Principles of Metallurgy

Improve your learning

Q. 1. List three metals that arc found in nature as oxide ores.

Answer : Three metals that are found in nature as oxide ore are : -

a. Zinc as Zincite[Zno]

b. Iron as Haematite [Fe_2O_3] and Magnetite [Fe_3O_4]

c. Manganese as pyrolusite [MnO_2]

Q. 2. List three metals that are found in nature in uncombined form.

Answer : Three metals that are found in nature in the uncombined form are:-

a. Silver

b. Platinum

c. Gold

These metals are found in the uncombined state because they are very much less reactive.

Q. 3. Write a note on the dressing of ore in metallurgy?

Answer : Ores that we obtain from the mines in the raw form are not very much pure and is usually contaminated with a very huge amount of impurities such as soil, sand, gravel etc.

Dressing of ore in metallurgy refers to a process in which we get rid of as much a possible of the unwanted rocky material already present in it.

Q. 4. What is an ore? On what basis a mineral is chosen as an ore? .

Answer : The minerals from which the metals can be extracted without economical loss and with the available technology are called ores.

A mineral is chosen as an ore based on the following considerations

a. Availability of the metal in a high percentage or composition.

b. Extraction of the metal from mineral should be economically profitable.

Q. 5. Write the names of any two ores of iron?

Answer : Any two ores of iron are : -

a. Haematite (Fe_2O_3) and

b. Magnetite (Fe_3O_4).

Q. 6. How do metals occur in nature? Give examples to any two types of minerals.

Answer : The earth's crust is the major source of metals.

In the crust, some metals which are less reactive mostly occur in their free states like the ore of Gold (Au), silver (Ag) and copper (Cu).

Most of the metals are found in nature in the move combined form due to their more reactivity. The compounds of the metals which occur in

in the earth, crust are called minerals.

Any two types of minerals are:-

Oxide minerals:

Bauxite ($Al_2O_3.2H_2O$), Haematite (Fe_2O_3),

Sulphide Minerals:

Zinc Blende (ZnS) Cinnabar (HgS) Galena (PbS)

Q. 7. Write short notes on froth floatation process?

Answer :

Froth floatation process

a. This method is mainly useful for sulphide ores which have a very low or almost no wetting property.

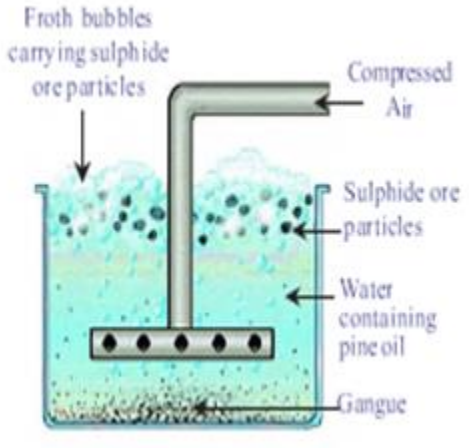
b. The ore with impurities is finely powdered and then is being kept in watercontaining pine oil all of which are taken in a floatation cell.

c. Air under pressure is blown to produce froth in the mixture prepared above.

d. Froth so produced, takes the ore particles to the top surface whereas impurities settle at the bottom.

e. Forth is separated and washed to obtain ore particles.

The above process is as shown below:-



Q. 8. When do we use a magnetic separation method for concentration of an ore? Explain with an example?

Answer : Magnetic Separation Method:

Between ore and gangue, if one of them is magnetic and the other is non-magnetic. Then they are separated by magnetic separation method.

It could be seen in the extraction of the magnetic ores like Haematite [Fe_2O_3] and Magnetite [Fe_3O_4]

In this process, the crushed ore is allowed to

pass through electromagnetic belts; then the mineral particles are retained in the belt while the gangue particles are thrown away.

Q. 9. Write short notes on each of the following:

i) Roasting ii) Calcinations iii)Smelting.

