PROSES-PROSES PENYAMBUNGAN - 1

SME 2713 – Manufacturing Processes

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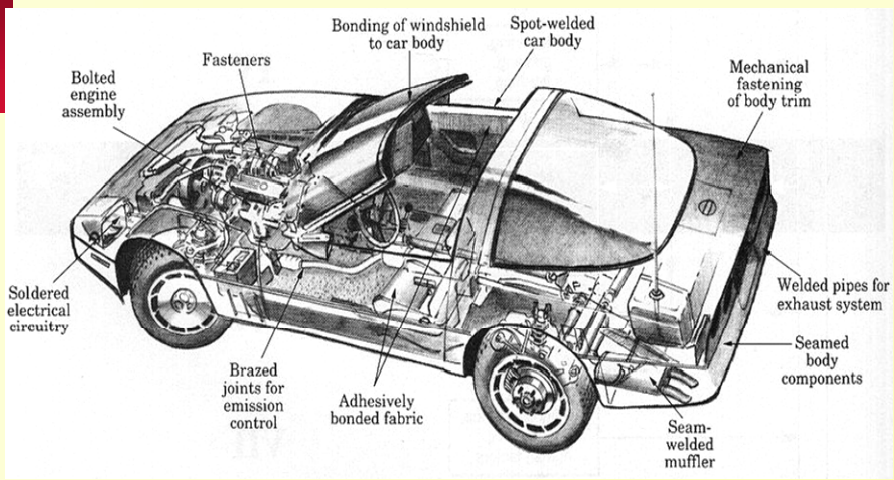
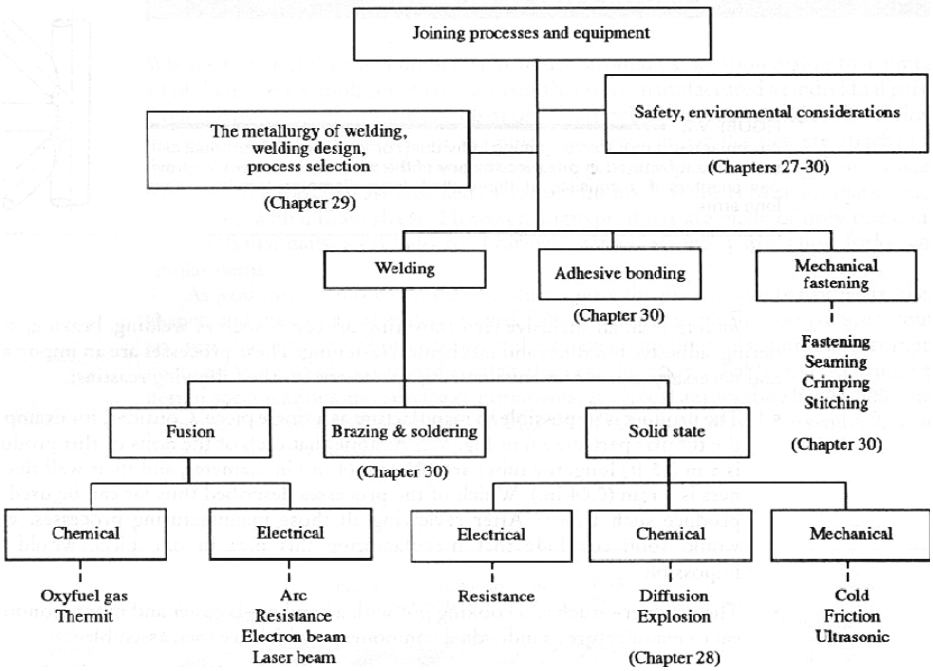
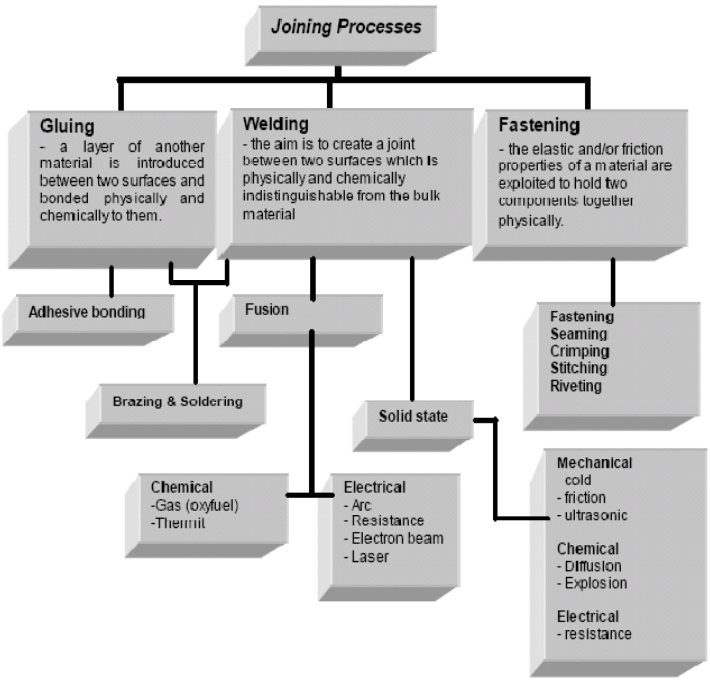
Outline

