

16 June

V.V-I

By - Rajamul Haque

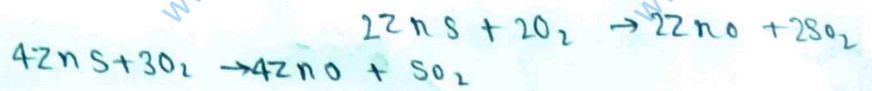
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## Metals

Metallurgy :- The process of extraction of metal from its ore and refining is called metallurgy.

Terms involved in metallurgy :-

1. Minerals :- Minerals are the compounds of metals found naturally in the earth's crust.
2. Ores :- Ores are minerals from which metals can be extracted economically and conveniently.
3. Gangue or Matrix : Gangue or matrix is the unwanted impurity<sup>present</sup> in the ore such as mud, sand, stones etc.
4. Leaching : Leaching is a widely used extraction method that converts the ore into aqueous solution.
5. Smelting : Smelting is the process of reduction of ore in a blast furnace.
6. Matte : Matte is a term used for the molten metal sulphides formed during smelting of Cu, Ni & Fe ores.



7. **Roasting** :- Roasting is a process of heating of sulphide ore to a high temperature in the presence of air. The process may convert a metal sulphide to a metal oxide or to a free metal.



8. **Calcination** : Calcination is a process of heating of carbonate ore to a high temperature in the absence of air or in a limited supply of air. It may remove the volatile impurities.

20<sup>th</sup> July

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## Extraction of Cu — (v.v. 72)

Chief Ore: Copper pyrite ( $\text{CuFeS}_2$ )

1. Concentration: The concentration of copper pyrite is done by froth floatation process.

2. Roasting: Concentrated ore is roasted in presence of air.

a) Free sulphur is oxidised and removed as  $\text{SO}_2$ ,



b) As and Sb are removed as their volatile oxides



c) Pyrite is converted to cuprous sulphide & ferrous sulphide with evolution of  $\text{SO}_2$ .



d) Cuprous sulphide & ferrous sulphide are partially oxidised.







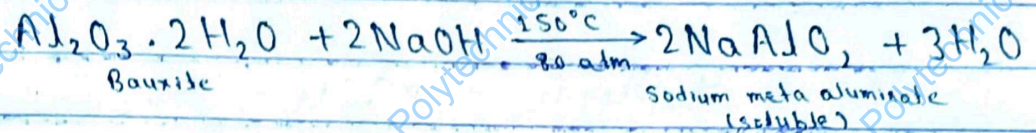
## Extraction of Al <sup>(N.V.T.)<sup>2</sup></sup>

Chief Ore: Bauxite ( $Al_2O_3 \cdot 2H_2O$ )

1. Refining of Bauxite [Removal of  $Fe_2O_3$ ]:

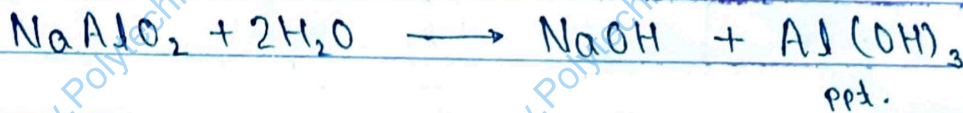
Bayer's Process:

a) The aluminium oxide reacts with concentrated NaOH sol<sup>n</sup> to form soluble sodium meta aluminate.

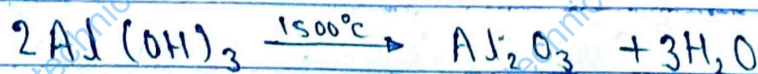


$Fe_2O_3$  remains insoluble & settle down then easily removed by filtration.

b) Sodium meta aluminate undergoes hydrolysis with the formation of  $Al(OH)_3$  precipitate.



c) The precipitate is filtered off, washed dried and calcinated at  $1500^\circ C$  to obtain pure alumina.



