

PHYSICO-CHEMICAL PARAMETERS FOR TESTING OF WATER- A REVIEW

^{1*}Varsha Nigam, ¹Neelam Behl, ²M.C. Kanchan

^{1*}Dept. of Botany, Guru Nanak Khalsa College, Yamuna Nagar 13500 (Haryana) INDIA

¹Dept. Of Zoology, Guru Nanak Khalsa College, Yamuna Nagar- 135001, Haryana, INDIA

²Principal, Guru Harkishan Degree College, Jhansi- 488002 (U.P.) INDIA

*Corresponding Author Email: varshanigam29@gmail.com

ABSTRACT

Due to increase population, advanced agricultural practices, industrialization, man-made activity, water is being highly polluted with different contaminants. Water is a vital resource for human survival. The availability of good quality water is an indispensable feature for preventing diseases and improving quality of life. It is necessary to know details about different physico-chemical parameters such as colour, pH, temperature, Electrical conductivity, Total Carbon di oxide, chloride contents, carbonate contents, bicarbonate contents, Total hardness, Dissolved Oxygen (DO), Biological oxygen Demand (BOD), Chemical Oxygen Demand (COD), Total alkalinity used for testing of water quality. Standards prescribed by World Health Organization (WHO) and Bureau of Indian Standard (BIS) for different physico-chemical parameters also have been given for comparing the value of real water sample.

KEY WORDS

Physico-chemical parameters, Electrical conductivity, BOD, COD, WHO, BIS.

INTRODUCTION

Water pollution is a serious problem in India as almost 70 per cent of its surface water resources and a growing percentage of its groundwater reserves are contaminated by biological, toxic, organic, and inorganic pollutants. In many cases, these sources have been rendered unsafe for human consumption as well as for other activities, such as irrigation and industrial needs. This shows that degraded water quality can contribute to water scarcity as it limits its availability for both human use and for the ecosystem.¹

Due to growth of population, agriculture, and industries, demand for domestic water has increased many times during the last few years. Improper waste disposal and over exploitation of resources has affected the quality, not only of tap water but also of ground water.²

Man for its expanding needs of food, shelter, energy etc. has exploited the natural resources at an uncontrolled rate as a result annual rainfall has declined from 3-4%. Denuded land does not soak

much water as a result most of the rainfall is running waste, less water is being stored in underground aquifer which are vital for maintaining river flow's in dry season and other usages. Water plays very vital role in the development of any city or urban centre. As one knows, with the growth of the city, the number of dwelling houses increases, the number of various businesses goes up; it results in to the migration of people from the rural areas to the urban areas for seeking jobs and earning fortunes. As a result of it the population of that area increases immensely. The increased number of people require lot of fresh water, basically for the drinking or consumption purpose.³

Water pollution has many sources. The most polluting of them are the city sewage and industrial waste discharged into the rivers. The facilities to treat waste water are not adequate in any city in India. Presently, only about 10% of the waste water generated is treated; the rest is discharged as it is into our water bodies. Due to this, pollutants enter groundwater, rivers, and other water bodies. Such water, which

ultimately ends up in our households, is often highly contaminated and carries disease-causing microbes. Agricultural run-off, or the water from the fields that drains into rivers, is another major water pollutant as it contains fertilizers and pesticides. Fertilizers have an indirect adverse impact on water resources. Indeed, by increasing the nutritional content of water courses, fertilizers allow organisms to proliferate. These organisms may be disease vectors or algae. The proliferation of algae may slow the flow in water courses, thus increasing the proliferation of organisms and sedimentation.

The use of land for agriculture and the practices followed in cultivation greatly affect the quality of groundwater. Intensive cultivation of crops causes chemicals from fertilizers (e.g. nitrate) and pesticides to seep into the groundwater, a process commonly known as leaching. Routine applications of fertilizers and pesticides for agriculture and indiscriminate disposal of industrial and domestic wastes are increasingly being recognized as significant sources of water pollution. Therefore it is necessary that the quality of drinking water should be checked at regular time interval, because due to use of contaminated drinking water, human population suffers from various water borne diseases.⁴ Water is not only an essential element for survival of life but also it is an important vehicle for economic development of the nation. Though water is a renewable resource the volume of usable water is limited in the nature. So it is essential to maintain the sustainability of water by adopting proper management technique in its utilization (Panjiar, 2010).⁵

The Central Pollution Control Board monitoring results obtained during 2005 indicate that organic pollution continues to be predominant in aquatic resources. Organic pollution measured in terms of bio-chemical oxygen demand (BOD) and *coliform* count gives an indication of the extent of water quality degradation in different parts of the country. It was observed that nearly 66 per cent of the samples had BOD values less than acceptable limits while 44 per cent of the samples indicated the presence of *coliform* while according to the BIS there should be no *coliform* in drinking water samples.

