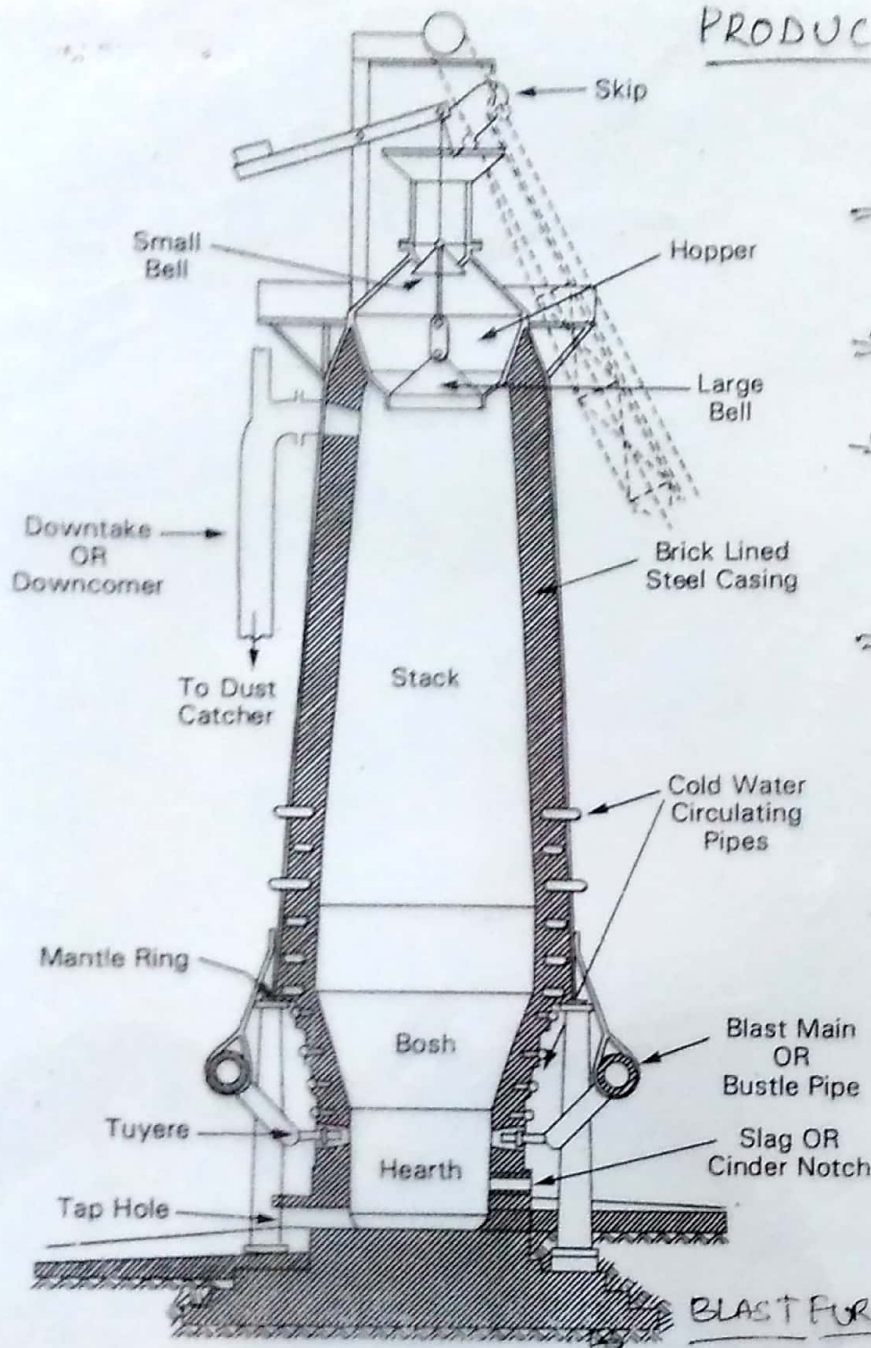


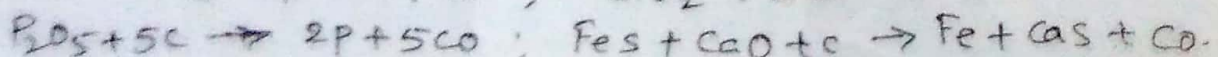
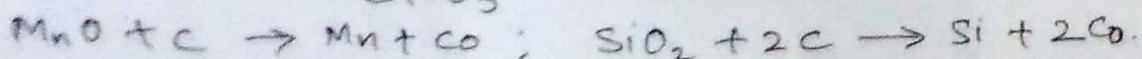
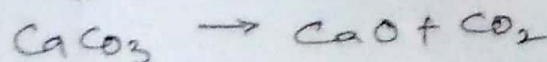
PRODUCTION OF PIG IRON



- ⇒ Hot air passes upwards.
- ⇒ Charge is descended.
- ⇒ Melting of slag and metal occurs in Bosh.
- ⇒ Finally molten slag and ~~metal~~ metal collect with hearth.
- ⇒ Metal will be collected thru tap hole and is casted into large bars called "pigs".
- ⇒ Size of the furnace 30m height, 8 to 10' dia.

BLAST FURNACE

