Principles Of Metal Refining With Examples For Metals Like Pb, Sn And Zn

REFINING OF METALS:

Metals obtained by reduction processes still contain some objectionable impurities and hence have to be refined. Refining techniques vary widely from metal to metal and also depend on the use to which a metal has to be put. Sometimes during refining some substances may have to be added to impart some desirable characteristics to the metal. In some cases a metal is refined to recover valuable by-products present as impurities.

In metallurgy, refining consists of purifying an impure metal. It is to be distinguished from other processes such as smelting and calcining in that those two involve a chemical change to the raw material, whereas in refining, the final material is usually identical chemically to the original one, only it is purer.

Refining of metal is one of the processes which involves the separation of impurities like sand particles, other metals etc. from the metal of choice. Therefore, refining of metal comes under the science of studying the metal's physical and chemical properties, called **Metallurgy**.

The methods for refining metals vary according to the type and use of the metals. Refining merely refers to as purification. Thus, metal refining removes the **gangue particles** or matrix from the metals obtained through the various reduction processes and gives a pure or refined metal.

The process of metal refining is carried out after the extraction of metal. The metals' refining process involves adding some substances that can confer desirable characteristics to the metals. Here, we will discuss the different refining processes of metals.

Methods for Refining of Metal

The impurities like unwanted metals, non-metals, an unreduced oxide of a metal, flux, slag etc. from the crude metals are eliminated to produce pure metals. The following methods are generally employed in the metal refining:

1. Liquation
2. Polling
3. Distillation
4. Electrolytic refining
5. Zone refining
6. Chromatography methods
7. Cupellation
8. Vapour phase refining

1. Liquation

In liquation, the easily fusible metals or the metals with a low melting point like tin, lead etc. are commonly used. The process mainly involves the following steps that can be summarized into:
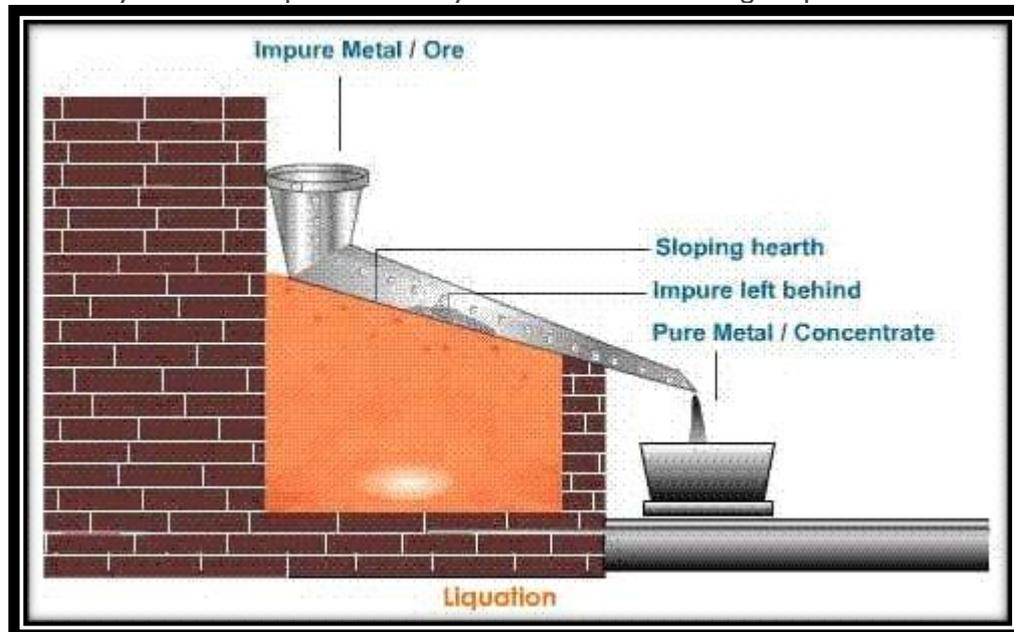
1. **Pouring** of impure metal: In this step, pass the impure metals over the sloping hearth of the reverberatory furnace.
2. **Heating**: Then, heat the metal at a temperature little above the melting point.
3. **Drain off**: Drain out the refined or pure metal by leaving the infusible impurities.

2. Polling

In the process of polling, stir the impure molten metal with the help of bamboo. The hydrocarbons will reduce the metal oxides present as an impurity. This method can refine metals like copper (Cu) and tin (Sn).
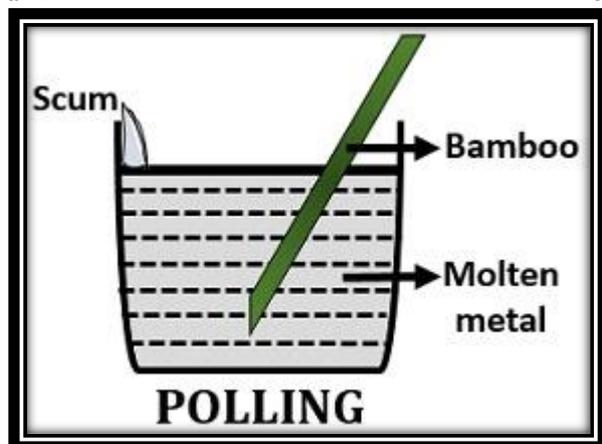

