



**POLLACHI INSTITUTE OF ENGINEERING AND TECHNOLOGY**  
**POOSARIPATTI, POLLACHI 642 205**  
**DEPARTMENT OF CHEMISTRY**  
**ENGINEERING CHEMISTRY - I**

**UNIT I**

**WATER TECHNOLOGY**

***PART A***

**1. Name the chief sources of water.**

Sea water, Rain water, Ground water and Surface water.

**2. Define hardness of water.**

Hardness is the property or characteristics of water, which does not produce lather with soap solution.

**3. What are the salts responsible for carbonate and non carbonate hardness of water?**

Carbonate hardness: Calcium bicarbonate & Magnesium bicarbonate

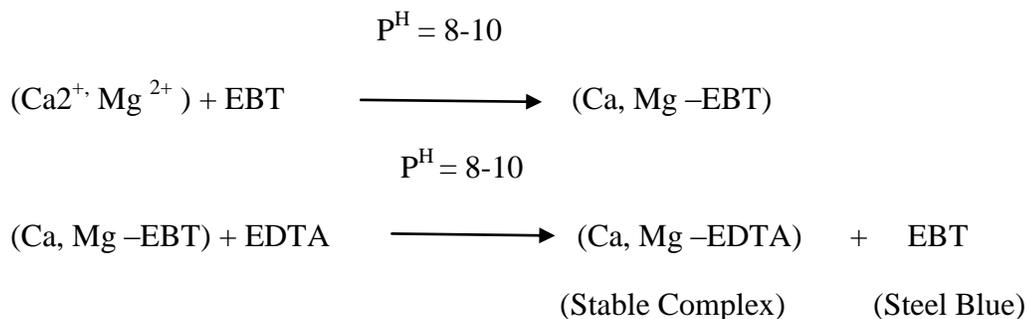
Non Carbonate hardness: Calcium Chloride, Calcium Sulphate, Magnesium Chloride, Magnesium Sulphate.

**4. Distinguish between hard and soft water.**

S.NO	Hard water	Soft water
1	Hard water does not produce lather with soap solution.	Soft water produces very good lather with soap solution.
2	It give wine red color with EBT indicator	It does not give wine red color with EBT indicator.

**5. Why  $\text{NH}_4\text{Cl}-\text{NH}_4\text{OH}$  buffer is used in EDTA titration?**

This complexation by EDTA and EBT with  $\text{Ca}^{2+}$  and  $\text{Mg}^{2+}$  ions are possible only at  $\text{pH} = 8-10$ , that can be maintained by this buffer.



## 6. Define Alkalinity.

Alkalinity is the water is a measure of its acid neutralizing ability. The natural alkalinity in water is imported by the hydroxides, carbonates and bicarbonates.

## 7. Why is water softened before using in boiler?

If hard water obtained from natural sources is fed directly into the boilers, the following troubles may arise.

- ❖ Scale and sludge formation
- ❖ Priming and foaming
- ❖ Caustic embrittlement
- ❖ Boiler corrosion

## 8. Name the impurities present in natural water.

- ❖ Suspended i impurities
- ❖ Colloidal impurities
- ❖ Dissolved impurities

## 9. What are scale and sludges?

**Sludge:** If the precipitate is loose and slimy it is called sludge. Sludges are formed by substances like  $MgCl_2$ ,  $MgCO_3$ ,  $MgSO_4$  and  $CaCl_2$ . They have greater solubilities in hot water than cold water.

**Scale:** If the precipitate forms hard and adherent coating on the inner walls of the boiler is called scale. Scales are formed by substances like  $Ca(HCO_3)_2$ ,  $CaSO_4$ , and  $MgCl_2$ .

## 10. What are the disadvantages of scale formation?

Scales acts as thermal insulators. It decreases the efficiency of boiler. Any crack developed on the scale, leads to explosion.

## 11. What is meant by priming and foaming?

**Priming:** It is the process of production of wet steam

**Foaming:** It is the formation of stable bubbles above the surface water.

## 12. What is meant by caustic embrittlement? How was it prevented?

Caustic embrittlement means intercrystalline cracking of boiler metal.

### Prevention:

- ❖ Using sodium phosphate as softening agent instead of sodium carbonate.
- ❖ Adding tannin, lignin to the boiler water, which blocks the hair cracks.

## 13. A sample of permanent hard water contains micro organisms. Name the one method each to remove hardness and micro organisms.

Demineralization and sterilization process.

