ENGINEERING MATERIALS AND JOINING PROCESS

The materials which have applications in engineering in making an article of utility are called asengineering materials.

Classification of engineering materials: Engineering materials are classified into following four types.

1) Metals and Alloys 2) Polymers 3) Ceramics 4) Composites.

Metals : A metal is a material that is typically hard, opaque, shiny, and features good electrical and thermal conductivity. Metals are generally malleable: they can be hammered or pressed permanently out of shape without breaking or cracking well as fusible and ductile

Metals can be either ferrous or non-ferrous. Ferrous metals contain iron while non-ferrous metals do not. Both ferrous and non-ferrous metals are divided into pure metals and alloys.

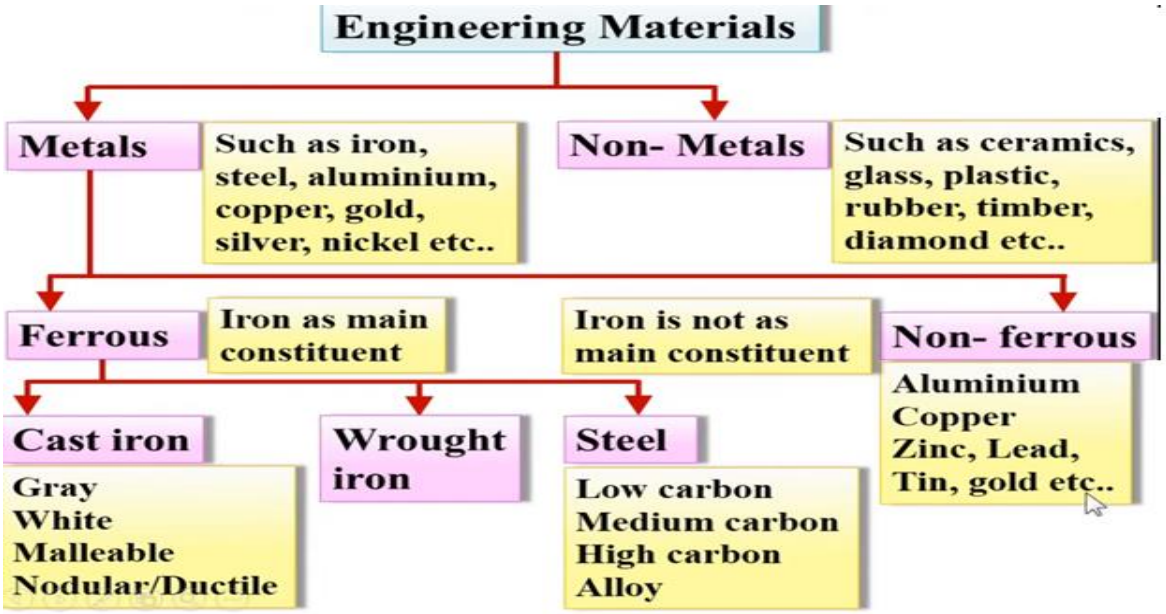
A pure metal is an element – Ex: iron, copper, gold - unalloyed (not mixed) with another substance.

An alloy is a mixture of two or more elements (Ex: iron and carbon) to make another metal with particular properties (Ex: steel).

MECHANICAL PROPERTIES OF ENGINEERING MATERIALS

1. **Strength**: It is the property of a material which opposes the deformation or breakdown of material in presence of external forces or load.
2. **Toughness:** It is the ability of a material to absorb the energy and gets plastically deformed without fracturing
3. **Hardness**: It is the ability of a material to resist to permanent shape change due to external stress.
4. **Brittleness:** Brittleness of a material indicates that how easily it gets fractured when it is subjected to a force or load. When a brittle material is subjected to a stress it observes very less energy and gets fractures without significant strain.
5. **Ductility**: Ductility is a property of a solid material which indicates that how easily a material gets deformed under tensile stress.
6. **Malleability**: Malleability is a property of solid materials which indicates that how easily a material gets deformed under compressive stress.

CLASSIFICATION OF ENGINEERING MATERIALS:



FERROUS METALS

Ferrous metals contain iron. Examples are cast iron, mild steel, medium carbon steel, high carbon steel, stainless steel, and high speed steel.

➢ Type of Ferrous metal

1. Cast iron

Composition: Alloy of iron and 2-5% carbon, 1-3% silicon and traces of magnesium, sulphur and phosphorus

Properties and characteristics: it is very strong but brittle. Cast iron has relatively low melting point, is wear resistant, possesses good fluidity, has admirable machinability and is resistant to deformation

Application: It is used to manufacture machine frames, columns, beds and plates, housing flywheel, manhole cover, automotive parts such as engine block, cylinder head, gear box case and machine parts which are not subjected to tension and shocks.

2. Steel

Steel is an alloy of iron and carbon which is produced either by basic oxygen steelmaking process or by electric arc furnace.

Steels are broadly classified into

a) Carbon Steels

b) Alloy Steels

c) Tool Steels

a) Carbon steels: Carbon steels are types of steel containing primarily iron and carbon. Other elements present in small proportions are sulphur, phosphorous, manganese and magnesium. The following types of carbon steel are.

