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PHYSICO-CHEMICAL CHARACTERIZATION OF CITY SEWAGE DISCHARGED INTO RIVER ARPA AT BILASPUR, INDIA

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ABSTRACT

The Bilaspur city sewage discharged into river Arpa at various sites. In the present investigation five sewage sampling sites were selected before they mixed with river water for analysis of physico- chemical properties like temperature, turbidity, conductivity, pH, total alkalinity, free carbon dioxide, total acidity, dissolved oxygen, biochemical oxygen demand, chemical oxygen demand, chloride, total hardness, nitrate nitrogen, nitrite nitrogen and total phosphate. The average value of various parameters observed as temperature range 23.54 to 25°c and the pH value ranged between 7.72 to 7.78.The others physicochemical parameters namely turbidity 20-36.17N.T.U., conductivity 0.64-1.08 mhos.cm^{-1},total alkalinity 594.75-969.41mg.l^{-1},free CO_2 37.35-60.42mg.l^{-1}, total acidity42.45-64.91mg.l^{-1}, dissolve oxygen 0.33-1.85mg.l^{-1}, BOD 58.77-112.42mg.l^{-1}, COD 420.62-547.25mg.l^{-1}, chloride 36.97-104.60mg.l^{-1}, total hardness 259.43-384mg.l^{-1}, nitrate nitrogen 0.111-0.184mg.l^{-1},nitrite nitrogen 0.017-0.02mg.l^{-1},and total phosphate within 0.85-1.03mg.l^{-1}range.

KEYWORDS : City Sewage

Water is one of the most important requirements for the survival of life on the earth. The demand of water increases due to the increase of human population in the cities. The supply of clean water is one of the most important problems faced by the municipality. The increasing demand for water supply generates bulk of waste water. The public waste water has been termed as sewage. It includes waste water from homes and commercial establishments and carried through sewers or open drains. Generally untreated or partially treated sewage water discharged into the rivers, low lying areas and agricultural fields. This has led to an other problem of water pollution, so the physico -chemical analysis of sewage is the primary need before it is off into river or agricultural fields. The physico-chemical property of city sewage has been investigated in India and elsewhere in the world. The important studies in India are those of Ahmadabad (Kothandarman et.al.,1963), Kanpur (Ray and David, 1966), Chandigarh (Vasisht and Sra,1996, Vasisht and Sheikher 1983 and Chona, 1990), Varanasi (Tripathi et .al.,1991), Delhi (Dakshini and Soni 1979), Agra (Saxena and Chauhan 1993), Almora (Joshi et. al.,1984 and Pathak and Bhatt 1992), Amritsar (Singh et.al.,1985), Ludhiana (Arora et. al., 1985), Aligarh(Gupta and Kumar, 1988), Hosangabad (Malviya et. al., 1990), (Trivedy et. al., 1990), Srinagar Garhwal (Gautam et. al., 1993), Bangalore (Ahipati et. al., 2006), Kollegalstretch (Vankatesharaju et. al., 2010), Varanasi (Thomas et. al., 2011), Moradabad (Sinha et. al., 2005), Kasi (Nayar et. al., 2008).

India is a large country with number of big and small rivers. These rivers played very important role in the evolution of religion, culture, settlements of villages, towns and cities in India. They provide water for irrigation, bathing, washing, fishing and recreational purpose. The water quality of these rivers started deteriorating in the last few decades. The important studies are of river Yamuna (Saxena and Chauhan,1993), river Ganga (Tripathi et.al.,1986,1991, Singh and Singh,1995), Chambal (Olania et.al., 1976), river Narmada (Palharya and Malviya, 1989 and Malviya et.al.,1990), river song(Kumar 1995) many cities, town and countless villages are situated at the bank of rivers. Untreated or partially treated domestic wastes are regularly discharged into them. This resulted in deterioration of water quality of these rivers. Many researchers have undertaken the study of physico-chemical and biological characteristics of river water polluted due to sewage discharged in India and abroad. The important studies are of river Ganga at Kanpur (Ray and David,1966) Ganga at Varanasi (Tripathi et.al.,1991) Yamuna at Delhi (Dakshini and Soni,1979), Yamuna at Agra (Saxena and Chauhan,1993), river Ganga at Patna (Bhowmick and Singh, 1985), Narmada at Hosangabad (Malviya,1990), Ganga at Varanasi (Singh and Singh, 1995),Ganga at Shuklaganj (Unnao) and Phaphaman (Allahabad(Sinha and

