

7.5 SILVER

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🌟 Learning outcomes

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

- Describe the Occurrence of silver
- Describe the extraction of silver by the cyanide process
- Explain the preparation and uses of silver chloride and silver nitrate

Symbol: Ag Atomic number: 47 Atomic weight: 107.9 amu Electronic configuration: $[\text{Kr}] 4d^{10}5s^1$

Occurrence of Silver

Silver occurs in both the native and combined states. The main producers of Ag metal are Mexico, the USA, Peru, Canada, Australia, etc.

The common ores of silver are

Argentite or silver glance, Ag_2S

Horn silver, AgCl

Ruby silver, Ag_3SbS_3

Argentiferous galena (PbS), which contains 0.01-0.1% Ag

Extraction of Silver by the cyanide process

Crushing and Pulverisation: Large lumps of ore are crushed with the help of a jaw crusher. The crushed ore is pulverised by Ball mills into a fine powder.

Concentration: The crushed ore is then mixed with water and a little pine oil in a tank. It is then agitated by blowing compressed air. Sulfide ore particles are wetted by pine oil and attach to air bubbles. They rise to the surface as froth, while gangue particles are wetted by water and sink. The froth is skimmed off.

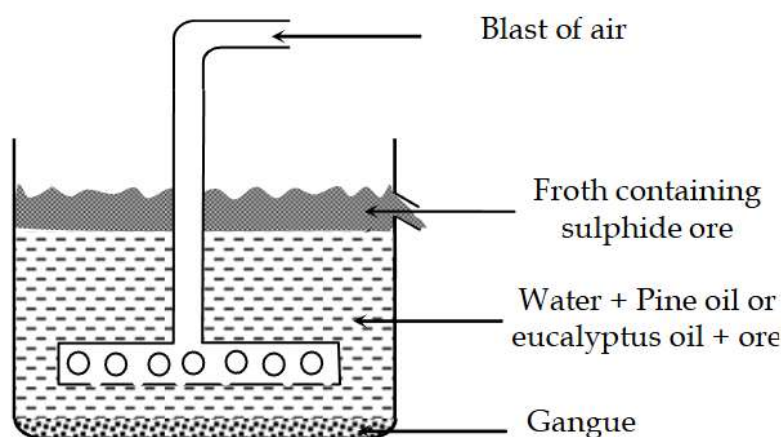
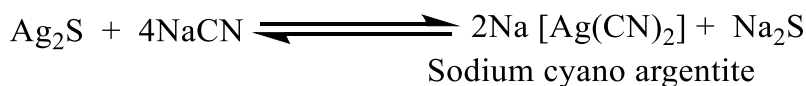


Figure: concentration of sulfide ore by the froth flotation method

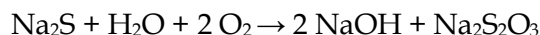
Why is pine oil used in froth flotation?

→ Because it preferentially wets the sulfide ore particles and helps them attach to air bubbles.

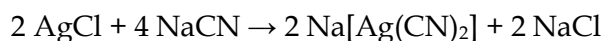
Formation of Complex Cyanides: Concentrated ore is then agitated with NaCN solution using air; soluble sodium argento-cyanide is formed.



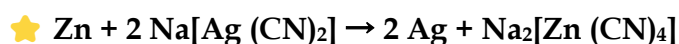
As the reaction is reversible, air is blown to remove Na_2S as $\text{Na}_2\text{S}_2\text{O}_3$ and S. This helps the reaction proceed in the forward direction.



The same procedure can be applied to Horn Silver (AgCl)



Precipitation of silver: The solution is then filtered and treated with zinc metal. Zinc, being more electropositive, displaces silver from the solution.

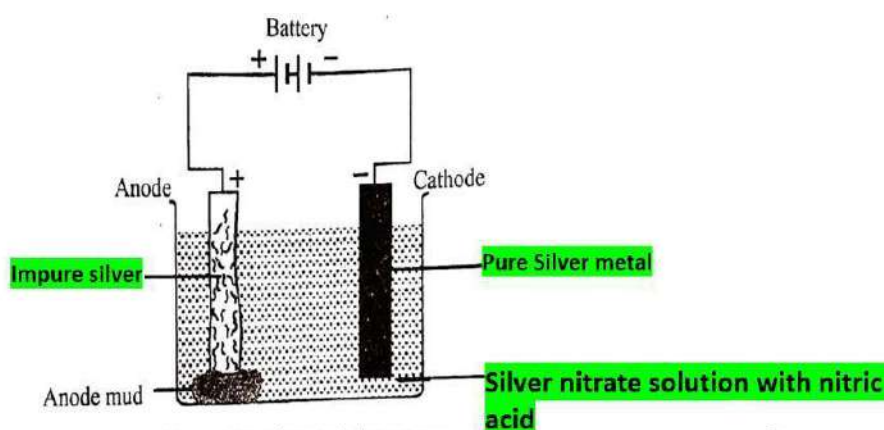


Spongy silver

The precipitated silver is removed by filtration and dried.