- **Mild steel or Low carbon steel:**

Composition: It has a carbon content of 0.05 to 0.3%. The balance is iron. The most popularly used carbon steel is mild steel.

Properties and characteristics: Tough, ductile and malleable. Good tensile strength, poor resistance to corrosion

Application: General-purpose engineering material like rivets, bolts, keys plain washer boiler plate's shaft, camshafts and gear.

- **Medium carbon steel**

Composition: It has a carbon content of 0.3 - 0.6% carbon. The remainder is iron content.

Properties and characteristics: Strong, hard and tough, with a high tensile strength, but less ductile than mild steel.

Application: It finds application in transmission shafts, springs, spring washers, crane hooks and hand tools etc.

- **High carbon steel**

Composition: It has a carbon content of 0.6 - 1.5%. it has an iron content of 96% to 97%

Properties and characteristics: Even harder than medium carbon steel, and more brittle. Can be heat treated to make it harder and tougher

Application: Cutting tools, hammers, chisels, screw, punches, drills lathe tools, leaf springs and milling cutter

➢ Alloy Steels

Alloy steel is an iron-based material, which, in addition to carbon, contains one or more intentionally added elements. Some of the common additions to alloy steel include: chromium, cobalt, columbium, molybdenum, manganese, nickel, titanium, tungsten, silicon, and vanadium.

The alloying elements are added to the steel to improve one or more of its physical and/or mechanical properties, such as: hardness, strength, toughness, high-temperature performance, corrosion resistance, and wear resistance.

➢ Stainless steel

Stainless steel is the name of a family of iron-based alloys known for their corrosion and heat resistance. One of the main characteristics of stainless steel is its minimum chromium content of 10.5%, which gives it its superior resistance to corrosion in comparison to other types of steels.

Properties and characteristics: Hard and tough, resists wear and corrosion

Application: Cutlery, kitchen equipment, surgical equipment, chemical handling equipment and cutlery etc.,

➢ Tool steel

Tool steels are a family carbon and alloy steels having distinct characteristics such as hardness, wear resistance, toughness, and resistance to softening at elevated temperatures. Tool steels comprise carbide-forming elements such as chromium, vanadium, molybdenum and tungsten in different combinations.

The primary properties of tool steels are listed below:

- Toughness
- Wear resistance
- Hardness
- Heat resistance

The major applications of tool steels are in the following processes:

- Forming, stamping, cutting and shearing of plastics and metals
- Extrusion of plastic sections e.g vinyl window frames and pipes
- Stamping of computer parts from metal sheets
- Slitting of steel coils into strips
- Dies for compacting of powder metal into forms such as gears.

Application of ferrous Metals and alloys:

1) Structural area: Steel is used as reinforcement in building construction, and in fabrication of Grills, Gates etc.

2) Automobile: In the manufacture of automobile parts like Engine Blocks, Gear Box, Gears, Chassis etc.

3) Bearings: Used for Bearing Housing, Bushes, Ball OR Roller Bearings etc.

4) Decorative Items: Stair case, Doors and Windows, Fittings for residence, Office, Hotels,

multiplexes etc.

5) Power generation: For the fabrication of Towers for the electricity Transmission Lines, Shafts for generators etc.

6) Household applications: For Stainless Steel utensils, Toys,

7) Industrial application: For the machine parts like Base, guide beds, Tool holders etc.

8) Tools, Jigs and Fixtures: For tools like cutting tools, hacksaw blade, chisels, vice, and clamping devices etc

9) Transportation: For manufacturing of Hooks for crane, Crane OR Lift Wires etc.

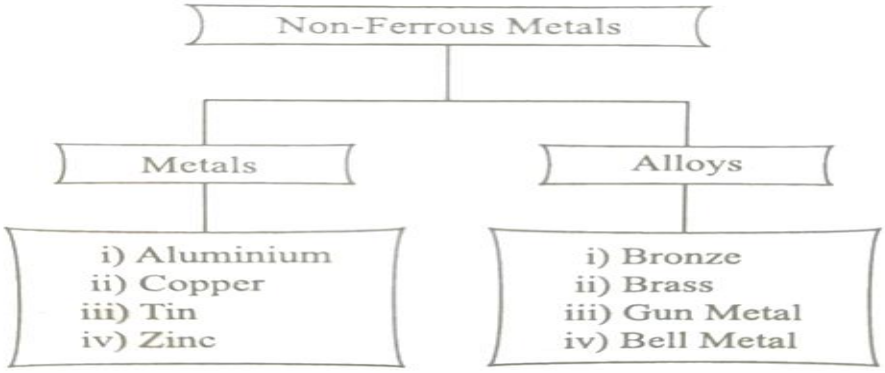
Railway Tracks,

10) Defense: for manufacture of Fighter Tanks, Weapons etc.

NON-FERROUS METALS & ALLOYS:

Metals containing elements other than iron as their chief constituents are usually referred to as non-ferrous metals.

Generally non-ferrous metals are costlier when compared to ferrous metals, but they are used for desirable properties. These desirable properties could be high conductivity, low weight, resistance to corrosion or non-magnetic property etc.