- Pig iron is obtained by the reduction of Iron ore in a Blast furnace.
- Continuous operation.
- Charge consists of Iron ore + coke + Lime stone
- Hot air blast (500°C to 750°C) is supplied thru tuyeres.



PRODUCTION OF WROUGHT IRON

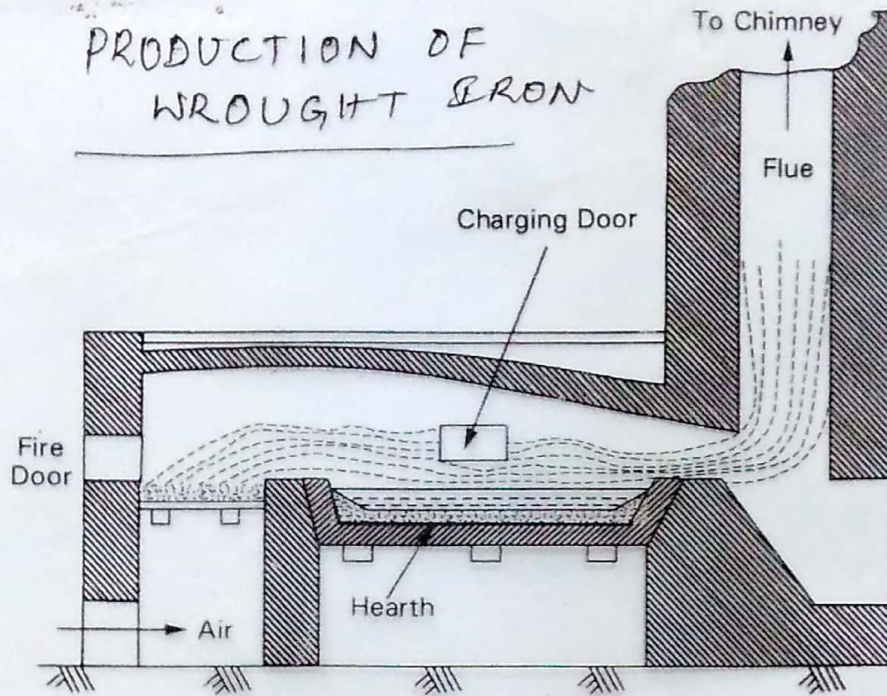
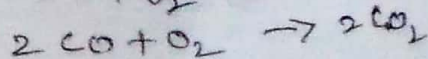
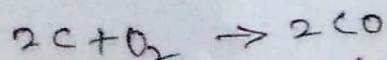
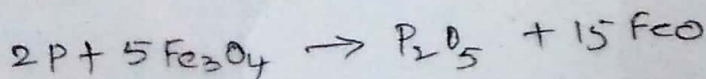
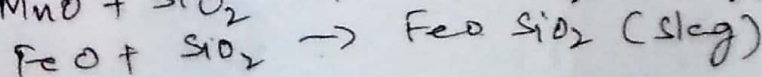
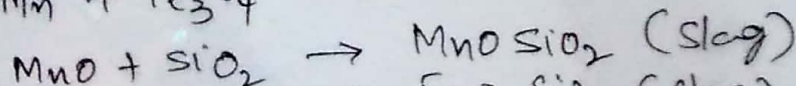
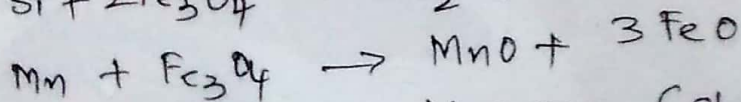
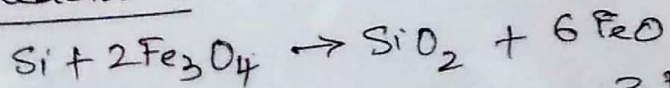


