

Chemistry Notes for class 12 Chapter 6

General Principles and Processes of Isolation of Elements

Earth crust is the source of many elements. Out of these elements, 70% are metals. Aluminium is the most abundant metal of earth crust and iron comes second. The percentage of different elements in earth crust are

O-49%, Si-26%, Al-7.5%, Fe-4.2%, Ca-3.2%, Na-2.4%, K-2.3%, Mg-2.3%, H-1%

Metals occur in two forms in nature (i) in native state (ii) in combined state, depending upon their chemical reactivities.

Native State

Elements which have low chemical reactivity or noble metals having least electropositive character are not attacked by oxygen, moisture and CO_2 of the air. These elements, therefore, occur in the free state or in the native state, e.g., Au, Ag, Pt, S, O, N, noble gases, etc.

Combined State

Highly reactive elements such as F, Cl, Na, K, etc., occur in nature combined form as their compounds such as oxides, carbonates sulphides, halides, etc.

Hydrogen is the only non-metal which exists in oxidised form only.

Minerals and Ores

The naturally occurring substances in the form of which the metals occur in the earth crust are called minerals.

Every mineral is not suitable for the extraction of the metal. The mineral from which the metal is economically and conveniently extracted is called an ore.

Thus, all ores are minerals but all minerals are not ores.

Combined state	Element	Ore/mineral
Oxides	Fe	Haematite (Fe_2O_3), Magnetite (Fe_3O_4), Limonite ($\text{Fe}_2\text{O}_3 \cdot 3\text{H}_2\text{O}$), Chromite ($\text{FeO} \cdot \text{Cr}_2\text{O}_3$)
	Al	Bauxite ($\text{Al}_2\text{O}_3 \cdot 2\text{H}_2\text{O}$), Diaspore ($\text{Al}_2\text{O}_3 \cdot \text{H}_2\text{O}$), Corundum (Al_2O_3)
	Mn	Pyrolusite (MnO_2)
	Zn	Zincite (ZnO)
	Ti	Rutile (TiO_2)
	Cu	Cuprite (Cu_2O)
	Sn	Cassiterite or tin stone (SnO_2)
	Carbonates	Ca
Mg		Magnesite (MgCO_3)
Ca, Mg		Dolomite ($\text{CaCO}_3 \cdot \text{MgCO}_3$)
Cu		Malachite [$\text{CuCO}_3 \cdot \text{Cu}(\text{OH})_2$]
Zn		Calamine (ZnCO_3)
Fe		Siderite or spathic ore (FeCO_3)
Pb		Cerussite (PbCO_3)
Au		Azurite [$2\text{CuCO}_3 \cdot \text{Cu}(\text{OH})_2$]
Sulphides	Fe	Iron pyrite (FeS_2)
	Cu	Copper glance (CuS_2)
	Cu, Fe	Copper pyrite or chalcopyrite (CuFeS_2)
	Hg	Cinnabar (HgS)
	Zn	Zinc blende (ZnS)
	Pb	Galena (PbS)
	Ag	Argentite or silver glance (Ag_2S)
	Halides	Na
Al		Cryolite (Na_3AlF_6)
K, Mg		Carnallite ($\text{KCl} \cdot \text{MgCl}_2 \cdot 6\text{H}_2\text{O}$)
Ag		Horn silver (AgCl)

Gangue or Matrix

Impurities associated with ores are called gangue or matrix.

