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Physico-Chemical Characteristics of Wastewater from Open Sewer Drainage System in Waluj MIDC Area of Aurangabad, Maharashtra, India

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Abstract The present paper deals with the studies on physico-chemical characteristics of wastewater generated from Waluj, Maharashtra Industrial Development Corporation (MIDC) area of Aurangabad city from Maharashtra, India. During the investigation, sampling was carried out from seven sampling sites in the month of March (pre monsoon season) and December (post monsoon season), 2015.The physico-chemical parameters such as temperature, pH, total solids (TS), total dissolved solids (TDS), total suspended solids (TSS), dissolved oxygen (DO), chlorides, chemical oxygen demand (COD), biological oxygen demand (BOD), total hardness (TH), oil and grease (O and G), alkalinity (Alk) and phosphate (PO^4) were analyzed by using widely accepted methods. The result of analysis reveals that, the some physico-chemical parameters were excided than the standard limits of parameters in pre-monsoon period. Open sewerage near chemical industrial area (site 4), shown the reddish color to sewage and displayed the higher values of the parameters such as pH-5, TS-95467 mg/lt, TDS-67300 mg/lt, COD-927 mg/l, BOD-178 mg/l, Chloride-1335 mg/l, Hardness-3500 mg/l, Alkalinity-1690 mg/l and there is no DO noted at this site. Whereas, the parameters from all selected sampling sites during post-monsoon period were found within permissible limit in accordance to BIS. The reported physico-chemical parameters will be helpful for deciding and adopting specific strategies for the sewage treatment and identifying some probable threat and risk to freshwater resources if added directly in them.

Keywords Aurangabad, Waluj MIDC, Wastewater, Physico-chemical parameters, Sewage treatment.

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Introduction

Aurangabad city is the seventh rapidly growing township in Asia and emerging as an industrial hub next to the Mumbai, Nagpur, Pune and Nasik cities of Maharashtra state. The industrial units has been established in Chikalthana, Waluj, Chite Pimpalgaon, Bidkeen and Shendra MIDC areas near to Aurangabad city (Bikkad and Mirgane 2009). The rapidly growing industrial units may leads in the generation of a huge quantity of industrial wastewater. Aurangabad is the main city of the Marathwada region.

The huge quantity of sewage is generated from the residential, commercial and industrial areas and flushing in sewer system (Bagul et al. 2015). The generated domestic wastewater is being directly discharged in the Kham River, through the sewer system. The disposal of untreated sewage in to river system deteriorate the quality of river water and may create the severe health problems in society, those who are using such untreated sewage mixed river water for domestic use (Sami and Mule 2015). It was also noted that, the downstream villages on the bank of the Kham River are using the sewage mixed river water for domestic and agricultural purposes and which may results in harmful impacts on human health as well as on flora and fauna of the river (Shinde et al. 2016).

Many time local resident populations have raised the complaints about the quality of local streams and underground water in news paper and in media. There were some incidences of fish mortality in river where the sewer mixed streams meets to river. Therefore this work of monitoring of wastewater quality in terms of its physico-chemical parameters was undertaken and determined in pre-monsoon and post monsoon seasons of 2015.

Study area

The Waluj MIDC area is present in Gangapur Taluka of Aurangabad District from Maharashtra State, India. It belongs to Marathwada region. It is located 18 km away from Aurangabad city towards west side. The area located 15 km from Gangapur. Villages in the periphery of Waluj MIDC are Lanzi (4 km), Pandharpur (4 km), Jogeshwari (4 km) and Patoda (6 km).

In order to study the physico-chemical characteristics of wastewater generated from residential areas and from an industrial area, the Waluj area from Aurangabad was selected as study area. During present investigation seven sampling sites from Waluj MIDC of Aurangabad city were selected. Open sewerage systems sampling sites were selected by considering different types of industries in the nearby areas. Seven different sampling sites were selected, which covers the major periphery of Waluj MIDC area. All the sampling sites except site 4 were containing running wastewater. All the seven sampling sites of study areas are as Nahla near automobile industry (site 1), Nahla near engineering industry (site 2), Nahla near pharmaceutical industry (site 3), Nahla near chemical industry (site 4), Nahla near breweries industry (site 5), Nahla near ranjangaon village (site 6), Nahla near plastic industry (site 7).