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Sinha. 2001), Ganga at Varanasi (Mishra and Triphati 2007), Ganga at Ghazipur(Yadav and Shrivastava 2011).

Site Description

Bilaspur is situated at 25°5'N latitude and 82°12'E longitude .\The height is 292.00m above M.S.L. It is situated in the eastern part of Madhya Pradesh, almost in the centre of the region known as Chhattisgarh.

River Arpa is a tributary of river Sheonath and Sheonath is confluent of river Mahanadi. It originates near Khodri (621-95 M.S.L.) in Bilaspur district. It blows near by 47.49 kilometers in hilly track and then enters plain. It enters Bilaspur city from Northern side and flows along the North-Eastern border of city. Over a distance of 10 kilometers forming a semicircle blow around Bilaspur. It leaves the city from East- Southern side. The river is non-perennial and vegetables are grown after December when the river is dry.

In the present investigation, 5 sites have been selected for sewage study. The sampling sites situated at the bank of river Arpa and the sewage samples were collected before they mixed with the river water.

The details of Sampling sites are given below-

Site 1- Releasing the sewage of Kurudand locality near mandir chowk.

Site 2- Releasing the sewage of Dabripara locality near nurse's quarter.

Site 3- Main sewage drain (Jawalinala) releasing the bulk of Bilaspur city sewage.

Site 4- Releasing the sewage of Dayalband and Nayapara locality near santoshi mandir.

Site 5- Releasing the sewage of Torba locality.

MATERIALAND METHODS

Sewage samples were collected from different sites for physico-chemical analysis. The sampling was done at one month's interval and the date of sampling was the15th of every month between 7 to 9A.M.The samples were collected in 2.5 liter Polythene bottles. Temperature, dissolve oxygen and free carbon dioxide were measured immediately on the spot. Then the samples were brought to the laboratory for analysis like turbidity, conductivity, free carbon dioxide, total alkalinity, total acidity, biological oxygen demand, chemical oxygen demand, Chloride, total hardness, nitrate nitrogen, nitrite nitrogen, and total phosphate. Standard method for the examination of water described by American Public Health Association (APHA), American Public Health Association (AWWA) and Water Pollution Control Federation (WPCE), were used to analyses different parameters of the sewage and river water.

RESULTS AND DISCUSSION

The average value of water quality parameters of different sites at Bilaspur has been shown in table -1. The average value of temperature ranges between 23.54-25°c. The temperature of different sites varied between 16.0°c and 28.5°c.The minimum temperature was recorded in the month of December in site 1.The maximum temperature was recorded in the month of September in site 4 and month of June in site 5.

The average value of turbidity range between 20 to 36.17 N.T.U. The minimum turbidity (10.0 N.T.U.) was recorded site 1 in the month of February and maximum turbidity (84 N.T.U.) was recorded site 4 in the month of May.

The conductivity of sewage water of different sites varied considerably in different months and range between 0.19 to 1.42 mmho.cm^{-1}. The minimum conductivity (0.19 mmho.cm^{-1}) was observed site 1 in the month of August. The maximum conductivity (1.42 mmho.cm^{-1}) in summer months of April and May in site 3.the average value range between 0.64 to 1.08 mmho.cm^{-1}.

The pH of all the sampling sites was more than 7.00, except site 4 where it was 6.9.The pH of sewage water fluctuated all the year round. It ranges between 6.9 and 8.60.The average value range between 7.60 to 7.78.

