

CHAPTER-NO-15:

ENVIRONMENTAL CHEMISTRY – II WATER

HARD WATER:

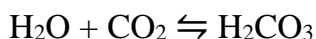
Water that gives little lather or form scum with soap is called hard water.

SOFT WATER:

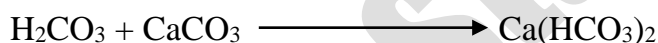
Water that easily gives lather with soap and does not form scum is called soft water.

CAUSES OF WATER:

Rain water dissolve carbon-dioxide from air. This carbon-dioxide reacts with water to produce carbonic acid.



When this carbonic acid (carbonated water) passes through the rocks containing calcium carbonate or magnesium carbonate then calcium and magnesium hydrogen carbonates are formed. These hydrogen carbonates causes hardness in water.



TYPES OF HARDNESS:

There are two types of hardness of water.

1) Temporary Hardness

2) Permanent Hardness

1) TEMPORARY HARDNESS:

Such hardness of water which can be easily removed by boiling the water is called temporary hardness. Temporary hardness is caused by calcium and magnesium hydrogen carbonates.

These hydrogen carbonates dissolve in water and cause temporary hardness.

2) PERMANENT HARDNESS:

Such hardness of water which cannot be removed by boiling the water is called permanent hardness. Permanent hardness is caused by sulphates and chlorides of calcium and magnesium.

These sulphates and chlorides dissolve in water and cause permanent hardness.

METHODS TO REMOVE TEMPORARY HARDNESS:

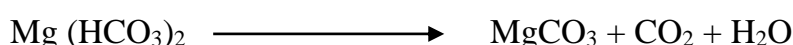
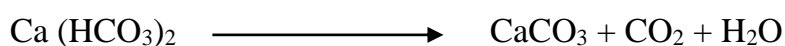
Two methods are used to remove temporary hardness.

1) Boiling Method

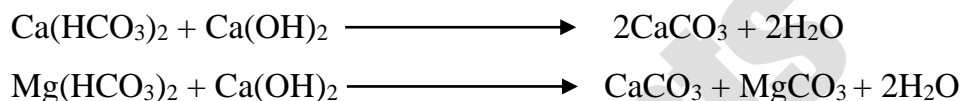
2) Clark's Method

1) **BOILING METHOD:** Temporary hardness of water can be removed by boiling the water.

During boiling, the soluble calcium and magnesium hydrogen carbonates are decomposed and as a result insoluble carbonates are formed. These insoluble carbonates are removed from water easily. Therefore after removal of insoluble carbonates water becomes soft.



CLARK'S METHOD: Temporary hardness of water can be removed on the large scale by using Clark's method. According to this method an estimated amount of slaked lime $\text{Ca}(\text{OH})_2$ is added in hard water. The slaked lime reacts with hydrogen carbonated and form insoluble carbonates. These insoluble carbonates are allowed to settle down at the bottom and soft water is collected from the top.



METHOD TO REMOVE PERMANENT HARDNESS:

Two methods are used to remove permanent hardness of water.

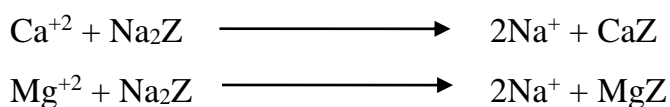
- 1) By adding washing soda 2) By ion exchange method

1) **BY ADDING WASHING SODA:** On the large scale permanent hardness of water can be removed by adding washing soda ($\text{Na}_2\text{CO}_3 \cdot 10\text{H}_2\text{O}$). As a result of this washing soda calcium (Ca^{+2}) and magnesium (Mg^{+2}) ions are removed and produce insoluble carbonates. These insoluble carbonates settle down at the bottom and soft water is separated from top.

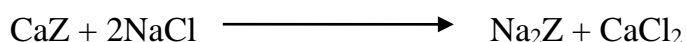


2) ION EXCHANGE METHOD:

On the large scale ion exchange method is used to remove permanent hardness of water. In this method the hard water is passed through a container filled with a suitable resin containing sodium ions. For this purpose a special sodium ion is used which is known as sodium zeolite. Sodium zeolite is natural ion exchanger. It is written as Na_2Z . This sodium zeolite exchange Calcium (Ca^{+2}) and magnesium (Mg^{+2}) ions which cause hardness. Sodium zeolite is chemically known as sodium aluminum silicate.



The ion exchange method is very economical method because the zeolite ions can be regenerated by heating with concentrated solution of NaCl .



DISADVANTAGE OF HARD WATER:

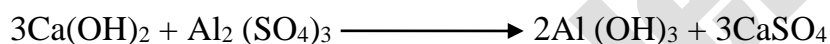
- i) Hard water wastes large amount of soap when it is used for washing.
 - ii) The soap forms scum with hard water. This scum can spoil the finish of some fabrics.
 - iii) Hard water form insoluble calcium and magnesium salts. These salts can block car radiators, boilers and hot water pipes.
 - iv) Hard water can cause kettles to fur.
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RAW WATER TREATMENT

The raw water is treated in a municipal water purification plant to make it fit for drinking and domestic purpose. Following four steps are used.

