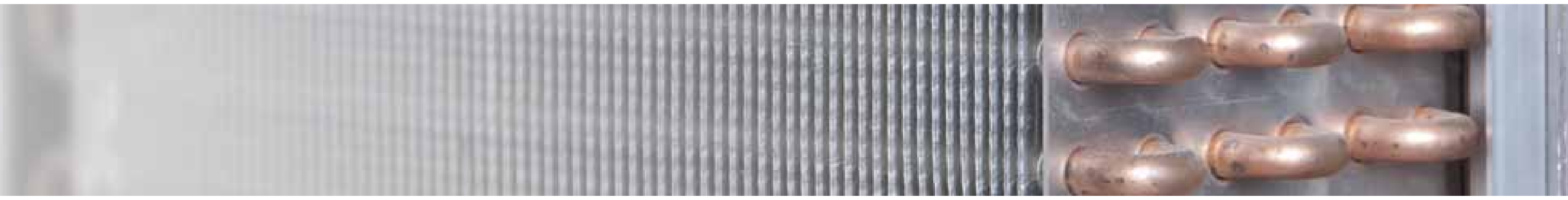


Basic knowledge

Piping in refrigeration

Piping is an important part of refrigeration systems. The incorrect design and implementation of the refrigerant pipes could result in faulty operation or even damage to the refrigeration system.

Four different types of piping are basically differentiated in the refrigeration system:

Name	Connects	Aggregate state	Temperature	Length
intake pipe	evaporator – compressor	vaporous	cold	long
delivery pipe	compressor – condenser	vaporous	hot	short
condenser pipe	condenser – collector	liquid	environment	short
liquid pipe	collector – evaporator	liquid	environment / cold	long

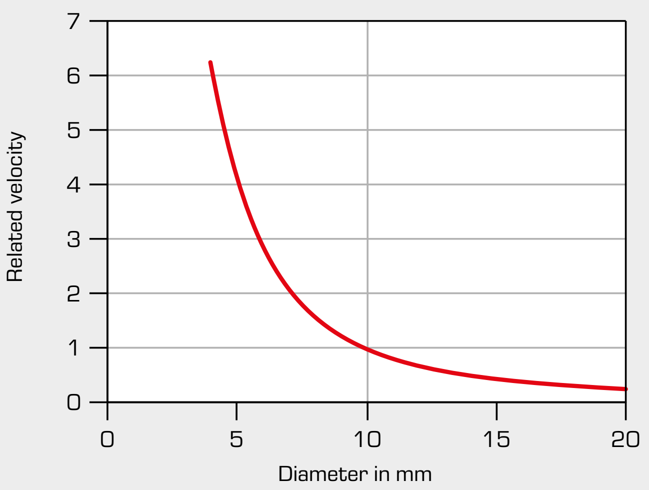
The properties of the different piping types have a direct effect on the constructive design. In long pipelines a low pressure loss must in particular be ensured. In piping with vaporous refrigerant the safe transport of oil must be ensured.

Cold or hot refrigerant pipes must be equipped with insulation to prevent heat loss or condensation on the surface.

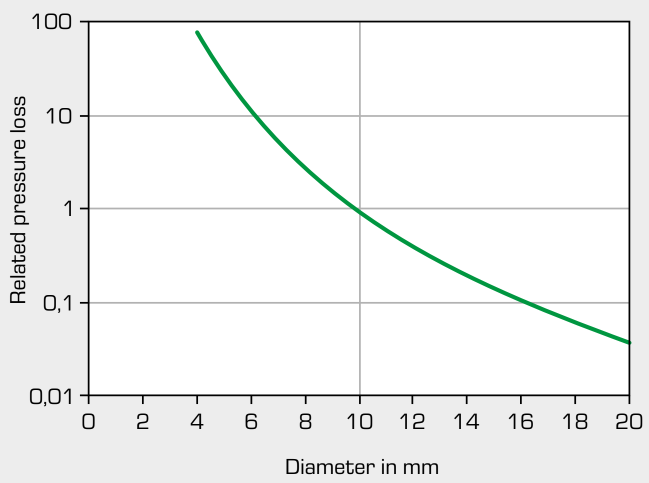
Effect of the pipe diameter on the velocity and the pressure loss

Pressure differences in the refrigerant pipes have an undesired effect on the boiling temperature of the refrigerant and thus on the operation of the system. Pressure differences can be caused by height differences in liquid pipes, or also by pressure losses in the piping. It is therefore important to dimension the piping correctly.

