

**Overview:**

- Zn is white silver color with  $T_m$ : 420°C.
- Density: 7.13 g/cm<sup>3</sup>
- Used to coat steel to protect it from corrosion at room temperature and for decorative finish.
- Fast rate of die casting. (ex. toys, car parts...etc.)

**Ores:**

- Zinc blende or Sphalerite (ZnS)
- Marmatite (ZnFe)S.
- Typical zinc ores generally contain about 5-15 % metal. Zinc ores are mined on a large scale in many countries including Australia, USA, Canada and Peru. Current world production is about 9 million tons each year, including recycled metal.
- In a few cases, samples of native zinc have been found, for example in Australia. This is the pure metal.
- The low concentrations of the zinc sulphide mineral in most zinc ores mean that the ore must first be concentrated before extracting the metal.

**There are two methods of zinc extraction;**

**1) Pyrometallurgy**

**2) Hydrometallurgy**



**Electrochemical treatment**

## 1) Pyrometallurgical treatment

### Stage 1

- The zinc blende (sphalerite: zinc sulphide) is first crushed to powder, wet grinding and then treated by froth flotation (that process is described in the copper lecture. It is used in the extraction of several metals).
- Froth floatation has been used with aid of  $\text{CuSO}_4$  to collect Zinc ore. The resulting material is known as 'concentrate'. It contains at least 50% zinc

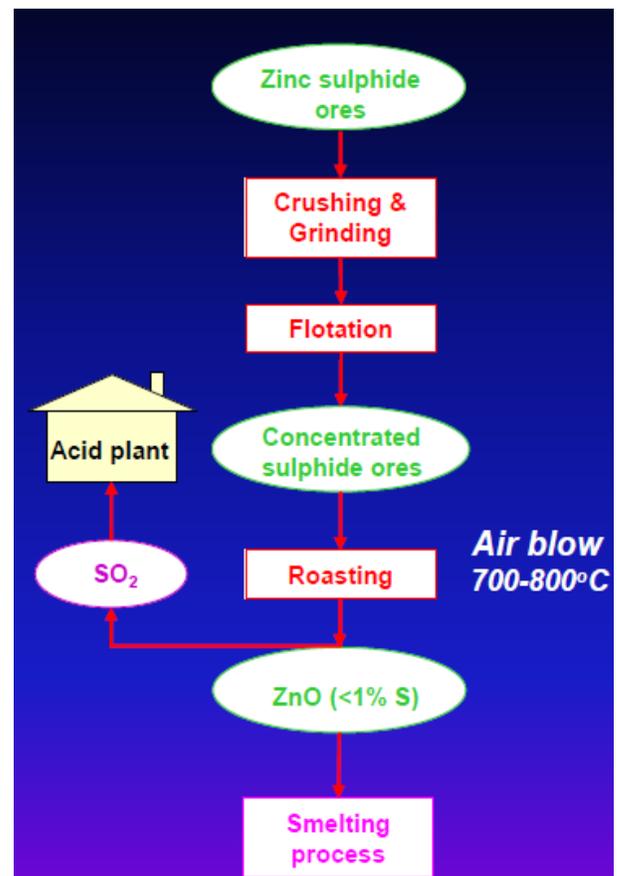
### *Production of zinc using blast furnace*

### Stage 2

- **Roasting** was done to convert sulphide Zinc ores to its oxide, by  $\text{O}_2$  flow & removal of  $\text{SO}_2$  at T of  $700\text{-}800^\circ\text{C}$ . This reaction is exothermic, which increases the temp. up to  $1000^\circ\text{C}$ .



Soluble in water  
& dilute acids

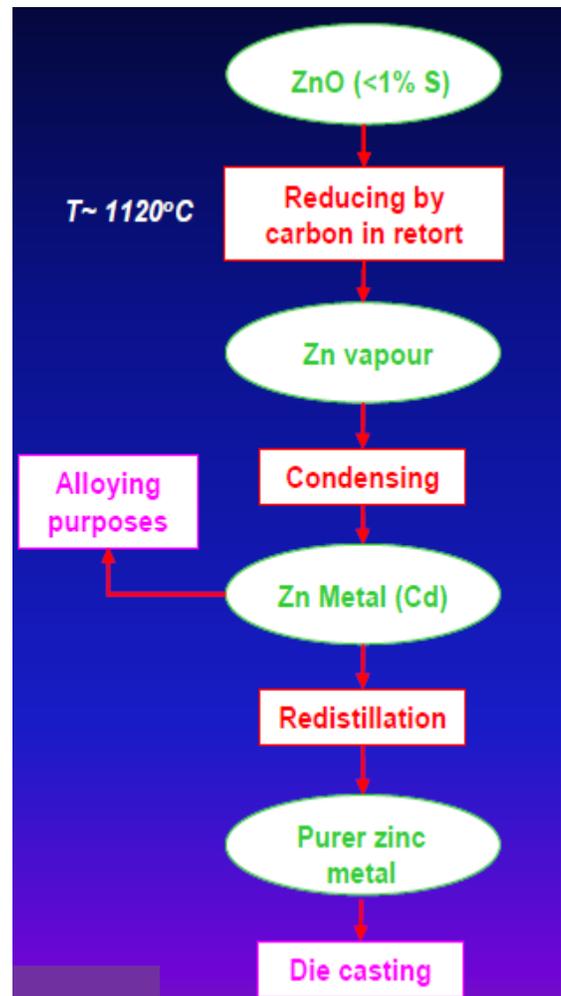


**Stage 3****(Smelting) Metal production**

The zinc oxide is then reduced to the metal using either a thermal or an electrolytic process.

