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Water Quality Assessment of Godavari River at Nashik, India: Impact of Sewage and Industrial Wastewater

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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 cot llected monthly, during period March 07 – February 08 and physico-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.

Keywords: *river pollution, Godavari river, sewage and industrial wastewater, physicochemical, chemical parameters, Nashik Thermal Power Stations.*

1.0 Introduction:

The chief sources of Godavari river water pollution identified as sewage constitute 84-92% and industrial waste 8-16% (Dhirendra, 2009). In most of cases sewage is partly or fully treated or untreated which is directly discharged into the streams and rivers. The use of partially treated wastewater and water supplies, contaminated with sewage for irrigation has been implicated as one of the highest sources of pathogenic micro-organisms, in addition to heavy metals contaminating vegetables and other agricultural settlements may pose serious health hazards (Doyle, 1990; Assadian et al., 2005; Singh K.P. et al., 2004; Okafo et al., 2003; Rai and Tripathi 2007). Water–borne diseases continue to pose a major threat to public health both in the developed and developing world (Ford, 1990). It has been estimated that 50,000 people die daily in the world as a result of water related disease (Schalekamp, 1990).

In a thermal power station, water plays an important role in generation of electricity. The intake water lifted by Nashik Thermal Power Station is from downstream of the Godavari river i.e. after Gangawadi. Hence water is contaminated, huge chemicals are required for production of filtered water (sump water), which is being used for production of deminerialized, domestic and soft water. Nashik TPS incurs high (1.7 times) expenses on chemicals as compared to other TPS in Mahagenco. To overcome from these difficulties, the quality assessment of intake water of Nashik Thermal Power Station is necessary for cost effective generation.

2.0 Materials and Methods:

Nashik is a major industrial town situated at Latitude 19° - 33’ and 20° - 53’ North with Longitude 73° – 16’ and 75° – 6’ East in Northern Maharashtra, at a height of 565 meters above mean sea level. The Godavari river flows through the city and has a length of 18 kms, in the area of Nashik Municipal Corporation. For the investigation of Godavari river 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 07 to February 08 and parameters were analyzed by the standard methods given in the 17th edition of Standard Methods (APHA/AWWA, 1989). DO was estimated by modified Winkler's method .To determine the B.O.D. samples were incubated at 25°C for 3 days and C.O.D. was carried out by the dichromate reflux method. The various parameters and methods of determination are summarized in Table 1.

Table 1: The various parameters and methods of determination

Parameters	Method of determination/ Instruments
Physical Parameters Electrical Conductivity, Total Dissolved Solids, Total Suspended Solids.	Water analyzer
Chemical Parameters pH	Water analyzer
Chemical Oxygen Demand (COD), Total Hardness,Calcium / Magnesium Hardness, Chlorides.	Volumetric Analysis
Sulphate, Phosphate, Nitrate, $Si0_2$, Zinc, Iron.	Spectrophotometer

3.0 Results and Discussion:

The analysis results of study sites with BIS limits are given in table 1 and 2. Conductivity of the Godavari river ranged from 283 to 1230 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 184 to 800 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 in the present study ranged from 19 to 110 mg/l at various sampling sites. 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 is one of the major reason for high TSS. In the present study, the pH values were ranged from 7.15 to 7.9 at various sampling sites. 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 from 2.80 to 8.0 mg/l at various sampling sites. 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 for Chalakudy river by Chattopadhyay, (2005). Higher values of BOD and lower values of DO indicate more amount of organic matter present in sewage (Wagh Vaishali, 2005). The same was observed in the present research work. The concentration of BOD in the Godavari river water ranged from 0 to 51 at various sampling sites. The concentration of COD of the Godavari river water ranged from 4 -152 mg/l at various sampling sites. 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 from 72 to 310 mg/lit at various sampling sites. 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 from 30 to 220 mg/lit at various sampling sites. Higher values at sampling station no 4, 5 & 6 reflected, it was due to receiving both industrial and domestic waste. The higher concentration of chloride observed for Kanhan and Pench by Khadse (2008). The concentration of sulphate in the Godavari river water ranged from 6.73 to 61 mg/lit at various sampling sites. The higher sulphate values were observed for Hindon river by Suthar, (2010). The concentration of phosphate in the Godavari river water ranged from 2.08 to 8.96 mg/lit at various sampling sites. The high value was due to constant

contamination of domestic sewage, cloth washing, bathing, decay of aquatic organisms, mankind activities and fertilizer runoff from agricultural field's sewage and other non-point sources. Similar corroboration between amount of phosphate and human activities was observed by Welch (1952) and Hutchinson (1957). Higher phosphate content is observed for the Cauvery river by Solaraj, (2009) and Chalakudy river by Chattopadhyay, (2005). The concentration of nitrate in the Godavari river water ranged from 1.20 to 5.18 mg/lit at various sampling sites. Higher nitrate content was observed by Suthar, (2010) in Hindon river and Meeri report, (2001). The annual average values of SiO_2, Zinc and Iron are used in Pearson Correlation Coefficient Analysis and summarized in table 3.

Difficulties in production of demineralized and soft water at Nashik TPS:

The intake water lifted by Nashik Thermal Power Station is from downstream of the Godavari river, hence it is very difficult task to treat such contaminated water and produce filter water. 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 (300 mg/l), chlorides (220 mg/l) hence it is a difficult task to produce demineralized water having conductivity less than 1 µS/cm and produce soft water. Due to high ionic loading, resin of demineralized and softening plant get exhausted faster and leading to high chemical consumption. Mentally stresses develop on chemist and other employees and they get tired by these processes.

