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ANALYSIS OF POLLUTION LOAD ON MAHANADI DUE TO MUNICIPAL SEWAGE IN 2004 AND REMEDIAL MEASURES

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ABSTRACT

The physico–chemical characteristics of Mahanadi water at Sambalpur Town were analyzed to determine the pollution load because of the discharge of untreated sewage at four different places. Samples were collected in the first week of April to September 2004.The collection of sample were from four different sewage discharge outlets of Sambalpur municipal council. The study revealed that there is sharp increase of BOD, COD, SS, TDS and hardness at the experimental sites. The suspended solid value reduced considerably on sedimentation. The BOD value also remains well within CPCB standard on biological treatment. For the reduction of COD and TDS, chemical treatment methods were carried out. Out of the six different methods described in this communication, the method involving activated charcoal, bleaching powder, ferric alum and lime were found to be most efficient and cost effective.

Key words : Municipal sewage, Remedial measures, Pollution load

INTRODUCTION

River Mahanadi is the largest river of Orissa and almost entire population of the state are dependent on its water directly or indirectly. Many big and small cities have come up on its banks, thus increasing the pollution load on the river water. The main pollutants are because of industrial, agricultural waste and sewage that find their way without being treated [1,2].Thus it is of paramount importance to study different physico–chemical parameters from time to time as the population also increases in the cities.

In the present study, exhaustive analysis of various physico–chemical parameters of Mahanadi have been studied, as the untreated sewage of Sambalpur city finds its way into the river at five different points from the Sambalpur municipal council sewage outlets. After construction of ring road surrounding the town along the bank of Mahanadi, small drain converged into single outfall. The pollution load of municipal wastewater clearly visible at the point of discharge.

In the present study, pollution load in river water has been assessed by analyzing fourteen different parameters. To reduce the parameters that matter most, like COD and TDS, six different chemical methods were used.

MATERIALS AND METHOD

Physiochemical analysis

The samples of water were collected from four sampling stations. These are

- Upstream of Durga Pali Nallah.
- Upstream of Dhobijora Nallah.
- Downstream of Dhobijori Nallah.
- Downstream of Hardjore Nallah.

The first sampling station was about 200 m upstream of Durgapali Nallah, which is the first outfall at Sambalpur to discharge municipal sewage into Mahanadi. The second sampling station was about 200 m upstream to Dhobijora Nallah. The third sampling station was selected near Kunjelpara Ghat, which is 200 m down stream to Dhobijora Nallah. The fourth sampling station was about 200 m down streams of Haradjore Nallah, which is the last outfalls carrying sewage into the river. The physico–chemical parameters were analyzed in the laboratory using the standard methods [3,4]. and shown in Table 1 to 4. Comparison of different parameters of Experimental site (E.S)–I and Experimental site (E.S)–IV are given in Table 5. The different parameters studied have been compared with WHO and CPCB standard and has been presented in tabular form in Table 6.

Table 1. Physico–chemical parameters of E.S – I

Parameters	Months					
	April	May	June	July	August	Sept
pH	8.6	8.4	8.4	8.3	8.2	8.2
Conductivity μ mhos/cm	130.5	137.3	128.5	68.9	74.6	67.4
Turbidity (In NTU)	3.0	4.0	11.0	124.0	112.0	59.0
TDS mg./L	112.0	70.0	93.0	32.0	95.2	106.2
SS mg./L	6.0	40.0	24.0	20.0	22.0	29.0
Total Hardness mg./L	52	54	50	28	28	26
Ca–Hardness mg./L	32	34	32	18	16	16
Mg–Hardness mg./L	16	34	32	18	16	16
DO– mg./L	14.4	8.8	8.2	7.1	7.0	6.9
BOD– mg./L	1.0	2.0	2.0	2.0	2.0	2.0
COD– mg./L	8.0	8.0	8.0	8.0	10.0	10.0
Total alkalinity mg./L	50	60	50	28	28	28
Cl^- mg./L	11	24	35	30	20	30
F^- in ppm	0.88	1.10	1.43	1.29	0.84	1.22