Fig. 4.3.1. PUDDLING FURNACE

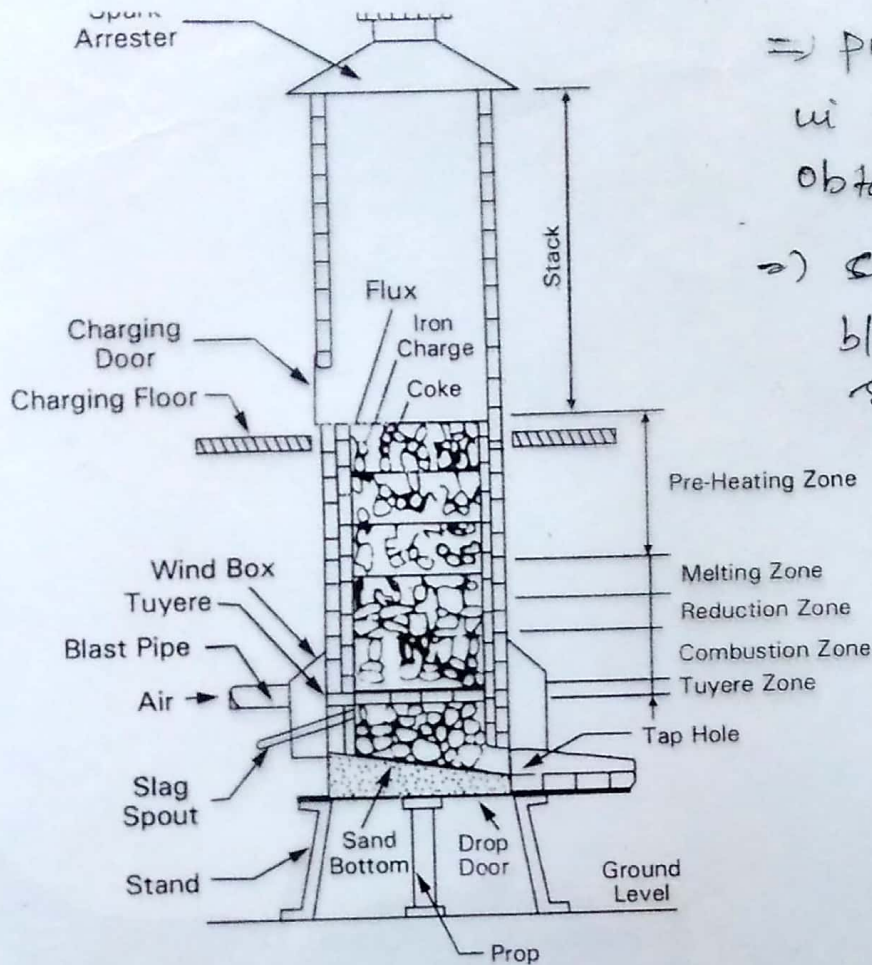
- => purest form of iron
- => 99.9% - Fe
- 1% - slag
- => NO Carbon.
- => Iron from the furnace taken out in the form of balls or blooms.

