Environment Conservation Journal 17(3) 133-142, 2016
ISSN 0972-3099 (Print) 2278-5124 (Online)
Abstracted and Indexed

Physico-chemical analysis of Sewage water treatment plant at Jagjeetpur Haridwar, Uttarakhand

R. Bhutiani ✉, D.R. Khanna, Shubham and Faheem Ahamad

Received: 21.05.2016 **Accepted: 19.08.2016**

Abstract

Water is quite essential natural element for all kinds of life. The quality of water is vital concern for mankind since it is directly linked with human welfare. The water samples were collected from sewage treatment plant (from both 18 MLD and 27 MLD) situated in Jagjeetpur, Haridwar. The study was carried out for a period of four months and total 15 sampling were done during this period. Results revealed that in inlet pH varied from 7.13 to 8.76 and in outlet 6.01 to 8.2, total solids in inlet varied from 751 mg/l to 897 mg/l and in outlet from 509 mg/l to 749 mg/l. The total hardness in inlet was found between 212mg/l to 249 mg/l and in outlet from 178 mg/l to 210 mg/l. Chloride in inlet varied from 96.5 mg/l to 112.9 mg/l and in outlet 45.4 mg/l to 57.2 mg/l , alkalinity values in inlet were reported between 178 mg/l to 211 mg/l and in outlet from 154 mg/l to 205 mg/l. Dissolved oxygen in inlet was found between 0.70 mg/l to 1.96 mg/l and in outlet from 4.01 mg/l to 6.22 mg/l. Biochemical oxygen demand in inlet ranges from 90 mg/l to 129 mg/l and in outlet from 3.6 mg/l to 8.5 mg/l , Chemical oxygen demand in inlet ranges from 231 mg/l to 252 mg/l and in outlet from 16 mg/l to 30 mg/l. This study showed that both the treatment plants are working in good condition.

Keywords: Physico-chemical parameters, reservoirs, sewage, treatment plant

Introduction

Water is essential natural element for all kinds of life. The quality of water is vital concern for mankind since it is directly linked with human welfare. It is unique liquid, without which life is impossible. It is naturally recycled through a process called hydrological cycle. The used water of a community is called waste water, or sewage. If it is not treated before being discharged into waterways, serious pollution is the result. Due to the rapid industrialisation and urbanization, wastewater has been continuously and excessively released into the environment, causing significant impacts on human and wild life (Borkar *et al.*, 2013). Many organic compounds are detected in different types in municipal wastewater affecting water quality human health and biodiversity in the ecosystem. Huge volume of sewage water is being produced in metropolitan cities due to ever increasing population. Sewage disposal is a major problem in most of the cities in India. In most of the cases the untreated sewage either finds way to the nearest water bodies or is intentionally put into the agricultural fields by the farmers as a substitute for irrigation. The water collected through sewerage system in outskirts of the city is discharged to agricultural lands without treatment which has both toxic and fertilizer values. There is an increase in the use of sewage water for irrigation especially in the out skirts of the cities, particularly in the dry area where there is scarcity of natural water (Girisha and Raju, 2008). Sewage and other industrial effluents rich in organic matter and plant nutrients are finding agricultural application as cheaper way of disposal (Nath *et al.*, 2009; Nagajyothi *et al.*, 2009). The use of industrial effluents for irrigation has emerged in the recent past as an important way of utilizing waste water. There are several advantage and disadvantage in using this sewage water for irrigation purpose (Raman *et al.*, 2002; Saravanmoorthy and Ranjitha Kumari, 2007). Sewage water contains higher amounts of nutrients which increases crop yield substantially and reduce the need for fertilizer, and ultimately decreases overall cost of production. Water pollution also occurs when rain water runoff from urban and industrial areas, from agriculture land and mining operations makes its way back to the receiving waters into the ground water (Ravish

