Analysis of Sea Water collected from diverse locations of Visakhapatnam

A research project report submitted
in partial fulfillment of the requirements for the degree of

Bachelor of Technology

in

Chemical Engineering

by

Under the guidance of

Dr. Ravi Kumar Sonwani

Department of Chemical Engineering
Indian Institute of Petroleum and Energy
Visakhapatnam

CERTIFICATE FROM MENTOR

This is to certify that the project report for Project-II **Analysis of Sea Water collected from diverse locations of Visakhapatnam** submitted to the Indian Institute of Petroleum and Energy-Visakhapatnam, in partial fulfilment of the requirements for the award of the degree of **Bachelor of Technology** in Chemical Engineering by ANKUR URANA(19CH10038)**,** is a bonafide record of the research work done by him under my/our supervision.

Dr. Ravi Kumar Sonwani
Assistant/Associate Professor
Department of Chemical Engineering
IIPE-Visakhapatnam

Place: Visakhapatnam
Date: 03/05/2023

Student's Declaration

I and my group members declare that this report represents our own ideas in our own words. Wherever others' ideas or words have been included, citations and references of the original sources are provided.

I and my group members also declare that we have maintained all principles of academic honesty and integrity and have not misrepresented or fabricated or falsified any idea/data/fact/source in our submission to the best of our knowledge.

I and my group members understand that any violation of the above will be cause for disciplinary action by the Institute and can also evoke action from the sources which have thus not been properly cited or from whom proper permission has not been taken when needed.

Place: Visakhapatnam

Date: 03/05/2023

Signature:

Name of the Student: ANKUR URANA

Name and roll number of other group members:

1. ANKUR URANA (19CH10038)
2. ATHAR RIZWAN (19CH10020)

Abstract

Visakhapatnam, a city of destiny, is surrounded by the beautiful beaches. It is a port city and industrial capital of Andhra Pradesh, India. In the last few decades, the sea water getting contaminated by various pollutants due to human activities and rapid industrialization. In this study, seawater samples collected from a different beaches of Visakhapatnam, India, were analyzed to determine the physicochemical characteristics. The pH, temperature, salinity, dissolved oxygen (DO), biochemical oxygen demand (BOD), chemical oxygen demand (COD), total dissolved solid (TDS) of the sea water samples were measured. The study revealed that the pH was varied from 8.0 to 8.2, indicating slightly alkaline nature of sea water. The salinity was varied between 27 and 29 Part Per Trillion (ppt), and the temperature ranged from 27 °C to 28.5 °C. The amount of DO was found beyond 5.0 mg/L which is suitable for marine life. Additionally, it was determined that the total dissolved solids were very high. According to the study, beach seawater is generally suitable for recreational uses and not acceptable for the drinking purpose. Therefore, the effective treatment of sea water required due to high salinity and TDS.

Keywords— Total dissolved solid (TDS), Total Suspended Solids (TSS), Biochemical oxygen demand (BOD), Dissolved Oxygen (DO) , pH.

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1. INTRODUCTION

Freshwater resources are vital for sustaining life on earth, yet they are facing significant pressure due to the unprecedented growth of human population, urbanization, and industrialization (Zarezadeh et al., 2023). As a result, the world's limited freshwater resources are threatened with pollution, and access to clean and safe drinking water has become a major challenge (Zhang and Oki, 2023). India is among the most stressed water nation in the world. A report published by NITI Aayog, India, mentioned that about 600 million people are facing the high water stress issues (NITI Aayog Report on Water Crisis, 2018). It was further reported that India is placed at 120th amongst 122 countries in the water quality index. In India, only a small percentage of the population has access to good quality drinking water. The degradation of hydrological environments due to inadequate management of water resources has further exacerbated the problem (Tiwari et al., 2022). To ensure the sustainable use of water resources, it is crucial to monitor the water quality on a continuous and periodic basis. According to United State Geological Survey, around 2/3 of Earth's surface is covered with water and found in rivers, lakes, icecaps and glaciers. The distribution of water on, in, and above the Earth is given in Fig. 1.

