

7.3 MERCURY

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🔗 Learning outcomes

After completion of the chapter, Students should be able to:

- ✓ Describe the occurrence of copper
- ✓ Describe the extraction of copper
- ✓ State properties of mercury.
- ✓ Explain the chemistry (preparation, properties, and uses) of calomel and corrosive sublimate.

Occurrence

Generally, it occurs in a combined state.

The main ore is sulphide ore, **cinnabar** (HgS).

It has also been found as an amalgam of gold and silver.

Hg is mainly extracted in Russia, Spain, Mexico, and Algeria.

In Nepal, Hg is reported from Tirche Pani/Taruka and the Khimti river.

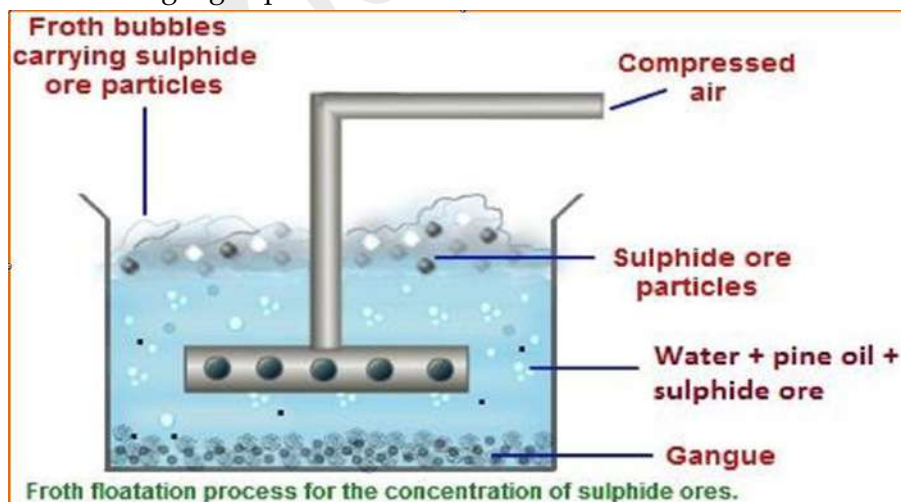
Extraction of Hg from Cinnabar

A) Crushing and Pulverisation

The ore is crushed in big jaw crushers, finely powdered in ball mills and sieved.

B) Concentration

- The process of removing gangue particles from ore.
- Gangue - unwanted material or impurities in the form of sand, rock etc. that surrounds the mineral in an ore deposit.
- The sulphide ores are concentrated by **the froth flotation process**.
 - The ore is powdered, and a suspension is created in water and pine or eucalyptus oil is added.
 - The suspension is stirred constantly by a blast of compressed air.
 - The oil (froth) wets the metal, and the water wets the gangue.
 - This frothy metal sulphide ore is skimmed off from the top.
 - The gangue particles remain at the bottom and are removed.

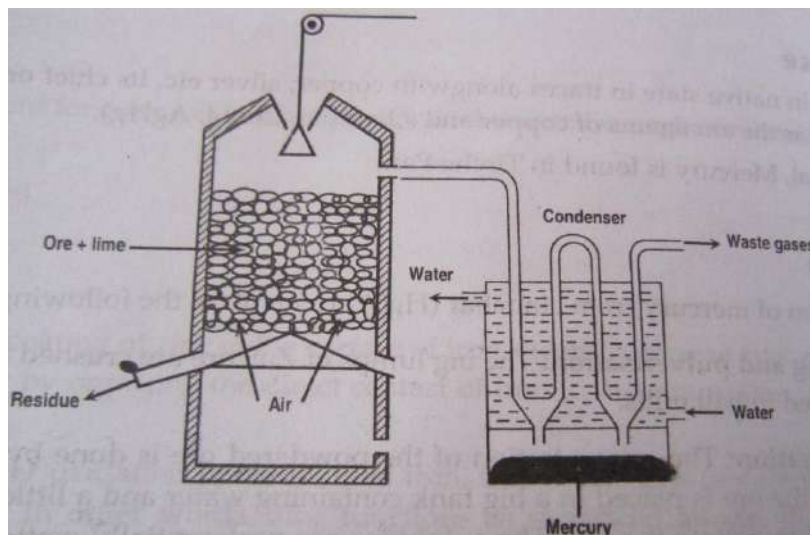


A) Roasting and Distillation

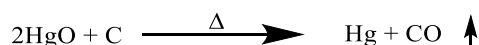
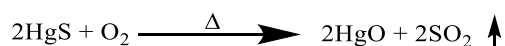
- In the modern process, the concentrated ore is mixed with 2% coke and charged into a **shaft**

furnace.

- A blast of air is introduced from the bottom to burn the fuel for heating purposes.



- The sulphide ore gets converted into oxide which then decomposes to give metallic mercury in vapour state.



