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Study of Physico-Chemical Characteristics of Penna River at Chennur, Cuddapah Basin, India

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ABSTRACT

Penna is an important water source for Kadapa district. Its water is used for drinking, irrigation, and industrial purposes throughout its course. Owing to this utilization its surface water quality is prone to vary in its physico-chemical characteristics, and thus the study was taken to analyze them. In 10 sample sites, the physico-chemical properties were analyzed. Hardness values were in the range of 194-344.52 mg L^{-1} and alkalinity was in the range of 120-226 mg L^{-1}. Calcium and bicarbonate ions formed the dominant ions in the river system. High electrical conductivity values and alkalinity values indicate that water is not that much suitable for agricultural purpose.

Key words: *Penna river, Physiochemical properties, Urbanization.*

1. INTRODUCTION

Water constitutes the basis for the survival of life, and the availability of water is one of the crucial environmental issues of the 21st century [1]. Rivers play an important role in the development of our country and sustenance of life, which are being polluted due to development activities like rapid industrialization, urbanization, etc. They support agriculture which depends on most of its water from surface sources such as river, reservoir, watershed, and groundwater resources. In addition to the loss of flow into the main channel due to the construction of dams in upper reaches, degradation in drainage channels and loss of forest cover, the environmental pollution due to the draining of untreated industrial wastewater and domestic wastewater has become a major concern. This has resulted in water pollution among rivers due to changes in physical and chemical properties of water causing health concerns, loss of agriculture output, soil health [2]. The degree of pollution is generally assessed by studying physical and chemical characteristics of the water bodies. Essentially, the surface water quality is characterized by various physico-chemical characteristics, and these parameters are prone to change owing to different kinds of pollution, seasonal fluctuation, and water extraction, etc. [3].

Increased urbanization and industrialization caused stress on the self-purification mechanism of rivers. It is of major concern that the rate of discharge of the pollutants into the water bodies is far higher than the rates of their purification. In this regard, the water quality assessment is considered both in terms of immediate situation and long-term period. Cleaning and overall assessment of water quality through out of its flow in the river Ganga have received greater attention during recent years. The anthropogenic activities pose a potential for further water quality deterioration in the Ganga River [4]. The present study was aimed to study the changes in physico-chemical parameters of river Penna near the Green Tech power plant which uses the water in Kadapa district, Andhra Pradesh. The river Penna is also known by the names, Pennar and Penneru. It is one of the major east-flowing rivers in South India. It originates in the Nandidurg Hill Range (part of the Eastern Ghats) in Karnataka and flows downstream in a northwestern direction into Anantapur district of Andhra Pradesh. It flows through Kolar and Tumkur districts of Karnataka and enters Andhra Pradesh in Hindupur of Anantapur district. It proceeds further eastward to Kadapa and Nellore districts and joins the Bay of Bengal. The Penna traverses a total length of 597 km through its course. Its catchment area lies between 13° 16’ and 15° 52’ Northern Latitude and 77° 04’ and 80° 10’ Eastern Longitude.

2. MATERIALS AND METHODS

Water samples were collected for physico-chemical analysis from ten sampling sites near Chennur village where Green Tech power plant is present

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(Figure 1). Water was collected in bottles of 1 L size, and these are analyzed using standard methods for physico-chemical properties. Samples were analyzed for following physico-chemical properties - pH, electrical conductivity (EC), total hardness (ethylenediaminetetraacetic [EDTA] titration method), total alkalinity (by simple titration method), chloride, and sulfate. All the experiment were done within 24 h of sampling.

2.1. pH

The pH is a way of expressing the hydrogen ion concentration of water. All the 10 samples are measured by pH meter (Elico) within 24 h.

2.2. EC

EC is a measure of the total concentrations of ionized substances in water. It is expressed in μS cm^{-1}. The samples are analyzed by using EC meter (Elico).

2.2.1. Hardness

The term hardness refers to the ability of water to precipitate soap. The major contributors to water hardness are dissolved calcium and magnesium ions. These ions combine with soap to form insoluble precipitates. Temporary hardness is due to the presence of bicarbonates of Ca and Mg salts present in the water. Permanent hardness is due to the presence of chlorides and sulfates of Ca and Mg ions.

