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Comparative Analysis of Different Methods used in Evaluation of Physio-chemical Parameters of Surface Water: A Review

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Abstract— Water plays a significant role in day-to-day life of all living beings on earth. Surface water bodies are extensively used for various purposes in domestic, industrial, and agricultural sector but the quality of water is getting deteriorated rapidly. Water contamination is a worldwide issue affecting every corner of the world. In the present era, surface water bodies get tremendously affected due to increased population, urban run-off, and industrial pollution. The polluted water not only affect human health but also have an adverse effect on the entire ecosystem. Several physical, chemical, and biological parameters are associated with the quality of water and the continuous measurement of all these parameters are needed to detect the contamination level in water bodies and their harmful effects. The water quality analysis requires different methods to measure different constituents and their concentration present in it. Different factors including environmental factors, methodological and human errors etc. results in fluctuations and erratic results so the focus is given on choosing the accurate method for measurement of various parameters. This review paper identified and inspected various methods of measurement for physio-chemical parameters, their applications, merits, and demerits related to the particular method used. This involves the comparative discussion on various methods used for investigation of water quality parameters and their proficiency in giving accurate results.

Index Terms— Physio-chemical parameters, Surface water bodies, Sensors, Spectrophotometer, Titration.

I. INTRODUCTION

Water is the most vital component required for the survival of life forms on earth [1,2]. The surface water bodies such as lakes, rivers, reservoirs, wetlands etc. are an integral part of our routine life and help in fulfilling the water demands in domestic, industrial, and agricultural areas [1,3,4]. But over period, surface water bodies are under huge pressure as the quality of water is deteriorating rapidly due to waste discharge from various point and nonpoint sources because of human intervention and industrial advancement [1,5,6,7]. The contamination of water is a global scenario and the gap between its demand and availability is increasing rapidly due to shortage of water and increase in population. In India, it was found that about 70% of surface water is affected by pollution and 40 million liters of wastewater daily enters surface water bodies [1, 2,4,8,9].

Thus, to avoid negative impact of polluted water on living system and environment, assessment of water quality plays a great role. The quality of water is the characteristic that indicates the acceptability of its consumption for living beings 10. So, it is very important to analyze surface water quality before its use to prevent water-borne diseases and other associated problems [2,5,11,12].

Keeping in view the importance of surface water and how its quality is getting deteriorated rapidly, various researchers have conducted their research on water quality analysis of different water bodies and their health impact. In most of the studies, various physico-chemical parameters such as Turbidity (tur), Alkalinity (alk), Electrical conductivity (EC), Total Dissolved Solid (TDS), Dissolved Oxygen (DO), Biological Oxygen Demand (BOD) etc. were measured using different methods of analysis [5,10,13,14]. This review is written with the purpose of providing information about the evaluation of various water parameters using different methodologies based on literature review from the previous work done by various researchers.

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II. PHYSICAL AND CHEMICAL PARAMETERS

The evaluation of water quality is very important to check the conditions of water bodies on which we depend for domestic, agricultural, industrial, and other activities. Various physical and chemical parameters need to measure to observe quality of water. Some physical tests such as pH, temperature, turbidity, TDS etc. and chemical tests such as alkalinity, DO, BOD, COD etc. are evaluated to check water status using various methods.

A. pH

pH is defined as the concentration of hydrogen ion (H^+) in water solution. The value of pH ranges from 0-14 where the value below 7 is considered to be acidic and above 7 is considered to be basic or alkaline in nature [15,16]. As per different standards, the acceptable pH value of water is considered to be between 6.5-8.5 (World Health Organization, Bureau of Indian Standards).

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The measurement of pH value in water sample is needed to evaluate change in H^+ concentration which affect various chemical reactions. The change in pH value led to change in quality of water and affect balance between acid-base mechanism. Increased pH in water lead to clogging of pipes and have high corrosive action. Low level of pH in water sample lead to increased amount of acidic content in water [17,18].