**14. Is it possible to remove permanent hardness by either boiling or adding lime alone?**

No, permanent hardness cannot be removed.

**15. Define softening of water. How is it carried out?**

The process of removing hardness producing salts from water is known as softening or conditioning of water.

Softening of water can be done in two methods

- ❖ External treatment
- ❖ Internal treatment

**16. What happens when temporary hard water is boiled?**



**17. Name the three substances used for sterilization.**

- ❖ Bleaching Powder
- ❖ Liquid chlorine
- ❖ Chloramines

**18. Soft water is not DM water whereas DM water is soft water – justify.**

The soft water, produced by lime soda and zeolite processes, does not contain hardness producing  $\text{Ca}^{2+}$  and  $\text{Mg}^{2+}$  ions, but it will contain other ions like  $\text{Na}^+$ ,  $\text{K}^+$ ,  $\text{SO}_4^{2-}$ ,  $\text{Cl}^-$  etc.,. On the other hand DM water does not contain both anions and cations.

**19. What is brackish water?**

Water containing dissolved salts with peculiar salty taste.

**20. What are the advantages of ion exchange resin?**

- ❖ Highly acidic or alkaline water can be treated by this process.
- ❖ The water obtained by this process will have very low hardness nearly 2ppm.

**21. Give some examples for cation and anion exchange resin.**

**Cation exchange resin:** Sulphonated coals, sulphonated polystyrenes.

**Anion exchange resin:** cross linked quaternary ammonium salts, urea formaldehyde resin

**22. What is aeration of water? Mention its purpose.**

The process of mixing water with air is known as aeration. The main purpose of aeration is

- ❖ To remove gases like CO<sub>2</sub>, H<sub>2</sub>S and other volatile impurities causing bad taste and odour to water
- ❖ To remove ferrous and manganous salts insoluble ferric and magnetic salts.

**23. What is reverse osmosis?**

A process by which pure solvent is separated from its contaminants by using a semipermeable membrane and applying high pressure on concentrated side.

**24. What is break point chlorination?**

Break point chlorination is the point at which all the impurities are removed from free chlorine begins to appear.

**25. Chloramine is preferred over bleaching powder or chlorine for sterilization of drinking water. Give reason.**

Chloramine is preferred over bleaching powder or chlorine, because it causes no irritating odour even if used in excess. Imparts good taste to treated water.

**26. What is sedimentation with coagulation?**

The process of removing fine suspended and colloidal impurities by adding the requisite amount of coagulant to water before sedimentation.

**27. Mention the requisites of the portable water.**

- ❖ It should be clear, colorless and odorless
- ❖ It should be cool and pleasant to taste
- ❖ It should be free from harmful bacteria and suspended impurities
- ❖ Hardness should be less than 500 ppm
- ❖ It should be free from dissolved gases and poisonous minerals.

**28. What is disinfection? Give two examples.**

When the water containing bacteria is irradiated by UV light, all the bacteria's are killed out. This process is known as disinfection.

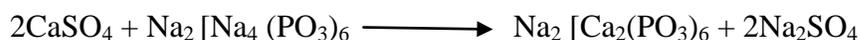
**29. What is the role of phosphates in the internal treatment of water?**

Scale formation can be avoided by adding sodium phosphate. It is used in high pressure boilers. The phosphate reacts with Ca<sup>2+</sup> and Mg<sup>2+</sup> salts to give soft sludges of calcium and magnesium phosphates.



**30. What is calgon conditioning? What is its use in water technology?**

Calgon is sodium hexa meta phosphate Na<sub>2</sub> [Na<sub>4</sub> (PO<sub>3</sub>)<sub>6</sub>], this substance interacts with calcium ions forming a highly soluble complex and thus prevents the precipitation of scale forming salts.

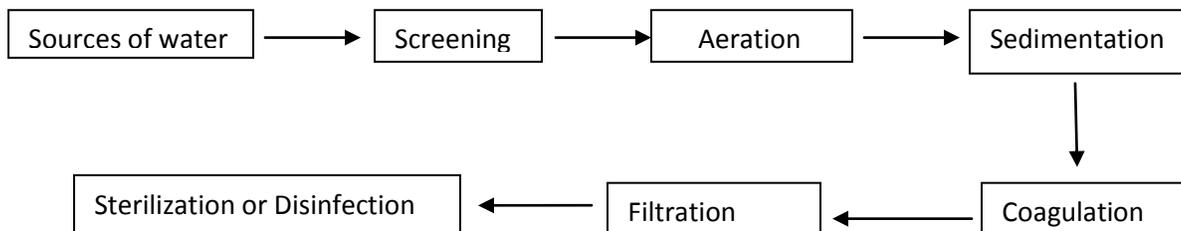


**31. What is disinfection? Give any two examples. Or how is UV light useful for achieving disinfection of water.**

When the water containing bacteria is irradiated by UV light, all the bacteria's are killed out. This process is known as disinfection. This is useful for sterilizing water in swimming pool.