3. Distillation

By the process of distillation, volatile metals like Zinc (Zn) and Mercury (Hg) or the metals possess a very low boiling point are generally used. The metal easily vaporizes by leaving behind the impurities. In this, heat the impure metal at a temperature above its melting point in a reverberatory furnace. Then, reconvert the vapours into the metal after the separation of gangue particles.
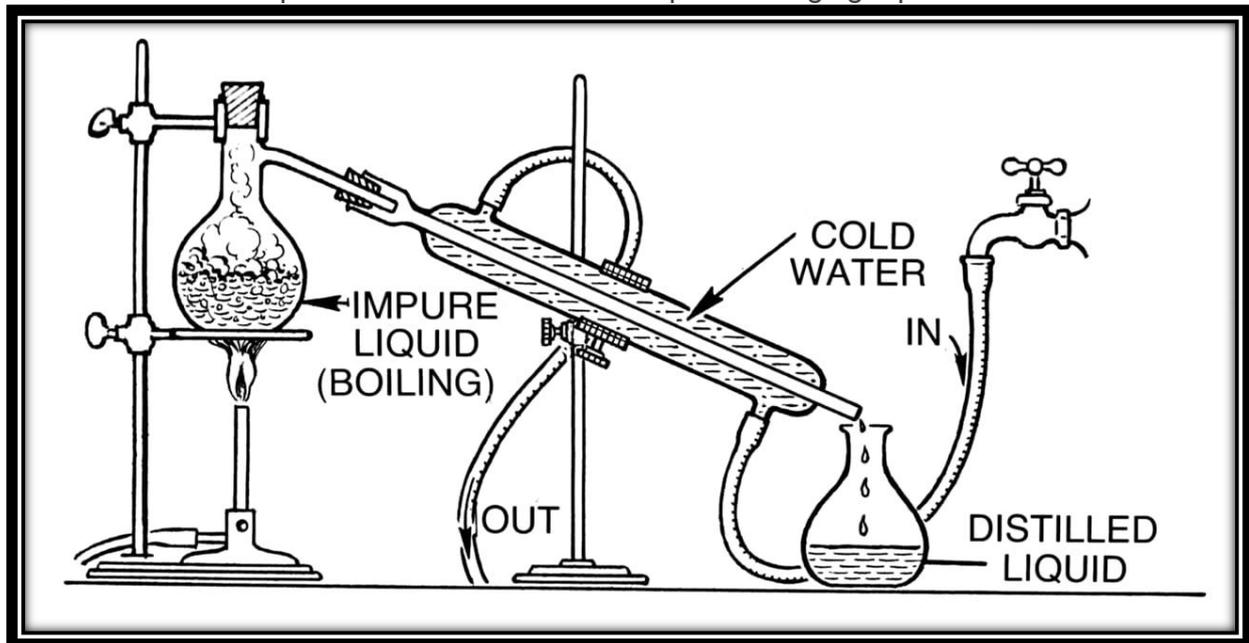
**Schematic   Diagram   of   Distillation**

4. Electrolytic Refining

It is the most widely used method, as it can be used to purify many metals. It works on the principle of electrochemical properties of the metals. The impure metal is of an anode, pure metal is of a cathode, and the electrolytic solution contains the salt of the same metal used. Under the electric field, the metals' impurities get dissolved from the anode (gets thinner), after which the pure metals get deposited at the cathode (gets thicker). The impurities generally deposit at the anode   base   as **sludge** or **anode**   **mud**.
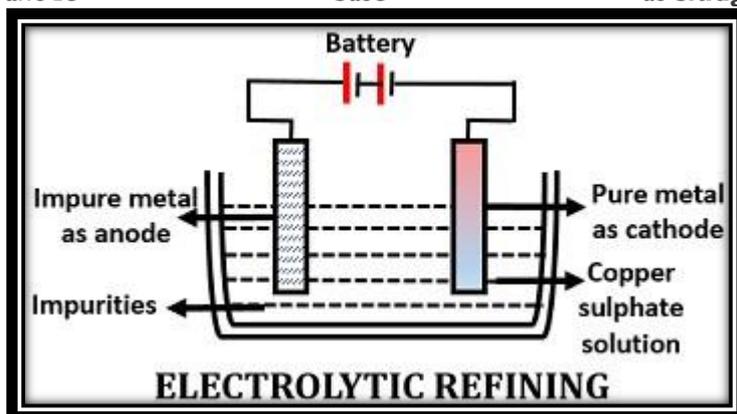
5. Zone Refining

William pfann first gave this method. Some inert gases are filled in the container to which the impure metals   are   kept   inside.   Then,   place   a   circular   heater   at   the   top   of   the   rod.

ZONE REFINING
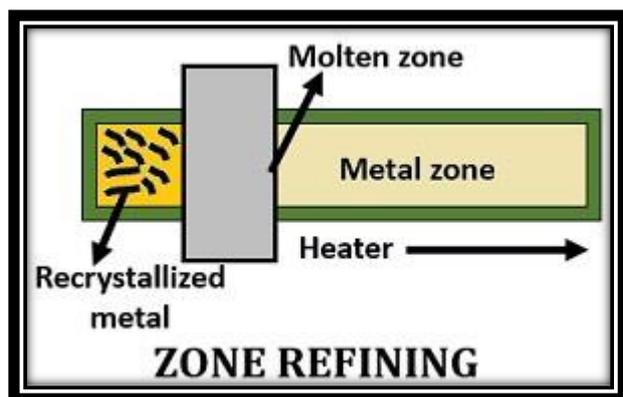
The impure metals heat up due to the circular heater. The pure metal crystallizes, and later it is cooled by the shifting of the heater to the next zone. The molten impurities will then move to the next zone along with the heater, which we can collect or separate from the last zone.

6. Chromatographic methods

This method is based on the principle that different components of a mixture are differently adsorbed on an adsorbent. The mixture is put in a liquid or gaseous medium which is moved through the adsorbent.

Different components are adsorbed at different levels on the column. Later the adsorbed components are removed (eluted) by using suitable solvents (eluant). Depending upon the physical state of the moving medium and the adsorbent material and also on the process of passage of the moving medium, the chromatographic method is given the name. In one such method the column of Al_2O_3 is prepared in a glass tube and the moving medium containing a solution of the components is in liquid form. This is an example of column chromatography. This is very useful for purification of the elements which are available in minute quantities and the impurities are not very different in chemical properties from the element to be purified. There are several chromatographic techniques such as paper chromatography, column chromatography, gas chromatography, etc. Procedures followed in column chromatography have been depicted in Fig.
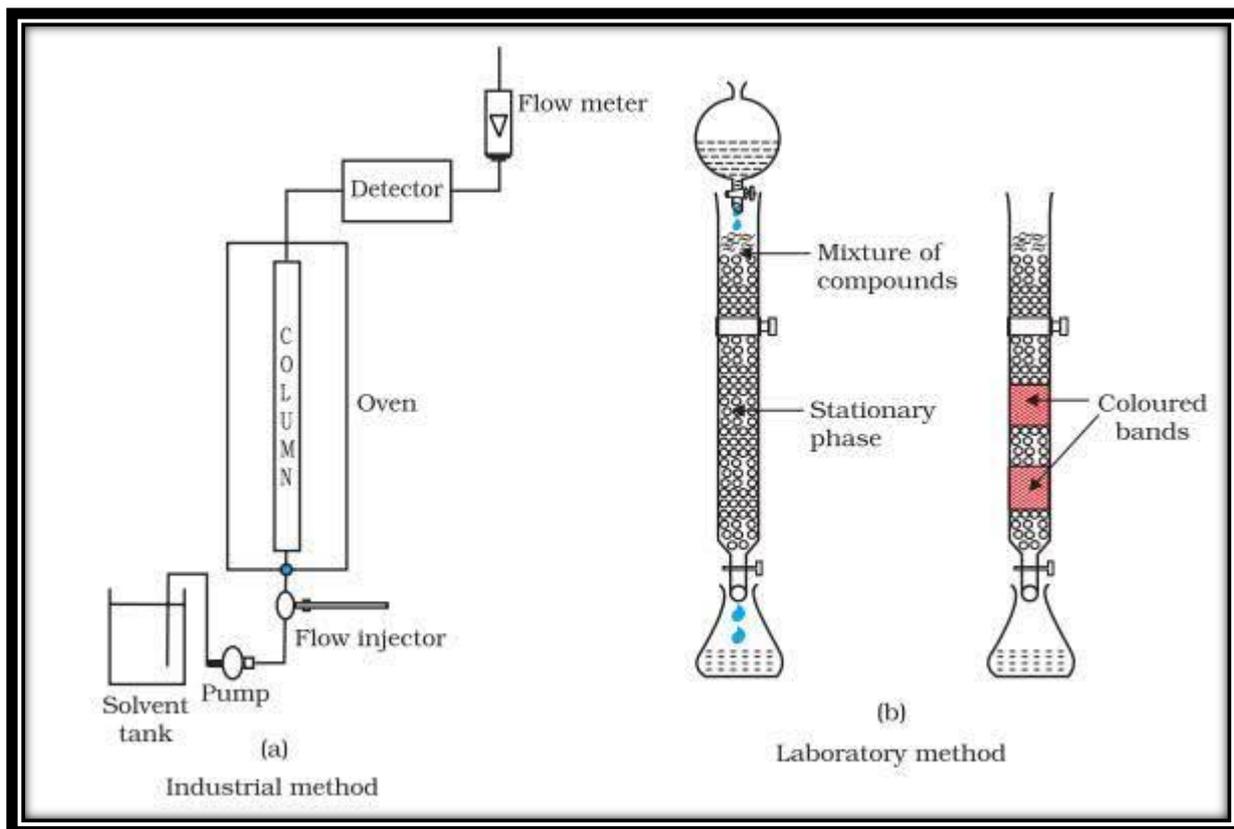
SCHEMATIC DIAGRAMS OF COLUMN CHROMATOGRAPHY