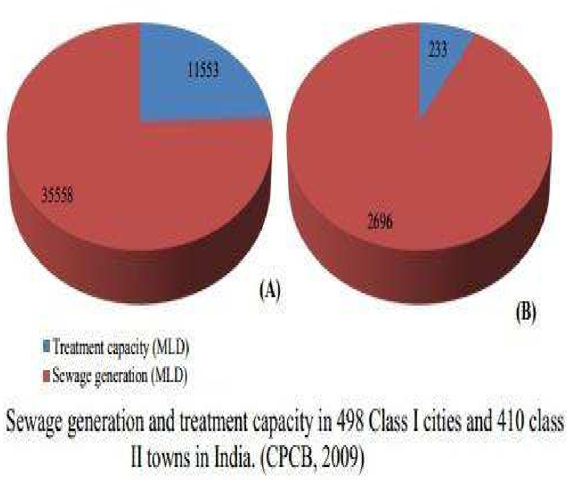
Author's Address
Limnology and Ecological Modelling Laboratory,
Department of Zoology and Environmental science, Gurukula Kangri Vishwavidyalaya, Haridwar.
E-mail: rbhutiani@gmail.com

Kumar, 2014). Sewage also contains microorganisms such as bacteria, viruses and protozoa, which are the main source of water borne infecting disease (Sharma and Kaur, 2011). Treatment of domestic and industrial waste has a long history and in many industrialized countries sewage system and treatment plants were installed initially 100 years ago. The purpose of waste water treatment is to remove the contaminants from water so that the treated water can meet the acceptable quality standards. The quality standards usually depend upon whether water will be reused or discharged into a receiving stream. Sewage treatment typically takes place in three stages and can be broadly classified as physical, chemical and biological.Today, treating wastewater is generally a complex, multi-step industrial process. (Metcalf and Eddy, 2003) The first step in a sewage treatment plant is generally some kind of mechanical treatment, where large objects and heavy materials are removed. The mechanical treatment may consist of a screening chamber (coarse and fine screening) and a degritor. To remove soluble organic matter and possibly also nitrogen from the wastewater, biological treatment is often the second step and followed by disinfection unit (Chlorine contact tank).

Wastewater production in India

The sludge removal, treatment and handling have been observed to be the most neglected areas in the operation of the sewage treatment plants (STP) in India. Due to improper design, poor maintenance, frequent electricity break downs and lack of technical man power, the facilities constructed to treat wastewater do not function properly and remain closed most of the time (CPCB, 2009). One of the major problems with waste water treatment methods is that none of the available technologies has a direct economic return. Due to no economic return, local authorities are generally not interested in taking up waste water treatments **(Trivedy and Nakate, 2001)** (Graph-1).

In the present investigation attempt has been made to know the Physico-chemical aspects of sewage and also to observe how much effectively the organic load reduces after the secondary treatment at the sewage treatment plant, Jagjeetpur, Haridwar.



Graph 1 Showing sewage generation and treatment facility in India

Materials and Method

Description of study area

The sewage treatment plant is situated in Jagjeetpur village near Haridwar city. It is approximately, 5.0 Km far away from Gurukula Kangri Vishwavidyalaya. Here the waste water from various areas of the city is collected and treated. Then treated water is either used for irrigation purpose, or discharged into the river Ganga flowing through the city. The pollution load of the water is reduced to such an extent that it may not have an adverse effect on the people of the other life forms who are dependent on the river Ganga. Sampling and testing has been Carried out as per the standard methods prescribed in APHA(2016) and Trivedy and Goel (1998), Khanna and Bhutiani (2008) for the examination of the water and waste water. The samples were collected from each site at an interval of 7 days starting from Jan 2016 to April 2016. Total 15 observations were made during the course of study. 2 Liters of sample were collected from each site from the depth of 60cm from the surface of water in the plastics Jerry cans. Jerry cans were thoroughly rinsed 5 or 6 times with the water before keeping the sample. Sampling sites selected for study are as follows –

SS-1 Inlet of sewage treatment plant (18 MLD),The raw sewage water is received in the inlet chamber before it proceeds for the treatment process. The site was chosen so as to analyze the physico-chemical properties of sewage water (Plate-1).

SS-2 Outlet of sewage treatment plant (18 MLD), After secondary treatment water is received in outlet chamber. The site was chosen so as to analyze the physico- chemical properties of treated sewage water (Plate-2).

SS-3 Inlet of sewage treatment plant (27 MLD), The raw sewage water is received in the inlet chamber before it proceeds for the treatment process. The site was chosen so as to analyze the physico-chemical properties of sewage water (Plate-3).