Materials and Methods

During the present study, the grab sampling method was used for collection of samples from selected sampling sites. The cleaned dry plastic container of 5 l capacity was used for the collection of sample. The water quality parameters viz. pH and temperature were recorded at sampling sites itself. Whereas, for dissolved oxygen sample was collected in clean BOD bottle and dissolved oxygen was fixed by adding manganous sulfate and alkali iodide azide reagent at the sampling site and further dissolved oxygen determined in laboratory. Samples were brought to laboratory for analysis of physico-chemical parameters viz. TS, TDS, TSS, EC, COD, BOD, O and G, ALK, Chl, TH, and PO^4. The parameters were determined by adopting standard and widely accepted methods as described by APHA (1999); Trivedi and Goel (1986); Khanna and Bhutiani (2013). The parameters were analyzed in laboratory and recorded the results.

Results and Discussion

The physical parameters were determined in field and in laboratory and the chemical parameters were determined in laboratory by using analytical grade reagents chemicals.

The results of physico-chemical characteristics

Table 1. Physico-chemical characteristics of wastewater samples with Mean and SD.

Sl. No.	Sample	Temp	pH	EC	TS	TDS	TSS	DO	Cl^-	COD	BOD	Alk	TH	O & G	PO^4
1	Site-1	27	9	1165	2038	1765	586	1	1	205	68	205	280	1	0.480
2	Site-2	26	8	1565	2934	2250	684	2	11	110	37	370	198	2	0.320
3	Site-3	26	8	1607	3090	2320	770	1	7	230	52	320	205	8	0.205
4	Site-4	26	5	0	95467	67300	28167	0	1335	927	178	1690	3500	0	0
5	Site-5	27	9	1284	2460	1150	1310	1	13	185	48	480	170	1	0.455
6	Site-6	27	8	1475	1687	300	1387	1	8	142	28	180	190	1	0.105
7	Site-7	28	9	1395	1859	789	1071	2	3	90	32	230	175	1	0.389
	Mean	27	8	1415	15648	10839	4854	1	197	270	63	496	674	2	99
	SD		27	13	663	982	951	868	867	850	812	787	756	725	695

of wastewater samples collected from Waluj MIDC of Aurangabad city during Pre and Post-monsoon period of the year 2015 were summarized in Tables 1 and 2 respectively and some individual determined parameters represented graphically in Figs 1 to 4.

Temperature

It is measured immediately at the sample collection site by using a thermometer. The variation in sewage temperatures observed in pre-monsoon season post monsoon seasons sample. The recorded range of temperature is in between 23 to 28 °C. Slight lowest temperature was recorded up to 23°C in post monsoon season, where as highest recorded up to 28°C. The average temperature of 27°C was recorded in pre-monsoon season where average 24°C in post monsoon season. The temperature of all sampling sites summarized in Tables 1 and 2. Temperature may control the biotic organism's activity in water flowing in sewer system at Waluj area.

Temperature is one of the most important factors for controlling ecological balance through, physiological behavior and distribution of organisms in water body (Saba and Yadhav 2014).

pH

The pH of the samples was determined immediately at sampling site by a pH meter. The results are shown in Tables 1 and 2 and represented graphically in Fig 1. The pH is a hydrogen ion concentration measures and predicts the acidic and allkaline nature of wastewater. In this study, pre-monsoon pH was recorded lowest 5 and higher up to 9 whereas post-monsoon it

Table 2. Physico-chemical characteristics of wastewater samples with Mean and SD. All parameters in mg/l except pH, temperature in °C, and electric conductivity (EC) in micro siemens/cm.

Sl. No.	Name of sample	Temp °C	pH	EC	TS	TDS	TSS	DO	Cl^-	COD	BOD	Alk	TH	O & G	PO^4
1	Site-1	23	8	1347	1370	600	770	2	39	189	57	185	158	1	0.77
2	Site-2	25	7	400	778	618	160	3	13	69	38	87	105	1	0.160
3	Site-3	25	8	1056	1549	720	830	3	11	167	60	49	78	6	0.60
4	Site-4	23	7	687	2390	1500	890	2	25	487	148	237	359	3	0.496
5	Site-5	24	8	980	1550	850	700	1	19	145	35	187	138	2	0.389
6	Site-6	24	8	1073	1400	600	805	3	28	123	29	130	145	1	0180
7	Site-7	23	7	995	1267	989	280	2	23	84	25	98	183	2	0.47
	Mean	24	7	934	1472	840	634	2	22	181	56	139	167	2	0
	SD	1	1	305	482	326	290	1	10	142	43	67	92	1	0

