

UNIT-III (ME201)

FERROUS MATERIALS

Ferrous materials are those which contain iron as their main constituent. Other constituents such as C, Mn, Si, S and P exist in varying proportions with iron(Fe) to form various ferrous materials such as pig iron, wrought iron, cast iron, alloy steel, carbon steel.

Pig iron is the impure iron which is extracted from iron ores (Red Haematite, Brown Haematite) melting with coke and flux (Limestone) in Blast furnace. So Pig iron is therefore, refined and remelted to produce other varieties of iron and steel.

WROUGHT IRON

Wrought iron is a highly refined iron (purest iron) which possesses at least 99% of iron. Wrought iron is produced by remelting of Pig iron in **puddling furnace**.

Composition:-

C = 0.02 -- 0.03 %
S = 0.008 -- 0.02 %
P = 0.05 – 0.25 %
Mn = 0.0 – 0.02 %
Si = 0.02 – 0.10 %
Fe = Rest

Properties:-

- (i): It has excellent corrosion resistance.
- (ii): It has high ductility and can be easily forged.
- (iii): It has good machinability and weldability.
- (iv): Its melting point is about 1500° C.
- (v): It can never be cast.

Applications:-

- (i): In forged articles.
- (ii): In manufacturing of iron bars, forging blooms and billets.
- (iii): In manufacturing of water and steam pipes.
- (iv): In manufacturing of nuts, bolts, chains, etc.

CAST IRON

Cast iron is basically an alloy of iron and carbon and is obtained by re-melting of pig iron with coke, lime stone and steel scrap in a **Cupola furnace**.

Composition:-

C = 1.7 – 4.5 %

Si = 1.0 – 3.0 %

S = 0.0 – 0.15 %

P = 0.0 – 1.0 %

Mn = 0.5 – 1.0 %

Fe = Rest

Properties:-

(i): Hard and brittle.

(ii): Weak in tension.

(iii): High compressive strength.

(iv): Excellent casting characteristics.

(v): Excellent damping characteristics.

(vi): High machinability and wear resistance.

The carbon in cast iron is present in two forms:-

- a) - Free carbon or Graphite
- b) – Combined carbon or Cementite

Types of Cast Iron

- i) – Gray Cast Iron (C = 3.0 – 3.5 %)
- ii) – White Cast Iron (C = 1.75 – 2.3 %)
- iii) – Malleable Cast Iron (C = 2.0 – 3.0 %)
- iv) – Nodular or Ductile Cast Iron (C = 3.2 – 4.2 %)

i) – Grey Cast Iron:-

This is obtained by allowing the molten metal to cool and solidify slowly. On solidifying, the iron is present with the carbon in the form of graphite flakes. It gives gray color fracture due to presence of graphite.

Composition:-

C = 3.0 – 3.5 %

Si = 1.0 – 2.75 %

S = 0.02 – 0.15 %

P = 0.15 – 1.0 %

Mn = 0.4 – 1.0 %

Fe = Rest

Properties:-

- (i) Due to free carbon (Graphite) it has self-lubricating properties.
- (ii) High machinability and wear resistance.
- (iii) Low tensile strength and high compressive strength.
- (iv) Excellent casting characteristics.
- (v) Excellent damping capacity.

Applications:- Machine tool structures, pipes, pipe fitting, manhole covers, piston, cylinder head, etc.

ii) – White Cast Iron:-

In white cast iron, carbon is in the combined form (Fe_3C). This carbide is known as Cementite and it is extremely hard and brittle. Cementite formation takes place due to rapid cooling of molten iron. It shows white colour at fracture.

Composition:-

C = 1.75 – 2.3 %

Si = 0.85 – 1.2 %

S = 0.0 – 0.12 %

P = 0.05 – 0.2

Mn = 0.1 – 0.4 %

Fe = Rest

Properties:-

- (i) Extremely hard and brittle.
- (ii) Poor machinability.
- (iii) High tensile strength
- (iv) Excellent wear resistance.

Applications:-

- (i) It's widely used in the manufacturing of wrought iron and malleable cast iron.
- (ii) Railway brake blocks, wheels and rim of ca