CHAPTER TEN

WATER, MIXTURES AND COMPOUNDS:

Introduction: This is the commonest substance on earth, covering about three quarters of the earth`s surface. Water is used for domestic purposes, used in industries and used to generate power or electricity. Some sources of water are the sea, rivers, lakes, streams and springs.

Properties of water:

These are classified into two groups and these are;

(1) The physical properties.

(2) The chemical properties.

Physical properties:

- It freezes at 0^0C.
- It boils at 100^0C.
- It is colourless and tasteless.
- It is neutral to litmus paper.
- It is a poor conductor of electricity when it is pure.-
- It maximum density is $1gcm^{-3}$ at 4^0C.
- It has a high surface tension.

Chemical properties of water:

- It contains hydrogen and oxygen in the ratio 2 : 1 respectively.

- It is a polar molecule.

Test for water:

- To test whether or not a substance is water or contains water, we add anhydrous copper II sulphate to it (i.e. copper (II) teraoxosulphate IV).

- If the anhydrous copper II sulphate which is white in colour turns blue or into blue crystals, then the substance is water or contains water.

Water as a universal Solvent:

There are few substances which do not dissolve in water to some extent, and even if you drink a glass of water, you are drinking part of the glass. Because water has the ability to dissolve many substances it comes into contact with, water from natural sources is not chemically pure. Rain water is generally considered to be the purest source of water supply, even though it contains a large quantity of carbon (IV) oxide, i.e. CO_2. The presence of this dissolved CO_2 in the water, make the rain water to become acidic (i.e. a weak acid called carbonic acid). In industrial areas, it is not safe to drink rain water since it may contain dissolved harmful gases. Due to the large quantity of sodium chloride in sea water, it is referred to as brine.

Solution: This is a uniform mixture of two or more substances, which are in a state of dispersion.

Aqueous Solution: This is formed when a gas, liquid or solid dissolves in water.

Concentration of a solution: This is the amount of solute in grams or moles dissolved in $1dm^3$ of the solution.

Hardness of water:

- Hardness of water is due to the presence of dissolved magnesium and calcium salts in the water, which gives rise to the presence of ca^{2+} or mg^{2+} ions within the water.
- Some of these dissolved salts are:
(i) Magnesium or calcium hydrogentrioxocarbonate (VI).
(ii) Magnesium or calcium choride or tetraoxosulphate VI, i.e. Mg (HCo_3)/ $Ca(HCo_3)_2$, $MgCl_2$/ $Cacl_2$ and $Mgso_4$/ $Caso_4$.
- When calcium and magnesium compounds (i.e. Ca^{2+} or Mg^{2+} ions) are present in water, the cleaning action of soap is destroyed.- - When soap is added to water which contains these ions or compounds, the ions react with the soap to form a curdy precipitate or scum which is insoluble.
- Until all these calcium or magnesium ions have been acted upon and removed by the soap, no lather will occur.

- Therefore in hard water, a large amount of soap is used o precipitate and remove the calcium and the magnesium ions, and only a small amount of it will be available to cause a lather.
- In this case, the soap wasted.

Types of hardness:

- There are two types and these are:
(1)Temporary hardness.

(2) Permanent hardness.

Temporary Hardness:

- This is hardness caused by the presence in the water of calcium or magnesium hydrogentrioxo carbonate, (calcium or magnesium hydrogencarbonate).
- This type of hardness can be removed by boiling the water for a few minutes.
- Because this type of hardness can be easily removed by boiling, it is called temporary hardness.
- Apart from boiling, temporary hardness can also be removed by adding calculated amount of calcium hydroxide to the H_2O.
- $Ca(HCO_3)_{2(aq)} \rightarrow CaCO_{3(solid)} + H_2O + co_2(g)$.
- By so doing the calcium is removed by converting it into $CaCO_3$, which is insoluble and cannot take part in further reaction.

Permanent Hardness:

- This is caused by the presence in the water of calcium tetraoxosulphate, i.e. calcium sulphate.
- Since this compound cannot be decomposed by boiling, the hardness it causes is referred to as permanent hardness, and this type of hardness can be removed by the addition of washing soda to the water.

N/B:

Both permanent and temporary hard water may be softened, (i.e. the hardness removed) by any of the following methods:

(a) **Distillation:**

- In this method, the water is vapourized and condensed back into water.
- By so doing, the condensed water becomes free from all the dissolved substances.

(b) By the addition of trioxocarbonate (IV) i.e. Na_2CO_3.

(c) By the addition of sodium aluminum trioxodisilicate i.e $NaAlSI_2O_6$.

Advantages of hard water:

- It has a more pleasant taste.

- It prevents lead poisoning.
- It contains dissolved calcium compounds which are good for bones and teeth formation.

Disadvantages of hard water:

- It does not easily form lather with soap, which wastes the soap.
- It cannot be used in the dying industries, since it interferes with the process. - It leaves scales in kettle, hot water pipes, boilers and radiators.

Soft water: This refers to water which easily forms lather with soap.