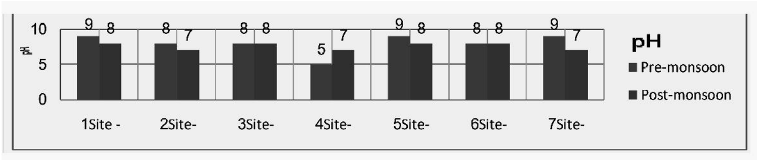

Fig. 1. Representation of pH in pre-monsoon and post-monsoon season at sampling sites at Waluj area during year 2015.

was recorded 7 to 8 in the range. Highly alkaline pH range observed 8 to 9 in pre-monsoon season whereas neutral to slightly alkaline pH range observed in post-monsoon season of March 2015.

In this investigation highly acidic sample recorded 5.0 nears chemical industry Site 4. This Site 4, sewage found a stagnant condition which has a reddish color. Alkaline nature of pH ≥ 9 is unsuitable for domestic and irrigation purposes (Kavitha et al. 2012). Whereas, the major sites of the sampling of both season noted alkaline in nature ranged within pH of 8 to 9. The findings of the present study are observed in agreement with CPCB guideline, except site 4 of the pre-monsoon season.

Electrical conductivity (EC)

Electrical conductivity of samples were recorded in unit umhos/cm and determined by using a digital conductivity meter. The results were summarized in Tables 1 and 2. The electrical conductivity in pre-monsoon were recorded as 1165 in site 1, 1565 in site 2, 1607 in site 3, 1284 in site 5, 1475 in site 6 and 1395 in site 7 whereas post-monsoon EC recorded as- 1347 in site 1, 400 in site 2, 1056 in site 3, 687 in site 4, 980 in site 5, 1073 in site 6 and 995 in site 7. In both seasons of 2015, all sampling sites recorded high EC as compare to prescribed water quality standards.

The high EC values of sample indicate that the presence of dissolved inorganic substances in ionized form. In the present study higher electrical conductivity of samples may be due to the high concentration of dissolved salts in the wastewater. The ions of elements might be liberated from the decomposed biotic material of plant and animal materials. The results of EC were noted varied significantly and findings are similar as reported by Igbinosa and Okoh (2009).

Total solids (TS)

Total solids include the suspended and dissolved solids in water. The total solids of wastewater were determined from the study area and results were listed in Tables 1 and 2. TS in pre-monsoon recorded as 2038 mg/l in site 1, 2934 mg/l in site 2, 3090 mg/l in site 3, 95447 mg/l in site 4, 2460 mg/l in site 5, 1687 mg/l in site 6 and 1859 mg/l in site 7 whereas in post-monsoon season recorded TS is 1370 mg/l in site 1, 778 mg/l in site 2, 1549 mg/l in site 3, 2390 mg/l in site 4, 1550 mg/l in site 5, 1400 mg/l in site 6 and 1267 mg/l in site 7. The higher TS value was recorded at sampling site 4, as 95,447 mg/l in pre-monsoon season. This higher value of TS might be due to accidental release of inorganic salts or industrial wastewater from nearby industries in the sewer line.

The removal of dissolved component is not easy task and affects on living components adversely. TS and TDS values increases conductivity of water, due to this rate of photosynthesis in aquatic plants is reduced significantly (Siyanbola et al. 2011).

Total dissolved solids (TDS)

The total dissolved solids (TDS) of wastewater from study area were determined and results were summarized in Tables 1 and 2. In pre-monsoon season the high TDS recorded as- 2250 mg/l in site 2, 2320 mg/l in site 3, 67,300 mg/l in site 4, 1150 mg/l in site 5, 300 mg/l in site 6 and 789 mg/l in site 7. The TDS of samples of pre and post-monsoon were recorded below permissible limits of BIS. In this research site 4 in pre-monsoon season showed high TDS and this site is near to chemical industry. A high content of dissolved salts change the density of water. High dissolved solids recorded in site 4 samples maybe due to discharge of industrial waste water in open sewer system; the similar results were also given by Dhingra et al. (2015) from industrial areas of Jaipur Rajasthan, India.