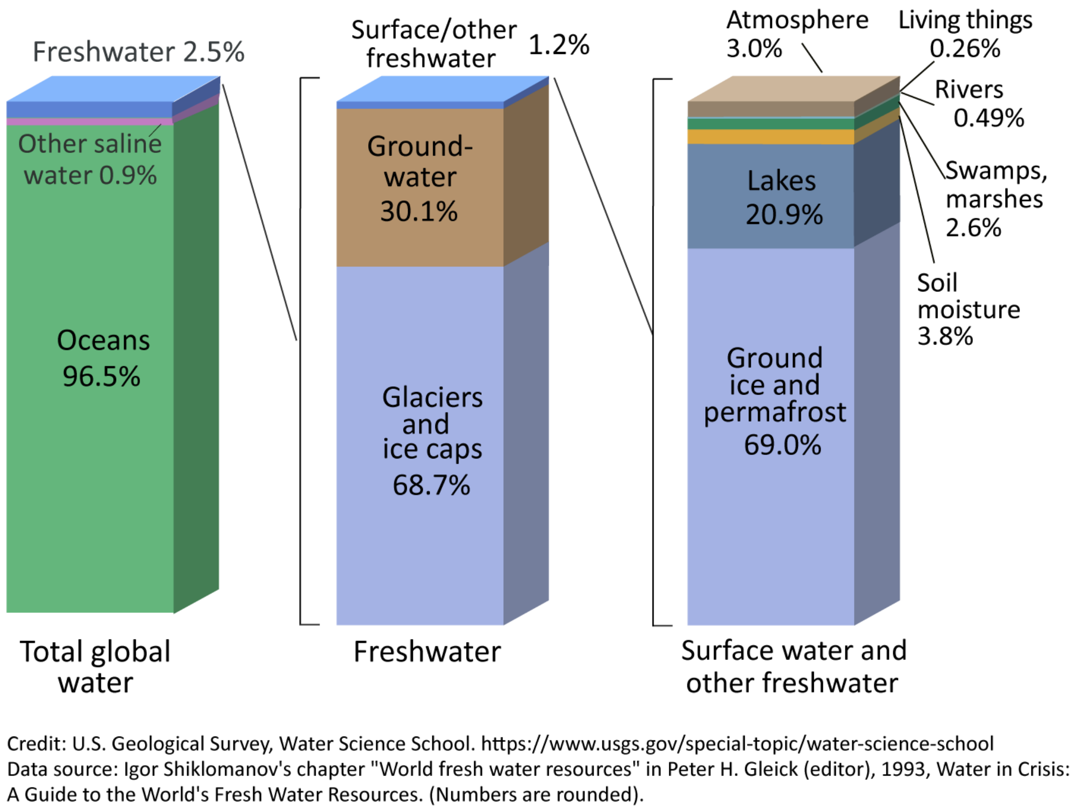

Figure 1. The distribution of water on Earth.

Visakhapatnam, a city of destiny, is surrounded by the beautiful beaches. It is a port city and industrial capital of Andhra Pradesh, India. In the last few decades, the sea water getting contaminated by various pollutants due to human activities and rapid industrialization. The aim of the study was to provide insights into the quality of seawater in the area and to identify potential sources of pollution that may impact the coastal ecosystem. The seawater samples collected from a different beaches of Visakhapatnam, India, were analyzed to determine the physicochemical characteristics. The pH, temperature, salinity, dissolved oxygen (DO), biochemical oxygen demand (BOD), chemical oxygen demand (COD), total dissolved solid (TDS) of the sea water samples were measured. The regular monitoring of water quality is essential for sustainable water resource management, and effective measures need to be taken to mitigate the sources of pollution.

2. LITERATURE REVIEW

Coastal areas are valuable ecosystems that provide numerous ecological, economic, and social benefits. However, these areas are under increasing pressure due to human activities and climate change, resulting in declining water quality. To ensure the sustainable management of coastal resources, it is essential to monitor and assess the quality of coastal water bodies. Water quality monitoring involves the collection and analysis of water samples to determine the presence and concentration of various pollutants and other indicators of water quality. Monitoring data can be used to assess the health of coastal ecosystems, identify sources of pollution, and evaluate the effectiveness of management strategies. Numerous studies have been conducted on water quality monitoring in coastal areas. One such study was conducted by Wan et al. (2019), which evaluated water quality in the coastal area of Xiamen, China, using multiple indices. The study found that the water quality in the coastal area was generally poor due to human activities such as aquaculture, sewage discharge, and shipping. The study recommended that the government and local communities take necessary measures to prevent water pollution and promote sustainable development.