Answer : i) Roasting:-

a. Roasting is a pyrochemical process in which the ore is heating in the presence of oxygen or in the presence of air below its melting point.

b. The sulphide ores are usually converted into oxides by the process ofroasting.

c. The products obtained in this process also are in the solid state.

Example - $2ZnS+3O_2 \rightarrow 2ZnO+2SO_2$

ii) Calcination

a. Calcination is a pyrochemical process in which the ore is heated in the absence of air.

Example – $MgCO_3 \rightarrow MgO + CO_2$

iii) Smelting

a. Smelting is a pyrochemical process, in which the ore is mixed with flux and fuel, and then it is strongly heated.

b. During smelting, the impurities (gangue) in the ore react with flux to form a slag which is removed.

c. For haematite ore, coke is used as fuel, and lime stone is used as a flux.

Example- $Fe_2O_3 + 3CO \rightarrow 2\ Fe + 3CO_2$

Q. 10. What is the difference between roasting and calcinations? Give one example for each?

Answer :

Roasting	Calcination
In this process, the ore is heated in the presence of air.	In this process, the ore is heated in the absence of air.
It is used for mainly for sulphide ores.	It is used for mainly for carbonate ore.
Example- $2ZnS+3O_2 \rightarrow 2ZnO+2SO_2$	Example- $CaCO_3 \rightarrow CaO + CO_2$

Q. 11. Define the temp i) gauge ii) slag.

Answer : i) gauge

The unwanted rocky materials or impurities present in the ore are called gangue.

ii) slag

The impurities that are obtained during the poling process gets oxidized to form scum over the surface of the molten metal. This scum is called slag.

Q. 12.Magnesium is an active metal if it occurs as chloride in nature, which method of reduction is suitable for its extraction?

Answer : Magnesium is an active metal. It occurs in chloride form in nature as $MgCl_2$. Hence electrolysis method would be a suitable method for its reduction.

Q. 13. Mention two methods which produce very pure metals?

Answer : Electrolysis and reduction are the two methods that produce very pure metals and are used I the extraction process of many useful ores to obtain the required metals in their pure form.

Q. 14. Which method do you suggest for extraction of high reactivity metals? Why?

Answer : Highly reactive metals like K, Ca, Mg, Ca etc., can be extracted by the method of electrolysis most conveniently.

The reason for the above conclusion are as follows:-

a. Simple reduction methods like heating with C, CO, etc in order to reduce the ores of these metals are not feasible yet.

b. The temperature required to carry out the above reduction is too high and very much expensive thus less economical.

Q. 15. Suggest an experiment to prove that the presence of air and water an essential for corrosion. Explain the procedure.

Answer : An experiment to prove that the presence of air and water are essential for corrosion is:-

Materials required:

Three test tubes, three iron nails, oil, water, anhydrous calcium chloride, rubber corks.

Procedure to follow : -

a. In the first step take 3 test tubes and place clean iron nails in each of them. Label the test tubes as A, B and C.

b. Pour some water in test tube A and cork it up.

c. Pour boiled distilled water in test tube B, and add about 1ml of oil and cork it up also.

d. Put some anhydrous calcium chloride in test tube C and cork it.

e. Leave these test tubes for a few days and then observe the nails.

f. It would be observed that the nails in test tube A and B would have rusted but not the nails in the test tube C.