Table 2. Physico–chemical parameters of E.S–II

Parameters	Months					
	April	May	June	July	August	Sept
pH	8.52	8.13	8.09	8.15	8.02	8.02
Conductivity µmhos/cm	135.7	142.8	138.7	92.5	83.7	73.5
Turbidity (In NTU)	4.3	6.7	119.0	120.0	135.16	115.3
TDS mg./L	120.2	124.0	114.0	33.1	116.0	120.6
SS mg./L	8.0	12.0	32.0	28.0	30.0	42.0
Total Hardness mg./L	52	55	53	34	32	30
Ca–Hardness mg./L	32	35	34	21	18	19
Mg–Hardness mg./L	18	37	36	23	20	20
DO–mg./L	8.2	8.1	7.8	7.0	7.0	6.7
BOD–mg./L	2.3	2.6	2.7	3.4	2.3	2.5
COD–mg./L	12.0	14.0	10.0	15.0	12.0	12.0
Total alkalinity Mg./L	55	62	58	38	31	31
CI mg./L	12.0	18.0	28.0	31.0	22.0	31.2
F^- in ppm	0.88	1.13	1.43	1.31	1.20	1.32

Table 3. Physico–chemical parameters of E.S–III

Parameters	Months					
	April	May	June	July	August	Sept
pH	8.45	8.03	8.00	8.06	7.80	7.90
Conductivity µmhos/cm	146.3	178.6	152.8	122.3	91.5	83.3
Turbidity (in NTU)	5.6	10.0	138.0	154.0	175.0	129.4
TDS (mg/L)	132.0	138.0	131.4	28.3	136.4	140.0
SS (mg/L)	12	22	48	44	48	60
Total Hardness(mg/L)	54	58	59	46	36	35
Ca–Hardness (mg/L)	36	37	38	28	21	21
Mg–Hardness (mg/L)	21	39	39	28	21	22
DO (mg/L)	8.1	8.0	7.0	7.0	6.8	6.5
B O D (mg/L)	3.5	3.3	4.5	5.3	3.2	4.8
C O D (mg/L)	16.0	18.0	12.0	19.0	15.0	13.0
Total alkalinity(mg/L)	57	63	62	46	36	33
Cl^- (mg/L)	12.0	36.0	39.0	32.0	23.0	34.3
F^- in ppm	0.89	1.17	1.30	1.36	1.32	1.38

Table 4. Physico–chemical parameters of E.S–IV

	Months					
Parameters	**April**	**May**	**June**	**July**	**August**	**Sept**
pH	8.3	7.9	7.9	7.8	7.9	7.8
Conductivity μmho/cm	155.7	235.2	167.0	143.9	105.1	93.9
Turbidity (in NTU)	9.0	14.0	368.0	40.20	248.16	254.0
TDS (mg/L)	176.0	182.6	104.0	40.43	109.0	196.3
SS (mg/L)	16	62	64	60	72	74
Total Hardness (mg/L)	56	60	62	50	38	38
Ca–Hardness (mg/L)	38	40	41	33	26	26
Mg–Hardness (mg/L)	24	40	41	33	26	26
DO (mg/L)	7.2	7.0	6.8	6.8	6.5	6.2
BOD (mg/L)	4.0	4.0	6.0	8.0	4.0	6.0
COD (mg/L)	19.0	20.0	14.0	22.0	18.0	16.0
Total alkalinity in (mg/L)	61	65	70	52	38	36
Cl^- (mg/L)	22.0	32.0	40.0	30.0	26.2	40.4
F^- in ppm	0.92	1.22	1.29	1.40	1.38	1.44

