Water Quality and Treatment

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Abstracts

Water quality is about the physical, chemical and biological characteristcs of water, determining its suitability for uses like drinking, recreation,or supporting ecosystem, assessed by parameters like pH, dissolved oxygen, temperature, turbidity, nutrients, and microbial life, with standards set by bodies like the EPA to manage pollution and protect public health and the environment.

Key Words: pH, D.O., Physical, Chemical and Biological.

Introduction

Water is one of the abundantly available substances in nature. It is an essential constituent of all animal and vegetable matter and forms about 75% of the matter of earth's crust. It is also an essential ingredient of animal and plant life. Water is distributed in nature in different forms. Such as Rain Water, River water and mineral water, Rain water is the purest form of naturally occurring water. It evaporates from sea as a result of extensive heat. The water vapors thus rising from the surface are drifted by the winds onwards on rising to high altitudes they undergo condensation and form small droplets. These droplets move in the sky in the form of clouds and aggregate continuously they become heavy enough unable to support their weight.

As a result, they fall down in the form of rain, since rain water is produced by a process of distillation, it is considered to be the purest form of water, the rain water, however is associated with dissolved gases such as CO_2, SO_2, NH_3 etc. from the atmosphere. India being a vast country with an area of about 806 million acres, the rain fall constitutes one of the most important and largest source of water. The water in the hilly districts and that from the snows that melt in the mountain regions, flows in the form of rivers.

The original river water is very pure, but it takes up suspended impurities as it flows through the plains. In this process, it also dissolves CO_2 from the atmosphere, which enables water to dissolves carbonates as it passes over the beds, some of the rain water percolates underneath the surface of earth, till it reaches an impervious strata which prevents its further penetration. This exudes in the form of springs.

Water from some springs contains dissolved sulphar compounds, such water is helpful in the cure of some skin disease. If water from the springs contains some salts such as $MgCl_2$ and $MgSO_4$, it is also known as Saline Water.

What is Water Pollution ?

Water pollution is defined as the presence of any foreign substances (Inorganic , Organic , Radiological or Biological) in water which tend to degrade the quality so as to constitute a hazard, or impair the usefulness. Several other definitions of water pollution have been advanced some of them are

- Water pollution is defined as "the addition of any substances to water or changing of water's physical and chemical characteristics in any way which interfaces with it is use for legitimate purposes."
- 'Discharges of wastes 'including radioactive or other substances actually or potentially harmful to such uses and alteration of properties of water in such a way as to harm , including temperature, taste, odour, pH or turbidity.

Water rarely is in pure state in a chemical scence. It contains various types of impurities such as dissolved gases (N_2,NH_3,Co_2,and H_2S), dissolved minerals(salts of Na , Mg and Ca), suspended matters (sand, silt and clay) and even microbes. The natural contaminants or impurities is normally very low and do not pollute water and it's potable.

But the access addition and contamination of impurities makes the water polluted and non-potable. Polluted waters, however are turbid, unpleasand, foul smelling , unfit for drinking , bath and washing or other purposes , they are harmful and are carriers several water born diseases such as Cholera, dysentery, Typhoid, giardiasis, yellow fever, onchuucerciasis , bilharziasis, gastroenteritis etc.

Water Pollution

Pollution may be defined in a number of ways. In case of water pollution, one extreme definition would be to say that unless water is 100% H_2O, that is unless it is pure in the general chemical sense. It is at least to some extent , polluted , however , such a definition is not realistic, because every water sample in contact with atmosphere contains dissolved gases , such as oxygen and carbon dioxide. Similarly every water sample in contact with sediment and rock contains dissolved species of silicon and calcium. In most cases, such a water is not considered to be polluted

Water pollutants may be categories according to their mode of occurrence in to physical, chemical and biological pollutants.

Categories of Water Pollutants

Categories	Nature	Examples
Physical	Temp	waste heat from industries
	Turbidity & colour	Dyes and pigments.
	suspended and floating matters	sand, silt ,metal pieces , plastics, rubber, wood chips, paper , scum , foams , carcasses, sewage etc.
Chemical	Organic	Detergents, tars, organic effluents from industries, pesticides , plastics. etc
	In organic	Nitrates, Phosphates, Chlorides, Florides , trace elements
Biological	Pathogenic	Bacteria, Fungi, Viruses, Nematodes , Worms , Protozoans
	Nuisance Organisms	Slimes, Molluscs, Algae, Water ,Nematodes etc.