1) **SEDIMENTATION**: It is the process in which water is allowed to stand in a reservoir. As a result the suspended matter sinks to the bottom.

2) **COAGULATION**: It is the process in which water is treated with slaked lime Ca(OH)_2 and alum $\text{Al}_2(\text{SO}_4)_3$. These materials react with each other and form aluminum hydroxide Al(OH)_3 . This aluminum hydroxide carries down dirt particles and bacteria.



3) **FILTRATION**: Filtration is a process in which water is filtered through sand and gravel. Sometimes water is filtered through charcoal to remove coloured and odorous compounds.

4) **CHLORINATION**: It is the final step of water purification in which chlorine is added to kill any remaining bacteria. Chlorine reacts with water to form Hypochlorous acid (HClO).

This hypochlorous acid kill bacteria. $\text{H}_2\text{O} + \text{Cl}_2 \longrightarrow \text{HClO} + \text{H}^+ + \text{Cl}^-$

SEWAGE WATER TREATMENT

Sewage water is passed through different treatment stages before it is discharged into lake, Stream, River or ocean. The sewage water treatment has following four main steps.

a) **PRIMARY SEWAGE TREATMENT**: In primary sewage treatment the waste water is allowed to stand in a large sedimentation tank to remove suspended particles.

b) **SECONDARY SEWAGE TREATMENT**: In this treatment the water obtained from sewage treatment is passed through sand and gravel filters. The aerobic bacteria converts most of the organic matter into stable inorganic materials.

c) **ACTIVATED SLUDGE TREATMENT**: In this step the sewage water is placed in large tanks and aerated with large blowers. As a result large and porous clumps are formed. These clumps absorb the contaminants. The aerobic bacteria further convert the organic material into sludge. This sludge is stored on land and used as fertilizer.

d) **CHLORINATION**: In this step the remaining matter is treated with chlorine to kill any remaining pathogenic microorganisms.

EXERCISE QUESTION

Page – No – 144 Q – No – 2(i): List the impurities present in rain water.

Ans: There are a large number of substances present in the atmosphere. For example, smoke particles, insects and bacteria, some harmful gases such as SO_2 , SO_3 , NO , NO_2 . These gases either react with rain water or get dissolved in it. All these above mentioned substances or materials are the impurities present in rain water.

Q – No – 2(ii): List toxic substances present in household Waste?

Ans: Household wastes includes soaps and detergents, paints and oil, food and vegetable wastes and garbage etc.

Q – No – 2 (iii): In what ways, industrial wastes pollute water?

Ans: The wastes from the industries may contain highly toxic compounds and heavy metals such as Pd, Cd, Hg, As, Sb, etc. All these compounds pollute the water. Industrial wastes may also contain large quantities of chromium salts. These salts dissolve in water and cause cancer.

Q – No – 2 (iv): What is water pollution? How water can be contaminated?

Ans: Contamination of water sources like lakes, rivers, oceans and ground water by human activities such as oil leakage, agricultural pesticides, industrial wastes etc is called water pollution.

Q – No – 2(v): List some water born diseases.

Ans: Some water born diseases are:

i) Cholera ii)Typhoid iii) Hepatitis iv) Jaundice

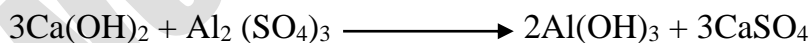
Q – No – 2(vi): What are pathogenic microorganisms?

Ans: The study of the causes and effects of diseases is called pathology and the microorganisms such as bacteria or viruses that causes such diseases are called pathogenic microorganisms.

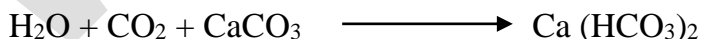
Q – No – 3: What is hard water? Why is it sometimes undesirable?

Ans: Water that gives little lather with soap or scum with soap is called hard water. Hard water has a large number of minerals dissolves in it. Usually it contains calcium and magnesium which does not work with soap and detergents. As a result large quantity of soap and detergents is used. Also these Calcium and magnesium ions can damage the water pipes and industrial boilers.

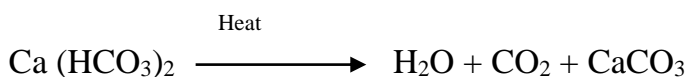
Q – No – 5: a) Reaction of slakes lime with alum.



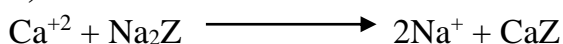
b) Carbonated rain water with lime stone.



c) Reaction that occurs when temporary hard water is boiled.



d) Ca^{+2} ions interact with sodium zeolite.



Q – No – 6: How buildings made of lime stone be affected by acid rain.

Ans: Acid rain has a corrosive effect on limestone or marble buildings. Acid rain contains SO_2 and whenever SO_2 comes in contact with limestone then corrosion occurs. As a result the building made of limestone badly affected by this corrosion.