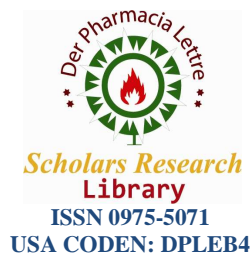




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Quality assessment of surface and ground waters in the vicinity of Vijayawada thermal power station

Y. Hanumantha Rao¹ and K. Ravindhranath^{2*}

¹Department of Chemistry, Andhra Loyola College (Autonomous), Vijayawada, Andhra Pradesh, India

²Department of Chemistry, K. L. University, Green Fields, Vaddeswaram, Guntur Dt., Andhra Pradesh

ABSTRACT

Surface and underground waters in the nearby areas of Vijayawada Thermal Power Station have been analyzed for various parameters at specific intervals for a period of nine months at rationally chosen sample stations to assess the impact of discharges of effluents from Thermal Station. The Physicochemical parameters chosen for study are: pH, alkalinity, conductivity, DO, BOD, COD, solids (dissolved, suspending and total), hardness (Ca, Mg, and total), salinity (chloride content), nitrogen compounds (nitrites, nitrates & ammonia) and phosphate. Further thermal pollution is also monitored in the said period. It is observed that the discharges of effluents from the Thermal Power Station are contaminating the water bodies and some of the parameters are touching or crossing the maximum permissible limits. Stratification due to thermal pollution is also noted. The major flaw observed is that the effluents of thermal power station are being discharged into the upside stream of Krishna River (i.e. above Prakasham Barriage) and not down side stream and thereby, the impounding lake waters at the barrage are being contaminated. As the water are stagnated, the impurities are being accumulated especially non-degradable ions over period of time by the processes such as 'bio-amplification' and affect the quality of the lake waters and thereby, endangering the health and wealth of habitants of Five districts of Andhra Pradesh who are depending up these waters for their drinking and agricultural needs.

Key words: Vijayawada Thermal Power Station, water bodies, physicochemical parameters, pollution

INTRODUCTION

Due to the substantial increase in the power conception and the availability of large coal and lignite deposits in India, many thermal power stations are being established along the coastal areas¹⁻³. These plants based on the burning of coal are turning to be environmental concern as the **flue-gas, sludge, fly ash and waste water produced** are polluting environment if proper disposal methods are not adopted⁴⁻¹⁶. Further, the water bodies receiving waste waters from thermal stations generally have higher temperatures than the normal and these higher temperatures decrease the DO contents in waters and thereby causing '**thermal stratification of water layers**' which results in developing strain on the aquatic life and biota and thereby, causing the disappearance of valuable species in water bodies near the thermal power stations¹⁷⁻¹⁹. Further, the toxic ions such as heavy metal ions, are leached into the nearby water bodies from ash ponds pertaining to the thermal power stations and are accumulated over a time due to bio-amplification phenomenon to dangerous levels and thereby turn be to be potential health hazards²⁰⁻²².

Although regulatory agencies are enforcing stringent norms to control and mitigate the potential treats of thermal power stations on environment, the lack of efficiency in implementing the regulatory measures is endangering the

peaceful human dwelling in serene laps of nature and moreover threatening the very human survival.^{3,18,23-25}. In the endeavor of generating the increasing thermal power, bigger pollution problems are being invited. The thermal power stations while generating electricity are contaminating the environment surrounding it and turning into the sources of hazardous substances.

In this context, it is essential to initiate case studies on the assessment of environmental contamination caused by thermal power stations in India in its vicinity with respect, air, water and soil^{4,26-30}.

Vijayawada Thermal Power Station (VTPS) is established near the sprawling rich city Vijayawada three decades back and there is a public concern that the power station is causing pollution to the environment. In this investigation it is endeavored to assess the impact of VTPS on the quality of waters in the water bodies in its vicinity.

MATERIALS AND METHODS

1. DESCRIPTION OF VIJAYAWADA THERMAL POWER STATION :

The Thermal station is located at Ibrahimpatnam, nearly 17 km away from Vijayawada Railway station in A.P. The huge water requirement for the thermal station is met from the impounded waters from the Prakasham Barrage constructed across Krishna River with stagnating capacity of 2 TMC of water and from where the Krishna river waters are being diverted to three main canals namely Bandar, Eluru and Buckingham Canals that runs mile and miles in different directions to cater the drinking and irrigation needs of people of five districts and these “live nerves” bring the prosperity for this areas and turned to be “blessing in disguise” for Telugu people.

The water requirements for the thermal power station are met from the stagnated placid waters of the barrage and after the waters are used for different purposes of the thermal power station, it is let into the same stagnated pool of Krishna River on the up-side of the river. A canal of dimensions 15 m breadth (average) x 3 m depth is being used to take the impounding waters at the barrage from Bhavanipuram intake point 12 K.M. away from the VTPS. The effluent from the VTPS, is being discharged into the impounding waters of the Prakasham Barrage through Bhudameru canal at Tummalapalem. The distance between Bhavanipuram intake point and the point of merging at Tummalapalem is 12 K.M. and the later is on the upper stream side of the Krishna River. In other words, the water for various purposes of VTP is being taken from the impounding waters at Prakasham Barrage and after use for steam generation and cooling, the effluent waters are being discharged into the same stagnated waters at the Prakasham barrage. If the effluent waters are contaminated with impurities especially of non-degradable nature, as the time proceeds, the accumulation of impurities in the pond increase and in due course, they may reach threshold values endangering the aquatic life and also the people in five districts who depend upon this Barrage waters.

2. ESTABLISHMENT OF SAMPLE STATIONS: (VIDE FIG NO. 1)

As has been depicted in the Fig.1, seven sample stations were established: 3 surface waters and 3 ground-waters

A: Surface waters:

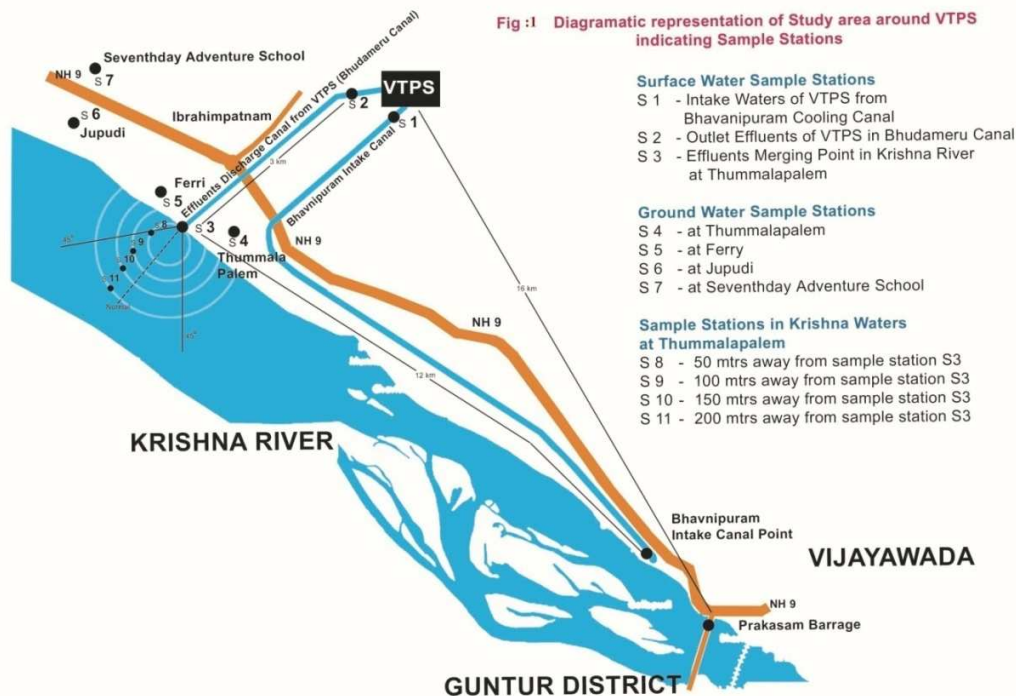
- Station No. 1: at Bhavanipuram intake point
- Station No.2: at outlet of the VTPS into Budameru canal at Ibrahimpatnam
- Station No.3: at Tummalapalem where the outlet water from VTPS is merging with Krishna River