Overall Water Quality

The Chemical Physical and biological aspects of water quality are inter-related and must be considered together. For example higher water temperature reduces the solubility of dissolved oxygen, and may cause dissolved Oxygen shortage. That kills more sensitive Fish species. The rotting Fish carcasses may contribute to a bacterial bloom some human swimmers or boaters ill.

Water quality is high variable over time due to both natural and human factors, water temperatures, photosynthetic activity, and flows vary with season, flows and therefore suspended sediment, can vary daily with rain fall.Nutrients loads can vary with season (home owners fertilizing in the Spring) flow (run off mechanisms affect pollutants wash off), and human management (nitrogen is released after a clear –cut).

A comprehensive characterization of natural water quality therefore requires a large amount of data. Water quality data is expensive and time consuming to acquire. However so water quality managers usually deal with a large amount of un certainty.

The Environmental protection Agency (EPA) is the federal agency charged with regulating water quality in the United States. They have set standards for acceptable levels of many aquatic contaminants in drinking water. They have also set targets or guideline for some water quality characteristics directed at aquatic ecosystem health fisheries concerns and safety for human reaction.

Effects and Drinking water Standards for some water quality characteristics -

Water quality characteristic of concern	Ecological or health effect	Standard	Notes
Dissolved Oxygen	high levels of dissolved oxygen are necessary for fish respiration	5.0 mg/ average 4.0mg / minimum	GA water quality standards
Temperature	Fish suffer metabolic stress at high temperature	90 ‘ F maximum	GA water quality standards
pH	pH affects the solubility of other water quality contaminants	6.0 – 9.5	GA water quality standards
Fecal coliform	fecal coliforms do not pose a health threat but serves as an indicators for bacteria that can causes illness in humans and aquatic life.	200 col/100 ml 1000 col/100 ml (Nov. - April) 4000 col / 100 ml (anytime)	GA water quality standards
Phosphorus	macro nutrients affects aquatic productivity and tropic states	no effective standard in GA	any existing standards are water body is specific
Total Nitrogen	Macronutrients affects productivity and trophic states	4.0 mg/ l	GA water quality standards
Nitrate	causes blue baby syndrome	10 mg/ l	federal Drinking water std.
Metals • **As** • **Cadmium** • **Chromium** • **Copper** • **Lead** • **Mercury** • **Silver**	Heavy metals cause a variety problems including interfering with vitamin uptake , neurological disorders and disruption of renal function. These problems result chronic and cumulative exposure	mg/l 0.05 0.01 0.05 1.0 0.05 0.002 0.05	federal drinking water standard s
TDS	general indicator of ion concentration affects tastes	500 mg / l	federal drinking water standard

Physical Pollution of water

The Physical Pollution of water brings about changes in water with regard to it's colour, odour, density, taste, turbidity and thermal properties etc.

Colour

The colour of water is due to presence of minute quantities of metallic ions, peat and humus materials from decaying vegetable matter. Industrial waste also contributes to colour of water.

Colour change is not harmful unless it is associated with a toxic chemical, but it may affect the quality of sunlight that penetrates to a given depth inhibiting plant and animal metabolism.

Most of the trade wastes discharged into water systems have pronounced colours due to organic dyes and inorganic complexes. It has been reported that even a micro quantity (0.02 ppm) of magenta in water imparts a distinct red colouration. Tannery wastes when discharged into iron containing water streams from deep green or blue colouration because of the interaction of tannins with iron. Water also becomes intensely coloured due to interaction between naturally occurring components in water and trade effluents which make it unsuitable for various purpose.

Temperature

it is measured immediately after collecting the water sample preferably on the site itself. This parameter is useful for calculating various factors such as Alkalinity or acidity of water.

The elevated temperatures has adverse ecological consequence on water. All Thermometers must be calibrated before measurement .

The depth Temperature is required for limnological studies, which may be measured with a reversing thermometer. The last device, viz, thermistor is the most reliable amongst measuring instruments.

Odour and Taste

The volatile compounds produce odour. The dilution of sample at which odour is just perceptible is a measure of it's intensity. The odour is qualitatively described as medicinal (phenolic) and fishy (due to algae), earthy (decaying matter) or chemical (chlorine). Odour is quality factor influencing acceptability of potable water.

