INVESTIGATION OF PHYSICOCHEMICAL PARAMETERS OF SOME SELECTED SITES OF SUPER THERMAL POWER STATION, MOUDA

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Abstract: Increasing demand of electricity resulted in construction of many new thermal power stations in our country. One of such thermal power station is NTPC, Mouda. The presented study was based on investigation of surface water physicochemical parameters of NTPC Super Thermal Power Station, Mouda, Maharashtra. Water samples were collected from the site -1 (Kanhan River, which is near NTPC Super Thermal Power Station Mouda) and site – 2 (receiving direct effluents form thermal power station) for the period of 12 months from November 2022 to October 2023 for the analysis. Various physicochemical parameters were analysed by using APHA standard procedure. In our investigation, it was found that the minimum value of TDS at site – 1 is 401 mgL-1 and maximum was 730 mgL-1. Whereas at site – 2 minimum value was recorded 1057 mgL-1 and maximum value was 1850 mgL-1 (the standard BIS value for TDS is 500mgL-1). Similarly, many parameters show values higher than the standard BIS values. The result revealed that site – 2 is having more pollution load as compared to site – 1. Because site – 2 is receiving direct effluents from thermal power station. An observation of the present study helps to increase effectiveness of management strategies to bringing back the originality of nearby surface water bodies of NTPC Super Thermal Power Station, Mouda.

Keyword: Physicochemical parameters, thermal power station, water pollution

1. Introduction: An essential component of life on Earth is water. According to World Health Organization (WHO) report, about 37% urban and 64% rural Indians are without access to safe drinking water [2], [15]. Freshwater touches every aspect of human life such as food, production, industrial, waste disposal and cultural requirement [3]. Thus, both quality as well as quantity of available freshwater are of concern. Urban regions experiencing fast unplanned urbanization and industrialization, such as Mouda Super Thermal Power Station, are likely to see worsening conditions. Mouda is a town and tehsil in Nagpur division which is located in the state of Maharashtra, India. It is famous for fertile agricultural land; thus, farming is the primary occupation. The main source of natural water for Mouda is the Kanhan River. Present study aims to investigate some physicochemical parameters of surface water quality of nearby area at NTPC super thermal power station Mouda.

2. Material and Methods:

2.1 Research area: The Mouda Super Thermal Power Station (TPS), also known as NTPC Mouda (Coordinates: 21°10′47″N 79°23′50″E. Mouda is a tahsil place in the Nagpur district of Maharashtra and situated on the banks of the Kanhan River approximately 40 km from Nagpur. Two units of 500 MW and two units of 660 MW are installed (Total 2320 MW) in the NTPC Mouda Super Thermal Power Station. For the collection of water samples two sites were selected. Site -1(21°08'41.5"N 79°23'30.8"E,

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Kanhan River, which is near NTPC Super Thermal Power Station Mouda) and site – 2 (21°11'13.2"N 79°24'10.7"E, receiving direct effluents from NTPC Super Thermal Power Station Mouda). Physicochemical parameters were analysed for the period of 12 months from November 2022 to October 2023. The sampling points were recorded with global positioning system (GPS)by Google application and map made by the QGIS software ver. 2.18.0 (Fig.1).

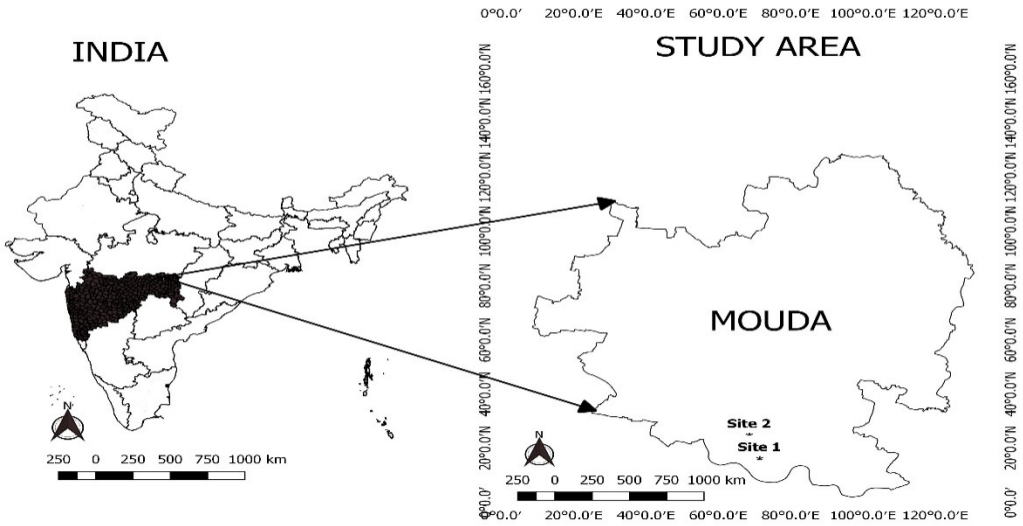

Fig. 1: Map of sampling points along with NTPC Super Thermal Power Station Mouda(QGIS software ver. 2.18.0)

