- Metallurgy -

Introduction:
The earth's crust is the main source of the metal. The occurrence of the state metal in earth crust in native state and in combined state metals which are less electropositive in nature occurrence in native state.

Metals which are highly electropositive occur in nature in combined state. The combined state of metal in the earth crust is known as minerals. Those minerals which can give the metal in large percentage economically and scientifically known as ore.

**Note**

All the ore are minerals but all the minerals cannot be ore.
The process which is used for the extraction of metal from its ore scientifically and economically known as metallurgy.
The most important ore of the metal is ore.

<table>
<thead>
<tr>
<th>Sr. No</th>
<th>Metal</th>
<th>Ore</th>
<th>Chemical formula/s</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Al</td>
<td>Bauxite</td>
<td>$\text{Al}_2\text{O}_3 \cdot 3\text{H}_2\text{O}$</td>
</tr>
<tr>
<td></td>
<td></td>
<td>corundum</td>
<td>$\text{Na}_3\text{Al}_2\text{O}_6$</td>
</tr>
<tr>
<td>2</td>
<td>Fe</td>
<td>Hematite</td>
<td>$\text{Fe}_2\text{O}_3$</td>
</tr>
<tr>
<td></td>
<td></td>
<td>magnetite</td>
<td>$\text{Fe}_3\text{O}_4$</td>
</tr>
<tr>
<td></td>
<td></td>
<td>pyrophylite</td>
<td>$\text{Fe}_5\text{O}_8$</td>
</tr>
</tbody>
</table>
The process of metallurgy carried out by the help of following four steps:

Step-1: Mining and Crushing of the Ore
Step-2: Dressing and Concentration of the Ore
Step-3: Conversion of Ore into metal
Step-4: Purification and Reafyning of the metal

In this step, we will extract ore from the earth crust by mining and converted into power from by Jaw Crusher.

The conversion of impure ore into power formed by Jaw Crusher is known as pulverization.

Step-2: Dressing and Concentration of the Ore:

There are many methods for the purification of ore, but the most important method are:

1. Hydraulic Washing
2. Magnetic Separation method
3. Froth Flotation method
4. Leaching
Hydromoling Washing

Impure Powder Ore

Filter

Water

Insoluble Impurity

Water Soluble Impurity

This method is non as gravity surfaction method and Navigation method.

In this method impure Powder Ore interdoluce in water due to which water soluble impurity separate out from Point A and water insoluble impurity which is lighter in weight remove Point B, and there the pure ore remain filter.
2- Magnetic Separation Method:

This method is more useful for separating such types of ore in which other ore impurities are in magnetic in nature. The non-magnetic substance always float on the magnetic wheel and the magnetic substance sink down the magnetic wheel.

3- Froth Flotation Method:

The froth is separated from the mixture containing the impure ore and water. The froth is then removed from the top of the froth flotation machine.
This method is more useful for the purification of the Sulphide Ore, because the wettablility of Sulphide Ore is greater in oil. For this purpose three main points are always noted.

1. Further ⇒ In this method we will use such type of oil which have greater tendency to float with Sulphide Ore. The main oil used for this purpose are:
   1. Pine Oil
   2. Eucalyptus Oil
   3. Camphor Oil

2. Collector Oil ⇒
   For maintaining the Sulphide Ore. In further for long type we will use for a collector. The most important collector for this purpose is Sodium Naphthal.

3. Depressing and activity agent ⇒
   A nature we will always Deplete mixture of Sulphide Ore, so Deplete are expensive Sulphide Ore we will depress unwanted Sulphide Ore by adding depressing agent, or
   Increase the active is or wanted Sulphide Ore by adding activating agent.
For obtaining PbS or we want to depress ZnS.
For this purpose we will use a depressing agent
Na₂CO₃ + NaCN.