Another study by Bhatia et al. (2018) assessed the water quality of coastal areas in India using the Water Quality Index (WQI). The study found that the water quality in the coastal area was poor due to industrialization, urbanization, and tourism. The study recommended that the government implement measures to reduce pollution and promote sustainable development. Similarly, a study by Camargo et al. (2019) evaluated the water quality of coastal areas in Brazil using the WQI. The study found that the water quality was poor due to untreated sewage, industrial waste, and oil spills. The study recommended that the government take measures to prevent pollution and promote sustainable development. Likewise, Zhang et al. (2018) assessed the water quality of coastal areas in China using the WQI. The study found that the water quality was poor due to industrialization, agriculture, and urbanization. The study recommended that the government implement measures to reduce pollution and promote sustainable development. The use of indices such as the WQI can help assess water quality and identify sources of pollution. The WQI is a composite index that takes into account several parameters, including dissolved oxygen, pH, temperature, total dissolved solids, turbidity, and various pollutants. The index provides a single numerical value that reflects the overall water quality, making it easier to communicate the results to stakeholders and decision-makers.

The findings of the above studies suggest that human activities such as industrialization, urbanisation, and agriculture are the main sources of water pollution in coastal areas. These activities can generate large amounts of waste, discharge pollutants into the water, and cause habitat destruction. As a result, measures should be taken to prevent pollution and promote sustainable development. To prevent pollution in coastal areas, it is essential to implement effective management strategies that address the root causes of pollution. These strategies may include the implementation of regulations to control and reduce pollution from various sources, the development of environmentally friendly technologies, the improvement of wastewater treatment infrastructure, and the promotion of sustainable land use practices. Furthermore, promoting sustainable development in coastal areas can help reduce the impact of human activities on the environment. Sustainable development involves balancing economic, social, and environmental factors to meet the needs of present and future generations. This can be achieved through the adoption of sustainable land use practices, the promotion of eco-tourism, and the development of alternative livelihoods for coastal communities.

Table 1. Summary of water quality index.

Study	Location	Index Used	Findings	Recommendations
Wan et al. (2019)	Xiamen, China	Multiple indices	Water quality generally poor due to aquaculture, sewage discharge, and shipping	Take measures to prevent water pollution and promote sustainable development
Bhatia et al. (2018)	Coastal areas in India	Water Quality Index (WQI)	Water quality poor due to industrialization, urbanization, and tourism	Implement measures to reduce pollution and promote sustainable development
Camargo et al. (2019)	Coastal areas in Brazil	WQI	Water quality poor due to untreated sewage, industrial waste, and oil spills	Take measures to prevent pollution and promote sustainable development

Zhang et al. (2018)	Coastal areas in China	WQI	Water quality poor due to industrialization, agriculture, and urbanization	Implement measures to reduce pollution and promote sustainable development

In conclusion, water quality monitoring in coastal areas is essential for the sustainable management of coastal resources. The use of indices such as the WQI can help assess water quality and identify sources of pollution. The findings of various studies suggest that human activities such as industrialization, urbanization, and agriculture are the main sources of water pollution in coastal

3. OBJECTIVE

The objective of this project is to collect water samples from different locations of the beaches of Visakhapatnam and analyze the various physicochemical parameters such as pH, temperature, dissolved oxygen, biochemical oxygen demand, total dissolved solids, and salinity.

4. METHODOLOGIES

4.1. Chemicals and analysis

All the chemicals and reagents used were of analytical grades. The double distilled water was prepared in laboratory. Water samples collected from four sampling stations for the analysis are given bellow: RK Beach, Tenneti Park, Rushikonda Beach, and Thotlakonda. The samples for analysis were collected in sterilized bottles using the standard procedure. The samples were stored at 4.0 °C for the further analysis. The DO was fixed sat the location in BOD bottle using standard protocol and future measured in laboratory. The analysis of various physiochemical parameters namely pH, temperature, DO, BOD, COD, TDS were carried out in laboratory.

4.2. pH

Testing the pH of seawater is a crucial step in determining the water's acidity or basicity. The term "potential of hydrogen" (pH) refers to the measurement of the concentration of hydrogen ions in a solution.

4.3. Temperature

A thermometer is frequently used to measure the temperature of saltwater. To get an accurate reading, it's crucial to check that the thermometer is calibrated correctly and that the measurement is being taken at the proper depth(1m) . Seawater's temperature can change based on a number of variables, including the location, season, depth, and weather.

