Welding

Module 19.2.1

Hard Soldering

- Hard soldering is a general term for *silver soldering and brazing .*

- *These are very* similar thermal joining processes to soft soldering in as much that the parent metal does not become fused or molten and that the filler alloy has to have a lower melting temperature range than the metals being joined.

Module 19.2.1

Explain the basic principles of hard soldering and braze welding.
Principles: joint types and materials joined, solders, fluxes, heating equipment, applications, safety precautions

Hard Soldering

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- The term ‘ brazing ’ is derived from the fact that the filler material (spelter) is a brass alloy of copper and zinc and a typical spelter containing 40% copper and 60% zinc melts at about 850°C to produce a strong and malleable joint. This is very much higher than the temperatures required when soft-soldering.

- Brazing is defined as a process of joining metals in which the molten filler material is drawn into the gap between the closely adjacent surfaces of the metals being joined by capillary attraction.

Principles of Brazing

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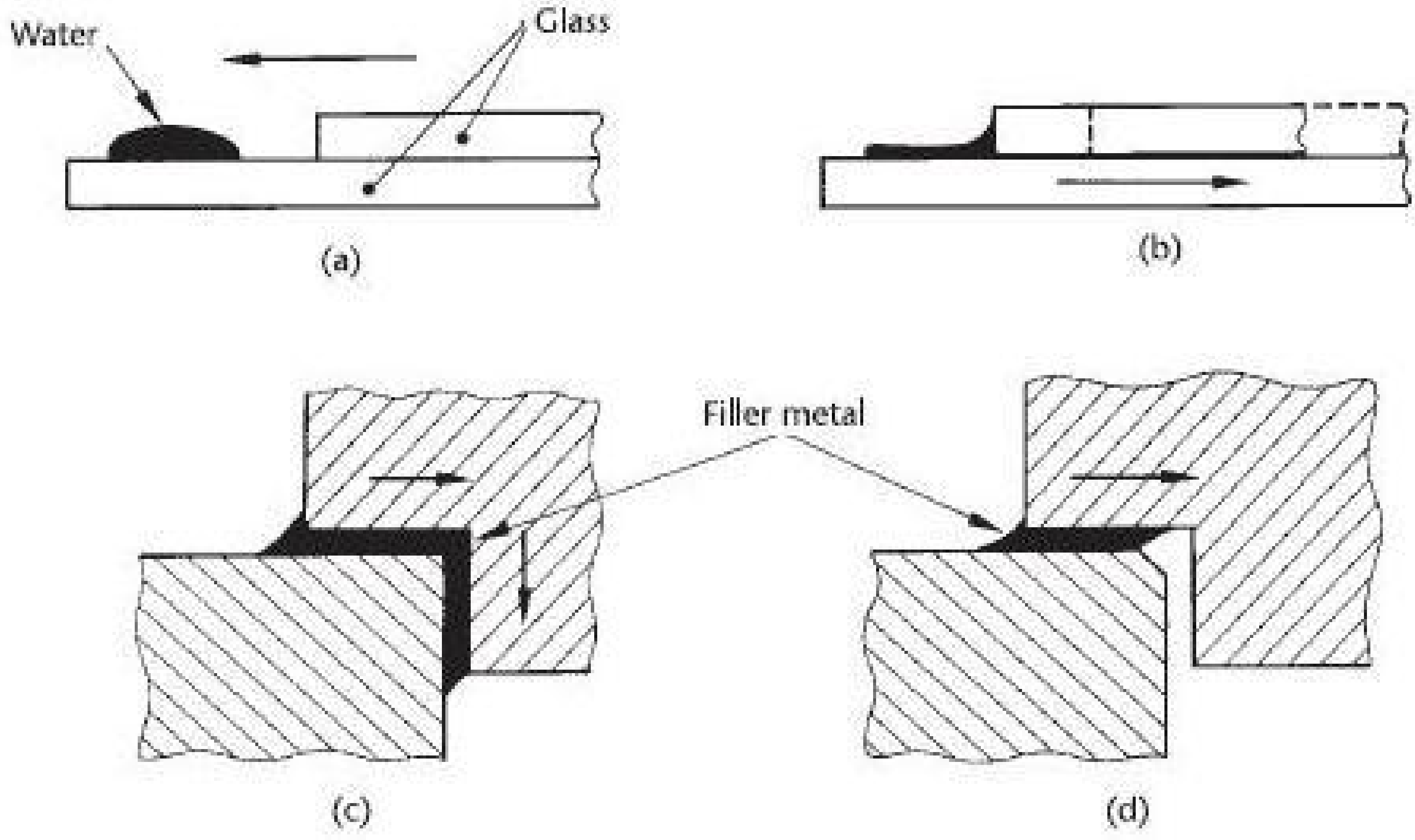
- The selection of a suitable filler alloy which has a melting range that is appreciably lower than that of the parent metals being joined – but substantially higher than that used for soft soldering.
- The thorough cleanliness of the surfaces being joined. Previously soft-soldered joints cannot be remade by hard soldering.
- The complete removal of the oxide film from the surfaces of the parent metal and the filler material by a suitable flux.
- The complete ‘ wetting ’ of the joint surfaces by the molten brazing alloy.