Refining: The dried silver is heated with KNO_3 in a crucible. The impurities in the silver get oxidised on the surface, and the liquid silver forms a compact mass on cooling. After that, impure silver is purified by the electrolytic method.

In this process, the anode is made up of impure Ag and the cathode is made up of pure silver. Here, 6% AgNO_3 solution with 1% HNO_3 is used as an electrolytic solution. When an electric current is passed, impure silver from the anode dissolves, and pure silver is deposited on the cathode. Other impurities settle down as anode mud.

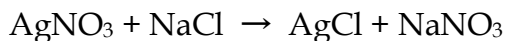


1. What is meant by spongy silver? 2
2. Give various steps involved in the extraction of silver from the silver glance. 5
3. Why are silver ores leached with metal cyanides for the extraction of silver? 2

Silver chloride

Preparation

By adding any soluble chloride to silver nitrate



The **white precipitate** is separated by filtration, washed, and dried.

Uses of Silver Chloride

AgCl is photosensitive and was used in photographic papers.

AgCl is used for making photographic paper.

Silver nitrate

Preparation

By dissolving the silver metal in dilute HNO_3 (e.g. $\text{HNO}_3 : \text{H}_2\text{O} = 1 : 1$) and evaporating the resulting solution to the crystallisation point.



Silver nitrate is a colourless/white crystalline solid. It is also called **lunar caustic** because it is a corrosive silver compound. Silver nitrate is a colourless/white crystalline solid. It can stain skin black when exposed to light because silver compounds are reduced to metallic silver, looking like the moon.

Uses of Silver Nitrate

- laboratory reagent in volumetric analysis for the estimation of chlorides, bromides, cyanides, and thiocyanates as well as in qualitative analysis to detect Cl^- , Br^- , I^- , CN^- , S^{2-} , $\text{C}_2\text{O}_4^{2-}$, CrO_4^{2-} etc.
- In medicine, photography, and electro-refining.
- Making indelible inks (voter's ink).
- Preparation of various silver compounds, like Tollens' reagent.
- As a dental antiseptic

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| 4. Give an important use of silver nitrate. | 1 |
| 5. Give two uses of silver nitrate. | 2 |

MCQs

1. Which one is Ruby silver?
a. Ag_2S b. Ag_2C c. AgCl d. Ag_3SbS_3
2. Lunar Caustic is
a. AgNO_3 b. AgCl c. Ag_2S d. $\text{AgNO}_3 + \text{AgCl}$
3. Silver is extracted from its sulfide ore by
a. Contact process c. Downs process B. Cyanide process d. Ostwald's process
4. In the cyanide process, silver ore is treated with:
A. NaCl B. NaOH C. NaCN D. HCl

5. Which of the following metals is extracted by the cyanide process?
a. Ag b. Na c. Al d. Cu
6. The soluble complex formed during the cyanide extraction of silver is:
A. $\text{Na}[\text{Ag}(\text{CN})_2]$ B. Na_2AgCl_3 C. AgNO_3 D. AgCl
7. In the electrolytic refining of silver, the anode mud obtained contains
a. Zn, Ag & Au b. Cu, Ag & Au c. Au d. Cu, Zn, Ag & Au
8. During electrolytic refining of silver, insoluble impurities such as gold may collect as:
A. Cathode deposit B. Electrolyte C. Anode mud D. Slag
9. The silver obtained after precipitation with zinc is called:
A. Pure silver B. Spongy silver C. Silver chloride D. Silver nitrate
10. In electrolytic refining of silver, impure silver is used as the:
A. Cathode B. Anode C. Electrolyte D. Salt bridge
11. Which of the following compounds is used as the silver source in silvering mirrors?
a. AgCl b. AgNO_3 c. AgBr d. AgS
12. Silver chloride is sensitive to:
A. Heat B. Pressure C. Light D. Sound
13. Which metal is used to precipitate silver from sodium argentocyanide solution?
A. Copper B. Iron C. Zinc D. Sodium
14. Silver nitrate is also known as:
A. Lunar caustic B. horn silver C. quick silver D. caustic soda
15. Which compound is used in the preparation of Tollens' reagent?
A. AgCl B. AgNO_3 C. Ag_2S D. NaCl
16. Which one is a silver halide?
A. Ag_2S B. AgCl C. AgNO_3 D. NaCN
17. All of them are extracted from pyrometallurgy except:
a. Ca b. Hg c. Fe d. Pb

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