The two diagrams show the effect of the diameter on the velocity and pressure loss in the pipe. Velocity and pressure loss are related to a diameter of 10 mm. For example, an increase in the diameter from 10 mm to 16 mm reduces the velocity by 60%. Conversely the reduction of the pipe diameter from 10 mm to 6 mm causes a tenfold pressure loss.



Velocity in dependence of the pipe diameter



Pressure loss in dependence of the pipe diameter

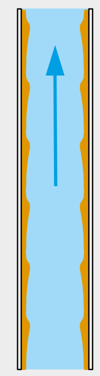
Oil transport in the refrigerant pipes

In refrigerant compressors some lubrication oil is carried along with the compressed refrigeration steam in the system. To prevent a lubrication oil deficiency in the compressor, this lubrication oil must be returned to the compressor and must not remain in the system.

In pipes with liquid refrigerant this is no problem because the lubrication oil is dissolved in the refrigerant. However, in the evaporator the liquid lubrication oil remains back and must be carried by the refrigerant steam along the wall of the intake pipe.

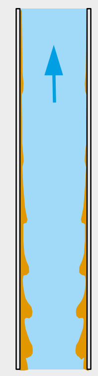
The oil transport is particularly difficult in rising intake pipes. Here a minimum velocity of approx. 4 m/s is required to transport the oil towards the compressor.

In intake pipes a compromise between low pressure losses and safe oil transport must therefore be found. It is recommended to maintain a velocity of 4 m/s for partial load and 9 m/s for full load.



v > 4 m/s

Thin oil film at the wall, good oil transport

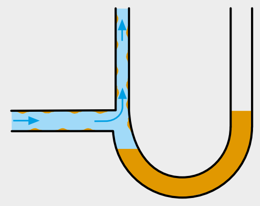


v < 4 m/s

Oil returns, no oil transport

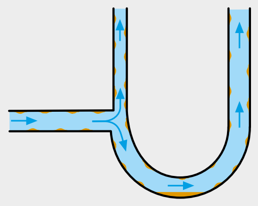
Double rising pipe for the safe oil transport at low load

At low load an oil-filled siphon closes one rising pipe. This increases the velocity in the remaining pipe. At high capacity the siphon is pressed empty and the second pipe activated. This keeps the pressure losses at high capacity low.



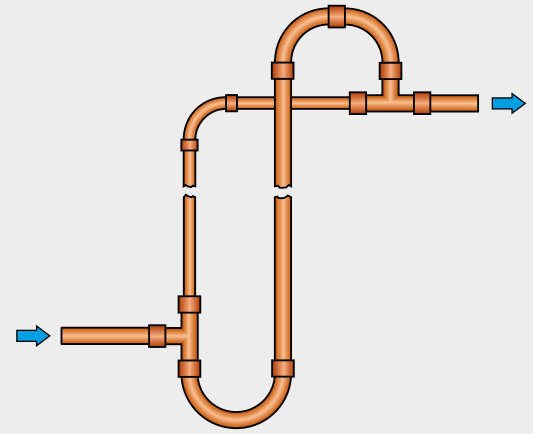
Low capacity:

Siphon filled with oil and only one rising pipe active

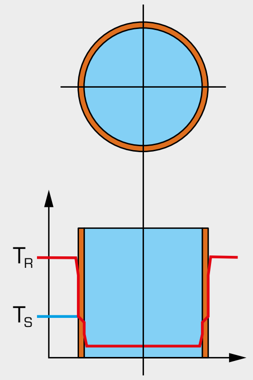


High capacity:

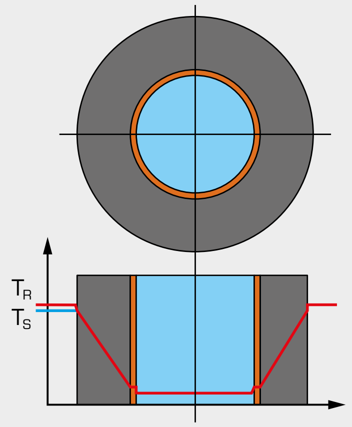
Empty siphon and two rising pipes active



Double rising pipe in the intake pipe



Temperature curve in the pipe without insulation



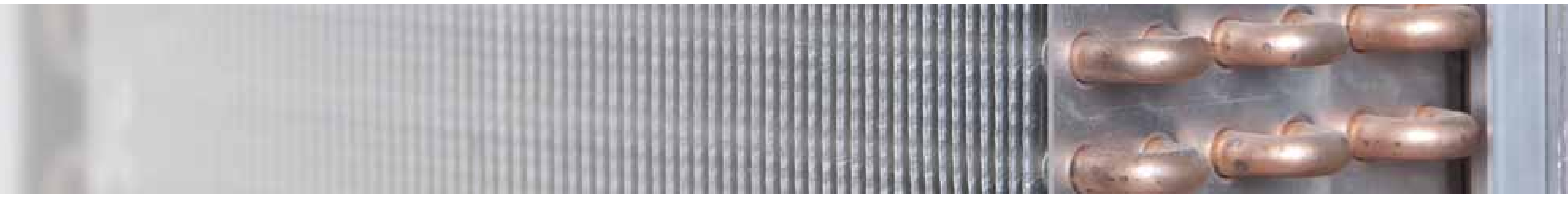
Temperature curve in the pipe with insulation

Pipe insulation

The metallic materials used in refrigerant pipes have a high thermal conductivity so that the surface temperature $\mathbf{T_S}$ of the pipe matches roughly the refrigerant temperature. This means that plenty of heat can be exchanged with the ambient air (temperature $\mathbf{T_R}$).

By surrounding the pipes with an insulating layer the surface temperature is adapted to the environment and the heat dissipation reduced.

In cold pipes the surface temperature $\mathbf{T_S}$ is thus kept above the dewpoint temperature and the condensation or freezing of the humidity in the air prevented. Dripping dew water can cause humidity – and corrosion damage.



Basic knowledge

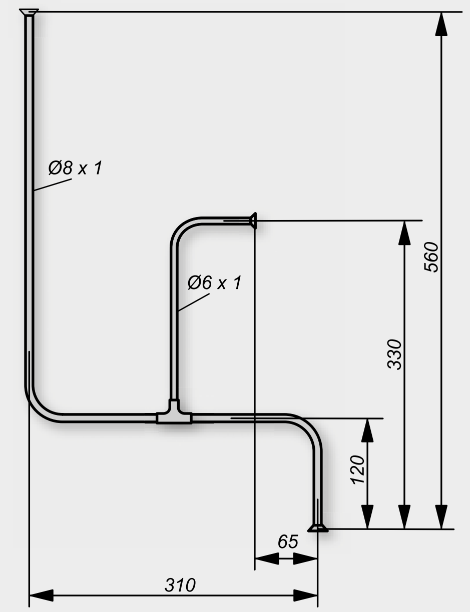
Making of piping

Making of piping

In refrigerating plants with HFC refrigerants, the refrigerant lines are usually made of copper tubing. Copper is an extremely low-temperature material and is therefore particularly suitable for components in refrigerating plants. Copper has increasing rigidity and deflection as the temperature decreases. Copper tubes meet special purity and strength requirements in refrigeration technology. The tubes are sealed with plastic caps until use to prevent contamination.