Capillary Action



Metals suitable for Hard Soldering

The following common metals and their alloys can be joined by hard soldering processes:

- Copper and copper-based alloys.
- Low, medium, and high carbon steels.
- Alloy steels including stainless steels.
- Malleable cast iron and wrought iron.
- Nickel-based alloys.
- Aluminium and certain aluminium alloys.

Metals suitable for Hard Soldering

- Metals and alloys of dissimilar compositions can be hard-soldered (brazed or silver-soldered) together, for example: copper to brass; copper to steel; brass to steel; cast iron to mild steel; and mild steel to stainless steel.

Filler Materials

Brazing filler alloys maybe classified into:

- Silver Solders
- Brazing alloys containing phosphorus
- Brazing brasses or ‘spelters’

Silver Solder

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- More expensive due to the high percentage of precious metal silver
- Produce strong & Ductile joints at much lower temperature than other filler metal
- Low processing temperature therefore little thermal effects on parent metal
- Borax or flux based upon boric acid are not suitable to used with silver solder as these flux are not sufficiently fluid at the processing temperature of silver solder

Brazing alloys containing phosphorus

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- Composed of silver, phosphorus & copper or just copper & phosphorus
- Usually referred as self fluxing brazing alloys as they have capability to braze copper component in air without the need of flux however for copper based alloys suitable flux is needed
- Only effective when used in oxidizing atmosphere and should only be used with copper and copper alloys otherwise a brittle and weak joint will be produced

Brazing brasses or ‘spelters

- Generally known as brazing spelters and uses borax as flux
- Processing temperature are relatively higher than other two filler metal
- Produces high tensile strength joints and suitable for producing high strength joints between ferrous components

Heat Sources for Brazing

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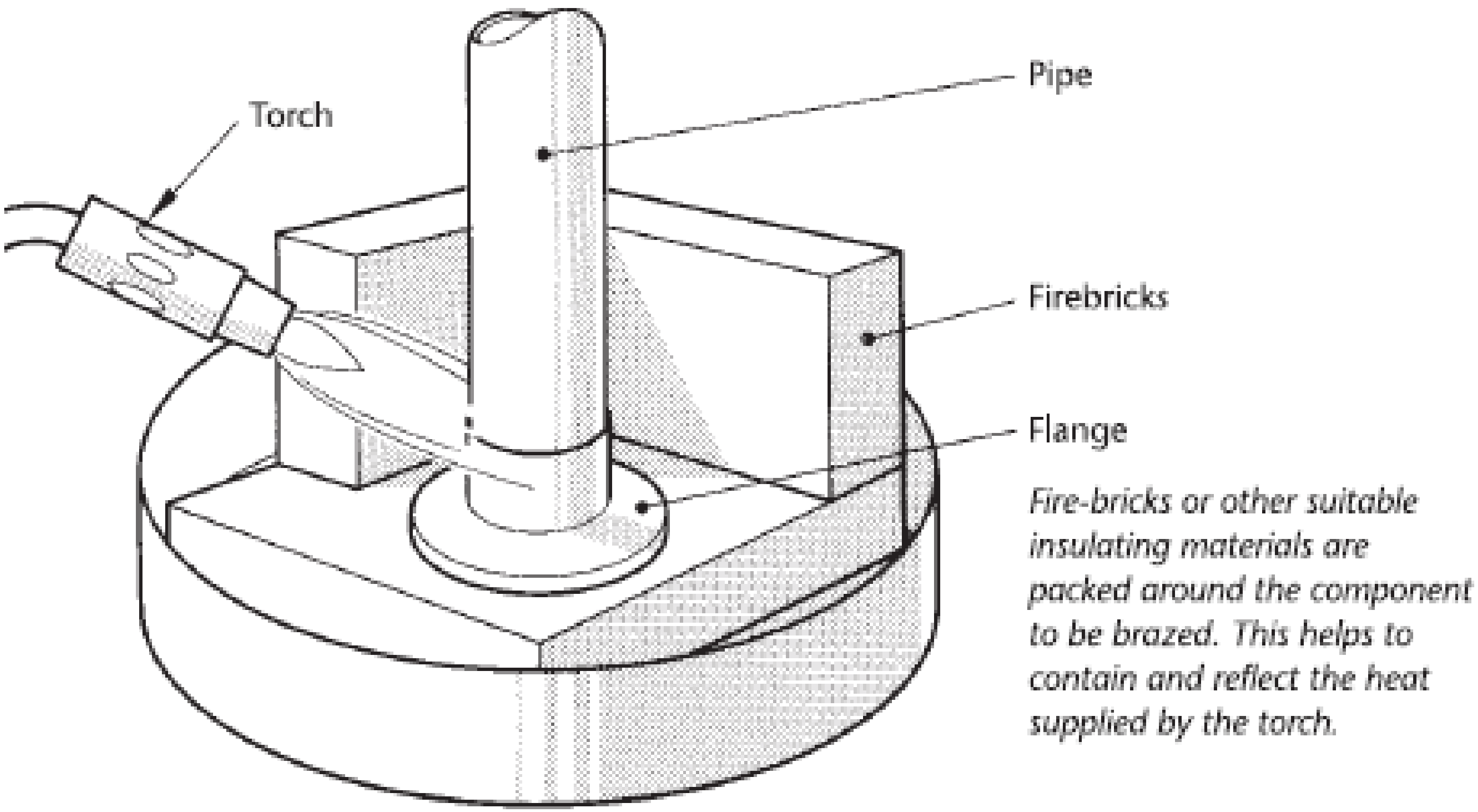
Heat sources for Brazing are:

- Flame brazing (torch)
- Furnace Brazing
- Dip Brazing
- Electric induction brazing
- Electric resistance brazing

Flame brazing (torch)

- Most versatile (Gas welding torch normally used for flame)
- Used in batch production for large or small assembly
- Spelter can be used in two ways
  - Granules of spelter is boiled with borax and a paste is formed which is then applied in the heated joint area, spelter melts and flows by capillary action
  - Tip of spelter is heated and dip I flux which is adhered to it then applied to the joint area which is also fluxed.

