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1) Describe the determination of dissolved oxygen (DO) in water by idometric / winkler's method.

→ The winkler method is a technique used to measure dissolved oxygen in water. Dissolved oxygen is used as an indicator of a water body.

The winkler method uses titration to determine dissolved oxygen in the water sample. A sample bottle is filled with water (no air is left to skew the results). The dissolved oxygen in the sample is then "fixed" by adding a series of reagents that form an acid compound that is then titrated with a neutralizing compound that results in color change. The point of color change is called the "endpoint" which coincides with the dissolved oxygen concentration in the sample. The sample will be less altered by atmospheric equilibration.

Dissolved oxygen analysis can be used to determine :

i) The health or cleanliness of a lake or stream.
ii) The amount and type of biomass a freshwater system can support.
iii) The amount of decomposition occuring in the lake, etc.

In the winkler method, an excess of maganese (II) salt, iodide (I^-) and hydroxide (OH^-) ions are added to a water sample causing a white precipitate of $Mn(OH)_2$ to form. This precipitate is then oxidized by the oxygen that is present in the water sample into a brown manganese - containing precipitate with manganese in a more highly oxidized state.

In the next step, a strong acid (HCl or H_2SO_4) is added to acidify the solution. The brown precipitate then converts the iodide ion (I^-) to iodine. The amount of dissolved oxygen is directly proportional

to the titration of iodine with a thiosulfate solution. Today, the method is effectively used as its colorimetric modification, where the trivalent manganese produced on acidifying the brown suspension is directly reacted with ethylenediaminetetraacetic acid to give a pink color.

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2) How permanent hardness of water can be removed by hot lime soda process ?

→ i) Permanent hardness is caused by the presence of soluble salt of calcium & magnesium other than bicarbonates such as chlorides and sulphate.

ii) Soda lime is a process used in water treatment to remove Hardness from water.

iii) This process is now obsolete but was very useful for the treatment of large volumes of hard water.

iv) Addition of lime (CaO) and soda (Na_2CO_3) to the hard water precipitates calcium as the carbonate and magnesium as its hydroxide.

v) The lime - soda uses, $Ca(OH)_2$ and soda ash, Na_2CO_3 to precipitate hardness from solution.

vi) Hot lime - soda process is usually carried out under pressure at temperature of 227 - 240 °F. At the operating temperature, hot process softening reactions go essentially to completion.

vii) The use of lime and soda ash permits hardness reduction down to 0.5 gr. or about 8 ppm, as calcium carbonate.

viii) Magnesium is reduced to 2-5 ppm because of the lower solubility of magnesium hydroxide at the elevated temperatures.

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3) State Zeolite process for the removal of hardness of water. Discuss it's merits over Soda lime process.

→ i) Zeolite is micro-porous mineral which is used as catalyst in many industrial purposes such as water purification and air purification.

ii) Zeolites are hydrated alumino silicates and its chemical formula is $Na_2O, Al_2O_3, x\,SiO_2, y\,H_2O$ ($x = 2-10$, $y = 2-6$).