Physico-chemical Parameters:-

The availability of good quality water is an indispensable feature for preventing diseases and improving quality of life. It is necessary to know details about different physico-chemical parameters such as color, temperature, acidity, hardness, pH, sulphate, chloride, DO, BOD, COD, alkalinity used for testing of water quality. Some physical test should be performed for testing of its physical appearance such as temperature, color, odour, pH, turbidity, while chemical tests should be performed for its BOD, COD, dissolved oxygen, alkalinity, hardness and other characters.⁴ Being a basic need of human development, health and well being, safe drinking water is an internationally accepted human right (WHO, 2001), which has been enlisted as one of the ten targets in the Millennium Development Goals (MDGs).⁶

Temperature:- Temperature effects the seasonal and diurnal variation. It controls the rate of all biochemical and biological reactions including growth, multiplication, decay, mineralization, production etc. Temperature is recorded with the help of maximum minimum thermometer.²

Electrical conductivity:- Ground water quality is measured by the method of electrical conductivity. As the salt is more conducive of electricity and if there is more amount of salt in a fixed volume of water the electrical conductivity of the water will be more in comparison to less saline water.⁷ The ability of a solution to conduct an electrical current is governed by the migration of solutions and is dependent on the nature and numbers of the ionic species in that solution. This property is called electrical conductivity. It is a useful tool to assess the purity of water.⁸

Electrical conductivity is measured with the help of EC meter. The permissible limit for electrical conductivity (EC) is 300 $\mu\text{S cm}^{-1}$. The instrument is standardized with known values of conductance observed with standard KCl solution. It gives an idea of soluble salts present in the water samples.⁴

Hydrogen Ion Activity (pH):-

pH is a term used to express the intensity of acidic or alkaline conditions. It is the expression of hydrogen ion concentration, more precisely, the hydrogen ion activity. pH is an important parameter in assessing

the water quality. Acidic conditions will prevail as pH value decreases and alkaline conditions will prevail as the pH value increases. It is determined with the help of pH meter.⁸

Total Carbon Dioxide:-

Total CO₂ is the sum of free CO₂ and CO₂ existing in the form of carbonates and bicarbonates. It is determined by value of free CO₂ and total alkalinity.² There are various readily measurable parameters of aquatic carbon dioxide system: such as pH (pCO₂), total dissolved inorganic carbon (DIC) and total alkalinity (TA). Surface water pCO₂ can be measured by photometric method (DeGrandpre 1993, Wang, Z 2002)⁹ and DIC CO₂ is measured by coulometer or by an infrared CO₂ analyzer (Dickson 1994).¹⁰ Total Alkalinity CO₂ is determined by HCl titration of the water sample to the CO₂ equivalence point. (Gran 1952).^{4,11} It is also titrated by using the standard methods of water analysis.^{2,6}

Total Alkalinity:-

Bicarbonate alkalinity together with carbonate alkalinity are called total alkalinity. Alkalinity, pH and hardness affect the toxicity of many substances in the water. It is determined by simple dil HCl titration in presence of phenolphthalein and methyl orange indicators.⁴ Alkalinity of water is its acid neutralizing capacity. The alkalinity of groundwater is mainly due to carbonates and bicarbonates. The acceptable limit of alkalinity is 200 mg/l and in the absence of alternate water source, alkalinity up to 600 mg/l is acceptable for drinking.

Total Hardness (TH):-

In groundwater hardness is mainly contributed by bicarbonates, carbonates, sulphates and chlorides of calcium and magnesium. So, the principal hardness causing ions are calcium and magnesium. It is measured by titration method by standardised EDTA sol. using Erichrome black T as indicator. Durfor and Becker (1964) have classified water as soft, moderate, hard and very hard.^{2,4,8}

Classification of water on the basis of total hardness (Durfor and Becker, 1964)¹³

Total Hardness (mg/l)	Nature of water
0-60	Soft
61-120	Moderate
121-180	Hard
>181	Very Hard

Carbonate Contents:- It is detected by titration method with standardised sulphuric acid using phenolphthalein as indicator. The acceptable limit of CO₃²⁻ is 75 mg/l (according to BIS and WHO) Carbonate contents in water are present mainly in association with Ca²⁺ and Mg²⁺. Whenever the pH touches 8.3, the presence of carbonates is indicated.^{2,4,8,12}