Flame brazing (torch)

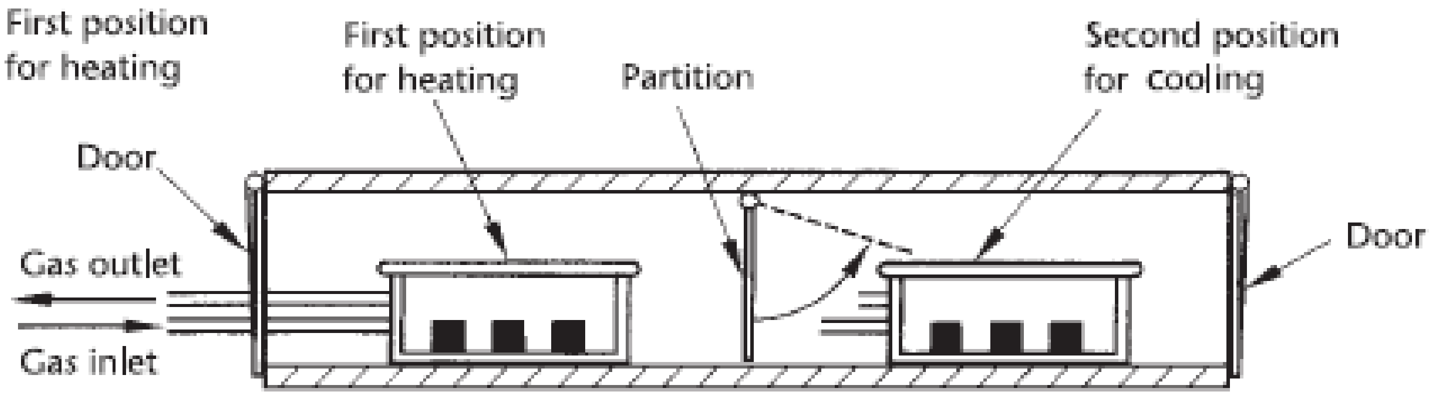


Furnace Brazing

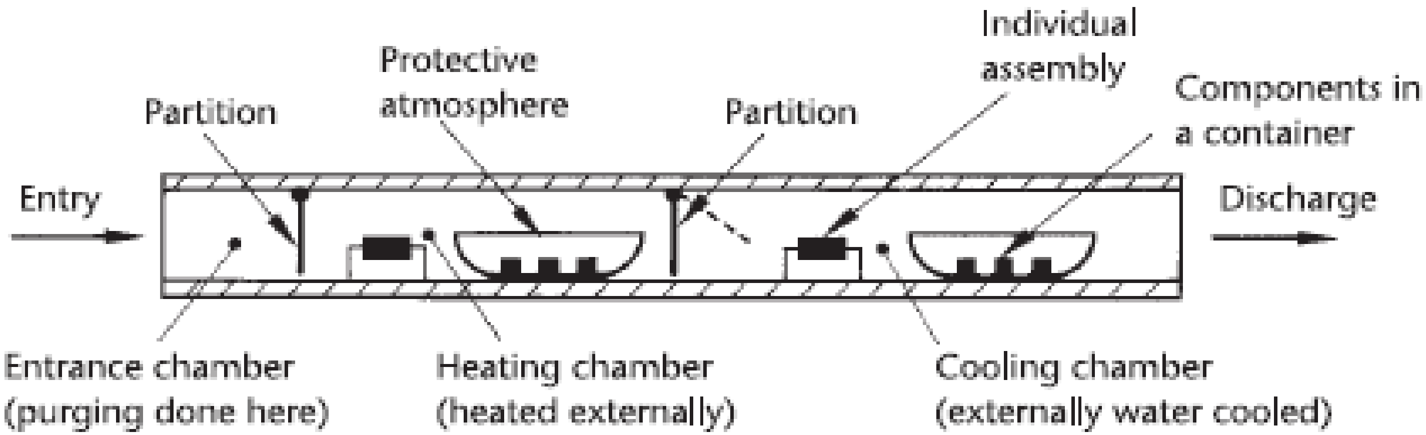
- Mainly used when controlled atmosphere is required & when components to be joined is design so that they can be pre assembled or hold them in position during brazing