- **Type of Non Ferrous metal**

1. Aluminium : It is one of the widely used metal in recent years which has replaced iron and steel because of its special properties like light weight and non-corrosiveness.

It is a white color metal extracted from bauxite. Their mechanical properties can be improved by mixing aluminium with other elements like silica, copper, zinc etc. These are called alloys of aluminium.

Properties and characteristics: Good strength-to-weight ratio, light, soft, ductile, good conductor of heat and electricity

Application: Kitchen equipment, window frames, general cast components

2. Copper

***Composition**:* Pure copper (an element)

***Properties and characteristics**:* Malleable and ductile, good conductor of heat and electricity, good corrosion resistance and light weight.

Application: copper tubes used in refrigerator and air conditioners and radiators due to high thermal conductivity, electrical wires and cables, used to make door knobs.

3. Zinc: It is very resistant to corrosion from moisture. However, zinc is a very weak metal and is used mainly for coating steel.

Applications: used as a coating on screws, steel buckets etc.

It is also used to galvanize iron based metals.

4. Lead: It is soft, malleable metal. It is also counted as one of the heavy metals. Lead has a bluish-white color after being freshly cut, but it soon tarnishes to a dull grayish color when exposed to air.

Applications: used for roof flashing, also used for batteries & for X-ray protection.

5. Tin: it is very ductile and very malleable material. It is resistant to corrosion from moisture. It is bright silver in appearance.

NON-FERROUS ALLOYS:

When two or more metals are mixed together in different proportions to get a homogenous mixture is called as an alloy.

They have better properties than metals and have wide applications.

1. Brass: 60% Copper, 40% Zinc
2. Bronze : 90% Copper, 10% Zinc
3. Gun Metal : 60% Copper, 38% Zinc, 2% Tin
4. Bell Metal: 80% Copper, 20% Tin.

1. Brass: It is an alloy of copper and zinc in equal proportions. It is soft, ductile, give good surface finish and good tensile strength. It is non corrosive to air and water but poor conductor of electricity. This is widely used in hydraulic fittings, pump lining, bushes and bearings.

2. Bronze: It is an alloy of copper and tin. It is comparatively hard, wear resistant and can be cast or rolled into sheet, rods etc.
3. Gun metal: It is a special alloy which contains 10% tin, 88% Cu and 2% Zinc. It is very hard and resistant to corrosion by water and atmosphere. It is used in boiler fittings, bushes, bearing glands etc.
4. Bell metal: This contains 20% tin and rest copper. It is very hard and resistant to surface wear. It is used to make bell, utensils etc.

Application of Non-ferrous Metals and Alloys:

1) Structural area: Stair case, Windows, Doors, Pipe Fittings, Electrical Wires, galvanized Pipes etc.

2) Automobile: Engine Blocks, Body parts and automobile parts.

3) Bearings: Bushes OR Bearings for rotating parts for both industrial and domestic application.

4) Decorative Items: Interior items like Show lamps, Idols, Bells, Jewelry items, door and window fittings.

5) Power generation: Turbine blades and castings, Electrical bus bars etc.

6) House hold applications: Home appliances and Toys.

7) Aerospace: Structural parts like aircraft wings, electrical fittings and connectors etc.

8)Refrigeration: For refrigerator tubing (Condensers and evaporators),Heat Exchangers, solar water heaters etc.

9) Defense: Marine shaft and Turbine blades.

CERAMICS

The word "ceramic" is derived from the Greek word keramikos meaning pottery.

➢ *"Ceramics can be defined as inorganic, non-metallic materials that are typically produced using clay and other minerals from the earth or chemically processed powders."*

➢ Ceramics may be crystalline in nature and are compounds of metallic and non-metallic elements such as aluminum and oxygen (alumina), silicone and nitrogen (silicon nitride) and silicon and carbon (silicon carbide).

GLASS:

➢ "Glass may also be defined as a **hard, brittle, transparent or translucent** material mainly compound of silica, combined with varying proportions of oxides of sodium, potassium,

calcium, magnesia, iron and other minerals."

➢ The term "glass" as ordinarily used refers to material which is made by the fusion of mixture of silica, basic oxides and a few other compounds that react either with silica or with the basic oxides.

SMART MATERIALS:

➢ Smart materials are a group of new and state-of-the-art materials developed in recent times and which have a tremendous influence on many of our latest technologies.

➢ The word "smart" implies that these materials are able to sense changes in their environment and then respond to these changes in a pre-determined manner.

➢ Smart materials, also called intelligent materials, are a concept that extends to both newer and traditional materials which form a part of modem sophisticated systems.

Two major categories of smart materials are discussed they are:

1. Piezo-electric materials
2. Shape memory alloys

1. PIEZO-ELECTRIC:

➢ Certain materials possess a property by which they experience a dimensional change when an electrical voltage is applied to them. Such materials are known as *piezoelectric* because of converse effect; that is they generate electricity when pressure is applied.

