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Water Quality-A Review

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Abstract

Water resources are equally important for natural ecosystem and human development. It is essential for agriculture, industry and human existence. All life on earth depends on water. Fresh water is a critical, finite, vulnerable, renewable natural resource on the earth and plays as important role in our living environment without it, life is impossible. More than 70% of the Earth's surface is covered with this simple molecule. Scientists estimate that the hydrosphere contains about 1.36 billion cubic kilometers of these substances of physicochemical parameters such as pH, colour, Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Total Suspended Solids (TSS), Total Dissolved Solids (TDS), and turbidity. The quality of water can be assessed by studying its physical and chemical characteristics. The present review paper describes about the importance of different parameters of water quality.

Keywords: BOD; COD; pH; Turbidity; TDS; TSS

Introduction

The quality of water is of vital concern for mankind since it is directly linked with human welfare. Water is most indispensable requirement for all living organisms and any alterations in water may lead to the issue of survival for these organisms. Good quality of water is essential for living organisms. The quality of water can be assessed by studying its physical and chemical characteristics. Because of vast population and negligence of human being the quality of water is being deteriorated day by day [1]. Enormous industrial growth has taken place throughout the world in the past few decades, to fulfill the increased demand of human civilization, which has created an overexploitation of available resources and caused pollution of water, land, and air. Rapid industrialization, urbanization and anthropogenic activities consequently cause water pollution which has brought a variable water crisis. Environmental pollutants arising from anthropogenic source have the potential to affect the aquatic ecosystem in a synergistic manner. The determination of such environmental pollutants can be assessed by physicochemical almost 70% of the water in India has become polluted due to the discharge of domestic sewage and industrial effluents in to natural water resources such as river, streams, lakes [2,3]. Water quality characteristics of aquatic environments arise from a multitude of physical, chemical and biological interactions. The Waterbodies Rivers, lakes, and estuaries are continuously subject to a dynamic state of change with respect to their geological age and geochemical characteristics. This is demonstrated by continuous circulation, transformation and accumulation of energy and matter through the medium of living things and their activities. This dynamic balance in the aquatic ecosystem is upset by human activities, resulting in pollution which is manifested dramatically as fish kill, offensive taste and odour, etc. The improper management of water systems may cause serious problems in availability of drinking water [4]. Water resource is most often polluted by industrial effluents. When waste from different industries is discharged without appropriate treatment in water bodies. The physical, chemical and biological characteristics of water are altered in such a way that they are more useful for the purpose for which they have being intended [5]. Consideration of water quality is important in wetland habitat evaluation because a host of interacting physical and chemical factors can influence the levels of the primary productivity and thus influence trophic structure and total biomass throughout the aquatic food web [6]. This paper deals with some parameters assessing the quality of water.

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Literature Review

Water pollutants

The large number of water pollutants may be broadly classified under the following categories:

- Organic pollutants
- Inorganic pollutants
- Sediments
- Radioactive materials
- Thermal pollutants

Organic pollutants

This group includes oxygen-demanding wastes, disease-causing agents, plant nutrients, sewage, synthetic organic compounds and oil.

Dissolved Oxygen (DO) is an essential requirement of aquatic life, *i.e.*, plant and animal population in any waterbody. The optimum DO in natural water is 4 to 6 ppm [7,8]. Decrease in this DO value is an index of pollution mainly due to organic matter, e.g., sewage (domestic and animal), industrial wastes from food-processing plants, paper mills and tanneries; wastes from slaughterhouses and meat-packing plants; runoff from agricultural lands, etc. All these materials undergo degradation by bacterial activity in the presence of DO, the net result being the deoxygenation process and quick depletion of DO.

Sewage and runoff from agricultural lands provide plant nutrients in natural setting in the natural biological process called eutrophication. Algal blooms and large amounts of other aquatic weeds cause serious problems. The waterbody, in the process of eutrophication, loses all its DO in the long-run and ends up in a dead pool of water.

Inorganic pollutants

This group consists of inorganic salts, mineral acids, finely-divided metals and metal compounds, trace elements, complexes of metals with organics in natural water, and organometallic compounds. The metal-organic interactions involve organic species of both pollutant (such as EDTA) and natural (e.g. fulvic acids) origin. Such interactions depend on and play a role in redox equilibria, colloid formation, acid-base reactions and micro-organisms-mediated reactions in water. These have an impact on the toxicity of metals in aquatic ecosystems and on the growth of algae in water [9,10].

Sediments

The natural process of soil erosion gives rise to sediments in water. It represents the most extensive pollutants of the surface waters. As a matter of rough estimate, suspended solid loadings reaching natural waters are about 700 times as large as the solid loading from sewage discharge. Soil erosion gets enhanced 5-10 times as a result of agricultural development and about 100 times due to construction activities [11].