SS-4 Outlet of sewage treatment plant (27 MLD),After secondary treatment water is received in outlet chamber. The site was chosen so as to analyze the physico- chemical properties of treated sewage water (Plate-4).

Plate-1 Showing sampling site-1 (Inlet of 18 MLD STP)

Plate-2 Showing sampling site-2 (Outlet of 18 MLD STP)

Plate-3 Showing sampling site-3 (Inlet of 27 MLD STP)

Plate-4 Showing sampling site-4 (Outlet of 27 MLD STP)

Results and Discussion

Results of various physico-chemical parameters observed under the present study i.e. water temperature, total dissolve solids (TDS), total solids(TS), total suspended solids (TSS), turbidity, pH, dissolved oxygen (DO) , biochemical oxygen demand (BOD), chemical oxygen demand (COD), alkalinity, acidity, total hardness (TH) and chlorides are presented in table 1-4 .

Temperature: Temperature affects sediment and microbial growth among other characteristics of water and it is also a known fact that the rate at which chemical reactions occur increase with increasing temperature and the rate of biochemical reactions usually double for every 10.0°C rise in temperature. Physically, less oxygen can dissolve in warm water than in cold water. This is because increased temperature decreases the solubility of gases in water. Increased temperature increases respiration leading to increased oxygen consumption and increased decomposition of organic matter (Pierce *et al.*, 1998). Since water temperature affects the concentration of biological, physical, and chemical constituents of water, the relatively high temperatures recorded would speed up the decomposition of organic matter in the water. At SS-1 the temperature ranged from17.3°C-27.6 °C with an average value21.2 °C ±3.4 °C. At SS-2 the temperature ranged from 18.4 °C -27.8 °C with an average value 21.9 °C ±3.1 °C. At SS-3 the temperature ranged from17 °C -24.4 °C with an average value 19.3 °C ±2.5 °C. At SS-4 the temperature ranged from 18.2 °C -25.5 °C with an average value 20.9 °C ±2.5 °C. The maximum temperature (27.8 °C) was found at SS-2 on 24/04/2016(Table 2) and minimum temperature (17 °C) was found at SS-3 on 04/01/2016(Table 3). There is an increase in the temperature during the study from January to April at all the sites this increase may be due to the increase in ambient air temperature. As the air temperature increases it affects the waste water temperature and waste water temperature increases accordingly.A more or less similar trend of temperature in waste water was found by Bhutiani *et al.*(2015), Sharma *et. al.*(2014) and Khanna *et. al.*(2014).

Total Solids (TS): At SS-1 the total solids ranged from 751mg/l-836 mg/l with an average value 796.9 mg/l ±33.9 mg/l. At SS-2 the total solids ranged from 509 mg/l-627mg/l with an average value 600.4 mg/l ±28.3 mg/l. At SS-3 the total solids ranged from 808mg/l-897mg/l with an average value 849.1 mg/l ±23.4 mg/l. At SS-4 the total solids ranged from 711mg/l-749mg/l with an average value 737.4 mg/l ±12.6 mg/l. The Maximum Total solids (897 mg/l) were found at SS-3 on 21/03/2016(Table 3) and minimum total solids (509 mg/l) were found at SS-2 on18/01/2016(Table 2). During the study period maximum removal of total solid was found in 18MLD STP in comparison to 27MLD STP. Similar trend was found in case of TDS and TSS.

Total Suspended solids (TSS):TSS of a water or wastewater sample is determined by pouring a carefully measured volume of water through a pre-weighed filter of a specified pore size, then weighing the filter again after drying to remove all water. Total suspended solids impart turbidity to the water or waste water. Greater the TSS greater will be the Turbidity. At SS-1 the TSS ranged from 340mg/l-432mg/l with an average value 375.6 mg/l ±26.0 mg/l. At SS-2 TSS ranged from 201 mg/l-247 mg/l with an average value 227.1 mg/l ±13.5 mg/l. At SS-3 the TSS ranged from 308 mg/l-384 mg/l with an average value 341.7 mg/l ±21.5 mg/l. At SS-4 the TSS ranged from 209mg/l-248mg/l with an average value 233.7 mg/l ±12.5 mg/l. The maximum TSS (432 mg/l) was found at SS-1 on 07/04/2016(Table 1) and minimum TSS (201 mg/l) was found at SS-2 on 04/01/2016(Table 2). A more or less similar trend of TSS in inlet and outlet was observed by O. H. I. Aly (2014) and Sharma *et. al.*(2014).

