

## CHAPTER 3:- CHEMICAL PARAMETERS OF WATER

### pH:

pH or the concentrations of hydrogen ions ( $H^+$ ) present in pond water is a measure of acidity or alkalinity. The pH scale extends from 0 to 14 with 0 being the most acidic and 14 the most alkaline. pH 7 is a condition of neutrality and routine aquaculture occurs in the range 7.0 to 9.0 (optimum is 7.5 to 8.5). Exceedingly alkaline water (greater than pH 9) is dangerous as ammonia toxicity increases rapidly. At higher temperatures fish are more sensitive to pH changes.

It is an important chemical parameter to consider because it affects the metabolism and other physiological processes of culture organisms. A certain range of pH (pH 6.8 — 8.7) should be maintained for acceptable growth and production. But in semi-intensive culture, optimum range is better maintained between pH 7.4 — 8.5. pH 7 is the neutral point and water is acidic below pH 7 and basic above pH 7. pH changes in pond water are mainly influenced by carbon dioxide and ions in equilibrium with it. pH can also be altered by a) Organic acids, these are produced by anaerobic bacteria ("acid formers") from protein, carbohydrates and fat from feed wastes, b) Mineral acids such as sulfuric acid (acid-sulfate soils), which may be washed down from dikes during rains and c) Lime application.

Like DO, a diurnal fluctuation pattern that is associated with the intensity of photosynthesis, occurs for pH. This is because carbon dioxide is required for photosynthesis and accumulates through nighttime respiration. It peaks before dawn and is at its minimum when photosynthesis is intense. All organisms respire and produce Carbon dioxide  $CO_2$  (continuously, so that the rate of  $CO_2$  production. Depends on the density of organisms. The rate of  $CO_2$  consumption depends on phytoplankton density. Carbon dioxide is acidic and it decreases the pH of water. Also, and carbonate would decrease. The consumption of  $CO_2$  during photosynthesis causes pH to peak in the afternoon and the accumulation of  $CO_2$  during dark causes pH to be at its minimum before dawn.

**Method employed :** Electrometric method

**Apparatus required:** Glass electrode, reference electrode (mercury/calomel or silver/silver chloride) and pH meter.

### Procedure:

The pH is determined by measuring the Electro Motive Force (E.M.F) of a cell comprising an indicator electrode (an electrode responsive to hydrogen ions such as a glass electrode) immersed in the test solution and the reference electrode (usually a mercury/calomel electrode). Contact between the test solution and the reference electrode is usually got by means of a liquid junction, which forms a part of reference electrode. E.M.F of this cell is measured with pH meter, that is a high impedance voltmeter calibrated in terms of pH. The electrode is allowed to stand for 2 minutes to stabilize before taking reading for reproducible results (at least  $\pm 0.1$  pH units).

### Salinity:

Salinity is the measure of all the salts dissolved in water. Salinity is usually measured in parts per thousand (ppt or ‰). The average ocean salinity is 35ppt and the average river water salinity is 0.5ppt or less. This means that in every kilogram (1000 grams) of seawater, 35 grams are salt. Because the water in estuaries is a mix of fresh water and ocean water, the salinity in most estuaries is less than the open ocean. Bottom water almost always contains more salt than surface waters.

The salinity of water is an important measure of water quality because different species of animal and plant life survive in different ranges of salinity. Even a small change in salinity could cause stress, or even death, to these organisms and could have a devastating effect on the local, and wider, ecosystem.

Sources of salinity in freshwater include urban and rural runoff from industry, sewage, agriculture and stormwater. Clearing of vegetation can also cause raised levels of salinity due to a resultant rise in the water table. Areas within the tidal limit of rivers that flow into the sea will experience fluctuations in salinity between low and high tide. In estuaries there is usually a gradual alteration in salinity, as freshwater entering the estuary from tributaries meets the seawater moving in from the ocean.

**Apparatus required:** Refractometer

**Procedure:** At first the refractometer calibrated with a blank (distilled water) and then the sample water is placed on prism. The salinity of sample is noted from ppt meter.

**Alkalinity:-**

Alkalinity is an aggregate property of the water sample which measures the acid-neutralizing capacity of a water sample. It can be interpreted in terms specific substances only when a complete chemical composition of the sample is also performed. The alkalinity of surface water is due to the carbonate, bicarbonate and hydroxide content and is often interpreted in terms of the concentrations of these constituents. Higher the alkalinity, greater is the capacity of water to neutralize acids. Conversely, the lower the alkalinity, the lesser will be the neutralizing capacity.

Alkalinity of sample can be estimated by titration with standard  $H_2SO_4$  or  $HCl$  solution. Titration to pH 8.3 or decolourisation of phenolphthalein indicator will indicate complete neutralization of  $OH^-$  and  $1/2$  of  $CO_3^{2-}$ , while to pH 4.5 or sharp change from yellow to orange of methyl orange indicator will indicate total alkalinity.