- Heat source may be gas oil in a muffle type furnace

Furnace Brazing



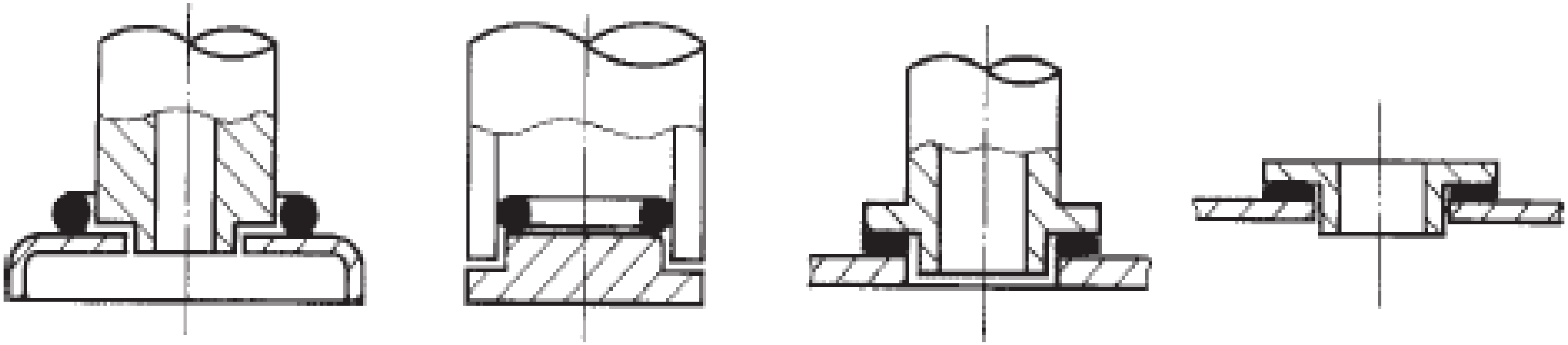
Schematic layout of batch brazing in a sealed container



Schematic layout of continuous brazing furnace

Individual assemblies or components for batch brazing (in trays) are passed through the furnace on a conveyor system. Inert or reducing atmospheres can be used to protect the work from oxidation.

Furnace Brazing



Filler metal for furnace brazing is used in the form of pre-placements. The components to be brazed are assembled with the filler alloy in the required position and fluxed if necessary. Pre-placed brazing alloy inserts are available in a variety of forms, such as wire rings, bent wire shapes, washers and foils.

Dip Brazing

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- Dip brazing can be defined in two ways
  - Molten filler metal dip brazing
  - Flux bath dip brazing
- Molten filler metal dip brazing
  - Component to be joined assembled and submerged in the bath of molten filler metal
  - Flux is floated on the surface to exclude the air
  - The parts should be raised & lowered several times through the molten flux into the molten brazing alloy to ensure penetration of flux & brazing alloy in the clearance

Dip Brazing

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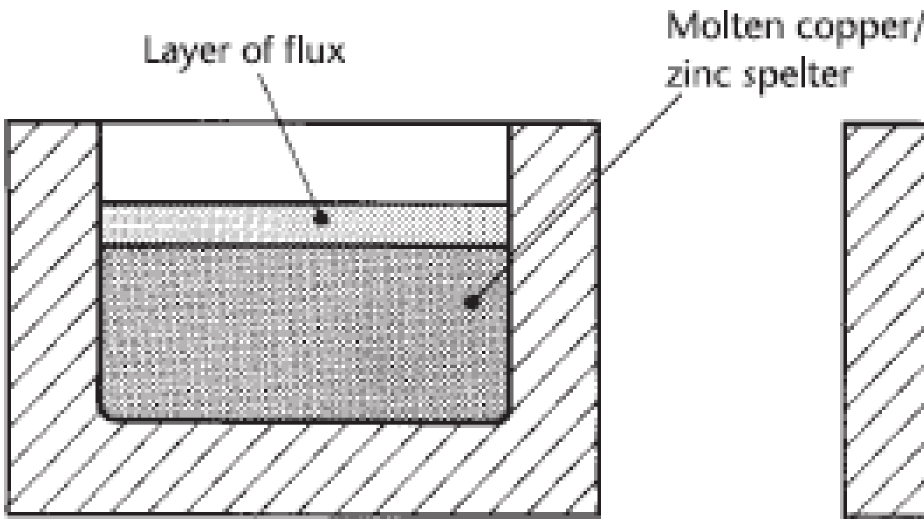
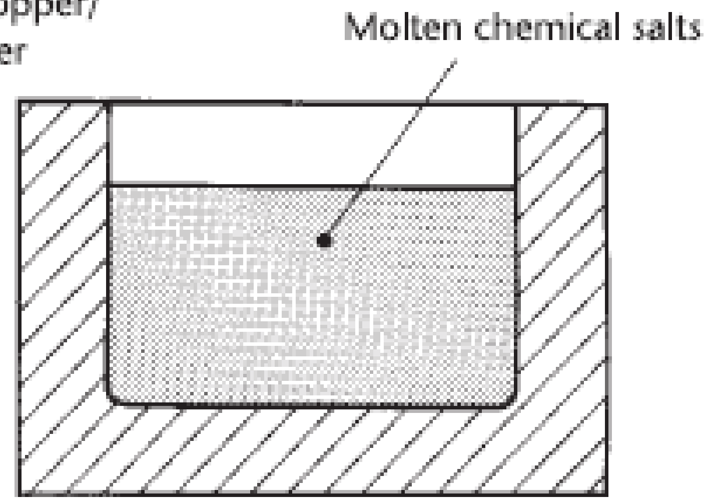
- Flux bath dip brazing
  - Also called salt bath dip heating & mainly used for aluminum components using spelters as brazing alloy
  - Molten salt is contained in salt bath
  - It enables the parts to be joined heated more rapidly than in furnace because of the greater heat conductivity of the liquid medium in the bath
  - Salt used is carefully chosen for their melting characteristics and ability to have a fluxing action

Dip Brazing



Dip brazing bath

The brazing bath is heated externally.