Radioactive materials

Four human activities are responsible for radioactive pollution:

- Mining and processing of ores to produce usable radioactive substances.
- Use of radioactive materials in nuclear weapons.
- Use of radioactive materials in nuclear power plants.
- Use of radioactive isotopes in medical, industrial and research applications.

Thermal pollution

The most modern power plants never have efficiency more than 40%. Power plant operating at 40% efficiency generates 16.7 joules of waste heat for every 41.8 joules of fuel burnt [12-15]. The condenser coils are cooled with water from nearby river or lake and discharged back to the latter with its temperature raised by about $10^{\circ C}$. This has obviously harmful effect on aquatic life. It decreases D.O. of water.

Water Quality Parameters and Standards

The parameters for water quality are listed in (Table 1). The permissible limits as laid down by the United States Public Health Drinking Water Standards (USPH). It refers to domestic water supplies for drinking water.

TABLE 1.**The parameters for water quality.**

Serial Number	Parameters	USPH Standard
1	Colour, Odour, Taste	Colourless, odourless, tasteless
2	pH	6.0-8.5
3	Specific conductance	300 mmho cm^{-1}
4	Dissolved Oxygen (D.O)	4.0-6.0 ppm
5	Total dissolved solids	500
6	Suspended solid	5.0
7	Chloride	250
8	Sulphate	250
9	Cyanide	0.05
10	Nitrate + nitrite	< 10.0
11	Fluoride	1.5
12	Phosphate	0.1
13	Sulphide	0.1 mg L^{-1} (ppb)
14	Ammonia	0.5
15	Boron	1.0
16	Calcium	100
17	Magnesium	30
18	Arsenic	0.05
19	Barium	1.0
20	Cadmium	0.01
21	Chromium (VI)	0.05
22	Copper	1.0
23	Iron (filterable)	<0.03
24	Lead	<0.05
25	Manganese (filterable)	<0.05

26	Mercury	0.001
27	Selenium	0.01
28	Silver	0.05
29	Uranium	5.0
30	Zinc	5.5
31	COD	4.0
32	Cardon $CHCl_3$ Extract (CCE)	0.15
33	Methylene blue active substances	0.05
34	Phenols	0.001
35	Pesticides (Total)	0.005
36	Polycyclic Aromatic Hydrocarbon	0.002 ppm
37	Surfactants	200
38	Gross Beta Activity	1000 pc/L
39	Radium - 226	3 pc/L
40	Strontium - 90	10 pc/L
41	Coliform cells/100 mL	100
42	Total Bacteria Count/100 mL	1.0×10^6

P^H: P^H is an indicator of the existence of biological life as most of them thrive in a quite narrow and critical pH range [16].

Colour: Colour is vital as most water users, be it domestic or industrial; usually prefer colorless water [17]. Determination of colour can help in estimated costs related to discoloration of the water.

Conductivity: Conductivity indicates the presence of ions within the water, usually due to in majority, saline water and in part, leaching. It can also indicate industrial discharges. The removal of vegetation and conversion into monoculture may cause run-off to flow out immediate thus decrease recharge during drier period [18-20]. Hence, saline intrusion may go upstream and this can be indicated by higher conductivity.

Turbidity: Turbidity may be due to organic and/or inorganic constituents. Organic particulates may harbour microorganisms. Thus, turbid conditions may increase the possibility for waterborne disease. Nonetheless, inorganic constituents have no notable health effects. The series of turbidity-induced changes that can occur in a water body may change the composition of an aquatic community. First, turbidity due to a large volume of suspended sediment will reduce light penetration, thereby suppressing photosynthetic activity of phytoplankton, algae, and macrophytes, especially those farther from the surface. If turbidity is largely due to algae, light will not penetrate very far into the water, and primary production will be limited to the uppermost layers of water [21,22]. Cyanobacteria (blue- green algae) are favored in this situation because they possess flotation mechanisms. Overall, excess turbidity leads to fewer photosynthetic organisms available to serve as food sources for many invertebrates. As a result, overall invertebrate numbers may also decline, which may then lead to a fish population decline. If turbidity is largely due to organic particles, dissolved oxygen depletion may occur in the water body. The excess nutrients available will encourage microbial breakdown, a process that requires dissolved oxygen. In addition, excess nutrients may result in algal growth. Although photosynthetic by day, algae respire at night, using valuable dissolved oxygen. Fish kills often result from extensive oxygen depletion.