- => Wrought iron is produced from pig iron.
- => In the furnace, ~~and~~ charge is not in contact with fire.
- => production of wrought-iron involves removal of carbon, silicon, manganese and phosphorus from pig iron.
- => charge consists of pig iron + iron oxide

Reactions:



PRODUCTION OF CAST IRON



⇒ pig iron is refined in cupola furnace to obtain cast iron.

⇒ cupola is similar to blast furnace but smaller in size.

(d = 1 to 2 m; H = 4d to 5d)

Cupola furnace

Operation of cupola : steps.

- ① preparation of cupola
- ② firing of cupola
- ③ charging
- ④ melting
- ⑤ Tapping
- ⑥ Dropping the bottom (closing the cupola).

charge : Metal (75% pig iron and 25% steel scrap)
+ coke + limestone

⇒ Alternate layers of metal, coke & limestone kept on the coke bed

⇒ Air blast enters the furnace thru tuyeres

⇒ combustion takes place.

⇒ Molten metal & slag available at the bottom.

Production of steel

— Steel is made from pig iron after oxidising the impurities

— Steel making processes

- Acid steel making
- Basic steel making

Acid steel making

- To refine pig iron which is low in S, P.
- Furnace lining - acid refractory material
ex: silica bricks

Basic steel making

- Used to remove S & P, besides other impurities.
- Furnace lining - Basic refractory material
ex: Dolomite or magnesite.

Production of steel involves:

- i) removal of undesirable impurities
- ii) correcting the carbon content to the SP-value
- iii) Addition of alloying elements (if reqd).