Total suspended solids (TSS)

Total suspended solids (TSS) is important parameter of domestic wastewater analysis. The results of total suspended were analyzed and summarized in Tables 1 and 2. In pre-monsoon season TSS of the sampling site recorded as 586 mg/l in site 1, 684 mg/l in site 2, 770 mg/l in site 3, 28,167 mg/l in site 4, 1310 mg/l in site 5, 1387 mg/l in site 6 and 1071 mg/l in site 7. The site 1 TSS was below permissible limit. The highest TSS was recorded at sampling site 4, which is near to chemical industries. In the post-monsoon season higher TSS were recorded as 770 mg/l in site 1, 830 mg/l in site 3, 890 mg/l in site 4, 700 mg/l in site 5, 805 mg/l in site 6 and below permissible limit recorded is 160 mg/l in site 2 and 280 mg/l site 7. The higher suspended solid might be released from residential and industrial area and which might be accidently or intentionally disposed in sewer system.

The wastewater containing higher load of suspended solids, cannot directly used for agricultural or any type of domestic use because inorganic TSS makes unsafe condition for soil strata and unsuitable for aquatic life as reported by Ewere et al. (2014) in Nigeria.

Dissolved oxygen (DO)

In the assessment of water quality dissolved oxygen plays a vital role. In aquatic biota entry of oxygen is through direct diffusion of air and by the process of photosynthesis by aquatic autotrophs. Dissolved oxygen of the sampling sites in pre-monsoon and post monsoon season were recorded in Tables 1 and 2.

The dissolved oxygen is present only at site 2 as 1.8 mg/l. The DO was absent in site 1 and site 3 to site 7. In post-monsoon DO of the sampling sites were recorded as 2.3 mg/l in site 1, 3.2 mg/l in site 2, 2.7 mg/l in site 3, 1.9 mg/l in site 4, 1 mg/l in site 5, 3 mg/l in site 6 and 1.5 mg/l in site 7. In post monsoon season all 7 sites shows dissolved oxygen constant. No oxygen content in the wastewater indicates higher level of pollutants in it. Low DO in samples indicating a high concentration of organic contents which increases biological oxygen demand. The similar results were recorded by Jayalakshmi et al. (2011) from around the city of Vijayawada, India.

Chloride (Cl^-)

Excess chloride available in wastewater not used directly by aquatic plant hence excess amount causes a harmful impact on aquatic life. The chloride content in wastewater collected from sewer system were analyzed and listed in observation 3 and 4. Chloride content of pre-monsoon was recorded in the range of 3 to 1335 mg/l. In post-monsoon season it is recorded in the range of 11 to 39 mg/l. Results are summarized in Tables 1 and 2.

The concentrations of chloride content available in sewage for both seasons show within permissible limits except site 4 in pre-monsoon season. The highest chloride content was present in site 4 which is near to chemical industry. The excess chloride content might be from the accidental input of salts in wastewater or it might be from domestic sources. The chloride content in other all sampling sites are within permissible limit. The dilution of sewage due to surface runoff may be the reason for having chlorides below permissible limits in remaining all sites. The high concentration of Chloride in excess (> 250 mg/l) resulting in a salty teste to water which is unacceptable to uses, (Chauhan 2014) studied the untreated sewage water of Ladwa town of Kurukshetra District of Haryana, India.

Chemical oxygen demand (COD)

In present study wastewater COD of seven sampling sites were determined in pre and post monsoon season at Waluj area. The results were recorded in Tables 1 and 2. The graphic presentation of COD is given in Fig. 2. COD recorded in pre-monsoon is in the range

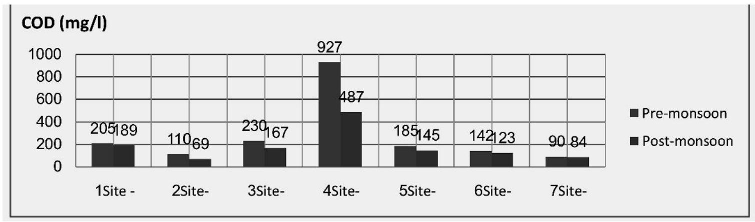

Fig. 2. The content of chemical oxygen demand (COD) in pre-monsoon and post-monsoon season at sampling sites at Waluj area during year 2015.

of 90 to 927 mg/l. Whereas in post-monsoon season it was recorded in the range 69 to 487 mg/l. During investigation higher COD values are recorded in pre-monsoon seasons as 927 mg/l and 487 mg/l in post monsoon season at sampling site 4. The higher values of COD may be due to containing organic and inorganic matter and due to the discharge of untreated wastewater in open sewerage.