Examples: Chlorination and Ozonation of water.

**32. What are the various stages in the treatment of domestic water supply?**



**33. Name some of the membranes employed in reverse osmosis process. State the advantages of this process.**

**Membranes:** Cellulose Acetate, Cellulose butyrate

**Advantages:**

- ❖ It removes ionic as well as non ionic, Colloidal Impurities.
- ❖ The life time of the membrane is high and it can be replaced within few minutes.

**34. What is blow down operation?**

Blow down operation is a process of removing a portion of concentrated water by fresh water frequently from the boiler during steam production.

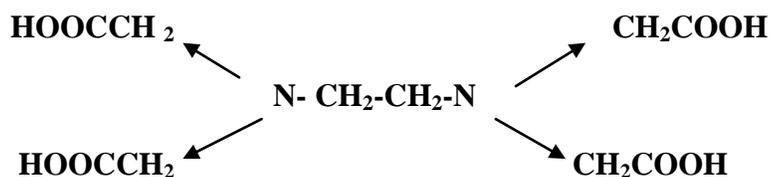
**35. What are the disadvantages of ion exchange resin?**

- ❖ Water containing turbidity, Fe, & Mn cannot be treated, because turbidity reduces the output and Fe, Mn form stable compound with the resin.
- ❖ The equipment is costly and more expensive chemicals are needed.

**36. Define desalination.**

The process of removing common salt from water is known as desalination. The water containing dissolved salts with peculiar salty or brackish taste is called brackish water.

**36. Draw the structure of EDTA.**



**37. What are the units of hardness of water?**

- ❖ Parts per Million (PPM)
- ❖ Milligrams/Litre (mg/lit)
- ❖ Clarke's degree ( $^{\circ}\text{Cl}$ )
- ❖ French Degree ( $^{\circ}\text{Fr}$ )

**38. Prove that mg/liter of hardness is same as ppm of water.**

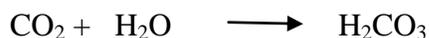
$$1\text{ppm} = 1\text{ mg/lit} = 0.1\text{ }^{\circ}\text{Fr} = 0.07^{\circ}\text{Cl}$$

**39. What are the causes for alkalinity of natural water?**

- ❖ Hydroxide alkalinity
- ❖ Carbonate alkalinity
- ❖ Bicarbonate alkalinity

**40. How does CO<sub>2</sub> causes boiler corrosion?**

Dissolved carbon dioxide in water produces carbonic acid, which is acidic and corrosive in nature.



***PART-B***

1. What is the principle of EDTA method? Describe the estimation of hardness of water by EDTA method?
2. (i) Write structure of EDTA & its reaction with  $\text{Ca}^{2+}$  and a role of  $\text{pH}$  in it.  
(ii) Explain why indicator EBT is added in estimation of hardness of water by EDTA method?
3. Describe the principle and method involved in the determination of different types amount of alkalinity?
4. Discuss the various methods of removal of microorganisms in water for domestic use.
5. Describe the different steps in purification of water for drinking (municipal) purpose? What is the usage of breakpoint chlorination?
6. Explain how sterilization of water carried out using chlorine. Give the mechanism?
7. What are boiler troubles? How are they caused? Suggest steps to minimize the boiler troubles?
8. Describe in detail problems (disadvantages) caused due to usage of hard water in boilers? (Or) What are the problems one would face when hardwater is used in boiler industries?
9. Discuss the causes and prevention of priming and foaming?
10. What is caustic embrittlement? How can it be prevented?
11. What is meant by boiler corrosion? How is it prevented?

12. Describe demineralization process of water softening. Explain the reactions involved?
13. How is exhausted resin regenerated in ion exchanger? Give the merits and demerits of ion exchange method?
14. Write short notes on internal conditioning of boiler feed water. Explain phosphate conditioning and carbonate conditioning in detail.
15. What is the principle of reverse osmosis? How is it used for desalination?