4.4. Dissolved oxygen

The classical iodometric method of Wrinkler is a sensitive and widely used method for determining DO in water. However, various ions and compounds such as nitrite, ferrous iron, sulphate, thiophosphate, polythionate, free chlorine, hypochloride, and organic matter can interfere in the DO analysis. Therefore, various modifications of the Wrinkler method have been proposed to correct these interferences. The classical iodometric method of Wrinkler will be used to determine the DO in water. The reagents required for the analysis include manganese sulfate solution, alkali-iodide-azide reagent, sulfuric acid, starch indicator, sodium thiosulfate titrant, standard potassium dichromate solution, and potassium iodide. The $MnSO_4$ solution should not give a color with starch when added to an acidified KI solution. The alkali-iodide-azide reagent should not give color with starch solution when diluted and acidified. A paste of 1 gm of soluble starch with distilled water and 3 gm of KI will be added to boiled water to prepare the starch indicator. Sodium thiosulfate titrant will be used to titrate the liberated iodine, and the standard potassium dichromate solution will be used for calibration. The test will be performed while maintaining the pH of the water between 7.2-8.6.

4.5. Biochemical oxygen demand (BOD)

The biochemical oxygen demand (BOD) of water samples is determined using this thorough process. BOD is a measurement of how much oxygen bacteria in water need to decompose organic materials. The BOD value increases as the amount of organic matter in the water increases. The BOD value is a crucial indication of the potency of wastewater and may be used to gauge the effectiveness of treatment facilities. The procedure involves filling two 300 mL BOD bottles with a specified amount of sample and dilution water. The initial dissolved oxygen (DO) of one bottle is measured, and both bottles are then incubated at 20 ±1 ºC for 5 days. After incubation, the final DO is measured and the BOD is calculated from the difference between the initial and final DO values. To ensure accurate results, it is important to minimize the degradation of the sample between collection and analysis. This can be done by analyzing the sample promptly or by cooling it to near-freezing temperature during storage. The apparatus required for the procedure includes a 300 mL BOD bottle, beaker, conical flask, burette, fixed volume pipette, measuring cylinder, watch glass, wash bottle, and thermometer. An incubator that is thermostatically controlled at 20 ±1 ºC is also required. All light should be excluded to prevent the possibility of photosynthesis production of DO. Several reagents are required for the procedure, including manganese sulfate solution, phosphate buffer solution, magnesium sulfate solution, calcium chloride solution, ferric chloride solution, ammonium chloride solution, alkali-iodide-azide reagent, sulfuric acid, starch indicator, and sodium thiosulfate titrant. The procedure involves adding specific amounts of each reagent to the sample and dilution water in the BOD bottles, as well as preparing a standard potassium dichromate solution and a hydrochloric acid solution. The microbial population in the water sample must also be insured to ensure accurate results.

4.6. Total dissolved solid (TDS)

As high levels of dissolved solids can indicate poor water quality and may affect the taste, colour, and odour of water, TDS is a crucial parameter in water quality testing. TDS has the potential to scale and corrode pipes and equipment as well as impact the solubility of minerals in water. Total Dissolved Solids, or TDS, is a term used to describe the total amount of dissolved inorganic and organic compounds in water. It is a measurement of the total quantity of all compounds in water that may flow through a filter having pores that are generally 2 micrometres in size. TDS is often stated in milligrammes per litre (mg/L) or parts per million (ppm). Seawater's TDS (Total Dissolved Solids) changes according to the ocean's latitude and depth. Seawater has a TDS of around 35,000 parts per million (ppm), or 3.5%, on average. This indicates that there are around 35 grammes of dissolved salts and minerals in a litre of saltwater. Along with ions of sodium, chloride, magnesium, calcium, and potassium, seawater also contains smaller concentrations of other minerals like iodine, bromine, and fluoride. Aside from these, factors like temperature, salinity, and ocean currents can also have an impact on the TDS of seawater.

4.7. Total suspended solid (TSS)

The total number of solid particles suspended in the water column is referred to as total suspended solids (TSS) in seawater. Plankton, silt, and other organic and inorganic components may be among these particles. The location, time of year, and meteorological conditions can all have an impact on the TSS content in saltwater. TSS may have a big effects on the ecosystem, marine life, and saltwater quality. Reduced water clarity, light penetration, and oxygen levels due to high TSS concentrations can have an impact on photosynthesis and other biological processes in marine animals. TSS stands for Total Suspended Solids, which refers to the amount of small solid particles that are suspended in water and can be captured by a filter. Testing the TSS of sea water typically involves collecting a water sample and filtering it through a pre-weighed filter. The filter is then dried and re-weighed to determine the amount of suspended solids. There are various methods to measure TSS, including gravimetric analysis, turbidity measurements, and optical methods. The method used will depend on the specific requirements of the test and the equipment available. It's important to note that TSS levels in sea water can vary widely depending on factors such as location, weather conditions, and anthropogenic activities. High levels of TSS can negatively impact marine life and ecosystem health.