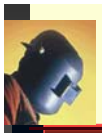
1. Introduction
2. Brazing
3. Soldering
4. Welding
5. Mechanical fasteners
6. Adhesives

1. Introduction



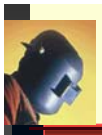






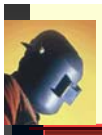
1. Introduction - *Joining and Assembly Distinguished*

- Joining - welding, brazing, soldering, and adhesive bonding.
  - These processes form a permanent or semi-permanent joint between parts.
- Assembly - mechanical methods (usually) of fastening parts together.
  - Some of these methods allow for easy disassembly, while others do not.



1. Introduction - *Welding*

- Joining process in which two (or more) parts are coalesced at their contacting surfaces by application of heat and/or pressure
  - Many welding processes are accomplished by heat alone, with no pressure applied
  - Others by a combination of heat and pressure
  - Still others by pressure alone with no external heat
  - In some welding processes a *filler* material is added to facilitate coalescence

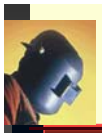


1. Introduction - *Why Welding is Important*

- Provides a permanent joint
  - Welded components become a single entity
- Usually the most economical way to join parts in terms of material usage and fabrication costs
  - Mechanical fastening usually requires additional hardware components (e.g., screws and nuts) and geometric alterations of the parts being assembled (e.g., holes)
- Not restricted to a factory environment
  - Welding can be accomplished "in the field"

1. Introduction - *Limitations and Drawbacks of Welding*

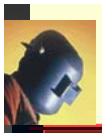
- Most welding operations are performed manually and are expensive in terms of labor cost
- Most welding processes utilize high energy and are inherently dangerous
- Welded joints do not allow for convenient disassembly
- Welded joints can have quality defects that are difficult to detect



1. Introduction - *Why Use Mechanical Assembly?*

- Ease of assembly – can be accomplished with relative ease by unskilled workers
  - Minimum of special tooling required
  - In a relatively short time
- Ease of disassembly – at least for the methods that permit disassembly
  - Some disassembly is required for most products to perform maintenance and repair

2. Brazing & Soldering

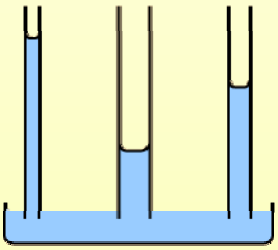


2. Overview of Brazing and Soldering

- Both use filler metals to permanently join metal parts, but there is no melting of base metals
- When to use brazing or soldering instead of fusion welding:
  - Metals have poor weldability
  - Dissimilar metals are to be joined
  - Intense heat of welding may damage components being joined
  - Geometry of joint not suitable for welding
  - High strength is not required

