# Zinc

## Ores of Zinc

1. Zinc blende: ZnS
2. Calamine: $ZnCO_3$
3. Zincite: ZnO

## Extraction of zinc from zinc blende

### 1. Crushing and pulverization

Big lumps of ores are crushed using jaw crushers to get crushed ore which is pulverized using a pulverizer or stamp mill to get powdered ore.

## 2. Concentration by froth floatation process

The powdered ore is taken in a tank containing water and a small amount of pine oil. The mixture is heated by a blast of air. Impurities are wetted by water and get collected at the bottom of the tank. Ore particles are wetted by oil and come to the surface as froth. The froth is skimmed off to collect concentrated ore.

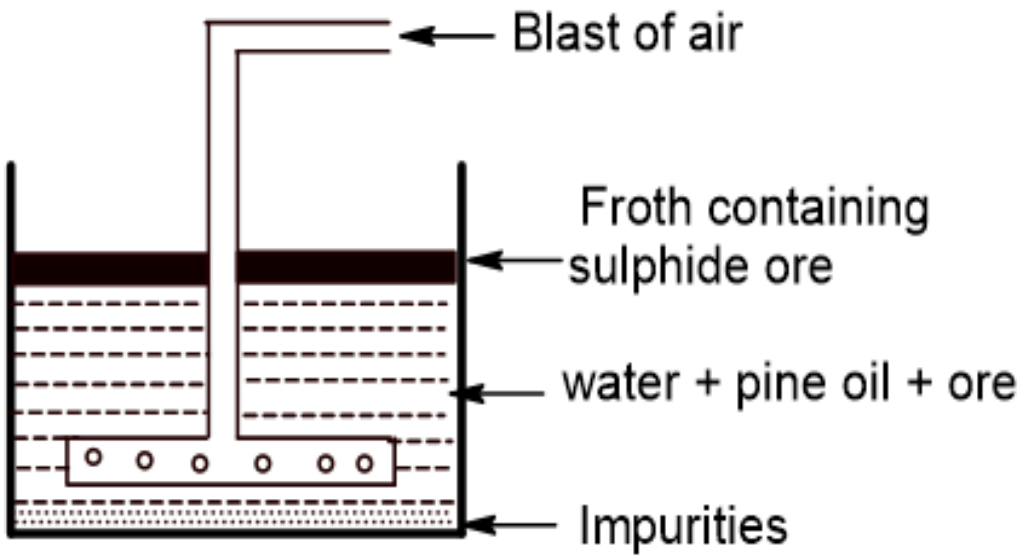



*Fig: Froth floatation process*

## 3. Roasting

The concentrated ore is roasted at 900°C in presence of air. Following changes takes place during roasting.

- Zinc sulphide is oxidized into its oxide.
  $2ZnS + 3O_2 \rightarrow 2ZnO + 2SO_2$
- Volatile impurities are removed.

## 4. Reduction

Zinc oxide formed after roasting can be reduced by the vertical retort process. In this process, roasted ore is mixed with coke in the ratio of 2:1. The retort is heated by burning the producer gas ($CO + N_2$) at around 1400°C. On doing so, ZnO gets reduced to Zn by coke (C) as:

$$ZnO + C \rightarrow Zn + CO$$

The zinc vapours and carbon monoxide gas are carried in the condenser by the mild current of producer gas from the bottom of the furnace. Zinc obtained in the condenser is known as spelter zinc.

