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PHYSICO-CHEMICAL PROFILING OF MALKHED DAM WATER FOR ENVIRONMENTAL AND PUBLIC HEALTH INSIGHTS

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ABSTRACT

Malkhed Dam is one of the most well-known lakes and wet areas in the Amravati district. In order to ascertain the physico-chemical characteristics of malkhed dam samples from KrushnajiSagarParyatanSthal, Amravati, Maharashtra, the study was conducted. Water samples were taken from five different Malkhed Dam locations. The physico-chemical properties of these water samples were examined. To analyze the samples for pH, hardness, chloride, alkalinity, TDS, and other factors, laboratory tests were conducted. When compared to BIS and WHO, the differences in a number of metrics were statistically significant ($p<0.05$). These factors were determined to be significant for water quality and shown a strong relationship with a number of other factors.The majority of the parameters in the current investigation are found to be within the IS and WHO recommended limits. It is evident from this early investigation that all of the lakes and moist areas are good sources of potable water.

KEYWORDS:-Malkhed dam, Physico-chemical Parameter,Malkhed, Amravati.

Introduction:-

Water is an essential natural resource vital for sustaining life and the environment. The quality of water in lakes and reservoirs is affected by both natural processes and human activities.Water is a universal solvent with the distinct ability to dissolve various substances, making it highly susceptible to contamination[1].Water for the consumption of human beings is available in different forms from different sources. Drinking water should be free from color, Salinity, Turbidity, and conductivity[2-3]. Assessing physico-chemical parameters is crucial for evaluating pollution levels and ensuring water safety for drinking, agriculture, and industrial use,The quality of water depends on various chemical constituents and their concentration[4]. The Malkhed Dam, situated on the Kholad River near Chandur Railway in the Amravati district of Maharashtra, India, is owned by the Government of Maharashtra. Standing 17 meters high, the dam was constructed and opened in 1972 with the primary purpose of supplying water for drinking and irrigation. In addition to its functional significance, Malkhed Dam is a well-known

recreational spot, offering boating facilities and attracting visitors as a popular picnic destination. Renowned for its scenic beauty and serene ambiance, the dam provides a peaceful retreat amidst nature.

Dams act as barriers within a river's fluvial system, disrupting the natural flow of water. With the growing demand for water and energy, numerous dams and reservoirs are continuously being constructed across the country. These structures are built over rivers to fulfill the water supply, irrigation, and household needs of local communities. However, such dam constructions can significantly impact the quality of river water[5].

The release of industrial and household trash into various water sources, including lakes, rivers, springs, and others, is the root cause of water pollution. A few of these contaminants are quite harmful. Therefore, a wide range of illnesses are caused by water contamination, which also damages irrigated land and causes fisheries to deteriorate. Rapid industrialization is making it more and more difficult to get water[6-7].The government has implemented strict regulations to prevent water pollution and invests significantly in filtration, storage, chlorination, and distribution. Some natural water sources are heavily impacted by microbial contamination from domestic sewage, animal and human waste, industrial discharge, and the growing use of agricultural chemicals. Therefore, conserving freshwater environments is of utmost importance, making regular pollution monitoring essential[5].

People are increasingly aware of the dangers of water pollution, and measures are being implemented to reduce it. Wastewater from factories is analyzed and undergoes appropriate treatment before being discharged into natural water bodies such as rivers or lakes, ensuring that it does not contribute to pollution[9-10]. Water should be tested based on various physico-chemical parameters. The selection of these parameters depends entirely on the intended use of the water and the required level of quality and purity[11-12].Water contains various impurities, including floating, dissolved, suspended, microbiological, and bacteriological contaminants. To assess its quality, physical tests should be conducted to examine attributes such as temperature, color, odor, pH, turbidity, and total dissolved solids (TDS). Additionally, chemical tests should be performed to evaluate parameters like biological oxygen demand (BOD), chemical oxygen demand (COD), dissolved oxygen, alkalinity, hardness, and other chemical properties[13-15].Anthropogenic activities have been observed in water reservoirs such as lakes, rivers, and dams, affecting their water quality[16].This study focuses on analyzing its water quality to determine compliance with established standards.

Need of Study-

Analyzing dam water is essential to ensure its quality and suitability for various applications, including drinking, irrigation, and industrial use. Assessing physico-chemical and biological parameters helps determine water purity and safety. Regular monitoring helps detect contaminants from industrial discharge, agricultural runoff, and human activities, aiding in pollution control. This process also plays a vital role in environmental protection by preventing ecological imbalances and safeguarding aquatic life. Ensuring the absence of harmful microorganisms and toxic substances is crucial for public health, reducing the risk of waterborne

diseases. Additionally, evaluating factors such as salinity, alkalinity, and hardness determines the suitability of dam water for agricultural use. Industries and households also benefit from water analysis as it ensures compliance with quality standards for various applications. Moreover, continuous monitoring promotes sustainable water management by supporting conservation efforts and efficient resource utilization. Overall, dam water analysis is fundamental to maintaining a clean and safe water supply while preserving environmental sustainability.