B: Ground Waters: To understand impact of VTPS ash ponds on the quality of ground waters, four stations have been established:

- Station No. 4: at Tummalapalem:
- Station No.5: at Ferri
- Station No. 6: at Jupudi village
- Station No. 7 : at Seventh Day Adventure School

Further, for studying the temperature variations, four more *sample station Nos. 8, 9, 10 and 11 were established at equidistant points on the sectors at 50 meters, 100 meters, 150 meters and 200 meters respectively from the point of merging of effluents from VTPS in Krishna River waters at Tummalapalem in Krishna River waters (Lake) as shown in the Fig No.1.* By rowing into the waters of Krishna with the help of a country boat, the temperature measurements were *made at three chosen points on each Sectors; one normal to the Krishna river bank and other*

two at an angle of 45° in clock wise and anticlockwise directions to the normal or bank. The averages of the measured temperatures were noted.



3. ANALYSIS:

(a) Collection of Samples:

(i) Surface waters:

By using 'sample thief' of capacity 2 lit, the samples were collected at the top, bottom and middle depths at the two opposite bank sides and also in the middle of the canal. The waters at the middle of the stream were collected by rowing in a boat. Thus collected waters were mixed and thus obtained samples were used for analysis. The same method of collection was adopted at sample Station Nos. 1, 2 and 3.

(ii) Ground Waters:

At sample stations 4, 5, 6 and 7 ground waters were collected from bore wells which were laid at depth of nearly 60 ft.

ESTIMATIONS: The samples were analyzed using the standard methods available in the literature for different parameters: pH, Conductivity, Dissolved Solids, Suspended solids, Total Solids, Salinity, D.O, B.O.D., C.O.D., Total Hardness, Calcium hardness, Magnesium hardness, Total Alkalinity, Phosphates, Nitrates, Nitrites and Ammonia.³⁰⁻³⁴

The obtained results were presented in Table No. 1-11.

RESULTS AND DISCUSSION

The various physicochemical parameters studied during the period: April 14 to Dec.14 were presented in the Table Nos. 1 to 11. The obtained results are presented hereunder.

1. pH and Alkalinity:**1.1: pH: (vide Table No. 1:1):**

pH values reflect the intensity of acidic or basic nature of waters. The permitted pH range for natural waters is 6-8; very high or low pH values indicate the industrial or chemical pollution.

In this work pH of the various samples collected at the Sample Stations 1-7, were determined and the observations were presented in the Table No. 1. The following observations are interesting to note:

a) The pH values varied from sample station to station and with respect to the time. The important observation was ***that surface water showed relatively more pH values than ground waters in the period August 14 to Dec. 14.*** As for example, in the month of Dec.14, the pH values were found to be 8.1, 8.4 and 8.5 in the surface sample station Nos. 1, 2 and 3 respectively while the values were 7.5, 7.6, 7.7 and 7.8 at the Station Nos. 4, 5, 6 and 7 respectively.

b) Further, the pH varied from 6.8 to 8.1, 6.9 to 8.4 and 7.1 to 8.5 for the Station Nos. 1, 2 and 3 respectively. ***It was interesting to note that there was a progressive increase in the pH values from April 14 to Dec. 14.***

c) For the ground waters for the same period of study, the pH varied from 6.7 to 7.5, 6.8 to 7.6, 6.9 to 7.7, 7.1 to 7.8 at the Station Nos. 4, 5, 6 and 7 respectively. The increasing trend in pH values as in the case of surface stations was noted. On comparing the pH values at a particular time for different Station Nos, ***the pH increased from Station No.1 to 3 for surface waters and from station No.4 to 7 for ground waters.*** As for example, in the month of April the pH values were found to be 6.8, 6.9 and 7.1 for the Station Nos. 1, 2 and 3 respectively while 6.7, 6.8, 6.9 and 7.1 for the Sample stations 4, 5, 6 and 7 respectively.

1:2: ALKALINITY: (vide Table No.1:2):

The alkalinity in natural waters is due to the presence of CO_3^{2-} and HCO_3^- which are formed due to the absorption of Carbon dioxide from air or by the respiration of aquatic organisms. The presence of OH^- indicates the industrial pollution. The CO_3^{2-} and HCO_3^- ions resulting from weak di-basic acid H_2CO_3 provide buffering action in keeping pH constant and thereby protects fish or other organisms from sudden changes in pH values.

The water samples at the Station Nos. 1-7 were analyzed for alkalinity. The obtained results were presented in the ***Table No.2.*** It was inferred from the data that:

a) the alkalinity of out letting waters was about 10-12 ppm more than in taking waters. For example in the month of April 14, the Alkalinity was found to be 200.0, 211.2 and 210.2 ppm at the Station Nos. 1, 2 and 3 respectively. The alkalinity showed increasing tendency from April 14 to Dec. 14 at the Surface station Nos. 1 to 3. For example, at the Sample Station No.3 the alkalinity was found to be 210.2, 215.5, 221.3, 220.2 227.2 234.2, 241.0, 246.0 250.0 ppm in the 9 months period from April 14 to Dec.14.

b) ***The Alkalinity was found be more in all the ground waters than surface waters.*** As for example: in the month of April, the values were found to be 272.2 ,342.0, 632.0 and 512.0 ppm at the Station Nos. 4,5,6 and 7 respectively while the alkalinity was 200.0, 211.2 and 210.2 ppm at the Station Nos.1,2 and 3 respectively.

c) Further, the water samples at Station Nos. 6 and 7 showed more values than at the Station Nos. 4 and 5 probably because the latter said stations were near to the Krishna Rive while the former two stations were near to the VTPS.

All these results indicate that VTPS is affecting the alkalinity of surrounding water bodies, both surface and ground waters.

2: CONDUCTIVITY: (vide Table No .2)

Conductivity is a measure of the content of dissolved salts. The conductivity measurements for the ear marked Station Nos. 1-7 were made to assess the content of dissolved solids and the obtained results were present in the Table No.2. The following salient points were worth to note:

a) The conductivity was found to varied from 542 to 561 μS for the Station No.1; from 561. to 580 μS for Station No. 2; from 565 to 584 μS for Station No.3 during the period April to Dec.. In the same period in the ground waters, the conductivity changed from 935 to 956 μS ; 2390 to 2460 μS ; 2185 to 2260 μS and 1398 to 1480 μS for Station Nos.4, 5, 6 and 7 respectively.

b) It was interesting to note that:

- i. at surface water sample stations, the conductivity was comparatively lesser than the ground water stations.

- ii. in the ground water Sample stations, the sample station at Tummalapalam (No.4) showed less conductivity than other ground water Station Nos.5,6 and 7 (vide item Nos. 4-7 in the Table No. 2).
- iii. the conductivity showed some increase in dissolved salts from the up taking point of water: Station No.1, to the out coming waters: Station No.2 and 3. For example in the month April 14, the conductivity was found to be 542 μ S at the Station No. 1 while the conductivity was 561 and 565 μ S at the station No. 3 and 4 respectively.

3: SUSPENDING, DISSOLVED AND TOTAL SOLID (vide Table No.3:1-3)

High dissolved solids impart inferior palatability and are hazardous for consumption. The maximum permissible limit is 500 mg /L The suspending solids indicate the pollution caused by the human activity. The samples at the Stations 1-7, were analyzed and presented in the Table Nos. 3:1; 3:2; 3:3.

