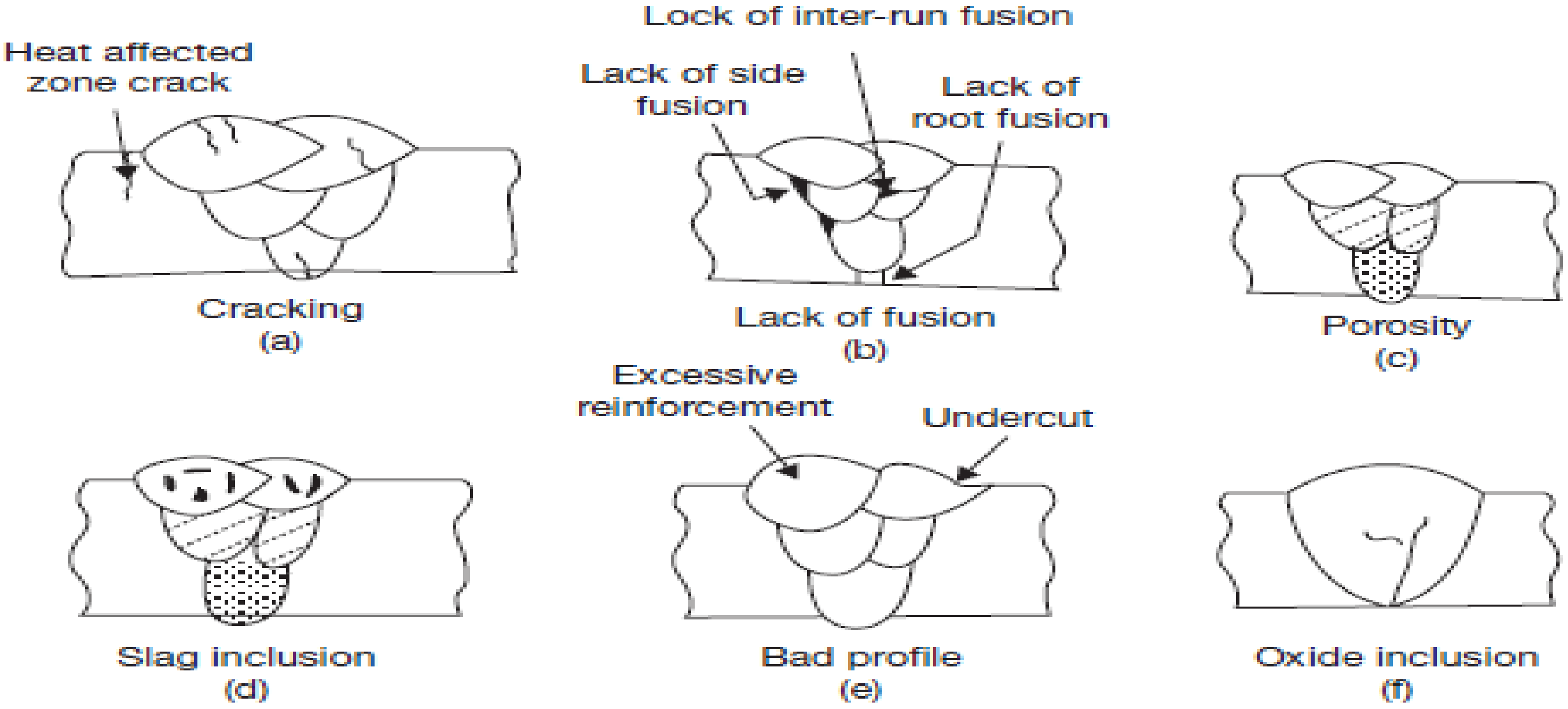
WELDING DEFECTS

A number of defects can occur during the welding processes, some of them are shown in



Welding Defects

WELDING DEFECTS

Cracks: Cracks occur in the welded joint due to improper welding and solidification of different metals.

Cracks may be of following types.

Micro Cracks: Very small Cracks, which can be seen with the help of microscope only.

Macrocracks: These cracks can be seen by naked eye.

Fissures: These cracks are wider, which occur at the surface of the metal.

