METALLURGY

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Human need to have some metals like **sodium, potassium, calcium, iron**, etc. in the human body.

Metallurgy is a science of extracting metals from their ores and modifying the metals into alloys for various uses.

A metallurgical process involve three main steps as follows:

(i) Concentration or Separation of the ore:

It is the process of removal of impuries from the ore.

(ii) Production of the metal:

It is the convertion of the ore into metal.

(iii) Refining of the metal:

It is the process of purification of the metal.

Terminology in metallurgy

Minerals:

A mineral may be a single compound or a complex mixture of various compounds of metals found in the Earth.

Ore:

The mineral from which a metal can be readily and economically extracted on a large scale is said to be an ore.

For example: Clay ($Al_2O_3 . 2 SiO_2 . 2 H_2O$) and bauxite ($Al_2O_3 .2 H_2O$) are the two minerals of aluminium, but aluminium can be profitably extracted only from bauxite. Hence, bauxite is an ore of aluminium and clay is its mineral.

Gangue or Matrix:

The rocky impurity associated with an ore is called gangue or matrix.

Flux:

It is the substance added to the ore to reduce the fusion temperature and to remove the impurities. E.g. Calcium oxide (basic), Silica (acidic).

Slag:

It is the fusible product formed when a flux reacts with a gangue during the extraction of metals. Flux + Gangue → Slag

Smelting:

Smelting is the process of reducing the roasted metallic oxide from the metal in its molten condition. In this process, impurities are removed as slag by the addition of flux.

Types of separation or concentration of an ore

There are four major types of separation of ores based on the nature of the ore.

(i) Hydraulic (Gravity Separation) method

Principle: The difference in the densities or specific gravities of the ore and the gangue is the main principle behind this method. Oxide ores are purified by this method. e.g., **Haematite Fe_2O_3** the ore of iron.

Method: The ore is poured over a sloping, vibrating corrugated table with grooves and a jet of water is allowed to flow over it. The denser ore particles settle down in the grooves and lighter gangue particles are washed down by water.

(ii) Magnetic separation method

Principle: The magnetic properties of the ores form the basis of separation. When either the ore or the gangue is magnetic, this method is employed. e.g., **Tinstone SnO_2** , the ore of tin.

Method: The crushed ore is placed over a conveyer belt which rotates around two metal wheels, one of which is magnetic. The magnetic particles are attracted to the magnetic wheel and fall separately apart from the nonmagnetic particles.

(iii) Froth floatation

Principle: This process depends on the preferential wettability of the ore with oil (pine oil) and the gangue particles by water. Lighter ores, such as sulphide ores, are concentrated by this method. e.g., **Zinc blende (ZnS).**

Method: The crushed ore is taken in a large tank containing oil and water and agitated with a current of compressed air.The ore is wetted by the oil and gets separated from the gangue in the form of froth. Since the ore is lighter, it comes on the surface with the froth and the impurities are left behind. e.g., **Zinc blende (ZnS).**

(iv) Chemical method or Leaching

This method is employed when the ore is in a very pure form.The ore is treated with a suitable reagent such that the ore is soluble in it but the impurities are not. The impurities are removed by filtration. The solution of the ore, ie., the filtrate is treated with a suitable reagent which precipitates the ore.

E.g. **Bauxite Al_2O_3 .$2H_2O$**, the ore of aluminium.

Oxide Ores	Carbonate Ores	Halide Ores	Sulphide Ores
Bauxite ($Al_2O_3 \cdot 2H_2O$)	Marble ($CaCO_3$)	Cryolite(Na_3AlF_6)	Galena (PbS)
Cuprite(Cu_2O)	Magnesite (($MgCO_3$)	Fluorspar(CaF_2)	Iron pyrite (FeS_2)
Haematite (Fe_2O_3)	Siderite($FeCO_{3)}$	Rock salt (NaCl)	Zinc blende (ZnS)

OCCURRENCE OF ORES IN TAMIL NADU

- **Lime stone:** Coimbatore, Cuddalore, Dindugul
- **Gypsum:** Tiruchi and Coimbatore Distiricts
- **Titanium minerals:** Kanyakumari, Tirunelveli and Tuticorin.
- **Chromite:** Coimbatore and Salem district.
- **Magnetite:**Dharmapuri, Erode, Salem, Thiruvannamalai.
- **Tungsten:** Madurai and Dindugal.

PROPERTIES OF METALS

Physical properties

1. Physical state: All metals are solids at room temperature except mercury and gallium.

2. Lustre: Metals possess a high lustre (called metallic lustre).

3. Hardness: Most of the metals are hard and strong (exceptions: sodium and potassium can be cut with a knife)

4. Melting point and Boiling point: Usually, metals possess high melting and boiling points and vaporize only at high temperatures (exceptions: gallium, mercury, sodium and potassium).

5. Density: Metals have a high density (exceptions: sodium and potassium are less dense than water).

6. Ductility: Metals are usually ductile. In other words, they can be drawn into thin wires without breaking.

7. Malleability: Metals are usually malleable, i.e, they can be beaten into thin sheets without cracking (except zinc and mercury).

8. Conduction of heat and electricity: Metals are good conductors of heat and electricity; silver and copper excel in this property (exception: tungsten)

9. Solubility: Usually, metals do not dissolve in liquid solvents.

Chemical Properties

Valence electrons: Atoms of metals usually have 1,2 or 3 electrons in their outermost shell.

Formation of ions: Metals form Positive ions by the loss of electrons and hence they are electro positive.

Discharge of ions: Metals are discharged at the cathode during the electrolysis of their compounds.

Atomicity: Molecules of metals in their vapour state are usually monoatomic.

Nature of oxides: Oxides of metals are usually basic.

Extraction of metal from metal oxide can be categorized into three types.

More reactive metals	Medium reactive metals	Less reactive metals
Na,K,Ca,Mg,Al	Zn,Fe,Pb,Cu	Ag,Hg
Electrolytic reduction of metal oxide into metal	Chemical reduction of metal oxide into metal using coke	Thermal decomposition of metal oxide into metal