2. Brazing

- Joining process in which a filler metal is melted and distributed by capillary action between faying surfaces of metal parts being joined
- No melting of base metals occurs
  - Only the filler melts
- Filler metal T_m greater than 450°C (840°F) but less than T_m of base metal(s) to be joined

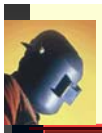


2. Strength of Brazed Joint

- If joint is properly designed and brazing operation is properly performed, solidified joint will be stronger than filler metal out of which it was formed
- Why?
  - Small part clearances used in brazing
  - Metallurgical bonding that occurs between base and filler metals
  - Geometric constrictions imposed on joint by base parts

2. Brazing Compared to Welding

- Any metals can be joined, including dissimilar metals
- Can be performed quickly and consistently, permitting high production rates
- Multiple joints can be brazed simultaneously
- Less heat and power required than FW
- Problems with HAZ in base metal are reduced
- Joint areas that are inaccessible by many welding processes can be brazed; capillary action draws molten filler metal into joint



2. Disadvantages and Limitations of Brazing

- Joint strength is generally less than a welded joint
- Joint strength is likely to be less than the base metals
- High service temperatures may weaken a brazed joint
- Color of brazing metal may not match color of base metal parts, a possible aesthetic disadvantage

2. Brazing Applications

- Automotive (e.g., joining tubes and pipes)
- Electrical equipment (e.g., joining wires and cables)
- Cutting tools (e.g., brazing cemented carbide inserts to shanks)
- Jewelry
- Chemical process industry
- Plumbing and heating contractors join metal pipes and tubes by brazing
- Repair and maintenance work

2. Brazing Applications

- Spectacle frames made of stainless steel can be seen on this photo. They have been brazed using the induction method.

- Ice cream scoop. The materials to be brazed are made of stainless steel and brass. The flame brazing method or induction brazing can be used here.

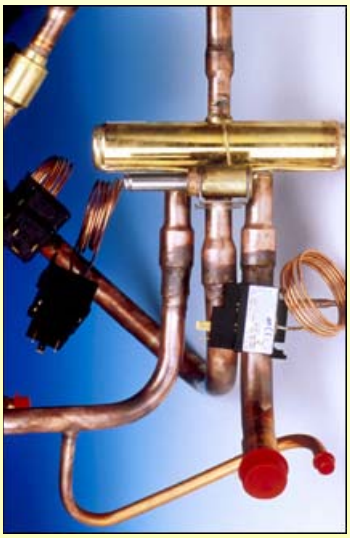
2. Brazing Applications

- The photo shows medical scissors from an operating theatre. This contains a hard metal - stainless steel brazed connection which can be made using the induction method. The working temperature of the brazing alloy is 770°C.

- Another example from the tool-making industry (metal processing) is shown by these hard metal end-mills where hard metal has been brazed to steel by induction brazing or flame brazing, working temperature 690°C.

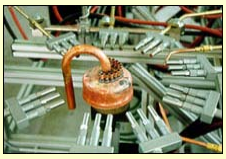
2. Brazing Applications

- The photos show an example of an application in the area of refrigeration and air conditioning technology. The materials to be brazed are made of copper, brass and steel. Flame brazing or induction brazing can be used as the brazing method.
- Ref : www.BrazeTec.com



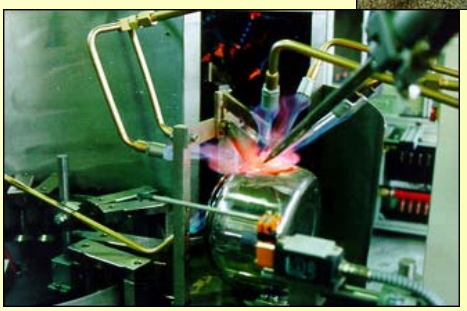
2. Brazing Applications

- The photos show a hot water boiler in a central heating system. The through-pipes were brazed to the boiler using the flame brazing method
- The brazing alloy BrazeTec S 2 or BrazeTec S 94 with respective working temperatures of 740 and 760°C can be used as alloys.
- No flux is required with these alloys due to the fact that the brazing involves a copper to copper connection.
- Ref : www.BrazeTec.com



