The temporary hardness of water is due to the ..

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3. **Metallic or interstitial hydrides :** The transition elements and rare earth metals combine with hydro gen to give interstitial hyd rides. They exhibit metallic properties and are powerful reducing agents. They are non stoichiometric com - pounds and their composition varies with temperature and pressure.
   eg. $LaH_{2\cdot76}$, $TiH_{1.73}$
4. **Polymeric hydrides :** These are solids containing mole cu les, linked together in two or three dimensions by hydro gen bridge bonds. e.g.: $(BeH_2)_n$, $(MgH_2)_n$ and $(AlH3)_n$

HYDROGEN PEROXIDE

Discovery : French chemist The nard 1818.

Occurrence : Traces in air, rain and plants.

PREPARATION OF HYDROGEN PEROXIDE

1. **Lab method :** From true peroxide by the action of ice cold dil. H_2SO_4

$$Na_2O_2 + H_2SO_4 \rightarrow Na_2SO_4 + H_2O_2$$
$$BaO_2 + H_2SO_4 \rightarrow BaSO_4 + H_2O_2$$

(HNO_3 is not used since it will oxidise H_2O_2).

2. **Merck process :** By passing CO_2 through a suspension of BaO_2 in ice cold water.

$$BaO_2 + H_2O + CO_2 \rightarrow BaCO_3 + H_2O_2$$

MANUFACTURE OF HYDROGEN PEROXIDE

1. By electrolysis of 50% ice cold H_2SO_4

$$2H_2SO_4 \rightleftharpoons H_2 + H_2S_2O_8$$
Persulphuric acid (Marshall's acid)

$$H_2S_2O_8 + H_2O \rightarrow H_2SO_4 + H_2SO_5$$
Permonosulphuric acid (Caro's Acid)

$$H_2SO_5 + H_2O \rightarrow H_2SO_4 + H_2O_2$$

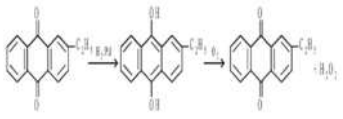
Mechanism :

$$H_2SO_4 \rightleftharpoons H^+ + HSO_4^-$$

At anode : $2HSO_4^- \rightarrow H_2S_2O_8 + 2e^-$

At cathode : $2H^+ + 2e^- \rightarrow H_2$

2. **Auto oxidation :** Most recent method used in America. In this method the anthraqui - none is reduced to anthraqu -inol by dissolving in an org- anic solvent and passing hyd - rogen in presence of Pd. On frothing, the anthraquinol derivative with air, 20% solut- ion of H_2O_2 is obtained and anthraquinone is regenerated.



3. By electrolysis of ammonium sulphate solution and sulp - huric acid. When aqueous solution of ammonium sulp - hate and sulphuric acid in equimolar proportion is elect -rolysed at low temperature ammonium persulphate is formed. The latter on distillation with sulphuric acid gives 30% solution of hydrogen peroxide.

$$(NH_4)_2SO_4 + H_2SO_4 \rightarrow 2NH_4HSO_4$$
$$NH_4HSO_4 \rightleftharpoons NH_4SO_4^- + H^+$$

At anode :
$$2NH_4SO_4^- \rightarrow (NH_4)_2S_2O_8 + 2e^-$$

At cathode : $2H^+ + 2e^- \rightarrow H_2(g)$

$$(NH_4)_2S_2O_8 + 2H_2O \rightarrow 2NH_4HSO_4 + H_2O_2$$

CONCENTRATION OF HYDROGEN PEROXIDE

- It is very carefully concent rated since it decomposes on heating or on standing.

decomposes on heating or on standing.
$$2H_2O_2 \rightarrow 2H_2O + O_2 \text{ (auto-oxidation)}$$

- Decomposition is catalysed by Cu, Ag, Pt, Co, Fe, MnO_2 etc.

The methods employed for concentration are

1. **Evaporation:** By careful evaporation of solution on a water bath (50% H_2O_2 is obtained).
2. **Dehydration in vacuum desicator :** The 50% H_2O_2 is dehydrated in a vacuum desi -cator in presence of conc. H_2SO_4 when 90% H_2O_2 is obtained.
3. **Vacuum distillation :** The 90% H_2O_2 obtained in step (ii) is distilled under reduced pressure to get 100% H_2O_2
4. **Cooling :** The traces of water left are removed by freezing in a freezing mixture when crystals of hydrogen peroxide separate out.

STRENGTH OF HYDROGEN PEROXIDE

The strength of hydrogen pero xide is indicated in terms of the volume of oxygen at NTP that 1 volume of H_2O_2 gives on heating. For example "20 volume H_2O_2 means 1 volume of H_2O_2 at NTP will give 20 volume of oxygen. The normality and percentage strength of H_2O_2 can be calculated as follows

$$2H_2O_2 \rightarrow 2H_2O + O_2$$

2 × 34 = 68 g 1 mole O_2 = 22.4 litres of O_2 at NTP

22.4 litres of O_2 at NTP are evolved from 68g of H_2O_2

x litres of O_2 at NTP would be evolved from $\frac{68}{22.4} \times x$ g of H_2O_2

where x is volume strength of H_2O_2

Hence strength of x volume of H_2O_2 = $\frac{68 \times x}{22.4}$ g/litre

- where 17 is the equivalent weight of H_2O_2

STORAGE OF HYDROGEN PEROXIDE

- It is stored in presence of traces of alcohol, acetanilide or sodium pyrophosphate which slow down the rate of decomposition of hydrogen peroxide.