Bicarbonate Contents:- It is also measured by titration with standardized sulphuric acid using methyl orange as indicator. Methyl orange turns yellow below pH 4.0. At this pH, the carbonic acid decomposes to give carbon dioxide and water. Bicarbonates in water are present mainly in association with Ca²⁺ and Mg²⁺.^{2,4,8}

Chloride Contents:- Chloride may present naturally in groundwater and may also originate from diverse sources such as weathering, leaching of sedimentary rocks and infiltration of Sea water etc. It is measured by titrating a known volume of sample with standardized silver nitrate solution using potassium chromate solution as an indicator.⁶ The maximum permissible limit of chloride in potable water is 250 mg/l.

Dissolved Oxygen:- The occurrence of dissolved oxygen in drinking water may be mainly attributed to 2 distinct phenomenon.

1. Direct diffusion from the air
 2. Photosynthetic evolution by aquatic autotrophs.
- Dissolved oxygen is an important factor that determines the quality of water in lakes and rivers.

The higher concentration of dissolved oxygen, provide better water quality. DO is determined by titration using modified Winklers method as given by Adoni et.al.1985^{2,14} Titration is done by standardised sodium thio- sulphate solution. This procedure needs special BOD bottles which seal the inside environment from atmospheric oxygen.

Biochemical Oxygen Demand (BOD):-

BOD is the amount of dissolved oxygen required in mg/l for stabilizing the biodegradable organic matter by microorganism of the sample under aerobic conditions and the oxidation of certain inorganic materials.(e.g., iron, sulphites)Typically the test for BOD is conducted over a five-day period, and determined by standered method.^{2,6,12}

Chemical Oxygen Demand (COD):-

COD is the amount of dissolved oxygen required to cause chemical oxidation of the organic material in water. Both BOD and COD are key indicators of the environmental health of a surface water supply and determined by APHA method.^{4,6.}

It is necessary that the quality of drinking water should be checked at regular intervals, because due to use of contaminated drinking water, human population suffers from various water borne diseases. The availability of good quality water is an indispensable feature for preventing diseases and improving quality of life. WHO and BIS guidelines of different physico-chemical parameters have been given below for comparing the value of real water sample.

DRINKING WATER QUALITY STANDARD (INDIAN AND WHO) ^{4,8,17,18,19}

Parameters	Bureau of Indian Standard (BIS)		World health organization (WHO)
	Acceptable limit	Maximum limit	
pH	6.5-8.5	6.5-9.5	6.5-9.5
Electrical conductivity	300	-	-
Total Alkalinity	200 ppm	600	-
Total Hardness	300ppm	600	200ppm
Ca ⁺²	75	200	75
Mg ⁺²	30	100	150
CO ₃ ²⁻	75	200	75
HCO ₃ ⁻	30	-	150
Cl ⁻	250ppm	1000	250 ppm
Biochemical Oxygen Demand (B.O.D.)	30	-	6
Chemical Oxygen Demand (C.O.D.)	-	-	10

CONCLUSION

The effects of water pollution are not only devastating to people but also to animals, fish, and birds also destroys aquatic life and reduces its reproductive ability. Polluted water is unsuitable for drinking, recreation, agriculture, and industry. It diminishes the aesthetic quality of lakes and rivers. Eventually, it is a hazard to human health.

To minimize the pollution in drinking water we can use modern technologies such as reverse osmosis and ozonation in large scale, which are effective in the

treatment of water but their feasibility in a rural setting needs to be worked out. The example of Reverse Osmosis water enterprise system in Gujarat is an initiative where WASMO in collaboration with a technology provider has set up community managed reverse osmosis system in 71 villages across the state to address the problem of salinity. The communities contributed 10% of the capital cost and the rest was provided by the government. The technology provider assists in training of village youth for running the RO plant. People are getting water at a price of 5 paisa

per lit per person. This type of an initiative not only solves the problem of providing safe drinking water but is also a source of employment for the village youth.¹⁶

The present review paper undertaken to account to bring an acute awareness among the people about the quality of water. The individual and the community can help minimize water pollution by simple housekeeping and management practices the amount of waste generated can be minimized.

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*Corresponding Author:

VARSHA NIGAM*

Department of Botany,
Guru Nanak Khalsa College, Yamuna Nagar
-13500 (Haryana) INDIA