2. Brazing Applications

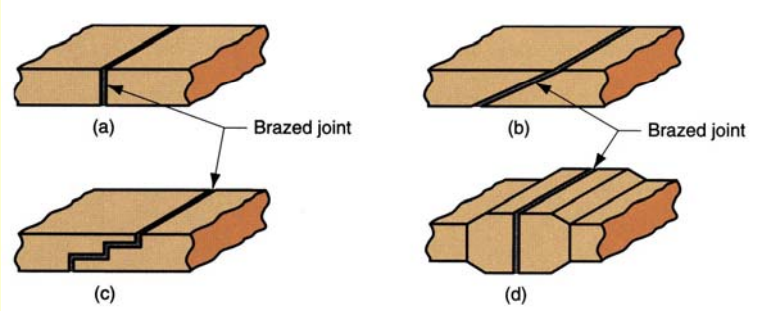
- A stainless steel pot is shown here, onto which a spout has been brazed via flame brazing.
- We recommend for this zinc-free BrazeTec 6009 brazing alloy (working temperature ca. 720°C) and BrazeTec special h flux.
- Ref : www.BrazeTec.com



2. Brazed Joints

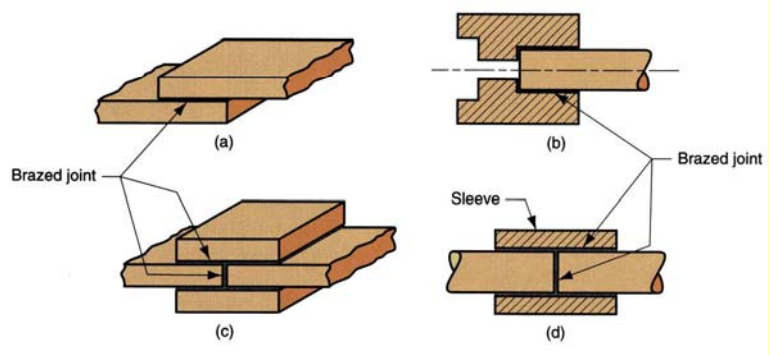
- Butt and lap joints common
  - Geometry of butt joints is usually adapted for brazing
  - Lap joints are more widely used, since they provide larger interface area between parts
- Filler metal in a brazed lap joint is bonded to base parts throughout entire interface area, rather than only at edges

2. Butt Joints for Brazing



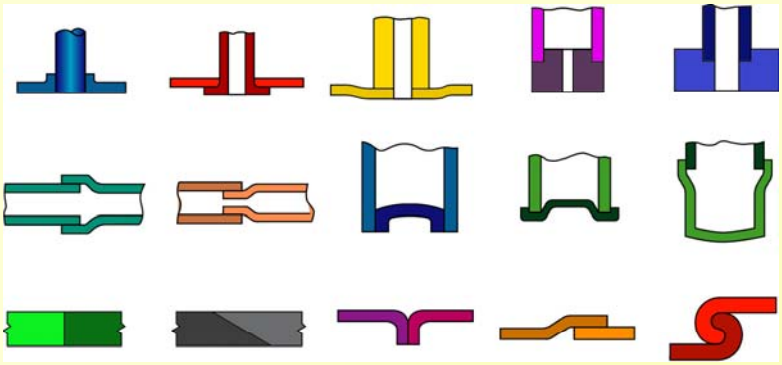
(a) Conventional butt joint, and adaptations of the butt joint for brazing: (b) scarf joint, (c) stepped butt joint, (d) increased cross-section of the part at the joint.