Metallurgy

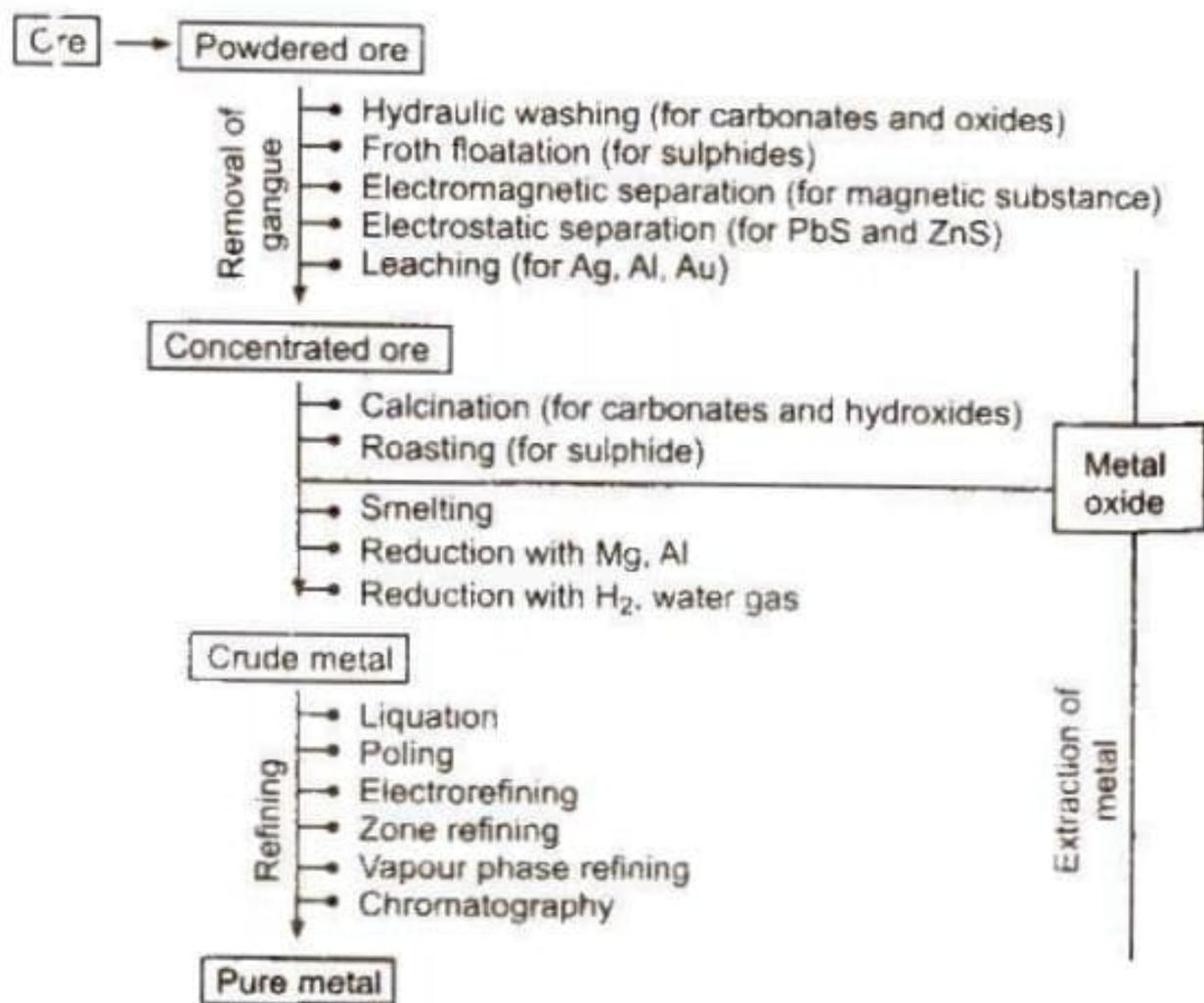
The entire scientific and technological process used for isolation of the metal from its ores is known as metallurgy.

Types of Metallurgical Processes

1. Pyrometallurgy Extraction of metals takes place at very high temperature. Cu, Fe, Zn, Sn, etc .. are extracted by this method.
2. Hydrometallurgical process In this method, metals are extracted by the use of their aqueous solution. Ag and Au are extracted by this method.
3. Electrometallurgical process Na, K, Li, Ca, etc., are extracted from their molten salt solution through electrolytic method.

Steps Involved in Metallurgy

Following steps are involved in the metallurgy :



Crushing of the Ore

The big lumps of ore are crushed into smaller pieces with the help of jaw-crushers. The process of grinding the crushed ore into fine powder with the help of the stamp mills is called pulverisation.

Concentration of Ores

Removal of unwanted materials (e.g., sand, clays, etc.) from the ore is known as ore concentration, ore dressing or ore benefaction. It can be carried out by various ways depending upon the nature of the ore.

Hydraulic Washing/Gravity Separation/Levigation

The process by which lighter earthy impurities are removed from the heavier ore particles by washing with water is called levigation. The lighter impurities are washed away. Thus, this method is based on the difference in the densities (specific gravities) of ore and gangue.

This method is commonly used for oxide ores such as haematite, tin stone and native ores of Au, Ag, etc.

Froth Flootation

This method is used for the concentration of sulphide ores. This method is based on the preferential wetting of ore particles by oil and that of gangue by water. As a result, the ore particles become light and rise to the top in the form of froth while the gangue particles become heavy and settle down. Thus, adsorption is involved in this method.

The froth can be stabilised by the addition of stabilisers (aniline or cresols).

Activator They activate the floating property of one of the component of the ore and help in the separation of different minerals present in the same ore (CuSO_4 is used as activator).

Depressants These are used to prevent certain types of particles from forming the froth with air bubbled, e.g., NaCN can be used as a depressant in the separation of ZnS and PbS ores. KCN is another depressant.

Collectors It increases the non-wettability of ore particles by water, e.g., pine oils, xanthates and fatty acids.

Electromagnetic Separation

This method of concentration is employed when either the ore or the impurities associated with it are magnetic in nature. e.g., chromite, FeCr_2O_4 , containing magnetic silicious gangue and wolframite FeWO_4 , containing cassiterite, SnO_2 (non-magnetic impurities) can be separated by this method.

Electrostatic Separation

This method is used for the separation of lead sulphide (good conductor) which is charged immediately in an electrostatic field and is thrown away from the roller from zinc sulphide (poor conductor) which is not charged and hence, drops vertically from the roller.

Chemical Method-Leaching

Leaching is the process in which the ore is concentrated by chemical reaction with a suitable reagent which dissolves the ore but not the impurities, e.g., bauxite is leached with a hot concentrated solution of NaOH which dissolves aluminium while other oxides (Fe_2O_3 , TiO_2 , SiO_2), remain undissolved and noble metals (Ag and Au) are leached with a dilute aqueous solution of NaCN or KCN in the presence of air.



and