Total dissolved solids (TDS): Dissolved solid refer to any minerals, salts, metals, cations or anions dissolved in water. Total dissolved solids (TDS) comprise inorganic salts (principally calcium, magnesium, potassium, sodium, bicarbonates, chlorides, and sulphates) and some small amounts of organic matter that are dissolved in water. At SS-1 the TDS ranged from 402 mg/l-445 mg/l with an average value 421.3 mg/l ±12.8 mg/l. At SS-2 TDS ranged from 366mg/l-395mg/l with an average value 379.9 mg/l ±8.3 mg/l. At SS-3 the TDS ranged from 480 mg/l-525 mg/l with an average value 507.4 mg/l ±13.2 mg/l. At SS-4 the TDS ranged from 489 mg/l-515 mg/l with an average value 503.7 mg/l ±6.5 mg/l. The Maximum TDS (525 mg/l) was found at SS-3 on 25/02/2016 (Table 3) and minimum TDS (366 mg/l) was found at SS-1on 17/02/2016 (Table 1). A more or less similar trend of TDS in inlet and outlet was observed by Negi and Vaishali (2015).

Turbidity: Turbidity is a term that refers to the optical property that causes light to be scattered and absorbed rather than transmitted in a straight line through water. Therefore, turbidity in water is caused by suspended and colloidal matter such as clay, silt, finely divided organic matter, plankton and other microscopic organisms. At SS-1 the turbidity ranged from 12 NTU-28 NTU with an average value 20.1 NTU ±5.2 NTU. At SS-2 the turbidity ranged from 9 NTU-25 NTU with an average value 16.7 NTU ±5.1 NTU. At SS-3 the turbidity ranged from 13 NTU-29 NTU with an average value 20.9 NTU ±5.2 NTU. At SS-4 the turbidity ranged from 8 NTU-22 NTU with an average value 15.3 NTU ±4.9 NTU. The maximum turbidity (29 NTU) was found at SS-3 on 24/04/2016 (Table 3) and inimum turbidity (9 NTU) was found at SS-2 on 28/01/2016 (Table 2). A more or less similar trend of turbidity in sewage was observed by Kumar and Chopra (2012) and Madan and Verma (2011).

pH:pH is important in water quality assessment as it influences many biological and chemical processes within a water body (Chapman, 1996). Water with a pH outside the normal range may cause a nutritional imbalance or may contain a toxic ion which can adversely affect the growth and development of aquatic life (Bolawa and Gbenle, 2012). As pH affects the unit processes in water treatment that contribute to the removal of harmful organisms, it could be argued that pH has an

Table- 1: Showing variation in physico-chemical parameters at site -1(Inlet of 18MLD STP)

Date /Parameter	Temp.	TS	TSS	TDS	Turb.	pH	DO	BOD	COD	TH	Alk.	Acidity	Cl
O4/O1/2016	18	823	398	425	15	7.46	1.75	102	231	240	200	315	112.5
12/O1/2016	17.3	751	341	410	21	8.04	1.79	100	234	230	207	325	99.8
18/O1/2016	19	756	340	416	14	7.88	1.74	105	238	236	198	318	102.5
28/O1/2016	18.2	803	388	415	12	7.66	1.81	95	233	233	201	316	106.3
O4/O2/2016	17.6	819	390	429	20	8.66	1.96	90	239	241	188	330	98.8
11/O2/2016	19.3	801	380	421	13	8.01	1.09	110	245	237	198	328	96.5
17/O2/2016	18.8	758	356	402	17	7.77	0.98	112	234	212	205	326	100.8
25/O2/2016	20	798	389	409	19	7.54	0.95	119	240	237	211	324	103.5
O2/O3/2016	22	818	390	428	18	8.34	0.9	119	243	239	178	340	106.4
10/O3/2016	21.8	836	398	438	24	8.76	0.99	108	245	247	179	335	105.6
21/O3/2016	22.6	800	375	425	28	7.96	0.85	115	241	234	196	333	112.9
29/O3/2016	23.2	793	348	445	22	8.04	0.82	121	246	248	203	342	109.8
O7/O4/2016	25.5	870	432	438	26	7.66	0.79	125	249	227	204	337	104.4
18/O4/2016	27.1	767	357	410	27	8.57	0.71	128	243	230	201.1	334	100.8
24/04/2016	27.6	760	352	408	25	8.65	0.7	129	246	236	204.5	344	110.2
Mean ± SD	**21.2 ±3.4**	**796.9 ±33.9**	**375.6 ±26.0**	**421.3 ±12.6**	**20.1 ±5.2**	**8.1 ±0.4**	**1.2 ±0.5**	**111.9 ±11.9**	**240.5 ±5.5**	**235.1 ±8.7**	**198.2 ±9.6**	**329.8 ±9.2**	**104.7 ±5.0**

