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Impact of Polluted Water of Godavari River on Production of Demineral and Cooling Water Used in Nashik Thermal Power Station, Eklahare, India

KEYWORDS: river pollution, Godavari river, sewage, industrial wastewater, physicochemical, chemical parameters, quality of intake water used in Thermal Power Stations.

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ABSTRACT *A systematic study has been carried out to assess the water quality at downstream of Godavari river at Nashikcity and its impact on Nashik Thermal Power Station, Eklahare. Water samples from six sampling stations were collected monthly, during period March 08 – April 09 and physic-chemical and chemical parameters were analyzed by the standard methods. The pollution level over a period of time is increasing on the river water mainly due to sewage, industrial and other wastewaters are directly discharge in the river. The use of Godavari river water is, mainly for domestic, industrial, agricultural purpose and huge amount of water is also utilized by Nashik Thermal Power Station for electricity generation. Hence the present study is aimed to examine the water quality of the Godavari river and to evaluate the impact of such contaminated water.*

Introduction:
The chief sources of Godavari river water pollution identified as sewage constitute 84-92% and industrial waste 8-16%. In a thermal power station, water plays an important role in generation of electricity. Raw water lifted from downstream of Godavari, is treated chemically and de-mineralised water is produced. It is used for generation of steam. Coal is pulverized and blown in the furnace with air and heat is liberated which is used for converting water (demineralised) into steam. This steam of high temperature and pressure is passing through turbine blades, which rotate the turbine. The turbine is coupled to a generator, which produces electricity. The intake water lifted by Nashik Thermal Power Station is from downstream of the Godavari river i.e. after Gangawadi. For treatment of such contaminated water huge chemicals are required for production of filtered water (sump water), which leading to high chemical cost. To overcome from these difficulties due to polluted water, the quality assessment of intake water of Nashik Thermal Power Station is necessary for cost effective generation.

Study area:
Nashik Thermal Power Station (NTPS) is a unit of generation of electricity. It is located at Eklahare, which is 6 Km away from Nashik Road. NTPS is situated at Latitude 19.97 ° North with Longitude 73.89 °East. Its total generation capacity is 630 mw through 3 sets of 210 mw. NTPS is situated on the bank of the Godavari river.

Methodology:
The six sampling stations were selected in order to get representative samples of natural and polluted water, covering 14.0 km. area approximately from Tapovan to Odha. Sampling stations have been referred as SN 1 -Tapovan before Sewage Treatment Plant, SN 2- Tapovan after Sewage Plant , SN 3 - Dasak Bridge (Sant Janardan Swami Bridge), SN 4 - Gangawadi, SN 5 -Inlet to WTP-II of NTPS ,SN 6 – Odha. Water samples from the sampling stations were collected monthly, by grab sampling method during the period March 08 to February 09 and parameters were analyzed by the standard methods given in the 17th edition of Standard Methods (APHA/AWWA, 1989).