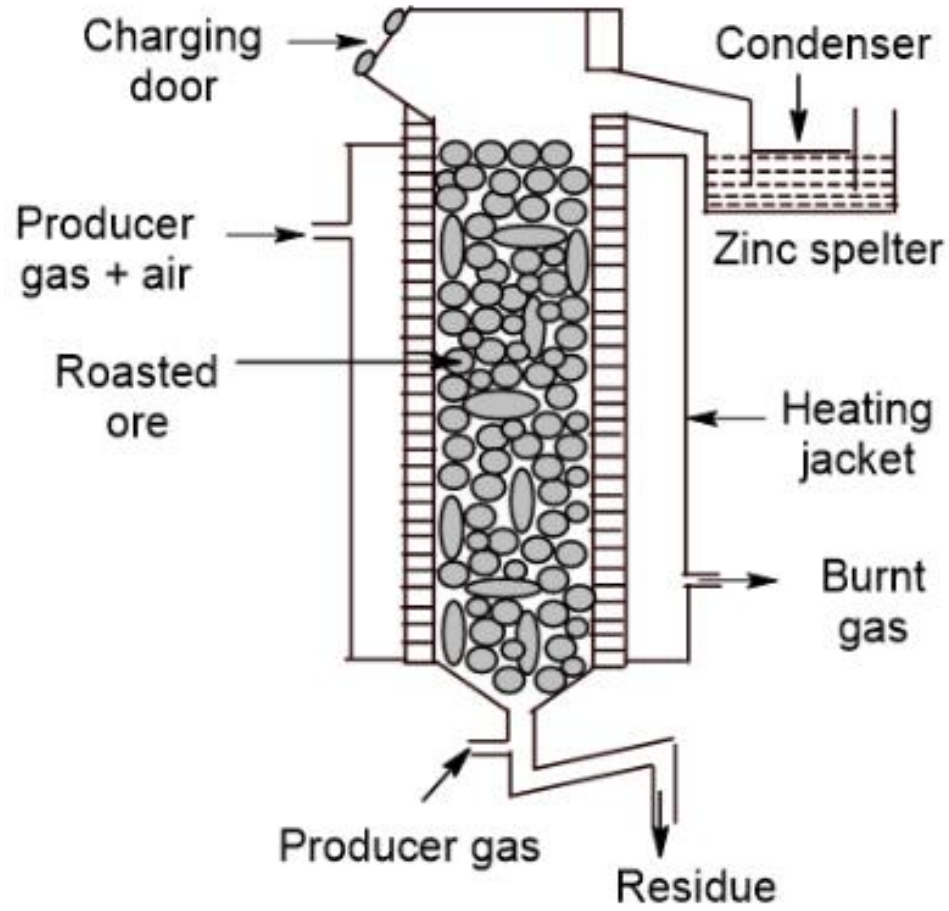



*Fig: Vertical Retort Process*

## 5. Purification or refining of Zinc

i. Distillation: The zinc spelter is subjected to distillation at 1000°C where impurities like iron (b.pt.= 3000°C) and lead (b.pt.= 1620°C) are left behind. Zinc (b.pt.=800°C) and cadmium (b.pt.=765°C) are collected as distillate. The distillate is distilled again at 800°C where cadmium is distilled off and zinc is left behind. This zinc is 99% pure.

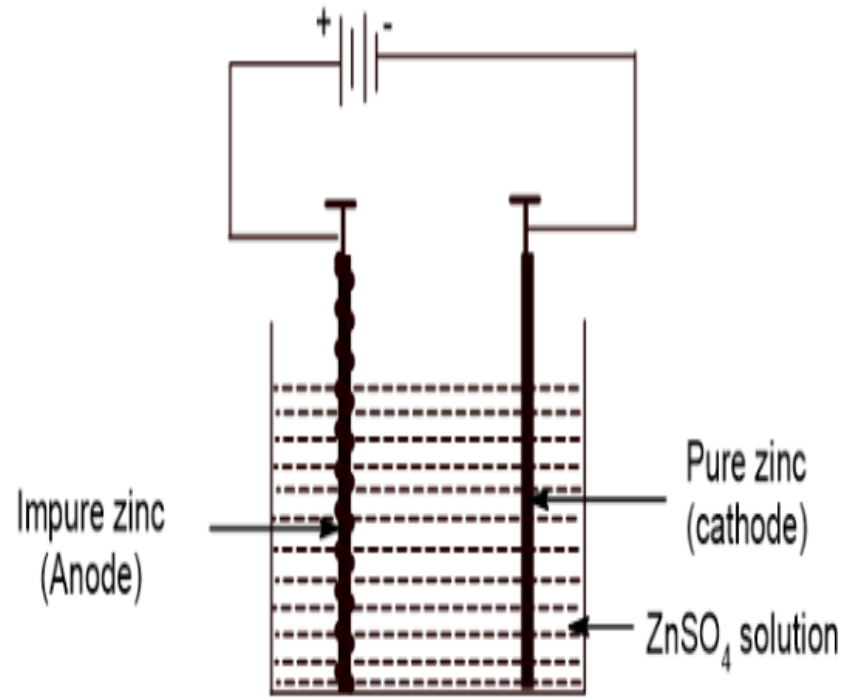
ii. Electrolysis: The impure zinc is taken as anode and a thin sheet of pure zinc is taken as a cathode in a large tank. Acidified $ZnSO_4$ solution is taken as an electrolyte. On electrolysis, the anode dissolves and is deposited as pure zinc in the cathode.