Table- 2: Showing variation in physico-chemical parameters at site -2(Outlet of 18MLD STP

Date /Parameter	Temp.	TS	TSS	TDS	Turb.	PH	DO	BOD	COD	TH	Alk.	Acidity	Cl
O4/O1/2016	19.6	596	201	395	12	6.04	6.18	5.0	22	200	185	295	49.5
12/O1/2016	18.4	601	215	386	19	7.64	6.06	4.6	21	194	189	301	51.4
18/O1/2016	19.7	509	219	390	11	6.01	6.22	4.2	16	190	180	295	53.2
28/O1/2016	19	590	210	380	9	6.76	5.95	5.7	17	185	186	290	54.3
O4/O2/2016	18.8	602	220	382	16	7.44	5.55	5.0	20	188	176	305	51.2
11/O2/2016	20.3	587	215	372	10	7.34	5.07	4.2	23	181	181	303	50.3
17/O2/2016	20.5	615	230	385	14	6.54	4.82	3.6	22	189	185	302	52.1
25/O2/2016	21.6	595	225	370	16	6.38	4.89	6.8	23	180	190	302	49.5
O2/O3/2016	22.3	601	233	368	13	7.58	4.44	7.0	23	178	160	312	52.3
10/O3/2016	22	602	236	366	20	7.99	5.01	5.5	26	180	164	302	51.3
21/O3/2016	22.6	617	233	384	25	7.00	4.99	6.4	27	194	170	301	49.2
29/O3/2016	23.9	618	240	378	19	7.53	4.69	7.3	23	195	182	311	47.3
O7/O4/2016	25.8	624	238	386	22	6.93	4.42	7.1	22	198	182	307	51
18/O4/2016	27.6	622	245	377	21	7.49	4.12	5.9	25	210	184	301	56.2
24/04/2016	27.8	627	247	380	23	7.23	4.01	6.8	30	199	205	311	57.2
Mean ± SD	**21.9 ±3.1**	**600.4 ±28.3**	**227.1 ±13.5**	**379.9 ±8.3**	**16.7 ±5.1**	**7.1 ±0.6**	**5.1 ±0.7**	**5.7 ±1.2**	**22.7 ±3.6**	**190.7 ±9.1**	**181.3 ±10.9**	**302.5 ±6.2**	**51.7 ±2.6**

indirect effect on health (Aramini *et al.*, 2009). At SS-1 the pH ranged from 7.46-8.76 with an average value 8.1±0.4. At SS-2 pH ranged from 6.01-7.99 with an average value 7.1±0.6. At SS-3 the pH ranged from 7.13-8.66 with an average value 7.9±0.4. At SS-4 the pH ranged from 6.1-8.2 with an average value 7.3±0.6. The maximum pH (8.76) was found at SS-1on 10/03/2016 (Table 1) and minimum pH (6.01) was found at SS-2 on 18/01/2016 (Table 2). A more or less similar trend was observed by Bhutiani *et al.* (2015), Khanna *et al.* (2013) David (2014) and Auwal *et. al.*(2013).

