The Principles of Brazing for Pipe Installation
What is there to learn about brazing?

This brochure will provide you with the basic knowledge needed to develop your brazing skills through practical application.

And we’re here by your side every step of the way – Fred Flame, Chris Melt, Dr. Bob Braze (from left to right).
What do melting point, melting range and working temperature mean?

A strong, safe and durable brazed joint requires that the joining area and the brazing material be heated to the recommended working temperature.

**Melting point**

Only pure metals and eutectic alloys have a definite melting point. Above this melting point, the material becomes liquid – and remains solid below it.

**Melting range**

Brazing alloys usually have a melting range (also referred to as melting interval). This melting range is limited at the bottom by the lower melting point – the solidus temperature – and at the top by the upper melting point – the liquidus temperature. After reaching the solidus temperature, the brazing alloy changes from a solid to a liquid state within the melting range and is completely liquid when it reaches the liquidus temperature.

**Working temperature**

The working temperature is the lowest surface temperature on the parent metals to be joined at which the brazing alloy moistens. This means that the brazing alloy as well as both of the materials to be joined in the brazing process must at least reach this temperature. The working temperature is always higher than the solidus temperature. It can lie below or above the liquidus temperature or fall with it.

Fred Flame says:

→ Brazed joints are secure, durable and have been well tried safe for generations.
What is the difference between soldering and brazing?

In soldering the melting temperature of the solder is below 450°C – in brazing it is above.

To be more precise:
The soldering temperature for soldering in pipe installations is approximately 250°C – for brazing the temperature is between 670°C and 730°C.

Which materials can be brazed?

All metallic material!

Brazing is a joining method that enables you to securely join the following material combinations – among others.

Copper
Steel
Copper
Gunmetal
Brass
Steel

Dr. Bob Braze says!

Brazing is a binding process for the secure and lasting joining of copper, gunmetal, brass and steel.
What is the capillary effect?

A strong, safe and durable brazed joint requires a narrow, even and smooth brazing gap. The optimum clearance for a capillary joint lies between 0.05 mm (0.002”) and 0.2 mm (0.008”).

When joining copper pipes by brazing, the individual pipe sections are connected via shaped pipe sockets or ready-made fittings.

This technique is called capillary brazing because it capitalizes on the capillary effect. Here, the narrow gap between the pipe socket and the pipe to be connected takes up the liquid solder. The brazing gap width must be the same along the whole of its length.

The brazing alloy can also fill longer brazing gaps – and defy gravity in the process.
What do you need for professional brazing?

For starters you need a heat source to effectively braze a joint. Plumbers, for instance, mainly use flame torches or electrical resistance brazing.

Open flame torches
These are brazing devices that operate with gas bottles or gas cartridges for different gas mixtures and burners.

Examples:

- Propane-intake air burner
- Propane-oxygen-burner with spray brazing head
- Acetylene-Oxygen-burner

The burner and fuel gases should be chosen so that the parts to be joined are heated to the brazing temperature along the whole of the crack length within a short space of time. Gentle heating is achieved by setting a soft, reducing flame.

Electrical resistance brazing devices
Electrical resistance brazing systems transfer the heat to the workpiece by direct contact with the aid of electrodes. These devices are the preferred choice for soldering tasks.
Do you need flux?

When air brazing: YES!

There is an exception, however: no flux is required for copper/copper joints with brazing alloys containing phosphorous.

 Flux is a solvent for metal oxides. It removes oxide films from the brazing surfaces and keeps them free of oxides throughout the brazing process. Brazing alloys moisten, spread and only bind on pure metallic surfaces. Flux is selected according to base metal and working temperature. Each flux type has an effective temperature range. The braze’s working temperature must lie within the flux’s effective temperature range.

What is a soft solder paste?

Solder paste is a ready to use mixture made of solder powder, a water-soluble flux and a binder.

They are used like flux together with a soft solder wire. Care must be taken that the solder type contained in the solder paste corresponds to the alloy in the soft solder wire. The metal powder content in the solder paste will ensure complete and even surface wetting. The working temperature is reached when the solder powder has melted.