Electrolyte :  $Al_2O_3$  :  $Na_3AlF_6$  :  $CaF_2$

Anode : Graphite rods

Cathode : Lining of gas carbon

Temp :  $900^\circ C$

## 2. Electrolytic reduction of alumina :

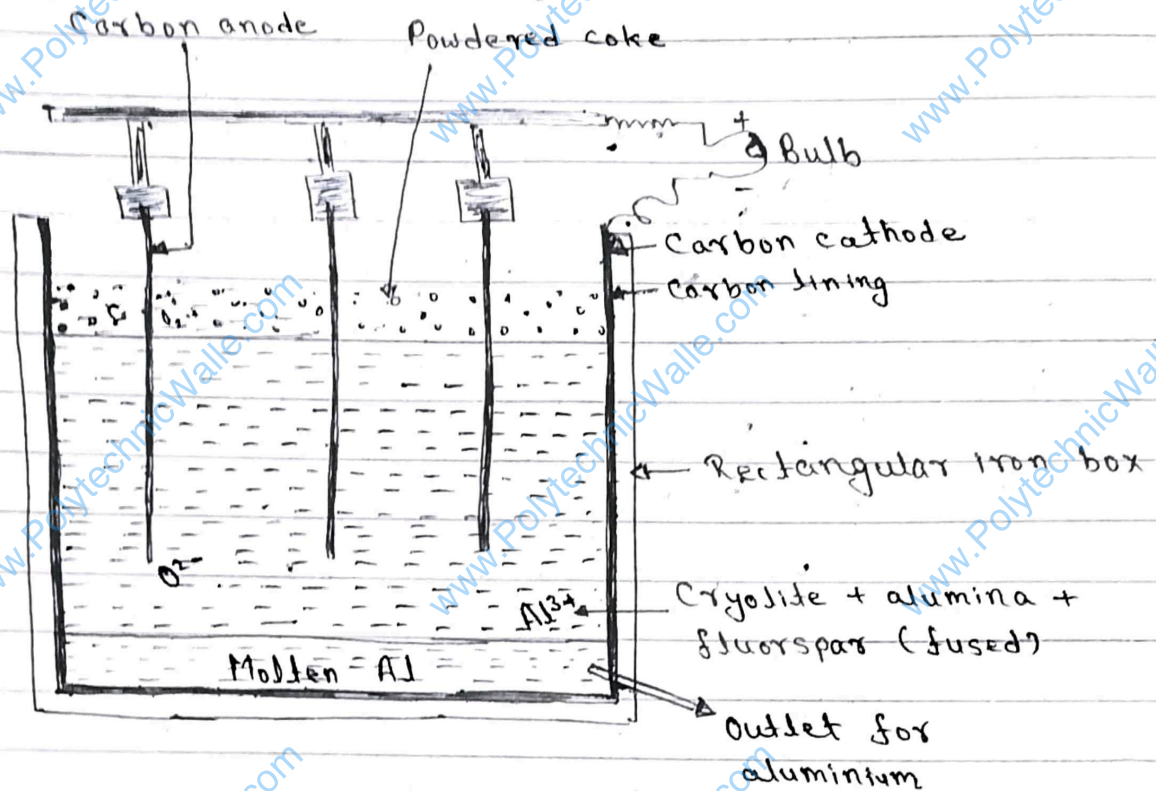
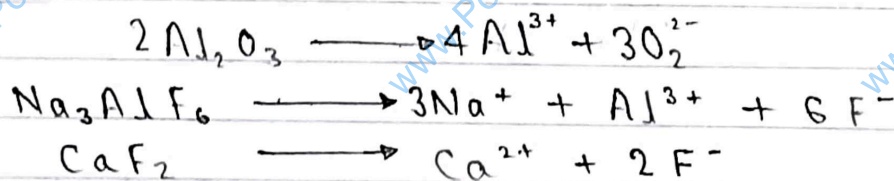
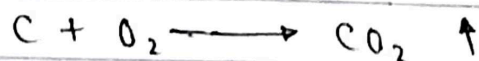
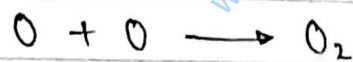
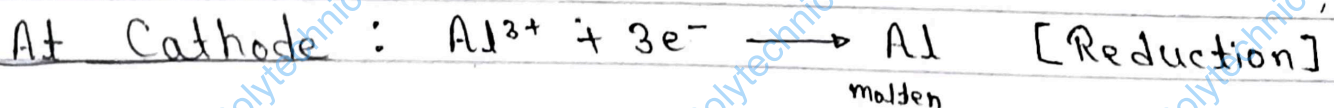