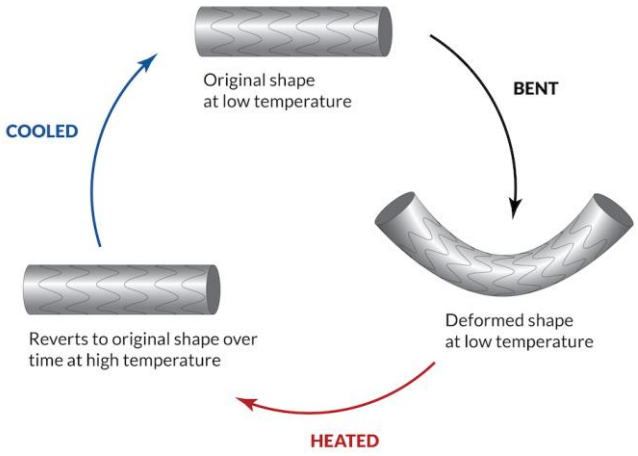
➢ Common among those which are used as piezo-electric materials are — Barium titanate (BaTiO3), lead titanate (PbTiO3), lead zirconate (PbZr03), potassium niobate (KNb03) etc.

2. SHAPE MEMORY ALLOYS:

➢ Shape memory alloys are those materials, even after being deformed, have the ability to remember and return to their original shape and size, upon appropriate heat treatment.

➢ Deformation is normally carried out at relatively low temperature, whereas, shape memory effect happens due to heating.

➢ Among materials that arc capable of recovering significant amounts of deformation, the best known are Nickel-Titanium (NITINOL) alloys; and some Copper based alloys (Cu-Zn-Al and Cu-Al-Ni).



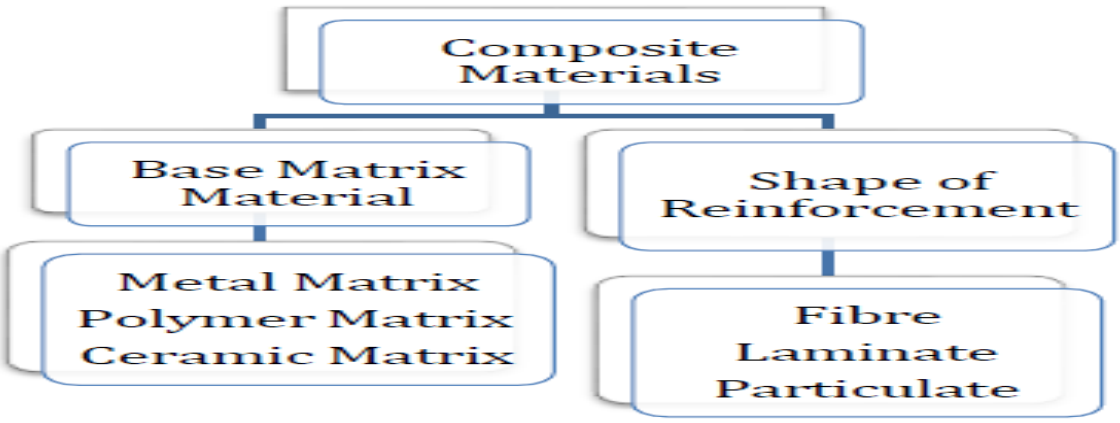
COMPOSITES

Composite materials are defined as a heterogeneous combination of two or more different materials which when combined are stronger than individual material.

CLASSIFICATION OF COMPOSITE MATERIALS:

Composite materials are classified as follows.

- Based on Matrix Material
- Based on Reinforcement
- Combination of more than one reinforcement.



- **Based on Matrix:**

a) **Metal Matrix Composites (MMC'S): The** materials like Aluminum Copper etc. when mixed with other materials like Tungsten, Chromium, Titanium, Molybdenum Oxides and carbides are added as reinforcement materials to develop better hardness, strength in composite form these canbe machined also.

Ex: Engine blocks and other parts of Automobiles, front and main landing gears and other parts ofAircraft.

b) **Polymer Matrix Composites (PMC'S):** The Polymer materials like resin, polyurethane and epoxy are reinforced with fibers (Glass fibers, Carbon Fiber), develop better hardness and strengthproperties.

Ex: Automobiles Bumpers, Air craft seats etc. use Fiber reinforced plastic (FRP).

c) **Ceramic Matrix Composites (CMC'S): These** are composed of ceramic materials reinforced with other ceramic materials. these composites can withstand high temperatures.

Ex: Exhaust Nozzles for Rockets to withstand high Temperatures. Aluminum oxide wheel mixed with silicon carbide gives better strength than Aluminum wheel.

- **Based on Reinforcement:**

a) **Particulates:** Particulates are the small irregular shaped reinforcement materials. These reinforcements have more or less equal size.

Fiber reinforced composite materials:

b) **Continuous fiber:** The reinforcement material is continuous and runs throughout the length ofMatrix.

c) **Discontinuous fiber:** The reinforcement is in discontinuous form. The ratio of l/d is more.

- **Application of composite materials in aerospace and automobiles:**

Aerospace application:

1. Aerospace application needs materials with lesser weight and more strength.
2. Aircraft Wing and other structure parts are made of composites.
3. Main landing Gear and Doors.
4. Front landing Gear and Doors,
5. Helicopter blades.
6. Rocket Nozzles which require high temperature are made of Composites,'
7. Air craft passenger seats are made of FRP
8. The parts like Dash board, interiors, etc. are made of composites.