An EDTA method was followed to determine the hardness. Di-sodium salt to ethylene Di amine Tetra acetic acid is used as the permanent complexing agent with the calcium and magnesium ions of hard water in the EDTA method. Eriochrome Black T indicator at pH 9-10 forms an unstable complex of wine red. After the titration, the sodium – salt of EDTA forms a stable complex with water containing Ca^{+2} and Mg^{+2} ions replacing the unstable complex. The completion of the complex formation is indicated by Eriochrome Black T indicator at a pH range 9-10 giving a blue.

Figure 1: The study area where the samples were collected.

2.3. Chloride

Chloride ions are present in water in the form of NaCl, $MgCl_2$, and $CaCl_2$. The argentometric method was carried out to determine the chloride ions. The chloride ions in the water sample are determined by titrating against standard silver nitrate solution using potassium chromate as an indicator.

2.4. Alkalinity

Alkalinity can be divided into two kinds based on titration against standard acid using either phenolphthalein or methyl orange indicator. Caustic alkalinity (carbonate) can be determined using phenolphthalein. Bicarbonate alkalinity can be found out by using methyl orange indicator. The methyl orange end point occurs only after the phenolphthalein end point. 100 ml of water sample is pipetted out into a clean flask and add 2 or 3 drops of phenolphthalein indicator to the flask. The burette is filled with N/50 H_2SO_4. The end point is noted after titrating with the acid against the water sample. The endpoint is the disappearance of pink. Then continue the titration after adding 2 or 3 drops of methyl orange indicator. The endpoint is the color change from yellow to pink.

2.5. Total Dissolved Solids (TDS)

A large number of salts are dissolved in natural water. The common one are carbonate, bicarbonates, chlorides, sulfates, phosphates, samples high in bicarbonate may be prolonged drying at 180°C to ensure complete conversion of bicarbonate to carbonate.

2.5.1. Sulfate

Sulfates occur naturally in numerous minerals that include barite, epsomite, and gypsum. The amount of sulfates in wastewater is a factor of concern for determining the magnitude of problems that can arise from the reduction of sulfates to hydrogen sulfide. The turbidimetric method of measuring sulfates is based on the fact that barium sulfates tend to precipitate in a colloidal form of uniform size and that this tendency is enhanced in the presence of sodium chloride, hydrochloric acid, and glycerol.

$$SO_4^{\ 2} + BaCl_2 \rightarrow BaSo_4$$

The absorbance of the barium sulfates formed is measured by a spectrophotometer at 420 nm and the sulfates ions concentration is determined by comparison of the reading with a standard curve.

3. RESULTS AND DISCUSSION

The physico-chemical properties of the river water are provided in Table 1.

3.1. pH

The pH range in the study is between 7.302 and 8.78 indicating the water is neutral to slightly alkaline in nature. In comparison, all the samples are in the

desirable range (Table 1). The variation can be due to the exposure of river water to atmosphere, biological activities, and temperature changes [5].

3.2. EC

EC values represent the soluble salts concentration in water, and its higher content may cause gastrointestinal irritation as the high EC represents the elevated salt content on water [6]. The EC range is between 2100 and 3770 µS cm^{-1}. The sample 3 has registered high value of 3770 µS cm^{-1}. A significant correlation was observed among EC values and hardness, calcium, and chloride ions. It indicates that the calcium is the dominant ion among cations and chloride formed the dominant one among the anions (Table 2). It was observed that all the samples have registered higher values than the desirable limits (500-1500 µS cm^{-1}) (Figure 2). EC is one of the important factors influencing crop yield. As the EC of water goes up, plants need to compete more with free ions in water for intake of water for plant growth. This means that an increase in EC reduces the availability of water to the plants. In general, water with EC <700 µS cm^{-1} is suitable for irrigation. Whenever the EC exceeds 700, plants experience difficulty in absorbing the water [6].

3.3. Hardness

Water hardness arises due to the presence of cations such as calcium and magnesium and anions such

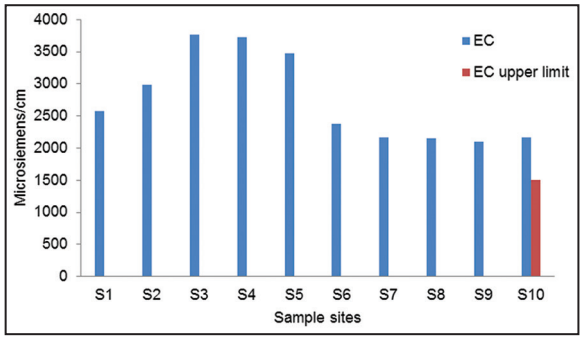

Figure 2: The comparison between the electrical conductivity (µS cm^{-1}) values and the upper desirable limit.

