OZONE :

- Ozone was first discovered by **Van Marum** in 1785
- The name ozone was given by **Schonbein.**
- **Sorret** assigned the formula of ozone as O_3.
- Ozone is present in the upper layers of atmosphere which is formed by the action of U.V. light on oxygen.
- Ozone layer in upper atmosphere is protecting the life on the earth from bad effect of U.V. radiations coming from the sun.

Preparation :

- Conversion of oxygen to ozone is endothermic

  $3O_2 \rightleftharpoons 2O_3 \quad \Delta H = +284.5$ kJ
- Ozone is prepared by subjecting cold, dry oxygen to silent electric discharge.
- Instruments used for the preparation of ozone are called ozonizers.
- The difference between Siemen's ozoniser and Brodie's ozonizers is only in medium.
- In **Siemen's ozoniser** silent electric discharge is produced by passing electric current through tin foils.
- In **Brodie's ozoniser** silent electric discharge is produced by passing electric current through copper wires dipped in sulphuric acid solution.
- The ozonised oxygen coming out of the ozonizer contain 10% ozone.
- Ozone is manufactured by **Siemen – Halske** method.
- Electrolysis of acidified water with high current density using platinum electrodes gives 95% ozone and 5% oxygen at anode.
- Chemically ozone can be prepared by heating oxygen to 2500°C and quenching it.

Properties :

- Ozone is a **Pale blue** pungent smelling, gas.
- In high concentration ozone is poisonous and produces headache and nausea if inhaled in large quantities.
- Ozone is heavier than air.
- Ozone is slightly soluble in water.
- Ozone is highly soluble in turpentine oil, glacial acetic acid or carbon tetrachloride.
- Ozone is respiratory irritant.
- Thermodynamically ozone is unstable and decomposes

  $2O_3 \rightarrow 3O_2 \quad \Delta H = -284.5$ kJ mol^{-1}
- Two volumes ozone convert's into three volumes of oxygen.
- Decomposition of ozone is **exothermic.**
- The nascent oxygen liberated during the decomposition ozonen is used in oxidation.

- Black lead sulphide is oxidised to white lead sulphate by ozone.

  $PbS + 4\ O_3 \rightarrow PbSO_4 + 4\ O_2$
- Halogen acids are oxidised to the corresponding halogens

  $2HCl + O_3 \rightarrow Cl_2 + H_2O + O_2$
- Ozone liberates iodine from moist KI

  $2KI + H_2O + O_3 \rightarrow 2KOH + I_2 + O_2$
- White shining silver is blackened by ozone due to first oxidation to Ag_2O and then reduction to Ag.

  $2Ag + O_3 \rightarrow Ag_2O + O_2$

  $Ag_2O + O_3 \rightarrow 2Ag + 2O_2$
- In the oxidation of SO_2 to SO_3 and $SnCl_2$ to $SnCl_4$ all the three oxygen atoms are utilised in oxidation and no oxygen gas is liberated.

  $3SO_2 + O_3 \rightarrow 3SO_3$

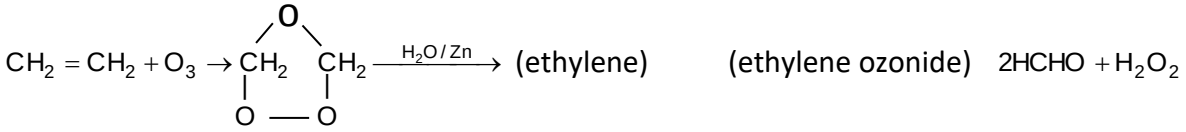
  $3SnCl_2 + 6HCl + O_3 \rightarrow 3SnCl_4 + 3H_2O$
- When ozone is passed through mercury tailing effect takes place.
- The phenomenon of lasing luster, meniscus and consequent sticking nature to glass by mercury is called **tailing effect.**
- Tailing effect of mercury is due to oxidation of mercury to **mercurous oxide**

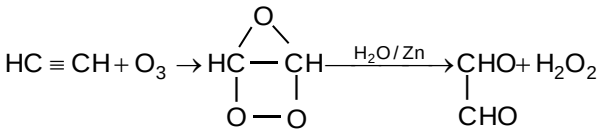
  $2Hg + O_3 \rightarrow Hg_2O + O_2$
- When the tailed mercury is washed with water the mercury regains its original properties.
- Ozone bleaches the vegetable colour by oxidation.
- Ozone can also act as reducing agent.
- Ozone reduces hydrogen peroxide to water

  $H_2O_2 + O_3 \rightarrow H_2O + 2O_2$
- Ozone reduces barium peroxide to barium oxide

  $BaO_2 + O_3 \rightarrow BaO + 2O_2$
- Ozone reduces silver oxide to silver

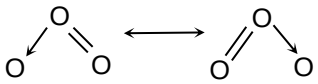
  $Ag_2O + O_3 \rightarrow 2Ag + 2O_2$
- Reduction of H_2O_2 and Ag_2O with O_3 is **mutual reduction** reaction.
- Ozone forms addition compounds with organic compounds containing double and triple bonds called ozonides.
- The ozonides undergo reductive hydrolysis in the presence of water and zinc metal forming carbonyl compounds.
- Formation of ozonide and subsequent reductive hydrolysis forming carbonyl compounds is called **ozonolysis** reaction .





