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SEASONAL VARIATION OF PHYSICOCHEMICAL PARAMETERS OF WASTE WATER FROM A SEWAGE TREATMENT PLANT, BHOPAL (INDIA)

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ABSTRACT

Physicochemical parameters of the influent and effluent water of the Badwai sewage treatment plant were analyzed during January to December 2009. In order to achieve this objective, water samples were collected from eight sampling points and analyzed for different physicochemical parameters like pH, temperature, electrical conductivity, turbidity, nitrate, nitrite, phosphate etc. These parameters were simultaneously monitored in the different stages of sewage treatment plant (STP) using standard methods. These parameters showed distinct seasonal variation. Higher phosphate value than the nitrate is a noteworthy feature during the present study.

Key words: Seasonal variation, Physicochemical parameters, Nitrate, Nitrite, Phosphate.

INTRODUCTION

The exponential growth in urbanization through migration of people from rural and semi-urban areas to cities in search of livelihood, has contributed to the deploring sewerage situations in most major cities of the world. In India, 40-50% of the populations of the major cities are served by sewer systems. Even where sewers exist, they are poorly designed, constructed or maintained. Raw sewage contains urine and faeces from toilet flushing as well as other types of human waste. The pathogens in raw sewage can contaminate ecological systems in addition to sickening humans and animals. In addition, raw sewage contains nutrients, which can stimulate the growth of aquatic plants[1,2]. Besides being exposed to bacteria and viruses, a person exposed to raw sewage may develop a range of illnesses, including gastroenteritis, which is marked by diarrhoea, vomiting, and abdominal pain[3].

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EXPERIMENTAL

Material and methods

The wastewater treatment facility is situated at geographical location: Bhopal, Madhya Pradesh, India, and geographical coordinates 23^o 15’ 44’’ North, 77^o 28’ 23’’ East. Badwai sewage treatment plant, which has a design capacity of the plant as 16.67 (MLD) receives domestic sewage, some light industrial wastewater, as well as run-off water. Wastewater samples were collected from the different stages of sewage treatment plant. The study period is divided into three seasons i.e. Summer, spring and winter season. Samples were collected monthly between January to December 2009. Samples were collected in plastic bottles, pre-cleaned by washing with non-ionic detergents, rinsed with water, 1 : 1 hydrochloric acid and finally with deionised water. Before sampling, the bottles were rinsed three times with sample water. pH, temperature, electrical conductivity, nitrate, nitrite and phosphate were analyzed in the analytical laboratory according to the standard procedure[4].

RESULTS AND DISCUSSION

The water quality analysis of different stages of wastewater in sewage treatment plant has been carried out. Physicochemical parameters like pH, temperature, electrical conductivity, turbidity, nitrate, nitrite and phosphate were analyzed and the results are shown in the Table 1.

Table 1: Seasonal variation of physicochemical parameters at different stages of sewage treatment plant

Parameter	Seasons	Influent of STP	Tank -1	Tank -2	Tank -3	Tank -4	Tank -5	Effluent of STP
pH	Summer	6.75	7.32	7.56	7.74	7.82	8.22	8.33
	Winter	6.54	6.74	6.88	7.25	7.31	7.41	7.45
	Spring	6.65	7.28	7.48	7.62	7.76	7.86	7.95
Temperature (^{o}C)	Summer	28.7	28.5	28.8	28.9	28.7	28.9	29.1
	Winter	23.5	23.7	23.6	23.8	23.7	23.9	24.2
	Spring	27.4	27.6	27.5	27.7	27.6	27.9	28.3

Cont…

Parameter	Seasons	Influent of STP	Tank -1	Tank -2	Tank -3	Tank -4	Tank -5	Effluent of STP
Conductivity (μmhos/cm)	Summer	1.914	1.752	1.643	1.603	1.572	1.425	1.325
	Winter	0.872	0.765	0.712	0.653	0.601	0.573	0.436
	Spring	1.432	1.342	1.131	1.284	1.142	1.023	0.918
Turbidity (NTU)	Summer	175.2	145.4	121.3	97.5	68.3	42.7	18.7
	Winter	130.5	105.2	86.7	65.4	41.3	21.8	9.2
	Spring	164.3	133.7	109.5	80.4	58.7	31.8	14.2
Nitrate (mg/L)	Summer	4.48	3.86	3.65	3.22	2.95	2.75	2.56
	Winter	2.43	2.34	2.12	1.98	1.78	1.52	1.24
	Spring	3.79	3.52	3.35	3.21	2.86	2.35	2.06
Nitrite (mg/L)	Summer	2.64	2.58	2.46	2.32	2.02	1.87	1.51
	Winter	1.18	1.17	1.12	1.11	1.01	0.92	0.75
	Spring	2.26	2.15	2.04	1.82	1.65	1.55	1.33
Phosphate (mg/L)	Summer	14.48	13.83	12.48	11.87	11.26	10.75	10.07
	Winter	11.42	10.13	9.47	7.86	6.84	6.23	5.93
	Spring	12.33	11.69	11.13	10.67	9.23	8.57	7.83