Fred Flame says

→ BrazeTec’s Degufit 3000 soft solder paste paired with BrazeTec 3 soft solder gives you great brazing results.
Getting ready for professional soldering and brazing

1. **Sizing**
   Cut the copper pipe into lengths at right angles using a stable telescopic pipe cutter with a fine feed. This prevents the pipe deforming and separates it cleanly with minimum burr inside.

2. **Deburring**
   Deburr the inside carefully after separating the pipe ends to prevent any narrowing of the pipe cross-section and resulting distortions. When cutting into lengths using a saw, also remove the additional outer burr that occurs. Remove distortions after deburring.

3. **Calibrating**
   Use a calibration ring to make sure the pipe ends of the soft copper pipes are the correct size. This way you’ll have the right capillary gap required for brazing. Copper pipe expanders with a capillary gap optimizer are particularly well suited for joints without fittings.

4. **Cleaning**
   Clean the brazing area on the parts to be joined (fittings and outside of pipe ends or inside of expanded pipes) until it is bright and shiny using a metal free cleaning pad. Also, be sure to remove any metal filings that may occur.
What’s the process for soldering?

1. Apply Degufit 3000 solder paste
   Apply the solder paste or flux evenly to the pipe ends. The use of soft solder paste is preferable because when it heats up, you can keep an eye on the solder powder to see if it melts – and prevent overheating.

2. Join the components to be brazed
   Fit the pipe and fitting or expanded pipes together – and make sure you maintain the right joint depth.

3. Heat up the brazing point
   Heat the workpieces with a resistance brazing device or burner. Choose the burner size according to pipe dimension. Set the burner so that a clear inner cone of flame with a soft flame aspect is visible. Heat the joint for soldering quickly and evenly.

4. Soldering
   As soon as the solder paste begins to glow, add the solder wire whilst turning the flame away – until a groove becomes visible that shows the soldering gap has been filled.

5. Clean-up
   Residual flux must be removed after brazing to prevent corrosion. Where possible, use water or a brush to remove any flux residue.

6. Test
   Carry out a regulation pressure test and rinse the pipes.

Fred Flame says:

→ Soft solder joints that have been carried out correctly look smooth and clean and do not require any touching up.
What’s the process for brazing?

1. **Apply flux**
   Flux only needs to be applied to the end of the pipe when brass or gunmetal fittings are used and the braze contains phosphorous.

   ➔ No flux is required when brazing copper/copper joints with brazing alloys containing phosphorous.

   The even application of the flux is vitally important even with brazing alloys containing silver in the pipe installations.

   ➔ We recommend the use of additional brazing alloy flux for pipe diameters exceeding 22 mm (.89”) when using flux coated brazing rods.

2. **Assemble the parts**
   Fit the pipe and fitting or expanded pipes together – and make sure you maintain the right joint depth.

3. **Heat the workpieces**
   Select the correct burner size to correspond with the pipe dimension. Set the burner so that a clear inner cone of flame with a strong flame aspect is visible. Heat up the brazing joint rapidly and evenly until the material has a cherry red glow.

4. **Brazing**
   Melt the brazing alloy down in the flame until the brazing gap is filled and keep the copper pipe glowing at a somewhat greater distance.

5. **Clean up**
   Remove any excess or residual flux once the joint is sufficiently cooled down.

6. **Test**
   Carry out a regulation pressure test and rise the pipe.

Fred Flame says

➔ Correctly executed brazing joints with brazing alloys containing phosphorous show a blue-grey coating on the brazing joint.
How strong is a solid brazed joint?

A high degree of stress can be placed on a brazed joint. This is made clear by the burst pressure test for example.

On a copper pipe fitting with five brazing joints, each individual brazing joint is actually stronger than the base metal. When connecting the pipe section to a high-pressure pump, the pipe’s wall bursts at a pressure of 280 bar (4,061 psi). The brazing joints themselves withstand the pressure and remain tight.

Also worth noting: a professionally brazed joint also withstand extremely high strains such as dynamic stress that occurs through vibrations.

What are the recommended brazing techniques?

