

* METALLURGY *

OXIDE ORE

- 1) Cuprite - Cu_2O
- 2) Haemetite - Fe_2O_3
- 3) Magnetite - Fe_3O_4
- 4) Bauxite - Al_2O_3
- 5) Cassiterite - SnO_2
or
Tin stone
- 6) Zincite - ZnO
- 7) Rutile - TiO_2
- 8) Pyrolusite - MnO_2
- 9) Chromite - $FeO.Cr_2O_3$
- 10) Kaolinite
 $\rightarrow Al_2(OH)_4Si_2O_5$

CARBONATE ORE

- 1) Lime stone - $CaCO_3$
- 2) Magnesite - $MgCO_3$
- 3) Malachite - **Green**
 $\rightarrow CuCO_3.Cu(OH)_2$
- 4) Siderite - $FeCO_3$
- 5) Azurite - **Blue**
 $\rightarrow 2CuCO_3.Cu(OH)_2$
- 6) Calamite - $ZnCO_3$
- 7) Cerussite - $PbCO_3$
- 8) Dolomite
 $\rightarrow CaCO_3.MgCO_3$

SULPHIDE ORE

- 1) Galena - PbS
- 2) Zinc blende - ZnS
or Sphalerite
- 3) Cinnabar - HgS
- 4) Chalcocite - Cu_2S
- 5) Chalcopyrite
 $\rightarrow CuFeS_2$
- 6) Argentite - Ag_2S
- 7) fool's gold
or Iron pyrite
 $\rightarrow FeS_2$

HALIDE ORE

- 1) Rock salt - $NaCl$
 - 2) Fluospar - CaF_2
 - 3) Cryolite - Na_3AlF_6
 - 4) Carnalite
 $\rightarrow KCl.MgCl_2.6H_2O$
 - 5) Silvine - KCl
 - 6) Etern Silver - $AgCl$
- Chile saltpetre
 $\rightarrow NaNO_3$
- Indian saltpetre
 $\rightarrow KNO_3$

- Mg iron \rightarrow 4% C, S, P, Mn, Si
- Cast iron \rightarrow 3% C, hard & brittle
- Wrought iron \rightarrow Commercial iron's purest form
- Prep \rightarrow Cast iron oxid. in reverber. furnace lined with Fe_2O_3
- Copper matte $\rightarrow Cu_2S + FeS$

Concentration of Ore - Gangue Removal

i) Hydraulic Washing

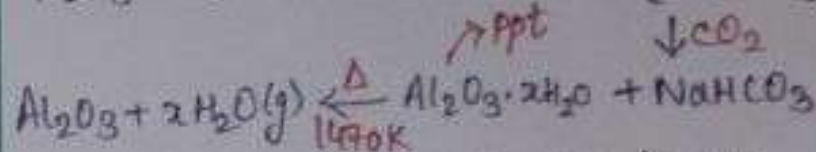
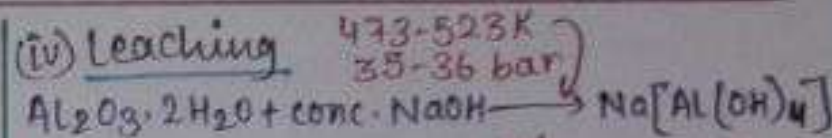
- density difference
- Used for heavy metals
 $\rightarrow Sn, Pb, Fe, etc.$

ii) Froth floatation

- for sulphide ores
 \rightarrow eg: $- Cu_2S, FeS_2, PbS$

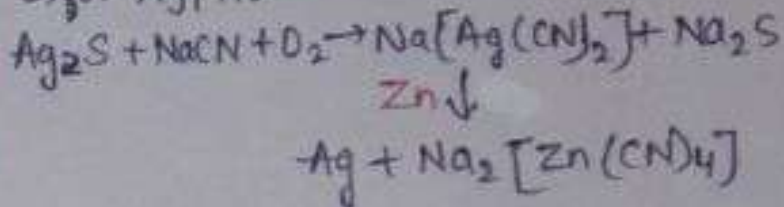
(iii) Electromagnetic Separation

- Froth stabilizers**
 - pine oil or Eucalyptus oil
- Collectors**
 - non-wetability of ores with H_2O
 - Pine oil, Salty, Xanthates,
K/Na-ethyl Xanthate
- Depressant** $\rightarrow NaCN \rightarrow$ Prevent
ZnS
 $PbS + NaCN \rightarrow$ No Rm.
 $ZnS + NaCN \rightarrow Na_2[Zn(CN)_4]$