7. Cupellation

This method employed to purify silver containing lead as an impurity. The impure silver is heated in a shallow vessel made of bone-ash under a blast of air. The lead is easily oxidized to powdery lead monoxide. Most of it is carried away by the blast of air. The rest melts and is absorbed by the bone ash cupel. Pure silver is left behind. Silver itself is not oxidized under these conditions.

The process is based on the principle that **precious metals** do not **oxidize** or react chemically, unlike the base metals, so when they are heated at high temperatures, the **precious metals** remain apart, and the others react, forming **slags** or other compounds.
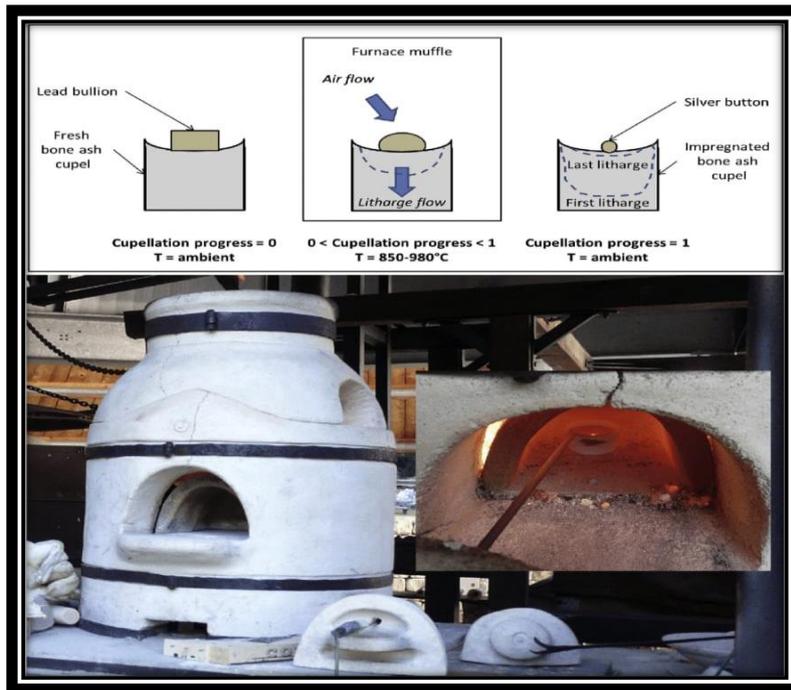
CUPELLATION

8. Vapour phase refining

In this method, the metal is converted into its volatile compound and collected elsewhere. It is then decomposed to give pure metal. So, the two requirements are:

(i) the metal should form a volatile compound with an available reagent,

(ii) the volatile compound should be easily decomposable, so that the recovery is easy.

Following examples will illustrate this technique.

Mond Process for Refining Nickel:

In this process, nickel is heated in a stream of carbon monoxide forming a volatile complex, nickel tetracarbonyl:

$$Ni + 4CO \xrightarrow{330-350\,K} Ni(CO)_4$$
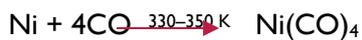
The carbonyl is subjected to higher temperature so that it is decomposed giving the pure metal:

$$Ni(CO)_4 \xrightarrow{450-470\,K} Ni + 4CO$$

van Arkel Method for Refining Zirconium or Titanium: This method is very useful for removing all the oxygen and nitrogen present in the form of impurity in certain metals like Zr and Ti. The crude metal is heated in an evacuated vessel with iodine. The metal iodide being more covalent, volatilizes:

$$Zr + 2I_2 \rightarrow ZrI_4$$
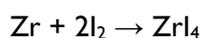
The metal iodide is decomposed on a tungsten filament, electrically heated to about 1800K. The pure metal is thus deposited on the filament.

$$ZrI_4 \rightarrow Zr + 2I_2$$

EXTRACTION AND REFINING OF Pb, Sn AND Zn

LEAD (Pb)

Lead is a chemical element with the symbol Pb (from the Latin plumbum) and atomic number 82. It is a heavy **metal** that is denser than most common materials. **Lead** is soft and malleable, and also has a relatively low melting point. **Lead** is a relatively unreactive post-transition **metal**.

Details of Pb:

Atomic Number: 82

Atomic Weight: 207.21 amu

Density: 11.34 gm/cm^3

Melting Point: 327.40^0 C

Boiling Point: 1737^0 C

Common Minerals of Pb:

Pb Oxides		Pb Sulphides		
NAME	CHEMICAL FORMULA	NAME	CHEMICAL FORMULA	
Cerrusite	$PbCO_3$	Galena	PbS	
Anglesite	$PbSO_4$			

EXTRACTION AND REFINING

TO REMOVE AND RECOVER REMAINING IMPURITIES FROM LEAD BULLION, EITHER PYROMETALLURGICAL OR ELECTROLYTIC REFINING IS USED; THE CHOICE BETWEEN THE TWO METHODS IS DICTATED BY THE AMOUNT OF BISMUTH THAT MUST BE ELIMINATED FROM THE BULLION AND BY THE AVAILABILITY AND COST OF ENERGY.