Fig: Electrolysis of Alumina

Ionisation :



Reactions :

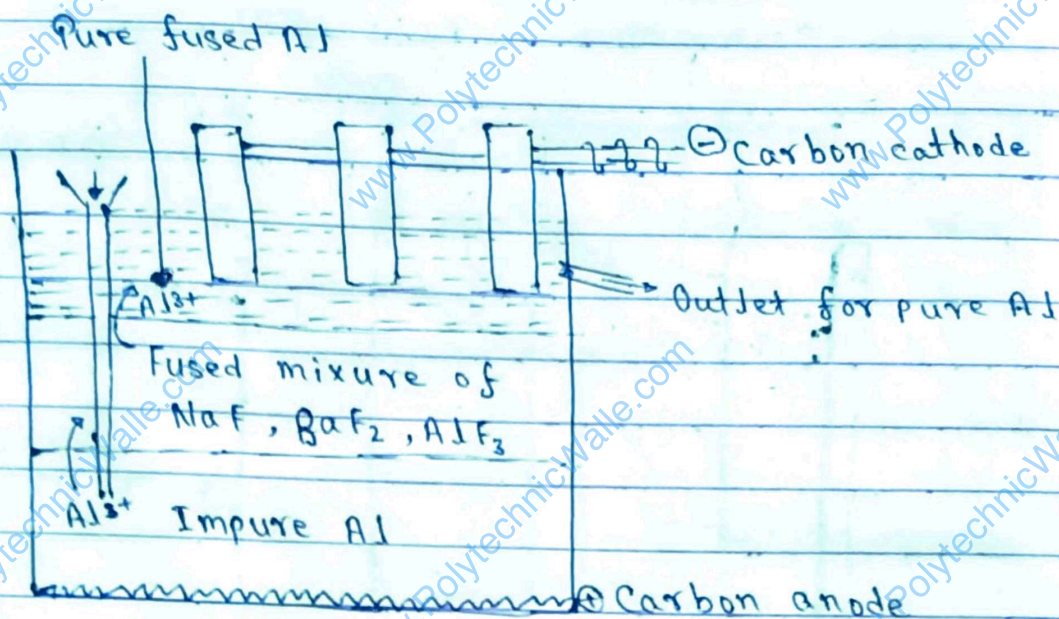


Result :

Al obtained at cathode is 95% pure.

Vaporise

### 3. Refining of Al [Hoopes' Process]:



#### Reactions:



Thus Al obtained is 99.99% pure.

## Metallurgy of Iron

### Introduction to Iron :-

V.V.I

### Important Ores of Iron

1. Magnetite  $\rightarrow$   $\text{Fe}_3\text{O}_4$
2. Hematite  $\rightarrow$   $\text{Fe}_2\text{O}_3$
3. Greathite  $\rightarrow$   $\text{Fe}_2\text{O}_3 \cdot \text{H}_2\text{O}$
4. Limonite  $\rightarrow$   $2\text{Fe}_2\text{O}_3 \cdot 3\text{H}_2\text{O}$
5. Siderite  $\rightarrow$   $\text{FeCO}_3$
6. Pyrite  $\rightarrow$   $\text{FeS}_2$

### Introduction to Iron

Symbol :- Fe      Position in P.T :- Series-3d

At No :- 26      Group-8<sup>th</sup>

Mass No :- 56      Period-4<sup>th</sup>

Electronic configuration :-  $3d^6, 4s^2$

### Resources of Fe :-

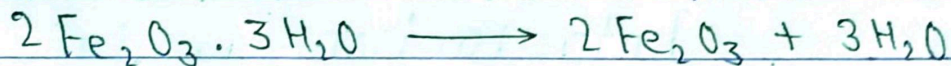
Andhra Pradesh, MP, UP, Bihar, Goa,  
Punjab, Maharashtra, Orissa, Tamilnadu

ImpExtraction Process of Iron

1. Crushing and Concentration: It means the ore is crushed and then separate the impurity from magnetic separation method.