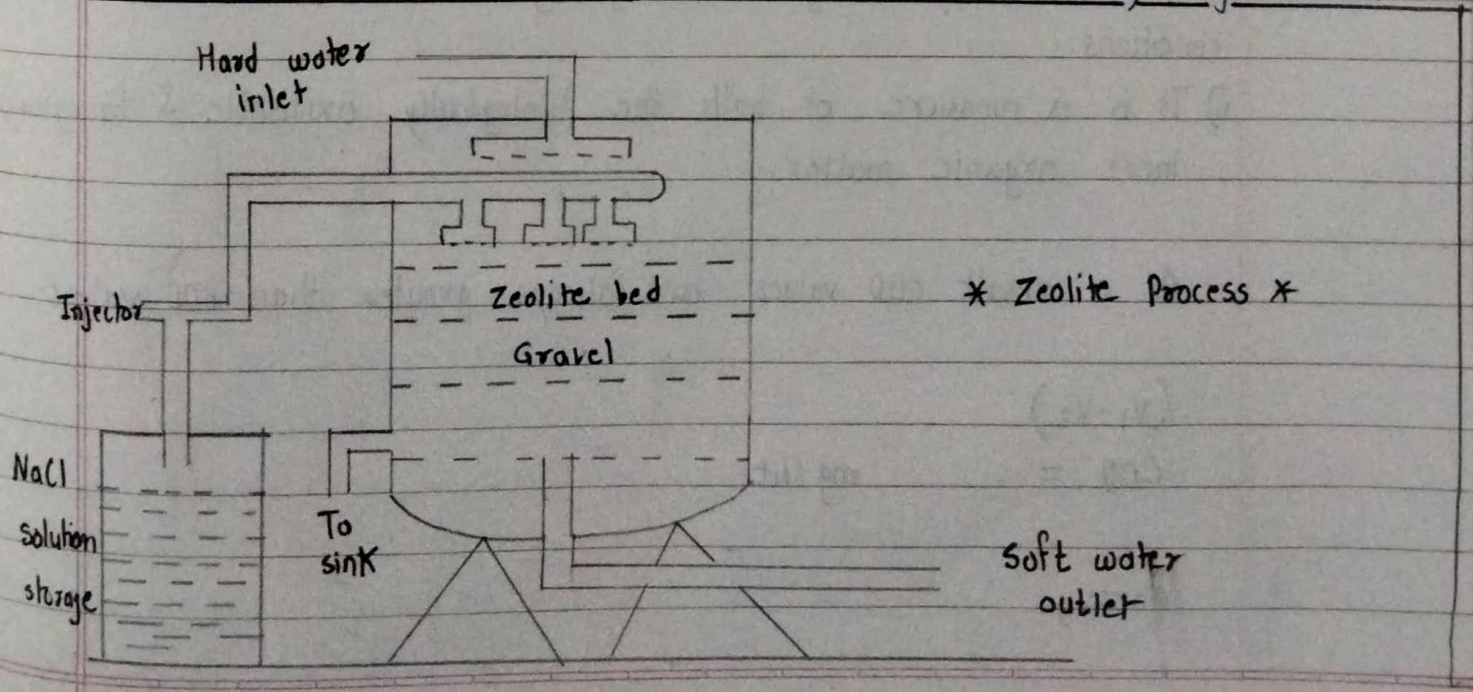
iii) Zeolites are two types : natural and synthetic.

iv) The natural zeolite that is used for water softening is gluconites or greensand.

v) Zeolites are characteristically soft to moderately hard, light in density, insoluble in water but can act as base exchangers in contact with water containing cations.

vi) Hence, these can remove Ca^{2+} and Mg^{2+} ions from water when hard water is passes through.
(Ca^{2+} (calcium) & Mg^{2+} (Magnesium) are the reason for hardness of water.)

vii) Zeolite process for water softening has become a commercial success for the reason that zeolite can be easily regenerated.



viii) Merits of Zeolite Process over Soda lime Process are as follows:

a) Zeolite process removes the hardness almost completely and water of about 10 ppm hardness is produced and in the lime soda process, hardness is removed only upto 15 ppm, which is not good for boilers.

b) In zeolite process, no impurities are precipitated, so there is no danger of sludge formation.
In lime soda process, large amount of sludge formed and creates problem of disposal of it.

c) Zeolite process requires less skill for maintenance as well as operation and lime soda process requires careful operation and skilled supervision.

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4. Explain the term chemical oxygen demand (COD) and give its significant.

→ Chemical Oxygen Demand (COD) :i) It is defined as the amount of oxygen required by organic matter in sample water for its oxidation by strong oxidizing agents ($K_2Cr_2O_7$) in hot conditions.

ii) It is a measure of both the biologically oxidisable & biologically inert organic matter.

As a result COD values are always greater than BOD values

$$COD = \frac{(V_1 - V_2)}{} \text{ mg/lit}$$

Where,

V_1 - Volume of ferrous ammonium sulphate in blank expt.
V_a - Volume of water sample taken for test.
V_2 - Volume of ferrous ammonium sulphate in test expt.