Application in automobiles:

Most of the parts of automobile parts which are made of steel are replaced by Composite materials,so that they can travel at faster speed and better fuel consumption. The followings are few applications.

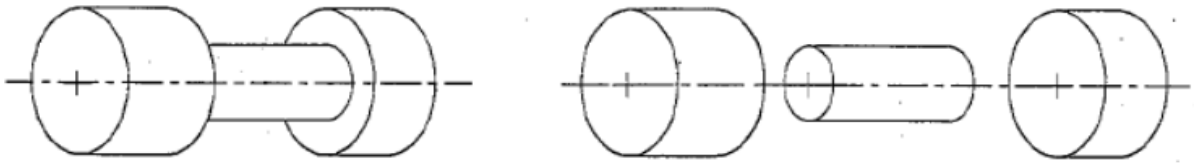
1. Automobile body parts including Doors etc. are made of composites.
2. The body parts like front Bumper and Rear bumpers are made of Composites.

3. The other parts like radiator grill, steering wheels, Dash board, interiors are made of composites.
4. Nylon reinforced rubber composites are used for automobile Tires.
5. Aluminum based MMC'S are used in Engine and other parts.
6. Housing for Lubricating oils, Brake oils, Water containers for cooling etc. are made of composites

JOINING PROCESS:

The Products which are not possible to manufacture as single piece are fabricated by joining different parts.

Examples of such products are steel furniture, computers and wooden chairs, bridges, transmission or electric towers.



(a) The required finished part (b) Three pieces, which can be joined

Classification of Joining Processes

All joining processes can be categorized based on the type of joint produced under two categories:

1. **Permanent Joint**: Permanent Joint: the joint is made such that it has the properties similar to the base metal of the two parts. Permanently joined parts cannot be separated in to their original shape, size and surface finish.

2. **Temporary joint**: A temporary joint can be easily dismantled separating the original parts without any damage to them.

The followings are the three joining processes.

a) Welding b) Brazing c) Soldering

SOLDERING

- Soldering is a process of joining two or more metal pieces by melting and then filling the joint by a solder. Solder and a flux are the two important things required during soldering. (OR)
- Soldering is a method of uniting two thin metal pieces using a dissimilar metal or alloy by the application of heat.
- The alloy of lead and tin is called soft solder, is used in varying proposition for sheet metal work, plumbing work and electrical junctions.

- The melting temp of the soft solder will be between 150° to 350° C.
- To clean the joint surfaces and to prevent oxidation a suitable flux is used while soldering.
- Zinc chloride is the flux that is commonly used in soft soldering.
- A soldering iron is used to apply the heat produced from the electrical source.
- An alloy of copper, tin, and silver known as hard solder is used for stronger joint. The soldering temp of hard solder ranges from 600° to 900° C

METHOD OF SOLDERING IRON METHOD/PROCEDURE

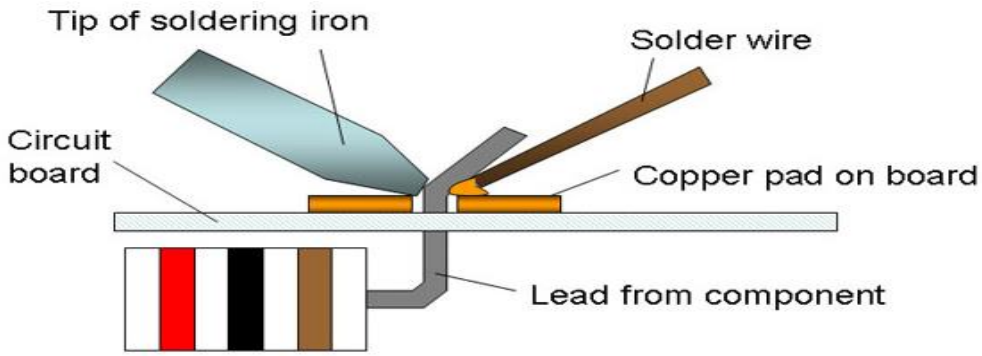
(i) Cleaning of joining surfaces

(ii) Application of flux

(iii) Tinning of surface to be soldered

(iv) Heating

(v) Final clean-up



i. Cleaning of joining surfaces: Firstly, the joining surface are cleaned mechanically to make free from dust, oil scale etc. and ensure that the molten filler metal wets the surfaces.

ii. Application of flux: Then the joining surfaces are coated with a flux usually rosin or borax. This cleans the surfaces chemically and helps the solder in making bond.

iii. Tinning of surface to be soldered: before carrying out the soldering operation, the soldering iron must be tinned. This is to remove a thin film of oxide that forms on the copper bit, which in turns does not allow the job to be heated and thus it becomes difficult to solder. In tinning the copper bit is heated and then rubbed with a file to clean it properly and then rotating with solder using resin. This causes the formation of a thin film of solder over the copper bit. This whole process is called tinning.

iv. Heating: the soldering iron is then heated and flowing molten filler metals fills the joints interface. Allow the soldered area to cool and then solidify thus making the joint.