The following observations may be noted:

- a) Total solids (TS), Total suspending (TSS) and Total dissolved solids (TDS) increased from Station No. 1 to Station No 3 during the period of study (vide Table Nos. 3:1- 3: items Nos. 1-3).
- b) TS, TSS and TDS found to be more in Ground water Station Nos. 4-7 than Surface water Station Nos. 1-3 (vide Table No.3.1-3: item No. 4-7).
- c) Further, the total solids (TS) increased from 324 to 400 ppm, 327 to 408 ppm and 329 to 415 ppm at Station Nos. 1, 2 and 3 respectively during the period of study (vide Table No. 3.3: item Nos. 1-3).
- d) For the Ground water Sample Station Nos. 4, 5, 6 and 7, the total solids varied from 585 to 668 ppm ; 1626 to 1705 ppm ; 1458 to 1530 ppm and 917 to 995 ppm respectively (vide Table No. 3.3: item Nos. 4-7) in the said period of study. Comparatively less total solids (TS) were noted at the Station No.4 than the other Ground water Sample Stations.
- e) The presence of relatively more amounts of suspending solids (TSS) even in ground waters indicated the graveness of the pollution caused by the VTPS in the surrounding ground waters. Its impact was more in 7th Sample Station at Seventh Day Adventures School than at the other ground water sample stations (vide Table No. 3:2).
- f) However, the dissolved solids were found to be relatively more in the Sample Station Nos. 5 and 6 than the other ground water station No 4 and 7 (vide Table Nos. 1:1: item Nos. 4-7). It is interesting to note that in the Station No.7, the dissolved solids are relatively lesser but suspending solids are more, than in the Ground water Station Nos. 5 and 6.

The results indicate that the Ground waters as well as surface waters are being affected by the VTPS.

4. DISSOLVED OXYGEN: (VIDE TABLE NOS. 4-6):

Dissolved oxygen is one vital parameter to determine the quality of water in water bodies to know whether waters are sustainable for aquatic life or not; higher the DO content better is the water. The temperature has profound effect on the DO: as temp increases, the DO content decreases.

In our present study DO content was monitored at the established Station Nos: 1-7 and the obtained results were presented in the Graph Nos. 4. **The following observations are significant:**

- a) Marked depletion of oxygen content between the feeding waters (Station No 1) and out letting waters (Station Nos. 2 and 3) was noted. D.O decreased from Station No 1 to 2 and then there was a slight increase between 2 and 3 stations. (vide Table No. 4: item Nos. 1-3). As for example in the month of April 2014, the DO decreased from 5.5 to 3.7 from Station No 1 to 2 and the DO marginally increased to 3.8 at the Station No.3. The trend was found to be the same in the other months of the study (vide Table No. 4).
- b) In the case of ground waters, D.O. was found to be changed from 2.2 to 4.2 ppm for the stations 4 to 7 in the month of April 14 and the same trend was observed in the remaining months (vide Table Nos.: 4: item Nos.4-7).
- c) The variation of DO content may have to be understood in conjuncture **with variation of temp. at the stations.** *The variation of temperature between the surface stations, 1 and 2 or 1 and 3 in a particular month was about nearly 10 °C (vide Table No. 11).* In other words, the out letting waters from VTPS were always nearly 10° C higher than the normal temperature. *This rise of temperature was decreasing the Dissolved Oxygen content in the waters. This reflects in the loss of ecological balance.*

The decrease of the D.O. content and the rise of the temperature (vide Table No. 11 for thermal pollution) was causing stress on biota and other aquatic life in the canals and in the merging area of the effluent waters in the waters in Krishna river at Station No 3. *In fact no or scanty biota was found along the “Budameru out let Canal of VTPS and further, at the merging point of the canal in the Krishna river at Tummalapalem. It is not out of*

narration to state that even animal are hesitating to get themselves refreshed with pleasant Krishna waters due to enhancement of temp. Even fisher men shifted their catching point of fish very far from the Station No 3 and 4 wherein they used to have a large and variety of catch of fish before the installation of VTPS. Our interaction with the *fisher men* revealed that they are quite *unhappy both with the catch and variety of aquatic life* and in fact *some fish species disappeared from the Krishna waters at the Thummalpalem surrounding due to the stress caused by the depletion of oxygen content and increase of temp.* Thus the VTPS started the cleaning effect of the biota and other aquatic life of Krishna river waters!?.

5: BOD: (vide Table No. 5):

BOD is a measure of the amount of organic pollution in water bodies and it is estimated by complete decomposition or stabilization of all biodegradable organics in a given volume of water by microorganisms: five days of incubation is called as 5-day BOD.

The water samples collected at the Sample Station Nos. 1-7 were analyzed for 5-day BOD. The results obtained were presented in the Table No. 5.

The following observations are significant:

- a. BOD increased for surface water Station Nos. 1, 2 and 3 in any period of study. BOD also varied for a particular surface station seasonally. In the stations 1, 2 and 3, BOD increased progressively from April to August 14 and then decreased.(vide Table No 5).
- b. In the case of ground waters, the samples at Station Nos. 4, and 5 showed relatively lesser values than the Station No. 6 and 7. As for example in April, the BOD values at 4 and 5 stations, were 26.0 ppm and 25.0 ppm respectively while at the Station Nos. 6 and 7, the values were 31.2 and 32.0 respectively (vide Table No. 5:item Nos. 4-7). The same trend was observed for other months of study.
- c. Contrary to the observations made for seasonal variations for the BOD content in the surface waters, the seasonal variations in the ground waters, showed a decreasing BOD values from April to August and then progressively increased (Vide Table No.5)

These trends in observations may be accounted for the possibility of increase of ground water table in rainy season and thereby the pollution is diluted. This is not the case with Surface waters wherein BOD increases progressively from April 14 to August 14 and then decreases. This is obvious because the river waters are more polluted in the rainy season then in other seasons.

6: COD: (vide Table No. 6):

The Chemical Oxygen Demand (COD) measures the oxygen required to oxidize all organics in waters including the non-biodegradable substances and it is estimated by oxidation of organics by using strong oxidizing agents like Potassium Dichromate and the obtained values are always higher than BOD values. BOD procedures require days together while COD can be obtained within a short period of nearly 2hrs. If the BOD/COD ratios is constant for a particular industry, and if the constant is known, just by knowing COD values, BOD values can be calculated. This is the procedure being adopted to calculate BOD quickly by the Industries.

COD values for water samples collected at the Sample Station Nos. 1-7 were presented in *Table No.6.*

The following points are worth noting:

- a. COD values are higher than BOD values at all stations: 1 to 7. For example: the COD values estimated at the Station Nos. 1, 2 and 3 in the months of April, are 38.5, 43.6 and 44.7 ppm respectively and the corresponding BOD values are: 28.1, 33.2 and 35.3 ppm (vide Table No.5: item Nos. 1-3 and Table No. 6: item Nos. 1-3).
 - b. COD values for the Station Nos.2 and 3 were found to be higher than Station No. 1 in any period of time. This indicates that the out-letting waters from the VTPS are relatively more polluted than the in taking waters.
 - c. BOD/COD ratio is not constant indicating variable nature of the pollution
 - d. *Like that of variation of BOD, the COD values varied with time and station.*
- **With time:** In the case of surface water stations: 1, 2 and 3, the COD values were increased from April to August and then decreased. With Ground water Stations Nos. 4, 5, 6 and 7, COD values decreased from April to August and then increased to Dec. (vide Table No. 6).
 - **With Station:** The COD of ground waters in the Station Nos. 4, 5, 6 and 7 were lesser than the COD of surface water stations: 1, 2 and 3 (Table No. 6).

These observations may be understood, in the same lines of discussion made in the case of BOD variations except that the COD values are more than BOD values.

7: HARDNESS OF WATER: (Ca, Mg, and total Hardness)

The presence of Calcium, Magnesium and other heavy metal ion salts cause hardens and the hard waters are unacceptable as they cause boiler troubles besides adverse health effects; waters with more than 300 ppm are hard and less than 75 ppm are soft. These hardness causing minerals enter the water due to the contact of water with soil and rock, especially limestone deposits; ground waters due to their long periods of contact are harder than surface running waters

In the present work the water samples collected at the Sample Station Nos. 1-7 were analyzed for Ca, Mg and Total Hardness and the results obtained were presented in the Table Nos. 7:1-3.