Unpleasant earthy or musty taste and odour are produced by industrial effluents containing Fe, Mn, free chlorine , phenols and aquatic actinomycetes. For example, even a 0.1 ppm of Fe can produce an inky, taste which phenol produce a bitter taste at 7 ppm. Mn oils , hydrocarbons, chlorophenols, petroleum products, synthetic detergents, pesticides etc. Produce characteristic taste in water.

The decomposed organic matter, algae, fungi, bacteria , and pathogens imparts peculiar taste. However these pollutants can be removed by conventional water purification techniques like chlorination, chemical precipitation and using activated carbon.

Odour pollution of water is caused both by chemical agents (like hydrogen sulphide, free chlorine, ammonia, phenols, alcohols, esters hydrocarbons) and biological agents (such as algae, fungi ,

microorganisms) lower the pH , higher will be the amount of H_2S produced and greater will be the odour nuisance. Certain organic and inorganic compounds of Nitrogen , Sulphur, phosphorus and purified organic matters present in sewage cause foul odour in polluted water.

Hydrogen Ion Concentration (pH)

pH a measure of hydrogen ion activity, is used to express the intensity of acidic or alkaline condition of a solution. It is also an important factor in water analysis since it enters into the calculations of acidity, alkalinity and processes like coagulation, disinfection and corrosion control the pH of a sample can be determined electrometrically or colorimetrically.

Chemical Pollution of water

The chemical pollution of water is due to the presence of inorganic and organic chemicals such as alkalies, toxic inorganic compounds, dissolved inorganic compounds , suspended inorganic compounds. The industrial wastes of certain industries such as DDT factory, High explosive factory, Battery factory etc. contains acids.

The most common form of pollution of water due to organic chemicals is because of the presence of proteins, fats, carbohydrates etc. These inorganic chemicals access to water bodies either through sewage or through industrial wastes. Important industries which contribute such chemicals are dyes, drugs , insecticides, pesticides, detergent and chemical industries.

The organic pollution of water may generally be due to the presence of suspended organic matter or dissolved organic matter. Toxic inorganic compounds are generally present in the industrial wastes of industries like Fertilizers, gas , liquors, coke, ovens alkali producing industries etc.

Some important toxic inorganic compounds are free chlorine, chloramines, H_2S, NH_3, Soluble sulphides and salts of many metals such as Pb, Ni, Cu, Cr, Hg, As,Zn, Ba, U, etc.

Chemical Oxygen Demand (COD)

Chemical oxygen Demand is the quantity of oxygen required during chemical oxidation of organic matter. It determines the amount required for chemical oxidation of organic matter in water which is formed due to decaying vegetable matter , animal and human excreta.

Biological Pollution of water : -

Bacteriological pollution of water is due to the presence of pathogenic bacteria, certain fungi pathogenic protozoa, viruses , parasites , worms etc. the important sources of bacteriological pollution are domestic sewage and industrial wastes.

Natural water are rich in bacteria, algae, protozoa, worms, and other organisms. The greater the amount of nutrients in water the faster the biological contamination. The most frequently occurring micro-organisms are bacteria, which takes an active part in formation of all aquatic populations. They inhibits sludge and other bottom grounds in large quantities and grow in to intricate shapes on under water objects , known as periphyton.

Biological Oxygen Demand:-

Microorganisms such as bacteria are responsible for decomposing organic waste, when organic matter such as dead plants, leaves, grass, clippings, manure , sewage, or even food waste is present in a water supply, the bacteria will begin the process of breaking down this waste. When this happens much of available dissolved oxygen is consumed by aerobic bacteria, robbing other aquatic organisms of oxygen they need to live. Biological oxygen demand is a measure of the oxygen used by microorganisms to decompose this waste.

If there is a large quantity of organic waste in the water supply, there will also be a lot of bacteria present working to decompose this waste. In this case the demand for oxygen will be high (due to all bacteria) so the BOD level will be high, as the waste is consumed or dispersed through the water, BOD level will begin to decline.

The main focus of waste water treatment plants is to reduce the BOD in the effluent discharged to natural waters. Waste water treatment plants are designed to functions as bacteria forms, where bacteria are fed oxygen and organic waste. The excess bacteria grown in the system are removed as sludge, and this " Solid " waste is then disposed of on land."

If the organic material contained in manure, slurries, silage effluents, waste milk or vegetable washings enter a water course, it is broken by micro organisms. This process removes oxygen from the water and in serve cases contamination, aquatic life can be killed through oxygen starration rather than direct poisoning.