Choosing the right brazing technique is the key to strong, safe and durable joints.

Please keep in mind that any DIN, DGW and the International Copper Association guidelines and directives as well as the guidelines issued by the copper pipe and tube manufacturers supercede the recommendations outlined here.

The following table gives an overview of the approved working techniques in Germany for individual installation areas:

<table>
<thead>
<tr>
<th>Installation area</th>
<th>Working technique</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drinking water</td>
<td></td>
</tr>
<tr>
<td>Cu-pipes soft (R220)</td>
<td>↓</td>
</tr>
<tr>
<td>Cu pipes Semi-hard (R250) up to 28 mm</td>
<td>↓</td>
</tr>
<tr>
<td>Cu pipes drawing hard (R290) up to 35 mm</td>
<td>↑</td>
</tr>
<tr>
<td>Heating</td>
<td>↑</td>
</tr>
<tr>
<td>Town, natural, liquid gas</td>
<td>↑</td>
</tr>
<tr>
<td>Refrigeration and air-conditioning technology</td>
<td>↑</td>
</tr>
<tr>
<td>Oil</td>
<td>↑</td>
</tr>
<tr>
<td>Compressed air</td>
<td>↑</td>
</tr>
</tbody>
</table>

↑ permitted   ↓ not permitted
Brazing is the optimum joining technique, proven for decades.

If you have any questions, please pay us a visit:

www.BrazeTec.com

➔ We will gladly help resolve your brazing issues.

The main advantages of brazing

1. Durable, solid and tight connections
2. Proven in practice for decades
3. Approved for all installation areas requiring permanent connections.
4. No need to invest in additional equipment
5. Low fitting and joining costs
6. Brazing materials are readily available
7. Can also be used in constrained areas
8. Independent of pipe and fittings systems
## Soft Solder paste, soft solders, soft solder flux

<table>
<thead>
<tr>
<th>BrazeTec Soft Solder Paste</th>
<th>Norm specification DIN EN 29453</th>
<th>Norm specification DIN EN 29453</th>
<th>Melting range in °C</th>
<th>Raw material</th>
<th>Fitting material</th>
<th>Flux DIN EN 2945-1</th>
<th>Use with</th>
</tr>
</thead>
<tbody>
<tr>
<td>BrazeTec Degufit 3000</td>
<td>S-Sn97Cu3</td>
<td>97 Sn, 3 Cu</td>
<td>230 – 250</td>
<td>Copper</td>
<td>Copper Brass Gunmetal</td>
<td>3.1.1.</td>
<td>BrazeTec 3</td>
</tr>
<tr>
<td>BrazeTec Degufit 4000</td>
<td>S-Sn97Ag3</td>
<td>96,7 Sn, 3,3 Cu</td>
<td>221 – 230</td>
<td>Copper</td>
<td>Copper Brass Gunmetal</td>
<td>3.1.1.</td>
<td>BrazeTec 4</td>
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</table>

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<thead>
<tr>
<th>BrazeTec Soft Solder</th>
<th>Norm specification DIN EN 29453</th>
<th>Norm specification DIN EN 29453</th>
<th>Melting range in °C</th>
<th>Raw material</th>
<th>Fitting material</th>
<th>Alternatively, can be processed with BrazeTec DIN EN 29454-1 3.1.1.</th>
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</thead>
<tbody>
<tr>
<td>BrazeTec 3</td>
<td>S-Sn97Cu3</td>
<td>97 Sn, 3 Cu</td>
<td>230 – 250</td>
<td>Copper</td>
<td>Copper Brass Gunmetal</td>
<td>BrazeTec Degufit 3000</td>
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<tr>
<td>BrazeTec 4</td>
<td>S-Sn97Ag3</td>
<td>96,7 Sn, 3,3 Cu</td>
<td>221 – 230</td>
<td>Copper</td>
<td>Copper Brass Gunmetal</td>
<td>BrazeTec Degufit 4000</td>
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<tr>
<td>BrazeTec Darifix 3</td>
<td>S-Sn97Cu3</td>
<td>97 Sn, 3 Cu</td>
<td>230 – 250</td>
<td>Copper soldering in household plumbing</td>
<td>BrazeTec Soldaflux 7000</td>
<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>BrazeTec Solder Flux</th>
<th>Norm specification (DIN EN 29454-1)</th>
<th>Effective temperature range in °C</th>
<th>Delivery form</th>
<th>Solvent for excess/residue</th>
<th>Use with</th>
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<tbody>
<tr>
<td>Soldaflux 7000</td>
<td>3.1.1.</td>
<td>150 – 400</td>
<td>Semi-liquid</td>
<td>water</td>
<td>BrazeTec 3, BrazeTec 4</td>
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</tbody>
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## Brazing alloys and brazing fluxes