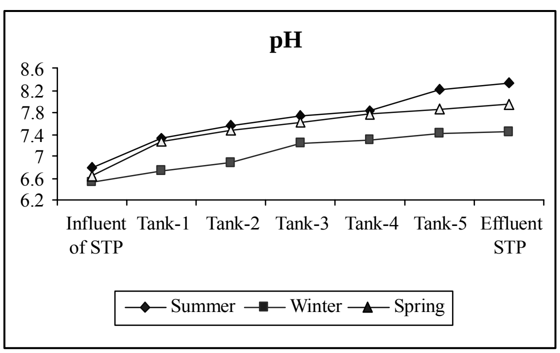

Fig. 1: Seasonal variation of pH in sewage treatment plant

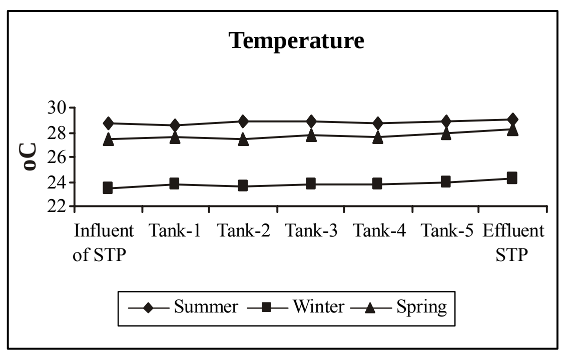

Fig. 2: Seasonal variation of temperature in sewage treatment plant

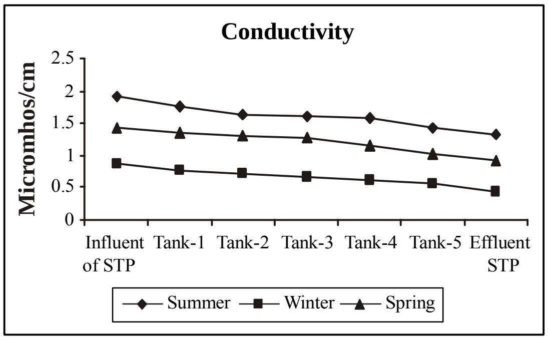

Fig. 3: Seasonal variation of electrical conductivity in sewage treatment plant

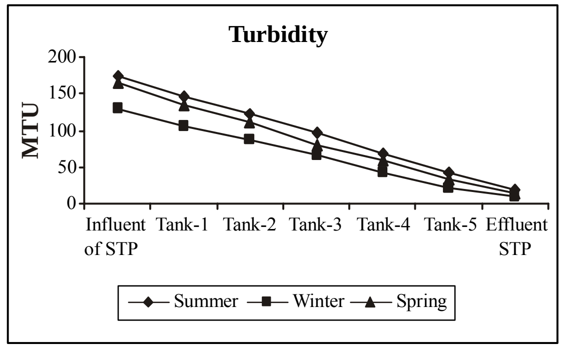

Fig. 4: Seasonal variation of turbidity in sewage treatment plant

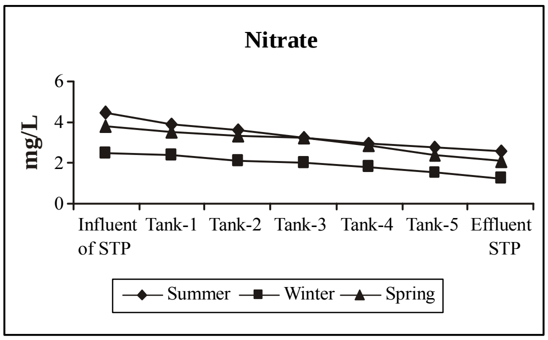

Fig. 5: Seasonal variation of nitrate in sewage treatment plant

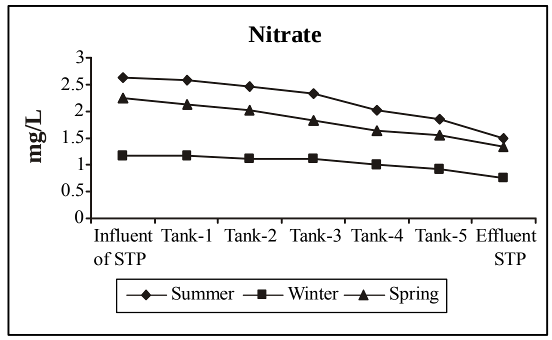

Fig. 6: Seasonal variation of nitrite in sewage treatment plant

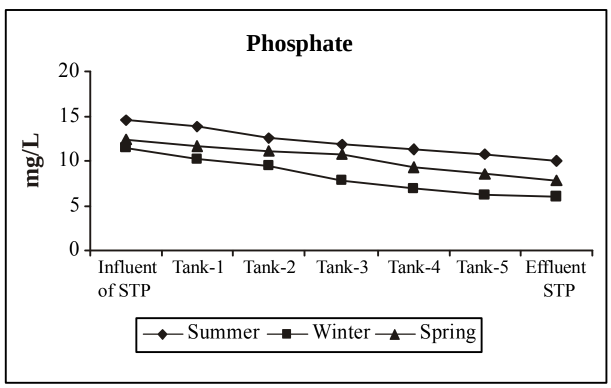

Fig. 7: Seasonal variation of phosphate in sewage treatment plant

pH

The high pH values during summer may be due to high photosynthesis of micro and macro vegetation resulting in high production of free CO_2, shifting the equilibrium towards alkaline side[5]. The pH controls the chemical state of many nutrient including dissolved oxygen, phosphate, nitrate etc.[6] The results of the physicochemical qualities of samples from the different points are as shown in Table 1. The pH ranged from 6.78 to 8.33 during summer, 6.54 to 7.45 during winter and 6.65 to 7.95 during spring. pH of the treated final effluent water varies from 7.45 to 8.33. These values fall within the World Health Organization limits[7-9].

Temperature

Temperature is basically important for its effect on other properties of wastewater. The temperature profile of the treated final effluent and receiving water body varies significantly and ranged from 28.7 to 29.1°C during summer; 23.5 to 24.2°C during winter and 27.4 to 28.3°C during the spring. The treated final effluent water has temperature range of 24.2 to 29.1°C. This is the recommended limit for no risk water quality guidelines for domestic use[10].

Electrical conductivity

Electrical conductivity is the capacity of water to carry ions, so it depends on the presence of ions and their concentration. Electrical conductivities of the water samples generally varied significantly and ranged from 1.325 to 1.914 µmhos/cm during summer; 0.436 to 0.872 µmhos/cm during winter and 0.918 to 1.432 µmhos/cm during the spring. Throughout the study period, treated final effluent water show conductivity from samples 0.436 to 1.325 µmhos/cm. Higher conductivities were observed in the effluent water of STP in summer (Fig. 3) and spring seasons, suggesting that there could be other point sources pollution entering into the receiving water body that resulted in the high values. The limit was exceeded in the receiving water body[11].

Turbidity

