

CHAPTER 2. PHYSICAL PARAMETERS OF WATER

COLOUR

In natural water, colour is due to the presence of humic acids, fulvic acids, metallic ions, suspended matter, plankton, weeds and industrial effluents. Colour is removed to make water suitable for general and industrial applications and is determined by visual comparison of the sample with distilled water.

Visual comparison: About 20ml of the sample and 20ml of distilled water were taken in two separate wide mouthed test tubes. The results were tabulated (as clear, greenish, greyish, brownish, blackish, etc) by comparing the colour of the sample with distilled water.

ODOR:

Odor of water is due to the accumulation of excretory wastes and organic and inorganic loads and also due to pollution. The odor of the investigated pond water was smelt by nose. The odor of an ideal pond water is not fishy or odorless (Das, 1997).

TEMPERATURE

Impinging solar radiation and atmospheric temperature brings about spatial and temporal changes in temperature, setting up convection currents and thermal stratification. Temperature plays a very important role in wetland dynamism affecting the various parameters such as alkalinity, salinity, dissolved oxygen, electrical conductivity etc. In an aquatic system, these parameters affect the chemical and biological reactions such as solubility of oxygen, carbon-di-oxide-carbonate-bicarbonate equilibrium, increase in metabolic rate and physiological reactions of organisms, etc. Water temperature is important in relation to fish life. The temperature of drinking water has an influence on its taste.

Apparatus required: Thermometer- 0.1° C division.

Procedure: Temperature measurement is made by taking a portion of the water sample (about 1litre) and immersing the thermometer into it for a sufficient period of time (till the reading stabilizes) and the reading is taken, expressed as °C.

TRANSPARENCY (LIGHT PENETRATION)

Solar radiation is the major source of light energy in an aquatic system, governing the primary productivity. Transparency is a characteristic of water that varies with the combined effect of colour and turbidity. It measures the light penetrating through the water body and is determined using Secchi disc.

Apparatus required: Secchi disc, a metallic disc of 20cm diameter with four quadrats of alternate black and white on the upper surface. The disc with centrally placed weight at the lower surface, is suspended with a graduated cord at the center.

Procedure: Transparency is measured by gradually lowering the Secchi disc at respective sampling points. The depth at which it disappears in the water (X_1) and reappears (X_2) is noted. The transparency of the water body is computed as follows:

$$\text{Transparency (Secchi Disc Transparency)} = (X_1 + X_2)/2$$

Where, X_1 = Depth at which Secchi disc disappears

X_2 = Depth at which Secchi disc reappear

Turbidity (NTU) = (Nephelometer readings) (Dilution factor*)

If the turbidity of the sample is more than 40 NTU, then the sample is diluted and the dilution factor is accounted in final calculations.



Fig:5 Secchi disc

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, re- 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 lark 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 ± 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 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. Groundwater almost always contains more salt than surface waters.

The salinity of water is an important measure of water quality because different species of animal life survive in different ranges of salinity. Even a small change in salinity could cause stress, or 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 $CaCO_3 = B \times \text{normality of acid} \times 50000 / \text{ml of sample}$

here,

$A =$ 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_3 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 ± 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 $\text{pH} > 12.0$, Mg^{++} ion precipitates with only Ca^{++} in solution. At this pH, murexide indicator forms a pink color with Ca^{++} ion. When EDTA is added 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.

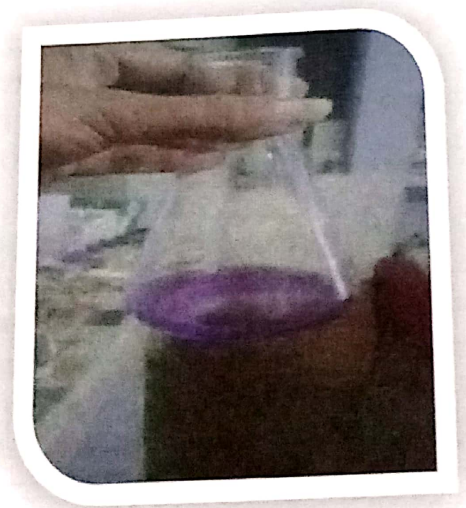


Fig 6: Results of total hardness test by titration method

CALCIUM HARDNESS

The presence of calcium (8th 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 low 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 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 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. Natural waters in their unpolluted state contain only minute quantities of nitrates. The stimulation of plant growth by nitrates may result in eutrophication, especially due to algae. The subsequent death and decay of algae produces 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 natural source of polluting nitrates is domestic sewage. Nitrates may find their way into ground water through leaching from soil and at times by contamination. They can be measured by the phenoldisulphonic