially de-greased by the manufacturer and supplied with its ends sealed. Any temporary open ends need to be blanked with rubber plugs during installation.

It is important to prevent the formation of oxide scale inside the tube when brazing refrigeration pipelines. This is achieved by connecting a nitrogen cylinder to one end of the pipeline via a regulator and passing a gentle flow of gas through the tube whilst heating. The nitrogen flow displaces the air and prevents oxidation. The flow should be continued until the tube has cooled.

Silver solder capillary fittings are usually recommended for oxygen and medical gas applications. Brazing should be in accordance with BS 1723 and joints should be visually inspected before carrying out a hydrostatic pressure test for strength. This is followed by a pressure test for leakage using nitrogen or other suitable inert gas following the guidelines set out in HSE guidance note GS4.

Refrigeration liquid lines are limited to a maximum of 25mm ID whilst vapour lines can be up to 40mm ID. Screwed compression fittings are limited to a maximum of 16mm ID. Flared fittings are only suitable for use with annealed tubes and are limited to a maximum of 22mm OD in locations where joints remain exposed for visual inspection.

Where there is any doubt regarding the suitability of the materials for any given application, reference should be made to the relevant manufacturer.

De-mountable joints

Figure 1 illustrates typical flange joints for brazing and use where disconnection is required. Traditional non-manipulative and manipulative compression joints can also be used provided the manufacturers figures for maximum temperature and working pressure are not exceeded.

New on the market are rolled-groove mechanical joints for EN 1057 copper tube (formerly table X and Y). The principle having been developed for use on steel tube for sprinkler installations. Figure 2 shows a coupling, this consists of an epoxy coated ductile iron housing that compresses an EPDM rubber gasket to form a pressure seal.

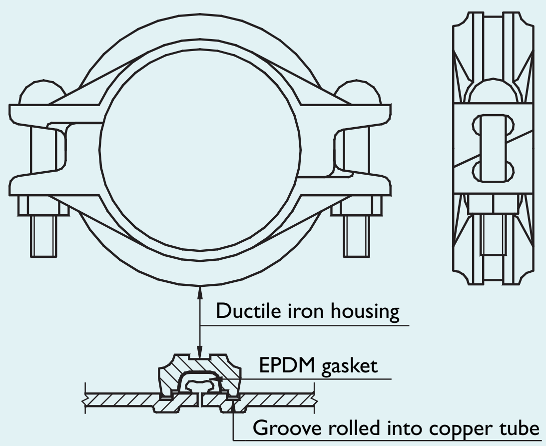

Figure 2 Rolled groove mechancial joint

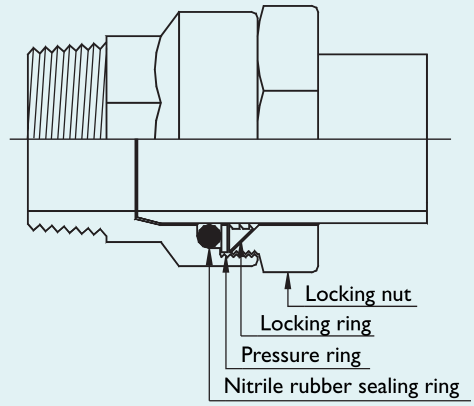

Figure 3 Ring seal joint 15 to 159 mm diameter.

The mechanical strength of the joint is achieved by the housing having tapered sides that enable it to lock into the rolled grooves.

Also recently introduced to the UK market is a Norwegian developed 'O' ring fitting made from dezincification resistant brass, see Figure 3. This uses a locking nut (or bolted flange ring on the larger sizes) to compress a split locking ring on to the tube for mechanical strength whilst a nitrile rubber ring forms the seal.

Safety note

Remember, all piping systems must be depressurised and drained before disassembly and removal of any fitting!

Cost and performance benefits of copper

Good corrosion resistance and the ability to carry a wide range of fluids make copper and its alloys suitable for virtually all pipeline services. Furthermore, coppers high thermal conductivity makes it the ideal material for heat exchangers. Its high strength, wear and corrosion resistance and the ability to be formed to close tolerances means that copper tube has a higher carrying capacity when compared to other tube made from other materials. The ease of fabrication of copper tube and the wide range of jointing and bending methods that are available, simplifies the manufacture and installation of pipeline services. Furthermore, the intrinsic properties of copper over its long, proven, working life results in improved cost effectiveness when compared to other materials.