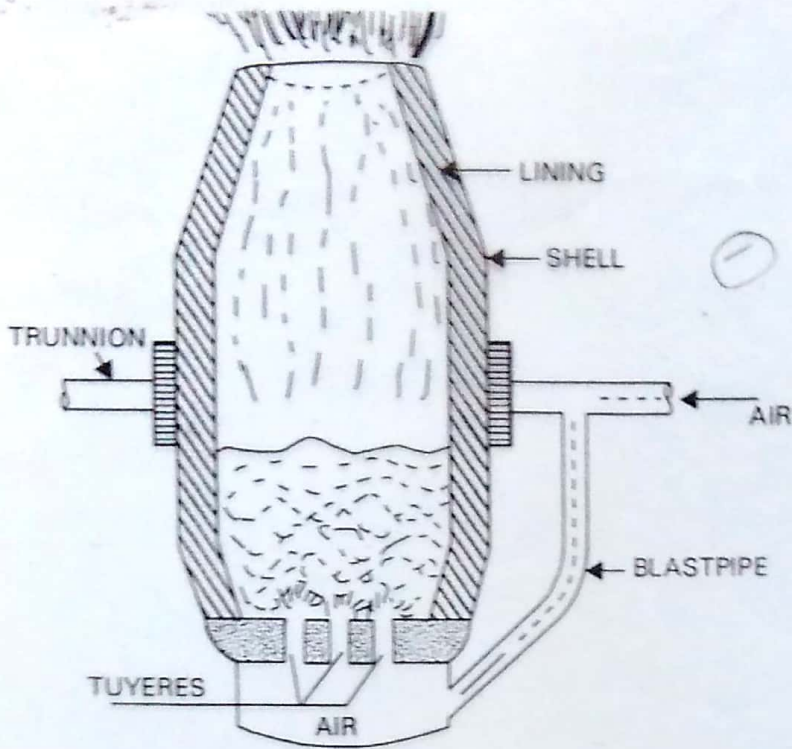


Fig. 4.5.1 BESSEMER CONVERTER

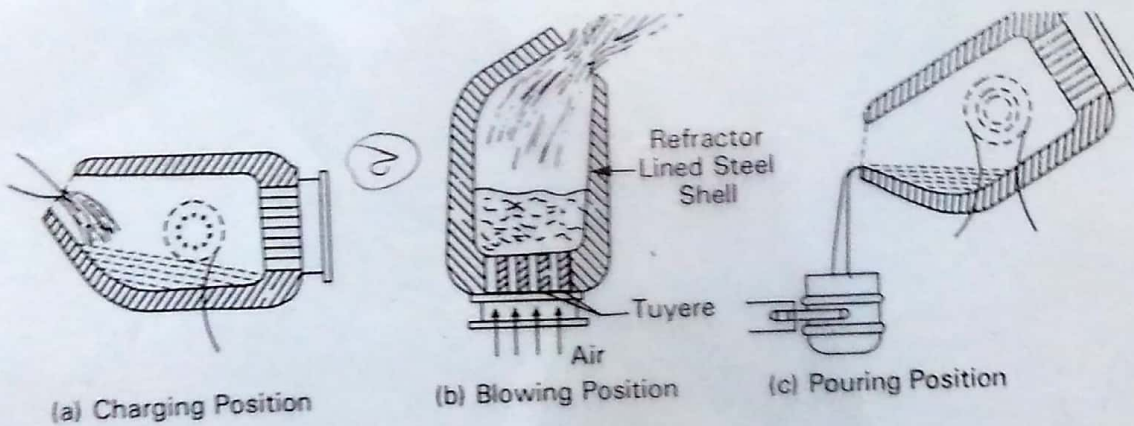


Fig. 4.5.2 BESSEMER PROCESS

- The molten pig iron is charged into the converter from the top.
- A stream of air is forced thru the molten metal to oxidise the impurities.
- No external heat source is reqd, since the oxidation of Si, Mn, C, P & S liberates enough heat.

The Reactions

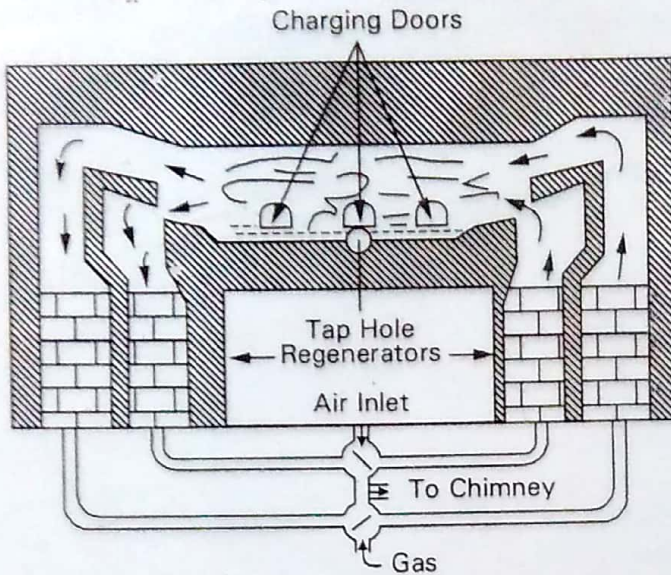


Bessemer converter is positioned in three different positions -

- 1) Charging
- 2) Blowing
- 3) Pouring

Before pouring into ladles, the composition is adjusted by adding ferro manganese, ferro silicon