2.2 Sample Collection and preparation:New 1.0-liter polypropylene (PET) bottles with secure stoppers were used to collect the water samples.The PET bottles were prepared in a number of ways for the collection of water samples, including cleaning them with detergent, washing them under a lot of running tap water, submerging them in 5% HNO3 for a whole night, rinsing them in distilled water, and lastly air drying them. The desiccated PET bottles were labelled with a unique identification number in order to identify the gathered samples. Samples were taken at a depth of 10 to 15 cm below the surface water. Air bubble formation was strictly avoided during the sampling process. Following sample collection, every PET bottle was placed in an ice box and promptly taken to the lab for further analysis. The sample were analysed according to APHA, AWWA, WEF.

2.3 Analytical methods: For the analysis, 19-physicochemical parameters were selected. Out of these, temperature, pH, TDS and EC were measured at the site itself at the time of collection. The analysis of water samples was carried out in accordance to standard analytical methods (APHA, AWWA, WEF).For the preparation of solutions, AR grade chemicals and double distilled water were used. Details of the analysis methods are summarized in Table I.

Table: I Water Quality Parameters, Units and Analytical methods as measured during Analysis

S.No.	Water Quality Parameters	Unit	Analytical Method
1	pH	pH unit	pH meter
2	Electrical Conductivity	µS/cm	Conductivity meter
3	Total Solids	mgL^{-1}	Gravimetric

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4	Total Suspended Solids	mgL^{-1}	Gravimetric
5	Total Dissolved Solids	mgL^{-1}	TDS meter
6	Temperature	^{o}C	Thermometer
7	Total Alkalinity	mgL^{-1}	Titrimetric
8	Total Hardness	$CaCO_3mgL^{-1}$	EDTA Titrimetric
9	Calcium Hardness	$CaCO_3mgL^{-1}$	Titrimetric
10	Magnesium Hardness	mgL^{-1}	Titrimetric
11	Chloride	mgL^{-1}	Argentometric
12	Sulphate	mgL^{-1}	UV Spectrophotometer
13	Phosphate	mgL^{-1}	UV Spectrophotometer
14	Ammonia	mgL^{-1}	EDTA Titrimetric method
15	Carbonate	mgL^{-1}	Calculation from pH and Alkalinity
16	Bicarbonate	mgL^{-1}	Calculation from pH and Alkalinity
17	Dissolved Oxygen	mgL^{-1}	Winkler's Azide method
18	Biochemical Oxygen Demand	mgL^{-1}	Winkler's Azide method
19	Chemical Oxygen Demand	mgL^{-1}	Open reflux method

All obtained values were compared with standard limit recommended by BIS standards IS-10500-2012 [5] (Table II and Table III).

Table:II Physicochemical analysis of Sites – 1 for the period of November 2022 to October 2023 and comparison with standards (IS 10500-2012).

S.No.	**Water Quality Parameters**	**Unit**	**Indian Standard IS-10500-2012**	**Minimum**	**Maximum**	**Mean**
1	pH		6.5 – 8.5	7.2	7.4	7.2

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2	Electrical Conductivity	µS/cm	-	577	778	702.66
3	Total Solids	mgL^{-1}	-	482	878	741.83
4	Total Suspended Solids	mgL^{-1}	-	81	243	145.83
5	Total Dissolved Solids	mgL^{-1}	500	401	730	**606.5**
6	Temperature	^{o}C	-	26.2	36.8	30.59
7	Total Alkalinity	mgL^{-1}	200	210	418	**327.75**
8	Total Hardness	mgL^{-1}	300	175	350	278.83
9	Calcium Hardness	mgL^{-1}	75	110	232	**185.33**
10	Magnesium Hardness	mgL^{-1}	30	26	122	**94.08**
11	Chloride	mgL^{-1}	250	57	117	93.08
12	Sulphate	mgL^{-1}	200	47	89	72.33
13	Ammonia	mgL^{-1}	0.5	0	42	**22.66**
14	Phosphate	mgL^{-1}	-	16	108	67
15	Carbonate	mgL^{-1}	-	0	0	0
16	Bicarbonate	mgL^{-1}	-	266	510	408.83
17	Dissolved Oxygen	mgL^{-1}	>5	3.6	11	**8.1**
18	Biochemical Oxygen Demand	mgL^{-1}	-	42	105	82.41
19	Chemical Oxygen Demand	mgL^{-1}	250	115	168	**145.41**