<table>
<thead>
<tr>
<th>Brazetec brazing flux</th>
<th>DIN EN 1045</th>
<th>Effective temperature range in °C</th>
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<tbody>
<tr>
<td>Brazetec h</td>
<td>FH 10</td>
<td>550–800</td>
</tr>
<tr>
<td>Brazetec rs</td>
<td>FH 21</td>
<td>über 800</td>
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### Brazing alloys

<table>
<thead>
<tr>
<th>Brazetec</th>
<th>Norm specification (EN 1044)</th>
<th>Composition in % wt.</th>
<th>Melting range in °C</th>
<th>Working temp. in °C</th>
<th>Raw material</th>
<th>Fitting material</th>
<th>Brazetec Flux</th>
<th>as per DIN 1045</th>
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</thead>
<tbody>
<tr>
<td>Silfos 94</td>
<td>CP 203</td>
<td>93,8 Cu, 6,2 P</td>
<td>710 – 890</td>
<td>760</td>
<td>Copper</td>
<td>Copper</td>
<td>n/a</td>
<td>FH 10</td>
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<tr>
<td>Silfos 2</td>
<td>CP 105</td>
<td>2 Ag, 91,7 Cu, 6,3 P</td>
<td>645 – 825</td>
<td>740</td>
<td>Copper</td>
<td>Copper</td>
<td>n/a</td>
<td>FH 10</td>
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<tr>
<td>4576</td>
<td>AG 104</td>
<td>45 Ag, 27 Cu, 2,5 Sn, 25,5 Zn</td>
<td>640 – 680</td>
<td>670</td>
<td>Steel</td>
<td>Copper</td>
<td>SteelBrassGunmetal</td>
<td>FH 10</td>
</tr>
<tr>
<td>4576U</td>
<td>AG 104</td>
<td>45 Ag, 27 Cu, 2,5 Sn, 25,5 Zn</td>
<td>640 – 680</td>
<td>670</td>
<td>Steel</td>
<td>Copper</td>
<td>SteelBrassGunmetal</td>
<td>Pipe/tube diameter &gt; 22 mm: add Brazetec h</td>
</tr>
<tr>
<td>4404</td>
<td>AG 203</td>
<td>44 Ag, 30 Cu, 26 Zn</td>
<td>675 – 735</td>
<td>730</td>
<td>Steel</td>
<td>Copper</td>
<td>SteelBrassGunmetal</td>
<td>BrazeTec h</td>
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<tr>
<td>3476</td>
<td>AG 106</td>
<td>34 Ag, 36 Cu, 2,5 Sn, 27,5 Zn</td>
<td>630 – 730</td>
<td>710</td>
<td>Steel</td>
<td>Copper</td>
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<td>3476U</td>
<td>AG 106</td>
<td>34 Ag, 36 Cu, 2,5 Sn, 27,5 Zn</td>
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<td>710</td>
<td>Steel</td>
<td>Copper</td>
<td>SteelBrassGunmetal</td>
<td>Pipe/tube diameter &gt; 22 mm: add Brazetec h</td>
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<tr>
<td>60/40</td>
<td>CU 301</td>
<td>60 Cu, 39,6 Zn, 0,3 Si, 0,1 Sn</td>
<td>875 – 895</td>
<td>900</td>
<td>Galvanized steel</td>
<td>–</td>
<td>BrazeTec rs</td>
<td>FH 21</td>
</tr>
</tbody>
</table>