RJC

RASĀYAN *J. Chem.*
Vol. 9 | No. 4 |858 - 863 | October - December | 2016
ISSN: 0974-1496 | e-ISSN: 0976-0083 | CODEN: RJCABP
http://www.rasayanjournal.com
http://www.rasayanjournal.co.in

SEASONAL VARIATIONS IN PHYSICO-CHEMICAL CHARACTERISTICS OF GROUND WATER COLLECTED FROM KONDAPALLI SANTHI NAGAR NEAR VIJAYAWADA THERMAL POWER PLANT (VTPS)

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ABSTRACT
Vijayawada Thermal Power Plant (VTPS) is one of the major sources of electricity to Andhra Pradesh state. It is located in Kondapalli village on Vijayawada-Hyderabad National Highway. In VTPS electricity is produced by rotation of turbines with the steam of Krishna river water. In the present study ground water samples were collected from Kondapalli Santhi Nagar near VTPS-Vijayawada, Krishna District to evaluate physicochemical parameters. The investigation reveals that the Kondapalli Santhi Nagar has a little impact by the effluents of VTPS on ground water. There is no much deviation from IS: 10500: 2012 drinking water standards except Fluoride, Pb, and Cr. But these three parameters have impact on human health in long period.
Keywords: VTPS, Santhi Nagar, Physico-chemical properties, Heavy metals.

INTRODUCTION

Vijayawada Thermal Power Plant (VTPS) is now called as Dr. Narla Tata Rao Thermal Power Plant. VTPS is one of the major sources of electricity to Andhra Pradesh state. It is located in Kondapalli village on Vijayawada-Hyderabad National Highway. Approximately 13 villages exist around VTPS. In VTPS electricity is produced by rotation of turbines with the steam of Krishna river water. In this process water was steam is produced by burning of Coal in huge amount.

In this continuous process the by-products so formed are causing environment (Air, water, Soil) pollution. In the present study we are examined the Physicochemical parameters of ground water and VTPS pollution impact on ground water of Kondapalli Santhi Nagar(KPSN) which is near VTPS.

Open fly ash dump yards and coal burning are major causes of pollution nearby thermal power plants. Burning of coal and its smoke was identified as significant threat to the environment. Present study was carried out to determine the physic chemical characteristics of ground water of Santhi Nagar nearby VTPS-Vijayawada, in three seasons

Study Area

In this study the samples of 3 season's (Monsoon-2013, Winter-2014, Summer-2014) samples were collected from Kondapalli Santhi Nagar (KPSN), the sampling locations are given in Table-1. Location is shown in Fig.-1.

Table-1: Sampling Locations

1	KPSN-1	80º 32' 24.19E	16º 36' 49.48N
2	KPSN-2	80º 32' 42.52E	16º 37' 20.41N
3	KPSN-3	80º 32'32.23E	16º 37' 19.0N
4	KPSN-4	80º 32'31.78E	16º 37' 18.63N
5	KPSN-5	80º 32'30.99E	16º 37' 17.13N
6	KPSN-6	80º 32' 24.16E	16º 37' 58.19N