Open-Hearth Process

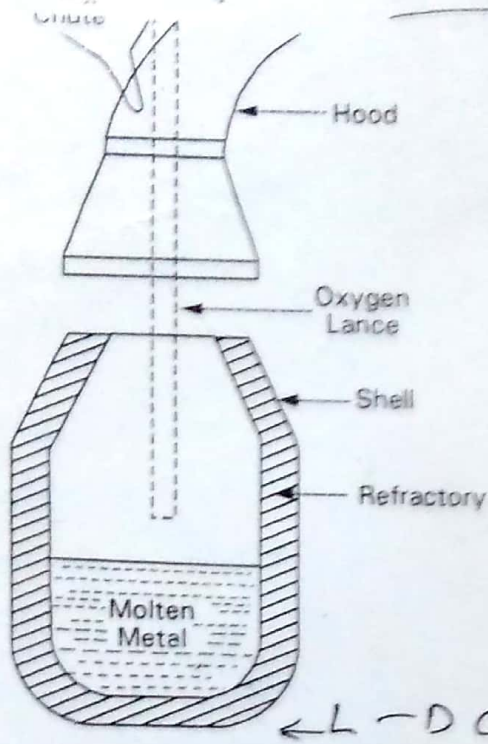


- In acid open-hearth process, charge is pig iron and steel scrap
- Heat is generated by burning of fuel gas which is transferred to the charge.
- Initially, some of the impurities are oxidized. Then oxidation of Si, Mn & C take place
- No. of samples will be analysed for correct composition and then finally ladled.
- In basic open-hearth process,
~~the~~ lime is added to the charge
- Apart from other elements, S & P are oxidized and forms slag

Uses: Acid open-hearth steel - for production of high grade steel. ex: Crank shafts, large ball & roller bearings etc

Basic open-hearth steel - for low cost applications
ex: wire ropes, general structural purpose etc

L-D Process



Charge)

Molten pig iron

+ 15 to 30% steel scrap

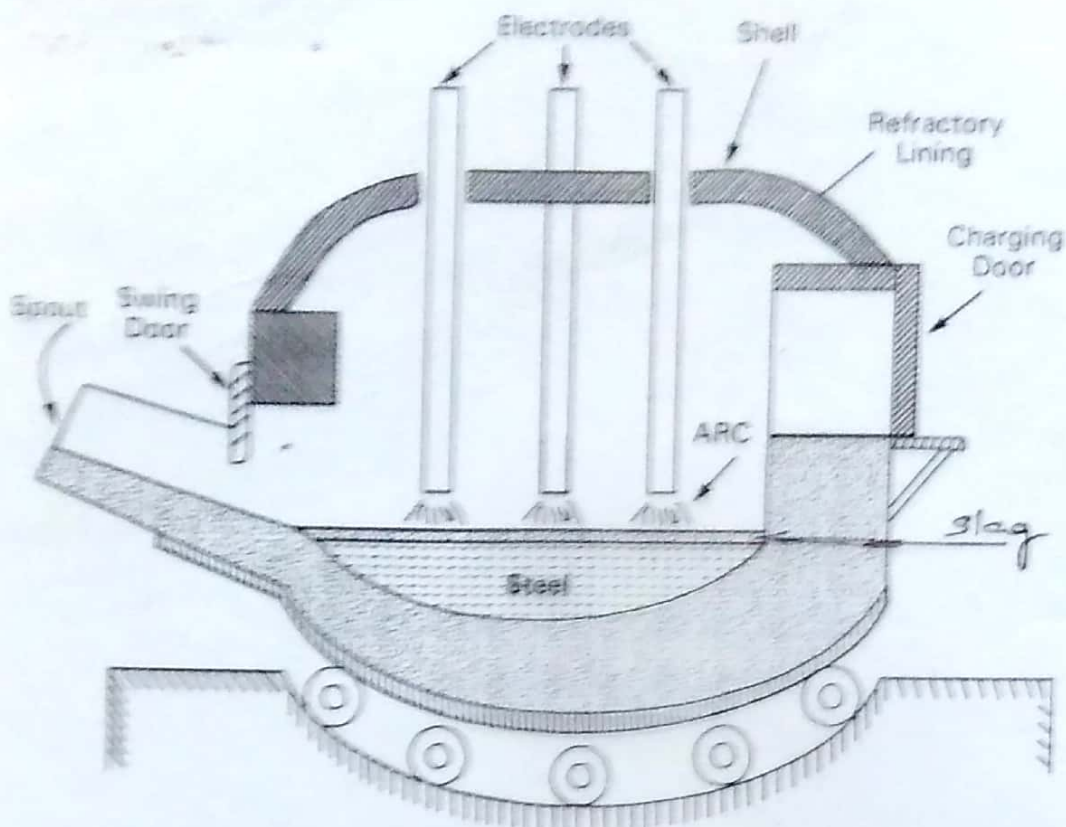
+ Lime

Oxygen at 10-5 bar pressure
is forced into molten metal.

