

Metal :-

The substance that has the following properties called metals.

- Shiny surface.
- Good conductor of heat and electricity.
- Can be melted.
- Usually capable of being shaped.

Exp# Gold, Tin, Copper etc.

→ Usually used in construction purposes.

(*) They are not exist as metal in nature but in form of compounds like oxides, Carbonates, sulphide, phosphates which are called ores. By removing impurities from ores metals are derived.

Types

↓
Ferrous metal.

→ The metal which has main constituent of iron & mostly used for engineering purposes.

Exps Cast iron, wrought iron & steel.

↓
Non Ferrous metal.

The metals which has no main constituent of iron called non-ferrous ~~iron~~ metal.

Exp:- Aluminum, Copper, Zinc, lead etc.

Non Ferrous Metals

1. Aluminium

Non ferrous metal with silvery white in colour and freshly broken surface.

- It is malleable (can be drawn into wires).
- It is less ductile than Copper.
- It has low thermal conductivity but good conductor of ~~heat~~ electricity.
- It shows resistance against nitric acid but easily corroded by alkalis.
- It is stable in neutral water.
- Aluminium can be riveted or welded but can't be soldered.
- It is usually soft, light and durable.

Uses:-

- As soft so not suitable for structural purposes.
- It is mostly used for making door & window frame, railing of shop.
- Aluminium powder is used for making paints.
- It is mostly used in internal parts of Combustion engine, airplanes, utensils etc.
- Aluminium alloys are widely used in manufacture of rolled section i.e. I section, round & rectangular pipes, rivets & bolts.
- Aluminium sheets are used in bathroom over tiles to protect them from getting worse.

2. Copper:-

It is bright shining metal with reddish in colour which turns greenish on exposure to weather.

- Usually malleable & ductile.
- Soft and good conductor of heat & electricity.
- Its tensile strength is high.
- Its resistivity to heat & electricity increase with content of impurities & amount of wire drawing.
- Cannot be welded except on red heat.

Uses:-

Mostly used in electrical equipment where supply of electricity is needed as good conductor of electricity.

- Used in wire.
- In building it is used for roofing, sheeting & damp proofing.
- Also used in connection for water supply in house.

3. Zinc:-

- It is non ferrous metal usually blue silvery in colour when oxidation is removed.
- Zinc is brittle metal at room Temperature
 - Zinc has good ductility & can be deform into desired shape.
 - Zinc has resistance to atmospheric corrosion.

Uses:-

- Used in manufacture of paints, rubber etc.
- It is also used to form alloys (different)

4. Lead:-

- It is dense, weakest and softest metal.
- It is malleable and can be drawn even with finger.
 - It can rolled into thin foils.
 - It has blue ^{grey} colour and dull metallic lustre when freshly fractured.
 - It loses its lustre when exposed to air.

→ Uses:-

- Used in paints.
- Lead pipes.
- & in batteries.

Ferrous metals

1. Iron

- Mostly commonly used in engineering construction.
- It is commonly available in nature but not in free state in form of ores.
- They are classified on basis of percentage of iron contents.
- They can in form of magnetite, Hematite, Limonite etc.

Extraction of Iron from Ores:-

- Its extraction process is very simple.
- The ores is heated in presence of reducing agent which liberate CO & CO_2 as a gas and metallic iron remain in hard form.

Uses:-

- It is form different alloys with different element having its own characteristics used for different services.

2. Cast Iron:-

- Cast iron is alloy of Carbon & iron having carbon contents $> 2\%$.
- It is hard & brittle.

- Strong in compression & weak in Tension.
- It cannot be magnetized. & low melting point.
- Cast iron containing large amount of manganese & Chromium are white in colour.

Types of Cast Iron:-

- Grey Cast iron.
- White Cast iron.
- Malleable Cast iron.
- Ductile Cast iron.

Uses:-

- Used in manufacture of wrought iron & mild steel.
- Because of its strength & low cost mostly used in engineering construction.
- Used for making ornamental casting such as wall bracket, manhole cover, sanitary fittings etc.

3. Steel:-

Steel is metal alloy of Carbon, iron and other elements.

- Because of its physical properties & easy availability mostly used in construction.
- On the basis of changing content of Carbon we get different steel of different properties.

Types:-

1. Mild Steel:-

It is also known as soft or low Carbon steel.

Here the percentage contents of carbon lies between 0.15-3.

- It rusts quickly & easily magnetized.
- It is malleable, ductile & tougher.

Properties:-

Its compressive strength ($800-1200 \text{ N/mm}^2$) is more than tensile strength ($600-800 \text{ N/mm}^2$).

Uses:-

Use in manufacturing of rolled section, reinforcing bar & railway track etc.

(2) High Carbon Steel:-

Here the carbon contents are more and ranges from 0.55 to 1.5%.

- It is also known as hard steel.
- It is tougher & elastic than mild steel.
- It can be welded difficultly.

Properties:-

Compressive strength (1350 N/mm^2) < Tensile strength ($1400-2000 \text{ N/mm}^2$)

Uses:-

- It can take shocks & vibrations i.e. why used for making tools & machines.
- Used in concrete as reinforcement member.

(3) High Tensile Steel:-

Also known as high strength concrete.

→ The carbon contents is 0.6-0.8%.

→ Ultimate strength (tensile) is of 2000 N/mm^2 & maximum elongation of 10%.

Uses:-

Used in prestressed concrete construction.