Water is considered to be of improved water quality, when it contains turbidity value of 1 NTU or below. Seasonal variation in the values of turbidity are shown in the Fig. 4. Turbidity was found in the range from 18.75 to 175.2 NTU during summer; 9.25 to 130.5 NTU during winter and 14.23 to 164.3 NTU during spring season. In particular, turbidity of the treated final effluent varies between 9.25 NTU and 18.75 NTU, but the turbidity values obtained from the effluent of STP in all seasons was higher than WHO standards[12]. These values are grossly exceeded in the water samples and it disqualifies the receiving water body for direct domestic use. Also, the excessive turbidity in water can cause problem with water purification processes such as flocculation and filtration, which may increase treatment cost[13].

Nitrate

In the present study, nitrate concentration range between 2.56 to 4.48 mg/L during summer; 1.24 to 2.43 mg/L during winter and 2.06 to 3.79 mg/L during spring season (Table 1). In the treated final effluent water samples, it varied from 1.24 mg/L and 2.56 mg/L and differ significantly (Fig. 5). The total nitrate levels obtained during the study period exceeded the regulatory limits and thus, it may be a source of eutrophication for receiving water[10]. Higher value of nitrate may be as a result of diffuse source from settlement and agriculture run off.

Nitrite

Seasonal variation in the nitrite are shown in Fig. 6. Nitrite content was found 1.51 to 2.64 mg/L in summer, 0.75 to 1.18 mg/L in winter and 1.33 to 2.26 mg/L in spring in influent water. In the treated effluent, water nitrite ranged from 0.75-1.51 mg/L. The total nitrite levels obtained during the study period are above the regulatory limits. The increased level of nitrite may cause problems to living being, if the receiving water bodies are used for domestic purposes. This may cause methaemoglo binemia[14].

Phosphate

The phosphate contents varied from 10.07 to 14.48 mg/L during summer; 5.93 to 11.42 mg/L during winter and 7.83 to 12.33 mg/L during spring season. The treated final effluent had phosphate ranges between 5.93 mg/L to 10.07 mg/L (Table 1). The phosphate content was higher during spring season. This may be due to the rapid decomposition of organic matters and evaporation in the water body due to high temperature. Higher phosphate-P values could be attributed to phosphorus in runoff from domestic, municipal and agricultural waste (non-point sources) flowing into rivers, as well as washing along the riverside with detergents[15].

CONCLUSION

The results revealed that the treatment plant exhibited effluent qualities that meet acceptable standard in physicochemical parameters, like pH, temperature and electrical conductivity. It is also observed that other parameters i.e. turbidity, nitrate, nitrite and phosphate value in the effluent water fell short of regularity limits for domestic use. If this water is further used, it may cause problems. The study showed a need for a continuous pollution monitoring programme of the sewage treatment plant, Bhopal.

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