Total Suspended solids: Total Suspended solids are an indication of the amount of erosion that took place nearby or upstream. This parameter would be the most significant measurement as it would depict the effective and compliance of control measures riparian reserve along the waterways. The series of sediment-induced changes that can occur in a water body may change the composition of an aquatic community. The settling of suspended solids from turbid waters threatens benthic aquatic communities. Deposited particles may obscure sources of food, habitat, hiding places, and nesting sites. Most aquatic insects will simply drift with the current out of the affected area [23]. Benthic invertebrates that prefer a low-silt substrate, such as mayflies, stoneflies, and caddis flies, may be replaced by silt-loving communities of Oligochaeta, pulmonate snails, and chironomid larvae. Increased sediment may impact plant communities. Primary production will decline because of a reduction in light penetration. Sediment may damage plants by abrasion, scouring, and burial. Finally, sediment deposition may encourage species shifts because of a change of substrate. Sediment deposition may also affect the physical characteristics of the stream bed. Sediment accumulation causes stream bed elevation and a decrease in channel capacity. Flooding is more likely after sediment accumulation because the stream cannot accommodate the same volume of water. Also, a substrate that is closer to the surface receives more light and supports increased numbers of photosynthetic organisms, such as rooted algae. As a result, recreational use may be threatened because moving parts of boats may become tangled in aquatic plants. Sediment, which is generally negatively charged, attracts positively charged molecules. Some of these molecules (phosphorus, heavy metals, and pesticides) are pollutants. These positively charged pollutants are in equilibrium with the water column and are often released slowly into the water resource.

Discussion

TDS: The Total Dissolved Solids (TDS) in water consist of inorganic salts and dissolved materials. In natural waters, salts are chemical compounds comprised of anions such as carbonates, chlorides, sulphates, and nitrates (primarily in ground water), and cations such as potassium (K), magnesium (Mg), calcium (Ca), and sodium (Na). In ambient conditions, these compounds are present in proportions that create a balanced solution. If there are additional inputs of dissolved solids to the system, the balance is altered and detrimental effects may be seen. Inputs include both natural and anthropogenic source [24].

BOD: BOD is a measure of organic pollution to both waste and surface water. High BOD is an indication of poor water quality. For this tree plantation project, any discharge of waste into the waterways would affect the water quality and thus users downstream.

Nitrate nitrogen: The growth of macrophytes and phytoplankton is stimulated principally by nutrients such as nitrates. Many bodies of freshwater are currently experiencing influxes of nitrogen and phosphorus from outside sources. The increasing concentration of available phosphorus allows plants to assimilate more nitrogen before the phosphorus is depleted. Thus, if sufficient phosphorus is available, high concentrations of nitrates will lead to phytoplankton (algae) and macrophyte (aquatic plant) production. This is mostly due to the usage of fertilizers.

COD: COD is an indicator of organics in the water, usually used in conjunction with BOD. High organic inputs trigger deoxygenation. If excess organics are introduced to the system, there is potential for complete depletion of dissolved oxygen. Without oxygen, the entire aquatic community is threatened. The only organisms present will be air- breathing insects and anaerobic bacteria. If all oxygen is depleted, aerobic decomposition ceases and further organic breakdown is accomplished anaerobically. Anaerobic microbes obtain energy from oxygen bound to other molecules such as sulphate compounds. Thus, anoxic conditions result in the mobilization of many otherwise insoluble compounds.

In areas of high organics there is frequently evidence of rapid sewage fungus colonization. Sewage fungus appears as slimy or fluffy cotton wool-like growths of micro-organisms which may include filamentous bacteria, fungi, and protozoa such as Sphaerotilus natans, Leptomitus lacteus, and Carchesium polypinuym, respectively. The various effects of the sewage fungus masses include silt and detritus entrapment, the smothering of aquatic macrophytes, and a decrease in water flow velocities. An accumulation of sediment allows a shift in the aquatic system structure as colonization by silt-loving organisms occurs. In addition, masses of sewage fungus may break off and float away, causing localized areas of dissolved oxygen demand elsewhere in the water body.

Ammonia nitrogen: Ammonia levels in excess of the recommended limits may harm aquatic life. Although the ammonia molecule is a nutrient required for life, excess ammonia may accumulate in the organism and cause alteration of metabolism or increases in body pH. It is an indicator of pollution from the excessive usage of ammonia rich fertilizers.

Potassium: Potassium is macro nutrient element for plant growth. It can occur naturally in minerals and from soils. High levels in surface water, especially in areas where there are agricultural activities as indicative of introduction of K due to application of fertilizers.

Microbiological: Microbiological test is to detect the level of pollutions caused by living thing especially human who live or work in the area especially upstream of the site. These tests are based on coliform bacteria as the indicator organism. The presence of these indicative organisms is evidence that the water has been polluted with faeces of humans or other warm-blooded animals.

Conclusion

The overall view for the water analysis parameters is complicated in terms of maintaining best quality of water on our planet. Imbalance in one of them creates misbalance in other parameters. Thus, we have to take extreme care to preserve the natural resource of water in its purest form.

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