The primary lead production process consists of four steps: sintering, smelting, drossing and pyrometallurgical refining. To begin, a feedstock comprising mainly of lead concentrate in the form of lead sulphide is fed into a sintering machine. Other raw materials may be added including iron, silica, limestone flux, coke, soda, ash, pyrite, zinc, caustic and particulates gathered from pollution control devices. In the **sintering machine** the lead feedstock is subjected to blasts of hot air which burn off the sulphur, creating sulphur dioxide. The lead oxide material existing after this process contains about 9% of its weight in carbon. The sinter is then fed along with coke, various recycled and clean up materials, limestone and other fluxing agents into a **blast furnace** for reducing, where the

carbon acts as a fuel and smelts or melts the lead material. The molten lead flows to the bottom of the furnace where four layers form: "**speiss**" (the lightest material, basically arsenic and antimony); "**matte**" (copper sulphide and other metal sulphides); **blast furnace slag** (primarily silicates); and **lead bullion** (98% lead, by weight). All layers are then drained off. The speiss and matte are sold to copper smelters for recovery of copper and precious metals. The blast furnace slag which contains zinc, iron, silica and lime is stored in piles and partially recycled. Sulphur oxide emissions are generated in blast furnaces from small quantities of residual lead sulphide and lead sulphates in the sinter feed.

Rough lead bullion from the blast furnace usually requires preliminary treatment in kettles before undergoing refining operations. During **drossing**, the bullion is agitated in a drossing kettle and cooled to just above its freezing point (370 to 425°C). A **dross**, which is composed of lead oxide, along with copper, antimony and other elements, floats to the top and solidifies above the molten lead.

The **dross** is removed and fed into a dross furnace for recovery of the non-lead useful metals. To enhance copper recovery, **drossed lead bullion** is treated by adding sulphur-bearing materials, zinc, and/or aluminium, lowering the copper content to approximately 0.01%.

During the fourth step, the lead bullion is refined using pyrometallurgical methods to remove any remaining non-lead saleable materials (e.g., gold, silver, bismuth, zinc, and metal oxides such as antimony, arsenic, tin and copper oxide). The lead is refined in a cast iron kettle by five stages. Antimony, tin and arsenic are removed first. Then zinc is added and gold and silver are removed in the zinc slag. Next, the lead is refined by vacuum removal (distillation) of zinc. Refining continues with the addition of calcium and magnesium. These two materials combine with bismuth to form an insoluble compound that is skimmed from the kettle. In the final step caustic soda and/or nitrates may be added to the lead to remove any remaining traces of metal impurities. **The refined lead will have a purity of 99.90 to 99.99%** and may be mixed with other metals to form alloys or it may be directly cast into shapes.

The **Parkes zinc-desilvering process** is the most widely used **pyrometallurgical method of refining lead bullion**. As in smelting, the lead is first melted and again allowed to cool below the freezing point of copper, which crystallizes and, along with any remaining nickel, cobalt, and zinc, is removed by skimming. The lead mix then passes to a reverberatory "softening" furnace, where the temperature is raised and the molten lead is stirred. A blast of air oxidizes any remaining antimony or arsenic, both of which harden lead (hence the term softening furnace), and these are skimmed off to be recovered later.

After softening, the lead goes to desilvering kettles, where small quantities (less than 1 percent by weight) of zinc are added. With stirring, the molten zinc reacts to form compounds with gold and silver, both of which are more soluble in zinc than in lead. The compounds are lighter than the lead, so that, on cooling to below 370 °C (700 °F) but above the melting point of lead, they form a crust that is removed and taken to a parting plant for recovery of the precious metals. The remaining zinc is then removed by reheating the molten lead to 500 °C (1,100 °F) and creating a vacuum over the surface. The zinc vaporizes, and the vapour is condensed as metal on the cool dome of the vacuum vessel, where it is collected for reuse.

The Harris process of softening and dezincing is designed to remove impurities from desilvered lead by stirring a mixture of molten caustic salts at a temperature of 450–500 °C (840–930 °F) into the molten lead. Metallic impurities react with the chemicals and are collected in the form of their oxides or oxysalts.

Lead bullion containing more than 0.1 percent bismuth can be purified by the Betterton-Kroll process, which usually follows softening, desilvering, and dezincing and involves treatment of the melt with calcium and magnesium. Bismuth unites with these metals to form compounds that rise to the surface. The compounds are skimmed off and treated for recovery of bismuth, a valuable by-product.

The Betterton-Kroll process produces a refined lead with bismuth contents of 0.005 to 0.01 percent. When a refined lead of higher purity is required, or when a lead bullion high in bismuth has to be

refined, employment is made of electrolytic refining. This process is costly, but it has the major advantage of separating lead from every impurity except tin in one vessel or one stage, and it does so without emitting lead-bearing fumes or gases. The bullion is cast into large plates, which are hung as anodes in electrolytic tanks where they dissolve. Pure lead is deposited on a thin sheet of lead that serves as the cathode. Impurities left behind can be recovered by many complex operations.

FLOW SHEET OF REFINING OF LEAD BULLION
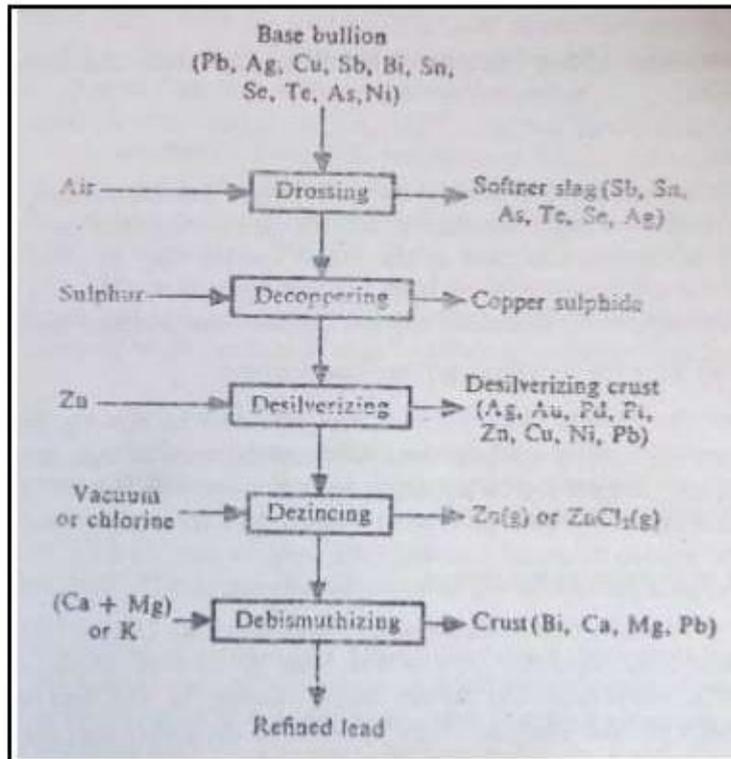
USE OF PB :-

❖ **MANUFACTURE OF BATTERY , CABLE , PIGMENT , FLEXIBLE SHEET AND PIPE** . BASIC PB carbonate such as $2PbCO_3.Pb(OH)_2$ used in Pb pigment form on basis of grade point. Also, litharge (PbO) used in reverberatory furnace for oxidation for pigmented varnish and glass production.