Table 5. % Variation of parameters in Es–I and Es–IV

Parameters	**Minimum value of ES–I**	**Maximum value of ES–IV**	**% of variation**
*pH	8.6	7.7	10.5 Decrease
Electrical Conductivity μ mho/cm	67.4	235.2	248.96 Increase
Turbidity NTU	3	402	13300 Increase
Total Dissolved Solid(TDS) mg/L	32	196.3	470.63 Increase
Suspended Solid(SS) mg/L	06	74	1133.34 Increase
Total Hardness mg/L	26	62	130.76 Increase
Ca–Hardness mg/L	16	41	156.2 Increase
Mg–Hardnessmg/l	16	41	156.2 Increase
*Dissolve Oxygen(DO)mg/l	10.4	4.2	59.61 Decrease
BilogicalOxygen Demand(BOD) mg/L	1.0	8.0	700 Increase
Chemical Oxygen Demand(COD)mg/L	08	19	137.5 Increase
Total Alkalinity mg/L	28	70	150 Increase
Cl^-	11	40	263.64 Increase
F^-	0.84	1.44	71.42 Increase

*Values decrease from ES–I to ES–IV

Table 6. Comparison of the values of physico–chemical parameters of the present study and the standard value

Parameters	W.H.O Standard	CPCB Standard	Present Values	
			Minimum	Maximum
pH	7.0 to 8.5	6.0 to 8.5	7.7	8.6
Turbidity (NTU)	5 to 25	–	3	402
TDS in mg./L	1 to 1500	500 to 2100	32.0	196.3
Total Hardness (mg./L)	100 to 500	300 to 600	26	62
Ca–Hardness	75 to 200	–	16	41
Mg–Hardness mg./L	30 to 150	–	16	41
DO in mg./L	–	4 to 6	4.2	10.4
BOD in mg./L	–	2 to 4	1.0	9.0
Chloride in mg./L	200	250 to 600	11.0	40.0
Fluoride in PPM	1 to 1.5	1.5	0.84	1.44

Chemical treatment:

One liter of sample was collected from experimental site – IV. It was taken in six separate beakers and was subjected for chemical treatment. Six series of treatment were carried out as described below.

Series 1 – Effluents (1 ltr.) + Bleaching powder (1 g)

Series 2 – Effluents (1 Ltr.) + Ferric alum (1 g)

Series 3 – Effluents (1 Ltr.) + Lime (1 g)

Series 4 – Effluents (1 Ltr.) + Bleaching powder (1 g) + Ferric alum (1 g) + Lime (1 g)

Series 5 – Effluents (1 Ltr.) + Activated charcoal (5 g) and then after 24 hrs, Bleaching powder (1 g) + Ferric alum (1 g) + Lime (1 g)

Series 6 – Effluents (1ltr) + Husk charcoal (5 g) and then after 24 hours Bleaching powder (1 g) + Ferric alum (1 g) + Lime (1 g)

The effluents were thoroughly stirred after addition of each chemical as mentioned against each series, and percentage removal of different parameters were studied after 24, 48, 72 and 96 hours respectively. 30 mL of sample from each beaker was taken out and the important parameters like COD and TDS were determined by literature method [9]. The results obtained were given in Tables 7 and 8.

Table 7. Reduction in COD values in different chemical treatment methods

Treatment with	Raw Effluents	After treatment				% of removal			
		24 hrs	48 hrs	72 hrs	96 hrs	24 hrs	48 hrs	72 hrs	96 hrs
Bleaching powder	22	21.26	19.5	18.2	17.4	3.4	11.2	17.1	21.7
Ferric alum	22	20.70	15.73	12.82	11.62	5.9	28.5	41.7	47.2
Lime	22	20.57	15.4	11.18	11.40	6.5	30.0	48.2	49.2
Bleaching powder + Ferric alum + Lime	22	8.76	7.37	6.18	5.41	60.2	66.5	71.9	75.4
Activated charcoal + Bleaching powder + Ferric alum + Lime	22	2.20	1.81	1.37	1.08	90.1	91.8	93.8	95.1
Husk charcoal+Bleaching powder + Ferric alum+Lime	22	4.03	3.52	3.08	3.00	81.7	84.4	86.0	86.4