Measurement Methods

Keeping into view the important of pH in water and how the quality of water get changed with small amount of variation in pH concentration, various studies had been done for the measurement of pH in water sample using various methods. The recommended methods to measure pH of water sample is by using pH meter and indicator method.

Indicator Method: In this method of pH measurement, the water sample is taken in a container and then indicator is added for analysis. The change in color of the sample compared to the indicator color using buffer solution indicates the pH level in water. The method also involves the use of pH paper strip that first immersed into indicator and then to the sample to measure pH based on change in color.

Strength/Gap: This method is very simple to use but it is not considered to be much effective method because it is not that accurate and is prone to errors. The indicator method is not even expected to check the pH of pure water because of the influence of indicator color [15].

pH Meter: In most of the studies, portable pH meters are used to measure pH value of water samples on the sampling site itself. In this method, the standard solution is taken in a container and then electrode is immersed into that container for some time to stabilize the temperature of water sample. At last, pH meter is adjusted and allowed to take the final reading.

Strength/Gap: pH meter is considered to be the most accurate, easy, and effective method of finding pH of water on daily basis because the variations in pH value can easily keep on control. The only thing that needs to take care of is to wash electrode with distilled water every time before use and make sure that during testing the tip of the electrode is dipped into the sample [7,14,19].

Of all the methods given above, pH meter is considered to be the most effective and widely used method. The digital values of pH meter provide much efficient and precise results than the pH paper and other indicator methods. Due to their portability and accuracy, most studies used pH meter for the water quality analysis [15,20].

B. Dissolved Oxygen (DO)

DO refers to the amount of free oxygen that is present in waterbody. DO is an important parameter to analyze because its value is very critical for the survival of whole ecosystem. It is an indication for knowing the health condition of water bodies as well as status of the environment [20,21]. The permissible value of DO in surface water is between 5-9.5 mg/l as per WHO and 4-6 mg/l as per BIS. The value of DO below 3 mg/l is considered to be a serious issue as per Environmental Protection Agency (EPA).

The value of DO depends upon temperature, dissolved substances, and aquatic organisms in water. The increase in microbial activity and temperature lead to decrease in DO level and cause high pollution load [22]. Due to rapid fluctuation in DO daily and seasonally, there is continuous change in the concentration of DO so it needs to be checked precisely in real time frame [7].

Measurement Methods

The evaluation of DO in surface water bodies is very important because of the dependence of aquatic life upon DO. To check the quality of water, various studies have been conducted to evaluate DO of surface water using various methods of analysis.

DO Meter: DO meter is an electronic device that is used to measure the value of DO in units (mg/l) by converting signals received when probe is placed in water sample. Using this method, DO can be analyzed at the sampling location using portable instrument.

Strength/Gap: This is considered to be the effective method because concentration of DO keep on changing within one-day time period. The only drawback of using this method is it is costly, require careful maintenance and need calibration after every sample testing [3,9,20].

Titrimetric Method: The chemical analysis in laboratory using titrimetric method was also used in various studied to measure DO of water sample. The titration method of analysis involves the addition of reagent that led to change in color of sample which indicates the amount of dissolved oxygen in it.

Strength/Gap: The titration method is the primary analytical method having great accuracy and highest detection ability. The demerits of this method are it is more complex and time-consuming because the final values need to be converted to units (mg/l) using equations. Moreover, it can easily get affected by change in environmental factors and is more prone to human error [2,16,21].

From various studies it was found that onsite measurement of DO using probe or digital meter is better than titrimetric method. It was found that measurement in laboratories lead to decreased result than actual value of DO due to various factors. This is the reason; portable instruments are mostly recommended [17,23].

C. Electrical Conductivity (EC)

The ability of water to conduct electric current is called electrical conductivity. EC is an important parameter to know types of ions and purity in water. The salts or ions that comes from rocks broken down due to pressure of water can be measured by EC to check condition of freshwater bodies based on geomorphology of the area [24,25]. The acceptable value of EC in surface water as per Central Pollution Control Board (CPCB) and BIS is between

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1000-2500 µs/cm and the value should not exceed above 700 µs/cm as per EPA.