The following results are significant:

- a. The total hardness was found to *be nearly 40 ppm more* for the surface sample Stations 2 and 3 than that of the Station No.1 in a particular period of time. *In other words, the out-letting waters are more contaminated than the in-taking waters with respect the hardness.* As for example in the month of April, the total hardness at the Station No. 1 was 220.0 ppm while it was 260.0 ppm and 259.0 ppm at the Station Nos. 2 and 3 respectively (vide Table No.7:1: item Nos. 1-3). *The trend continued in other periods of analysis.*
- b. The ground water was harder than the surface water. The sample at the stations 4 and 5 showed relatively less hardness than at Station No.6 and 7. As for example in the month of April, the total hardness of water sample at the Station No. 4 and 5 were 321.0 and 365.0 ppm respectively while it was found to be 620 ppm and 710.0 ppm at the Sample stations 6 and 7 respectively (vide Table No. 7:1: item Nos. 4-7). Same is the trend in the other periods for the study.
- c. When the samples were analyzed at different stations in different periods of study for Ca-hardness and Mg-hardness, the following interesting results were found:
 - i. The out-let waters at the Stations 2 and 3 were about 30 to 40 ppm harder than the sample waters at the Station No.1 with respect to Ca-hardness and 10-12 ppm harder with respect to the Mg-hardness. For example in the month of April, the Ca-hardness was found to be 135.0, 175.0 and 174.0 ppm (vide Table No.7:2: item Nos. 1-3) and Mg-hardness 78.0 ppm, 90.0 ppm and 91.0 ppm at the stations 1, 2 and 3 respectively (vide Table No.7:3:item Nos. 1-3). The same trend was observed in the other seasons also both for Ca-hardness and Mg-hardness.
 - ii. The Ca-hardness as well as Mg-hardness showed increasing tendency from April to August and then onwards decreased. As for example at the Station No. 1, the Ca-hardness increased from 135.0 ppm in of April to 152.0 ppm in August and decreased to 130.0 ppm in Dec. 2014 (vide Table No.7:2: item No.1). Similarly, Mg-hardness was found to be increasing 78.0 ppm in the month of April at the Station No 1 to 95.0 ppm in the month of August and then wards, it started decreasing and was 65.0 ppm in the month of Dec. 14 (vide Table No.7:2: item No.1). *This may be attributed to the more flow in Krishna river causing diluting effect on the hardness.*
 - iii. In ground waters, the Sample at 6 and 7 stations were found be more harder than at Samples at 4 and 5 stations both with regard to the Ca-hardness and Mg-hardness. For example in the month of April, Ca-hardness was found to be 230.0, 284.0, 539.0 and 619.0 ppm (vide Table No.7:2: item Nos. 4-7) and Mg-hardness was found to be 87.0, 94.0, 105.0 and 104.0 ppm at the station Nos. 4, 5, 6 and 7 respectively. *This indicates that the ground waters at the station nearer to VTPS namely, 6 and 7 are more polluted than the stations 4 and 5 which were nearer to the Krishna river.*

The inference of the above observations is that the VTPS out-letting waters are harder than in- taking waters and it indicates sufficient treatment is not being given to the waste water by the VTPS before letting into the environment. The ground waters around the areas Jupudi and Seventh Day adventure school are also being polluted by the VTPS.

8. SALINITY (Chlorides) OF WATER: (vide Table No. 8):

Salinity is an ecological factor of great significance to determine potability of water besides influencing the types of organisms and plants that can be grown; plants adapted to saline conditions are called a halophytes and Organisms (mostly bacteria) are classified as extremophiles- organisms that can withstand a wide range of salinities is eurhaline.

The samples of VTPS at the station Nos 1-7 were analyzed for salinity and the results were presented in the Table No. 8. **The following observations are significant:**

a. The out letting waters at the Station Nos. 2 and 3 showed more salinity than in taking waters. The magnitude of enhancement is of the order of **10 to 15 ppm**. *This bears the testimony that the out letting waters are not sufficiently purged.*

b. The ground sample waters at the stations 6 and 7 showed more salinity than sample waters at the station Nos.4 and 5. In line with indications with respect to other parameters, the effect of VTPS on Salinity (chloride) was found to be more at 6 and 7 stations than other Ground water samples as Station No. 4 and 5.

The fact that the salinity (chloride) was found to be more in effluent waters of VTPS than in letting waters and the presence of more content of salt (chloride) in the Ground water samples 6 and 7 indicates that adequate measure are not being followed by VTPS authorities in safe guard the environment.

9. NITROGEN COMPOUNDS:

The toxicity of different forms of nitrogen in water bodies is of the order Nitrite > Ammonia > Nitrates. Nitrites even less than 0.5 is harmful cause methaemoglobin formation in the blood and blocks the oxygen absorption by blood. Ammonia is a strong cell poison and can cause damage to the gills of fish at levels as small as 0.25ppm; clinical signs include (but are not limited to) increased mucus production, red or bleeding gills, darkening of body coloration, 'gasp' for air at the surface and increased respiration rate. Nitrates. Nitrate is reduced to nitrite under reduction conditions and thus obtained Nitrite combines with hemoglobin in the blood resulting methemoglobin.

In the present work the samples at the Station Nos. 1-7, were analyzed for Nitrite, Nitrate and Ammonia and the obtained results were presented in the Table Nos. 9:1-3. **The following interesting results were noted:**

a. The concentration of ammonia at the Sample station No.1 is more than at 2nd and 3rd stations. It is expected because at relatively **high temp. prevailing at 2nd and 3rd stations, the solubility of ammonia decreases and hence ammonia is stripped off (vide Table No. 9:3: item No. 1-3).**

b. The ground waters at the station Nos.6 and 7 are more polluted than 4 and 5 stations with respect to ammonia. The conc. was found to be 0.12, 0.09, 0.34 and 0.28 ppm at the station Nos. 4, 5, 6 and 7 respectively in the month of April (vide Table No. 9:3: item Nos. 4-7). The tendency is same in the other periods of collection.

c. One of the **frightening observation made was that the Nitrite concentration was found in out letting waters (effluents) as well as in ground waters while its concentration was "nil" in in-taking waters (vide Table No. 9:2).** The very fact that the out letting waters was found to have concentration ranging from 0.026 ppm to 0.034 ppm at various periods of study at the Station No.2 and from 0.028 to 0.036 ppm at the Station No.3 **indicated the VTPS pollution with respect to this poisonous ion (vide Table No. 9:2: item Nos. 2 &3).**

d. Further, even the ground water stations were polluted by VTPS with respect to Nitrites. Nitrite concentration varied from 0.012 ppm to 0.023 ppm, 0.013 to 0.021 ppm, 0.02 to 0.04 ppm and 0.022 to 0.42ppm at the ground water sample stations 4, 5, 6 and 7 respectively in the period of study April to Dec. (vide Table Nos. 4-7) **The values obtained suggest that the impact is less at the Station Nos. 4 and 5 which are nearer to the Krishna River than at the station Nos. 6 and 7 which are in the vicinity of the VTPS.**

e. These observations indicates that the VTPS causing grave ground water pollution also especially with respect to Nitrites and thus endangering the lives of dwelling persons in the surrounding areas. **Unless sufficient environmental purification techniques are followed, the Vijayawada city is at the threshold of danger due to the presence of Nitrite ions in water bodies around the VTPS.**

f. **Nitrate** concentrations in out letting waters of VTPS at the Station Nos.2 and 3 were found to be more than in-taking waters, Station No.1 (vide Table No. 9:1). At the Station No. 1, the in-taking water had Nitrate concentration of 5.6 ppm in the month of April while the out let concentrations of Nitrate at the Station Nos. 2 and 3 were found to be 8.2 and 8.1 ppm respectively (vide Table No. 9:1:item No. 1-3). The Concentration of Nitrate at the Sample Stations 1, 2 and 3 was found to be 6.4, 9.1 and 9.0 ppm in the month of May; 6.1, 8.9 and 9.0 ppm in June; 7.6, 9.7 and 9.6 ppm in July; 7.1, 10.1 and 9.9 ppm in August; 7.4, 9.5 and 9.4 ppm in Sept.; 7.2, 10.2 and 10.1 ppm in Oct.; 7.2, 10.4 and 10.1 ppm in Nov.; 6.5, 8.5 and 8.4 ppm in Dec. 14 respectively (vide Table No.9:1:itme Nos. 1-3).