CHEMICAL PROPERTIES OF HYDROGEN PEROXIDE

1. **Acidic nature :** It is weakly acidic in nature and pure hydrogen peroxide turns blue litmus into red. (Ka = 1.57 × 10^{-12} at 293 K). It ionises in two steps H_2O_2 $H^+ +$

$$H_2O_2 \rightleftharpoons H^+ + HO_2^-$$
$$HO_2^- \rightleftharpoons H^+ + O_2^{2-}$$

- Hence it forms two series of salts eg. $NaHO_2$ sodium hydroperoxide and Na_2O_2 (Sodium peroxide)

2. **Oxidising agent :** It is strong oxidising agent in acidic as well as in basic medium.

$$H_2O_2 + 2H^+ + 2e^- \rightarrow 2H_2O \quad E^\circ = 1.77\ V$$
$$H_2O_2 + OH^- + 2e^- \rightarrow 3OH^- \quad E^\circ = 0.88\ V$$

or

$$H_2O_2 \rightarrow H_2O + O$$
$$PbS + 4O \rightarrow PbSO_4$$

$$2FeSO_4 + H_2SO_4 + O \rightarrow Fe_2(SO_4)_3 + H_2O$$
$$[Fe(CN)_6] + H_2O + O \rightarrow 2K_3[Fe(CN)_6] + 2KOH$$
$$H_2Cr_2O_7 + 4O \rightarrow \underset{\text{Blue peroxide of chromium}}{2CrO_5} + H_2O$$
(Chromic acid)

$$C_6H_6 + O \rightarrow C_6H_5OH$$

In basic medium

$$2Cr^{3+} + 3H_2O_2 + 10OH^- \rightarrow 2CrO_4^{2-} + 8H_2O$$
$$Mn^{2+} + H_2O_2 + 2OH^- \rightarrow MnO_2 + 2H_2O$$

In basic medium

$$2Cr^{3+} + 3H_2O_2 + 10OH^- \rightarrow 2CrO_4^{2-} + 8H_2O$$
$$Mn^{2+} + H_2O_2 + 2OH^- \rightarrow MnO_2 + 2H_2O$$

3.Reducing agent :

a.In acidic medium

$$\underset{\text{Pink}}{2MnO_4^-} + 6H^+ + 5H_2O_2 \rightarrow 2Mn^{2+} + 8H_2O + 5O_2$$
$$Cr_2O_7^{2-} + 8H^+ + 3H_2O_2 \rightarrow 2Cr^{3+} + 7H_2O + 3O_2$$

b.In basic medium

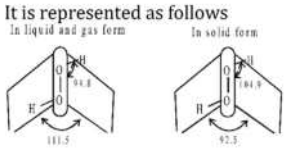
$$2K_3[Fe(CN)_6] + 2KOH + H_2O_2 \rightarrow 2K_4[Fe(CN)_6] + 2H_2O + O_2$$

4.Bleaching properties : Its bleaching action is due to oxidation reaction.

$$H_2O_2 \rightarrow H_2O + O$$
$$dye + O \rightarrow dye\ is\ oxidised\ and\ bleached$$

STRUCTURE OF HYDROGEN PEROXIDE

It is represented as follows



TEST OF HYDROGEN PEROXIDE

1.It liberates I_2 from acidified KI

$$2KI + H_2O_2 \rightarrow 2KOH + I_2$$

2.Perchromic acid :

$$H_2Cr_2O_7 + 4H_2O_2 \rightarrow \underset{\text{Blue colour (chromium peroxide)}}{2CrO_5} + 5H_2O$$

(acidified H_2O_2 + amyl alcohol + $K_2Cr_2O_7$) → blue colour

3. With titanic sulphate it gives orange red pertitanic acid

$$Ti(SO_4)_2 + H_2O_2 + 2H_2O \rightarrow 2H_2SO_4 + H_2TiO_4$$

4.Black lead sulphide turned white

$$PbS + 4H_2O_2 \rightarrow PbSO_4 + 4H_2O$$

USES OF HYDROGEN PEROXIDE

- It is used as a bleaching agent, disinfectant, source of power (90% H_2O_2 as fuel in submarines, rockets and helicopters), in restoration of old paintings in which lead oxide is used as white paint.

IIT/NEET Foundation CHEMISTRY

WATER

Water is one of the most abundant substances in nature. The 4/5th of the earth surface is covered with water.

SOURCES OF WATER

The sources of water are

1.Surface water

a. Flowing water - streams and rivers
b. Still water - ponds, lakes and reservoirs

2.Underground water - water from wells

3.Rain water

4.Sea water

TYPES OF IMPURITIES PRESENT IN WATER

Dissolved impurities

- Inorganic salts eg. : Ca^{2+}, Mg^{2+}, Fe^{2+}, Al^{3+}, Na^+, K^+ traces of Zn^{2+} and Cu^{2+} (cations) and Cl^-, F^- etc. (anions)Gases eg.: CO_2, N_2, O_2, oxides of nitro gen, H_2S etc.Organic salts

Suspended impurities :

- Inorganic : eg.: sand and clay
- Organic : eg.: animal matter, vegetable etc.

3. **Colloidal impurities :** Finely divided clay, $Al(OH)_3$, $Fe(OH)_3$ colouring matter etc.
4. **Bacterial impurities :** Micro-organisms and bacteria

Effect of impurities : The impu -rities effect the followings

- Colour
- Taste
- Hardness
- Alkalinity
- Turbidity
- Odour

SOFT AND HARD WATER

- The water which produces large amount of lather with soap is known as soft water and which forms a scum with soap is known as hard water.

TYPES OF HARDNESS OF WATER

- Temporary hardness: It is due to the presence of bicarbonates of calcium or magnesium or both.
- Permanent hardness : It is due to the presence of chlorides and sulphates of calcium and magnesium.

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