2. Lap Joints for Brazing



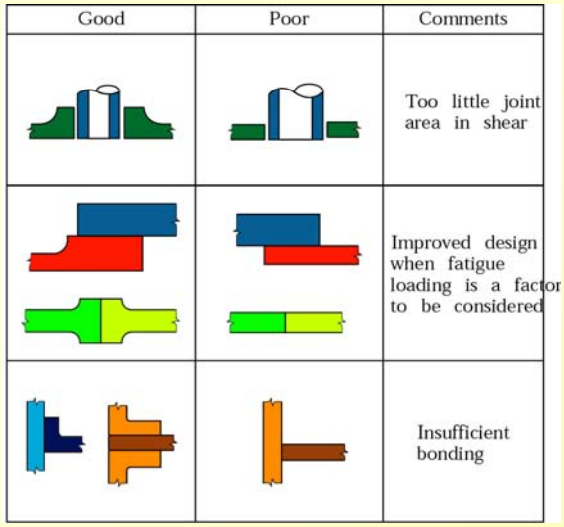
(a) Conventional lap joint, and adaptations of the lap joint for brazing: (b) cylindrical parts, (c) sandwiched parts, and (d) use of sleeve to convert butt joint into lap joint.

2. Joint Designs Used in Brazing



Joint designs commonly used in brazing operations. The clearance between the two parts being brazed is an important factor in joint strength. If the clearance is too small, the molten braze metal will not fully penetrate the interface. If it is too large, there will be insufficient capillary action for the molten metal to fill the interface.

2. Brazing Design



Examples of good and poor design for brazing.

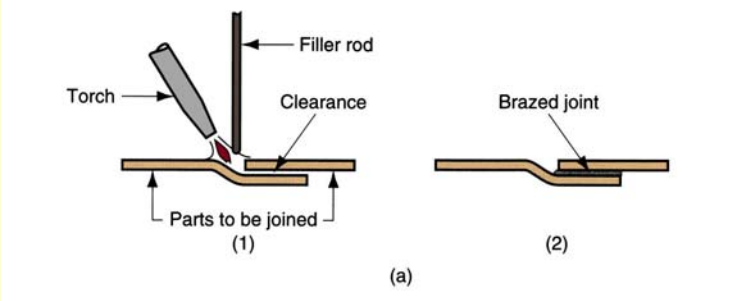
2. Some Filler Metals for Brazing

Base metal(s)	Filler metal(s)
Aluminum	Aluminum and silicon
Nickel-copper alloy	Copper
Copper	Copper and phosphorous
Steel, cast iron	Copper and zinc
Stainless steel	Gold and silver

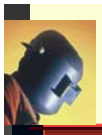
2. Desirable Brazing Metal Characteristics

- Melting temperature of filler metal is compatible with base metal
- Low surface tension in liquid phase for good wettability
- High fluidity for penetration into interface
- Capable of being brazed into a joint of adequate strength for application
- Avoid chemical and physical interactions with base metal (e.g., galvanic reaction)

2. Applying Filler Metal

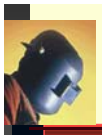


Several techniques for applying filler metal in brazing: (a) torch and filler rod. Sequence: (1) before, and (2) after.



2. Brazing Fluxes

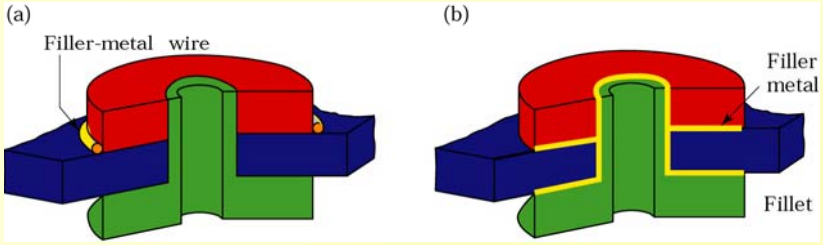
- Similar purpose as in welding; they dissolve, combine with, and otherwise inhibit formation of oxides and other unwanted byproducts in brazing process
- Characteristics of a good flux include:
  - Low melting temperature
  - Low viscosity so it can be displaced by filler metal
  - Facilitates wetting
  - Protects joint until solidification of filler metal