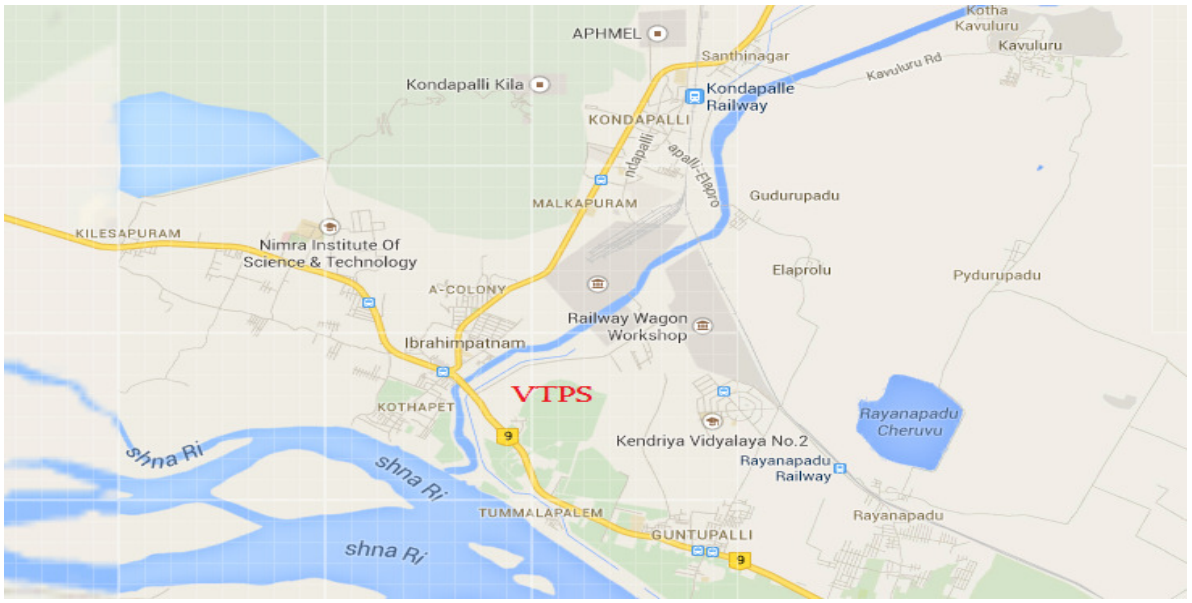

Fig.-1: Location of VTPS nearby National Highway-9 and Krishna River

EXPERIMENTAL

Sample Collection

The samples were collected and stored in clean polythene bottles fitted with screw cap and brought to the laboratory in the sampling for detailed physico-chemical analysis. [1-5] The water samples were collected in a separate clean bottle and acidified with nitric acid to a pH below 2.0 to minimise precipitation and adsorption of certain cations such as aluminium, cadmium, copper, iron, lead, manganese, silver and zinc.

Chemical: All the Chemicals were used analytical grade from local vendor in Vijayawada.
Instruments: The list of equipment for this study shown in Table-2.

Table-2: List of Equipment

S.No.	Instrument	Make and Model number
1	pH Meter	Elico
2	Electrical Conductivity Meter	Elico
3	U.V-Visible Spectrophotometer	Tech comp, 2301,Hitachi software
4	Ion Selective Electrode Meter	Elico
5	Atomic Absorption Spectrometer	LABINDIA-7000
6	Electrical Balance	Denver-A200DS
7	Flame photometer	Electronics India- 1385

Water samples were analysed by standard methods. The type of methods are given in Table-3.

Table-3: Drinking water permissible and required parameters and List of methods

Test Parameter(s)	Test Method	Requirement acceptable Limit as per IS: 10500: 2012	Permissible Limit in Alternative source as per IS 10500:2012
pH	4500. H^+B	6.5 to 8.5	No relaxation
Color	2120. B	5	15
Odor	2150. B	Agreeable	Agreeable
Electrical Conductivity	2510-B		
Total Dissolved Solids 180ºC	2540. C	500	2000

Turbidity	2130. B	1	5
Total Hardness as $CaCO_3$	2340. C	200	600
Calcium as Ca	3500. Ca.B	75	200
Magnesium as Mg	3500. Mg.B	30	100
Total Alkalinity as $CaCO_3$	2320. B	200	600
Chlorides as Cl^-	4500. Cl^-.B	250	1000
Sulphates as SO_4	4500. SO_4^{2-}.E	200	400
Chemical Oxygen Demand	5220. B	-	-
Biochemical Oxygen Demand	IS: 3025	-	-
Dissolved Oxygen	4500. O.C		
Fluoride as F^-	4500. F^-.C	1	1.5
Nitrates as NO_3^-	4500. NO_3^-.B	45	No relaxation
Sodium as Na	3500-Na.B		
Potassium as K	3500-K.B		
Cadmium as Cd	APHA 3111B/3030E	0.003	No relaxation
Mercury as Hg	APHA 3111B/3030E	0.001	No relaxation
Arsenic as As	APHA 3111D/3030E	0.07	No relaxation
Lead as pb	APHA 3111B/3030E	0.01	No relaxation
Total Chromium as Cr	APHA 3111B/3030E	0.05	No relaxation
Iron as Fe	APHA 3111B/3030E	0.3	No relaxation
Manganese as Mn	APHA 3111B/3030E	0.1	0.3
Copper as Cu	APHA 3111B/3030E	0.05	1.5