Salt bath

Baths are usually fitted with an insulated lid or cover to prevent heat loss.

Electric induction brazing

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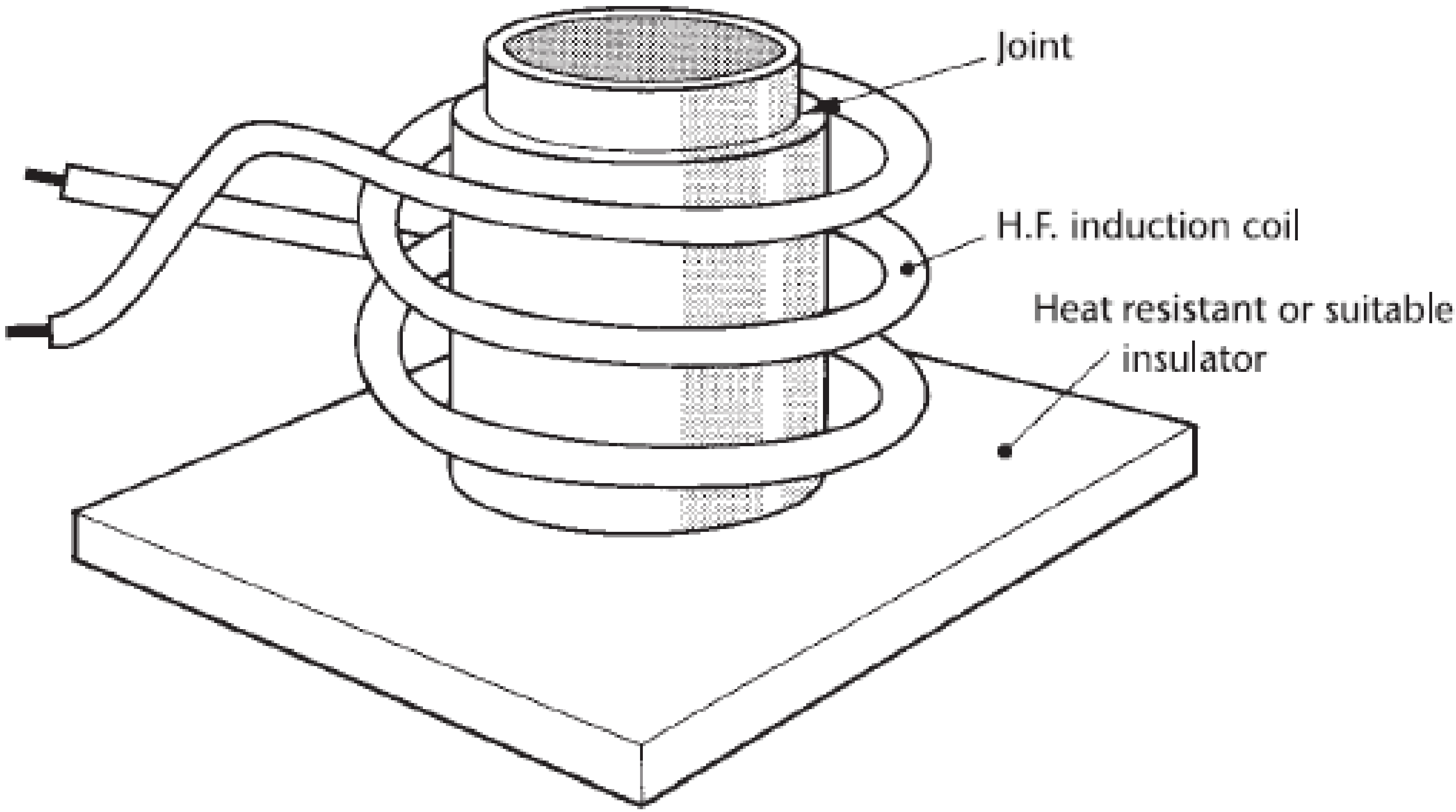
- Induction heating is used to braze part that are self jigging
- The assembly to be brazed is placed in magnetic field of a solenoid carrying a high frequency AC current
- The heat required for brazing is generated within the joint material itself