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Table III Physicochemical analysis of Sites – 2 for the period of November 2022 to October 2023 and comparison with standards (IS 10500-2012)

S.No.	Water Quality Parameters	Unit	Indian Standard IS-10500-2012	Minimum	Maximum	Mean
1	pH		6.5 – 8.5	7.2	8.1	7.59
2	Electrical Conductivity	µS/cm	-	1585	1995	1851.5
3	Total Solids	mgL^{-1}	-	1488	1992	1847.25
4	Total Suspended Solids	mgL^{-1}	-	46	460	270.25
5	Total Dissolved Solids	mgL^{-1}	500	1057	1850	**1547.25**
6	Temperature	^{o}C	-	23.5	37.1	
7	Total Alkalinity	mgL^{-1}	200	533	610	**573.91**
8	Total Hardness	mgL^{-1}	300	421	572	**515.58**
9	Calcium Hardness	mgL^{-1}	75	308	438	**383.08**
10	Magnesium Hardness	mgL^{-1}	30	96	242	**132.83**
11	Chloride	mgL^{-1}	250	146.64	340	237.22
12	Sulphate	mgL^{-1}	200	127	293	**235.41**
13	Ammonia	mgL^{-1}	0.5	66	90	**81.75**
14	Phosphate	mgL^{-1}	-	119	192	165.08
15	Carbonate	mgL^{-1}	-	0	0	0
16	Bicarbonate	mgL^{-1}		650	744	703.25
17	Dissolved Oxygen	mgL^{-1}	>5	4.4	14.4	8.31
18	Biochemical Oxygen Demand	mgL^{-1}	-	178	269	225.58
19	Chemical	mgL^{-1}	250	355	513	**413.75**

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	Oxygen Demand					

3. Result and Discussion:

3.1 Temperature: Temperature is one of the most significant factors in the aquatic environment since it directly affects a wide range of physical, chemical, and biological features [4]. During the study period, the temperature was recorded in between 26.2 oC and 36.8 oC for site-1 and between 23.5 oC and 37.1 oC for site-2, respectively. The peak summer months (i.e. in June month). that prevailed during the investigation period may have contributed to the greater value of water temperature recorded in this study.

3.2 pH: Water's acidity and alkalinity are determined by its hydrogen ion concentration, which is expressed using the pH scale. Natural water has a pH of 6.5 to 8.5. The interplay of acid and bases causes a departure from the ideal pH of 7.0. The recorded pH values were comparatively lower at site – 1 (7.2 to 7.4) but higher at site – 2 (7.2 to 8.1). Reference [8] also reported an increase in pH values with addition of effluents from thermal power station. The utilization of both organic and inorganic components in the thermal power station in the study area may be the cause of the higher pH value.

3.3 Electrical Conductivity (EC): Electrical conductivity is a numerical expression of the ability of an aqueous solution to carry an electric current and serves as a tool to assess the purity of water [9]. The recommended maximum EC level in drinking water is 1000 µS/cm (WHO). The maximum electrical conductivity (1995 µS/cm) was seen at site 2, while the least value (577 µS/cm) was obtained at site 1. (Table 2 & 3).

3.4 Total Dissolved Solids (TDS): TDS is the mixture of dissolved organic matter and inorganic salts (principally Ca 2+, Mg2+, K+, Na+, HCO3, Cl-, and SO4+) in water. The range of TDS measured at the two sites was found to be 401 mgL-1 –730 mgL-1 for site – 1, and 1057 mgL-1 –1850 mgL-1 for site – 2 (Table 2 & 3). The thermal power station's receiving direct effluents may be the cause of the highest TDS value observed at site 2. The similar observations were also recorded by [8].

3.5 Total Alkalinity: Alkalinity is a measure of acid-neutralizing capacity. Overly alkalinity imparts a bitter taste to the water and reacts with cations to produce precipitates. The alkalinity of samples ranged between (210 mgL-1 – 418 mgL-1) and (533 mgL-1 - 610 mgL-1) for site – 1 and site – 2 respectively. All of the measured values were higher above the regulatory limit of 200 mgL-1 for total alkalinity (BIS). It may be the combined effect of industrial activities and direct effluents from the thermal power plant in the study area.

3.6 Total Hardness: Total hardness of water is complex mixture of anions and cations specially Ca+ and Mg2+[10]. Total hardness from the water samples at recorded sites ranges between 175 mgL-1- 350 mgL-1 for site – 1 and 421 mgL-1 – 572 mgL-1 for site – 2. As per IS: 10500-2012, desirable limit for hardness is 300 mgL-1. The highest amount of total hardness in the water may be due to presence of high content of calcium and magnesium in addition to sulphate, bicarbonate and ammonia in the effluents from NTPC Mouda.