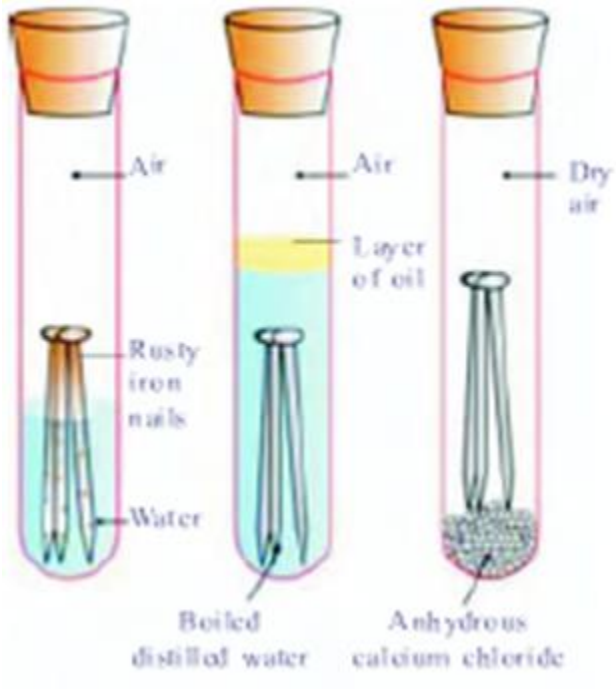
Explanation –

a. In test tube A, the nails are being exposed to air and water. Hence the nails rusted.

b. In the test tube B, the nails are only being subjected to the water as the oil cancelled the exposure to air. Hence, the nails are also rusted here.

c. In test tube C the nail is only being exposed to dry conditions because the anhydrous Calcium Chlorate present had absorbed any moisture if present in the test tube. Hence, here the nails had not rusted due to the absence of air and water.

Hence from the above experiment we can conclude that air and water are essential for corrosion.



Explanatory Diagram

Q. 16. Collect information about extraction of metals of low reactivity silver, platinum and gold and prepare a report.

Answer : <u>Extraction of silver</u>

1) Silver occurs in both combined state as well as in the free state. The important ores of silver are Argentite (Ag_2S) copper, Silver glance, Horn silver, Ruby silver etc.

2) Silver is extracted from the ore-Argentite (Ag_2S)

3) The ore is crushed, concentrated and then treated with sodium cyanide solution.

4) The reaction forms sodium argento cyanide [$Na[Ag(CN)_2]$].

$Ag_2S + 4\ NaCN \rightarrow 2\ Na\ [Ag(CN)_2] + 2\ Ag.$

5) This solution of sodium argento cyanide combined with zinc dust forms tetra ayano zincate and principle silver. This precipitated silver is called spongy silver.

$Zn + 2\ Na\ [Ag(CN)_2] \rightarrow Na_2\ [Zn(CN)_4] + 2\ Ag.$

6) The spongy silver is fused with potassium nitrate to obtain pure silver. Then the silver obtained is purified by the electrolytic process.

Extraction of Platinum

1) Platinum is rarely found on its own, but in combination with other base & precious metals.

2) The extraction process of platinum is quite complex, which includes milling the ore and smelting it at high temperatures. This removes base metals notably the concentrate PGM (platinum Group Metals) – gold, platinum & palladium.

3) The PGM matter is further processed by electrolysis to remove nickel, cobalt & copper.

4) The high grade concentrate is treated by solvent extraction distilling, ion- exchange treatments to separate the PGM's into its separate metals.

Extraction of Gold

1) Gold is usually found alone or alloyed with mercury or silver.

2) In all methods of gold ore refining, the ore is usually washed and filtered at the mine, then sent to the mill. At the mill, the ore is ground into smaller particles with water, then ground again in a ball mill to further pulverize the ore.

3) Several processes can be used to separate the gold from its ore, They are-

a. Carbon-in-pulp Method:

i. In this method, the ground ore is mixed with water before cyanide is added. Then carbon is added to bond with the gold.

ii. The carbon-gold particles are put into a caustic carbon solution, separating out in the gold.

b. Cyanide process

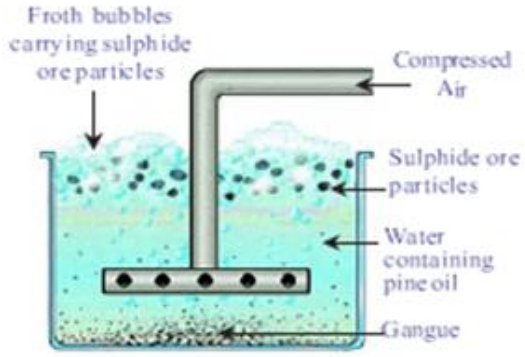
i) The ground ore is put in a tank containing a weak cyanide solution, and then zinc is added.

ii) The zinc causes a chemical reaction which separates the gold from the ore.