Waste from agriculture tend to have a high BOD when compared with treated and untreated domestic sewage.

	BOD (Mg, O_2/litre of pollutant)
Treated domestic sewage	20 – 60
Raw domestic sewage	300 – 400
Vegetable washings	500 – 3000
Dirty Water (parlors , washing /and runoff)	1000 – 2000
cattle slurry	10000 – 20000
pig slurry	20000 – 30000
silage effluent	30000 – 80000
Milk	140000

Dissolved oxygen (D.O.)

Dissolved oxygen is one of the most important indicators of water quality. Oxygen is also introduced into the water as a byproduct of aquatic plant photosynthesis. When dissolved oxygen becomes too low, fish and other aquatic organisms cannot survive.

Free oxygen is required by all aerobic organisms for the activity of respiration. About 21% of free oxygen is present in the air while varies amount of free oxygen is in water in dissolved form. It is about 8 – 10 ppm or mg/l. the saturation level of dissolved oxygen is 14 – 15 ppm at

4^0 C in fresh clean water.

With the rise of temperature the capacity of dissolving oxygen by the water is reduced and reaches at Zero ppm level at boiling point (WOC) all the time all water are not at saturation level , they have some saturation deficits (about 70 – 85% saturation level) some time during active photosynthesis by aquatic plants the release of oxygen may be so much as to cause over saturation or super saturation to 200% saturation level.

D.O. of any water is mainly regulated by it is free interchange at the water and the regulated by it is free interchanged at the water and the atmosphere interface photosynthetic production of oxygen, and consumption of oxygen by aquatic fauna (including decomposers) in their respiratory activity.

Variation in D.O. is also noted at different depth of water, obviously because the oxygenation from air takes place in upper zone i.e photic zone.

Estimation of D.O. provides us insight in to the nature of prevailing conditions. for instances in presence of organic matter load of sewage or presence of heterotrophs, the D.O level drops down considerably surface level of water may be at saturation level but sub surface of water may suffer from D.O. deficiency. There is an increasing demand of oxygen with the rise in growth of heterotrophic organisms such as aquatic bacteria, fungi, protozoan etc.

Source of Water Pollution

There are many specific cause of water pollution , but there are two broad categories of water pollution –

1. **Point Source :** Occurs when harmful substances are emitted directly into a body of water, an example of point source of water pollution is a pipe form an industrial facility discharge effluent directly in to a river.
2. **Non Point Source :** Delivers pollutants indirectly through transport of environment change, an example of non point source of water pollution is when fertilizer from a farm field is carried into a stream by rain .

Water the most abundant and wonderful natural resource is extremely essential for survival of all living organisms. But today clean water has become a precious commodity and it's quality is threatened by numerous source of pollution which are as follows –

- Sewage and domestic wastes
- detergents
- industrial effluents
- fertilizers

Sewage is commonly a cloudy dilute aqueous solution containing mineral and organic matter. About 75% of water pollution is caused by sewage domestic wastes and food processing plants. It also

includes human excreta, soap , detergents, metal , glass , rubbish garden waste and sewage sludge from cess pool etc. domestic sewage and other wastes are thrown untreated or partially treated in to the water bodies such as ponds, lakes , streams and rivers since the dumping is uncontrolled especially near big cities the water bodies are not able to recycle them and their self regulating capability is lost. This may lead to a number of serious problems.

Detergents are of recent origin, used as cleansing agents and derived from surfactant (10 – 30%) builder (15%) and other ingredients. Household detergent contain several pollutants which severly affect the water bodies. They contain surface active agents and contribute to phosphate of Sodium, Sodium silicates, Sodium sulphate , amides and several other builders in water. Present day sewage contains appreciable quantities of synthetic detergents.

The most important disadvantages of detergents is the environmental pollution caused by the factory refuse discharged to nearby water sources.

Industrial effluents discharged into water bodies contain toxic chemicals , hazardous compounds, phenols, aldehydes, ketones, amines, cyanides, metallic wastes, plasticizers, toxic acids, corrosive alkalies, oils , greases, dyes, biocides, suspended solids, non-biodegradable matter radioactive wastes and thermal pollutant from numerous industries.

Modern Agriculture rely heavily an artificial fertilizers, including several biocides, although these chemicals enhance vegetation but they disrupt the entire natural aquatic ecosystem they actually pollute the water indiscriminate and excessive use of fertilizers on land has also created an adverse ecological effect on aquatic ecosystem. Because some of them are washed off land into rivers and lakes , through irrigation rain, seepage, drainage etc. One of the major ingredients of fertilizer are phosphate salts which cause algae bloom.