To detect the different types of alkalinity, the water is tested for phenolphthalein and total alkalinity, using

Equations:

Phenolphthalein alkalinity (mg / L) as  $CaCO_3 = A \times \text{normality of acid} \times 50000 / \text{ml of sample}$

Total alkalinity (mg/L) as  $CaCO_3 = B \times \text{normality of acid} \times 50000 / \text{ml of sample}$

Where,

A = titrant (mL) used to titrate

B = titrant (mL) used to titrate

N = normality of the acid (0.02N  $H_2SO_4$  for this alkalinity test)

50,000 = a conversion factor to change the normality into units of  $CaCO_3$

Once PA and TA are determined, then three types of alkalinities, i.e, hydroxides, carbonates and bicarbonates can be easily calculated from the table:

Table 3 : Calculation of Alkalinity of samples

Result of Titration	OH alkalinity as $CaCO_3$	$CO_3$ alkalinity as $CaCO_3$	$HCO_3$ alkalinity as $CaCO_3$
PA = 0	0	0	TA
PA < 1/2TA	0	2PA	TA - 2PA
PA = 1/2TA	0	2PA	0
PA > 1/2TA	2PA - TA	2(TA - PA)	0
PA = TA	TA	0	0

## TOTAL HARDNESS

Hardness is predominantly caused by divalent cations such as calcium, magnesium, alkaline earth metal such as iron, manganese, strontium, etc. The total hardness is defined as the sum of calcium and magnesium concentrations, both expressed as CaCO<sub>3</sub> in mg/l. Carbonates and bicarbonates of calcium and magnesium cause temporary hardness. Sulphates and chlorides cause permanent hardness.

Table 4: Hardness Chart (for drinking water)

Soft	0 - 60 mg/l
Medium	60 - 120 mg/l
Hard	120 - 180 mg/l
Very Hard	> 180 mg/l

### Principle:

In alkaline conditions EDTA (Ethylenediamine tetra acetic acid) and its sodium salts react with cations forming a soluble chelated complex when added to a solution. If a small amount of dye such as Eriochrome black-T is added to an aqueous solution containing calcium and magnesium ions at alkaline pH of  $10.0 \pm 0.1$ , it forms wine red colour. When EDTA is added as a titrant, all the calcium and magnesium ions in the solution get complexed resulting in a sharp colour change from wine red to blue, marking the end point of the titration. Hardness of water prevents lather formation with soap rendering the water unsuitable for bathing and washing. It forms scales in boilers, making it unsuitable for industrial usage. At higher  $\text{pH} > 12.0$ ,  $\text{Mg}^{++}$  ion precipitates with only  $\text{Ca}^{++}$  in solution. At this pH, murexide indicator forms a pink color with  $\text{Ca}^{++}$  ion. When EDTA is added  $\text{Ca}^{++}$  gets complexed resulting in a change from pink to purple indicating end point of the reaction.

**Apparatus required:** Lab glassware-burette, pipette, conical flask, beakers etc.

**Procedure** Exactly 50ml of the well-mixed sample is pipetted into a conical flask, to which 1ml ammonium buffer and 2-3 drops of Eriochrome black-T indicator is added. The mixture is titrated against standard 0.01M EDTA until the wine red colour of the solution turns pale blue at the end point.



Fig 6: Results of total hardness test by titration method

## CALCIUM HARDNESS

The presence of calcium (Ca) most abundant) in water results from passage through or over deposits of limestone, dolomite, gypsum and such other calcium bearing rocks. Calcium contributes to the total hardness of water and is an important micro-nutrient in aquatic environment and is especially needed in large quantities by molluscs and vertebrates. It is measured by EDTA titrimetric method. Small concentration of calcium carbonate prevents corrosion of metal pipes by laying down a protective coating. But increased amount of calcium precipitates on heating to form harmful scales in boilers, pipes and utensils.

**Principle:** When EDTA (Ethylene-diamine tetra acetic acid) is added to the water containing calcium and magnesium, it combines first with calcium. Calcium can be determined directly with EDTA when pH is made sufficiently high such that the magnesium is largely precipitated as hydroxyl compound (by adding NaOH and iso-propyl alcohol). When murexide indicator is added to the solution containing calcium, all the calcium gets complexed by the EDTA at pH 12-13. The end point is indicated from a colour change from pink to purple.

**Apparatus required:** Burettes, pipette, conical flask, beakers and droppers.

**Procedure:** A known volume (50ml) of the sample is pipetted into a clean conical flask, to which 1ml of sodium hydroxide and 1ml of iso-propyl alcohol is added. A pinch of murexide indicator is added to this mixture and titrated against EDTA until the pink color turns purple.