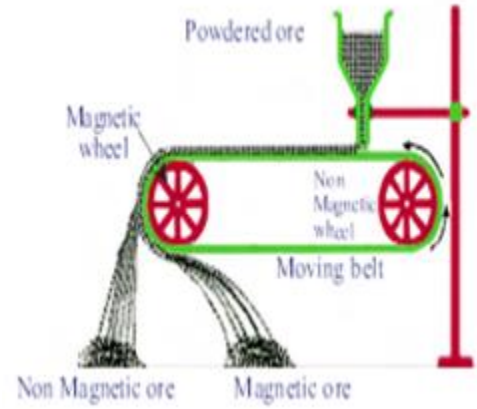
iii) The gold is then removed from the solution with a filter press.

Q. 17. Draw the diagram showing i) Froth floatation ii) Magnetic separation.

Answer : i)



Froth floatation



Magnetic separation

Q. 18. Draw a neat diagram of Reverboratory furnace and label it neatly?

Answer :

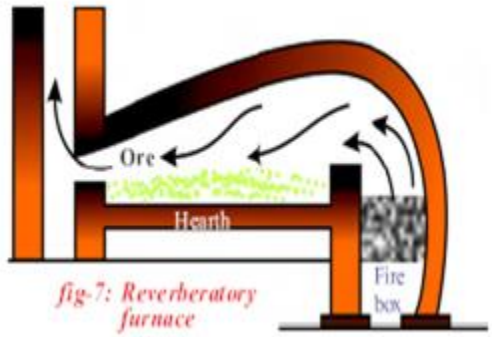


fig-7: Reverberatory furnace

Q. 19. What is an activity series? How does it help in the extraction of metals?

Answer : To understand the way in which the metal that are very close in properties to each other react and to obtain their order of reactivity we study their reactions with cold water, steam, dilute and strong acids and based upon their reactivity order in these reactions we make our activity series.

Arrangement of the metals in decreasing order of their reactivity is known asthe activity series.

Use of activity series in the extraction of metals:

i) The method is used for a particular metal for the reduction of its of its ore to the metal depends on the position of the metal in the activity series.

ii) The T metals at the middle of the activity series can be extracted by any of the following methods -

a. Reduction of metal oxide with carbon.

b. Reduction of oxide ores with CO(Carbon monoxide).

c. Self reduction of sulphide ores.

d. Reduction of ores with more reactive metals (thermite process).

iii) The metals which are present at the bottom of the activity series which areless reactive can be extracted by heating alone because these elements are often found in a free state in nature.

Q. 20. What is the thermite process? Mention it's applications in daily life?

Answer :

1) The thermite process involves the reaction of metal oxides with Aluminum.

2) When highly reactive metals such as sodium (Na), calcium (Ca) aluminum (Al) are used as reducing agents, they haver the tendêncy to displace themetals of lower reactivity from the compound.

3) These displacement reactions are highly exothermic. The amount of heat evolved is so large that metals produced in this reaction would be in a molten state.

Applications of thermite process:

1) The reaction of Iron Oxide (Fe_2O_3) with aluminum is used to join railings of railway tracks or to join cracked machine parts.

2) It is also used for joining of the cracked metal utensils in the house.

Q. 21. When do we use handpicking and washing methods in our daily Give, examples? How do you correlate, these examples with enrichment of ore?

Answer :

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Hand pickling:

Hand pickling can be used for cleaning rice, cereals, grading of vegetables and fruits etc., in our day to day daily life.

In the ore, particles and the impurities are different in their shape, size, colour etc., using that property, the ore particles are handpicked separating them from other impurities.

Washing:

1) Washing can be used in our daily life to separate the impurities from cloth, rice, cereals etc.

2) In this process ore particles are at first crushed and kept on a soapy surface they are then washed with a controlled flow of water. Less dense impurities are carried away by water flow, leaving the more dense ore particles behind.