Lecture 5

Water Quality Monitoring: Estimation of Chemical parameters

CHEMICAL PARAMETERS

Solids: Total solids include suspended and dissolved solids. Amount of *total solids* in a water sample can be determined by evaporating the water and weighing the residue. Amount of *suspended solids* is determined by filtering the sample of water through filter paper, followed by drying the filter paper and weighing the solids. The quantity of *dissolved solids* including the colloidal solids is determined evaporating the filtered water (obtained from the suspended solid test) and weighing the residue [1].

Total solids can also be considered as the sum of organic and inorganic solids. Amount of *inorganic solids* can be determined by fusing the residue of total solids in a muffle-furnace and weighing the fused residue. Amount of *organic solids* is the difference between the amount of inorganic and total solid.

Hardness: Hardness of water is due to the presence of carbonates and sulphates of calcium and magnesium ions in the water. Sometimes hardness in the water can also be caused by the presence of chlorides and nitrates of calcium and magnesium.

Presence of hardness in water prevents the lathering of the soap during cleaning of clothes, etc.

Hardness is usually expressed in mg of calcium carbonate per litre of water. Hardness is generally determined by Versenate Method. In this method, the water is titrated against EDTA salt solution using Eriochrome Black T as indicator solution. While titrating, color changes from wine red to blue. In general, under a normal range of pH values, water with hardness up to 75 mg/L are considered as soft and those with 200 mg/L and above are considered as hard. In between, the water is considered as moderately hard. Underground water is generally harder than the surface water, as they have more opportunity to come in contact with minerals.

For boiler feed water and for efficient cloth washing, etc., the water must be soft. However, for drinking purposes, water with hardness below 75 mg/L is generally tasteless and hence, the prescribed hardness limit for drinking ranges between 75 to 150 mg/L.

Chlorides: Sodium chloride is the main substance in chloride water. The natural water near the mines and sea has dissolved sodium chloride. Similarly, the presence of chlorides may be due to the mixing of saline water and sewage in the water. Excess of chlorides is considered as dangerous and makes the water unfit for many uses.

Chloride content is determined by titrating the wastewater with silver nitrate and potassium chromate. Appearance of reddish color confirms presence of chlorides in water.

Chlorine: Dissolved free chlorine is never found in natural waters. It is present in the treated water resulting from disinfection with chlorine. The chlorine remains as residual in treated water for the sake of safety against pathogenic bacteria.

Residual chlorine is determined by the starch-iodide test. In starch-iodide test, potassium iodide and starch solutions are added to the sample of water due to which blue color is formed. This blue color is then removed by titrating with sodium thiosuplhate solution, and the quantity of chloride is calculated. On the addition of ortho-iodine solution if yellow color is formed, it indicates the presence of residual chlorine in the water. The intensity of this yellow color is compared with standard colors to determine the quantity of residual chlorine.

The residual chlorine should remain between 0.5 to 0.2 mg/L in the water so that it remains safe against pathogenic bacteria.

Iron and Manganese: These are generally found in ground water. The presence of iron and manganese in water makes it brownish red in color. Presence of these elements leads to the growth of micro-organism and corrodes the water pipes. Iron and manganese also causes taste and odor in the water. The quantity of iron and manganese is determined by colorimetric methods.

pH: pH value is the logarithm of reciprocal of hydrogen ion activity in moles per liter. Depending upon the nature of dissolved salts and minerals, water may be acidic or alkaline. When acids or alkalis are dissolved in water, they dissociate into electrically charged hydrogen and hydroxyl radicals, respectively. Dissolved gases such as carbon dioxide, hydrogen sulphide and ammonia also affect the pH of water [2]. pH of natural water is generally in the range of 6-8. Industrial wastes may be strongly acidic or basic and their effect on pH value of receiving water depends on the buffering capacity of receiving water. pH lower than 4 have sour taste and above 8.5 have bitter taste. At pH below 6.5, corrosion starts to occur in pipes [3].

Lead and Arsenic: These are not usually found in natural waters. But sometimes lead is mixed up in water from lead pipes or from tanks lined with lead paint when water moves through them. These are poisonous and dangerous to the health of public. The presence of lead and arsenic is detected by means of chemical tests.

Dissolved Gases: Oxygen and carbon dioxide gases are found in the natural waters of all types. In addition, water may contain some amount of hydrogen sulphide and ammonia depending upon the pH and anaerobic/aerobic condition of water.

Surface water absorbs oxygen from the atmosphere. Algae and other tiny plant life of water also give oxygen to the water. Dissolved oxygen is necessary for sustenance of aquatic life in water and to keep it fresh. The water absorbs carbon dioxide from the atmosphere. Calcium and magnesium salts get converted into bicarbonates in presence of carbon dioxide and cause hardness in the water. The presence of carbon dioxide can easily determined by mixing the lime solution in the water.

Nitrogen: Nitrogen may be present in the water in the form of nitrites, nitrates, free ammonia, and albuminoidal nitrogen. The presence of nitrogen in the water indicates the presence of organic maters in the water.

The presence of the nitrites in the water, due to partly oxidized organic matters, is very dangerous. Therefore, in no case nitrites should be allowed in the water.

The nitrites are rapidly and easily converted to nitrates by the full oxidation of the organic matters. The presence of nitrates is not so harmful. But nitrates > 45 mg/L can cause “mathemoglobinemia” disease to the children.

Free ammonia is obtained from the decomposition of organic matters in the beginning, therefore if free ammonia is present in the water, it will indicate that the decomposition of the organic matters has started recently. The presence of nitrites indicates partial decomposition of organic matters, whereas the presence of nitrates indicates fully oxidized matters.

Metals and other chemical substances: Water contains various types of minerals and metals such as iron, manganese, copper, lead barium, cadmium, selenium, fluoride, arsenic, etc.

Arsenic, selenium are poisonous, therefore they must be removed totally. Human lungs are affected by the presence of high quantity of copper in the water. Fewer cavities in the teeth will be formed due to excessive presence of fluoride in water.

The quantity of the metals and other substances can be done indirectly by colorimetric methods using UV-visible spectrophotometer or directly by the use of sophisticated instruments such as Atomic Absorption Spectrophotometer (AAS), Atomic Emission Spectrophotometer (AES), Inductively Coupled Mass Spectrophotometer (ICP-MS), etc.

REFERENCES

[1] http://www.nlsenlaw.org/environmental-management/eia-public-hearing/law-policy/s-o-1533-e-14-09-2006-environmental-impact-assessement-notification-2006-english

[2] http://www.cpcb.nic.in/GeneralStandards.pdf.

[3] http://www.auroville.info/ACUR/documents/laboratory/chemical_analysis_of_water.pdf.