BrazeTec®

SAXONIA® TECHNICAL MATERIALS

# Selection Rules of Brazing Alloys and Fluxes


Brazing is BrazeTec

## 1. Introduction

Welding additives are virtually always material-specific, meaning that they are first and foremost selected depending on the composition of the base materials to be joined together. They usually have the same or a similar composition to the base material.

In contrast, brazing alloys are only material-specific in exceptional cases. In general, the same brazing alloy can be used for a variety of base materials.

A number of criteria are decisive for selecting a brazing alloy:

- the nature and state of treatment of the base materials
- the dimensions and manufacturing tolerances of the workpieces
- the equipment which is available for carrying out the brazing work
- the loads (magnitude, direction, type) at the locations of the joints
- operating temperature
- operating pressure
- media attacking the brazed connections
- further processing of the workpieces
- applicable regulations relating to the technique
- work safety
- economic production

## 2. Selection criteria and derived selection rules

### 2.1 Nature and state of treatment of the base materials:

- The alloy must melt at a *lower temperature* than the base material (by at least 50 – 100°C).
- The alloy must be able to wet the base material.
- The alloy must be chosen such that desired treatment states, as a result of for example hardening, homogenising and cold-strengthening, are as little as possible affected by the heating.

### 2.2 Dimensions and manufacturing tolerances of the workpieces:

- Workpieces having joint clearances of more than 0.5 mm (brazing joints) are brazed using the braze welding technique. As relatively large amounts of alloy are required for this, it is preferred to use the silver-free brazing alloys BrazeTec 60/40 and BrazeTec 48/10.

- If the workpiece cannot be heated uniformly over the whole length to be joined, the braze welding technique is again used.

- Workpieces having joint clearances of less than 0.5 mm are joined using the crack brazing technique. For wide joints it is best to use a more viscous brazing alloy. This viscous state can be achieved by working the alloy below the liquidus temperature. The broader the melting point interval of the alloy, the easier this is from a heat transfer point of view. An alloy with a broad melting point interval is hence used for wide joints. The reverse also applies: the narrower the joint, the narrower the melting point interval of the alloy may be.

### 2.3 Available equipment

The alloy must be able to be processed using the equipment which is available.

- Furnace brazing:
  a) Use cadmium-free and if possible zinc-free brazing alloys.

  b) Preferably brazing alloys with a narrow melting point interval.

  In general, high melting point brazing alloys are used.

- Torch brazing and induction brazing:

  Low melting point silver and CuP brazing alloys are respectively used.

### 2.4 Mechanical loads at the joints

For joints, the following strengths can be assumed:

**a) Brazed joints**

| | |
|---|---|
| Tensile strength: | 200 MPa (N/mm$^2$) |
| Shearing strength: | 100 MPa (N/mm$^2$) |

**b) Soldered joints**

| | |
|---|---|
| Shearing strength: | 3 MPa (N/mm$^2$) |

A degree of joint filling of 80% is assumed for these values. Higher joint strengths have been achieved with most brazing alloys on test specimens in accordance with DIN 8525 (see BrazeTec product range).

### 2.5 Operating temperature

Higher operating temperatures virtually always cause significant strength decrease in the brazed joints. The maximum operating temperatures given for the products should not be exceeded for long periods.

Brief exceeding of these temperatures is permitted as long as there is no noteworthy load on the brazed joint.

In principle, mechanical and thermal loads on brazed joints must be considered together. If in addition to higher mechanical loads there are also higher operating temperatures, no cadmium-containing and tin-containing brazing alloys should be used. Brazing alloys such as BrazeTec 4404, BrazeTec 4900 and in particular BrazeTec 48/10 are better suited under such conditions.

### 2.6 Operating pressure

- Increased pressure causes a mechanical load at the brazed joint. In addition to the pressure, the constructional design must also be known so that the mechanical load can be determined. The operating temperature must also be taken into consideration here.

- For brazed joints which have to be vacuum tight, the vacuum resistance of the brazing alloys must be checked using vapour pressure curves. Brazed joints are usually vacuum tight. If vacuum tightness has to be guaranteed at high temperatures, the zinc-free and cadmium-free brazing alloys must be used.

### 2.7 Types of media

- Air
  Virtually all alloys can be used. BrazeTec Silfos alloys should not be used in industrial atmospheres which contain high levels of sulphur.

- Flammable gases
  Brazing is prescribed for flammable gases. The following alloys are allowed in accordance with the GW 2 Work Sheet:
  BrazeTec 4576, BrazeTec 3476,
  BrazeTec 4404, BrazeTec Silfos 2,
  BrazeTec Silfos 94.
  If sulphur-containing media (e.g. motor oils, air from stalls) come into contact with the brazed joint, phosphorus-containing alloys must not be used.

  According to ISO 9539, 1988 Edition, acetylene lines must be joined using alloys which do not contain more than 46% Ag and not more than 37% Cu (BrazeTec 4576 or BrazeTec 4404).

- Technical gases
  There are no restrictions on alloy selection for technical gases such as compressed air, oxygen, nitrogen, hydrogen, carbon dioxide, argon and helium.

- Liquids
  Distilled water, organic solvents, alcohols, ammonia-free refrigerants/coolants and sulphur-free oils do not require special brazing alloys. Phosphorus-containing brazing alloys cannot be used for sulphur-containing media.

  Brazed joints are resistant to solutions of weak acids or diluted bases if copper, copper-alloys or carbon steels are the base materials.