5. RESULT AND DISCUSSION

Table 2. Experimental parameter of the sea samples collected from different locations.

Parameters	RK Beach	Tenneti Park	Rushikonda Beach	Thotlakonda
TSS (mg/L)	852	974	1170	1136
TDS (mg/L)	27200	27600	27300	27000
Temperature (°C)	28.01	27.9	27.7	27.9
Conductivity (s/m)	2.14	2.27	2.08	2.3
pH	8	8.02	8.01	8.18
DO (mg/L)	6.2	6.4	7.4	6.6
BOD (mg/L)	4.33	4.57	4.6	4.3

The results of the sea water analysis conducted at RK Beach, Tenneti Park, Rushikonda Beach, and Thotlakonda are presented in the table above. The parameters analyzed include TSS, TDS, temperature, conductivity, pH, DO, BOD, and COD.

5.1. Total suspended solids (TSS):

The TSS values for all the locations analyzed were high, ranging from 852 mg/L at RK Beach to 1170 mg/L at Rushikonda Beach. These high values can be attributed to the anthropogenic activities such as discharge of untreated sewage and industrial effluents, oil spills, and littering.

Figure 2 : Total suspended solids of samples collected from different locations.

5.2. Total dissolved solids (TDS):

The TDS values at all the locations were found to be in the range of 27000-27600 ppm. The high TDS values could be due to the presence of minerals, salts, and other dissolved solids that are naturally present in seawater. However, anthropogenic activities such as discharge of industrial effluents and untreated sewage can also contribute to the high TDS levels.

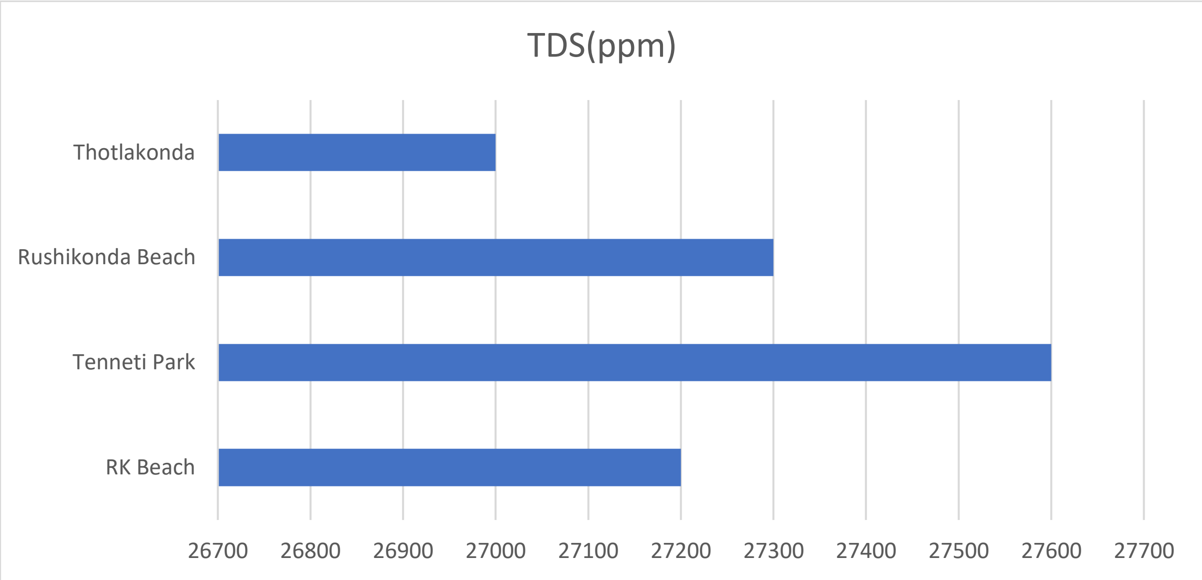

Figure 3 : Total dissolved solid of samples collected from different locations

5.3. Temperature

The temperature values ranged from 27.7°C to 28.01°C, with the lowest temperature recorded at Rushikonda Beach and the highest at RK Beach. The variation in temperature could be attributed to the differences in the location's geographical features, climate, and anthropogenic activities.