- ZnO is treated in blast furnace, reduction done with carbon & limestone ( $\text{CaCO}_3$ ) at  $500^\circ\text{C}$  as a preheating, then  $\text{O}_2$  supplied from top furnace to produce carbon monoxide (CO) at  $1300^\circ\text{C}$  to produce zinc vapor and lead (Pb).

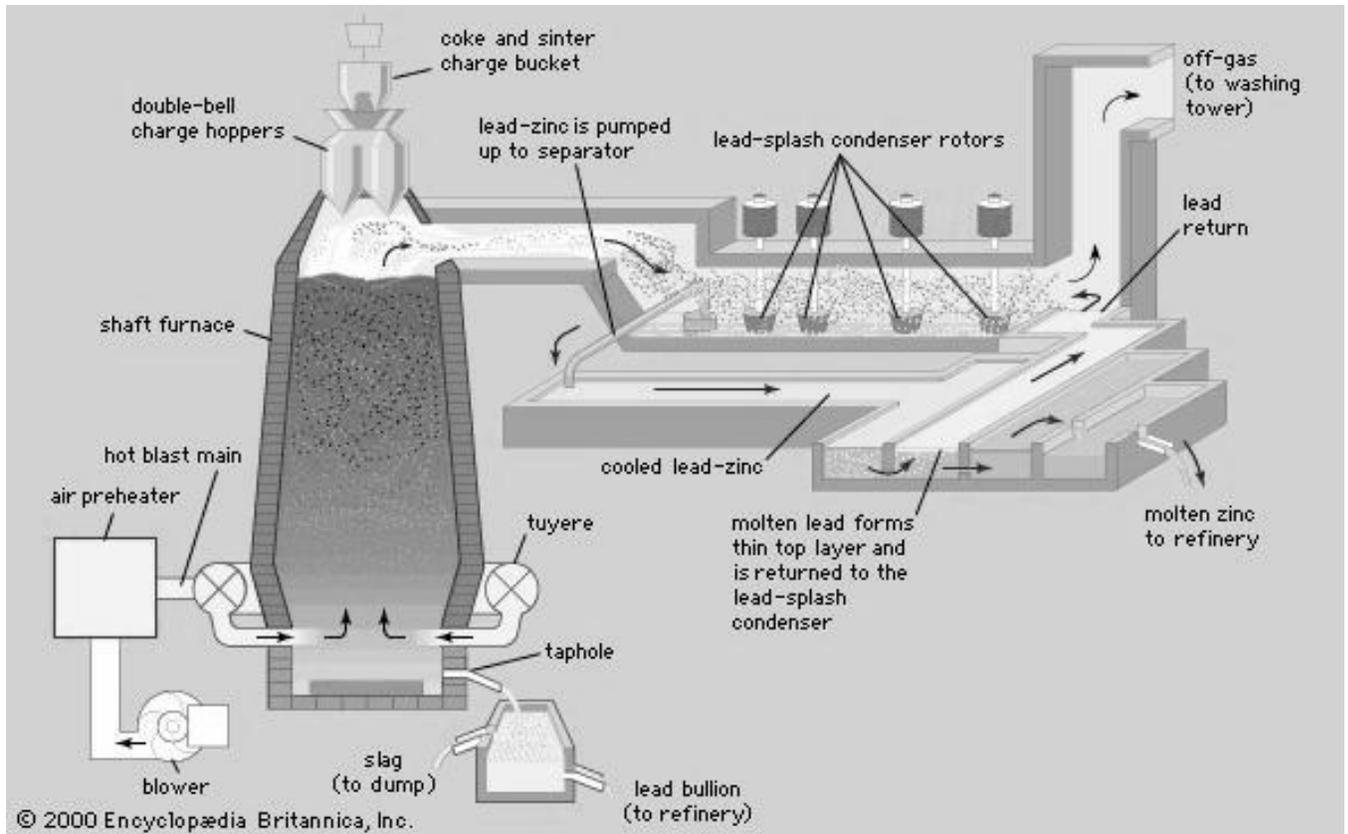
Reduction smelting reaction as follows:



- Zn vapor is drawn at  $1000^\circ\text{C}$  then cooled rapidly to  $550^\circ\text{C}$  in molten lead bath to produce condensate zinc (contains small amount of Cd) which is denser than other component (Zn sinks to the bottom), then tapped off, while slug (lighter) is tapped from above.
- Two layers will form as follows:
  1. Zinc contains 1wt%Pb  $\longrightarrow$  drawn to more refining by distillation to produce 99.9% Zn.
  2. Pb contains 2.25wt% Zn  $\longrightarrow$  return to condenser.