## MAGNESIUM HARDNESS

Magnesium is a relatively abundant element in the earth's crust, ranking eighth in abundance among the elements. It is found in all natural waters and its source lies in rocks, generally present in lower concentration than calcium. It is also an important element contributing to hardness and a necessary constituent of chlorophyll. Its concentration greater than 125 mg/L can influence cathartic and diuretic actions.

**Principle:** Magnesium hardness can be calculated from the determined total hardness and calcium hardness.

High concentration of magnesium proves to be diuretic and laxative, and reduces the utility of water for domestic use while a concentration above 500 mg/L imparts an unpleasant taste to water and renders it unfit for drinking. Chemical softening, reverse osmosis and electro dialysis or ion exchange reduces the magnesium hardness to acceptable levels.

## NITRATES

Nitrates are the most oxidized forms of nitrogen and the end product of the aerobic decomposition of organic nitrogenous matter. The significant sources of nitrates are chemical fertilizers from cultivated lands, drainage from livestock feeds, as well as domestic and industrial sources. Nitrates in their unpolluted state contain only minute quantities of nitrates. The stimulation of plant growth may result in eutrophication, especially due to algae. The subsequent death and decay of algae causes secondary pollution. Nitrates are most important for biological oxidation of nitrogenous matter. Certain nitrogen fixing bacteria and algae have the capacity to fix molecular nitrogen in nitrates. A major source of polluting nitrates is domestic sewage. Nitrates may find their way into ground water from soil and at times by contamination. They can be measured by the phenoldisulphonic method.

## CHAPTER 4 - BIOLOGICAL PARAMETERS OF WATER

### PLANKTON ANALYSIS:

The physical and chemical characteristics of water affect the abundance, species composition, stability and productivity of the indigenous populations of aquatic organisms. The biological methods used for assessing water quality includes collection, counting and identification of aquatic organisms, biomass measurements, measurements of metabolic activity rates, toxicity tests, bioaccumulation, biomagnification of pollutants, and processing and interpretation of biological data. The work involving plankton analysis would help in

1. Explaining the cause of colour and turbidity and the presence of objectionable odour, tastes and visible particles in waters.
2. The interpretation of chemical analyses.
3. Identifying the nature, extent and biological effects of pollution.
4. Providing data on the status of an aquatic system on a regular basis.

**Plankton:** A microscopic community of plants (phytoplankton) and animals (zooplankton), found usually free floating, swimming with little or no resistance to water currents, suspended in water, non-motile or insufficiently motile to overcome transport by currents, are called "Plankton".

Phytoplankton (microscopic algae) usually occurs as unicellular, colonial or filamentous forms and is mostly photosynthetic and is grazed upon by the zooplankton and other organisms occurring in the same environment.

Zooplankton principally comprise of microscopic protozoans, rotifers, cladocerans and copepods. The species assemblage of zooplankton also may be useful in assessing water quality.

The structure of photosynthetic populations in the aquatic ecosystems is dynamic and constant changing in species composition and biomass distribution. An understanding of the community structure dependent on the ability to understand the temporal distribution of the different species. Changes in species composition and biomass may affect photosynthetic rates, assimilation efficiencies, rates of nutrient utilization, grazing, etc.

Plankton, particularly phytoplankton, has long been used as indicators of water quality because of their short life spans, planktons respond quickly to environmental changes. They flourish both in highly eutrophic waters while a few others are very sensitive to organic and/or chemical wastes. Some species have also been associated with noxious blooms causing toxic conditions apart from the taste and odour problems.

**Plankton net:** The plankton net is a field-equipment used to trap plankton. It has a polyethylene filtered mesh size and a graduated measuring jar attached to the other end. A handle holds the net. The mesh number 30 of size 60 mm of the net determines the size range of the plankton trapped. The mesh number 30 of size 60 mm is used for collecting samples.

**Sampling Procedure:** The manner in which sampling is done should conform to the objectives of the study. The surface samples (samples collected from the surface) are collected as close to the water surface as possible, mostly towards the center of the pond at regular intervals. A known volume of the sample,  $\text{M}$  is filtered and plankton are filtered and preserved for further analysis.

**Labels:** The sample label has the date, time of sampling, study area lake name and the volume measured and pasted on the containers of 50ml capacity.

**Preservation:** The samples collected into the 100ml polyethylene vials were preserved by adding suitable amounts of 1ml chloroform to act as the preserving agent and 2ml of 2% formalin for preservation and analyses.

**Concentration technique:** The plankton nets are used to collect samples for the qualitative and quantitative estimation of the plankton, by filtering a known volume of water (5-50 liters) through the net depending on the plankton density of the tanks.

**Qualitative evaluation of plankton:** water sample is placed on a glass slide and observed for different planktonic organism under microscope.