Control of water pollution

Water is most essential commodity in India for living and all modern industrial agricultural and commercial undertaking water exists in three forms i.e. liquid gaseous (vapour) and solid (snow and ice) of the total water available on the earth some 97% is salt water and the rest about 3% is fresh water .

The source of water on the earth are rain , surface water , ground water and the sea . Rain water carries the washed out minerals, salt and organic matter from earth’s surface and is stored in different water bodies such as ponds, rivers and lakes. It percolates underground and is stored there as ground water.

The source of fresh water are ponds , wells, lakes, and rivers. Distilled water is almost neutral heaving pH 7 but most water are slightly alkaline having pH more than 7 since they contains salts – natural water bodies contains numerous organisms, the fresh potable or non polluted water is free from pathogenic micro-organisms and chemical substances polluted water is characterized by it’s oxygen demand and solid content. A test called Biochemical Oxygen Demand measure the level of organic pollution.

Under the global environmental monitoring system, monitoring of **Indian National Aquatic Resources** and **Ganga Action Plan (GAP)** program have been undertaken for monitoring of the river, ground water and lakes. Under GAP, nine water quality monitoring station established on river Ganga at nine different locations. Some are Kannauj, Allahabad , Varanasi, Patna, Patliputra, Murshidabad, Munger, Baharampur, Kolkata.

For the control of water pollution, strong policy has been adopted by the government in different action such as

- The Central Ganga Authority -→ another government agency, was constituted in February 1985 to guide and over see the implementation of the action plan for restoring the quality of river ganga.
- Federal Water pollution control act (1972) discussing about stabilize uniform nationwide control for each category of major polluting industry.
- Safe Drinking water act (1974) has been launched by the government for the required minimum safety standard for every community water supply among the contaminants regulated are Bacteria, Nitrates, Arsenic, Barium, Cadmium, Chromium, Fluoride, Silver , Pesticides, Radioactivity and turbidity also regulated, this act also contains provision to project ground water aquifers.
- The water (prevention and control pollution) case act , 1977 could recognized the value of this before in industries, every drop of water used in levied to prevent the was tag of water. Sewage treatment, which is the major case of water pollution, needs power requiring technology.

Conclusion

During this project work I force many positive and negative situation . most of the pollution has taken waste condition in which occur Sangam condition was getting disturb day by day.

The situation of Sangam was very disturb mainly due to the water pollution only which increased day by day and condition of sangam was also worse day by day and it's all due to sewage water , house hold detergent products by animals, humans etc.

Due to the water pollution the amount of dissolved oxygen in stream is dependant on the water, Temp, the quantity of sediment in the stream by photosynthesizing plants, dissolved oxygen is measured in milligrams per liter (mg/l) or parts per million .

"The main focus of waste water treatment plants is to reduce the BOD in the effluent discharged to natural waters. Waste water treatment plants are designed to function as bacteria forms, where bacteria are fed oxygen and organic wast. The access bacteria grown in the system are removed as sludge and this "solid" waste is the disposed of on land"

" BOD is a measure of the amount of oxygen that bacteria will consume while decomposing organic matter under aerobic conditions."

COD does not differentiate between biologically available and inert organic matter , and it is a measure of the total quantity of oxygen required to oxidize all organic material into carbon dioxide and water. COD

values are always BOD measurement take five days. As the river re-aerates due to atmospheric mixing and as algal photosynthesis add oxygen to the water , the oxygen level will slowly increase down stream.

Now the positive things come to see in first of all the beauty of Sangam. Synthetic detergents are toxic water pollution to concentration low as 1 ppm are toxic to fish which are exposed for 24 hrs or more when a synthetic detergents decompose and are reduce to the basic inorganic chemical components they may cause serious additional problems detergents contain much phosphorus one of the most important fertilizer when added to water it stimulates algal and aquatic vegetation.

Photosynthesis is generally accelerated during day light hours. These process may stimulate additional heat when light falls on them. The plants produced oxygen frequently 100% saturation.

The synthetic detergents are not easily decomposed by bacteria and are rich source of phosphate that hasten the process of Eutrophication of water with frequent algal blooms, those algal blooms impart colour, colour and unpleasant taste of the water and may cause inconvenience in water supply fish forming and make.

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