Results AND Discussion
The analysis results of study sites with BIS limits are given in table 1, 2 and 3. Conductivity of the Godavari river ranged from 236 to 1438 µS/cm at various sampling sites. The conductivity values were higher at Dasak Bridge sampling station (SN-3) because Nasardi river contain domestic sewage as well as industrial effluents and joins the Godavari river. On other hand, the leaching of chemical fertilizers spread on agricultural lands by rainwater also causes high water conductivity (Sawidis, 1997). The same was observed in this study. The TDS of the Godavari river ranged from 113 to 935 mg/l at various sampling sites. The higher value of TDS was observed at SN-3 due to mixing of sewerage, detergent and soaps required for cloth washing and mixing of industrial effluent in the Godavari river. The higher TDS values were observed for Noyyal river by Suthar, (2010). The concentration of total suspended solids was ranged from 24 to 225 mg/l at all sampling stations. The high total suspended solids are due to the direct input of massive local discharges of the Nashik city and industries, mixing of Nasardi river effluents in the Godavari river. The pH values were ranged 7.00 to 8.1. The higher pH at some sites could be due to bicarbonates and carbonates of calcium and magnesium in water. The concentration of dissolved oxygen in the Godavari river water ranged minimum 2.80 for sampling station no 2 and 3 for the month of June 08 and maximum 6.20 observed for sampling station no 4 for the month of March 08. The depletion of DO values indicates that the Godavari river was polluted. The low DO values were observed in the Godavari river in MERI report, (2001) and Chalakudy river by Chattopadhyay, (2005). Higher values of BOD and lower values of DO indicate more amount of organic matter present in sewage water (Wagh Vaishali, 2005). The concentration of BOD in the Godavari river water ranges for 5 to 69 at various sampling stations ranges, minimum (sampling station no 5 in the month of May 08) and maximum 69 mg/l (sampling station no 4 in the month of July 08). The concentration of COD of the Godavari river water ranged from minimum 16.0 (sampling station no 5 in the month of May 08) and maximum 208 mg/l (sampling station no 4 in July 08). The high value of COD is due to mixing of domestic and industrial effluent in the river water. The concentration of hardness in the Godavari river water ranged minimum 96 mg/l (sampling station no1 and 2 in the month of December 08 and April 08) and maximum 324 (very hard) mg/l (sampling station no 5 in the month of Oct 08). The higher total hardness was due to mixing of domestic effluents in the river water and anthropogenic activities. The higher range of hardness for the Godavari river reported by Gaikwad, (2000) and for the Kanhan and Pench rivers reported by Khadse et. al., (2008) due to mixing of urban runoff. The concentration of chloride in the Godavari river water ranged minimum 50 mg/l (sampling station no 1 in the month of December 08) and maximum 240 mg/l (sampling station no 4

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in the month of July 08). The high concentration of chloride is considered to be an indication of pollution due to high organic waste of animal origin. The higher concentration of chloride observed for Kanhan and Pench by Khadse (2008). The concentration of sulphate in the Godavari river water ranges at all sampling stations ranged from minimum 7.13 mg/l (sampling station no 6 in the month of May 08) and maximum 66 mg/l (sampling station no 4 in the month of March 08). The increase in sulphate level at sampling station no may also due to human activities along the riverbank and leaching from fertilized and irrigated agricultural land. The higher sulphate values were observed for Hindon river by Suthar, (2010). The concentration of phosphate in the Godavari river water ranged from minimum 1.8 mg/l (sampling station no 1 in December 08) and maximum 4.95 mg/l (sampling station no 6 in Nov 08) all sampling stations, the high value was due to constant contamination of domestic sewage, cloth washing, bathing, decay of aquatic organisms and mankind activities. Similar corroboration between amount of phosphate and human activities was observed by Welch (1952) and Hutchinson (1957), Cauvery river by Solaraj, (2009) and Chalakudy river by Chattopadhyay, (2005). The concentration of nitrate in the Godavari river water at all sampling stations ranged from minimum 1.40 mg/l (sampling station no2 in April 08) and maximum 4.06 mg/l (sampling station no 3 in October 08). Higher nitrate content was observed by Suthar, (2010) in Hindon river and Meeri report, (2001), it was due to mixing of sewage water in the river.

Difficulties in production of demineralised and soft water at Nashik TPS: The intake water lifted by Nashik Thermal Power Station is from downstream of the Godavari river i.e. after Gangawadi. For treatment of such contaminated water huge chemicals are required for production of filtered water (sump water), which is being used for production of demineralized, domestic and soft water. The dematerialized water is used for production of steam in boiler and the soft water is used for cooling of steam in condensers. The dematerialized and softening plant of Nashik Thermal Power Station was designed for important water parameters total hardness 178-mg/l and chlorides 50 mg/l. The present study reveals that the water has high ionic loading i.e. maximum total hardness (324 mg/l), chlorides (240 mg/l) and high microbial contamination, hence it is a very difficult task to produce demineralized water having conductivity less than 1 µS/cm. Due to successive regenerations, chemicals, manpower and energy cost is high. Nashik TPS incurs high (1.7 times) expenses on chemicals as compared to other TPS in Mahagenco. NTPS has installed separate domestic water pipeline for drinking purposes from Chehedi pumping station of Darana river which leads in cost.