The alkalinity of sewage water of different sites was very high all the year round, it did not reflect monthly or seasonal trend and fluctuated all the year round. The average value range between 594.75 to 969.4 mg.1^{-1}. The minimum alkalinity recorded (231. 25 mg.1^{-1}) in site 1 and site 3 in the month of August and maximum alkalinity was recorded in site 3(1375.00 mg.1^{-1}) in the month of November.

The free carbon dioxide the sewage of different sites was generally low in the summer and rainy season then it increase gradually with fluctuations. The average value of

carbon dioxide was range between 37.35 to 60.42 mg.1^{-1} The minimum free carbon dioxide value of sewage was (3.96 mg,1^{-1}) in site 1 and 3 in the month of August and maximum value of free carbon dioxide was (130.68 mg,1^{-1}) in site 3 in the month of November.

The total acidity in the sewage decreased in summer months with miner fluctuations at different sites. The average values range between 42.45 to 64.91mg.1^{-1} .The minimum values were recorded in site 1 and 3 (4.50 mg^{-1}). The maximum value was recorded site 3 (134.40 mg.1^{-1}).

The average value of dissolve oxygen content in sewage water varied between 0.33 to 1.85 mg.1^{-1}.The minimum values (nil) was recorded in site 3 in the month of February, March, October and November. Maximum value was recorded site 1(4.58 mg.1^{-1}).

The average value of BOD range between 58.77 to 112.42 mg.1^{-1}.The lowest values were recorded in site 1 and 4(10 mg.1^{-1}) in the month of September and May and highest value was recorded in site 4 (265.2 mg.1^{-1}) in the month of April.

The average COD values of sewage water fluctuated between 420.62 to 547.25 mg.1^{-1}. The lowest value of COD in site 5(148.80 mg.1^{-1}) in the month of September and highest value was also recorded in site 5 in the month of April (1000 mg.1^{-1}).

The chloride content of sewage fluctuated all the year round. The chloride was lowest in the rainy season at all the sampling sites. The average value range between 36.97 to 110.24 mg.1^{-1}. The lowest value (6.68 mg.1^{-1}) reported in site 1 in the month August and highest value recorded in site 4(146.17 mg.1^{-1}) in the month of February.

The average values of total hardness range between 259.43 to 384.12 mg.1^{-1}.The minimum value was recorded in site 3(100 mg.1^{-1}) in the month of August and highest value was recorded in site 5(474.26 mg.1^{-1}) in the month of February.

The nitrate nitrogen content in sewage water fluctuated all year the round. The average value recorded between 0.111 mg.1^{-1} to 0.184 mg.1^{-1}. The minimum value was recorded in site 1(0.03 mg.1^{-1}) in the month of May, June and August and highest value was recorded in site 1(0.33 mg.1^{-1}) in the month of December.

The nitrite nitrogen in sewage water varied narrowly in different months in all sampling sites. The value range between 0.017 to 0.023 mg.1^{-1}. The lowest value recorded in site 1(0.01 mg.1^{-1}) from February to July and October and highest value was recorded in site 4(0.09 mg 1^{-1}) in the month of October.

The total phosphate value in sewage water does not show variations all the year round. The average value range between 0.85 to 1.03 mg.1^{-1}.The minimum value was recorded in site 1(0.44 mg 1^{-1}) in the month of September and highest value was recorded in site 3(1.12 mg.1^{-1}) in the month of October.