The disposal of industrial and domestic waste may be responsible for having higher values for COD. In present investigation site 4 higher value of COD may be due to such unforeseen conditions. Sewer water contains low concentration of cations but high concentration of anions therefore it shows higher load of COD and total suspended solids, as reported by Soudani et al. (2011) in the study of potential adsorbent for municipal and industrial wastewater treatment.

Biological oxygen demand (BOD)

The biological oxygen demand (BOD) is an important parameter which indicates the organic load in water body. The microorganism in water utilize the dissolved oxygen hence larger the number of microorganism in water maximum the demand of oxygen. The results were recorded in Tables 1 and 2 and graphic presentation of BOD is given in Fig. 3.

Pre-monsoon BOD_3, of sampling sites was recorded in the range of 32 to 178 mg/l whereas post-monsoon BOD_3 in the range of 29 to 148 mg/l. The pre-monsoon season BOD values for sampling site 1 to 7 are 68, 37, 52, 178, 48, 28 and 32 mg/l. Where in post-monsoon season 57, 38, 60, 148, 35, 29 and 25 mg/l respectively.

The sampling site 4, indicating the higher BOD values indicating higher organic pollution load in

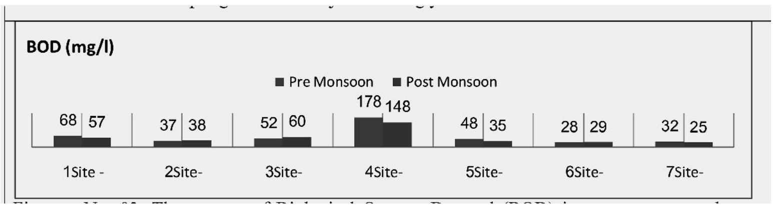

Fig. 3. The content of biological oxygen demand (BOD) in pre-monsoon and post-monsoon season at sampling sites at Waluj area during year 2015.

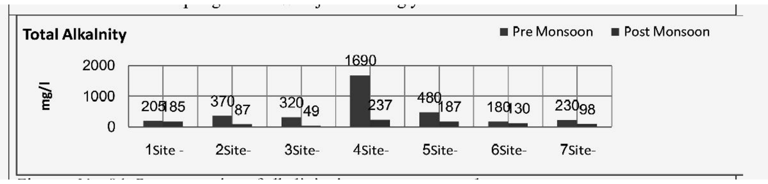

Fig. 4. Representation of alkalinity in pre-monsoon and post-monsoon season at t sampling sites at Waluj area during year 2015.

wastewater. The results of present work revealed that, although very low DO level but concentration of BOD and COD was not reduced due to required time for reactions may interrupted as reported by Rathore et al. (2014) in the study of physico-chemical analysis of water of Ayad River at Udaipur, Rajasthan, India.

Alkalinity

The alkalinity of sewage due to the salt of carbonates, borate silicates and phosphate along with free ions in hydroxyl state. It is the capacity of water to neutralize strong base and this occurs due to the presence of calcium, carbonate, sodium, hydroxide compound and bicarbonates in wastewater.

The total alkalinity of collected wastewater samples sites in pre-monsoon and post monsoon season at Waluj area were summarized in Tables 1 and 2 whereas it is graphically presented in Fig. 4. The total alkalinity of wastewater sampling sites was recorded in 180 to 1690 mg/l as $CaCO_3$ range. Whereas in post-monsoon alkalinity was recorded as 49 to 237 mg/l as $CaCO_3$ range. The higher values of total alkalinity were recorded during pre-monsoon season as 1690 mg/l in site 4 and lowest values were recorded in post monsoon season as 49 mg/l to site 3. It is concluded that the higher alkalinity in river water is not suitable to use such water for agricultural purposes, as mentioned by Kumar and Bahadur (2009), during the study pollution potential of river Kosi at Rampur, India.