Table 1: Physico-chemical properties of Penna river water samples.

Sample no.	pH	EC µS cm^{-1}	Hardness mg L^{-1}	Ca^{+2} mg L^{-1}	Mg^{+2} mg L^{-1}	Chloride mg L^{-1}	Carbonate mg L^{-1}	Bicarbonate mg L^{-1}	TDS	Sulfate
S 1	7.57	2580	217.8	167.16	49.64	219.79	0	190	1210	246.4
S 2	8.78	2990	194.04	119.7	74.3	265.8	32	120	1370	370
S 3	7.88	3770	344.52	212.66	131.86	287.14	0	226	1760	274.8
S 4	8.11	3720	312.84	192.5	120.34	304.87	0	220	1690	114.8
S 5	8.72	3480	253.14	156.25	96.89	283.6	22	162	1650	172.8
S 6	7.73	2370	233.64	144.2	89.44	159.52	0	214	1100	293.6
S 7	8.04	2160	227.7	140.5	87.2	134.71	0	190	1010	252
S 8	7.37	2150	237.6	146.6	91	148.89	6	182	990	228.8
S 9	7.3	2100	213.84	132	108.16	141.8	0	188	980	200
S 10	7.34	2170	233.64	144.2	89.44	148.89	0	184	990	225.6
WHO/BIS	7-8.5	500-1500	200-600	75-200	50-150	250-1000	-	30-150	500-1500	200-400

EC=Electrical conductivity, TDS=Total dissolved solids

Table 2: Correlation matrix of analyzed physico-chemical parameters.

Parameters	pH	EC	Hardness	Ca	Mg	Cl	Alkalinity	TDS	Sulfate
pH	1								
EC	0.624	1							
Hardness	0.053	0.739*	1						
Ca	−0.23	0.716*	0.934**	1					
Mg	−0.01	0.493	0.787**	0.551	1				
Cl	0.681*	0.968**	0.573	0.599	0.299	1			
Alkalinity	−0.502	0.153	0.613*	0.713*	0.527	−0.3	1		
TDS	0.63	0.998**	0.732*	0.716*	0.484	0.964**	0.149	1	
Sulfate	0.18	−0.214	−0.402	0.389	−0.404	−0.141	−0.429	−0.211	1

EC=Electrical conductivity, TDS=Total dissolved solids, *,**Significant value: 0.05 was considered as the significant value for rejection of the null hypothesis

as bicarbonates, chlorides, and sulfides [7]. In the present study, the range of hardness is 194-344.52 mg L^{-1}. Among the samples sites, all the samples have registered lower value than the WHO limit.

3.4. Calcium

Calcium ions usually increase the hardness content in the river water. The range of Ca^{+2} ions is 119.7-212.66 mg L^{-1}; the higher values and the strong relationship with EC, hardness, alkalinity indicates that calcium forms the dominant cation in the Penna river and readily associates with bicarbonate system of fresh water systems. Except sample 3, all the nine samples figured below the WHO desirable limit [8,9].

3.5. Magnesium

Magnesium ions may increase the hardness values in the river water by forming magnesium bicarbonates and magnesium carbonates. The range values include 49.64-120.34 mg L^{-1}, and this shows that all the samples were in the desirable limit. Magnesium did not show any significant relationship with other parameters indicating its lesser content in the river water.

3.6. Alkalinity

Alkalinity is a measure of the ability of water to neutralize acids. The relative quantities of the alkalinity species are pH dependent. The bicarbonates values were in the range of 120-226 mg L^{-1}, and a strong correlation was observed with hardness and calcium values. This indicates that bicarbonates form the dominant anion in the system. This may be due to the phytoplankton growth. The growth will be usually higher if organic wastes are being added to the water. Except one sample, all the sample values were above the desirable range (Figure 3). Among the 10 samples, three samples – Sample 2, 5, and 8 have recorded carbonate alkalinity in the range of 6-32 mg L^{-1}.