The above data reveals that the lowest average value of sewage water like temperature, conductivity total alkalinity, free carbon dioxide, DO, COD, chloride, total hardness, nitrate nitrogen, and total phosphate value minimum in site 1 and average highest value like temperature, pH, COD, and nitrate nitrogen were recorded in site 5, similarly highest value of conductivity, total alkalinity, chloride, total hardness reported in site 4. The highest value of turbidity, free CO□, total acidity reported in site 3 and highest value of BOD recorded in site 2. So the average value of minimum content in sewage water reported in site 1 and average maximum content reported in site 3, 4, and 5 followed by site 1 and 2.The minimum physico-chemical characters of sewage water generally recorded in the month of August and September because due to rainy season but maximum data generally highest in the month of October, November, April and May because the amount of water became less and concentration of content became high. The above findings have been reported by Saxena et. al. (1970), Verma et. al. (1978), Mishra (1979), Tripathi et. al. (1986,1991), Joshi and Bist (1993), Datar and Vasistha (1992), Trivedi et. al.(1990), Gautam et. al. (1993), Boruah et. al. (1995), Kumar (1995) and Rai et. al. (2012). The above study also reveals that water of river Arpa is deteriorated very badly as a result of addition of urban waste and domestic sewage, which enters the river through sewage drains and affects the health of the people of down stream of Bilaspur because the water is used for bathing, washing , irrigation for vegetables and other purposes.

Table 1 : Average Value and Minimum and Maximum range of Water Quality

(All values are in mg.$1.^{-1}$ except temperature, turbidity, conductivity and pH)

Physico-chemical characteristics	SITE-1		SITE-2		SITE-3		SITE-4		SITE-5	
	Average value	Range	Average value	Range	Average value	Range	Average value	Range	Average value	Range
Temperature °c	23.54	16.0-28.0	24.0	17.5-28.0	24.25	18.0-28.0	24.75	20.0-28.5	25.0	20.0-28.5
Turbidity	32.75	10.0-62.0	33.92	17.0-74.0	36.17	14.0-62.0	31.25	12.0-84.0	20.0	10.0-36.0
Conductivity	0.64	0.19-0.85	0.97	0.84-1.16	1.05	0.26-1.42	1.08	0.92-1.30	0.95	0.77-1.22
pH	7.72	7.0-8.2	7.60	7.3-8.3	7.73	7.2-8.4	7.65	6.9-8.5	7.78	7.4-8.6
Total Alkalinity	594.75	231.25-762.50	854.26	700.38-1112.50	966.50	231.25-1375.0	969.41	804.38-1112.50	835.83	706.50-981.25
Free co_2	37.78	3.96-102.96	52.18	15.84-84.48	60.42	3.96-130.68	51.40	19.80-79.20	37.35	11.88-63.36
Total Acidity	42.93	4.50-117.00	55.12	18.00-96.00	64.91	4.50-134.40	58.41	27.0-90.0	42.45	13.50-72.00
Dissolved Oxygen	1.85	0.22-4.58	0.99	0.21-2.08	0.33	Nil-1.35	1.30	0.31-3.26	0.99	0.22-2.70
Biochemical Oxygen Demand	84.80	10.4-171.6	112.42	36.4-207.0	77.08	30.00-134.4	110.50	10.4-265.2	58.77	19.2-115.2
Chemical Oxygen Demand	420.62	182.32-976.94	521.52	172.0-961.55	468.30	199.50-900.01	487.29	275.20-853.85	547.25	148.80-1000.00
Chloride	36.97	6.68-49.91	85.54	71.23-122.43	100.19	15.58-128.63	110.24	98.77-146.17	104.60	71.23-121.21
Total hardness	259.43	104-0-348.55	305.63	200.0-390.00	333.33	100.00-440.00	384.12	310.00-470.00	360.94	296.00-474.26
Nitrate nitrogen	0.111	0.03-0.33	0.117	0.04-0.30	0.184	0.04-0.35	0.114	0.04-0.31	0.137	0.04-0.32
Nitrite nitrogen	0.023	0.01-0.08	0.017	Nil-0.05	0.021	0.01-0.04	0.022	0.01-0.09	0.022	Nil-0.08
Total phosphate	0.85	0.44-1.09	1.00	0.82-1.09	1.03	0.93-1.12	0.99	0.88-1.10	0.95	0.86-1.09

Therefore, prior to its application to the land for crop irrigation or discharged into the river system, its proper treatment is essential.

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