Significance of COD : i) It measures the effect of pollutants on dissolve oxygen.

ii) It helps in designing & calculation of efficiency of the water treatment plants.

iii) It helps in deciding the disposal of domestic & industrial effluents in various types of water streams.

5) Write note on ion exchange resins.

→ i) An ion-exchange resin is a resin ~~or~~ that acts as a medium for ion exchange.
ii) It is an insoluble matrix normally in the form of small microbeads, usually white or yellowish.
iii) The trapping of ions occurs along with the accompanying release of other ions and thus the process is called ion exchange.
iv) There are multiple types of ion-exchange resin. Most commercial resins are made of polystyrene sulfonate.

Application of Ion Exchange Resins:

a) Cation resins : Positively charged cation resins remove positively charged ionic water contaminants.

b) Hardness Removal : i) Strong cation resin is effective for water softening, which removes hardness ions.
ii) It has been used in residential, commercial and industrial applications.
iii) Like tiny magnets, strong cation resin beads remove scale-forming calcium (Ca^{2+}) and magnesium (Mg^{2+}) ions by exchanging them for sodium ions.
iv) Hardness levels are reduced and sodium levels are increased.

c) Deionization : i) Strong cation and Strong anion resins employed in combⁿ either individually or mixed can be used to reduce minerals and total dissolved solids. ii) Minerals in water are exchanged with H^+ & OH^- from resin beads to form highly Purified Water (H_2O).

6) Distinguish between COD & BOD.

→ i) Chemical Oxygen Demand (COD): Chemical oxygen demand is the amount of oxygen required to break down the organic material via oxidation.

ii) Biological Oxygen Demand (BOD): Biological Oxygen Demand is the amount of oxygen micro-organisms to break down organic material.

Chemical Oxygen Demand (COD)	Biological Oxygen Demand (BOD).
a) It can be determined by putting a ~~sealed~~ water sample with a strong oxidising agent under specific temperature conditions for a short period.	a) It can be determined by placing a sealed water sample under specific temperature conditions for five days.
b) To quantify the amount of oxidisable pollutants found in water bodies, COD is used	b) It is used to waster loadings in treatment plants.
c) It provides a measurement on how an effluent will affect the water body.	c) It is used for evaluation of BOD removal efficiency of the waste plants.
d) Value of COD is higher than BOD	d) Value of BOD is lower than COD.

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75) List the advantages and limitations of
a) Zeolite Method b) Soda lime process

→ a1) Advantages of Zeolite Process:

i) In this process, water about less than 10-15 ppm is obtained.
ii) It requires less time for softening.
iii) The process automatically adjust depending on hardness of water.
iv) Water obtained is quite clear
v) The equipment requires less space and maintanance as well as operation still.

a2) Limitations of Zeolite Process:

i) The treated water contains more sodium salt than in lime soda process.
ii) Highly acidic water is not suitable as it affects minerals.
iii) FeMn impurities in the water can't be removed easily.
iv) The method only replaces Ca^{2+}, Mg^{2+}, ions but acetic acid ions like HCO_3^- & CO_3^- leaves behind in the soften water.

b) Advantages of Soda lime process:

i) The residual hardness after the treatment is 15 to 30 ppm.
ii) The process is economical.
iii) Due to high temperature, the rate of reaction is rapid.
iv) De-gassification takes place for dissolved gases like CO_2.
v) Viscocity of soften water is less.

vi) Pathogenic micro-organisms are reduced due to higher pH of treated water.
vii) The treated water become alkaline hence, corrosion of distribution pipes is reduced.

b2) Limitations of Hot lime & soda process.

i) Hardness upto 15 ppm which is not suitable for boiler.
ii) Treated water become alkaline and it leads to costic embrittlement of boilers.
iii) Careful operation and skilled supervision is required.
iv) Disposal of sludge in large amount causes problem.