3.7. Chloride

The average value of chloride ion is 209.5 mg L^{-1} with a range of 134.7-304.6 mg $L^{-1,}$ and the values indicate that they are in the desirable limits. Chloride

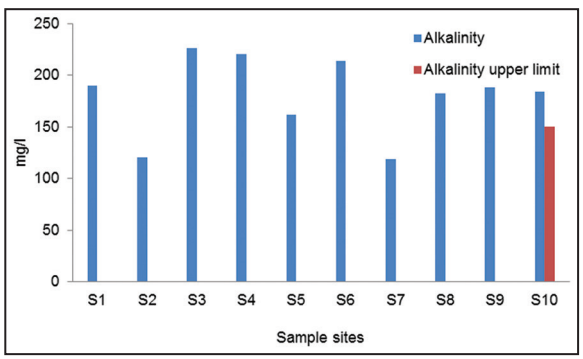

Figure 3: The comparison between the alkalinity (mg L^{-1}) values and the upper desirable limit.

is the only ion that showed a significant relationship with pH values. Further, chloride ions formed a strong relationship with EC and TDS values indicating that chloride ion represent the dominant anion present in the water and also in precipitates.

3.8. TDS

The mean value of TDS is 1275 mg L^{-1}, and the range is between 919 and 1760 mg L^{-1}. Except with magnesium all parameters such as EC, chloride, calcium, and hardness have showed a significant relationship. It corroborates that the chlorine and calcium formed the major ions in the river water.

3.9. Sulfate

The average value of sulfate is 237.8 mg L^{-1} with a range of 114.8-370 mg L^{-1}, and all the sample sites were within the desirable range. The values of sulfate did not show any significant relationship with any of the parameter indicating its separate entity in the river water system.

4. CONCLUSIONS

Physico-chemical properties of the Penna river water samples were analyzed at 10 sample sites. pH, EC, TDS, hardness, bicarbonate, carbonate, Cl, Ca, Mg, and SO_4 were analyzed using the standard procedures. The values were compared permissible range. The high EC and high alkalinity values indicate that water is not that much suitable for agriculture purpose and hence has to be used with caution. The results show that the renewable energy power plant which essentially uses the water for power generation and as well for letting pollution load has not caused a deleterious effect on water except for the increase in alkalinity levels.

5. REFERENCES

1. M. Rawat, (2008) An evaluation of acute gastrointestinal illness in rural areas of Thar desert, ***The Ecosan,*** **2(2):** 137-142.
2. S. S. Patil, I. B. Ghorade, (2013) Assessment of physicochemical characteristics of Godavari river water at Trimbakeshwar and Kopargaon, Maharashtra (India), ***Environment,*** **3(3):** 149-152.
3. M. Vasanthy, R. Velmurugan, (2009) Groundwater quality assessment in and around port Blair Andaman and Nicobar Islands, ***The Ecoscan,*** **3(3&4):** 247-250.
4. L. Singh, S. K. Choudhary, (2013) Physico-chemical characteristics of river water of Ganga in middle Ganga plains, ***International Journal of Innovative Research in Science, Engineering and Technology,*** **2(9):** 4349-4357.
5. R. K. Gangwar, P. Khare, J. Singh, A. P. Singh, (2012) Assessment of physicochemical properties of water: River Ramganga at Bareilly, ***Journal of Chemical and Pharmaceutical Research,*** **4(9):** 4231-4234.

6. K. Ramesh, L. Elango, (2012) Groundwater quality and its suitability for domestic and agricultural use in Tondiar river basin, Tamil Nadu, India, ***Environmental Monitoring Assessment*****, 184(6):** 3887-3899.
7. P. Ravi Kumar, M. Aneesul Mehmood, K. K. Somashekar, (2013) Water quality index to determine the surface water quality of Sankey tank and Mallathahalli Lake, Bangalore Urban district, Karnataka, India, ***Applied Water Science*****, 3:** 247-261.
8. WHO, (1996) ***Guidelines for Drinking Water Quality*****,** Vol. 2. Geneva: World Health Organization, p231.
9. Bureau of Indian Standards, (1998 & 2012) ***Indian Standard Drinking Water***, ICS 13.060.20. IS:10500, 2nd Revision. New Delhi, India: Bureau of Indian Standards.

****Bibliographical Sketch***

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