There are different types of cracks. Cracks occurred in the base metal is known as cold crack because it occurs at low-temperature due to improper welding, high cooling rate, wrong filler material, high carbon and phosphorous in parent metal. Crack occurred in the

hot metal zone or weld metal zone is known as hot cracks and it occurs due to improper solidification, clamping, etc.

WELDING DEFECTS

Lack of Fusion: Wrong weld parameters, such as poor weld design, feed rate, welding speed, current, and voltage, lead the problem of fusion and penetration. A proper arc length, good weld design may prevent the problem of poor fusion and improper penetration.

Porosity: Porosities are voids, holes or cavities of usually spherical shapes. It is caused by gas entrapped in weld metal during solidification, and chemical reactions during welding contaminants such as dirt, oil, grease, rust, paint, etc. Blowholes are voids of large size.Porosity and blowholes are scattered throughout the cross-section of a weld randomly. Small porosities appeared on the surface are known as pinholes. Pinholes are smaller in size. To reduce the porosity there should be proper shielding of the molten metal pool, proper cleaning, i.e., free from oil, grease, paints, etc., to avoid absorption of gases like O2, N2, H2.

WELDING DEFECTS

Slag Inclusion: Slag inclusion in the form of oxides, sulphur, and flux in the weld causes poor strength and leads to corrosion in the metal. It occurs due to inadequate cleaning of the welding areas.

Shrinkage Cavity: It occurs in the welding of thicker parts where a large amount of filler metal is required. The molten metal shrinks during solidification and forms a cavity on the surface, which is known as shrinkage cavity.

Undercutting: Undercutting is a form of a groove on the welding surface. It occurs due to high current and high arc voltage. Proper controlling of current and voltage can prevent it.

Spatter: Spatters are small bead thrown in all directions during welding. It occurs due to very large current and wrong electrode selection.

Distortion: Distortion is a result of the improper rate of heating and cooling in the weld zone or adjacent metal leading to the generation of stresses. Proper clamping and smaller diameter electrode may reduce the problem.

Defect	Description	Primary Causes	Remedies (Prevention/Repair)
Lack of Fusion	Failure of the weld metal to fuse completely with the base metal or with a previous weld bead.	**Insufficient Heat Input** (low current/voltage or high travel speed), **Incorrect Angle**, or **Surface Contamination** (oxides, scale).	**Increase current/voltage** and **reduce travel speed**. Ensure the **base metal is clean**. Use the **correct torch/electrode angle** to direct the arc into the joint edges.
Porosity	Gas pockets or bubbles trapped within the solidified weld metal.	**Surface Contamination** (rust, grease, moisture), **Inadequate Shielding Gas** flow (too high or too low), **Long Arc Length**, or **Damp Consumables**.	**Thoroughly clean** the base metal and **dry consumables** (use a rod oven). Ensure **optimal gas flow** and maintain a **short arc length**.
Slag Inclusion	Non-metallic solid material (slag) trapped within the weld metal or between weld layers.	**Incomplete Slag Removal** between passes in multi-pass welds, **Low Current/Voltage**, or **Fast Travel Speed** (not allowing slag to float out).	**Thoroughly clean** all slag between passes. **Adjust current and speed** to maintain a molten weld pool that allows slag to rise.

Shrinkage Cavity (Crater Crack/Pipe)	A depression or void formed at the end of a weld bead when the molten metal solidifies too quickly, particularly when the arc is broken suddenly.	**Abrupt termination** of the arc, **Insufficient filler metal** added to the crater, or high welding speed.	**Fill the crater** by pausing or using a **"crater fill"** function (or upslope/downslope). For cracks, **grind out the defect** and re-weld.
Undercutting	A groove melted into the base metal adjacent to the toe of the weld, reducing the material thickness.	**Excessive Current**, **Long Arc Length**, **High Travel Speed**, or **Incorrect Electrode Angle** (directing too much heat to the edge).	**Reduce current** and **slow down travel speed**. Maintain a **short arc length**. Adjust the **work angle** to favor the center of the joint.
Distortion	The warping or change in shape of the base metal caused by the non-uniform expansion and contraction of the metal during heating and cooling.	**Excessive Heat Input**, **Poor Joint Fit-up**, **Improper Clamping**, or **Unbalanced Weld Sequence**.	**Minimize heat input** (use lower current/faster speed). Use **clamping and fixturing** to restrain the metal. Employ **balanced weld sequences** (e.g., skip or back-step welding).