RESULTS AND DISCUSSION

The physico-chemical qualities of the ground water samples of KPSN are investigated, and the level of metal ions estimated. The obtained results are compared with IS 10500:2012 drinking water standards. The IS 10500:2012 drinking water standards [6] are given in Table-3. The concentrations of the most significant pollutants in the various seasons were shown in Table-4, 5 and 6.

Table-4: Physico and chemical parameters Kondapalli SanthiNagar, nearby VTPS-Vijayawada in Monsoon-2013

Test Parameter(s)	Unit	Results					
		KPSN-1	KPSN-2	KPSN-3	KPSN-4	KPSN-5	KPSN-6
pH	--	7.8	7.1	7.2	7.4	7.2	7.6
Color	Pt.Co	<5	<4	<5	<5	<5	<5
Odor	TON	No Odor	No Odor	No Odor	No Odor	No Odor	No Odor
Electrical Conductivity	µmos/cm	1845	2440	2202	2115	2260	1950
Total Dissolved Solids at 180ºC	mg/L	1506	1550	1250	1350	1560	1410
Turbidity	NTU	2.10	3.10	3.52	3.10	1.95	3.10
Total Hardness as $CaCO_3$	mg/L	440	430	420	410	390	370
Calcium as Ca	mg/L	105	95	110	90	85	80
Magnesium as Mg	mg/L	40	50	40	45	40	35
Total Alkalinity as	mg/L	310	320	350	370	390	370

$CaCO_3$							
Chlorides as Cl^-	mg/L	495	580	460	490	550	555
Sulphates as SO_4	mg/L	330	310	320	370	360	345
Chemical Oxygen Demand	mg/L	<5	<5	<5	9.8	<5	<5
Biochemical Oxygen Demand	mg/L	BDL	BDL	BDL	BDL	BDL	BDL
Dissolved Oxygen	mg/L	4.4	4.1	4.3	4.6	4.2	4.4
Fluoride as F^-	mg/L	3.5	1.1	1.4	2.6	1.7	1.3l
Nitrates as NO_3^-	mg/L	40	44	59	62	45	60
Sodium as Na	mg/L	90	85	90	85	90	80
Potassium as K	mg/L	2	3	4	5	4	5
Cadmium as Cd	mg/L	BDL	BDL	BDL	BDL	BDL	BDL
Mercury as Hg	mg/L	BDL	BDL	BDL	BDL	BDL	BDL
Arsenic as As	mg/L	BDL	BDL	BDL	BDL	BDL	BDL
Lead as pb	Mg/L	BDL	BDL	BDL	BDL	BDL	BDL
Total Chromium as Cr	mg/L	0.16	BDL	0.07	1.2	0.09	0.01
Iron as Fe	mg/L	0.45	0.42	0.40	0.39	0.35	0.40
Manganese as Mn	mg/L	BDL	BDL	0.1	0.1	0.1	BDL
Copper as Cu	mg/L	BDL	BDL	BDL	0.02	BDL	0.03

Table-5: Physico and chemical parameters Kondapalli SanthiNagar nearby VTPS-Vijayawada in Winter-2014