$$ZnSO_4(aq) \rightleftharpoons Zn^{++} + SO_4$$

$$At\ anode : \underset{Impure}{Zn(s)} \rightarrow Zn^{++} + 2e^-$$

$$At\ cathode : Zn^{++} + 2e \rightarrow \underset{Pure}{Zn}$$

This obtained zinc is 99.5% pure.




Flg: Electrolytic cell

## Physical properties

1. It is blueish white solid when pure but tarnishes to grey when exposed to moist air.
2. It is good conductor of heat and electricity.
3. It melts at 420°C and boils at 907°C.
4. It is malleable and ductile at 100-150°C and brittle at 200°C.

## Chemical properties

1. Action of air: Zinc is not affected by dry air but gets tarnished when exposed to moist air.

$$2Zn + H_2O + O_2 + CO_2 \rightarrow \underset{\text{Basic zinc carbonate}}{ZnCO_3.Zn(OH)_2}$$

When zinc is heated with air at 500°C, it burns with blueish white flame giving white woolly (dense white smoke) zinc oxide called philosopher's wool or pompholyx.

$$2Zn + O_2 \xrightarrow{500^\circ C} \underset{\text{Philosopher's wool}}{2ZnO}$$

2. Action with acids: Zinc lies above hydrogen in the electrochemical series. Therefore, it produces $H_2$ gas from dilute, mineral and non-oxidizing acid. It shows amphoteric nature. Hence, it reacts with acid as well as the base.

1. Action with $H_2SO_4$:

$$Zn + \underset{conc.}{2H_2SO_4} \rightarrow ZnSO_4 + SO_2 + 2H_2O$$

$$Zn + \underset{dil.}{2H_2SO_4} \rightarrow ZnSO_4 + H_2$$

2. Action with HCl

$$Zn + \underset{dil.\ or\ conc.}{HCl} \rightarrow ZnCl_2 + H_2$$

3. Action with $HNO_3$

$$Zn + \underset{conc.}{4HNO_3} \longrightarrow Zn(NO_3)_2 + 2NO_2 + 2H_2O$$

$$3Zn + \underset{moderate\ conc.(1:1)}{8HNO_3} \longrightarrow 3Zn(NO_3)_2 + 2NO + 4H_2O$$

$$4Zn + \underset{dil.}{10HNO_3} \longrightarrow 4Zn(NO_3)_2 + 2N_2O + 4H_2O$$

$$4Zn + \underset{very\ dil.}{10HNO_3} \longrightarrow 4Zn(NO_3)_2 + NH_4NO_3 + 3H_2O$$

3. Action with alkali

$$Zn + 2NaOH \rightarrow \underset{Sodium\ zincate}{Na_2ZnO_2} + H_2$$

4. Displacement reactions: Zinc can displace less reactive metal from its salts.

$$Zn + CuSO_4 \rightarrow ZnSO_4 + Cu$$
$$Zn + 2AgNO_3 \rightarrow Zn(NO_3)_2 + 2Ag$$

## Uses of zinc

1. It is used for making alloys.
2. It is used as a reducing and lab reagent.
3. It is used in the galvanization of iron.
4. It is used to prepare hydrogen gas.