- C, S, P, Si, Mn & other elements gets oxidised.



- SiO_2 , MnO & P_2O_5 - forms slag
- CO escapes as gas
- process time - 25 to 30 min.
- before pouring into ladles, alloying elements are added.
- process is used for soft steel, high carbon & alloy steels.



charge:
Steel scrap +
lime + iron ore.

Fig. 4.8.1 THE ELECTRIC ARC FURNACE

2. Steel making by electric processes

- Better control of the composition and temp. of molten bath.
- Costly. Use is restricted to high quality steel.
- Two types:
 - ① electric arc furnace
 - ② electric induction furnace

Electric arc furnace:

- The electric current is passed into the furnace through graphite or carbon electrodes.
- Available in both acid & basic arc furnaces.

process: steel scrap is charged into the furnace.

- Current is turned on.
- Electrodes are lowered to get arc.

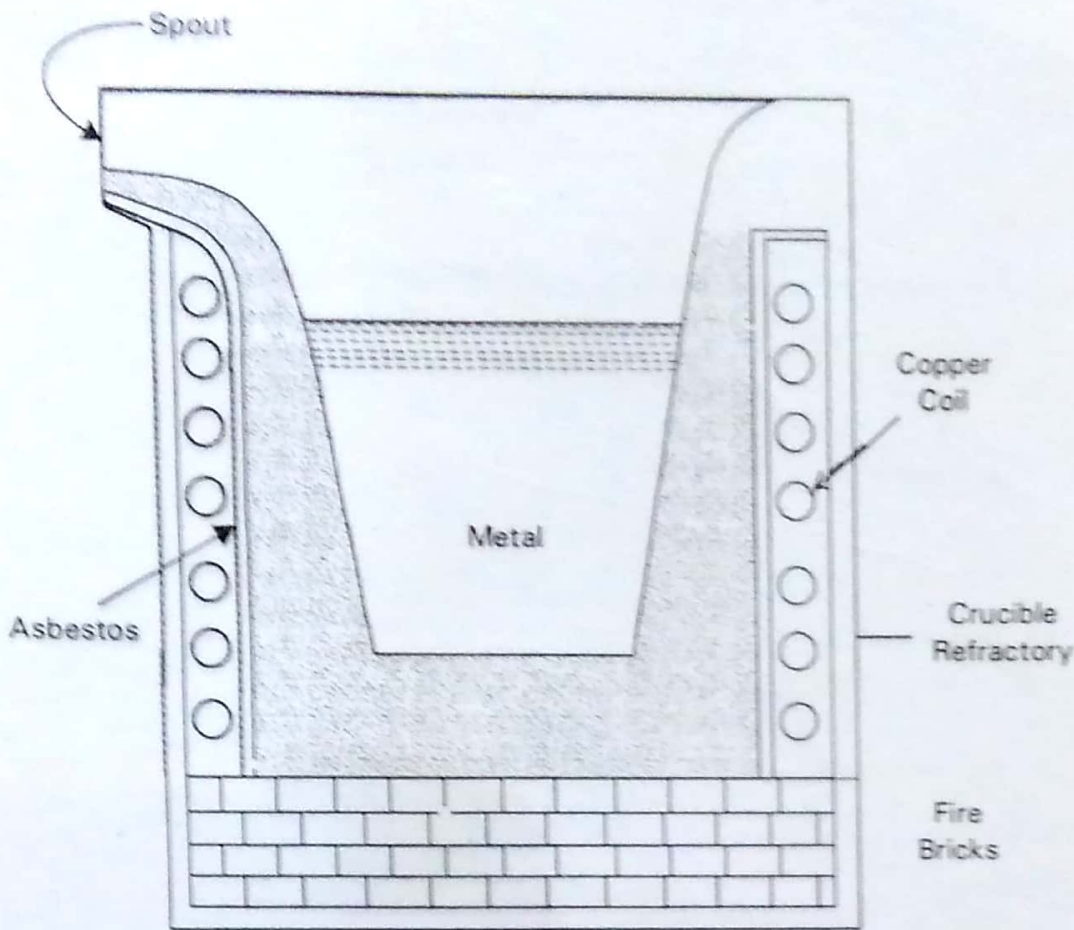


Fig. 4.8.2 HIGH FREQUENCY INDUCTION FURNACE

- Copper coil wound around a refractory crucible.
- current is passed thru the coil and the charge melts. This current produce a stirring action in the melt to ensure thorough mixing.
- Used for making high alloy tool steels, die steels and heat resistant steels.