Electric induction brazing



Electric induction brazing

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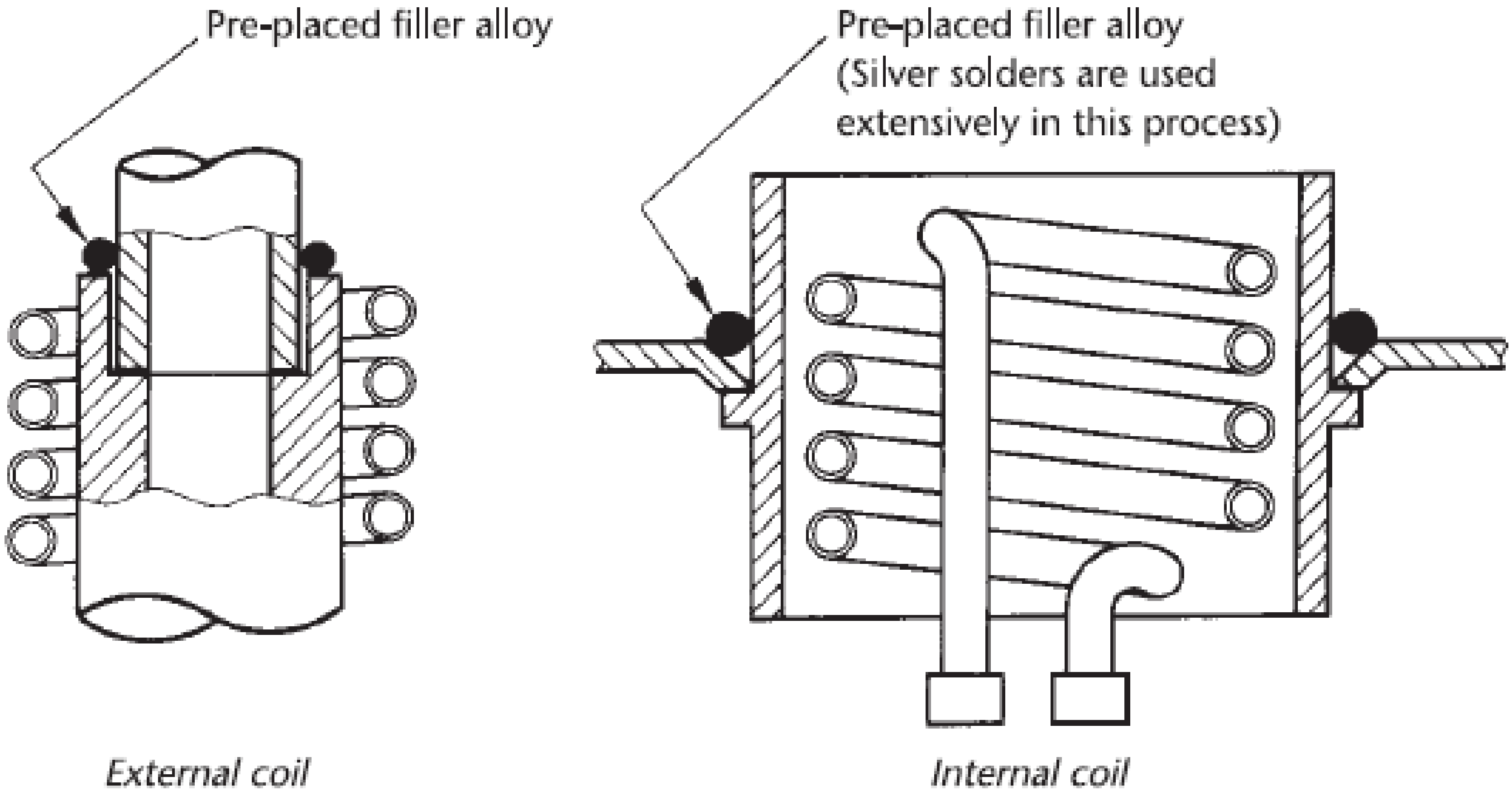