5.4. Conductivity

The conductivity values ranged from 2.08 to 2.3 s/m, with the highest value observed at Thotlakonda. The high conductivity values could be attributed to the presence of dissolved salts and minerals in seawater.

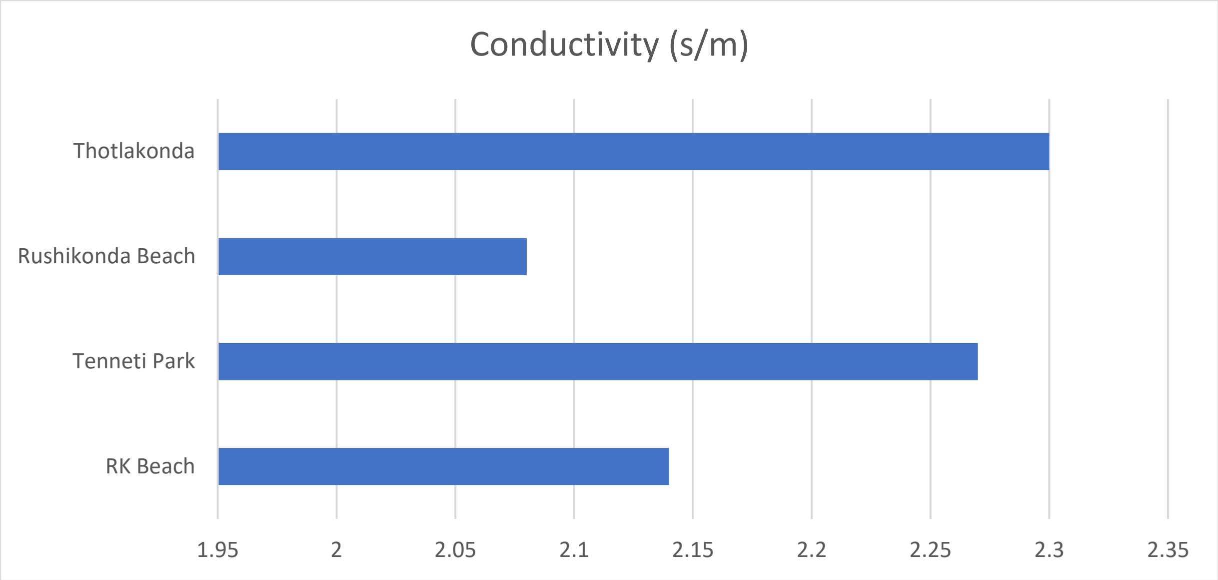

Figure 4 : Conductivity of samples collected from different locations.

5.5. pH

The pH values at all locations were found to be slightly basic, ranging from 8.00 to 8.18. The slightly basic pH values of seawater are naturally occurring and are attributed to the presence of carbonates, bicarbonates, and hydroxides.