The concentration of EC depends upon ions, nutrients, and dissolved substances. The higher conductivity in surface water is found if it passes through area having clay soil and less conductivity is found when it flows through area having granite rocks [24]. In natural water system, there found a direct relation between TDS and EC. TDS plays a major role in finding value of EC as it is equal to the approximate index of total dissolved substances in the water sample because TDS is analyzed based on concentration of dissolved ions and EC measurement depends upon ion strength, temperature, and dissolved ion value [26].

Measurement Methods

Conductivity is a general parameter to measure the overall quality of surface water. The significant changes in the concentration of conductivity specify the presence of other pollutants in the water body. For this, measurement of electrical conductivity of water is done using the given below method.

EC Meter: Various studies were done to measure the conductivity of water sample on the sampling location using EC meter and probe. In this method, the probe is immersed inside the water and the voltage is applied between electrodes. The decrease in voltage inside the sample led to the measurement of conductivity.

Strength/Gap: This measurement method can be applied both in the field as well as in the laboratory. It is considered to be the appropriate and easy method of analysis. The only thing that needs to be taken care of is to rinse the probe with water after every use and if the sample is taken for later measurements, make sure to preserve them in clean polyethylene bottles [1,27,28].

D. Total Dissolved Solid (TDS)

TDS is the amount of the total constituents (organic and inorganic) dissolved in water sample. It is generally the representation of various minerals present in water body. The permissible value of TDS in surface water is about 500 mg/L as per Canadian Council of Ministers of Environment (CCME), WHO and BIS. The TDS value in surface water bodies can be due to any source, including contamination by geological condition, domestic waste, and runoff from roads. It depends upon the ratio of overflow of water to the flow of subsoil [18,25].

The measurement of TDS is quite difficult and need much work but it is an important indicator to measure chemical contaminants in water sample. The higher concentration of TDS in water is not always a major issue but some harmful chemicals affect the environment badly so need proper analysis of water before use [26].

Measurement Methods

TDS is a good indicator of water quality and talks about the aesthetic appearance of the water. For this purpose, evaluation of TDS is very important. Various studies have been conducted to measure TDS of water sample using different methods of testing.

TDS Meter: TDS can be measured at the sample collection point using TDS meter. For the analysis, TDS meter is calibrated and then the sample is taken in a clean bottle. The electrode is immersed into the bottom of the water sample, hold it for some time and allow for the final reading in the meter.

Strength/Gap: TDS meter is considered to be the easiest way of measuring TDS of water sample on routine basis. The only limitation of this method is it is used to give general demonstration about the contaminants present but does not indicate the type of dissolved substances in water sample [29].

Using TS and TSS values: TDS can also be measured by the simple calculation if the value of Total Solid (TS) and Total Suspended Solid (TDS) is known. For the precision of the TDS value, the correct analysis of TS and TSS is needed.

Strength/Gap: This is the easiest method of analyzing TDS by subtracting value of TSS from the value of TS if both the values are already calculated. The only limitation of using this method is if there comes error in single calculation the whole result will give wrong values [8].

Gravimetric Method: Gravimetric method is another method to evaluate TDS of water sample. If the concentration of dissolved solids is much in TDS, gravimetric method can effectively work for analysis.

Strength/Gap: Gravimetric method of measuring TDS helps to know the actual content of dissolved material in water sample but it is not possible in the field analysis because most of the dissolved contents are sensitive to temperature and can lost during the process of evaporation that led to variations in the values analyzed [30].

Among all the method discussed above, every method has its own merits and demerits but gravimetric method is considered to be most accurate method of measuring TDS, although, it is time consuming but it measures the actual residues in the water sample after evaporating the solvent.