Manufacturing of steel:-

1. Bessemer Process:-

- Most commonly used now a days.
- Introduced in 1856.
- Iron ore get heated in couple furnace and sent to Bessemer converter.
- Hot air is given to it in order to oxidize it.
- Carbon & manganese is added depending on requirement. Hot air is again blasted.
- The melted material is poured into mould to form blocks of steel.

2. Linz & Donawitz (L.D) Process:-

- Also known as basic oxygen process.
- It is modification of Bessemer's process.
- In this case steel can be made in 25 min.
- It is 10 times faster than open hearth process.
- It does not required heat for steel making.

(3) Open hearth process:-
It also known as siemen's Martin process.

→ It is batch (heat) process.

(*) The furnace is first filled with scrap materials such as shredded vehicle or waste material.

→ It is heated.

→ After melting, heavy scrap such as building, construction or steel milling scrap is added with pig iron from blast furnace.

→ Slag forming agent such as limestone is added.

(*) The oxygen & other impurities decarburize the pig iron & excess carbon away, forming steel.

(*) Slow process than other easy to control.
quality of steel.

(4) Electric Process:-

It is ~~can~~ costly but no heat is required.
→ steel is form in electric arc furnace.

(5) Crucible Process:-

In this process wrought iron is packed with charcoal and heated to promote diffusion of carbon into iron to form steel.

• In this process cast steel is obtained is hard & used for surgical equipment.

③ Duplex Process:-

→ It is two steps process.

In first step steel heated in Bessemer converter & then partially refined melt was transfer to open hearth furnace to finish the process.

(*) Combination of Acid Bessemer's process and basic open hearth process.

(7) Cementation process:-

It is old process used carburization of iron process. In this process the amount of iron carbon is increased.

→ In this process wrought iron is converted into steel.

Alternate layers of sifted wood charcoal & iron bar are placed in fire, the top of which made air tight by layer of clay. This prevent burning of charcoal. It is then heated in large furnace. Max heat reached to about 48 hours & continued for 8 to 12 days.

→ The high temp cause iron to absorb more carbon & change into steel.

(*) The steel obtain not ready for use as distribution of carbon not homogenous.

We used two processes for make it useable.

1. Crucible Steel Formation:-
The steel obtained is cut into pieces & melted in crucibles. This will equalize the distribution. We can also add other components to increase its strength and other properties.

2. Shear Steel Formation:-
Cut it into suitable length of any shape & heat it and welding it which expands the product.

Heat treatment of steel:-

We heat steel in order to achieve the desired properties of steel.

- For example
A steel of given composition can be made soft, ductile, & tough by one heat treatment & same steel can be made relatively hard, tough by other.

Objectives:-

- To enhance properties such as strength, ductility etc.
- To refine grain.
- To remove gases.
- To relieve internal stresses & strain.
- To give it different shapes (desired).

Hot Rolled Steel:-

It is formed by heating rolling steel at a temp above steel recrystallization temperature.

i.e. above 1700 degree °F

Properties:-

- It is usually easy to manufacture
- Its dimensions are less precise as compared to hot rolled steel after cooling.
- It can be shaped easily as at high temp shape easily change.
- (*) Blue grey finish appearance
- (*) It is rough when tough.
- (*) Weaker in strength.

Uses:-

The following things are made from hot rolled steel I-beam & other construction materials that not required precise shape & tolerance.

2. Cold Rolled Steel:-

It is manufactured below recrystallization temp, typically at room temp.

- Its dimensions are precise, smooth corner.
- It has glossy grey finish appearance
- Stronger steel.
- It has 80% better yield strength.
- 40% better tensile strength.
- It is expensive than hot rolled steel.

Uses:-

It is mostly used in machinery world where quality factor and appearance factor are important to consider.

Stainless Steel:-

It is alloy of steel that is corrosion resistant which contain Chromium (10.5%) & Carbon content (1.2%) by mass).

Properties:-

- Good resistant to corrosion.
- More attractive in appearance & less maintaining.
- Higher ductility.
- Higher strength & hardness.
- High work hardening rate.

Uses:-

It is used in.

- Roofing.
- Structure.
- Equipments.
- Wall support product etc.
- House hold utensil.

Important failures in steel:-

1. Failure due to Plastic Deformation-

It is permanent deformation occur in steel when steel is subjected to tensile, compressive, bending or torsion deformation that cause it to elongate, compress, buckle or twist.

2. Instability:-
This phenomena occur when perturbations produce large movement (vibration) and the structure never return to its original equilibrium position.

3. Creep:-
It is property of material which enables it under constant load deform slowly but progressively under certain period.

→ It occur as a result of long term exposure to high level of stress that are still below the yield strength of material.

4. Stress:-

Steel also fail due to stress. It occur when ~~com~~ forces (Push or pull) act in combination on material.

* When force act on steel its get distort its shape to counterbalance the effect of force

→ But if the force is large than internal failure will cause steel to break.

5. Corrosion:-

Steel get corroded when it gets exposed to outside moisture.

→ Due to corrosion it lacks most of

g its properties.
→ It also reduces its asthetic.

5. Fatigue:-

Steel usually fail by this method when force is applied repeatedly on it.

6. Brittle Failure:-

• Brittle fracture usually occur due to low temperature.

→ It depends upon the contents of carbon.
If more carbon easily break i.e more brittle.

($\pm$) Brittle fracture is sudden, very rapid cracking of steel under stress where it does not give us any evidence of fracture.

→ Give us no sign for safety & fracture at once.