❖ **RED LEAD (PB$_3$O$_4$)** : Higher Oxide of Pb made by heating Litharge under control condition about 450^0 C and same use as Litharge .

❖ LEAD CHROMATE : NORMAL YELLOW CHROMATE MADE BY THE PRECIPITATE FROM THE SOLUTION OF LEAD ACITATE AND NITRIDE TO WHICH SODIUM BICARBONATE WILL BE ADDED .

Area of Extraction:-

- HZL – Major production of Pb in Jharkhand (Tundoo)

- Visakhapatnam (Andhra Pradesh) – 15,000 tonne/year

Tin (Sn):

Tin is not extracted commercial scale in India although tin deposits have been detected in Ranchi and Hazaribagh (Jharkhand). The entire present requirement of almost 10,000 tons per year is being met by imports.

Details about of Tin:

Atomic Number: 50

Atomic Weight: 118.71 amu

Density: 7.31 gm/cm^3

Melting Point: 231.9$\circ$C

Boiling Point: 2270$\circ$C

Common Minerals of Tin:

Cassiterite: SnO_2

Extraction of Tin:

The concentration contains FeS are oxidize to oxide during smelting. Carbothermic reduction of SnO_2 is feasible at moderate temperature. At higher temperature $(1200\text{-}1300)^0$ C FeO is more stable. The difference in stability between FeO and SnO_2 used as the basis of selectivity of reducing SnO_2 to Sn. The difference in stability further reduce because slag has higher affinity for Tin oxide compare with iron oxide and tendency for attain separation of Tin from Fe becomes difficult. So smelting of Tin has done in 3 ways.

First stage, 99% obtain partially reduction of tin concentration almost all Fe in slag. The slag further reduced in 2 stages. First stage produce tin contain 5% and in the second stage tin contain 20% Fe. Third stage have very low % of tin. So, 2nd and 3rd stage subjected to liquation to eliminate Fe.

When Sn-Fe alloys heated to a temperature higher than melting point of Sn. The metal known as first run metal contain 99.9% Sn. Temperature progressively increase Fe content in Sn increase

known as second run metal. Where, for taking smelting in rotary instead of reverberatory furnace of higher efficiency Sn recovery. First smelting slag is reduce and Sn volatile either in form of SnO or SnS. Clean slag discarded after reduction vapour pressure of SnS greater than SnO. So, SO_2 presence is beneficial.

Refining of Tin:

There is mainly two methods of refining of Sn as Pyrometallurgical refining (or fire refining), and electro refining.
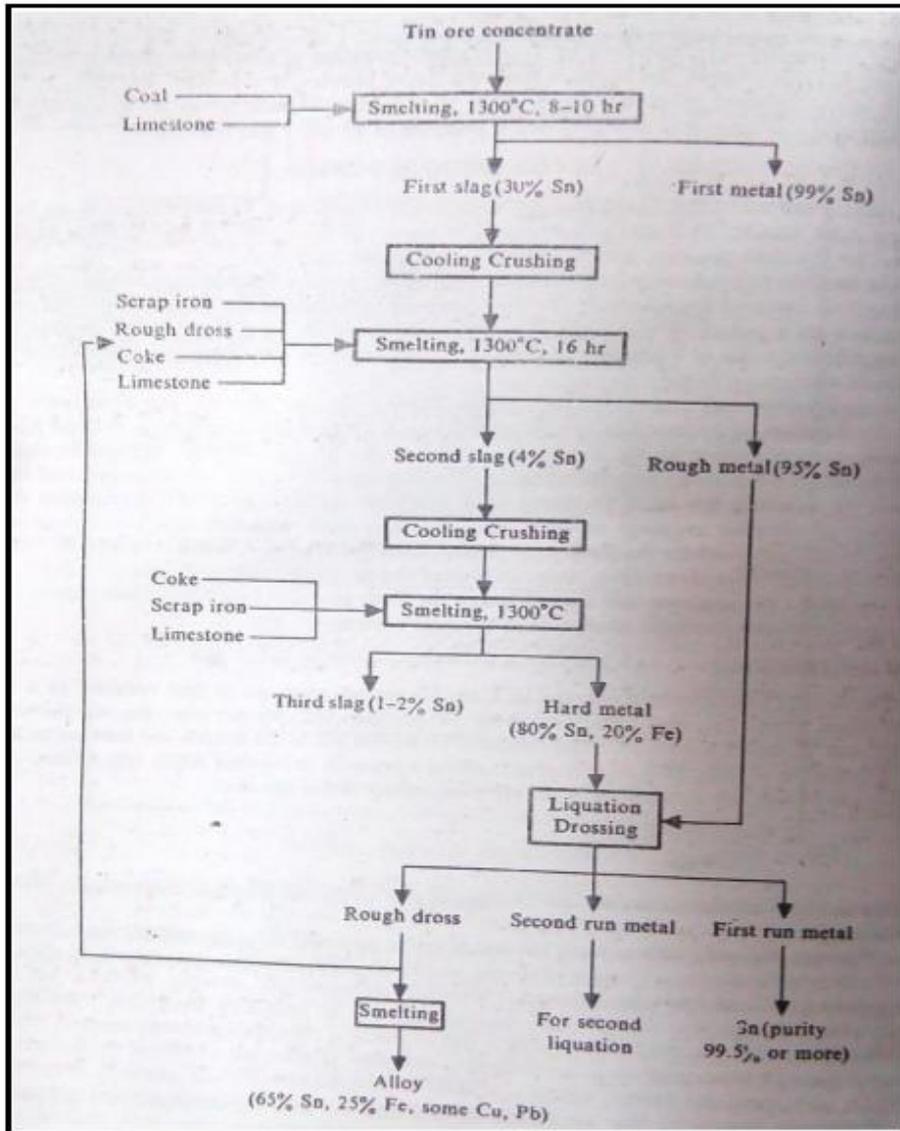
Pyrometallurgical Refining:

Ultimate recovery of Tin is more than 85%. Principle is to several common impurities from intermetallic compounds with each other or with Sn. Thus, if impure liquid tin is cooled to a temperature just above the melting point of tin (232^0 C), these inter metallic compounds as Cu_2Sb, Cu_3Sn, Cu_3As, $FeSb_2$, $FeSn_2$, FeAl etc. have higher melting point than tin. So separate out and get floats. S adds to remove Cu in CuS form. AlAs and AlSb by addition of Al, As, and Sb eliminated.