Table 8. Reduction in tds values in different chemical treatment method

Treatment with	Raw Effluents	After treatment				% of removal			
		24 hrs	48 hrs	72 hrs	96 hrs	24 hrs	48 hrs	72 hrs	96 hrs
Belaching powder	196.3	189.04	168.23	161.36	158.81	3.7	14.3	17.8	19.1
Ferric alum	196.3	165.09	146.44	141.34	135.84	15.9	25.4	28.0	30.8
Lime	196.3	164.90	157.24	151.54	147.82	16.0	19.9	22.8	24.7
Bleaching powder + Ferric alum + Lime	196.3	108.6	95.8	88.34	63.5	44.7	51.2	53.9	55.00
Activated charcoai + Bleaching powder + Ferric + Lime	196.3	58.89	53.59	50.65	49.07	70.00	72.70	74.20	75.00
Husk charcoal + Bleaching powder + Ferric alum + Lime	196.3	88.54	84.61	80.88	78.54	54.9	56.9	58.8	60.0

RESULTS AND DISCUSSION

An exhaustive comparison of physico–chemical data of the different sites I, II, III and IV were made so far as the different parameters like BOD, COD, TDS etc. are concerned.

It was found that most of the parameters increased manifolds in experimental site–III and IV, which is quite common, considering the amount of untreated sewage discharge into the river. Some parameters like turbidity, TDS, SS, hardness, BOD, COD, alkalinity; and ions like chloride and fluoride were found to be marginally increased as compared to experimental site–I, but the increased value remained well under the prescribed standard of CPCB and WHO[5,6].

Six different ways of treatment were devised to bring the pollution load down to CPCB and WHO limits, in order to make the river water consumable. They are

Series – 1 Treatment with bleaching powder,

Series – 2 Treatment with ferric alum,

Series – 3 Treatment with lime,

Series – 4 Treatment with mixture of bleaching powder + ferric alum + lime,

Series – 5 Treatment with mixture of activated charcoal + bleaching powder + ferric alum + lime, and

Series – 6 Treatment with mixture of husk charcoal + bleaching powder + ferric alum + lime

The results indicated asubstantial reduction of COD and TDS on treatment with above mentioned ways.

When the sample of water from experimental site–IV was treated as per the method mentioned above [7,8,10], the treatment with activated charcoal + bleaching powder + ferric alum + lime was most efficient but not economical, whereas the treatment with husk charcoal + bleaching powder + ferric alum + lime is comparatively economical and percentage removal of pollution load is also encouraging.

These facts have been represented graphically and also in tabular form in Figures 1 and 2 and Tables 7 and 8.