Electric resistance brazing

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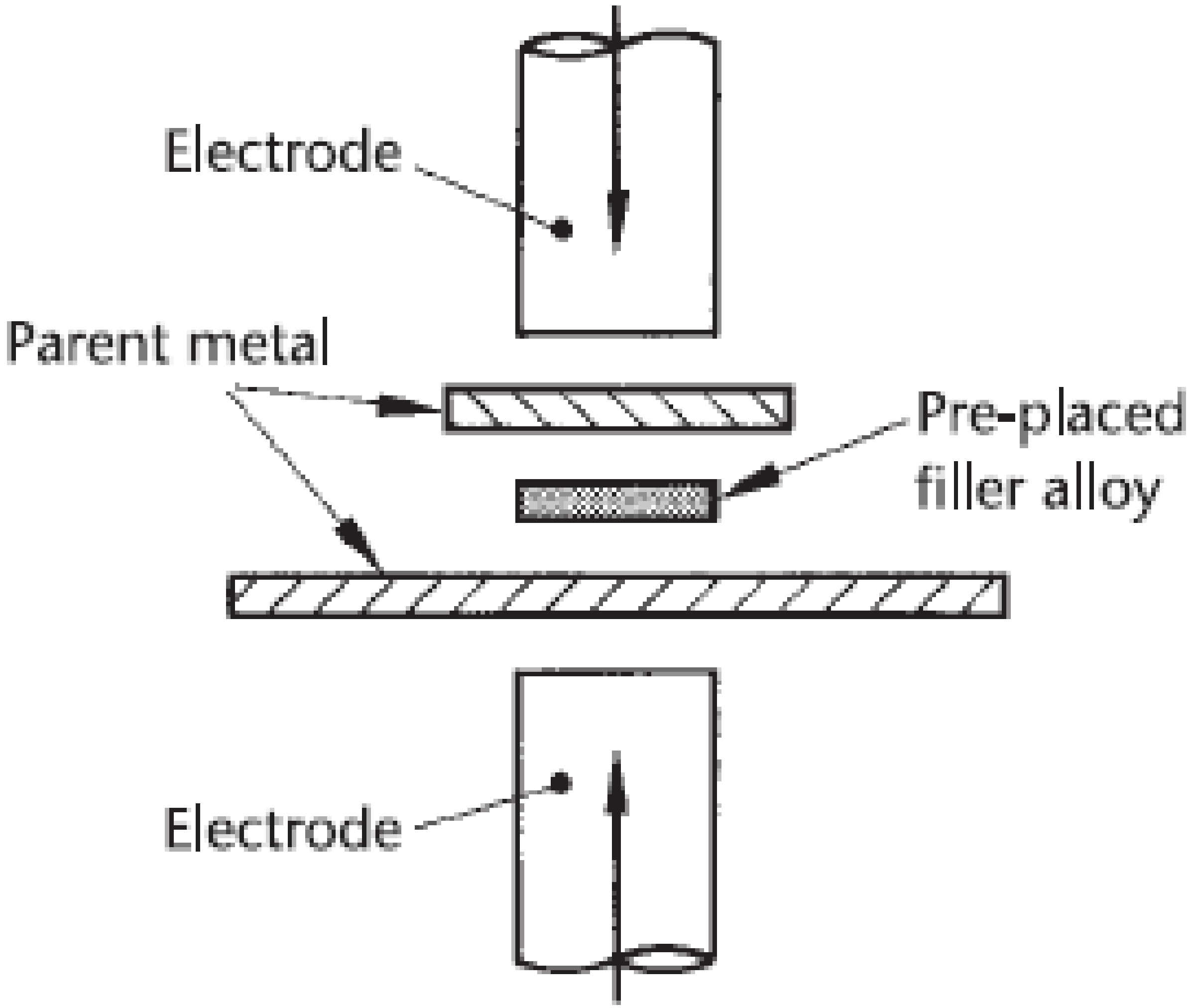
- In this process the heat required for brazing is generated by the passage of high value electric current through the joint material at low voltage
- The resistance by the joint material in current flow and carbon electrodes are responsible for the heat generated
- No jigs required as the carbon electrode hold the pieces itself

Electric resistance brazing



Types of Brazed joints

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There are two basic types of brazed joint, namely the lap joint and the butt joint.

However, there are many combinations and variations of these joints designed to meet specific requirements.

The factors affecting the strength of hard soldered joints are similar to those that apply to soft soldering but, since the mechanical strength of the filler materials (brazing alloys) is very much greater than that for soft solders, the overall joint strength is very much higher.

Braze Welding

- Braze-welding can be used to join similar or dissimilar metals by using a filler material with a lower melting temperature range than the parent metals being joined.

- When brazing , the filler material is drawn into a close-fitting joint by capillary attraction. When braze welding the joint gap is not so closely fitting, there is no capillary penetration and a relatively large quantity of filler material is used.

Braze Welding

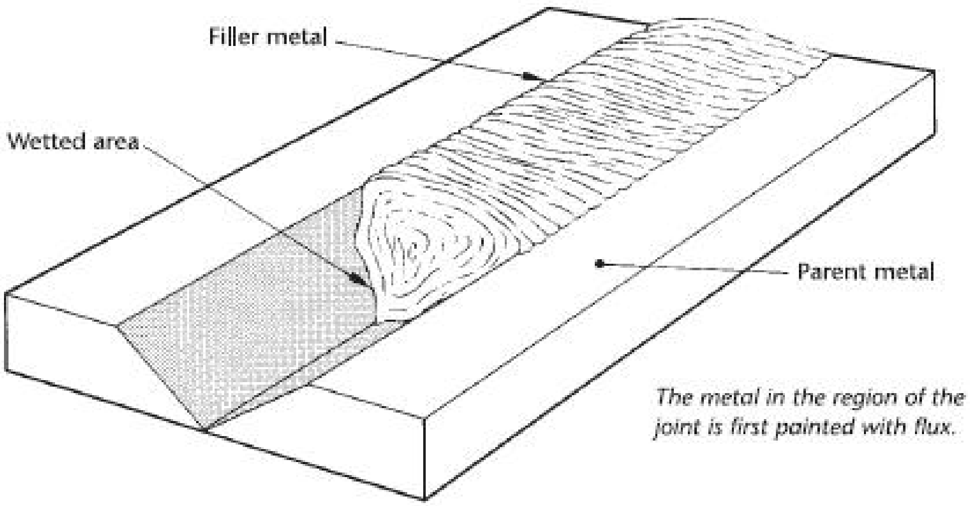
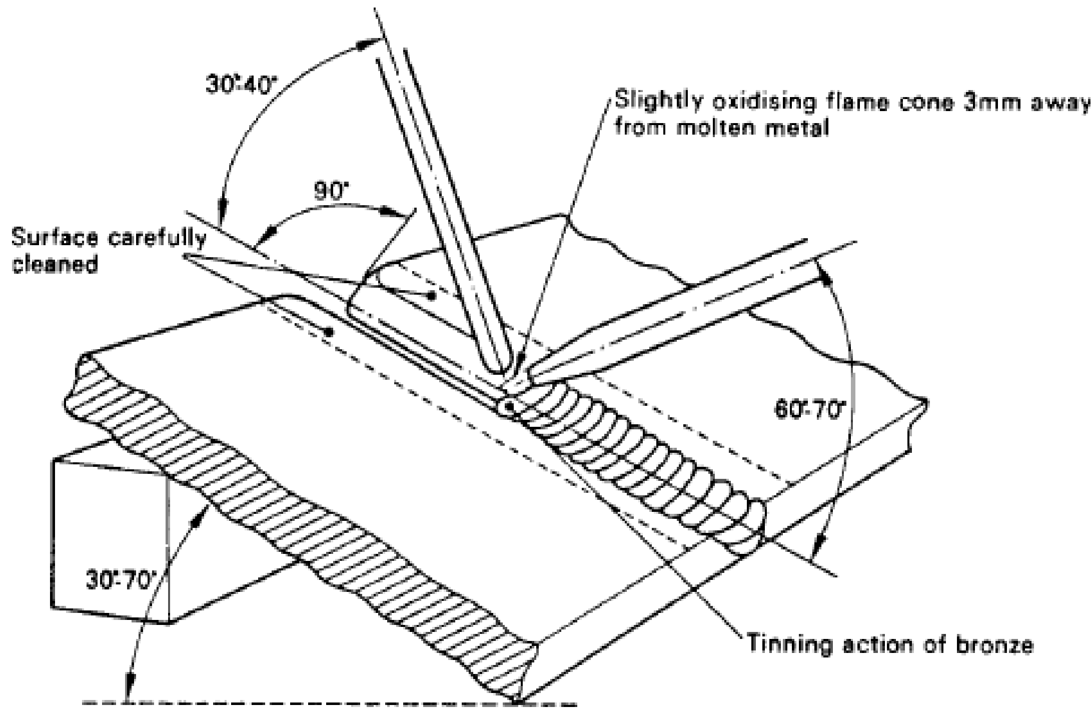