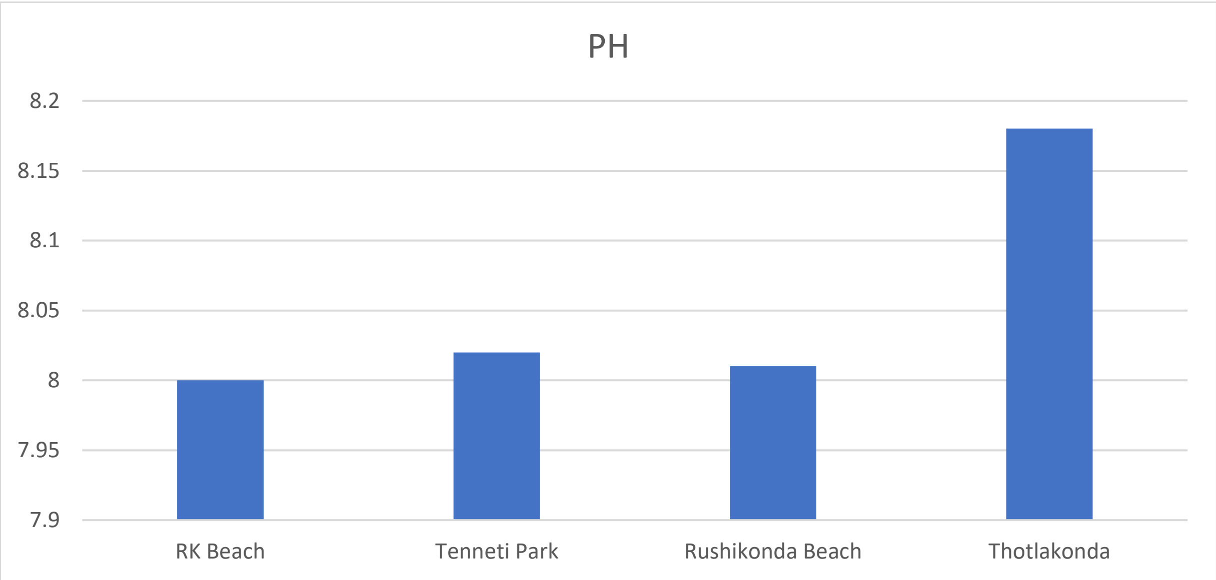

Figure 5 : Potential of hydrogen of samples collected from different locations

5.6. Dissolved oxygen (DO)

The DO values for all locations were within the acceptable limits, ranging from 6.2 ppm to 7.4 ppm. The high DO values could be attributed to the high photosynthetic activity of phytoplankton and the mixing of seawater with the atmosphere.

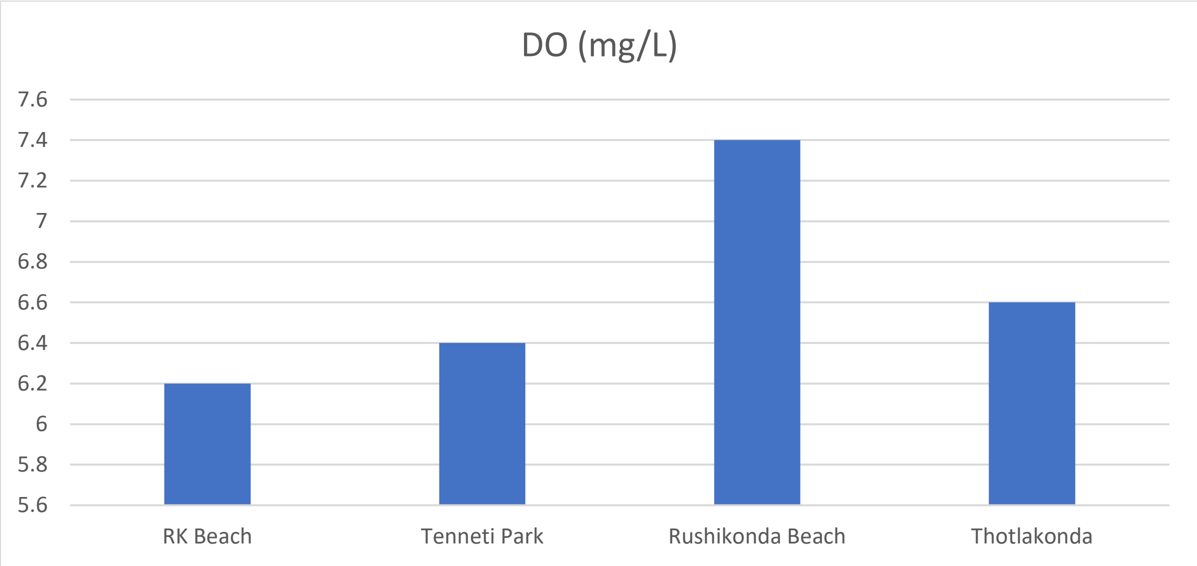

Figure 6 : dissolved oxygen of samples collected from different locations

5.7. Biochemical oxygen demand (BOD):

The BOD values for all locations were found to be within the acceptable limits, ranging from 4.3 mg/L to 4.6 mg/L. The lower values observed at Thotlakonda could be attributed to the lower anthropogenic activity compared to other locations.