g. Nitrate concentration varied between 5.6 ppm to 7.6 ppm at the Station No. 1, 8.2 to 10.4 ppm at the Station No. 2 and 8.1 to 10.1 ppm at the Station No.3 for the period of study April to Dec 2014 (vide Table No. 9:1:item Nos. 1-3).

h. **The ground water showed the dangerous levels of Nitrate ion concentration.** At the Sample Station 4, the concentration varied from 15.1 to 16.2 ppm for the said period of study. Similarly, the concentration of Nitrate varied from 14.3 to 18.3 ppm, 21.1 to 23.5 ppm, 20.5 to 24.1 ppm at the Sample Stations 4, 5, 6 and 7 respectively for period of study: April 14 to Dec. 14.

i. The pollution due to Nitrate at the sample stations: 6 and 7 is relatively more than at the sample stations 4 and 5 (vide Table No. 9:2: item Nos. 4-7). For example, in April, the concentration of nitrate was found to be 15.1 and 14.3 ppm at the stations 4 and 5 while it was found to be 21.1 and 23.5 ppm at the stations 6 and 7 respectively. Similarly, the conc. are: 15.7, 14.8, 20.9 and 22.5 ppm in May; 16.2, 15.0, 22.1, 23.2 ppm in June; 14.5, 13.9, 22.2 and 21.5 ppm in July; 13.5, 12.9, 21.9 and 20.5 ppm in Aug., 13.2, 16.3, 22.7 and 23.1 ppm in Sept., 15.1, 15.4, 22.9 and 24.1 ppm in Oct., 16.1, 17.2, 23.2 and 23.2 ppm in Nov. and 16.2, 18.3, 23.5 and 21.5 ppm in Dec. respectively for the sample stations 4, 5, 6 and 7.

All these data indicate that VTPS is causing pollution with respect to Nitrogen compounds and the water bodies near the VTPS are under environmental pollution threat of Nitrite and Nitrate contamination.

10. PHOSPHORUS (vide Table No. 10):

Like Nitrogen, Phosphorus, is an essential nutrient that contributes to the growth of algae and the eutrophication of lakes. Phosphorus can enter water from sewage or from agricultural runoff containing fertilizers and animal wastes. Phosphate, the inorganic form of phosphorus, had been commonly used in detergents in the past but even with the ban on phosphate-based detergents, the amount phosphorus occurring water from other sources poses a significant environmental problem. **This parameter was also assessed for the sample waters collected at the station nos. 1-7 in various periods to know the effect of VTPS on the surface and underground waters in the vicinity of VTPS. The results were present in the Table No 10. The following observations are significant:**

- The out letting waters of VPTS at the surface sample stations 2 and 3 were found to have more phosphates than in taking waters. For example, in the month of April the phosphate was found to be 1.8 ppm at the station 1 and at the stations 2 and 3, the phosphate was found to be 2.5 ppm and 2.3 ppm respectively (vide Table No. 10: item Nos. 1-3). Similarly in the other periods of investigation also, the trend was found to be the same. *This indicates that the VTPS is causing phosphate pollution though to a small degree.*
- The concentration of phosphate showed seasonal variation also. The concentration was found to vary from 1.8 to 3.1, 2.5 to 3.8 and 2.3 to 3.7 ppm at the sample stations 1, 2 and 3 respectively during the period of study: April to Dec. 2014.
- In ground waters samples at the stations 4, 5, 6 and 7, the concentration of Phosphate showed more values than surface waters. Further, the samples at the Sample station Nos.6 and 7 (near to VTPS) were found to have relatively more phosphate than at the sample stations 4 and 5 (near to Krishna River).

These observations infer that the VTPS waste waters are also causing Phosphate contamination.

11. THERMAL POLLUTION (vide Table No. 11):

When the hot effluents from thermal stations are discharged into nearby water bodies, aquatic life is destroyed due to the thermal shocks and this is termed as Thermal pollution..

Hence, **in this work a systematic study is made to understand the temperature variations with respects to season and at different stations.** The temperature measurements were made in the surface Station Nos. 1, 2 and 3 and also at four more sampling stations Nos.8, 9, 10 and 11 established at four points on the sectors at 50 meters, 100 meters, 150 meters and 200 meters respectively from the point of merging of out letting hot water with Krishna river water as shown in the Fig No. 1.

The data obtained at various stations was presented in the Table No: 11:

The data indicates:

- at any time, the temp. of the out let (effluent) waters from VTPS either at station No.2 or at station No. 3 are always 7°C to 12°C more than the temp of in taking waters at Station No 1 (vide Table No 11:items:1-3).
- Even gushing waters of Krishna River are not decreasing the content of heat in the waste waters of VTPS quickly and it is due to the fact that waste waters are huge in quantity and so, the temperatures are not coming to the normal quickly. For example, at the sectors at 50, 100, 150 and 200 meters away from merging point, the average temps. of mixed Krishna waters were 49.0°C, 44.9°C, 42.4°C and 41.6°C respectively in the month of April.; 54.2°C, 52.6°C, 51.2°C and 48.3°C in the month of May; 48.5°C, 46.5°C, 44.5°C and 43.5°C in the month of June; 47.5°C, 48.3°C, 43.5°C and 40.0°C in the month July; 45.5°C, 42.5°C, 40.3°C, and 37.5°C in the month of August; 45.0°C, 40.0°C, 35.5°C and 33.0°C in the month of Sept.; 38.0°C, 34.5°C, 31.3°C and 28.0°C in the month of Oct.; 35.0°C, 32.0°C, 29.0°C, and 27.0°C in the month of Nov.; 34.0°C, 31.0°C, 28.0°C and 25.0°C in the month of Dec. 14. (Vide Table No.11: Sample station Nos. 8,9,10 and 11).

c. On comparison of the data at Station No.1 with Station No.11, it was inferred that the temperatures are not coming to the normal even at 200 meters away from the mixing point of hot waters.

d. It is an interesting observation that in the surrounding area of water column around the Station No. 3 extending to about 200 meter scanty is the aquatic life found.

Thus the VTPS effluents are causing thermal pollution especially in a sector of water column around the Tummalapalem discharging point which extends to about 200 meters from the Station No. 3 in the lake resulting 'stratification' of layers and subsequent loss of pond ecological balance and thereby endangering the aquatic life. The increase in temperatures in water bodies, decreases the content of DO in waters but causes the increase in the biological demand of oxygen for aquatic organisms and this results in the stress on the organisms leading to the loss of biota and organisms especially valuable species of fish and it is a common feature especially in summer season to see dead fish floating bally up in water bodies and getting washed to the banks.

Hence, adequate measures are to be taken by VTPS in sufficiently cooling the discharging waters from the thermal stations such that the aquatic life and other biota is allowed to be sustained in the nearby water bodies.