v. Final clean-up: after completing the soldering and joints are formed, clean it with steel wool or solvent to remove left over flux. After this clean the soldering iron using a damp sponge

Advantages of soldering

1. Low cost and easy to use
2. Soldered joints are easy to repair or do rework
3. The soldered joint can last for many years
4. Low energy is required to solder
5. An experienced person can exercise a high degree of control over the soldering process

Disadvantages of soldering

1. Not suitable for heavy sections
2. Temperature is limited
3. Strength is limited.

BRAZING PROCESS:

- Joining of two metals without preparing any joint is called as brazing operation. The mechanism of the joint is Wetting and Surface Alloying.
- The temperature of the joint must be greater than the melting point of metals. So here in the case of brazing, the temperature of the joint must be greater than 450-degree centigrade.
- It is a process of joining similar or dissimilar metals using filler material. The filler material is called **Spelter** and the filler material is made up of **Copper alloy**.
- Out of the different metals, the molten metals copper, zinc alloy is having the highest capillary action. hence, it is used as a filler rod in the brazing operation.

WORKING PRINCIPLE OF BRAZING PROCESS:

- First, you need to take two work pieces to join them through the process of brazing. As in the case of soldering, we had used a soldering gun and filler material for the formation of joint whereas, in the Brazing process, a paste is used, this is the mixture of (Spelter) and is to be applied on to the work region.
- The type of joint formed is **Permanent** and the **load bearing capability** is also **high**.

Method of brazing

1. Cleaning the surface of the parts.
2. Application of flux at the place of joint.
3. Common borax and mixture of borax and boric acid is used as flux.
4. The joint and the filler material are heated by gas welding torch above the melting temperature of the filler material.
5. It flows into the joint space and a solid joint is formed after cooling.

Advantages of Brazing

1. It is easy to learn.
2. It is possible to join virtually any dissimilar metals.
3. The bond line is very neat aesthetically.
4. Joint strength is strong enough for most non-heavy-duty type of application.

Disadvantages of Brazing

1. Brazed joints can be damaged under high temp.
2. Brazed joint require a high degree of cleanliness.
3. The joint colour is often different from that of the base metal.

DIFFERENCE BETWEEN SOLDERING AND BRAZING:

No.	Soldering	Brazing
1	Soldering is done at temperature below 200 C.	Brazing is done at temperature above 450C but below the critical temperature of metal.
2	Filler material used is solder	Filler material used is spelter.
3	These joints are weaker than brazing joints.	It forms stronger joint.
4	It is used in electrical industries to joint capacitor, resistor, wire etc. to the electronic plate.	It is used to mechanical industries to joint different metals.
5	It does not need a special training to soldering.	It needs special trading.
6	It is a cheaper process.	It is a costly process.
7	Soldering does not need to preheat of base metal.	This process needs preheating of base metal.
8	It is used to joint electronics component.	It is used in automotive industries and pipe fitting.

WELDING:

Welding is the process of joining together two pieces of metal with or without the application of heat or pressure or both is applied and with or without addition of filler metal for formation of metallic bond.

CLASSIFICATION OF WELDING

1. Arc welding:

- Gas tungsten arc welding (TIG) or GTAW
- Gas metal arc welding (MIG)
- Submerged arc welding
- Shielded metal arc welding (SMAW)
- Plasma arc welding

2. Resistance welding:

- Spot welding
- Seam welding
- Projection welding
- Resistance butt welding

3. Gas welding:

- Oxy acetylene gas welding
- Oxy hydrogen welding
- Air acetylene welding
- Pressure gas welding

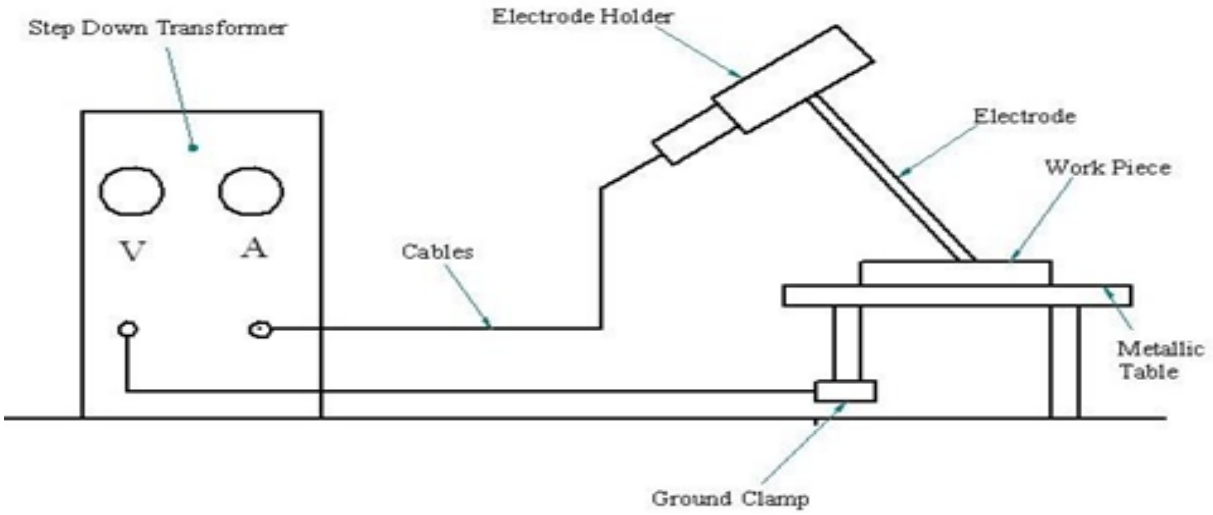
4. Thermo chemical welding:

- Thermit welding
- Atomic hydrogen welding

5. Radiant energy welding process:

- Electron beam welding
- Laser beam welding

Arc Welding:



- It is a fusion welding process in which the melting and joining of metals is done by the heat energy generated by the arc between the work and electrode.
- An electric arc is generated when the electrode contacts the work and then quickly separated to maintain the gap. A temperature of 5500°C is generated by this arc.
- This temperature is sufficient to melt most of the metals.
- The molten metal, consisting of base metal and filler, solidifies in the weld region. In order to have seam weld, the power source moves along the weld line.

WORKING OF ARC WELDING:

- First ON the electric power source (AC or DC).
- As the electrode is brought near the base metal (2-4 mm apart) where the welding is to be done, spark or arc starts to produce in between the base metal and electrode.
- Intense heat is generated due to the arc produced. The heat produced melts the base metal, electrode core (or filler material in some case) and flux coating. The flux coating on the electrode provides a shielding environment (shielding gas) to the weld from the atmospheric contamination. The molten metal or slag gets deposited in between the two metal pieces to be joined and gets solidifies. After solidification, it forms a strong bond between the two metal pieces.
- Shielding gas is used to protect the melt or weld from atmospheric contamination.
- After completion of the welding process, the job (metal pieces) is cooled down by dipping it in an appropriate coolant. It can also be left for air cooling.

Types of electrodes used in Arc welding:

- A welder needs an electrode to generate an electric current to do arc welding.
- In welding, an electric current is conducted through an electrode which is used to join the parent metals.

Two types of electrodes are used: **consumable and non-consumable**

- **Consumable electrodes**: The electrodes which melt due to heat developed by the arc and become part of the weld bond are called consumable electrodes.

The main characteristic of consumable electrodes is that they have a low melting point so that the arc will melts metal pieces as well as the tip of the electrode which acts as the filler material in the gap.

- **Non-Consumable electrodes**: The electrodes which do not consume during the welding process i.e., which do not melt away by arc heat and fuse on the weld bead, are called non-consumable electrodes. Most of the non-consumable electrodes are made up of carbon, graphite, or tungsten.

GAS WELDING:

- Gas welding is a welding processes that melts and joins the metals by heating them with a flame caused by a reaction of fuel gas and oxygen.
- The gases that can be used for heating are
  (i) Oxygen and acetylene
  (ii) Oxygen and hydrogen.
- The most commonly used method is oxy acetylene gas welding due to its high flame temperature.
- The flux may be used to deoxidize and cleanse the weld metal.
- The flux melts, solidifies and forms a slag skin on the resultant weld metal.

OXY-ACETYLENE GAS WELDING:

- Oxy-fuel welding (OFW) is also known as Gas welding or Oxy-fuel gas welding.
- The term Oxy-fuel' is used to denote a combination of Oxygen and a Fuel gas, means it's a process in which Oxygen and a fuel (combustible gas) both are required.
- Most commonly used fuel gas is Acetylene and thus the name Oxy-Acetylene welding (OAW) is also used for this process, when Acetylene is used as a fuel gas.

- The required heat for welding is generated by a flame caused by the chemical reaction between oxygen and the fuel gas (Acetylene). Fuel gas and Oxygen are combined in a mixing chamber, provided in the welding torch itself. Additional filler metal can be used with this process. A flux may be used to protect the molten weld pool. Flux deoxidizes and cleanses the weld metal. The flux melts, solidifies, and forms a slag on the weld metal.