E. Alkalinity

The ability of the water to neutralize acid is the measure of alkalinity. It consists of carbonate and hydroxide ion in water sample. The ability of natural water to act as buffer for maintaining constant pH depends upon the calcium and carbonate ions in the solution. Alkalinity in water measures its cumulative properties and can be inferred if the chemical composition of water sample is known [24].

The alkalinity in water can be affected due to weather changes, acid mining, industrial wastewater discharge and geological conditions [31,32]. The allowed value of alkalinity in surface water is about 200mg/L as per WHO and BIS standards. Higher alkalinity in water resists the stable pH in water and cause harmful effects on aquatic

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life and environment. Thus, required amount of alkalinity in water is needed to prevent any fluctuations in water pH [24,33].

Measurement Methods

The measurement of alkalinity is an important parameter to know how much acid can be suitable for the water sample without affecting its quality. Various studies were conducted to measure alkalinity of water sample using titrimetric method of analysis.

Titrimetric Method: This method involves electrometric measurement in which sample of water is titrated with sulphuric acid indicator having known value of pH and concentration and end point pH is taken as 4.5. All the sampling bottles used in this method need to be properly rinsed with vast amount of water after use.

Strength/Gap: Titration method is the quantitative technique that helps to determine values of unknown concentrations and is the widely used method for alkalinity measurement in water. But after sample collection, the biological activity continues and it make changes in the sample so it is recommended to preserve sample at 4°C and to done analysis as soon as possible after sample collection [12,34].

F. Total Hardness

Total hardness in water is calculated in terms of calcium carbonate concentration expressed in mg/l and is defined as the sum of calcium and magnesium ion concentration in water. Hardness is basically considered as the capacity of water to consume soap. The capacity of water to react with detergent to produce foam and to produce scales in water pipes and boilers is considered to be due to hardness of water. The critical factor indicating the hardness of water is the amount of calcium and magnesium ratio in water [24,35].

Hardness of surface water bodies such as rivers, streams etc. depends upon the geology of the adjacent area and sometimes get affected by human activities. The permissible limit of total hardness in water is 300mg/l as per BIS and 600mg/l according to CPCB and ICMR standards. Excessive hardness in water lead to various health effects such as skin irritation, cardiovascular diseases, cerebrovascular disease and many more [36]. Thus, it is very important to know the concentration of hardness in water to overcome its ill effects on health of people [7,28].

Measurement Methods

The measurement of hardness in water is an important parameter to analyze to maintain balance between corrosion and scaling. Various studies were conducted to measure total hardness in water using titrimetric method of measurement.

Titrimetric Method: Titration is an analytical technique that can be used for the analysis of water hardness. This is the most widely used method of measuring hardness in natural water sources such as drinking water, groundwater, and surface water. It involves titration with ethylene diamine tetra acetic acid (EDTA) solution to measure calcium and magnesium concentration in sample of water [1,12,13].

In this method, the indicator (Erichrome Black-T) is added to the water sample and is titrated with complexing agent, EDTA as disodium salt. The indicator is used to measure the total hardness in water base on concentration of calcium and magnesium ions.

Strength/Gap: The titrimetric method is the most widely used method of analyzing total hardness in water but the titration should be conducted at standard temperature because at freezing temperature, the color change will take time and much higher temperature led to decomposition of indicator. The hardness of water also depends upon the pH level as the low pH led to acidity and high pH lead to alkalinity and increased alkalinity is the reason for increased hardness in water [37,38]. To lessen the precipitation of calcium ion, the analysis should be done as soon as possible [3,20].

G. Biological Oxygen Demand (BOD)

Biological oxygen demand is the chemical parameter that involves the analysis of the amount of oxygen that is needed by the aquatic organisms to breakdown organic material in the body of water. BOD disrupt the dissolved oxygen content in surface water bodies and analyzed to give estimation of organic water quality. The increased BOD in water lead to decreased DO available for aquatic life and the waste discharge with high BOD leads to various water related issues [17,18]. The acceptable value of BOD in surface water bodies is 30 mg/l in inland surface water and 100 mg/l in coastal areas as per CPCB and BIS standards.

