

## Conversion of concentrated ore into oxide form

# Metallurgy

### a) Calcination

**Calcination is a process in which ore is heated, generally in the absence of air, to expel water from a hydrated hydroxide ore and carbon dioxide from a carbonate ore at temperature below their melting points to form metal oxide.**

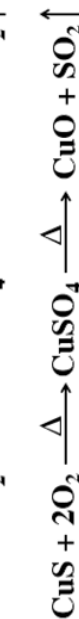
$$\text{Bauxite ore} + \text{coke} + \text{N}_2 \xrightarrow{1800^\circ\text{C}} \text{AlN} \xrightarrow{\text{H}_2\text{O}} \text{Al(OH)}_3 + \text{NH}_3 \xrightarrow{\Delta, 1500^\circ\text{C}} \text{Al}_2\text{O}_3$$

**$C + SiO_2 \text{ (gangue)} \rightarrow CO_2 \uparrow + Si \uparrow$**   
**By product or side product of serpec's process is silicon.**

## By Chemical Separation Method Leaching

### b) Roasting

**$2\text{Na}[\text{Ag}(\text{CN})_2] + \text{Na}_2\text{S}$**   
**In absence of air reaction is reversible.**

$$4\text{Na}_2\text{S} + 5\text{O}_2 + 2\text{H}_2\text{O} \longrightarrow$$
$$2\text{Na}_2\text{SO}_4 + 2\text{S} + 4\text{NaOH}$$


## Reduction of ore to the metal

### By Pyrometallurgy

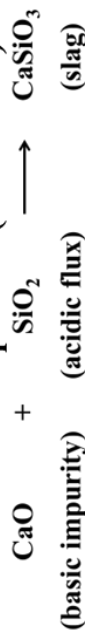
Some Reactions of Reduction By Carbon



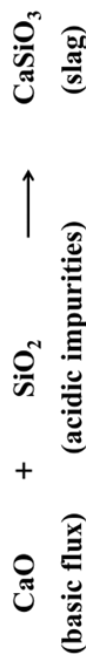
### Flux

Two types of Flux are used.

**a) Acidic Flux** Substance used to remove basic impurities (metal oxide)

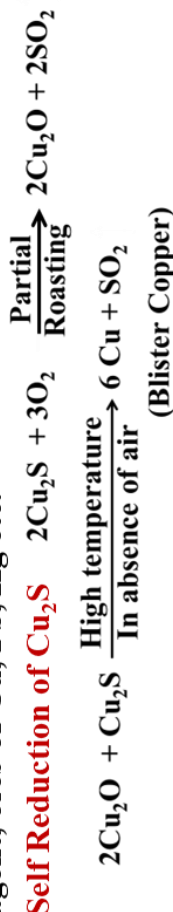


**b) Basic Flux** Substance used to remove acidic impurities (non metal oxide)



### Self reduction (Auto reduction)

Compounds of certain metals are reduced to metal without using any additional reducing agent, ores of Cu, Pb, Hg etc.



## MIND MAP

## Metallurgy

### By Electrometallurgy

#### i) Electrolytic Reduction

This process is mainly used for the extraction of highly electropositive metals.

Na, K, Mg, Ca, Al, etc.

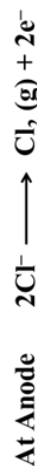
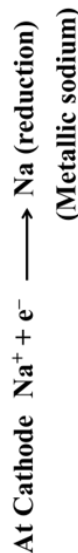
e.g. Manufacture of metallic sodium (Down's process)

The various reactions that take place are

#### On Fusion



#### On Electrolysis



### By Hydrometallurgy



Black ppt.

### Alumino Thermite Process

In this process those metal oxide will be reduced which require high temperature and at high temperature carbon reacts with metal to form metal carbide.

In this process we will use Aluminium as a reducing agent.



## i) Poling Process

This process is used for the purification of copper and tin.



## ii) Liquefaction

This method is used for the refining of metals having low melting point and are associated with high melting impurities.

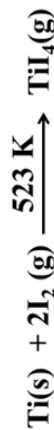
Ex. Pb, Sn, Sb, Bi and Hg.

## iii) Distillation

Metals having low boiling point are refined by this method, for example, zinc, cadmium and mercury.

## Van-Arkel Process

In this method, the metal is converted into a volatile unstable compound (e.g. iodide), and impurities are not affected during compound formation.



Impure

(i) Volatile in nature

(ii) Relatively thermally unstable



## MIND MAP

## Metallurgy

### Amalgamation Process

For noble metal Au, Ag from the native ore.



## Refining of Metals

### Mond's process

Nickel is purified by using CO gas. This involves the formation of nickel tetracarbonyl.



(i) Volatile in nature

(ii) Relatively thermally unstable

### Cupellation (removal of Lead from Silver or Gold)

In this process the molten impure metal is heated in a cupel, which is boat-shaped dish made of bone ash or cement, and a blast of air is passed over the molten metal.

## Electro-refining of Metals

Metals such as Cu, Ag, Zn, Sn, Pb, Al, Ni, Au are refined by this method.

The impure metal is made the anode of an electrolytic cell, while cathode is thin plate of pure metal.

### Electrorefining of Cu

|             |                                                                         |
|-------------|-------------------------------------------------------------------------|
| Anode       | Impure copper                                                           |
| Cathode     | Pure copper                                                             |
| Electrolyte | An aqueous solution of $\text{CuSO}_4 + 5\% \text{ dil H}_2\text{SO}_4$ |

## Thermodynamics of Reduction Processes (Ellingham Diagram)

Limitation of Ellingham Diagram

The graph simply indicates whether a reaction is possible or not i.e., the tendency of reduction with a reducing agent is indicated.

This is so because it is based only on the thermodynamic concepts.