2. Heating Methods in Brazing

- Torch Brazing - torch directs flame against work in vicinity of joint
- Furnace Brazing - furnace supplies heat
- Induction Brazing – heating by electrical resistance to high-frequency current in work
- Resistance Brazing - heating by electrical resistance in parts
- Dip Brazing - molten salt or molten metal bath
- Infrared Brazing - uses high-intensity infrared lamp

2. Furnace brazing



Several techniques for applying filler metal in brazing: (b) ring of filler metal at entrance of gap. Sequence: (1) before, and (2) after.

2. Induction heating

- What is Induction Heating?

2. Brazing methods

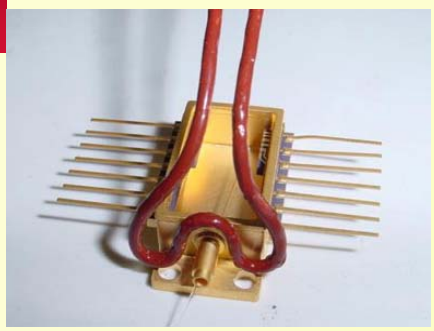
- Brazing could be performed manually with a hand-held torch, or automatically in a furnace.
- The joints should be properly cleaned before brazing and all methods, except vacuum brazing and vibration brazing, require flux.
- The use of flux causes environmental problems and the remaining flux must be completely removed to eliminate corrosion.
- Accordingly, vacuum brazing is more and more used, for example, in the production of automotive heat exchangers

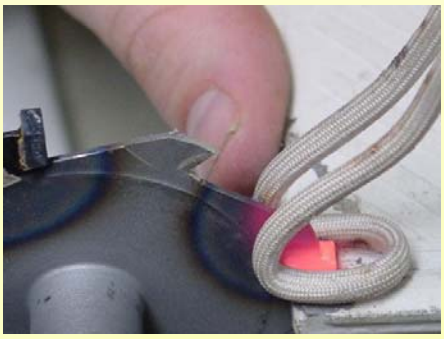
2. Brazing methods

- Torch brazing machine

2. Brazing methods

- Induction brazing



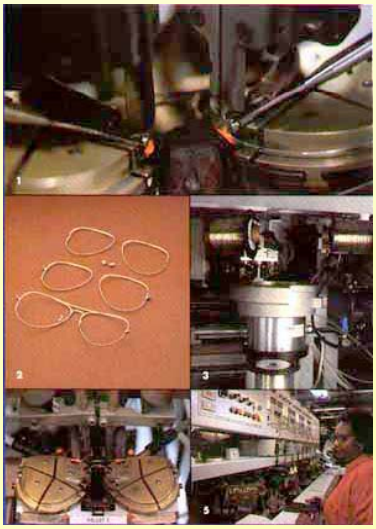


2. Brazing methods

- Induction brazing

2. Brazing methods

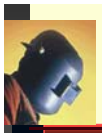
- The bridge of a sunglass frame is brazed.
- Various metal frame parts are joined during the induction brazing process.
- Handy & Harman/Lucas-Milhaupt filler metal in wire from is used.
- Brazing provides invisible joints as this browbar is brazed.
- A total of 10 joints are formed during the fully automated process.



2. Brazing methods

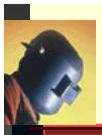
- Another application example from air conditioning technology is a condenser for an air conditioning unit.
- A detailed photo of the copper pipe bend is shown. For brazing this connection, the flame brazing method can be used or alternatively, depending on the working material, the furnace brazing method with an inert gas. For copper to copper brazing, the phosphorus-containing BrazeTec S 2 brazing alloys with a working temperature of ca. 740Â°C and BrazeTec S 94 with a working temperature of ca. 760Â°C can be used.