The various sources responsible for presence of much BOD in water are dead organisms, leaf, wood, organic manure, urban runoff etc. that led to depletion of oxygen in water bodies and ultimately affect the whole ecosystem. The amount of oxygen presence in water depends on other factors such as temperature, pH and other organic and inorganic constituents. Thus, BOD measurement is important to evaluate the amount of oxygen consumed by organisms in a specific time frame [4,33].

Measurement Methods

The BOD value in water body is dependent upon the measurement of dissolved oxygen in water sample at the beginning and at the end of the incubation period. Various studies were conducted to measure BOD of natural water bodies using BOD probe method, BOD_5 test and spectrophotometry.

Probe method: The method involves the electrochemical analysis in which there are two metal electrodes are present and involves the attachment of microbes that are electrochemically active to the electrodes for the BOD calculation. The constant voltage is applied between anode and the cathode. The electrical potential between the anode and the cathode is measured and the difference between their values helps to provide information about the metabolic activity of microorganisms present.

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Strength/Gap: The method is used for easy and continuous monitoring of BOD as it does not involve the use of any titrant or reagents for assessment purpose. This is the more rapid way of analyzing BOD as compared to 5-day BOD test. This method is suitable for analysis of effluents that are stable but not able to analyze diversified effluents in water. It involves short span of analysis but considered to be less accurate than BOD_5 measurement [30,39,40].

BOD_5 test: The test involves the measurement of two samples from the same site. One is analyzed immediately and the other sampling bottle is kept at incubation period for 5 days at temperature of 20°C to measure the dissolved oxygen content in sampling bottles. The difference in two measurement values gives the results of total BOD in water sample.

Strength/Gap: This method of testing BOD is widely used method of analysis but need some precautions while testing. During analysis, make sure that the sampling bottles should be cleaned properly. There should be label on each bottle to avoid any confusion. This test is reliable in providing accurate result only if done accurately because it can be affected by some minor issues such as unclean bottles, bubbles in samples, non-linearity etc. The only drawback is that the sample dilution can cause error and testing for long 5-days led to inaccuracy in results [1,2].

Spectrophotometry Method: This method is used for real time analysis of BOD measurement. The method involves the collection of water sample in clean bottles and kept in refrigerator at temperature of 4°C before taking to laboratory for analysis. The suspended solids need to be removed from the sample and then filtered sample is taken for analysis using UV spectrophotometer.

Strength/Gap: This method is widely accepted method of measurement as it helps in rapid analysis along with accurate results. It is time saving and effective method of analyzing BOD and do not need sample preparation using reagents as used in BOD_5 test. The only problem in analysis with this method occur when the suspended solid concentration is very high in water [3,23].

Of the above-described methods, every method has its own merits and demerits. BOD probe method is used for rapid measurement of BOD, Spectrophotometer method has received importance because of the simplicity and accuracy of the method whereas BOD_5 determination is a lengthy procedure that depends upon microbial population and cause difficulty in acquiring consistent results but still it is more popular because of the determination of effect of organic waste and sewage in dissolved oxygen of surface water [40,41,42].

H. Chemical Oxygen Demand (COD)

COD is the important index to check the quality of surface water bodies by measuring organic and inorganic content in the water. COD is an important parameter that involves the chemical analysis to measure concentration of dissolved oxygen needed to oxidize organic substances. It helps to determine biologically active as well as inactive components in water bodies [16,17]. The permissible value of COD in surface water bodies should be less than 250 mg/l as per CPCB and BIS standards.

The COD level in surface water is increased due to the discharge of runoff containing food waste, debris of plants and animals, pesticides, and other trash etc. into water bodies. Thus, to overcome this problem, the assessment of COD in water is important to check organic pollution load because the higher COD level in water lead to depletion of dissolved oxygen in water.

Measurement Methods

Titration method and colorimetric methods are widely used for the assessment of COD level and several studies have been conducted by various researchers for the COD analysis in surface water bodies using these methods [2,19,30,43,44].