The making of a piping is divided into several steps:

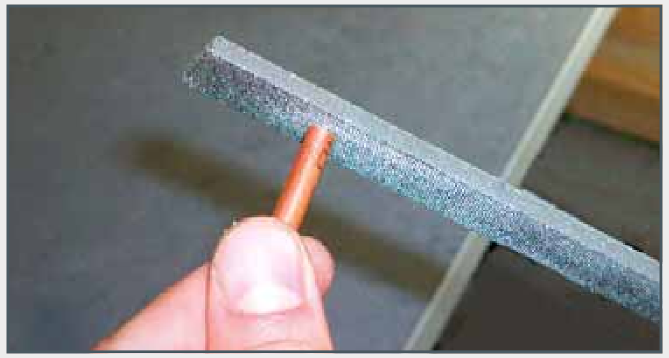
- determining the required length
- trimming the pipe and preparing the cutting surfaces
- bending in accordance with the desired pipe run
- soldering or flaring to joint the pipe section to other pipe sections or fittings



Sketch for a piping with soldered fittings, pipe ends flanged

Trimming the pipe and preparing the cutting surfaces

Determining the length of the pipe section. Here the additions for bends and flanges must be taken into account. Sawing off the pipe.



Filing the saw cut smooth, the cutting surface must be perpendicular to the pipe axis

Deburring inside

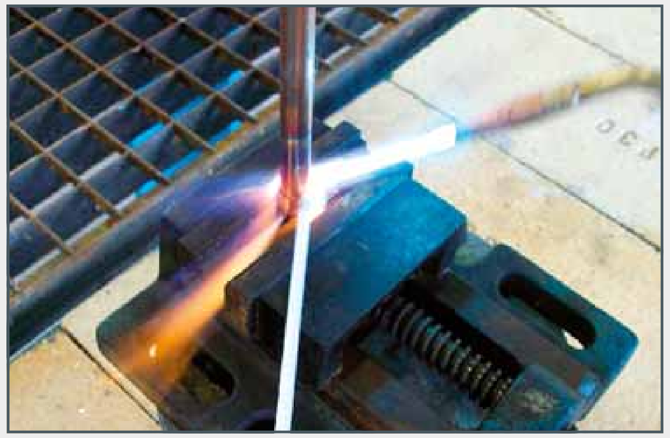
Deburring outside

Bending the pipe

Inserting the pipe into the bending device

Bend to the desired angle

Hard soldering of pipes and fittings – non-detachable joint



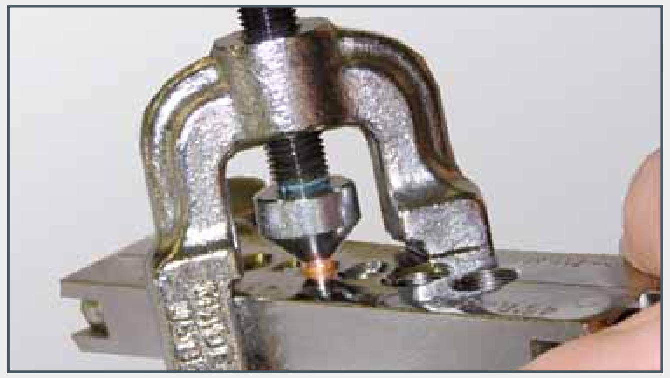
Heating the workpieces up to the soldering heat and melting of flux material and solder. By capillary effect solder automatically fills the soldering gap.

Due to the high demands on strength, copper pipes and fittings are hard soldered. During hard soldering the metallic materials are joined with the aid of a filler material (solder). The melting point of the hard solder must be at least 450°C. The materials are not melted.

Important when hard soldering

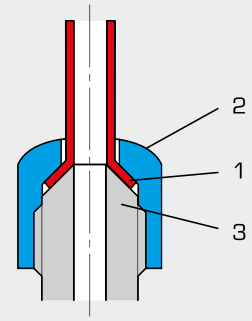
- metallic pure soldering location
- suitable with the correct melting point and flux material
- correct soldering gap between 0.1 and 0.3mm
- correct workpiece and solder temperature
- inert gas (e.g. nitrogen) to prevent scaling inside the pipe

Flaring of pipes – detachable joints



Flaring of the pipe with the flaring tool

Detachable joints are often made by flared joints. Here the pipe end is widened conically **1** and pressed with a union nut **2** onto the sealing cone **3** of the fitting. When tightening the flared joint the sealing surface must be lightly coated with oil.



Cross-section of a flared joint