  Corrosion-proof brazed joints cannot be made with zinc-containing silver brazing alloys on corrosion resistant steel, even if only mains water comes into contact with the joint (knife-edge corrosion). BrazeTec 6009 is more favoured than zinc-containing silver brazing alloys, although knife-edge corrosion can also not be excluded for this alloy. Corrosion-proof brazed joints can be made with amongst other things nickel-based brazing alloys (furnace brazing).

- Seawater and brackish water resistant copper-nickel-iron alloys, and also carbon steels and other copper alloys, are preferably brazed with BrazeTec 4404 brazing alloy (not chromium-nickel steels) if they come into contact with seawater. Joints which come into contact with foodstuffs should be brazed with antimony-free, lead-free and cadmium-free alloys.

### 2.8 Further processing of brazed components

- Galvanising

  When using high melting point brazing alloys such as BrazeTec 60/40 or BrazeTec 48/10 the flux residues must be mechanically removed. Work can often be carried out with gaseous flux.

  Low melting point silver brazing alloys are preferred, as the flux residues can be easily removed. Cadmium-free alloys generally form smoother round corners. In special cases, silicon-containing silver brazing alloys are to be recommended.

- Enamelling / heat treatments

  The alloy must be chosen such that during the further processing stages the alloy does not melt or is not subjected to too high stress as a result of the heating and mechanical loads.

### 2.9 Regulations

The alloy must comply with specific regulations and guidelines, including standards, instructions and specifications of the client.

### 2.10 Work safety

- Vapours
  Flux/alloy vapours are produced when brazing in air.

  Flux vapours don’t always have to be extracted but it is recommended. Flux vapours primarily cause irritation.

  According to the current state of knowledge, alloy vapours are harmless, provided cadmium-containing alloys are not being used. When working with cadmium-containing alloys, extraction or breathing protection is required.

- Wastewater
  The wastewater may contain a maximum of 0.1 mg/litre cadmium ions (the value complies with local regulations). Standard detoxification methods don’t always satisfactorily remove cadmium from the wastewater to below the limit value.
  By selecting a cadmium-free alloy, this problem is alleviated/avoided.

### 2.11 Economics of brazing

The brazing alloy which is used must be the alloy which permits the most economical manufacturing method.

The low melting point silver brazing alloys are relatively expensive. Due to the lower working temperatures, there are however a number of advantages which often considerably outweigh the higher costs of the alloys. The following principle applies here: „The cost of the alloy does not determine the economics“, but rather the „total cost of the finished component “.

Advantages of lower working temperatures:

+ Lower energy costs
+ Less shape distortion
+ Less scaling
+ Prevention of recrystallisation

## 3. Determining costs

The cost of brazing is made up of the following:

- Material costs for the brazing alloy and flux or controlled atmosphere
- Auxiliary materials (degreasing baths, scouring)
- Energy
- Depreciation of brazing equipment or brazing plants
- Manufacturing costs and overheads

**Procedure for carrying out brazing work:**

- Preparation (grinding, degreasing, etc.)

- Brazing
  - Joining the individual components
  - Positioning the individual components
  - Brazing alloy and (if required) flux additions
  - Heating (for manual brazing).

- Post-brazing work
  - Remove flux (if applicable)
  - De-scale (if applicable)
  - Rectify shape distortion (if applicable)
  - Inspection
  - Protect against corrosion (if applicable)

## 4. Brazing alloys

- **Cadmium-free universal alloys**
  This range of alloys has been extended because of the environmental benefits. Being cadmium-free, these products make an excellent contribution to protecting the health of those carrying out the brazing work.

- **Cadmium-containing universal alloys**
  These are typical silver brazing alloys which have the lowest working temperatures for heavy metal alloys. These are only suitable for joints with operating temperatures up to 150°C. These BrazeTec alloys are no longer recommended due to their cadmium content and associated health problems!

- **Silfos alloys**
  Special brazing alloys for copper materials. To be used without flux on copper, silver and copper-tin base materials. Suitable for copper-zinc base materials if flux is also used. Not suitable with sulphur-containing media, and not suitable for iron and nickel containing base materials.

- **Brazing alloys for hard metal brazing**
  Besides being used for hard metals, these alloys are also used for materials which are relatively difficult to wet such as chromium, molybdenum, tungsten, tantalum, niobium and cobalt. The manganese component provides good wetting properties, the nickel component confers high strength.

  For hard metal tools which are prone to cracking, layer-alloy BrazeTec 49/Cu must be used.

- **Brazing alloys for brazing aluminium**

  Suitable for pure aluminium and aluminium alloys having solidus temperatures above 640°C.

- **Brazing alloys for special applications**

- **Brazing alloys sheathed with flux**

- **Palladium-containing brazing alloys**

- **Vacuum brazing alloys**

- **Special soft solders „Soldamoll“**

  These solders are used when the cheap bulk solders based on lead-zinc no longer meet the requirements for the joint.

## 5. Fluxes

In the first instance the choice of flux depends on the working temperature of the selected alloy. The working temperature of the alloy must lie within the active temperature range of the flux.

In the second instance the choice of flux depends on the base material to be brazed.
See the BrazeTec product range for information.

Residues of the hygroscopic flux must be removed in order to prevent corrosion phenomena.

If scouring does not suffice, use BrazeTec-Flux-Ex for steel components or BrazeTec-Neacid for mixed metal components.

Non-hygroscopic fluxes do not cause corrosion phenomena. They can be best be removed by mechanical means.

- Special solder flux „Soldaflux“
- Brazing alloy pastes