Dichromate Titration Method: The method is the chemical analysis involving the use of strong oxidants for measurement in acidic environment. The oxidant such as potassium dichromate ($K_2Cr_2O_7$) is used for the analysis. The titrimetric method involves the incubation of sample with strong oxidant at specific temperature. 30 ml of sample, 10 mg of mercuric Sulphate ($HgSO_4$)/mg of chloride and 5 ml of 95% sulphuric acid (H_2SO_4) is used in sampling. When the oxidation process is completed, the amount of organic load can be calculated by the amount of oxidant left in the sample solution [2,19,30].

Strength/Gap: The COD measurement using this method is suitable for the waste that are very toxic for BOD analysis but some toxic substances are resistant to dichromate oxidant and give false or low COD value. The titration method is widely used for COD assessment as it provides accuracy and precision but the only problem is one need to be very careful during experimentation because the COD vials contain some toxic substances in it [44,45].

Colorimetric Method: The method involves the use of spectrophotometer for analysis of water sample. For the analysis of COD, UV absorbance spectrometer is used. The sample is digested using $K_2Cr_2O_7$, H_2SO_4 and $HgSO_4$. After digestion, COD level in water sample is analyzed by measuring absorbance of digested assay solution at wavelength of 600 nm using UV-Visible Spectrophotometer. The samples were analyzed at specific wavelength so there should be a suitable correlation between the absorbance and organic content under perfect conditions [3,46].

Strength/Gap: The method is considered to be very easy and time-saving as the only manual thing involves is to digest the sample and rest of the work is done by the instrument itself. The method is simple but it has less stability. It is good for the measurement of complex samples but every time during analysis, it may lead to change in wavelength range and cause instability in obtained results [43,44].

It was found in various studies that although spectrophotometry is the easiest way of analyzing water sample to measure COD but it lacks precision as compared to

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standard titrimetric method. This is the reason many studies have used titrimetric indication method in their analysis [44,47].

I. Phosphorus

Phosphorus is an important parameter that acts as nutrient for plants and animals if in desired quantity and helps to stable ecosystem. But a small increase in concentration of phosphorus lead to imbalance of the whole food chain as it leads to extreme objectionable events such as increases algal blooms, eutrophication and DO depletion that affect the life of aquatic organisms. Phosphorus does not have any adverse impact on humans and animals until it is present in higher concentration in water [23]. Thus, the required amount of Phosphorus in surface water bodies is very important to make the balance between different factors of the environment [18]. The acceptable value of phosphorus in water is 5 mg/l as per BIS and 6 mg/l as per Environment Quality Standards (EQS).

Phosphorus concentration escalated in the water bodies can be due to natural sources (rocks, sediments, and minerals) as well as due to anthropogenic sources (runoff having detergents and fertilizers). Phosphorus is present both in organic and inorganic forms in water. They can either dissolved inside the water body or remain suspended on the surface [48]. To maintain balance in the ecosystem, the assessment of phosphorus level in water is very important otherwise increase in algal blooms release toxic substances and will affect life forms [49].

Measurement Methods

Phosphorus measurement in water bodies is a challenging task because it encompasses the measurement of very low-level concentration of phosphorus as small change in concentration has a significant impact on the rivers and streams. A lot of studies were carried out by different researchers for phosphorus assessment in water using ascorbic acid colorimetric method.

Colorimetric Method: The method is specifically used for the determination of total phosphate and total orthophosphate dissolved or suspended in water. The method involves the use of reagent carrying ascorbic acid and ammonium molybdate that react with phosphate in the water sample. The infrared photometer and light path of 2-2.5 cm is used for the analysis. The proportion of blue color indicate the amount of phosphorus in water and the spectrophotometer used to analyze the standard concentration [24,34].

Strength/Gap: The spectrophotometer or colorimetric method is primarily used for the determination of very low concentration of phosphorus in water sample but some points need to be kept in mind before analysis such as the sample should be preserved in refrigerator at 4°C, the sampling tubes should be washed properly 3-4 times with distilled water and the sample should not be preserved more than 48 hours of period [19,50].