Extraction of Aluminium

- Aluminium is extracted from Bauxite. ($\text{Al}_2\text{O}_3 \cdot 3\text{H}_2\text{O}$)
- After mining, the ore is crushed and treated with sodium hydroxide solution for producing Alumina.

- Two methods.

① Bayer process. — Used for producing pure Alumina.

② Hall process — Metallic aluminium is produced by electrolysis in a bath of molten cryolite (an aluminium mineral).

- As a result of electrolysis action, aluminium is deposited at cathode (bottom of the cell) and oxygen is liberated at the anode.

The molten aluminium is tapped into the ladle.

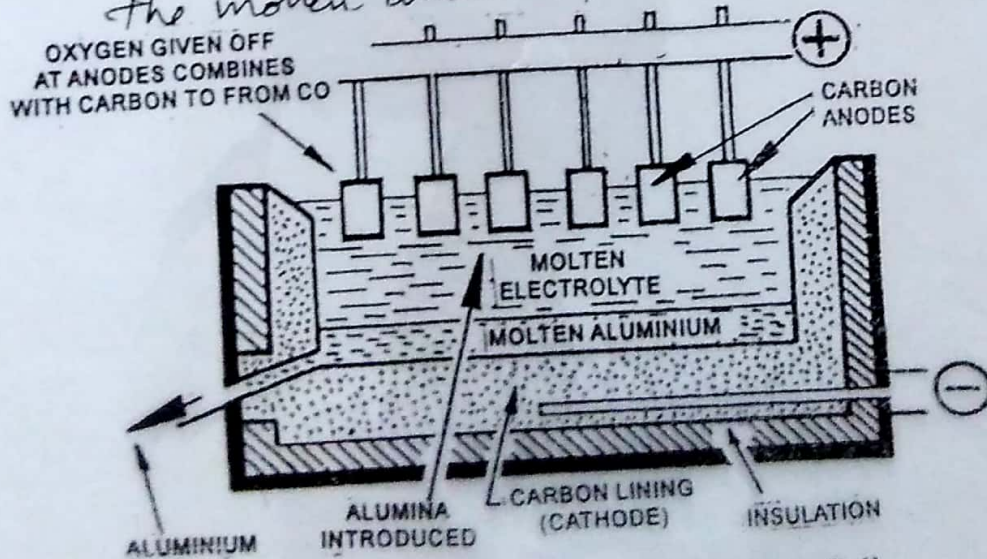


Fig. 9.9 Production of Aluminium - Electrolytic Cell

Extraction of copper

- Copper is found in small quantities in its ores.

- Imp. copper ores:

① Chalcopyrite ($CuFeS_2$)

② Chalcocite (Cu_2S)

③ Covellite

④ Bornite

Stages in extraction of copper.

① Ore dressing - crushed and ground to fine powder

② Roasting - sulphide gets oxidised to reduce the sulphur content.

③ Smelting - melting operation.

④ Converting - the molten metal is charge into the converter and air is blown from & sulphur are removed.

⑤ Refining - copper is further refined to oxidise the impurities.