**The process of depositing a thin layer of zinc over the surface of iron is called galvanization.*

## Compound of zinc

### A. White vitriol: $ZnSO_4.7H_2O$

### Preparation

i. From Zn, ZnO, $ZnCO_3$, $Zn(OH)_2$ with dil.$H_2SO_4$

$$Zn + H2SO4 \rightarrow ZnSO_4 + H_2$$
$$ZnO + H_2SO_4 \rightarrow ZnSO_4 + H_2O$$
$$ZnCO_3 + H_2SO_4 \rightarrow ZnSO_4 + H_2O + CO_2$$
$$Zn(OH)_2 + H_2SO_4 \rightarrow ZnSO_4 + 2H_2O$$
$$ZnSO_4(aq.) \xrightarrow{crystallization} ZnSO_4.7H_2O$$

ii. From ZnS

$$ZnS + 2O_2 \xrightarrow{below\ 800^\circ C} ZnSO_4$$

### Physical properties

- It is a white crystalline solid.
- It is efflorescent and loses water when exposed to air.
- It is highly soluble in water.

## Chemical properties

### i. Action of heat

White vitriol when heated gives the following reaction :

$$\mathrm{ZnSO_4.7H_2O} \xrightarrow[\text{Above}]{70^\circ\mathrm{C}} \mathrm{ZnSO_4.H_2O} \xrightarrow[\text{Above}]{280^\circ\mathrm{C}}$$

$$\mathrm{ZnSO_4} \xrightarrow{800^\circ\mathrm{C}} \mathrm{ZnO} + \mathrm{SO_2} + \frac{1}{2}\mathrm{O_2}$$

### ii. Action of NaOH

$$ZnSO_4 + 2NaOH \rightarrow Zn(OH)_2 + Na_2SO_4$$

$$Zn(OH)_2 + 2NaOH \rightarrow Na_2ZnO_2 + 2H_2O$$

iii. Action with barium sulphide

$$ZnSO_4 + BaS \rightarrow \underset{\substack{Lithopone \\ (white\ pigment)}}{ZnS.BaSO_4}$$

iv. Formation of double salt

$$K_2SO_4 + ZnSO_4 + 6H_2O \rightarrow \underset{Double\ salt}{K_2SO_4.ZnSO_4.6H_2O}$$

v. Action with potassium ferrocyanide

$$2ZnSO_4 + K_4[Fe(CN)_6] \rightarrow \underset{Zinc\ ferrocyanide\ (white\ ppt.)}{Zn_2[Fe(CN)_6]} + K_2SO_4$$

## Uses

- Used as electrolyte.
- Used as an eye lotion.
- Used to check bleeding.
- Used to prepare lithopone, a white pigment.

**Rinman's green: ZnO.CoO*

## Some important questions for practice;

**Multiple Choice Questions;**

1. The iron pipes carrying drinking water are covered with Zinc to prevent from rusting this process is called…..
   a) allow formation b) electroplating c) galvanization d) electrifying
2. Colored salts are not generally formed by
   a) Fe b) Ni c) Co d) Zn
3. Zinc oxide is known as
   a) Zinc white b) Chinese white c) Philosopher's wool d) All
4. Rinmann's green is
   a) $Co(AlO_2)_2$ b) ZnO.CoO c) $Pb_3O_4$ d) $MgZnO_4$
5. The metals never found in nature in Free State is
   a) Cu b) Ag c) Au d) Zn

**Short Answer Questions;**

1. A metal (M) having atomic number 30 is referred as non-typical transition metal and it belongs with the group IIB.
   i. Identify the metal (M) and write its chief ore.
   ii. Why (M) is called non-typical transition metal?
   iii. Write the chemical process occurring in reduction step during the extraction of (M).

2. An important compound non typical transition metal zinc which is used as eye lotion and is also called white vitriol.
   i. write down a method of preparation of white vitriol.
   ii. What happens when white vitriol is heated to 800 c?
   iii. Define double salt giving an example of it.
   iv. How is Lithopone obtained from white vitriol?
   v. why is zinc considered as non typical transition metal?

3. Write the chemistry of white vitriol.
   a) What action takes place when aqueous sodium hydroxide is added to zinc sulphate solution drop till excess?
   b) why zinc displace copper from copper sulphate solution?
   c) why is zinc not considered as a transition element?
   d) Write the action of heat on white vitriol.
   e) Write one of the application of white vitriol.