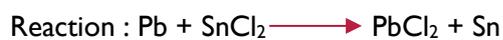Reaction : $2AlAs + 6H_2O \longrightarrow 2AsH_3 + 2Al(OH)_3$

Reaction : $2AlSb + 6H_2O \longrightarrow 2SbH_3 + 2Al(OH)_3$

NH_4Cl add with tin after Al treatment to remove surplus Al as

Reaction : $Al + 3NH_4Cl \longrightarrow AlCl_3 + NH_3 + 3/2H_2$

Smelting of Tin Concentrate

Pulverize coal separate and precipitate out $AlCl_3$. Deleading of Sn by $SnCl_2$ based on

Reaction : $Pb + SnCl_2 \longrightarrow PbCl_2 + Sn$

A Sn-Pb alloy removes from $PbCl_2$-$SnCl_2$ mixture by melting in contact with Zn.

Reaction : $SnCl_2 + PbCl_2 + 2Zn \longrightarrow 2ZnCl_2 + Pb + Sn$

Any excess Ca or Mg is removed by adding NH_4Cl according to the reaction

Reaction : $2NH_4Cl + Ca(Mg) \longrightarrow 2NH_3 + H_2 + Ca(Mg)Cl_2$

Electro Refining of Sn:

Using a mixture of H_2SO_4 and phenol sulphonic acid as electrolytes is feasible. If, Sn contains large amount of impurities such as Pb, Bi, Sb, As etc. Mixture of Cresol sulphonic acid and phenol sulphonic acid now used as electrolyte.

It is analyse 95% Sn dissolve in pure metal to obtain at cathode sheet of 99.95% Sn.
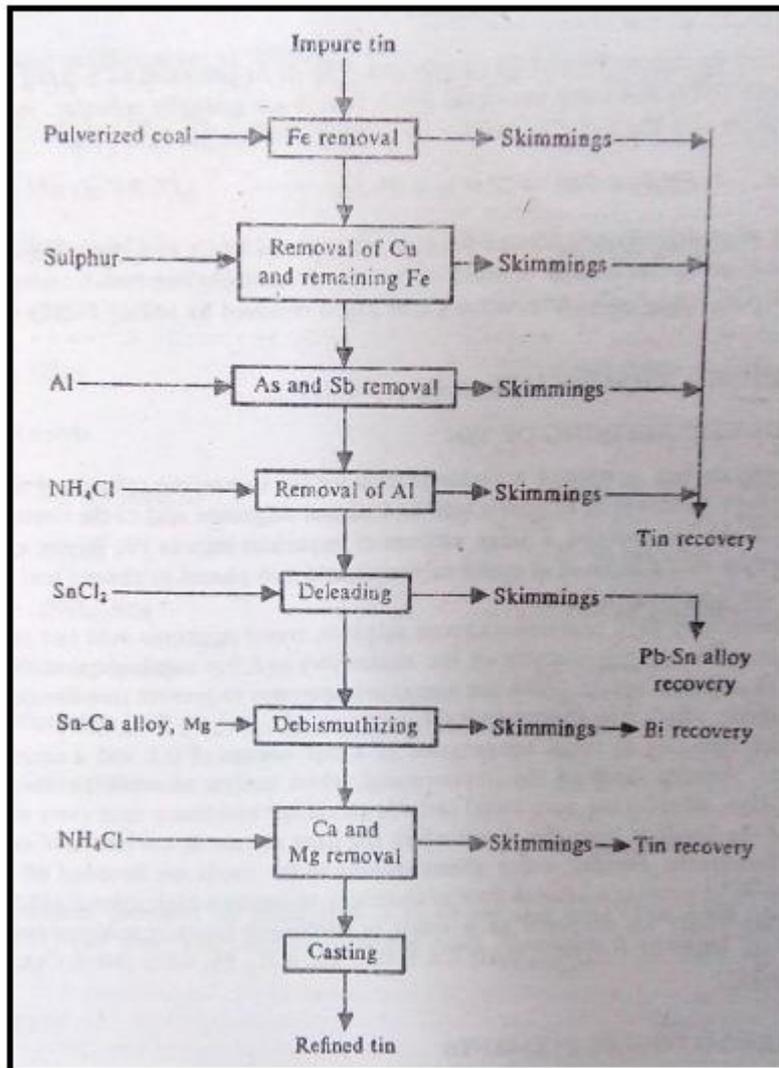
Flow Sheet of Production of Refined Tin

Use of Sn:

• Resistance to both corrosion and toxicity. So, for plating cans, general plating other materials.

Area of Extraction:

• Bolivia

• Malaysia

• Indonesia

ZINC (Zn):

Details about of Zn:
Atomic Number: 30
Atomic Weight: 65.38 amu
Density: 7.13 gm/cm³

Melting Point: 419.5^0 C
Boiling Point: 910^0 C

Common minerals of Zn :

Zinc Oxides		Zinc Sulphides	
Name	Chemical Formula	Name	Chemical Formula
Zincite	ZnO	Sphalerite	ZnS
Franklinite	[ZnO(Fe, Mn)$_2$O$_3$]		
Willemite	Zn$_2$SiO$_4$		
Smith Sonite	ZnCO$_3$		

Extraction And Refining

Zinc concentrate is produced by separating the ore, which may contain as little as 2% zinc, from waste rock by crushing and flotation, a process normally performed at the mining site. **The zinc concentrate is then reduced to zinc metal in one of two ways: either pyrometallurgically by distillation (retorting in a furnace) or hydrometallurgically by electrowinning.** The latter accounts for approximately 80% of total zinc refining.

ELECTROLYSIS PROCESS (HYDROMETALLURGICAL PROCESS) :

Four processing stages are generally used in hydrometallurgic zinc refining: calcining, leaching, purification and electrowinning. **Calcining, or roasting**, is a high-temperature process (700 to 1000 °C) that converts zinc sulphide concentrate to an impure zinc oxide called calcine. Roaster types include multiple-hearth, suspension or fluidized-bed. In general, calcining begins with the mixing of zinc-containing materials with coal. This mixture is then heated, or roasted, to vaporize the zinc oxide which is then moved out of the reaction chamber with the resulting gas stream. The gas stream is directed to the baghouse (filter) area where the zinc oxide is captured in baghouse dust.