Study Area-

Malkhed is a village located in the Chandur Railway tehsil of Amravati District, Maharashtra, situated at a latitude of 20.8404627°N and a longitude of 77.9090536°E. The total area of the dam is 6,717 km². Water samples were collected using the grab sampling method in a polythene bottle. Some parameters, such as temperature and color, were measured on-site. The study aimed to analyze the physico-chemical parameters of the water in Malkhed Lake.

Objective of Study-

The objectives of water analysis for lake water are to assess its physical, chemical, and biological properties, determining its suitability for various uses such as drinking, recreation, and supporting aquatic life. It aims to identify harmful pollutants, including chemicals, heavy metals, and microorganisms, which could impact public health or the environment. Monitoring pollution levels from industrial, agricultural, or domestic activities is crucial to understanding their effect on the lake ecosystem. The analysis also helps protect aquatic life by tracking factors like dissolved oxygen, pH, and nutrient levels that influence species survival. Additionally, it plays a key role in identifying risks of eutrophication caused by excessive nutrients like nitrogen and phosphorus, which can lead to harmful algae blooms. Water quality analysis ensures the lake remains safe for recreational activities and supports sustainable management practices by guiding conservation and restoration efforts. It also ensures that the water complies with environmental regulations, contributing to the lake's long-term health and ecological balance.

Properties of Water-

Water has several unique properties that make it essential for life and crucial for various processes. Some key properties of water include:

1. Polarity– Water molecules have a partial positive charge on the hydrogen atoms and a partial negative charge on the oxygen atom, making water a polar molecule. This polarity allows water to dissolve many substances, making it a universal solvent.
2. Cohesion– Water molecules tend to stick together due to hydrogen bonding, which gives water a high surface tension and allows it to form droplets and travel through plant roots.
3. Adhesion– Water can also stick to other materials, which helps it climb up plant roots and stems against gravity in a process known as capillary action.
4. High Specific Heat– Water has a high specific heat capacity, meaning it can absorb and retain a large amount of heat without a significant change in temperature. This property helps regulate temperature in living organisms and the environment.
5. High Heat of Vaporization– It requires a substantial amount of heat to convert water from liquid to vapor. This is why sweating cools the body, as water absorbs heat when it evaporates.

6. Transparency– Water is transparent to visible light, allowing sunlight to penetrate aquatic environments, which is essential for photosynthesis in aquatic plants.
7. Density– Water is most dense at 4°C and becomes less dense as it freezes. This is why ice floats on water, providing insulation for aquatic life in cold conditions.
8. pH Neutrality– Water has a neutral pH of 7, making it neither acidic nor basic, which is crucial for supporting life in various ecosystems.
9. Solubility– Water can dissolve a wide range of substances, including gases, salts, sugars, and other organic compounds, making it an essential medium for biological processes.

These properties of water are fundamental to its role in supporting life, regulating climate, and facilitating numerous biological, chemical, and physical processes.

Water Quality Parameters-

Water quality parameters are indicators used to assess the condition of water, helping to determine its suitability for various uses such as drinking, recreation, irrigation, and supporting aquatic life. Common water quality parameters include:
1. pH– Measures the acidity or alkalinity of water. A pH of 7 is neutral, below 7 is acidic, and above 7 is alkaline.
2. Temperature– Influences the rate of chemical reactions and the oxygen levels in water. It can affect aquatic life and the solubility of gases.
3. Turbidity– The cloudiness or haziness of water caused by suspended particles. High turbidity can indicate pollution and affect aquatic life.
4. Dissolved Oxygen (DO)– The amount of oxygen dissolved in water. It is essential for the survival of fish and other aquatic organisms.
5. Biological Oxygen Demand (BOD)– The amount of oxygen required by microorganisms to break down organic matter in water. High BOD indicates pollution and poor water quality.
6. Chemical Oxygen Demand (COD)– Measures the total oxygen required to oxidize both organic and inorganic substances in water. It is an indicator of water pollution.
7. Total Dissolved Solids (TDS)– The total concentration of dissolved substances in water, including salts, minerals, and metals. High TDS levels can affect the taste and quality of water.
8. Alkalinity– The capacity of water to neutralize acids, indicating its buffering capacity. It helps maintain pH stability in water.
9. Hardness– The concentration of calcium and magnesium ions in water. Hard water can cause scale buildup in pipes and appliances but is not harmful to health.
10. Nutrients (Nitrogen, Phosphorus)– High concentrations of nitrogen and phosphorus can lead to nutrient pollution, causing algae blooms and eutrophication in water bodies.
11. Chlorine– The presence of chlorine in water, typically used for disinfection. Excess chlorine can be harmful to aquatic life.
12. Heavy Metals (Lead, Mercury, Arsenic)– Toxic metals that can contaminate water and pose serious health risks if consumed.
13. Fecal Coliform/Bacteria– Presence of harmful bacteria from human or animal waste, indicating potential contamination and a risk to human health.