III. DISCUSSION

The quality of water majorly depends upon the constituents present in it and the presence of pollutants lead to increased concentration of different parameters which need to be checked properly [17,51,52]. The surface water bodies are increasingly contaminated due to various impurities added into it by natural or anthropogenic factors [1,18,34]. Thus, the water quality assessment is very important from the ecological perspective not only for human beings but also for the whole ecosystem [29,53]. Various factors such as soil erosion, fertilizers, discharge containing plastic, food waste and other trash into water affect the quality of water very badly and make it unfit for use without treatment [10,34,54].

For this, assessment of different parameters using best technique is important for precise and accurate results. Based on extensive literature survey from various studies on water quality assessment, some methods found to be used more than the other methods because of their user-friendly procedure and efficiency.

For instance, the titrimetric method for analysis of alkalinity, hardness and COD is widely used as compared to other methods of measurement [12,19,55,56]. Likewise, various studies also showed the use of titration method for the measurement of other parameters such as calcium, magnesium, bicarbonate, and chloride analysis [2,8,34,57]. In many studies, the titration method is also used for measurement of DO in water as well [2,21]. The titrimetric method is the widely accepted method for analysis of various parameters as it involves the volumetric analysis for measurement of volume of samples involved. The titration methods measure the concentration of titrant solution as well as standard solution and helps to identify the unknown concentration of the sample. Apart from this, titration method is well known for its easy methodology and sample handling procedure as well as testing can be carried out without the use of costly instruments [58,59,60].

Among various studies carried out by different researchers for BOD analysis using dilution and spectrophotometric method showed that both the methods provide approximately same result except in the samples of down streams where BOD value cause high pollution. The studies revealed that spectrophotometric method is better for analysis of organic load in water sample by rapid and direct estimation. Apart from this, UV-Spectrophotometry method involves less operational cost, no chemicals, no prior treatment of samples and real time monitoring of pollution load but much importance is given to dilution method when suspended solid concentration is higher. The only thing required in BOD_5 test is to do accurate dilution within 48hours from sampling for precise and accurate results [41,61,62,63].

In different reports, the in-situ measurement methods were used for the analysis of various parameters such as pH, EC, DO, BOD and TDS [9,14,27,29,30,56]. The on-site measurement methods for the analysis of pH, DO and EC has given much importance in various studies because preservation of water samples for long duration led to changes in the concentration and cause fluctuations in their actual values. Keeping into view the importance of field measurement, various researchers focused much on measurement of some parameters using potable instruments [15,20,55,56].

In different reports, TDS measurement was done using potable meter, Gravimetric method and using value of TS and

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TSS [8,29,30]. Among different methods, TDS meter is widely used because of its rapid measurement but it suffers from a major limitation that it provides only approximate values. TDS in water sample contain both the dissolved as well as suspended constituents and the TDS meter fails to provide separate results. Though, gravimetric method is very time-consuming and lengthy procedure but has advantage of giving exact concentration of all the constituents or ions present, hence, it has given much preference for accurate results as compared to other methods [26,64,65].

Thus, from the comprehensive study of the available literature, it was found that the above-mentioned methods are much significant for measuring water quality parameters as compared to other methods.

IV. CONCLUSION

This review highlights various methods used for the analysis of water quality parameters focusing on frequency of use, strength and weakness related to each method. From literature survey it was observed that most of the researchers used similar procedures for analysis of any parameter but there is still more than one method that can be used for the measurement of single parameter. As the physical and chemical parameters in water bodies get affected by the change in season as well as due to change in pollutant concentration due to natural and anthropogenic causes thus, the use of reliable methods for the measurement of various parameters is recommended for proper identification of increased concentration of pollutants so that necessary measures can be taken to protect the waterbody.

CONFLICT OF INTEREST

The Authors Declare That There Is No Conflict of Interests.

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