Method
In this case of this method impure Powdered Ore
is contained by the Container.
So introduce by the React 0₅₁ + water and Air
after that rotating by the Paddinging

Leaching &
To separate pure ore from the impure ore by the
help of some chemical substance, Know it as leaching
The chemical which is used for this purpose is
Know as leaching agent.

\[
\text{Al}_2\text{O}_3 \cdot 2\text{H}_2\text{O} + \text{NaOH} \rightarrow \text{Na}[\text{Al}(\text{OH})_4] + \text{Impurity} \downarrow \\
\text{Impure (aq)}
\]

\[
\text{Na}[\text{Al}(\text{OH})_4] + \text{CO}_2 \rightarrow \text{Al}_2\text{O}_3 \cdot \text{H}_2 + \text{NaOH} \cdot \text{CO}_3 \downarrow \\
\text{(Pure)}
\]

Conversion of pure ore into metal.
In this process we will converted pure ore
into metal applying following 2 steps;
1- Conversion of pure ore into its Oxide.
2 - Conversion of Oxide into metal.
The conversion of ore into its oxide
Carry done by two way.
1. Calcination

In this process we will convert the pure ore into its oxidise by limiting supply of air or in the absence of air.

\[ \text{Al}_2 \text{O}_3 \cdot 2\text{H}_2\text{O} \xrightarrow{\Delta} \text{Al}_2 \text{O}_3 + 2\text{H}_2\text{O} \uparrow \]

\[ \text{ZnCO}_3 \xrightarrow{\Delta} \text{ZnO} + \text{CO}_2 \uparrow \]

Calamine

2. Roasting

In this process the pure ore is heated in the exist of air.

\[ \text{Ag}_2 \text{S} + \text{O}_2 \rightarrow \text{Ag}_2 \text{O} + \text{SO}_2 \uparrow \]

\[ \text{PbS} + \text{O}_2 \rightarrow \text{PbO} + \text{SO}_2 \uparrow \]

→ Conversion of oxide into metal 8-

The conversion of metal oxide into ore can be done by one of the following methods.

1. Smelting

In this process metal oxide is heated with carbon atom due to its metal & oxidant with carbon mono oxide gas.

\[ \text{ZnO} + \text{C} \rightarrow \text{Zn} + \text{CO} \]

\[ \text{PbO} + \text{C} \rightarrow \text{Pb} + \text{CO} \]
2. Highly electro reduction of metal oxide (by highly electro active metal)

In this process the metal of metal oxide converted by highly electro active metal.

\[ \text{Al} + \text{Fe}_2\text{O}_3 \rightarrow \text{Al}_2\text{O}_3 + \text{Fe} \]

So this method the oxygen metal always be in molten state.

This molten metal use for welding purpose there for this process is known as thermite welding.

# Electro lighting die Combining method

\[ \text{Al}_2\text{O}_3 \text{ Anode} \]

\[ 2\text{O}_2^- \rightarrow \text{O}_2 + 4e^- \]

\[ \text{Cathode} : \]

\[ \text{Al}^{3+} + 3e^- \rightarrow \text{Al} \]
Purification of the impure metal

By the bulk of above process the obtained metal will be impure, for the purification of this impure metal we will use different type of process.

1. Electro refining method
2. Electro refining method is more suitable method for the purification of impure metal

Electro refining method is more useful method for the purification of the impure metal. In this method impure metal is connected always at the anode in pure metal connected always connected with cathode.

Both electrodes are dipped into electrolyte solution.

Electrolytic refining of Copper:

Impure Cu

Cathode

Anode

Cu (SO₄)

Cu²⁺

Cu (SO₄)

(09)

Pure Cu
Anode:
\[ Cu \rightarrow Cu^{+2} + 2e \]
\[ (\text{impure}) \] 
\[ (aq) \]

Cathode:
\[ Cu^{+2} + 2e \rightarrow Cu \]
\[ (aq) \] 
\[ (pure) \]

# Metallurgy of Li

Li does not occur in nature as free state because it is highly electro-negative metal. The most important ore from which Li can be extracted are:

1. \( Na_2Al_2(SiO_3)_3 \) \( (OH)_2 \) Lepidolite
2. \( LiAl(Si_2O_5)_2 \) Felsahite
3. \( LiAl(SiO_3)_2 \) Spodumene

The extraction of Li is highly carried out by the help of Spodumene ore.