14. Pesticides and Herbicides– Chemicals used in agriculture that can contaminate water and affect ecosystems and human health.
15. Salinity– The concentration of dissolved salts in water. It is particularly important in marine and estuarine ecosystems.

These parameters help in monitoring water quality, identifying pollution sources, and ensuring the safety and sustainability of water for various purposes.

Drinking Water Standards-

1. pH: Measures the acidity or alkalinity of water, with an ideal range of 6.5 to 8.5. It affects water taste and prevents pipe corrosion.
2. Electrical Conductance (EC): Indicates water's ability to conduct electricity, dependent on dissolved ions. The ideal range is 50 - 1500 µS/cm, with higher values showing more dissolved solids, which can affect water quality and cause scaling.
3. Alkalinity: Refers to the water's capacity to neutralize acids. It stabilizes pH and should range from 20 - 200 mg/L.
4. Calcium (Ca^{2+}): A mineral contributing to water hardness, with an ideal range of 30 - 100 mg/L. It's essential for bone health but affects water hardness.
5. Magnesium (Mg^{2+}): Another mineral contributing to water hardness, with ideal levels between 10 - 30 mg/L. Magnesium is vital for muscle and nerve function.
6. Chloride (Cl^-): A chemical compound that impacts water's taste and can indicate contamination. The ideal range is 30 – 250 mg/L.
7. Silica (SiO_2): Naturally occurring in water, often causing scaling in pipes. The ideal range is 5 - 50 mg/L.
8. Phosphate (PO_4^{3-}): Primarily from agricultural runoff and wastewater, phosphates can cause algal blooms. The ideal level is 0.1 – 1.0 mg/L.
9. Total Dissolved Solids (TDS): Measures dissolved substances like salts and metals. TDS should ideally be below 500 mg/L for drinking water.
10. Chemical Oxygen Demand (COD): Indicates the amount of oxygen required to oxidize pollutants. The ideal range is below 10 mg/L, and high values signal pollution.
11. Dissolved Oxygen (DO): Essential for aquatic life, with an ideal range of 5 – 8 mg/L. Low DO levels indicate water contamination.
12. Hardness: Caused by calcium and magnesium ions, it affects water quality and appliance longevity. Ideal hardness is 60 – 180 mg/L.
13. Turbidity: Refers to water cloudiness caused by suspended particles. Turbidity should be below 5 NTU for safe drinking.
14. Sulphate (SO_4^{2-}): Can cause bitter taste and digestive issues, with an ideal range of 150 – 250 mg/L.

Material and Methods:-

All samples were collected during the first week of February 2025, with a total of five samples taken from Malkhed Dam. The reservoir samples were obtained from four corners and the center of the dam, ensuring comprehensive coverage. These samples were collected from a

depth of approximately 15-20 cm below the water surface, taking care to avoid any floating debris or sediment contamination. Standard procedures were followed for the analysis of physico-chemical parameters. All chemicals used were of analytical reagent (AR) grade to ensure purity, and double-distilled water was used for the preparation of reagents and solutions. The glassware was thoroughly cleaned using commercial HCl, followed by rinsing with distilled water, methanol, and acetone to maintain accuracy in the analysis[8,19].

Sample Collection-

Water samples were collected from5 different locations of Malkhed Dam lakes at varying depths to ensure comprehensive analysis. At the time of collection temp should be measured.Sampling was conducted in sterilized bottles and transported to the laboratory under controlled conditions.Standard methods were followed for sample collection andpreservation[17].

Analysis-

All five collected water samples were analyzed for physico-chemical parameters using a Water Analyzer Kit. This microcontroller-based instrument is designed to measure physico-chemical properties in water samples one at a time. The kit includes a combined electrode, a conductivity cell, and a temperature probe. The pH and salinity levels were determined using the combined electrode and conductivity cell, while the temperature was measured with the temperature probe. The readings obtained from these measurements are summarized in the table[8,18].