All of the calcining processes generate sulphur dioxide, which is controlled and converted to sulphuric acid as a marketable process by-product.

Electrolytic processing of desulphurized calcine consists of three basic steps: leaching, purification and electrolysis. **Leaching** refers to the dissolving of the captured calcine in a solution of sulphuric acid to form a zinc sulphate solution. The calcine may be leached once or twice. In the double-leach method, the calcine is dissolved in a slightly acidic solution to remove the sulphates. The calcine is then leached a second time in a stronger solution which dissolves the zinc. This second leaching step is actually the beginning of the third step of purification because many of the iron impurities drop out of the solution as well as the zinc.

After leaching, the solution is purified in two or more stages by adding zinc dust. The solution is purified as the dust forces deleterious elements to precipitate so that they can be filtered out. Purification is usually conducted in large agitation tanks. The process takes place at temperatures ranging from 40 to

85°C and pressures ranging from atmospheric to 2.4 atmospheres. The elements recovered during purification include copper as a cake and cadmium as a metal. *After purification the solution is ready for the final step, electrowinning.*

Zinc electrowinning takes place in an electrolytic cell and involves running an electric current from a lead-silver alloy anode through the aqueous zinc solution. This process charges the suspended zinc and forces it to deposit onto an aluminium cathode which is immersed in the solution. Every 24 to 48 hours, each cell is shut down, the zinc-coated cathodes removed and rinsed, and the zinc mechanically stripped from the aluminium plates. **The zinc concentrate is then melted and cast into ingots and is often as high as 99.995% pure.**

Electrolytic zinc smelters contain as many as several hundred cells. A portion of the electrical energy is converted into heat, which increases the temperature of the electrolyte. Electrolytic cells operate at temperature ranges from 30 to 35°C at atmospheric pressure. During electrowinning a portion of the electrolyte passes through cooling towers to decrease its temperature and to evaporate the water it collects during the process.

PYROMETALLURGICAL PROCESS:

Roasting and sintering

Both of the main extraction methods for the production of zinc, electrolysis and smelting, require the prior removal of sulfur in a highly exothermic oxidation reaction:

$$ZnS + 1.5O_2 \longrightarrow ZnO + SO_2$$

For the electrolytic production of zinc, the roasting of concentrates is achieved in fluidized-bed roasters, in which finely divided and heated particles of concentrate are suspended in a rising stream of air. The sulfur content can be reduced to less than 0.5 percent, and a high-strength (10 percent) sulfur dioxide gas is forwarded to a sulfuric acid plant. The process is thermally efficient, and the resulting calcine is in the form of small particles that can easily be leached into solution for further treatment.

The process described above becomes difficult to operate if the grade of concentrate falls and particularly if the lead content rises above 3 percent. For this reason, and because a strong, lumpy feed is required, the zinc-lead blast furnace utilizes a sintering process to supply its oxidized feed. Fine concentrates are mixed with crushed returned sinter to give a material containing about 6.5 percent sulfur. This is fed onto a moving grate and fired in an updraft of air, and the sintered cake leaving the machine is broken into a convenient lump size. By virtue of its strength and hardness, sinter is an ideal feed for the blast furnace. A gas containing 7.5 percent sulfur dioxide is passed to a sulfuric acid plant.

THE ZINC – LEAD BLAST FURNACE

Sintered zinc and lead concentrates, mixed with metallurgical coke, are charged into the top of a shaft furnace, into which preheated air is blown through nozzles, or tuyeres, at the base (see figure). This procedure is similar to that followed in an iron blast furnace, with the important difference that the major products of reduction here are a zinc-bearing gas and liquid phases that separate in the furnace hearth and are tapped periodically. (The liquids consist of molten lead, containing recoverable copper and silver, and the gangue content of the charge, in the form of a molten oxide slag.)
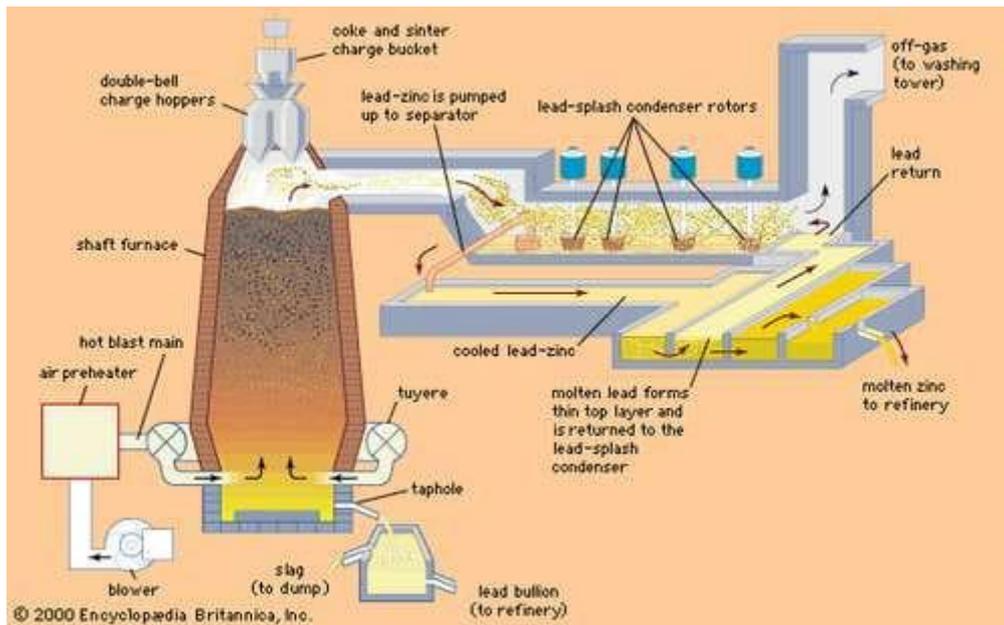
A zinc-lead blast furnace and lead-splash condenser.

The gas stream, containing 8 percent zinc, 10 percent carbon dioxide, and 20 percent carbon monoxide, is directed from the upper shaft to a lead-splash condenser, a chamber in which an intense shower of lead droplets is thrown up by rotors revolving in a pool of molten lead. The zinc vapour is absorbed into the lead, and, by withdrawing the lead continuously and cooling it, the saturation point of zinc in lead is reached and molten zinc separates as a distinct layer on the surface. On removal of the zinc overflow, the partially cooled lead is returned to carry out further shock-chilling.