- Then Redistillation at T of  $765^{\circ}\text{C}$  to vaporize *Cd* off.
- Zinc produced by this process is about 98.5% pure and can be further refined if required.
- Around 15% of the world's zinc is produced this way.

The blast furnace used in this process is illustrated in figure below.



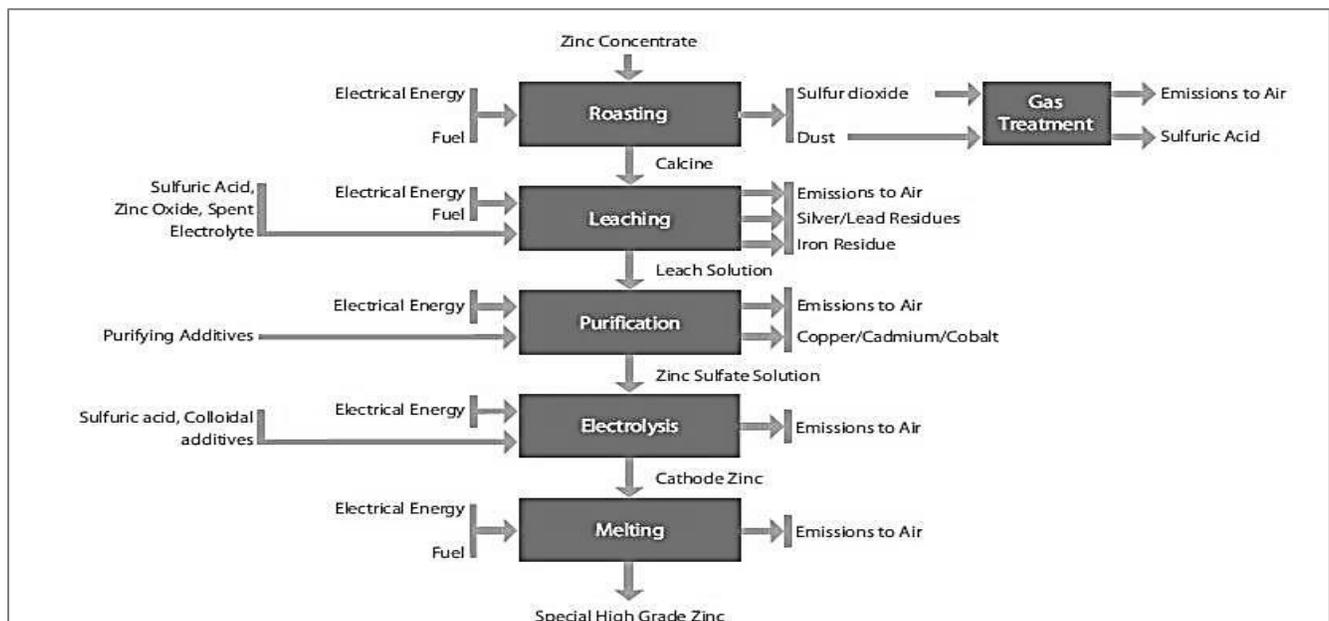
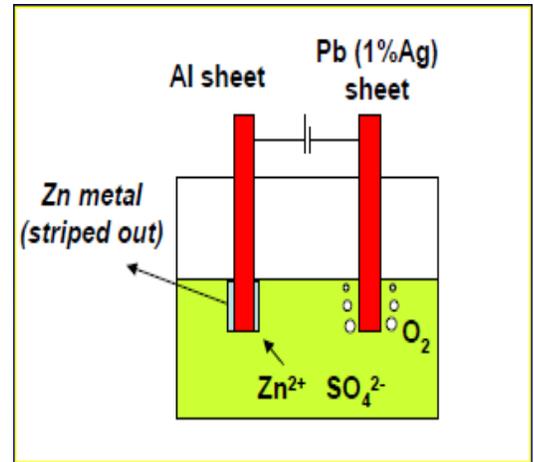
**Electrolytic refining (Hydrometallurgy)**

They consist of 4 steps: leaching, purification, electrolysis, and melting & casting.

- The crude zinc oxide is dissolved in dilute sulphuric acid (H<sub>2</sub>SO<sub>4</sub>) to produce a solution of Zinc sulphate after filtration and purification the solution.



- ZnSO<sub>4</sub> electrolysed using a (Pb-1%Ag) anode and an aluminium cathode.
- O<sub>2</sub> is released at anode, while Zinc is deposited on the cathode. H<sub>2</sub>SO<sub>4</sub> is regenerated at the anode and can be used again.
- The zinc is stripped periodically from the cathode melted and cast into blocks (ingots) for many different purposes.
- Electrolytically refined zinc is generally 99.995% pure.
- About 80% of the world's zinc is produced using this process.



Hydrometallurgy of zinc extraction