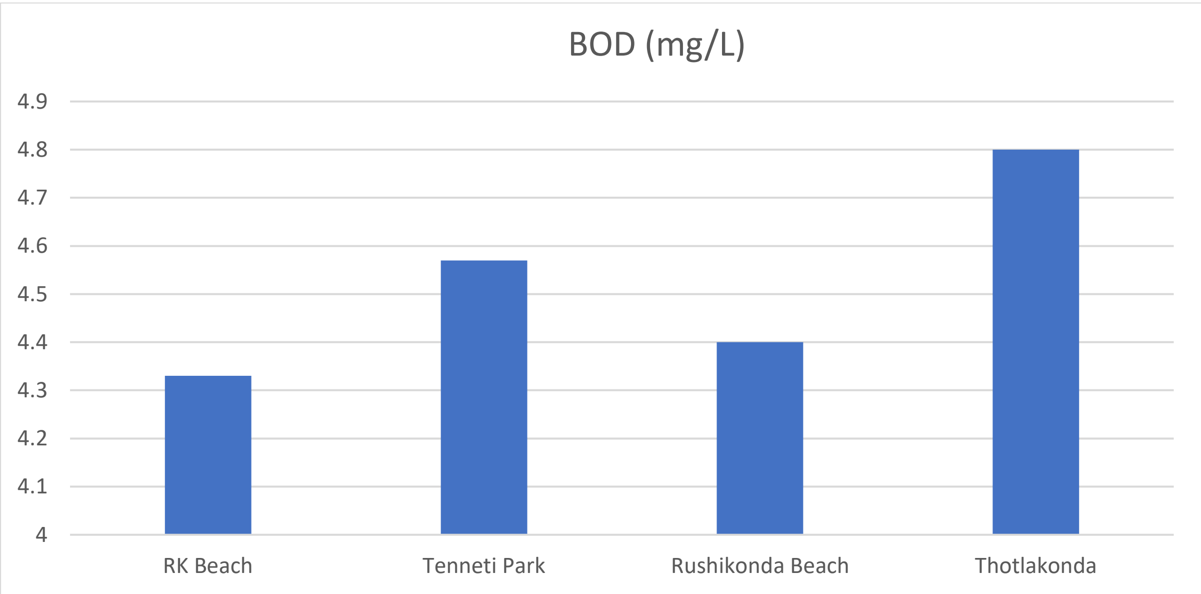

Figure 7 : Biochemical oxygen demand of samples collected from different locations.

In conclusion, the analysis of seawater samples from RK Beach, Tenneti Park, Rushikonda Beach, and Thotlakonda revealed that the water quality parameters were within acceptable limits. However, the high TSS and TDS values observed at all locations indicate that anthropogenic activities have an impact on the quality of seawater. Continuous monitoring of the seawater quality is essential to maintain the ecological balance and preserve the marine ecosystem.

6. CONCLUSION

Based on the results of the sea water analysis conducted at RK Beach, Tenneti Park, Rushikonda Beach, and Thotlakonda, several important conclusions can be drawn. Firstly, it is evident that all four locations have a high level of total dissolved solids (TDS), with values ranging from 27000 ppm to 27600 ppm. This indicates a high concentration of salts and minerals in the water, which could have a negative impact on marine life and other organisms that rely on these ecosystems. Secondly, the total suspended solids (TSS) levels were also found to be relatively high at all four locations, ranging from 852 mg/L to 1170 mg/L. High levels of TSS could lead to reduced light penetration in the water, potentially affecting photosynthesis and the growth of aquatic plants. Thirdly, the pH levels of the water at all four locations were found to be slightly basic, ranging from 8 to 8.18. Fourthly, dissolved oxygen (DO) levels were found to be within the acceptable range for healthy marine ecosystems, ranging from 6.2 ppm to 7.4 ppm. Adequate levels of DO are essential for the survival of fish and other aquatic organisms. Finally, biochemical oxygen demand (BOD) and chemical oxygen demand (COD) levels were found to be relatively low at all four locations, indicating that there is relatively little organic matter and pollutants present in the water. Overall, while there are some concerns regarding the high levels of TSS and TDS in the water at these locations, the results of this analysis suggest that the sea water at RK Beach, Tenneti Park, Rushikonda Beach, and Thotlakonda is generally healthy and able to support marine life. According to the study, beach seawater is generally suitable for recreational uses and not acceptable for the drinking purpose.

7. FUTURE PROSPECTIVE AND LIMITATIONS

The future prospects of sea water testing are promising, as there is a growing need for accurate and reliable analysis of water quality in coastal areas, as well as in offshore drilling and production operations. With increasing awareness of environmental issues and the impact of human activities on ocean ecosystems, the demand for more comprehensive and sophisticated methods of sea water testing is likely to grow. Advancements in technology such as sensors, remote monitoring systems, and artificial intelligence (AI) are also likely to revolutionize sea water testing, enabling real-time and continuous monitoring of water quality parameters such as temperature, salinity, dissolved oxygen, and nutrients. This will help to provide a more accurate and timely assessment of the status of marine ecosystems, as well as enhance the ability to respond quickly to any incidents that may occur. Overall, the future prospects of sea water testing are positive, as there is a growing need for accurate and reliable analysis of water quality in marine environments.

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