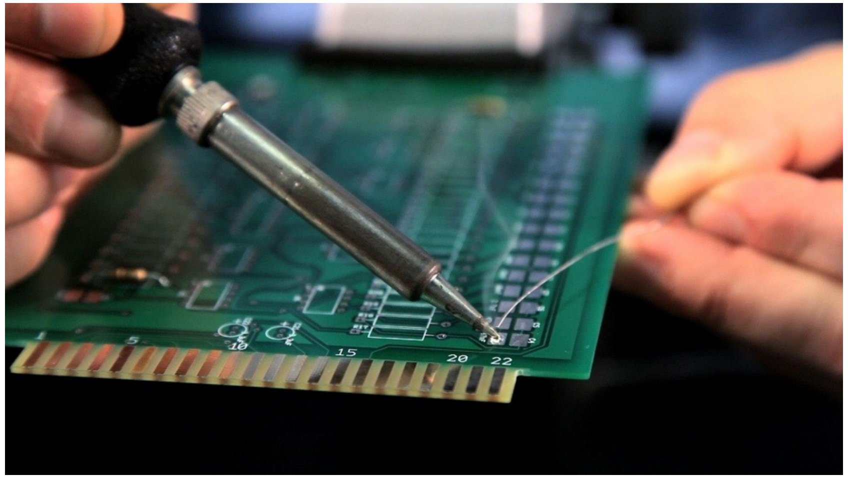
SOLDERING

- Soldering is a method of joining similar or dissimilar metals by means of a filler metal whose **melting point is below 450°C**.

- The filler metal is drawn into the joint by means of **capillary action** (entering of fluid into tightly fitted surfaces).

- Though soldering obtains a good joint between the two plates, the strength of the joint is limited by the strength of the filler metal used.

- Soldering is normally used for obtaining a neat leak proof joint or a low resistance electrical joint. The soldered joints are not suitable for high temperature service because of the low melting temperatures of the filler metals used.



SOLDERING

Procedure

- **Cleaning -** The soldering joints also need to be cleaned meticulously to provide chemically clean surfaces to obtain a proper bond. Solvent cleaning, acid pickling and even mechanical cleaning are applied before soldering.

- **Flux application** - To remove the oxides from joint surfaces and to prevent the filler metal from oxidizing, fluxes are generally used in soldering.

- Rosin and rosin plus alcohol based fluxes are least active type and are generally used for electrical soldering work. The organic fluxes such as zinc chloride and ammonium chloride are quick acting and produce efficient joints. These are to be used for only non-electrical soldering work.

SOLDERING

Procedure

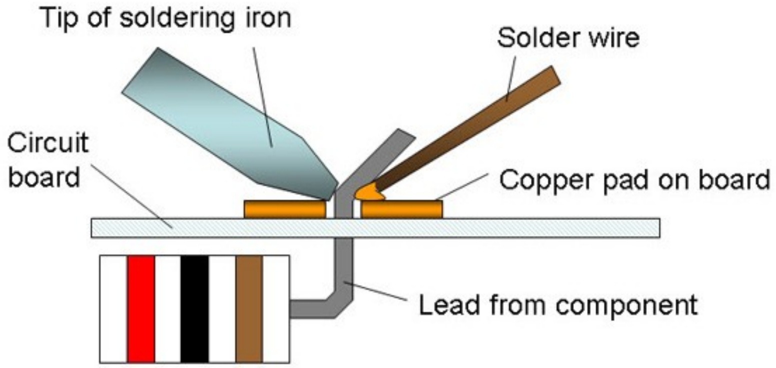
Types of Solders – **There are two types **– *soft solder and hard solder*

- Soft solders are usually alloys of tin and lead which have low melting points (150 – 190 degree Celsius).
- Soft solders are used in those applications, where the joint is not subjected to heavy loads and high temperatures.
- Hard solders are alloys of silver and lead or alloys of silver and copper and zinc.
- The melting point of hard solder ranges from 300 – 600 degree Celsius.
- Hard solder is used to make strong joints that can resist high temperatures.