Observation and Results:-

The table displays the physico-chemical characteristics of water samples taken from ten distinct places.

Table 1

Physico-chemical parameters of water

Sr. no.	Parameter	Sample 1	Sample 2	Sample 3	Sample 4	Sample5
1.	pH	7.6	7.7	7.6	7.6	7.7
2.	Temperature	38° C	39° C	38° C	39° C	38° C
3.	Turbidity NTU	4.51	4.46	4.75	4.52	4.50
4.	Colour	Colorless	Colorless	Colorless	Colorless	Colorless
5.	Dissolved Oxygen (DO)	4.2 mg/L	3.9 mg/L	3.9 mg/L	4.1 mg/L	4.2 mg/L
6.	Biological Oxygen Demand (BOD)	3.1 mg/L	2.9 mg/L	3.2 mg/L	3.2 mg/L	3.1 mg/L
7.	Total Dissolved Solids (TDS)	380 mg/L	375 mg/L	378 mg/L	381 mg/L	379 mg/L
8.	Alkalinity	182 mg/L	179 mg/L	183 mg/L	181 mg/L	182 mg/L
9.	Electrical Conductance (EC)	342µmho/cm	343µmho/cm	345µmho/cm	347µmho/cm	345µmho/cm
10.	Total Hardness	129 mg/L	132 mg/L	133 mg/L	131 mg/L	129 mg/L
11.	Calcium	11.2 mg/L	11.3 mg/L	11.2 mg/L	10.9 mg/L	11.1 mg/L
12.	Magnesium	1.1 mg/L	0.9 mg/L	1.1 mg/L	1.0 mg/L	0.9 mg/L
13.	Chloride	29.1 mg/L	29.0 mg/L	29.2 mg/L	29.1 mg/L	28.9 mg/L
14.	Phosphate	0.04 mg/L	0.05 mg/L	0.04 mg/L	0.03 mg/L	0.04 mg/L
15.	Sulphate	126 mg/L	126 mg/L	127 mg/L	126 mg/L	125 mg/L

Discussion:-

The water quality analysis of the given samples reveals that the pH values range from 7.6 to 7.7, indicating slightly alkaline conditions, which are within acceptable limits for drinking and aquatic life. The temperature varies between 38°C and 39°C, which is relatively high and could promote microbial growth, possibly influenced by environmental factors during sampling. Turbidity levels range from 4.46 to 4.75 NTU, which, although slightly on the higher side, remain within the permissible limit of 5 NTU, indicating minimal suspended particles. All samples are colorless, reflecting the absence of visible contamination or colored impurities.

The dissolved oxygen (DO) levels range from 3.9 to 4.2 mg/L, slightly lower than the recommended level for healthy aquatic environments, indicating a moderate presence of organic matter. The biological oxygen demand (BOD) ranges from 2.9 to 3.2 mg/L, suggesting moderate organic pollution, as values below 3 mg/L are generally considered good. Total dissolved solids (TDS) vary between 375 and 381 mg/L, which is well within the permissible drinking water limit of 500 mg/L, indicating moderate mineral content. The alkalinity values range from 179 to 183 mg/L, reflecting a good buffering capacity to resist sudden pH changes.

Electrical conductance (EC) values range from 342 to 347 µmho/cm, suggesting moderate ion concentration, which correlates well with the TDS levels. Total hardness ranges from 129 to 133 mg/L, indicating moderately hard water, primarily due to calcium and magnesium ions. The calcium concentration ranges from 10.9 to 11.3 mg/L, while magnesium levels vary between 0.9 and 1.1 mg/L, both being quite low and contributing minimally to hardness. Chloride levels range from 28.9 to 29.2 mg/L, significantly below the permissible limit of 250 mg/L, indicating no salinity issues. Phosphate concentrations range from 0.03 to 0.05 mg/L, indicating minimal nutrient pollution, reducing the risk of algal blooms. Sulphate levels range from 125 to 127 mg/L, which are well within the acceptable range of 250 mg/L, indicating no significant sulphate contamination.

Conclusion:-

The water quality analysis indicates that most parameters fall within the acceptable limits for drinking and general use, reflecting satisfactory water quality. The slightly alkaline pH, moderate temperature, and low to moderate levels of dissolved solids and hardness suggest that the water is generally safe. While the slightly elevated temperature and turbidity levels may require attention, they are not significantly problematic. The low dissolved oxygen (DO) levels hint at minor organic contamination, but the moderate biological oxygen demand (BOD) values do not indicate severe pollution. Additionally, the minimal levels of nutrients such as phosphates and the absence of significant color, salinity, or sulphate contamination further affirm the quality of the water. Overall, the water is suitable for consumption and poses no major health risks.

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