Figure 1

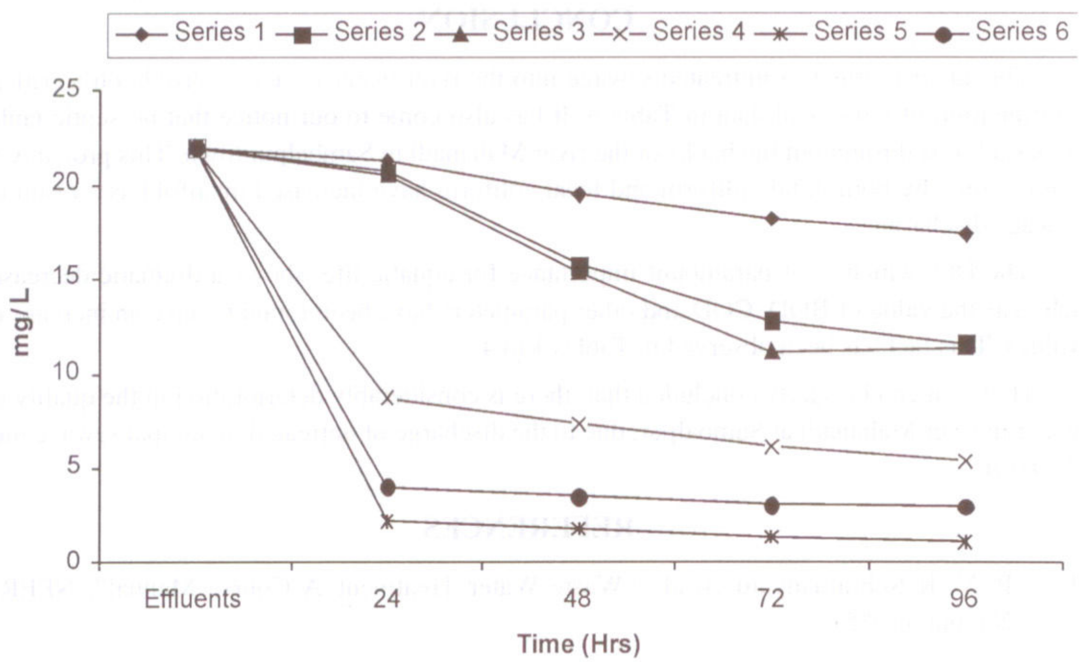
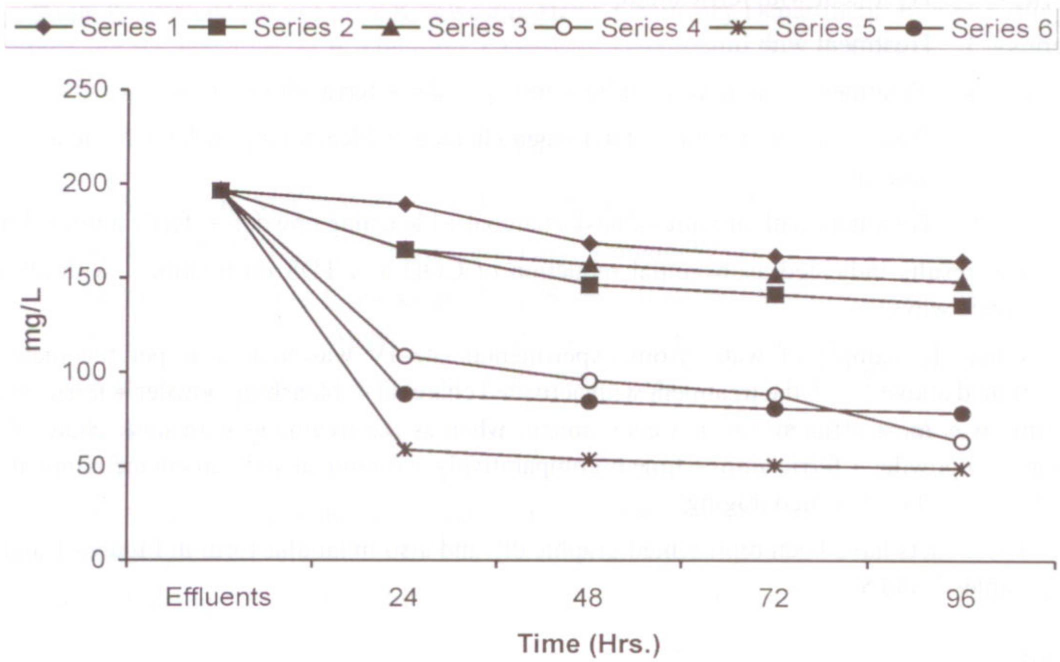


Figure 2



CONCLUSION

The adverse effect of untreated sewage into the river water is clearly visible on a critical examination of numerical data in Table 6. It has also come to our notice that no septic tanks exists, almost throughout the banks of the river Mahanadi in Sambalpur town. This probably is the reason why both; total coliform and fecal coliform have increased manifold as a result of sewage discharge.

The DO, which is of paramount importance for aquatic life, shows a dramatic decrease, whereas the value of BOD, COD and other parameters have been found to have an increase in values. This fact has been observed in Tables 1 to 4.

Hence, it can be safely concluded that, there is considerably deterioration in the quality of water in river Mahanadi at Sambalpur, due to the discharge of untreated municipal sewage into the river.

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