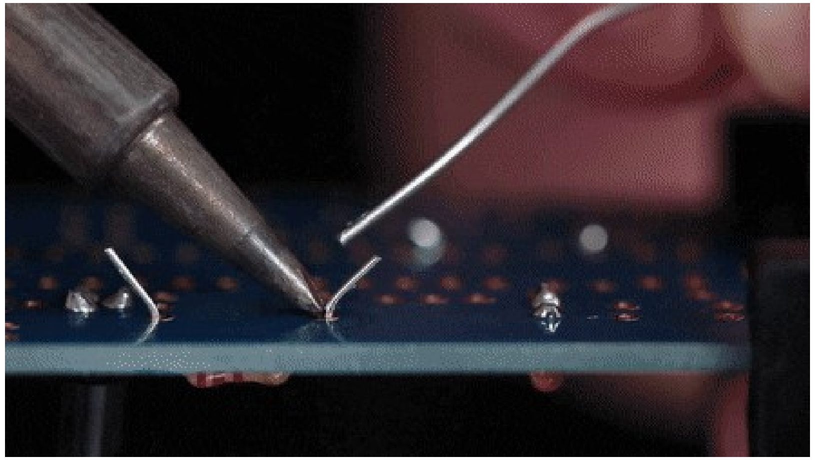
SOLDERING

Procedure

- The most commonly used soldering methods are,
  - **With soldering iron (flame or electrically heated)**
  - Dip soldering
  - Wave soldering



- A soldering iron is a copper rod with a thin tip which can be used for flattening the soldering material.



- The soldering iron can be heated by keeping in a furnace or by means of an internal electrical resistance whose power rating may range from 15 W for the electronic applications to 200 W for sheet metal joining.

- This is the most convenient method of soldering but somewhat slower compared to the other methods.

SOLDERING

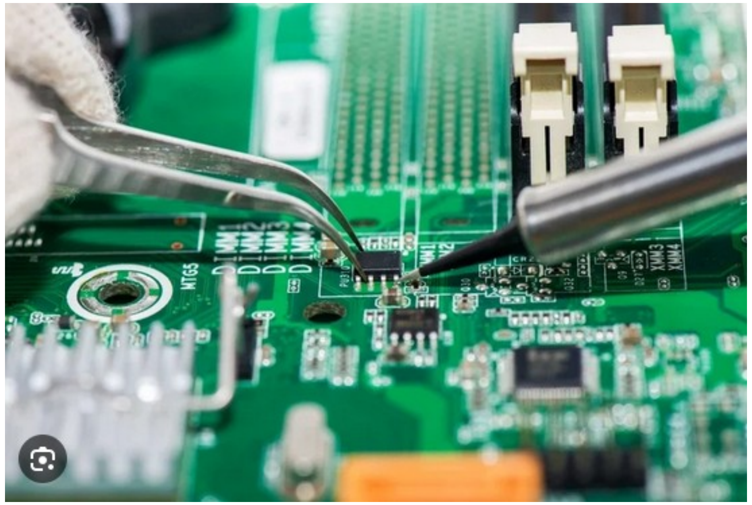
Applications

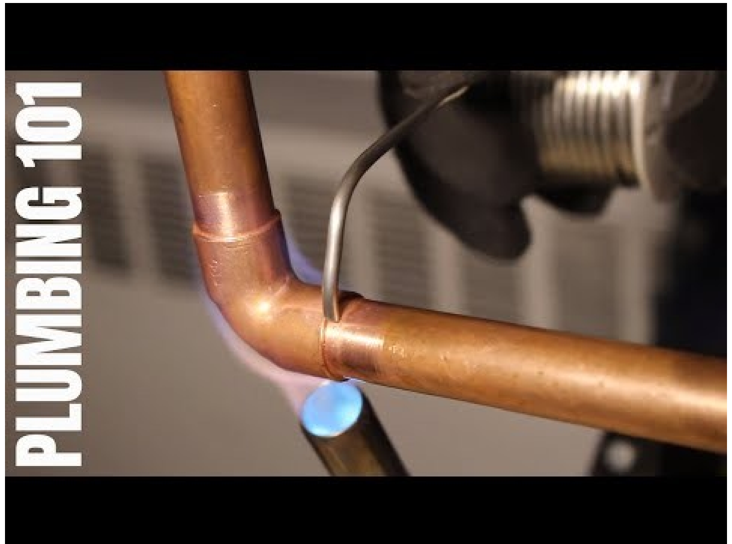
Assembling electronic components to printed circuit boards