Mac Arther Forrest Cyanide Process

\rightarrow for Ag/Au

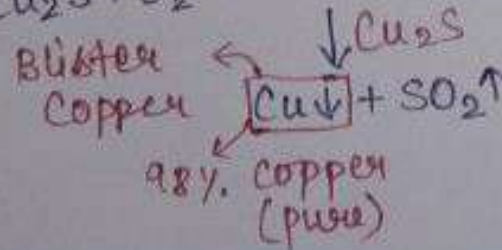
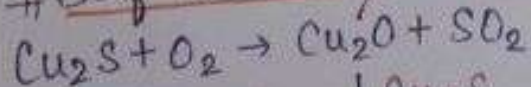


Reduction of Ore

1) Roasting → Reverberatory furnace

- O_2 present; Sulphide ore Redⁿ
- below metal m.p → heated ore → porous & dry
- Sulphide ore → oxide ores
$$ZnS + O_2 \rightarrow ZnO + SO_2 \uparrow$$

Self Reduction → Impurity



2) Calcination → $O_2 \rightarrow X$

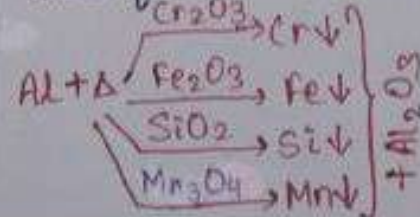
- ore - high temp.
- Reducing carbonates & hydroxides ores
- Remove volatile impurities

3) Smelting → $O_2 \rightarrow \checkmark$

- metal oxide → metal
- R.A → CO, C, Al

Gold Schmidt aluminothermite Process

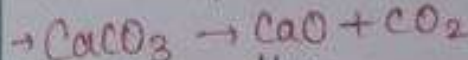
- Al + metal oxide → Metal
- Used for Cr, Fe, Mn, Si



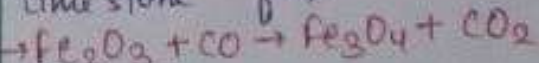
metallic oxides we convert → Redⁿ → Metals

Blast-furnace

- low temp. → 500-800 K

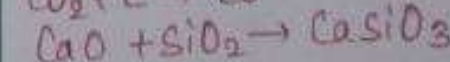
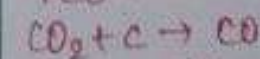
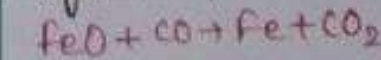


Lime stone flux

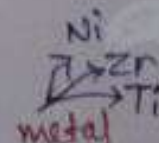
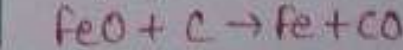
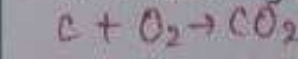


(Iron ore)

- High temp. → 900-1500 K



- Coke Burning



Refining of Ore

1) Liquation

→ Used for metals with low mp → eg. Sn, Pb, Si

2) Distillation

→ for metals with low bp
eg.:- Zn, Hg, Cd bp diff. >> 25

3) Electrolysis Refining

- For Cu, Zn • Cathode → Pure metal
- Anode → Impure metal
- Oxi. → Impurities nikal jayengi

4) Chromatography

↳ Useful → Column chromatography

5) Zone Refining

→ Impurities → more soluble in melt form

→ for semiconductors

↳ eg.:- Ge, Si, Ga, Be, In

→ Impurities dissolve hoti hai
leaching - metal dissolve hota hai

Alumina → Na_3AlF_6 → Alumina mp low karta

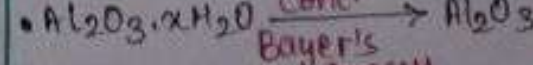
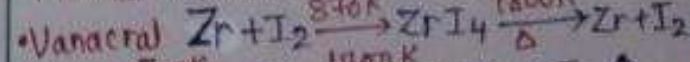
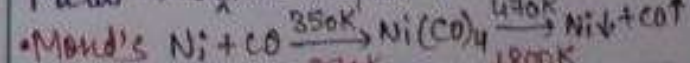
CaF_2 → conductivity / fluidity ↑ se karta hai

Zn conc. → ZnS → ZnO + C

Rapid chilling (Distillat) → Zn + CO ← Belgian Process

6) Vapour Phase refining

Metal → volatile compound → decompose



Al³⁺ → Al (pure)

Al₂O₃ + Na₃AlF₆ + CaF₂

Cathode → Iron container with C lining

Anode → Graphite

Cathode → Al → Al³⁺ + 3e⁻

Anode → Al³⁺ + 3e⁻ → Al

Bayer's process

Hall-Heroult process

Al (99%)

Hoope's Method

Al (99.9%)