Table 2: The parameters of the Godavari river for the period March 07- February 08

SN	Cond (µS/cm)		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	357-938	680	232-782	475	36-110	53	7.15-7.8	7.44	3-8	4.92	2.4 -35	17.9
SN 2	283-1108	712	184-720	463	30-72	50	7.15-7.9	7.53	3-8	4.98	3.0 -32	14.33
SN 3	326-1230	704	212 -800	458	35-150	60	7.17-7.9	7.61	2.8-6.4	4.03	3-46	23.48
SN 4	415-969	614	270-630	399	40-69	59	7.02-7.9	7.52	2.8 -7	4.79	0-51	17.17
SN 5	295-1022	613	192-664	398	19-70	35	7.36-7.7	7.56	3-7.1	4.37	0-33	12.66
SN 6	314-1046	619	204-680	402	20-75	38	7.3-7.8	7.56	2.8 -7	4.66	0-35	14.58

Table 3: The parameters of the Godavari river for the period March 07- February 08

SN	COD (mg/l)		TH (mg/l)		Ca H		Mg H		Cl		SO_4	
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	12-96	50.17	88-240	168.17	48-160	101.25	40-108	66.92	36-128	73.67	6.73- 56.07	31.14
SN 2	8-100	42.92	72-245	183.08	43-144	110.58	29-101	72.5	36-128	73.67	11.27-56.51	31.01
SN 3	6-120	67.67	92-250	172.75	58-156	104.58	34-94	68.17	30-136	88.25	13.12 -42.7	33.52
SN 4	4-152	50.08	110-260	182.17	66-148	111.5	44-112	70.75	44-128	80.25	12.6- 44.36	28.11
SN 5	4-100	39.42	100-300	187.17	64-152	113	36-148	74.17	36-220	93	12.17-40.68	27.31
SN 6	6-106	45.08	105-310	190.75	67-150	113.08	38-160	77.67	36-200	88.08	12.8-61	30.69

Table 4: The parameters of the Godavari river for the period March 07- February 08.

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	2.54-6.94	4.8	1.47- 4	2.7	19.53-	26.82	0-1.2	0.4	0-4.7	0.9
SN 2	2.08-7.08	5.2	1.2-4.09	3.0	20.38-	28.11	0-0.88	0.4	0-4.8	1.2
SN 3	2.66-7.23	4.9	1.54-4.18	2.8	24.18-34.1	27.67	0-2.88	0.8	0-5.6	1.0
SN 4	3.18-7.51	5.2	1.84-4.34	3.0	20-34	26.22	0-1.48	0.6	0.08-	1.1
SN 5	2.89-8.67	5.4	1.67-5.01	3.2	19.2-36.5	25.89	0-0.98	0.5	0-5.3	0.8
SN 6	3.03-	5.5	1.75-5.18	3.1	19-36.6	24.99	0-0.92	0.5	0-5.28	0.8

Pearson Correlation Coefficient Analysis: By using this technique negative and positive association between two parameters of the Godavari river water samples 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. It has been found the positive correlation between conductivity and TDS for all six sampling stations. Pearson correlation coefficient analysis is summarized in Table 5.

Table 5: Pearson correlation coefficients of the water quality parameters for the period March 07- February 08.

	pH	COND	TDS	TSS	TH	Ca H	Mg H	CL	DO	BOD	COD	SO4	PO4	NO3	SIO2	Zn	Fe
pH	1																
COND	-.218	1															
TDS	-.283	.833*	1														
TSS	-.109	.095	.410	1													
TH	.436	-.020	-.360	-.878*	1												
Ca H	.414	-.507	-.764	-.610	.771	1											
Mg H	.601	-.235	-.626	-.770	.912*	.855*	1										
CL	.807	-.524	-.556	-.101	.182	.281	.479	1									
DO	-.748	.415	.472	.323	-.324	-.239	-.532	-.947**	1								
BOD	.439	.235	.400	.680	-.512	-.583	-.359	.432	-.328	1							
COD	.345	.250	.385	.747	-.593	-.606	-.411	.370	-.235	.986**	1						
SO4	.197	-.899*	-.908*	.000	-.038	.531	.288	.533	-.351	-.166	-.119	1					
PO4	.683	-.603	-.847*	-.328	.428	.671	.752	.843*	-.752	.025	.012	.738	1				
NO3	.519	-.488	-.727	-.711	.857*	.972**	.914*	.385	-.399	-.531	-.589	.446	.690	1			
SIO2	-.025	.366	.788	.562	-.407	-.566	-.635	-.330	.334	.442	.383	-.598	-.700	-.524	1		
Zn	.927**	-.058	-.322	-.192	.510	.460	.716	.747	-.685	.379	.327	.185	.754	.529	-.268	1	
Fe	-.200	.264	.571	.531	-.299	-.210	-.514	-.605	.706	.061	.063	-.383	-.663	-.290	.805	-.359	1

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

4.0 Conclusion:

From the investigation of downstream of the Godavari river at Nashik city, it was concluded that the quality of the Godavari river is contaminated. 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 stations no 4 (Gangawadi) the Nashik Thermal Power Station lifted water for its use. For treatment of such polluted water huge chemicals are required which results in higher cost of filter water. The present study reveals that the water is having high chlorides and hardness. Because of high ionic loading on resin of de-mineralized and softening plant leading to high chemical consumption and thereby cost. The downstream of the Godavari river water is also used for agricultural purposes, the crop yield has suffered terribly due to use of polluted water.The focusing point of the study is that, the downstream of Godavari river at Nashikcity is polluted due to addition of domestic and industrial effluents in the river water. Hence the users of the Godavari river are badly affected due to use of such contaminated water.

4.1 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.

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