Making connections between copper pipes in plumbing systems

Joints in sheet metal objects such as food cans, metal containers

Semi – permanent patch for a leak in a container, or cooking vessel





BRAZING

- **Brazing is the coalescence of a joint with the help of a filler metal whose melting point is above 450°C and is below the melting point of the base metal.**

- The filler metal is drawn into the joint by means of capillary action (entering of fluid into tightly fitted surfaces).

- Brazing is a much widely used joining process in various industries because of its many advantages.

- Dissimilar metals such as stainless steel to cast iron can be joined by brazing. Except aluminium and magnesium, brazing can join almost all metals.

- The brazed joints are reasonably stronger, depending on the strength of the filler metal used. But the brazed joint is generally not useful for high temperature service because of the low melting temperature of the filler metal.

BRAZING

Procedure

- In brazing, joints need to be extremely clean. Any grease or oil present in the joint prevents the flow of filler metal. Hence, the joint should be thoroughly cleaned using proper solvents. Oxides and scales present are removed by acid pickling.

- Fluxes are added into the brazed joint to remove any of the oxides present or prevent the formation of the oxides so that the base metal and the filler metal remain pure during the joining.

- The fluxes generally used are combinations of borax, boric acid, chlorides, fluorides and tetraborates, and other wetting agents.

BRAZING

Procedure

- Depending on the type of base metals brazed, a number of filler metals (**spelter**) are available.

- The joint obtained in brazing is by means of the diffusion of the filler metal into the base material, associated with the surface alloying. Copper based materials are generally used for brazing ferrous materials.

- Silver brazing makes use of a silver based filler metal. Silver brazing is used to give high strength (tensile strength up to 900 MPa) joints. Though originally used for jewellery applications, silver brazing is now extensively used in industrial applications

BRAZING

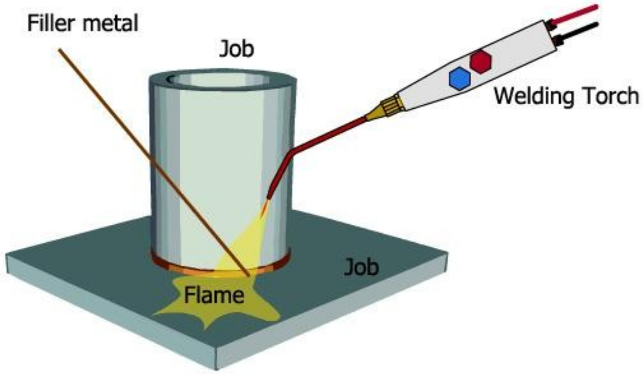
Procedure

- Heat sources that are used for brazing are a molten bath of brazing filler metal, **oxy-acetylene torch, controlled atmosphere furnace, electrical resistance heating and induction heating.**

- In torch brazing, a reducing flame (oxy-acetylene or propane) is generally used to inhibit oxidation.

- Torch brazing is generally a manual operation with the operator having considerable skill in judging the operating conditions of the brazing.

- It is also possible to mechanize torch brazing by employing multiple torches with a conveyor line that can bring the brazing joints to the torches.



BRAZING

Advantages

- The requirement of less preheating and permitting greater welding speed, a shorter cooling-
  - off period, and is less likely to crack metals.
- No splash or weld spatter.
- A little or no finishing requirement of the completed joints.
- No requirement of as much skill as the technique required for fusion welding.

Disadvantages

- If the joint is to be exposed to corrosive media, the filler metal must have the required corrosion-resistant characteristics.
- All brazing alloys lose strength at elevated temperatures.
- If the joint is to be painted, all traces of the flux must be removed.