Table 1 Physicochemical characteristics of the Godavari river in Nashikcity for period March 08 to February 09.

SN	Cond		TDS (mg/l)		TSS (mg/l)		pH		DO(mg/l)		BOD (mg/l)	
BIS limit	-		500 mg/l		-		-		5 mg/l		30 mg/l	
	Ranges	Avg	Ranges	Avg	Ranges	Avg	Ranges	Avg.	Ranges	Avg	Ranges	Avg
SN 1	236-1352	568.67	113-880	365.67	28-216	74.83	7-7.6	7.31	3-6	5.1	8-40	18.5
SN 2	240-1335	617.92	115-868	387.58	28-130	73.17	7-7.65	7.37	2.8-6	4.9	7-35	19.2
SN 3	258-1438	656.58	134-935	410.75	30-225	71	7.15-7.7	7.46	2.8-6	4.52	8-41	24.92
SN 4	323-1385	669.92	158-900	419.08	24-210	69.42	7.1-7.94	7.52	3-6.2	4.43	8.1-69	27.01
SN 5	385-1369	701.67	219-890	429.17	26-160	67.25	7.05-8	7.54	3.5-6.1	4.76	5-35	19.44
SN 6	415-1352	783	270-880	478.42	28-130	73.17	7-8.1	7.55	3.8-6	4.95	8-36	19.89

Table 2 Physicochemical characteristics of the Godavari river in Nashikcity for period March 08 to February 09.

SN	COD (mg/l)		TH (mg/l)		Ca H		MgH		Cl (mg/l)		SO_4 (mg/l)	
BIS limit	150 mg/l		300 mg/l		75 mg/l		30 mg/l		250 mg/l		200 mg/l	
	Ranges	Avg	Ranges	Avg	Ranges	Avg	Ranges	Avg.	Ranges	Avg	Ranges	Avg
SN 1	22-120	55.17	96-270	177.33	72-162	116.75	20-150	60.33	50-152	89.17	10.18–48.1	22.66
SN 2	23-110	61.42	96-268	195.17	72-180	119.82	24-142	75.33	56-200	110	10- 48.31	22.47
SN 3	24-128	75.70	120-290	205.25	72-175	119.08	48-160	86.17	63-150	108.33	11.45-50.14	24.53
SN 4	25-208	80.58	140-260	206	86-170	130.75	40-135	76.08	56-240	112.08	15.4–65.99	31.06
SN 5	16-110	58.17	128-324	216.33	80-180	132.92	47-172	83.42	56-220	122.33	8.17–51.99	27.83
SN 6	26-108	61.33	130-275	209.42	82-182	131.92	48-124	77.5	58-185	121.83	7.13– 47.6	25.47

Table 3 Physicochemical characteristics of the Godavari river in Nashikcity for period March 08 to February 09.

SN	PO_4(mg/l)		NO_3(mg/l)		Sio_2		Zn		Fe	
BIS limit	-		45 mg/l		-		5 mg/l		0.3 mg/l	
	Ranges	Avg	Ranges	Avg	Ranges	Avg	Ranges	Avg	Ranges	Avg
SN 1	1.8 – 4.5	3.12	1.42 – 4.8	3.19	13.37 -35.75	23.99	0-1.22	0.55	0.32 -1.2	0.73
SN 2	1.54–5.0	3.47	1.4 – 3.4	2.33	14.01– 39.28	26.38	0 – 1.28	0.6	0.34-2.32	0.92
SN 3	2.16-4.9	3.49	1.68 – 4.06	2.8	12.31– 39.41	26.11	0 -1.31	0.73	0.4 -1.38	0.83
SN 4	2.63–4.81	3.93	1.85 – 3.5	2.66	16.2 – 34.02	25.43	0-1.3	0.61	0.44– 1.4	0.79
SN 5	2.3 – 4.5	3.44	1.90- 4.20	2.92	16.6 – 34.56	26.83	0-1.35	0.64	0.33-1.36	0.77
SN 6	2.34–4.95	3.88	1.82- 3.9	2.74	21.87 -34.04	27.93	0-1.32	0.73	0.33-1.27	0.75