3.7 Calcium: Calcium play an important role in biological systems. It is the most abundant ion in the fresh water. Calcium concentrations for site – 1 were found to vary from 110 mgL-1 to 232 mgL-1 with an average value of 185.33mgL-1 and for site – 2, 308 mgL-1 – 438 mgL-1 with average value of 383.08 mgL-1. The prescribed limit for calcium is 300 mgL-1 as per IS-10500-2012. (Table 1).It may be due to direct effluents from the power plant. A similar result recoded by [17].

3.8 Magnesium: Magnesium is beneficial metal but is toxic at higher concentration [13]. The magnesium value ranged from 26 mgL-1 – 122 mgL-1 with mean value of 94.08 mgL-1 and from 96 mgL-1 – 242 mgL-1 with mean value of 132.83 mgL-1 for site – 1 and site – 2 respectively (Table – 2 and 3). The prescribed limit of magnesium is 30 mgL-1. The maximum value observedat site – 2 due to direct receiving effluent from NTPC super thermal power station.

3.9 Chloride: The chloride concentration as an indicator of pollution by industrial effluents.

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Exposure in higher concentration with chloride are subjected to laxative effects [6], [10]. One of the main inorganic anions in water and wastewater is chloride. The acceptable limit of chloride in drinking water is 250 mgL-1. The observed values in all sites are within the desirable limit except for site – 2 (340 mgL-1)(Table 2 and 2).

3.10 Sulphate: The values of sulphate ranged within 47 mgL-1 – 89 mgL-1 (with a mean value 72.33 mgL-1) and 127 mgL-1 – 293 mgL-1(with a mean value 235.4 mgL-1) respectively at site – 1 and site – 2. The higher values can be attributed to addition of industrial effluents into the site – 2. The present observation finds support with the work of reference[14].

3.11 Phosphate: The phosphorus is an essential plant nutrient and often controls aquatic plant growth in fresh water (APHA 2012). The phosphate content in site – 2(119 mgL-1 – 192 mgL-1) were comparatively higher at site – 1(16 mgL-1-108 mgL-1). The discharge of effluent from the source point may lead to increase the concentration. Similar observations were recorded byreference [1].

3.12 Ammonia: Ammonia (NH4+) is a water-soluble gas that exist at low level (0.1 mgL-1) in natural waters. NH4+ comes from the nitrogen-containing organic material and gas exchange between water and the atmosphere [1]. Ammonia is responsible for biodegradation of wastes and hence is a good indicator of water contamination. In present work,all the values are extremely higher than the desirable limit (0.5 mgL-1) (Table No. II and III).

3.13 Chemical Oxygen Demand (COD): COD is a measure of the oxygen required for the chemical oxidation of organic matter with the help of strong chemical oxidant. Hence it is used as an indicator of organic and inorganic substances of river water by sewage discharge and anthropogenic activities [11]. The COD concentration of site – 1 (115 mgL-1 – 168 mgL-1) with average value were 145.58 mgL-1 were lower as compared to the site – 2 (355 mgL-1 – 513 mgL-1) with average value were 413.75 mgL-1. Due to direct effluent from NTPC Mouda super thermal power station, site – 2 readings might be elevated.

3.14 Dissolved Oxygen:The dissolved oxygenwas recorded at site – 1 range from 3.6 mgL-1– 11.0 mgL-1 and at site – 2 from4.4 mgL-1 – 14.4mgL-1respectively. Elevated level of dissolved oxygen content due large decomposition of organic matter which indicate large amount of pollution [11].

3.15 Biochemical Oxygen Demand (BOD): Aerobic decomposition of organic matter by the microorganism called as biochemical oxygen demand. The BODobserved from the water samples at site – 1 (42 mgL-1 to 105 mgL-1) with mean value 82.41 mgL-1 and site – 2 (178 mgL-1 – 269 mgL-1) with mean value 225.58 mgL-1. The highest demand of oxygen in the water was recorded at site – 2 due to the possible addition of high amount of waste from the NTPC Mouda. During the whole investigation period, the elevated values of physico-chemical parameters were found at site – 2. The results of present investigation were coincideswith the work of [7], [8], [12].

4. Conclusion: Some of the water samples having values for BOD, COD, magnesium, calcium, chloride, sulphate, phosphate, electrical conductivity, alkalinity, total hardness, and BOD and COD that are higher than what Indian Standards. During our investigation, it is observed that the values of parameters like pH, biological oxygen requirement, and temperature are all within acceptable limits. It is observed that water quality at site – 2 is significantly more contaminated than site – 1. However, Site 1 is also contaminated as a result of urbanization and industrialization. Therefore, authority take stringent action to stop further deterioration of surface water quality in and around NTPC Mouda.

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