In Spodumene Felsah and Li_2SO_4 as the most major impurity, the extraction of Li from Spodumene carry out the by the help of following steps:

1. Mining or Crushing of the Ore,
2. Densifying of the Ore.

In this step be will purify the impure ore by applying different types of method like hydrometallurgy, washing, magnetic separation method and so on.
Here we will purify the one by the bulb of concentration. \( \text{H}_2\text{SO}_4 \).

\[
\text{LiAl} (\text{SiO}_3)_2 + \text{H}_2\text{SO}_4 \rightarrow \text{Li}_2\text{SO}_4 + \text{Al}_2 (\text{SO}_4)_3 + \text{FeSO}_4
\]

Impure

\[
\text{Li}_2\text{SO}_4 + \text{Al}_2 (\text{SO}_4)_3 + \text{FeSO}_4 + \text{MgSO}_4 + \text{H}_2\text{O} + \text{Na}_2\text{CO}_3 \rightarrow
\]

\[
\text{Li}_2\text{SO}_4 \rightarrow \text{Al}_2 (\text{CO}_3)_2 \downarrow + \text{Fe}_2\text{CO}_3 \downarrow + \text{MgCO}_3 \downarrow
\]

\[
\rightarrow \text{Li}_2\text{SO}_4 + \text{Na}_2\text{CO}_3 \rightarrow \text{Li}_2\text{CO}_3 \downarrow + \text{Na}_2\text{SO}_4
\]

Solution

Conversion ab \( \text{Li}_2\text{CO}_3 \) into \( \text{LiCl} \)

\[
\text{Li}_2\text{CO}_3 + 2\text{HCl} \rightarrow \text{LiCl} \downarrow + \text{H}_2\text{O} + \text{CO}_2 \uparrow
\]

Conversion ab \( \text{LiCl} \) into \( \text{Li} \)

Anode

\[
\text{Cl}^- \rightarrow \text{Cl} + e
\]

\[
\text{Cl} + \text{Cl} \rightarrow \text{Cl}_2 \uparrow
\]

Cathode:

\[
\text{Li}^+ + e \rightarrow \text{Li}^+
\]

Lead (molten)
Beryllium (Be) is a metal in the 3rd period of the periodic table.

Be does not occur in the free state in nature. The most important ore of Be are:

- 2BeO·SiO₂ - Chrysoprase (Beryl Phenacite)
- BeO·Al₂O₃ - Chryso Beryl
- 3BeO·(Al₂O₃·6SiO₂) - Beryl

Extraction of Be with Beryl:

1) Mining of the ore,
2) Crushing of the ore,
3) Leaching of the ore.

\[ 3\text{BeO} \cdot \text{Al}_2\text{O}_3 \cdot 6\text{SiO}_2 + \text{K}_2\text{CO}_3 \rightarrow \text{BeO} + \text{Al}_2\text{O}_3 + \text{K}_2\text{Si}_3\text{O}_7 + \text{CO}_2 \uparrow \]

\[ \text{BeO} + \text{Al}_2\text{O}_3 + \text{K}_2\text{Si}_3\text{O}_7 + \text{H}_2\text{SO}_4 \rightarrow \text{BeSO}_4 + \text{Al}_2(\text{SO}_4)_3 + \text{K}_2\text{SO}_4 + \text{H}_2\text{O} + \text{SiO}_2 \downarrow \]

\[ \text{BeSO}_4 + \text{K}_2\text{SO}_4 \cdot \text{Al}_2(\text{SO}_4)_3 \cdot 24\text{H}_2\text{O} \rightarrow \text{BeSO}_4 + \text{K}_2\text{SO}_4 \cdot \text{Al}_2(\text{SO}_4)_3 \cdot 24\text{H}_2\text{O} \]  

\[ \text{BeSO}_4 \cdot \text{H}_2\text{O} \rightarrow \text{BeSO}_4 \cdot \text{K}_2\text{SO}_4 \cdot \text{Al}_2(\text{SO}_4)_3 \cdot 24\text{H}_2\text{O} \]  

\[ \text{BeO}_3 \rightarrow \text{BeO} + \text{CO}_2 \uparrow \]

Conversion of BeO into Be₂:

\[ \text{BeO} + \text{C} \rightarrow 2\text{Be} + \text{CO} \uparrow \]
Uses of Li and Be =>

# Use of Li:

i) For making alloy
ii) For making glass
iii) Use in medicine
iv) For making high-quality alkali lubricants;
v) Use in rocket fuel.

# Use of Be

i) Use for making steal
ii) Use for making window for x-ray
iii) Be is used as a moderator in nuclear reactor.
iv) It is use for making artificial fiber.
v) It is use for making split ring in generator and motor.