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Pearson Correlation Coefficient Analysis:
By using this technique negative and positive association between two parameters of the Godavari river water were determined. An annual average value of individual parameter was calculated for different sites and submitted to Multiple Correlation Analysis to SPSS software version 17. The values around 0.70 and above are considered as very strong positive correlation. Also other parameter correlation has found the positive and negative has correlations between the parameters obtained by Pearson correlation coefficient analysis is summarized in Table 3.

Table 3: Pearson correlation coefficients between the water quality parameters for the various sampling stations for March 08 - February 09.

	pH	COND	TDS	TSS	TH	Ca H	Mg H	CL	DO	BOD	COD	SO4	PO4	NO3	SIO2	Zn	Fe
pH	1																
COND	.962**	1															
TDS	.949**	.991**	1														
TSS	-.582	-.392	-.310	1													
TH	.899*	.843*	.778	-.800	1												
Ca H	.317	.167	.232	-.146	.025	1											
Mg H	.036	.132	.012	-.286	.380	-.654	1										
CL	.804	.892*	.832*	-.404	.847*	-.200	.547	1									
DO	-.405	-.273	-.247	.691	-.563	-.136	-.100	-.167	1								
BOD	.307	.197	.218	-.424	.335	.299	-.180	-.026	-.930**	1							
COD	.299	.216	.232	-.386	.341	.240	-.084	.030	-.924**	.991**	1						
SO4	.669	.470	.460	-.768	.633	.697	-.175	.231	-.705	.649	.605	1					
PO4	.877*	.771	.802	-.545	.719	.499	-.343	.455	-.590	.602	.553	.775	1				
NO3	-.143	-.274	-.213	.064	-.299	.265	-.745	-.497	.282	-.200	-.327	-.033	.124	1			
SIO2	.765	.889*	.844*	-.269	.776	-.223	.521	.981**	-.164	.023	.093	.159	.435	-.572	1		
Zn	.694	.784	.785	-.206	.667	-.298	.136	.731	-.328	.277	.295	.097	.625	-.163	.774	1	
Fe	-.272	-.150	-.229	.005	.038	-.622	.833*	.199	-.227	.101	.216	-.279	-.473	-.848*	.259	.001	1

***Correlation is significant at the 0.05 level (2 tailed)** ****Correlation is significant at the 0.01 level (2 tailed)**

Conclusion:
From the investigation of downstream of the Godavari river at Nashik city, it was concluded that the quality of the Godavari river is deteriorating day by day. The domestic wastewater of the city was a major factor that is responsible for the contamination of the Godavari river and can be recognized by the key parameters like DO, BOD, COD. At sampling stations no 1, 3 and 4 the water quality is highly polluted low DO and high BOD was observed. This is due to mixing of Nashik city effluents at sampling station no 1 and Nasardi effluents that contain high organic load before this sampling station no 3. The high BOD values observed at sampling stations no 4 (Gangawadi) indicates that more amount of organic matter is present in sewage at this site. After this sampling station no 4 (Gangawadi) Nashik Thermal Power Station lifts water for power station use.

Recommendations to control contamination in study area.
The proper treatment should be given to the sewage and industrial effluents of Nashik city properly before discharging it into the river so as to reduce pollution load of the Godavari river water. NMC should ensure the availability and efficiency of existing sewage treatment plants. Nashik TPS should get rebate in charges paid to Irrigation department and MPCB cess. The water quality monitoring station will be necessary besides the proper enforcement of the present rules and regulations.

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