2. Calcination and Roasting: The concentrated ore is heating in excess of air.

(a) Moisture &  $\text{CO}_2$  are removed.



(b) S, As, etc. are oxidised to their oxides & are removed as volatile gases.



(c) Ferrous oxide is oxidised to ferric oxide.



(d) The entire mass becomes porous.

introduced in a blast furnace  
for smelting.

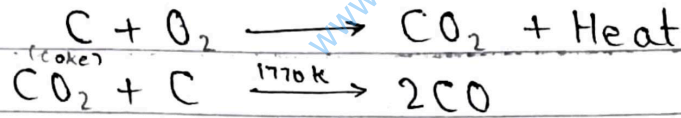
Flux  $\rightarrow$  Lime stone

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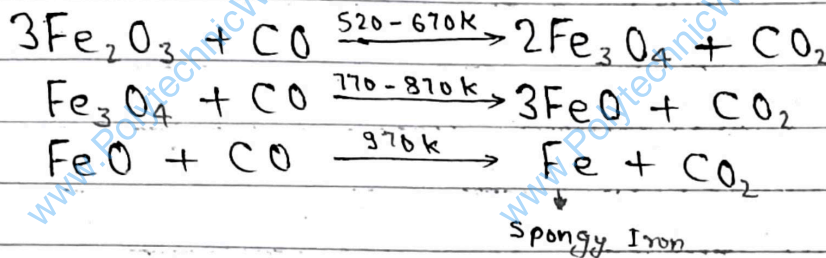
3. Smelting :- In this process, the calcined ore is mixed with lime stone ( $\text{CaCO}_3$ ) and coke and the mixture is strongly heated to high temperature. It is carried out in the blast furnace.

## Chemical Reactions :

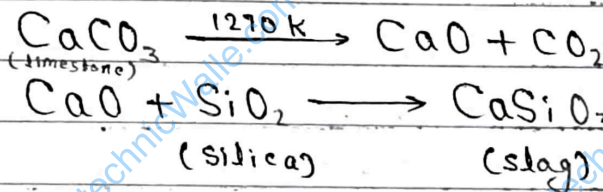
### 1. Combustion Zone :



### 2. Reduction Zone :



### 3. Slag Formation Zone :



### 4. Fusion Zone :

- Just above the combustion zone.
- Temperature ranges b/w 1470 - 1770 K.
- The spongy iron melts at 1570 K & collects at the bottom.

Note : Make Smelting Process Diagram from yourself (must)

## Composition of Pig Iron :

Iron  $\rightarrow$  92.95 %

Carbon  $\rightarrow$  2.5 - 4.5 %

Silicon  $\rightarrow$  1 - 2 %

Manganese  $\rightarrow$  0.1 - 1.5 %

Phosphorus  $\rightarrow$  0.5 - 2 %

Sulphur  $\rightarrow$  0.1 - 1 %

## Applications of Pig Iron

1. Pig iron is used for making steel and pure iron units.
2. Pig iron is used for the production of ductile iron.

## Applications of Cast Iron

1. It is used to make pots & pans.
2. It is used for baking purposes.
3. It is used in piping applications.
4. It is used in parts of automobiles and construction machinery.
5. Washing machine parts, hangers, electric motors, heads of I.C. engines etc.

Malleable Iron  
↓

## Applications of Wrought Iron

1. Building construction
2. Rail road
3. Bridge railings, sludge tanks etc.
4. Condenser tubes, heat exchangers.
5. Coal handing equipment, cooling towers.