3. Soldering



3. Soldering

- Joining process in which a filler metal with T_m less than or equal to 450C (840F) is melted and distributed by capillary action between faying surfaces of metal parts being joined
- No melting of base metals, but filler metal wets and combines with base metal to form metallurgical bond
- Soldering similar to brazing, and many of the same heating methods are used
- Filler metal called *solder*
- Most closely associated with electrical and electronics assembly (wire soldering)



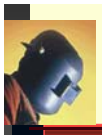
3. Soldering Advantages / Disadvantages

Advantages:

- Lower energy than brazing or fusion welding
- Variety of heating methods available
- Good electrical and thermal conductivity in joint
- Easy repair and rework

Disadvantages:

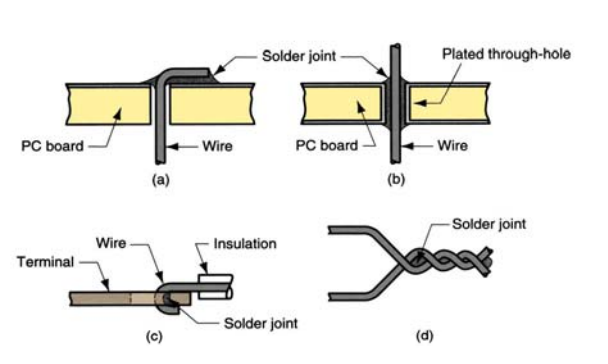
- Low joint strength unless reinforced by mechanically means
- Possible weakening or melting of joint in elevated temperature service



3. Solders

- Usually alloys of tin (Sn) and lead (Pb). Both metals have low T_m
- Lead is poisonous and its percentage is minimized in most solders
- Tin is chemically active at soldering temperatures and promotes wetting action for successful joining
- In soldering copper, copper and tin form intermetallic compounds that strengthen bond
- Silver and antimony also used in soldering alloys

3. Mechanical Means to Secure Joint



Techniques for securing the joint by mechanical means prior to soldering in electrical connections: (a) crimped lead wire on PC board; (b) plated through-hole on PC board to maximize solder contact surface; (c) hooked wire on flat terminal; and (d) twisted wires.

3. Functions of Soldering Fluxes

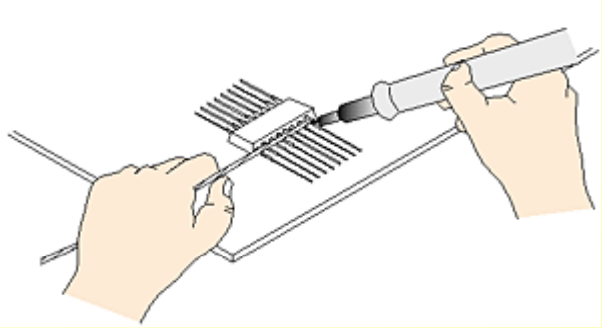
- Be molten at soldering temperatures
- Remove oxide films and tarnish from base part surfaces
- Prevent oxidation during heating
- Promote wetting of faying surfaces
- Be readily displaced by molten solder during process
- Leave residue that is non-corrosive and nonconductive

3. Soldering Methods

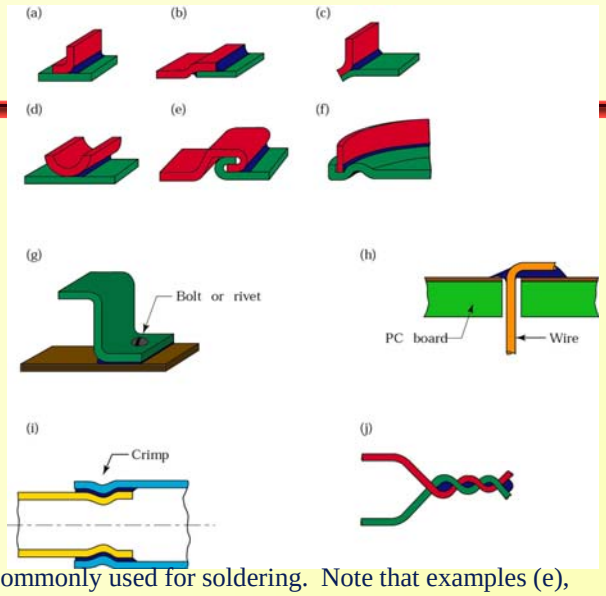
- Many soldering methods same as for brazing, except less heat and lower temperatures are required
- Additional methods:
  - Hand soldering – manually operated *soldering gun*
  - Wave soldering – soldering of multiple lead wires in printed circuit cards
  - Reflow soldering –used for surface mount components on printed circuit cards