Figure 10.22 The wetting action in braze welding



Braze Welding

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- In braze-welding as distinct from fusion welding the melting temperature range of the filler material is lower than that of the parent materials being joined.

- As a result of this, the process of braze-welding requires a lower temperature than that required for full fusion welding which, in turn, results in less distortion and oxidation of the parent metals. When braze-welding, the work-piece must be thoroughly clean and free from scale, oil/grease, paint, metal plating or any other surface contaminant.

Flux (Braze Welding)

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- The flux should become completely molten at a temperature at least 50°C below the melting point of the filler material and retain its activity at a temperature at least 50°C above the melting temperature of the filler material.
- Fluxes of the borax type are suitable when braze-welding.
- A paste or a powdered flux worked into a paste with water can be more thoroughly and evenly spread than a dry flux in powder form.
- If a powder flux is used the tip of filler rod should be heated and dipped into the flux powder in order to pick up a ‘ tuft ’ of flux.

Metals suitable for Braze Welding

- Cast Iron
- Copper
- Galvanized Mild Steel
- Malleable Cast Iron
- Mild Steel
- A Combination of any two of the above

Applications

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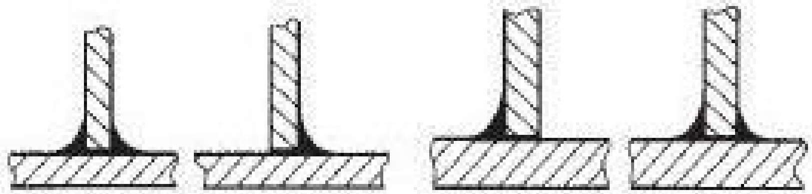
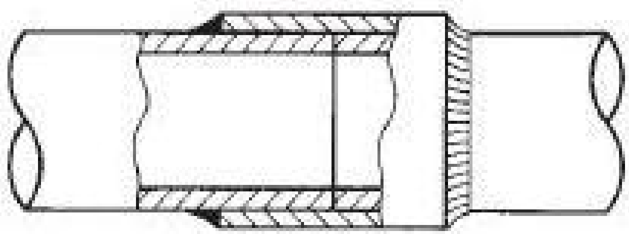
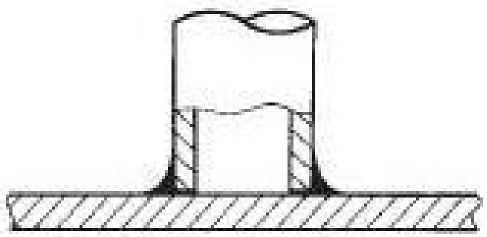


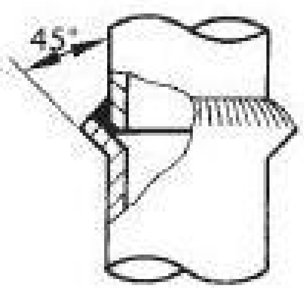
Examples of 'Tee fillet' joints in mild steel.



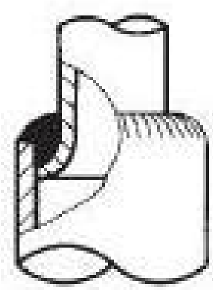
Sleeve joint for mild steel pipes
The mating surfaces of the pipes should be accurately machined. The sleeve and the pipes should be a close fit.



Tube plate joint for mild steel assemblies



(a)



(b)

(a) *Bell type butt joint*

(b) *Diminishing joint*
The end of the smaller pipe is belled out to fit into the large pipe.

Applications

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