Total hardness

The total hardness of seven samples was determined in pre and post monsoon seasons and results were listed in Tables 1 and 2. The total hardness of seven sampling sites in pre-monsoon season 280 mg/l in site 1, 198 mg/l in site 2, 205 mg/l in site 3, 3500 mg/l in site 4, 170 mg/l in site 5, 190 mg/l in site 6 and 175 mg/l in site 7, as $CaCO_3$. Whereas post-monsoon season total hardness was recorded as 158 mg/l in site 1, 105 mg/l in site 2, 78 mg/l in site 3, 359 mg/l in site 4, 138 mg/l in site 5, 145 mg/l in site 6 and 183 mg/l in site 7.

The higher TDS in sewer water was recorded due to contamination of domestic wastwater, garbage, fertilizers and might cause due to increases nutrient status of water body and finally resulted intoeurophication of aquatic system. The similar predictions were given by Chaurasia and Pandey (2007) from some water ponds of Ayodhya-Faizabad, India.

Oil and grease

Oil and grease of seven sampling sites in pre-monsoon season is recorded in between 1 to 8 mg/l whereas; in post-monsoon season it was recorded in the range of 1 to 6 mg/l. Results are listed in Tables 1 and 2. In the present study high concentration of oil and grease 8.3 mg/l recorded in sampling site 3 which near to pharmaceutical industry, the excess oil and grease makes a coating or film on the surface of the water and floats. The same results of oil and grease was reported by Jadhav and Mule (2016), in his study of wastewater quality of sewer system of urban area of Aurangabad city, Maharashtra, India.

Phosphate

The phosphorus is an important nutrient required to growth of aquatic plants. The phosphorus in the form of phosphate is utilized by plant for growth. The total phosphate (PO_4) contains seven sampling sites from Waluj area were determined and the results of pre and post monsoon seasons were listed in Tables 1 and 2. The phosphate at seven sampling sites in pre-monsoon was recorded in the range of 0.78 to 0.480 mg/l whereas; in site 4 phosphates was not detected. In the post-monsoon season phosphate content were recorded in the range of 0.47 to 0.496 mg/l. During the investigation, all sampling site found phosphate within permissible limit. Phosphate may occur in surface water coming through untreated wastewater discharge and use detergent, fertilizers in water for various purposes, the results of total phoshate are found similar to Popa et al. (2012), findings of analysis noted variation in site of domestic waste contain lipid, protein and degraded products whereas the industrial waste site results was noted quite different therefore the relationship of two sites was disappears.

Correlation coefficients (r)

The correlation coefficient (r) between different pairs of the physicochemical parameters were furnished in the Table 2 for pre-monsoon season and Tables 3 and 4 for post monsoon season. The interferences drawn by observing the correlation coefficient of various pairs of sewage parameters is outlined as below.

The pH in the pre-monsoon positively coefficients with EC (0.85%), DO (0.59%), O and G (0.26%), PO^4 (0.22%) and in the post-monsoon highly correlate with EC (44%), TSS (32.0%), DO (0.32%). Electrical conductivity (EC) highly correlate in pre-monsoon with DO (0.59%), whereas in post monsoon found higher coefficient with chloride (0.60%), alkalinity (0.08%) and PO^4 (0.14%).

In pre-monsoon TDS observed highly coefficient with Alkalinity (0.98%) TH (1.00%), COD (0.99%), BOD (0.98%). Chloride highly coefficient in pre-monsoon with COD, BOD and TH whereas in post-monsoon highly coefficient with alkalinity (0.61%). COD and BOD observed vice versa highly correlated with each other in both seasons as (0.99%) with BOD and (0.97%) with TH. Whereas, in post-monsoon COD highly coefficient with (0.98%) with BOD (0.82%). Alkalinity observed highly coefficient with TH in both season as (0.98%) and (0.76%) respectively.

The coefficient of variation for temperature, pH, EC, TDS, TH, COD, BOD, PO^4, O and G, DO found near to value 1 means the good relation between to variables but some parameters having around zero value occurred in no any to relation noticed.

The parameters of EC-TDS, BOD-COD, TDS and Chloride noted good correlation which will help to develop and establishing of water quality modeling

Table 3. Physico-chemical characteristics of wastewater samples and correlation coefficient.