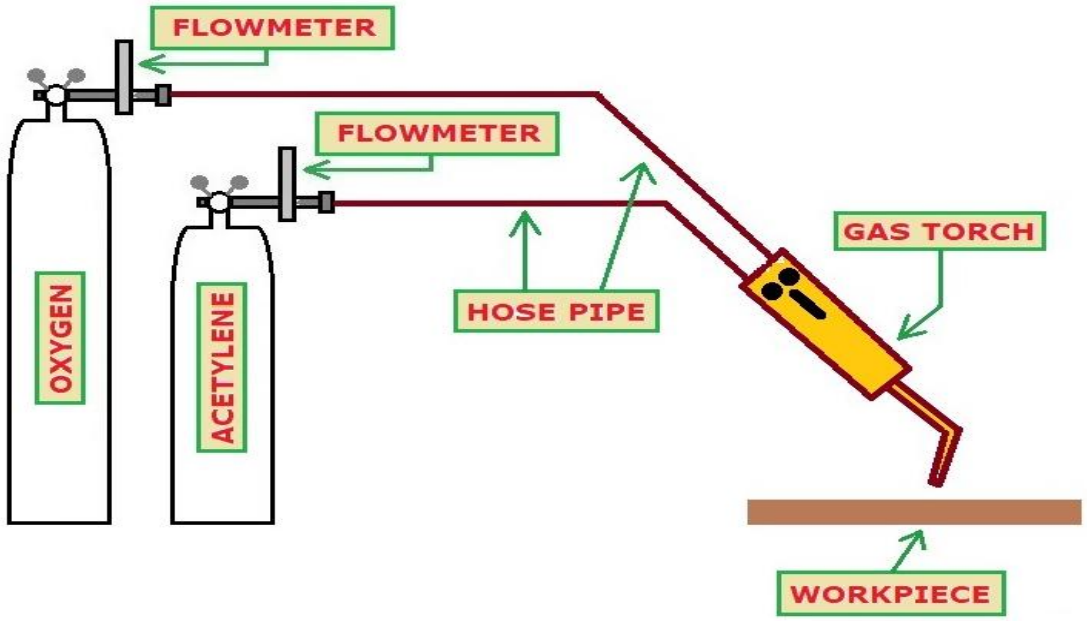


Fig 4.3 Oxy-Acetylene Gas Welding Machine

A typical Oxy-Acetylene welding (OAW) setup contains the following basic items (Figure – 1):

- Oxygen Cylinder
- Acetylene cylinder
- Hose pipes
- Gas torch
- Filler Metal (Optional)
- Flux (Optional)
- Safety valves (Flashback arrestor/Non returning valve or Check valve)

WORKING PRINCIPLE OF OXY ACETYLENE WELDING

- The working principle of Oxy Acetylene Welding is simple in the process even though it is effective and efficient. The *temperature of the flame* is about 3,500

degrees centigrade. It uses the Fuel gases like Oxygen and Acetylene to weld the material.

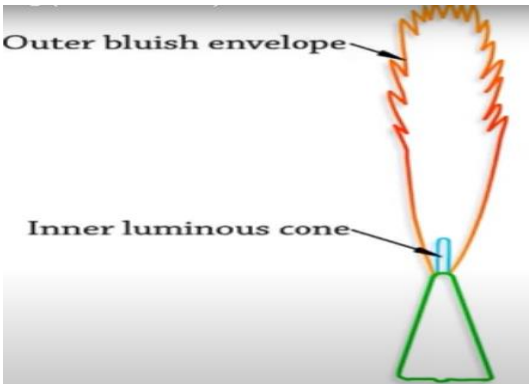
- In this process, the welding torch produces the high-temperature flame with the help of oxygen and acetylene.
- Due to the high flame, the metal that needs to be weld gets weak and melted, meanwhile, a filler material is used to fill the gaps between two work pieces. As the filler is cooled, the two work pieces will be joined.
- Usage of type of Filler material depends upon the metal that needs to be weld.
- *For example,* if we want to weld the mild steel metal, then we have to use the mild steel filler. Similarly, if we want to weld the aluminum metal, then we have to use the aluminum filler.

FLAME AND ITS TYPES:

- A flame can be defined as a region where gaseous elements burn, generating heat and light. All combustible materials, whether liquid or gaseous, emit flames as they burn.
- There are three basic flame types: neutral (balanced), excess acetylene (carburizing), and excess oxygen (oxidizing) as shown below.

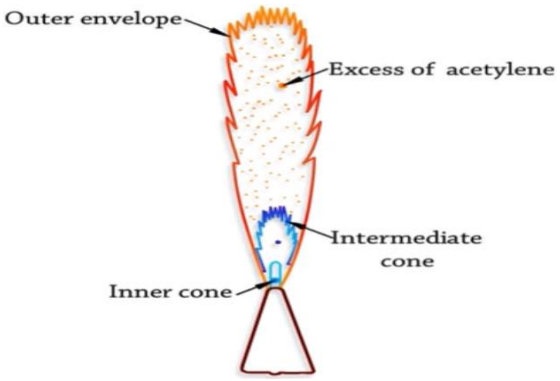
Neutral Flame:

As the name implies, this flame has equal amount of oxygen and gases fuel by the volume. This flame burns fuel completely and does not produce any chemical effect on metal to be welded. It is mostly used for welding mild steal, stainless steel, cast iron etc. It produces little smoke. This flame has two zones. The inner zone has white in color and has temperature about 3100 degree centigrade and outer zone has blue color and have temperature about 1275 degree centigrade.



Carburizing Flame:

This flame has excess of fuel gas. This flame chemically reacts with metal and form metal carbide. Due to this reason, this flame does not used with metal which absorb carbon. It is smoky and quiet flame. This flame has three regions. The inner zone has white color, the intermediate zone which is red in color and outer cone has blue color. The inner cone temperature is about 2900 degree centigrade. This flame is used to weld medium carbon steel, nickel etc.



Oxidizing Flame:

When the amount of acetylene reduces from natural flame or amount of oxygen increases, the inner cone tends to disappear and the flame obtain is known as oxidizing flame. It is hotter than natural flame and has clearly defined two zones. The inner zone has very bright white color and has temperature of about 3300 degrees centigrade. The outer flame has blue in color. This flame is used to weld oxygen free copper alloy like brass, bronze etc.