3. Soldering Methods

- Soldering with a soldering iron.

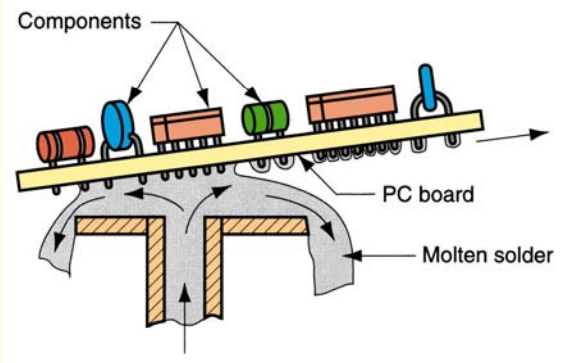


3. Joint Designs Used in Soldering



Joint designs commonly used for soldering. Note that examples (e), (g), (i), and (j) are mechanically joined prior to being soldered, for improved strength. *Source*: American Welding Society.

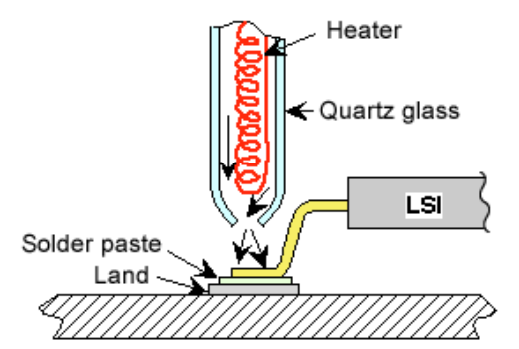
3. Soldering Methods



Wave soldering, in which molten solder is delivered up through a narrow slot onto the underside of a printed circuit board to connect the component lead wires.

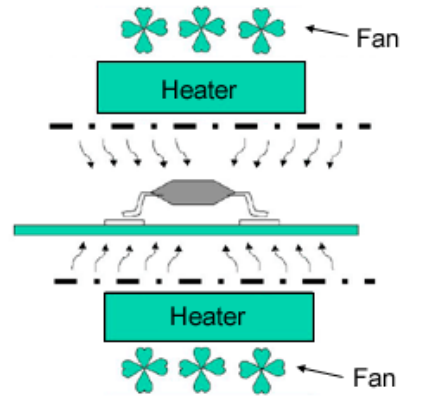
3. Soldering Methods

- Convection reflow soldering. This method consists in soldering the component by heating air or N2 gas with a heater and spraying compressed gas from a nozzle onto the joint. The temperature is adjusted by adjusting the heat source or the flow of gas



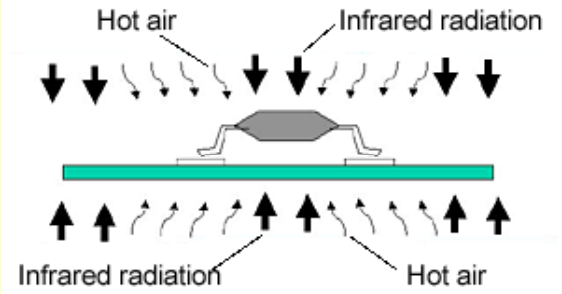
3. Soldering Methods

- Convection reflow soldering



3. Soldering Methods

- Convection infra-red reflow soldering. This method solves the problem of the comparatively longer soldering time of the Convection reflow method by combining it with infrared reflow



3. Soldering IC interconnects :