Test Parameter(s)	Unit	Results					
		KPSN-1	KPSN-2	KPSN-3	KPSN-4	KPSN-5	KPSN-6
pH	--	8.2	7.3	7.4	7.8	7.5	8.1
Color	Pt.Co	<5	<4	<5	<5	<5	<5
Odor	TON	No Odor	No Odor	No Odor	No Odor	No Odor	No Odor
Electrical Conductivity	µmos/cm	1877	2501	2439	2318	2539	2102
Total Dissolved Solids at 180ºC	mg/L	1498	1661	1359	1402	1627	1460
Turbidity	NTU	2.13	3.19	4.12	2.23	2.19	3.26
Total Hardness as $CaCO_3$	mg/L	468	461	437	448	401	392
Calcium as Ca	mg/L	117	99	127	102	99	104
Magnesium as Mg	mg/L	45	57	48	53	49	42
Total Alkalinity as $CaCO_3$	mg/L	323	341	371	398	403	393
Chlorides as Cl^-	mg/L	501	604	489	514	563	578
Sulphates as SO_4	mg/L	341	338	351	391	393	397
Chemical Oxygen Demand	mg/L	<5	<5	<5	9.8	<5	<5
Biochemical Oxygen Demand	mg/L	BDL	BDL	BDL	BDL	BDL	BDL
Dissolved Oxygen	mg/L	4.4	4.1	4.3	4.6	4.2	4.4
Fluoride as F^-	mg/L	1.47	1.40	1.42	1.38	1.45	1.47
Nitrates as NO_3^-	mg/L	47	48	50	49	53	52
Sodium as Na	mg/L	101	93	111	109	96	99
Potassium as K	mg/L	3	4	5	7	6	7
Cadmium as Cd	mg/L	BDL	BDL	BDL	BDL	BDL	BDL
Mercury as Hg	mg/L	BDL	BDL	BDL	BDL	BDL	BDL
Arsenic as As	mg/L	BDL	BDL	BDL	BDL	BDL	BDL
Lead as pb	Mg/L	BDL	BDL	BDL	BDL	BDL	BDL
Total Chromium as Cr	mg/L	BDL	BDL	0.05	BDL	0.06	BDL

Iron as Fe	mg/L	0.49	0.46	0.47	0.43	0.46	0.49
Manganese as Mn	mg/L	BDL	BDL	0.1	BDL	0.1	BDL
Copper as Cu	mg/L	BDL	BDL	BDL	0.05	BDL	0.05

There is a significant change in the pH value during the observation periods, the observed values are in the range 7.1(KPSN-26) to 7.8(KPSN-1) in Monsoon-2013, 7.3(KPSN-2) to 8.2(KPSN-1) in winter-2014, 7.7(KPSN-2) to 8.3(KPSN-1) in summer- 2014. The period of summer has high pH: It may be due to high temperature in summer.[7] EC values are in the range of 1845(KPSN-1)-2440(KPSN-2) micro omhos/cm in monsoon, 1877(KPSN-1)-2539(KPSN-2) micro omhos/cm and in summer 1997(KPSN-1)-2732(KPSN-2) micro omhos/cm. High EC values were observed for all the samples indicating the presence of high amount of dissolved inorganic substances in ionized form the higher electrical conductivity affected the germination of crops resulting reduced yield. [8] The TDS is found up to 1560mg/l – KPSN-5 in monsoon season, 1661mg/l-KPSN-2 in winter-2014 and 1890mg/l-KPSN-2 in summer-2014. There is a considerable change in hardness; the observed values are 370(KPSN-6) -440(KPSN-1) mg/ml in monsoon-2013, 392(KPSN-6)-468(KPSN-1) mg/ml in winter-2014, 471(KPSN-5)-526(KPSN-4) mg/ml in summer.