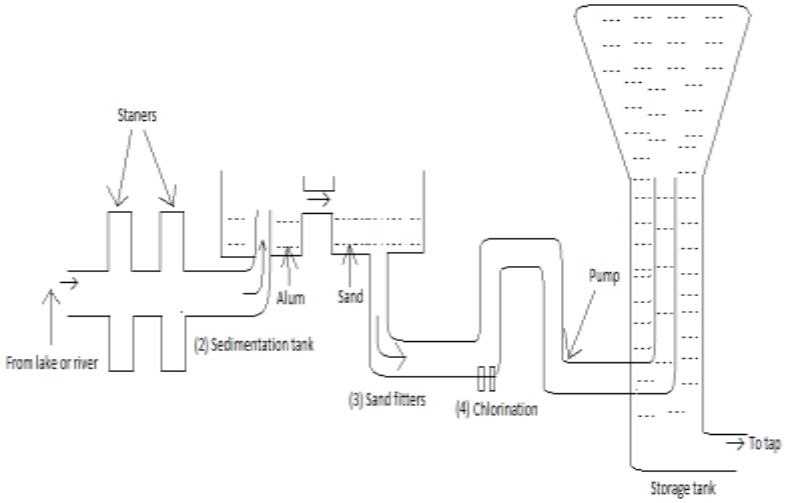
Advantages of soft water:

- It saves a lot of soap, when used for washing.
- It can be used in the dyeing and tanning industries, since it does not interfere with the process.
- It does not leave scales in kettle, hot water pipes, boilers and radiators.

Disadvantages of soft water:

- It cannot prevent lead poisoning.
- It has a less pleasant taste than hard water.

Water Purification Plant:



Need for purification of H_2O:

Water from natural sources such as rivers is not safe for drinking, since it may contain germs and impurities. These impurities may either be dissolved or un-dissolved, while some of the germs may be very dangerous.

- To make the water safe for domestic and other usage, it must be subjected to thee purification.

Purification procedure:

- The purification of water for public use involves two main process and these are

(I) Filtration (II) Sterilization

(a) Rubbish free river water is pumped through filter beds filled with consecutively finer layers of gravel and sand.

- Both organic and inorganic debris are retained or removed from the water. In short, the river water is filtered.

(b) The filtered water is next treated with powdered potash alum, (potassium aluminum tetraoxosulphate VI) in a sedimentation tank.

- The alum encourages the fine particles in the water to settle at the bottom of the tank, which makes the water clear.

(c) The clear water is then treated with a carefully controlled quantity of chlorine, to kill the harmful microbes and bacteria (germs).
(d) This treated water is finally pumped into a storage tank, where it is carried in pipes to homes and factories.

N/B:- For villages and small communities which have to depend on polluted water bodies for their water supply, it is necessary that the water is boiled and filtered.

Water conservation:

- This is a method used to make water available especially during the dry season, and to cut down the cost of water treatment as well as water bills. -
Some of the methods used in the conservation of domestic water supply, include the following:

(1) Polytank:

- In this method, the water is stored in a tank made of rubber, and since the tank is rust free or does not rust, the water is good for drinking.

(2) Metallic tank:

- In this method, the water is stored in tanks made of iron.
- Rusting sometimes occurs and in case the iron is contaminated with lead, then lead poisoning may occur.

(3) Underground tank:

- The water in this case is stored in underground tanks made of cement , and the stored water stands contamination by underground water.

The effects of rapid or increasing population growth on the the supply of treated water:

(1) There will be pressure on the available water, leading to long queues.
(2) Time wasting occurs since people have to walk long distances looking for water.
(3) People will illegally sell water to others at very high prices.

(4) Public disorder may occur for those in queues waiting to fetch water, may quarrel and fight.
(5) People may be compelled by circumstances beyond their control, to use water from wrong sources for their domestic use.

The economic activities associated with water:

(1) Used to generate electricity.
(2) For bleaching.
(3) For irrigation.
(4) For the cooling of hot industrial machines.
(5) Used as a solvent in industrial processes.
(6) For dyeing.
(7) For washing and cleaning.

The water cycle:

(1) The water of the great oceans, rivers and lakes evaporates into the atmosphere.
(2) On reaching the cooler part of the atmosphere, it condenses and falls as rain into water bodies.
(3) The sun once again causes the water to evaporate into the atmosphere, and the whole process is repeated.

Hygroscopic, deliquescent and efflorescent substances:

- Substances and elements are affected by the amount of water vapour within the atmosphere, and for this reason, substances may be classified as:

(I) Hygroscopic substances:

- These are substances which even though are capable of absorbing water from the atmosphere, do not form solutions.
- An example of such a substance is sodium chloride or NaCl.

(II) Diliquescent substances:

- These substances are capable of absorbing water from the atmosphere to form solutions.
- An example of such a substance is $FeCl_3$.

(III) Efforescent substances:

- These are the hydrated salts, or those salts with water molecules attached to them.

- This attached water is referred to as the water of crystallization.
- They loose this water of crystallization when they are exposed to the atmosphere at room temperature.
- An example of such a substance is $Na_2SO_4.11H_2O$.