	Temp	pH	EC	TS	TDS	TSS	DO	Cl^-	COD	BOD	Alk	TH	O & G	PO^4
Temp	1													
pH	0.36	1.00												
EC	0.21	0.35	1.00											
TS	-0.33	-0.95	-0.96	1.00										
TDS	-0.34	-0.95	-0.96	1.00	1.00									
TSS	-0.30	-0.95	-0.96	1.00	1.00	1.00								
DO	0.43	0.59	0.71	-0.71	-0.71	-0.70	1.00							
Cl^-	-0.32	-0.95	-0.96	1.00	1.00	1.00	-0.70	1.00						
COD	-0.40	-0.92	-0.95	0.99	0.99	0.98	-0.81	0.99	1.00					
BOD	-0.41	-0.88	-0.97	0.97	0.97	0.96	-0.80	0.97	0.99	1.00				
Alk	-0.40	-0.90	-0.94	0.98	0.98	0.98	-0.71	0.98	0.97	0.95	100			
TH	-0.33	-0.95	-0.96	1.00	1.00	1.00	-0.71	1.00	0.99	0.97	0.98	100		
O & G	-0.37	0.26	0.49	-0.33	-0.32	-0.35	-0.15	-0.34	-0.25	-0.27	-0.32	-0.34	100	
PO^4	-0.01	0.22	-0.04	-0.17	-0.16	-0.18	-0.07	-0.17	-0.10	0.04	-0.24	-0.14	-0.12	1.00

Table 4. Physico-chemical characteristics of wastewater samples and correlation coefficient.

	Temp °C	pH	EC	TS	TDS	TSS	DO	Chl	COD	BOD	Alk	TH	O & G	PO^4
Temp °C	1													
pH	0.47	1.00												
EC	-0.39	0.44	1.00											
TS	-0.57	-0.27	0.10	1.00										
TDS	-0.61	-0.75	-0.31	0.81	1.00									
TSS	-0.26	0.39	0.52	0.75	0.22	1.00								
DO	0.73	0.32	-0.23	0.41	-0.51	-0.10	1.00							
Chl	-0.62	0.00	0.60	0.19	-0.01	0.33	-0.14	1.00						
COD	-0.45	-0.41	-0.12	0.92	0.81	0.61	0.21	0.23	1.00					
BOD	-0.30	-0.46	-0.24	0.84	0.79	0.51	-0.09	0.11	0.98	1.00				
Alk	-0.65	-0.21	0.08	0.66	0.56	0.47	-0.49	0.61	0.71	0.59	100			
TH	-0.70	-0.68	-0.19	0.79	0.90	0.30	-0.36	0.37	0.87	0.82	0.76	100		
O & G	-0.62	-0.42	-0.10	0.93	0.91	0.52	-0.57	0.01	0.82	0.74	0.63	0.81	100	
PO^4	-0.34	-0.45	0.14	0.33	0.47	0.01	-0.46	-0.34	0.13	0.14	-0.27	0.14	0.42	1.00

and new technology adaption (Venkatesh et al. 2009).

Conclusion

The present investigation reveals that some physico-chemical parameters exceeded the standards of sample collected in pre-monsoon period. Whereas the values of parameters from selected sampling sites during the post-monsoon period were found within the permissible limit in accordance to BIS this may happen due to concentration diluted due rainy season. The physico-chemical parameters pH, TS, TDS, COD, BOD, Chloride, Hardness, Alkalinity and Phosphate in pre-monsoon season are comparatively highly concentrated.

The result of the sewage analysis of site 4 in pre-monsoon is highly needed of urgent attention to take sewage pollution problems in the urban and industrial area. The pollutant load in wastewater was high and it was acidic with pH-5, TS-95467, TDS-67300, COD-927, BOD-178, Chloride-1335, Hardness-3500, Alkalinity-1690. The other parameters such as DO, EC, O and G are in limits. The threatening sewage characteristics at the sampling site 4 which near of chemical industry indicating these sectors contain polluted water quality of Kham River due to disposal of sewage and industrial waste.

The discharge from the Waluj MIDC sewer without any treatment mixed in Kham River and make sewage highly polluted, which could not be used for irrigation, animal feeding, fishing. The results also reflect there is an urge need of adoption of cost-effective wastewater treatment technology and strict implementation of guidelines issued by the state pollution control board for erecting and operation of the effluent treatment plant at each nearby industrial unit. However, for a cluster of small manufacturing units, there is a need to establish common sewage treatment plant for treatment of sewage or industrial effluent should be connected to common effluent treatment plant facility for better and safe surface water resources.

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