There is a little change in the samples in summer- 2014 because of temperature. There is no turbidity in all places in all seasons. Concentration of nutrients like nitrate, phosphate, is within the permissible limits. The fluoride content of groundwater generally ranges from 0.2 to 1.5 mg L-1. [9, 10] Fluoride is observed in all places in different seasons. KPSN-5 and KSNP-4 and KPSN-1 showed higher value for Fluoride i.e. 1.7, 2.6 and 3.5 mg/l in monsoon, seasons respectively. The present study areas are located at Krishna River in 0.5-1.0 km. The COD, BOD, DO levels are within the limits. Most of the samples contained Pb, Cr remaining metals like Hg, As are absent in all seasons. Deviations were observed by groundwater samples from municipal water and water quality standards indicating groundwater pollution. The reason behind this may be due to industrial activities and industrial discharge.[11]

Table-6: Physico and chemical parameters Kondapalli Santhi Nagar, nearby VTPS-Vijayawada in Summer-2013

Test Parameter(s)	Unit	Results					
		KPSN-1	KPSN-2	KPSN-3	KPSN-4	KPSN-5	KPSN-6
pH	--	8.3	7.7	7.8	8.1	7.9	8.2
Color	Pt.Co	<4	<4	<5	<5	<4	<5
Odor	TON	No Odor	No Odor	No Odor	No Odor	No Odor	No Odor
Electrical Conductivity	µmos/cm	1997	2732	2604	2587	2705	2428
Total Dissolved Solids at 180ºC	mg/L	1738	1890	1575	1662	1873	1659
Turbidity	NTU	2.89	3.97	4.63	3.71	3.52	4.12
Total Hardness as $CaCO_3$	mg/L	518	524	480	526	471	492
Calcium as Ca	mg/L	143	117	138	131	108	164
Magnesium as Mg	mg/L	63	71	59	66	58	78
Total Alkalinity as $CaCO_3$	mg/L	546	428	501	471	492	469
Chlorides as Cl^-	mg/L	599	740	698	844	718	756
Sulphates as SO_4	mg/L	368	377	386	399	400	400
Chemical Oxygen Demand	mg/L	<5	<6.5	<5	9.8	<8.0	<5
Biochemical Oxygen Demand	mg/L	BDL	BDL	BDL	BDL	BDL	BDL
Dissolved Oxygen	mg/L	5.8	5.1	4.9	5.9	6.2	6.4
Fluoride as F^-	mg/L	1.47	1.40	1.42	1.38	1.45	1.47
Nitrates as NO_3^-	mg/L	47	48	50	49	53	52

Sodium as Na	mg/L	101	93	111	109	96	99
Potassium as K	mg/L	8.2	6.7	6.4	7.9	7.5	8.5
Cadmium as Cd	mg/L	BDL	BDL	BDL	BDL	BDL	BDL
Mercury as Hg	mg/L	BDL	BDL	BDL	BDL	BDL	BDL
Arsenic as As	mg/L	BDL	BDL	BDL	BDL	BDL	BDL
Lead as pb	Mg/L	BDL	BDL	BDL	BDL	BDL	BDL
Total Chromium as Cr	mg/L	BDL	BDL	0.05	0.07	BDL	0.06
Iron as Fe	mg/L	0.51	0.59	0.62	0.77	0.58	0.66
Manganese as Mn	mg/L	BDL	BDL	BDL	0.23	0.18	0.27
Copper as Cu	mg/L	BDL	BDL	BDL	0.05	BDL	0.05

CONCLUSION

There is no much deviation from IS: 10500: 2012 drinking water standards except Fluoride, Pb, Cr. But these three parameters have impact on human health in a longer period. Indirectly the VTPS effluents are entering into the ground water in the form of toxic metals. The public have been using mineral water for drinking purpose for the past 4 to 5 years. But economically poor people are in a critical position in few slum areas. The government and village development authorities, Public health centres should take care of the problem of pollution in the ground water consumed by poor people.

ACKNOWLEDGEMENT

One of the authors (Dr. G. Krishnaveni) is thankful to UGC for the financial assistance in the minor research project with title "Identification of VTPS (Vijayawada Thermal Power Station) pollution effect on surrounding villages" Ref. No. MRP -4343/12 (MRP/UGC-SERO) Dtd: 26.03.2012.

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[RJC-1518/2016]