- The vapour of mercury, along with gases, comes out from the furnace and is passed through Y-shaped water-cooled iron pipes, which act as condensers where vapours of mercury condense, and waste gases escape from outlets.
- Mercury thus obtained is about 99.7% pure.

C. Purification

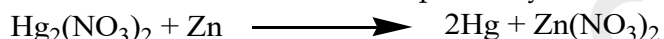
Mercury thus obtained is not pure and contains impurities like Zn, Cd, Fe, Pb, Ag, Au, etc., so it is refined by following methods;

- Certain reactive metals form their oxides due to their partial oxidation by air. These are removed by filtration through chamois leather or canvas.
- Impurities like Zn, Fe, Cu, etc. are removed by introducing the crude mercury into a tube that contains 5% HNO_3 .

The metals form their soluble nitrates and get separated from mercury.



If any mercurous nitrate is formed, it is displaced by these metals,



The mercury thus purified may contain Au, Ag, Pt, etc. as impurities. These are removed by vacuum distillation, where more volatile mercury is distilled off, leaving impurities.

Properties of mercury

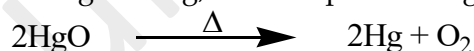
- Mercury is a silvery-white liquid.
- It solidifies at $-38.9\text{ }^{\circ}\text{C}$ and boils at $357\text{ }^{\circ}\text{C}$.
- It is the heaviest liquid known at ordinary temperature, and its density is 13.6.

1. Action with air:

At ordinary temperature, mercury does not react with air. When heated up to 350°C , it slowly oxidises to mercuric oxide,



On strong heating, it decomposes to Hg and O₂.



1. Action with acids:

a) With HCl:

It is not affected by dilute or concentrated HCl.

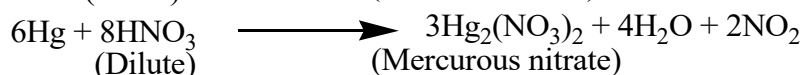
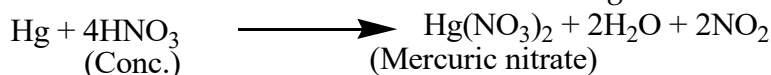
b) With H_2SO_4 :

It does not react with dil. H_2SO_4 , but reacts with conc. H_2SO_4 to give SO_2 gas.



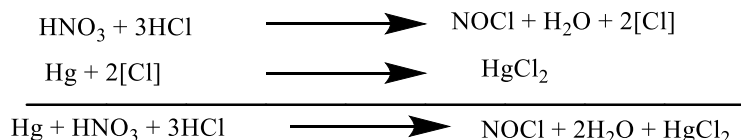
c) With HNO_3 :

Mercury reacts with different concentrations of HNO_3 to give different oxides of nitrogen.



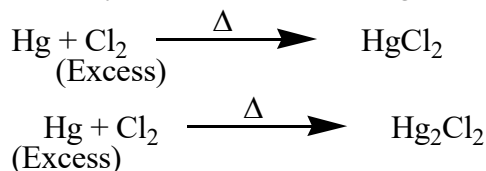
d) With aqua regia:

Aqua regia is a mixture of concentrated nitric acid and concentrated hydrochloric acid in a molar ratio of 1:3. Mercury dissolves in aqua regia to form mercuric chloride.



2. Action with halogen:

When mercury is heated with a halogen, it gives a different product under different conditions.



Mercury poisoning

Mercury vapours are poisonous and can cause giddiness, tremors, lung and brain damage if inhaled.

Many organic and inorganic mercuric compounds are also poisonous. They may cause deafness, brain damage and even death.

Uses of Hg

- In the thermometer, barometer, etc.
- In the mercury vapour lamp.
- In the extraction of gold & silver by the amalgamation process.
- To make amalgams; some amalgams are used in dentistry
- In the manufacture of ayurvedic medicine, e.g., “*Paro Vasma*”.

Calomel Hg_2Cl_2 [Mercurous chloride]

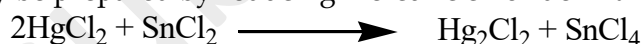
Preparation

1. From mercuric chloride:

When HgCl_2 and Hg are mixed in a 4:3 ratio and heated in an iron vessel, Hg_2Cl_2 sublimes off.

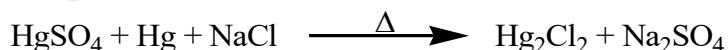


It may be prepared by reducing mercuric chloride with stannous chloride,



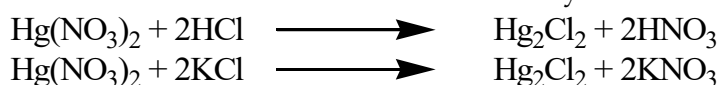
2. From mercuric sulphate:

When mercuric sulphate is heated with sodium chloride in the presence of mercury, Hg_2Cl_2 is formed,



3. From mercuric nitrate:

When mercuric nitrate solution is treated with any soluble chloride, Hg_2Cl_2 is formed.