## Metallurgy of Cu

### Importants Ores of Cu

#### 1. Sulphides :

- (a) Copper pyrite  $\rightarrow$   $\text{CuFeS}_2$   
 (b) Copper glance  $\rightarrow$   $\text{Cu}_2\text{S}$   
 (c) ~~Box~~

#### 2. Oxides :

- (a) Cuprite  $\rightarrow$   $\text{Cu}_2\text{O}$   
 (b) Melaconite  $\rightarrow$   $\text{CuO}$

#### 3. Carbonate :

- (a) Melachite  $\rightarrow$   $\text{CuCO}_3 \cdot \text{Cu(OH)}_2$   
 (b) Azurite  $\rightarrow$   $[2\text{CuCO}_3] \text{Cu(OH)}_2$

In India, Cu ores are found in UP, MP, Rajasthan, Bihar, Karnataka etc.

### Properties of Cu

1. Colour  $\rightarrow$  Reddish brown
2. Malleable  $\rightarrow$  High malleable [thin sheets]
3. Ductile  $\rightarrow$  High ductile [long wires]
4. Heat & Electricity  $\rightarrow$  Good conductor of heat & electricity
5. Melting point  $\rightarrow$   $1083^\circ\text{C}$
6. Boiling point  $\rightarrow$   $2210^\circ\text{C}$

## Applications of Cu

1. Electrical industry : It is used for making electric wires.
2. Household : It is used for making utensils, pans & coins, etc.
3. Metallurgy : It is used in electroplating & electrotyping industry.
4. Alloying : It is used for making alloys like brass, bronze, gun metal, german silver etc.
5. Ornaments : Cu is alloying with Au & Ag to make them hard for the purpose of making ornaments & coins.

## Metallurgy of Al

(3M)  
Al is a reactive metal and found in combined state in nature. It is most abundant metal on earth's crust.

### Importants Ores of Al

#### 1. Oxides :

- |              |   |                       |
|--------------|---|-----------------------|
| (a) Corundum | : | $Al_2O_3$             |
| (b) Diaspore | : | $Al_2O_3 \cdot H_2O$  |
| (c) Bauxite  | : | $Al_2O_3 \cdot 2H_2O$ |
| (d) Gibbsite | : | $Al_2O_3 \cdot 3H_2O$ |

#### 2. Fluoride :

- |              |   |             |
|--------------|---|-------------|
| (a) Cryolite | : | $Na_3AlF_6$ |
|--------------|---|-------------|

#### 3. Silicate :

- |                |   |  |
|----------------|---|--|
| (a) China clay | : | $Al_2O_3 \cdot 2SiO_2 \cdot 2H_2O$             |
| (b) Mica       | : | $K_2O \cdot 3Al_2O_3 \cdot 6SiO_2 \cdot 2H_2O$ |
| (c) Feldspar   | : | $K_2O \cdot Al_2O_3 \cdot 6SiO_2$              |

### Resources of Al

- Bauxite found in France, Ireland & U.S.A. in sufficient quantity.
- In India, bauxite occurs in UP, J&K, Bihar, MP, Gujarat, Karnataka & Tamilnadu.

## Properties of Al

1. Colour : White & silvery luster.
2. Weight : Light metal
3. M.P. :  $660^{\circ}\text{C}$
4. B.P. :  $1800^{\circ}\text{C}$
5. Malleability : High malleable
6. Ductility : High ductile
7. Hardness : Not very hard
8. Conductivity of heat & electricity : Good.
9. Specific gravity (density) : 2.7
10. Special property : Tough & high tensile strength.

## Applications of Al

1. In electrical engineering for making wires and transmission cables.
2. Used in making household utensils, cans, heating appliances, etc.
3. Used in photographic flash bulbs.
4. Used for making alloys.
5. Used in aircrafts, automobiles and other industry.
6. Al powder is used as a reducing agent in the production of certain metals like Cr.
7. Used in the manufacture of thermite which is used for welding purposes.