Table 1:1 VARIATION OF pH VALUES

ITEM NO	SAMPLE STATION Nos.		APRIL 14	MAY 14	JUNE 14	JULY 14	AUGUST 14	SEPT 14	OCT 14	NOV 14	DEC 14
1	SURFACE WATER	1	6.8	7.0	7.2	7.4	7.6	7.9	8.0	7.8	8.1
		2	6.9	7.1	7.3	7.5	7.5	7.8	8.1	8.3	8.4
		3	7.1	7.4	7.8	7.9	8.2	8.3	8.4	8.4	8.5
4	GROUND WATERS	4	6.7	6.9	7.1	7.2	7.3	7.4	7.3	7.4	7.5
		5	6.8	6.9	7.1	7.3	7.4	7.3	7.5	7.6	7.6
		6	6.9	7.0	7.0	7.1	7.2	7.4	7.3	7.6	7.7
		7	7.1	7.3	7.4	7.5	7.6	7.6	7.7	7.5	7.8

TABLE No: 1:2: VARIATION OF TOTAL ALKALINITY

ITEM NO	SAMPLE STATION Nos.		TOTAL ALKALINITY IN PPM								
			APRIL 14	MAY 14	JUNE 14	JULY 14	AUGUST 14	SEPT 14	OCT 14	NOV 14	DEC 14
1	SURFACE WATER	1	200.0	205.2	210.3	215.3	220.2	225.2	230.3	235.6	240.9
		2	211.2	216.5	222.2	226.2	231.2	236.5	242.5	247.2	251.5
		3	210.2	215.5	221.3	220.2	227.2	234.2	241.0	246.0	250.0
4	GROUND WATERS	4	272.2	278.2	284.2	290.5	296.2	302.3	308.0	314.1	320.1
		5	342.0	348.2	354.2	360.3	366.1	372.0	378.2	384.2	390.2
		6	632.0	638.2	644.8	650.8	656.9	662.7	668.4	674.5	680.0
		7	512.2	518.2	524.3	530.2	536.5	542.2	548.0	554.0	560.2

Table 2: VARIATION OF CONDUCTIVITY (in μ S)

ITEM NO	SAMPLE STATION Nos.		APRIL 14	MAY 14	JUNE 14	JULY 14	AUGUST 14	SEPT 14	OCT 14	NOV 14	DEC 14
1	SURFACE WATER	1	542	544	547	549	551	554	556	559	561
		2	561	563	566	568	570	573	575	578	580
		3	565	567	570	572	574	577	579	582	584
4	GROUND WATERS	4	935	937	940	944	947	949	951	954	956
		5	2390	2407	2416	2420	2430	2440	2446	2450	2460
		6	2185	2193	2205	2219	2226	2236	2246	2250	2260
		7	1398	1407	1416	1425	1435	1446	1456	1460	1480

Table No. 3:1: VARIATION OF TOTAL DISSOLVED SOLIDS (TDS) (in ppm)

ITEM NO	SAMPLE STATION Nos.		APRIL 14	MAY 14	JUNE 14	JULY 14	AUGUST 14	SEPT 14	OCT 14	NOV 14	DEC 14
1	SURFACE WATERS	1	320	332	340	349	358	368	379	389	395
2		2	321	332	341	350	358	369	380	390	400
3		3	321	332	341	350	358	369	379	390	405
4	GROUND WATERS	4	579	588	597	605	614	623	641	650	660
5		5	1618	1629	1640	1649	1660	1666	1675	1684	1695
6		6	1450	1457	1468	1474	1482	1491	1502	1511	1520
7		7	904	913	914	933	942	952	959	970	980

Table No. 3:2 : VARIATION OF TOTAL SUSPENDED SOLIDS (TSS) (in ppm)

ITEM NO	SAMPLE STATION Nos.		APRIL 14	MAY 14	JUNE 14	JULY 14	AUGUST 14	SEPT 14	OCT 14	NOV 14	DEC 14
1	SURFACE WATERS	1	3	3.1	3.3	3.5	4	4.3	4.6	4.9	5
2		2	6	6.2	6.4	6.8	7	7.3	7.6	7.9	8
3		3	8	8.1	8.3	8.5	9	9.3	9.6	9.85	10
4	GROUND WATERS	4	6	6.2	6.4	6.8	7	7.3	7.6	7.85	8
5		5	7.9	8	8.2	8.4	8.9	9.2	9.5	9.75	10
6		6	7.8	7.9	8.1	8.3	8.8	9.1	9.4	9.65	10
7		7	12.8	12.9	13.1	13.3	13.8	14.1	14.4	14.65	15

Table No. 3:3: VARIATION OF TOTAL SOLIDS (TS) (in ppm)

ITEM NO	SAMPLE STATION Nos.		APRIL 14	MAY 14	JUNE 14	JULY 14	AUGUST 14	SEPT 14	OCT 14	NOV 14	DEC 14
1	SURFACE WATERS	1	324	335	344	353	362	373	384	395	400
2		2	327	338	347	356	365	376	387	398	408
3		3	329	340	349	358	367	378	389	400	415
4	GROUND WATERS	4	585	594	603	612	621	630	649	658	668
5		5	1626	1637	1648	1657	1669	1676	1685	1694	1705
6		6	1458	1465	1476	1482	1491	1501	1512	1521	1530
7		7	917	926	937	946	955	964	973	984	995

Table No. 4: VARIATION OF DISSOLVED OXYGEN (DO) (in ppm)

ITEM NO	SAMPLE STATION Nos.		APRIL 08	MAY 08	JUNE 08	JULY 08	AUGUST 08	SEPT 08	OCT 08	NOV 08	DEC 08
1	SURFACE WATERS	1	5.5	5.8	4.9	4.8	5.2	5.5	5.8	6.0	6.0
2		2	3.7	3.8	3.9	4.0	4.2	4.3	4.3	4.4	4.4
3		3	3.8	3.9	4.1	4.2	4.2	4.4	4.4	4.5	4.5
4	GROUND WATERS	4	2.2	2.39	2.6	2.7	2.9	3.1	3.3	3.6	3.8
5		5	3.21	3.43	3.65	3.86	4.07	4.29	4.5	4.7	4.9
6		6	4.0	4.12	4.32	4.56	4.76	4.97	5.19	5.4	5.6
7		7	4.2	4.32	4.52	4.76	4.96	5.17	5.39	5.6	5.8

Table No. 5: VARIATION OF BIOLOGICAL OXYGEN DEMAND (BOD) (in ppm)

ITEM NO	SAMPLE STATION Nos.	APRIL 14	MAY 14	JUNE 14	JULY 14	AUGUST 14	SEPT 14	OCT 14	NOV 14	DEC 14	
1	SURFACE WATERS	1	28.1	33.2	38.2	44.1	50.5	45.1	41.1	38.1	35.2
2		2	33.2	36.3	39.2	42.3	45.6	43.3	42.3	42.2	42.3
3		3	35.3	38.3	41.3	44.4	47.2	46.7	45.2	44.3	43.1
4	GROUND WATERS	4	26	24	22	20	17	18.25	19.5	20.75	22
5		5	25	23	21	20	19	20	21	22	23
6		6	31	29.5	28	26.5	25	26	28	30	32
7		7	32	30	28	26	24	27	30	32	34

Table No. 6: VARIATION OF CHEMICAL OXYGEN DEMAND (in ppm)

ITEM NO	SAMPLE STATION Nos.	APRIL 08	MAY 08	JUNE 08	JULY 08	AUGUST 08	SEPT 08	OCT 08	NOV 08	DEC 08	
1	SURFACE WATERS	1	38.5	43.2	48.1	54.2	60.2	57.2	54.2	49.2	45.2
2		2	43.6	45.1	49.2	52.1	55.3	54.1	53.3	53.3	52.3
3		3	44.7	46.1	52.3	55.4	57.1	56.1	55.2	54.4	54.2
4	GROUND WATERS	4	32.1	31.2	29.1	27.2	25.2	27.1	28.3	29.4	30.1
5		5	33.2	32.1	29.3	28.2	27.1	28.3	29.5	30.4	31.2
6		6	37.2	37.2	36.3	34.2	32.2	34.3	37.2	38.2	40.3
7		7	36.4	38.4	37.2	35.2	32.3	35.2	38.3	41.2	42.2

Table No. 7:1: VARIATION OF TOTAL HARDNESS (in ppm)