In existing smelters, shaft furnaces vary in area from 15 to 27 square metres (180 to 290 square feet), and capacities range from 50,000 to 100,000 tons of zinc and 30,000 to 50,000 tons of lead per annum. The zinc-lead blast furnace has the flexibility to accept a wide range of mixed ores and residues in its feed. Complex sulfide ores have to be sintered, but oxidized residues such as zinc ashes and drosses recovered from galvanizing processes, oxides produced from low-grade residues, lead smelter dusts, and steel-mill dust high in lead and zinc can bypass the sinter roasting process. A number of cold and hot briquetting techniques are available to consolidate these low-grade materials so that they may be charged directly to the furnace.

Distillation refining

The blast furnace produces an ordinary grade of zinc containing 1.2 percent lead. This can be used in general galvanizing, but an additional refluxing operation must be performed to produce high-grade zinc. The operation is performed in two fractionating columns, each consisting of a series of superposed rectangular trays made of bonded silicon carbide refractory material and arranged to allow a descending flow of liquid metal and an ascending flow of metal vapour. In the first column, a large part of the zinc is vaporized and freed from impurities with higher boiling points, such as lead and iron. The distilled vapour is condensed and fed into the second column, where the liquid's remaining impurity, cadmium, with a boiling point lower than that of zinc, is distilled. High-purity zinc is then run off from the bottom of the column.

Refluxing process

The New Jersey Zinc Company invented this process in 1930.

The process take advantage of the relatively low boiling point of zinc (907 °C (1,665 °F)) as compared to the impurities being removed in the first "column": iron and aluminium. Therefore, in the first column the zinc is heated above its boiling point and allowed to rise to a condenser. The iron and aluminium impurities sink to the bottom in the form of a solid or liquid. There are still lead and cadmium vapor impurities. In order to remove the lead 2-3% of the vapor is condensed, which draws the majority of the lead out of the vapor; down to the point where it is only 0.003% of the total contents. Finally the vapor is pumped into the cadmium column where it is cooled to an intermediate temperature below the boiling point zinc, but still above the boiling point of cadmium (767 °C (1,413 °F)). The zinc leaves out the bottom as a refined liquid, while the cadmium leaves out the top as vapor.

Flow sheet Explanation

The technique of smelting and converting not applicable for Zn extraction because ZnS not melt even at 1500^0 C. Zn% 55 in concentrate treated under roasting, then it go for sintering where roasted oxide ground and agglomerates then go under C reduction to give Zn in vapour form. For volatilisation hearth roaster used instead of other.

Initial stage roasting i.e. volatilisation a hearth roaster employs. Then remaining PbS removed during sintering rather than high temperature. In order to prevent distillation of Pb present in Zn concentrate to obtain high grade Zn with low Pb in retort distillation.

In most cases, fluid bed roaster allotted instead of hearth roaster because of following advantages

- Autogeneous

- Good control over high through put of Zn calcine

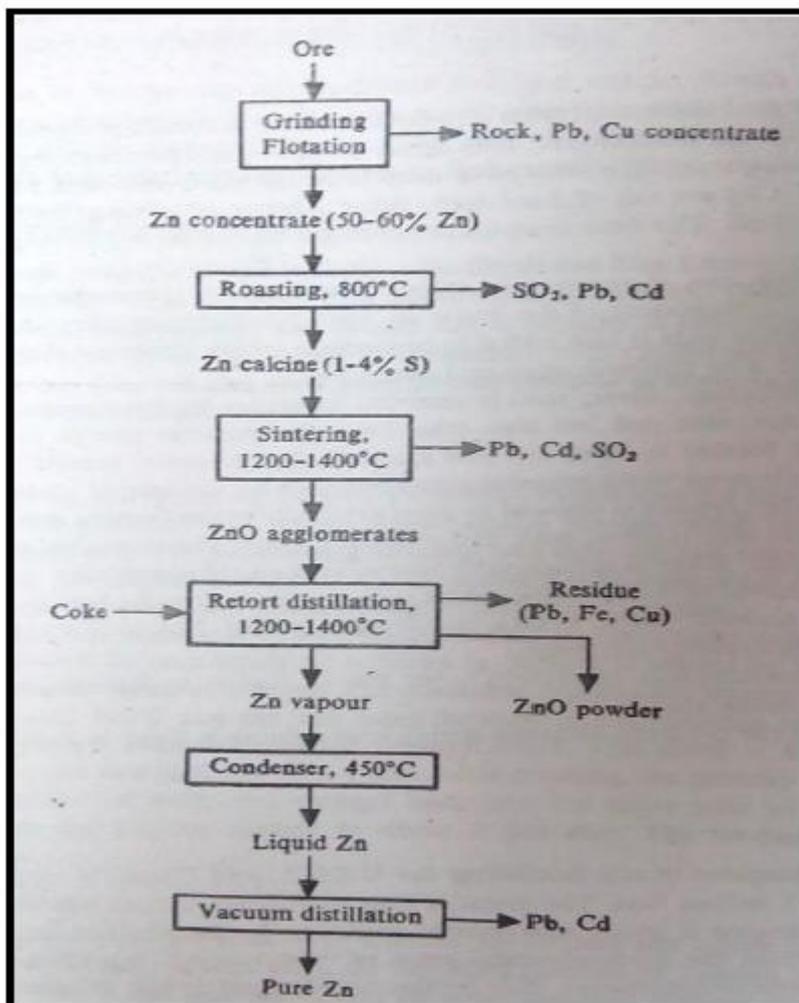- Generate SO_2 suitable for acid production

Fig. : Extraction of Zinc by Reduction of ZnO by Carbon

Uses or Applications:
- ❖ Zn extensively used as a protective coating for steel (Galvanization).
  - o Restrict atmosphere corrosion by impervious basic $ZnCO_3$ layer.
  - o Zn is more electropositive.
- ❖ Fabrication of Cu-Zn alloys i. e. brasses.
- ❖ Spraying – Zn used as for spraying in comparison to other metal on that metal which has low melting point.
- ❖ Rolled Zn: Usual method of cold working. Zn is rolled to sheet, plate, and strip. Where, sheet plates are rolled from 98.5% Zn.
- ❖ Pigment: Zn in the form of its oxides used in manufactured of paints.
- ❖ Alloys: Mainly Cu-Zn alloy produce of 30-37% Zn which is much less plastic when cold and worked about 5000 C which mainly used as die casting alloy.

Area of Extraction:
- ❖ Zawar Mines (Rajasthan).
- ❖ HZL (Hindustan Zinc Ltd.).

❖ COMINCO-BINANI at Kerala

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