(Acetylene) (Acetyleneozonide) (Glyoxal)

- Ozone is diamagnetic substance
- Ozone is angular in shape
- The bond angle in ozone is 116° 49′
- The O–O bond length in ozone is 128 pm (1.28 A°) which is intermediate of O – O single bond length (1.48 A°) and double bond length (1.21 A°)
- Ozone is a resonance hybrid of two structures



- The hybridisation of central oxygen in ozone is sp^2
- The bond order in ozone is 1.5

Uses :

- Ozone is used in purifying the drinking water by destroying bacteria and virus.
- Ozone is used in improving the quality of air in crowded places like underground railways, mines, cinema halls etc.
- Ozone is used in bleaching oils, oil paintings, ivory articles.
- Ozone is used in the manufacture of artificial silk and synthetic camphor.
- Ozone is used in the detection and determination of number of double and triple bonds in unsaturated organic compounds.
- A mixture of ozone and cyanogen ($O_3 + C_2N_2$) is used as **rocket fuel.**

Sodium thiosulphate :

- Anhydrous sodium thiosulphate $Na_2S_2O_3\ 5H_2O$ is known as **hypo**
- Hypo can be prepared by boiling sodium sulphite solution with sulphur

  $Na_2SO_3 + S \rightarrow Na_2S_2O_3$
- When sulphur is boiled with caustic soda hypo will be formed along with sodium sulphide and sodium pentasulphide

  $6NaOH + 12S \rightarrow Na_2S_2O_3 + 2Na_2S_5 + 3H_2O$
- Sodium pentasulphide can be converted into hypo by atmospheric oxidation

  $2Na_2S_5 + 3O_2 \rightarrow 2Na_2S_2O_3 + 6S$

- When SO_2 gas is passed into sodium sulphide solution hypo will be formed

  $2Na_2S + 3SO_2 \rightarrow 2Na_2S_2O_3 + S$

Properties :

- Hypo is an **efflorescent substance**
- Hypo can form **super saturated solution .**
- When heated to 488 K it loses water of cyrstalisation.
- At high temperatures hypo decomposes to sulphur dioxide, sodium sulphide and sulphur.
- With dilute acids hypo liberates SO_2 gas and colloidal sulphur will be formed

  $S_2O_3^{2-} + 2H^+ \rightarrow SO_2 + S + H_2O$
- With dilute solution of hypo silver nitrate gives first a white precipitate which immediately turns to yellow, brown and finally black due to the formation of black silver sulphide

  $Na_2S_2O_3 + 2Ag\ NO_3 \rightarrow Ag_2S_2O_3 + 2NaNO_3$

  $Ag_2S_2O_3 + H_2O \rightarrow Ag_2S + H_2SO_4$
- With concentrated solution of hypo, silver nitrate first gives a white precipitate of silver thiosuphate which dissolves due to the conversion into complex

  $Na_2S_2O_3 + 2AgNO_3 \rightarrow Ag_2S_2O_3 + 2NaNO_3$

  $Ag_2S_2O_3 + 3Na_2S_2O_3 \rightarrow 2Na_3\ [Ag(S_2O_3)_2]$
- Silver halides dissolve in hypo solution due to the formation of sodium argento thiosulphate complex

  $AgBr + 2S_2O_3^{2-} \rightarrow [Ag\ (S_2O_3)_2]^{3-} + Br^-$

  $AgBr+2Na_2S_2O_3 \rightarrow Na_3[Ag(S_2O_3)_2]+ NaBr$ …(1)
- Chlroine oxidises hypo to sodium sulphate

  $Na_2S_2O_3+Cl_2+ H_2O \rightarrow Na_2SO_4 + 2HCl + S$ …(2)
- Iodine oxidises hypo to sodium tetrathionate

  $Na_2S_2O_3 + I_2 \rightarrow Na_2S_4O_6 + 2NaI$……(3)

Uses :

- Hypo is used in photography as a fixing agent due to its complexing property with silver bromide (reaction 1)
- Hypo is used in textile industry as antichlor to remove excess Cl_2 used in bleaching (reaction 2)
- In the laboratory hypo is used in iodometric titration for the estimation of copper etc (reaction 3)
- In metallurgy hypo is used in the extraction of gold and silver.
- Hypo is used as antiseptic in medicine.