ITEM NO	SAMPLE STATION Nos.	APRIL 14	MAY 14	JUNE 14	JULY 14	AUGUST 14	SEPT 14	OCT 14	NOV 14	DEC 14	
1	SURFACE WATERS	1	220	234	239	241	243	231	220	212	200
2		2	260	265	271	277	278	261	257	251	250
3		3	259	265	270	278	279	271	263	257	248
4	GROUND WATERS	4	321	324	315	308	310	307	325	315	310
5		5	365	362	351	349	368	369	372	365	370
6		6	620	631	645	651	641	639	642	647	650
7		7	710	712	701	692	722	725	710	714	720

Table No. 7:2: VARIATION OF CALCIUM HARDNESS (in ppm)

ITEM NO	SAMPLE STATION Nos.	APRIL 14	MAY 14	JUNE 14	JULY 14	AUGUST 14	SEPT 14	OCT 14	NOV 14	DEC 14	
1	SURFACE WATERS	1	135	141	147	149	152	145	139	135	130
2		2	175	182	189	191	193	192	179	175	170
3		3	174	181	187	190	192	190	176	171	171
4	GROUND WATERS	4	230	220.3	227.5	225.3	225	223.75	222.5	221.25	220
5		5	284	282.8	281.5	280.3	279	277.8	276.5	275.3	274
6		6	539	538.5	538	537.5	537	536.5	536	535.5	535
7		7	619	618	617	616	615	614	613	612.5	612

Table No. 7:3: VARIATION OF MAGNESIUM HARDNESS (in ppm)

ITEM NO	SAMPLE STATION Nos.		APRIL 14	MAY 14	JUNE 14	JULY 14	AUGUST 14	SEPT 14	OCT 14	NOV 14	DEC 14
1	SURFACE WATERS	1	78	84	90	94	95	88	81	73	65
2		2	90	96	102	106	107	100	93	85	77
3		3	91	95	101	104	108	97	93	83	73
4	GROUND WATERS	4	87	95.5	87.5	81.8	85	83.3	92.5	93.8	85
5		5	94	79	69	68	89	91	95	89	91
6		6	105	92	107	113	104	102.5	106	111.5	102
7		7	104	94	84	76	97	101	97	101.5	105

Table No. 8: VARIATION OF SALINITY (Chloride) (in ppm)

ITEM NO	SAMPLE STATION Nos.		APRIL 14	MAY 14	JUNE 14	JULY 14	AUGUST 14	SEPT 14	OCT 14	NOV 14	DEC 14
1	SURFACE WATERS	1	67	67.9	69.5	70.87	71.9	72.9	73	74	75
2		2	77.3	78.2	79.8	80.9	82.1	83.1	83.3	84.3	85.3
3		3	82.2	83.1	84.7	85.8	87	88	88.2	89.2	90.4
4	GROUND WATERS	4	68	74	80	85	90	96	100	105	110
5		5	163	169	175	180	185	191	195	200	205
6		6	318	324	330	335	340	346	350	355	360
7		7	108	114	120	125	130	136	140	145	150

Table No. 9:1: VARIATION OF NITRATES (in ppm)

ITEM NO	SAMPLE STATION Nos.		APRIL 14	MAY 14	JUNE 14	JULY 14	AUGUST 14	SEPT 14	OCT 14	NOV 14	DEC 14
1	SURFACE WATERS	1	5.6	6.4	6.1	7.6	7.1	7.4	7.2	7	6.5
2		2	8.2	9.1	8.9	9.7	10.1	9.5	10.2	10.4	8.5
3		3	8.1	9	9	9.6	9.9	9.4	10.1	10.1	8.4
4	GROUND WATERS	4	15.1	15.7	16.2	14.5	13.5	13.2	15.1	16.1	16.2
5		5	14.3	14.8	15	13.9	12.9	16.3	15.4	17.2	18.3
6		6	21.1	20.9	22.1	22.2	21.9	22.7	22.9	23.2	23.5
7		7	23.5	22.5	23.2	21.5	20.5	23.1	24.1	23.2	21.5

Table No. 9:2: VARIATION OF NITRITES (in ppm)

ITEM NO	SAMPLE STATION Nos.		APRIL 14	MAY 14	JUNE 14	JULY 14	AUGUST 14	SEPT 14	OCT 14	NOV 14	DEC 14
1	SURFACE WATERS	1	NILL	NILL	NILL	NILL	NILL	NILL	NILL	NILL	NILL
2		2	0.026	0.027	0.028	0.029	0.03	0.031	0.032	0.033	0.034
3		3	0.028	0.029	0.03	0.031	0.032	0.033	0.034	0.035	0.036
4	GROUND WATERS	4	0.014	0.012	0.016	0.014	0.016	0.020	0.018	0.022	0.023
5		5	0.013	0.014	0.018	0.017	0.019	0.019	0.016	0.018	0.021
6		6	0.020	0.021	0.034	0.035	0.036	0.037	0.038	0.039	0.040
7		7	0.022	0.023	0.036	0.037	0.038	0.039	0.040	0.041	0.042

Table No. 9:3: VARIATION OF AMMONIA (in ppm)

ITEM NO	SAMPLE STATION Nos.	APRIL 14	MAY 14	JUNE 14	JULY 14	AUGUST 14	SEPT 14	OCT 14	NOV 14	DEC 14	
1	SURFACE WATERS	1	0.95	0.92	1.1	1.2	0.8	0.9	0.85	0.75	0.67
		2	0.24	0.31	0.18	0.23	0.12	0.18	0.26	0.28	0.14
		3	0.20	0.28	0.11	0.19	0.08	0.13	0.19	0.23	0.12
4	GROUND WATERS	4	0.12	0.13	0.14	0.18	0.03	0.07	0.05	0.16	0.18
		5	0.09	0.08	0.12	0.14	0.10	0.11	0.12	0.09	0.15
		6	0.34	0.29	0.36	0.40	0.42	0.46	0.38	0.36	0.34
		7	0.28	0.25	0.26	0.31	0.28	0.34	0.19	0.18	0.17

Table No. 10: VARIATION OF PHOSPHATE (in ppm)

ITEM NO	SAMPLE STATION Nos.	APRIL 14	MAY 14	JUNE 14	JULY 14	AUGUST 14	SEPT 14	OCT 14	NOV 14	DEC 14	
1	SURFACE WATERS	1	1.8	2	2.2	2.2	3.2	2.6	2.8	3	3.1
		2	2.5	2.9	3.1	2.9	3.9	3.4	3.3	3.9	3.8
		3	2.3	2.8	3.2	3	3.8	3.5	3.2	3.9	3.7
4	GROUND WATERS	4	4.4	4.6	3.9	4.2	4.3	3.9	3.8	4.2	4.3
		5	4.6	4.7	3.8	4.1	4	3.8	4.1	4.4	3.9
		6	5.6	5.5	5.1	5.4	4.8	4.4	4.8	4.9	4.8
		7	5.8	5.6	4.9	5.3	4.7	4.8	5	5.2	4.9

TABLE No: 11: VARIATION OF TEMPERATURES (in °C)

ITEM NO	SAMPLE STATION Nos.	TEMPERATURE IN °C									
		APRIL 14	MAY 14	JUNE 14	JULY 14	AUGUST 14	SEPT 14	OCT 14	NOV 14	DEC 14	
1	SURFACE WATERS	1	40.2	41.0	40.5	38.5	37.2	32.4	29.0	24.6	24.0
		2	54.2	58.0	55.0	51.5	48.5	44.6	41.5	37.5	36.0
		3	53.1	55.8	52.1	49.5	48.0	44.0	39.8	35.5	35.0
4	GROUND WATERS	8	49.0	54.2	48.5	47.5	45.5	45.0	38.0	35.0	34.0
		9	44.9	52.6	46.5	45.3	42.5	40.0	34.5	32.0	31.0
		10	42.4	51.2	44.5	43.5	40.3	35.5	31.3	29.0	28.0
		11	41.6	48.3	43.5	40.0	37.5	33.0	28.0	27.0	25.0

CONCLUSION

In the present study, the quality of water in the water bodies in the vicinity of VTPS has been assessed continuously for a period of 9 months with respect to various physicochemical parameters such as pH, alkalinity, conductivity, DO, BOD, COD, solids (dissolved, suspending and total), hardness (Ca, Mg, and total), salinity (Chloride content), Nitrogen compounds (Nitrites, Nitrates & Ammonia) and Phosphate. Further thermal pollution caused by the effluents from the VTPS in the nearby water bodies has also been monitored in the said period. The observations and inferences have been presented at relevant places under 'results and discussions' in above text.