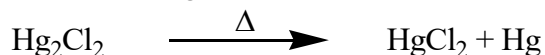


Properties

1. White powder, insoluble in cold water, soluble in hot water.
2. It sublimes when heated.

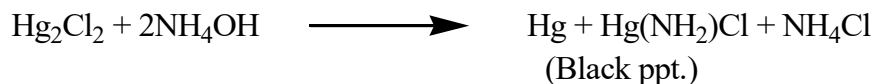
3. Action of heat:

It dissociates into Hg and mercuric chloride when strongly heated.



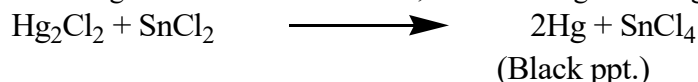
4. Action with ammonia:

When Hg_2Cl_2 is treated with ammonia, a black precipitate of metallic mercury and basic mercuric aminochloride is formed.



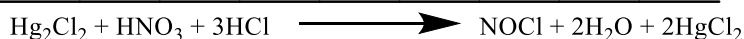
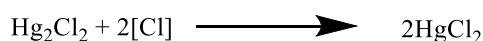
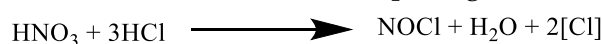
5. Action stannous chloride:

When Hg_2Cl_2 is treated with SnCl_2 , it reduces Hg_2Cl_2 to Hg.



6. Action with aqua regia:

Mercurous chloride dissolves in aqua regia due to the formation of mercuric chloride.



Uses of Calomel

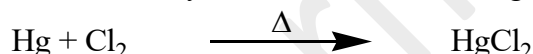
- In medicine as a **purgative** (to clean the intestines).
- In the manufacture of a **calomel electrode**.

Corrosive Sublimate HgCl_2 [Mercuric chloride]

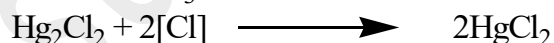
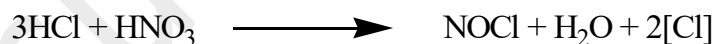
Preparation

1. From Mercury:

When mercury is heated with chlorine gas, HgCl_2 is formed.

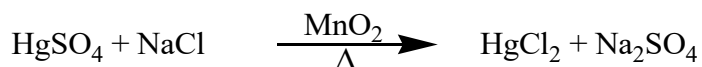


It is also prepared by treating mercury or Mercurous chloride with aqua regia.



2. From HgSO_4 :

When mercuric sulphate is heated with sodium chloride in the presence of MnO_2 , HgCl_2 is sublimed off.



3. From HgO :

When mercuric oxide is treated with dil. HCl , HgCl_2 is formed.



Properties

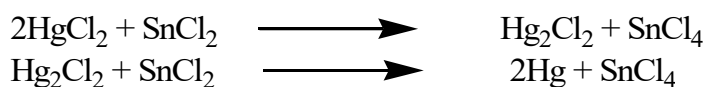
1. White crystalline solid.
2. Slightly soluble in cold water but strongly soluble in hot water.
3. Poisonous and corrosive in nature.
4. **Action of heat:**

It is stable towards heat, but on strong heating it decomposes to free mercury and chlorine.



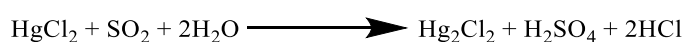
5. Action with stannous chloride:

When HgCl_2 is treated with SnCl_2 , mercuric chloride is reduced to mercurous chloride and then to Hg.



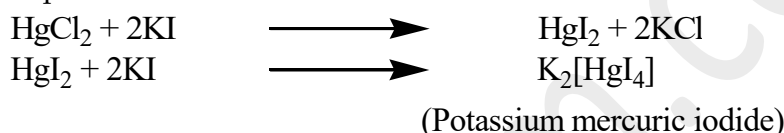
6. Action with sulphur dioxide:

When SO_2 gas is passed through a solution of mercuric chloride, a white precipitate of mercurous chloride is formed.

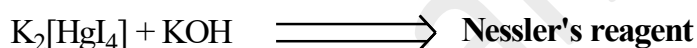


7. Action with potassium iodide:

When mercuric chloride solution is treated with KI solution, a red scarlet precipitate of HgI_2 is formed. On further addition of KI solution, the scarlet ppt. dissolves due to the formation of the complex potassium mercuric iodide.



The alkaline solution of potassium mercuric iodide is called **Nessler's reagent** and is used to detect ammonia.



8. Action with ammonia:

When mercuric chloride is treated with ammonia, a white ppt. of ammonobasic mercuric chloride is formed.



Uses

- As an antiseptic to sterilise surgical instruments.
- To prepare Nessler's reagent.
- In preserving skin, wood, fur, etc.
- It is used as an antidote (medicine used against poison).

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