The present study indicates that the surface and ground waters are being polluted by the effluents from VTPS endangering the people dwelling in the nearby areas. It is very surprising to note that the effluents from the VTPS are being discharged into the up-side stream (and not down-side) of Krishna river from the Prakasham Barrage and thereby polluting the stagnated lake waters of the barrage, which is severing the water requirements of six districts through three major canals, viz., Eluru, Bandar and Bahimhang canals and for which the prosperity in this area is attributed. The contamination waters is effecting the "health and wealth" of the people dwelling in these areas. Generally power station effluents are merged either into sea, or into the down waters of stream or river and not in lakes serving the drinking needs of habitations.

If the receiving water bodies of the effluent are reservoirs or lakes as that of VTPS,, water environment is intensively affected due to the stagnation of waters in the reservoir or lakes and it will turn to be a proverbial "bowel" collecting impurities to "hand-over" them to the habitations which depends upon the gift of nature, "Water"

and thereby the so called “sign posts” of human development, thermal power stations, turn into the “dangerous signals” directing to “human graves”. The Power Plants should be “boon” to the people” and not “bane”.

So, the effluent waters from VTPS are to be sufficiently treated before discharging into the water bodies because the impurities entered into the waters get accumulated during the course of time through the processes such as ‘bio-amplification’, especially with respect to the non-degradable ions and further, the effluents are to be sufficiently cooled to avoid thermal pollution.

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REFERENCES

- [1] S.C. Bhattacharyya, *Int. J. Energy Res.*, **21**, 287 (1997).
- [2] R. Mohapatra and J.R. Rao, *J. Chem. Biotechnol.*, **76**, 9 (2001).
- [3] S.K. Dhadse and L.J. Bhagia, *J. Sci. Ind. Res.*, **67**, 11 (2008).
- [4] I.V. Suresh, C. Padmakar, Prabha Padmakaran, M.V.R.L. Murthy, C.B. Raju, R.N. Yadava and K. Venkata Rao, *Environ. Manage. Health*, **9**, 200 (1998).
- [5] Y. Benito, M. Ruiz, P. Cosmen and L.J. Merino, *Chem. Eng. J.*, **84**, 167 (2001).
- [6] K.B. Dutta, S. Khanra and D. Mallick, *Fuel*, **88**, 1314 (2009).
- [7] D.C. Adriano, A.L. Page, A.A. Elseewi, A.C. Chang and I. Straughan, *J. Environ. Qual.*, **9**, 33 (1980).
- [8] S.V. Mattigod, G. Sposito and A.L. Page, Factors Affecting the Solubilities of Trace Metals in Soils, Chemistry in the Environment, American Society of Agronomy, Soil Science Society of America, ASA Special Publication No. 40 (1980).
- [9] D.S. Cherry, R.K. Guthrie, J.H. Rogers, J. Cairns and K.L. Dickson, *Trans. Am. Fish. Soc.*, **105**, 686 (1976).
- [10] D.S. Cherry and R.K. Guthrie, *Water Air Soil Pollut.*, **9**, 403 (1978).
- [11] D.S. Cherry, R.K. Guthrie, S.R. Larrick and F.F. Sherberg, *Hydrobiologia*, **62**, 253 (1979).
- [12] R.K. Guthrie, D.S. Cherry, E.M. Davis and H.E. Murray, In eds.: J. M. Bates and C.I. Weber, Establishment of Biotic Communities within a Newly Constructed Ash Settling Basin and Its Drainage System, Stream Channelization, A Symposium, ASTM STP730, American Society of Testing and Materials, Philadelphia, pp. 243-294 (1981).
- [13] W.L. Specht, D.S. Cherry, R.A. Lechleitner and J. Cairns, *Can. J. Fish Aquat. Sci.*, **41**, 884 (1984).
- [14] J.H. Van Hassel and K.V. Wood, *J. Fresh Water Ecol.*, **2**, 571 (1984).
- [15] P. Padmakaran, C.B. Raju and A. Subba Rao, *Clay Res.*, **13**, 30 (1994).
- [16] C.L. Ram, K.N. Srivastava, C.R. Tripathi, K.S. Thakur, K.A. Sinha, K.A. Jha, E.R. Masto and S. Mitra, *Environ. Geol.*, **51**, 1119 (2007).
- [17] R.K. Dart and R.J. Stretton, Thermal Pollution, in Microbiological Aspects of Pollution Control, Elsevier, Amsterdam, pp. 185-191 (1980).
- [18] V.A. Kyakk, *J. Thermal Eng.*, **49**, 306 (2002).
- [19] K.V.K. Nair, Impact of a Nuclear Power Station on the Hydrobiological Characteristics of Katpakkam Waters, Proc. Sea Water Qual. Demands Natl. Chem. Methodological Laboratory, Bombay (1985).
- [20] M.H. Fulekar, *Indian J. Environ. Protection*, **13**, 185 (1993).
- [21] K. Fytianos, B. Tsaniklidi and E. Voudrias, *Environ. Int.*, **24**, 477 (1998).
- [22] T. Prahraj, M.A. Powell, B.R. Hart and S. Tripathy, *Environ. Int.*, **27**, 609 (2002).
- [23] C.B. Patel and G.S. Pandey, *Sci. Total Environ.*, **57**, 67 (1986).
- [24] P. Chugh, Fly Ash Utilization USA, Present in the Seminar on ‘Fly Ash Utilisation’ held at New Delh (India), pp. 26-27, March (1996).
- [25] A.F. D'yakov, I.V. Gordin, A.P. Bersenev and B.S. Fedoseev, The Environmental Control Activities of Thermal Power stations in Protecting Reservoirs, Thermal Engineering ISSN 0040-6015, Vol. 44, pp. 967-973 (8 ref. in it) (1997)
- [26] ISI, Drinking Water Standards, Indian Standard Institute Publication No 10500 (1983).
- [27] H.A. VanderSloot and B.J.T. Nieuwendijk, In eds.: I.W. Duedall, D.R. Kester, R.K. Park and B.H. Ketchum, Release of Trace Elements from Surface-Enriched Fly Ash in Seawater, Waste in the Ocean, 4, Wiley, New York, p. 818 (1985).
- [28] T.M. Florens, *Water Res.*, **11**, 681 (1977).
- [29] B. Subramanian, S.K. Prabu and A. Mahadevan, *Water Air Soil Pollut.*, **53**, 131 (1990)

- [30] L.S. Clesceri, A.E. Greenberg and A.D. Easton, Standard Methods for the Examination of Water and Wastewater, American Public Health Association, Washington D.C., edn. 20 (1998).
- [31] P.M.J. Woodhead, J.H. Parker and I.W. Parker, *Mar. Fish. Rev.*, **44**, 16 (1982).
- [32] G.H. Jeffery, J. Bassett, J. Menddham and R.C. Denney, Vogel's Text Book of Quantitative Chemical Analysis, edn 5, ELSS (1989).
- [33] D.S. Ramteke, and C.A. Moghe, **1988**. Manual on water and wastewater analysis. National Environmental Engineering Research Institute (NEERI), Nagpur.
- [34] M. Sunil Kumar and Shailaja, R., **1998**. Water studies: Methods for monitoring water quality. Center for Environmental Education, Bangalore