DO:A sufficient level of oxygen must be present in any aquatic ecosystem to support life and facilitate the natural behavior of the species. Oxygen exists in water in a dissolved stage at a level equal to its saturation concentration, which is mostly dependent on temperature. It is determined through the Winkler iodometric method. The amount of oxygen dissolved in water depends on the rate of aeration from the atmosphere, temperature, air pressure and salinity. At SS-1 the DO ranged from 0.70 mg/l-1.96 mg/l with an average value 1.2 mg/l ±0.5 mg/l. At SS-2 DO ranged from 4.01 mg/l-6.22 mg/l with

Table 3 Showing variation in physico-chemical parameters at site -4(Outlet of 27MLD STP)

Date /Parameter	Temp.	TS	TSS	TDS	Turb.	PH	DO	BOD	COD	TH	Alk.	Acidity	Cl
O4/O1/2016	17	851	341	510	14	7.13	1.95	94	232	243	210	310	105.4
12/O1/2016	17.1	837	317	520	22	8.04	1.88	98	235	233	207	325	102.6
18/O1/2016	17.3	879	367	512	15	7.88	1.65	102	240	237	200	318	100.8
28/O1/2016	17.6	842	342	500	13	7.66	1.47	108	243	234	198	316	99.8
O4/O2/2016	17.6	818	308	510	21	8.66	1.46	108	241	241	189	330	102.5
11/O2/2016	17.9	859	344	515	17	7.93	1.4	110	243	237	201	328	110.6
17/O2/2016	17.9	808	318	490	18	7.77	1.4	112	237	214	207	326	104.8
25/O2/2016	18	851	326	525	19	7.54	1.1	117	242	238	213	324	100.8
O2/O3/2016	18.2	842	342	500	18	8.34	1.12	117	246	241	187	340	99.8
10/O3/2016	19.4	856	368	488	23	7.98	1.0	120	247	247	182	335	104.6
21/O3/2016	19.3	897	384	513	29	7.96	0.95	122	241	235	198	333	99.7
29/O3/2016	21.8	840	319	521	23	8.01	0.88	125	249	249	205	342	100.5
O7/O4/2016	22	853	345	508	27	7.66	0.75	128	252	237	206	337	109.6
18/O4/2016	23.5	877	358	519	26	8.56	0.89	120	245	236	203	334	100.8
24/04/2016	24.4	826	346	480	29	8.51	0.98	129	247	240	211	350	110.9
Mean ± SD	19.3 ±2.5	849.1 ±23.4	341.7 ±21.5	507.4 ±13.3	20.9 ±5.3	7.9 ±0.4	1.23 ±0.4	114.0 ±10.6	242.7 ±5.4	237.5 ±7.9	201.1 ±9.1	329.8 ±10.6	103.6 ±3.9

Table- 4: Showing variation in physico-chemical parameters at site -4(Outlet of 27MLD STP)

Date /Parameter	Temp.	TS	TSS	TDS	Turb	PH	DO	BOD	COD	TH	Alk.	Acidity	Cl
O4/O1/2016	18.2	737	231	506	11	6.1	6.08	5.2	20	200	182	208	49.6
12/O1/2016	18.6	713	210	503	17	6.9	6.03	6.4	21	200	160	215	50.8
18/O1/2016	18.9	749	248	501	10	7.1	5.75	5.8	20	200	178	211	51
28/O1/2016	18.8	747	232	515	8	7.4	5.88	6.1	25	201	168	218	50.1
O4/O2/2016	19.6	728	221	507	9	8.2	6.01	6.3	22	198	170	221	48.8
11/O2/2016	19.4	711	209	503	16	7.8	5.26	6.8	24	198	165	216	47
17/O2/2016	19.7	748	239	509	10	6.7	5.92	7.2	23	200	180	210	49.9
25/O2/2016	19.9	738	234	504	12	6.7	5.75	7.5	27	204	178	215	46.4
O2/O3/2016	20.4	734	228	506	14	7.5	4.98	6.5	27	210	154	239	49.7
10/O3/2016	20.6	732	235	497	20	7.9	5.01	7.4	23	195	160	236	48
21/O3/2016	20.8	749	239	510	22	8.1	4.78	8.1	23	192	168	232	46
29/O3/2016	23.3	752	242	510	21	6.9	4.56	6.4	27	204	179	240	45.4
O7/O4/2016	24.6	736	247	489	20	7.4	4.88	7.5	20	190	180	237	49
18/O4/2016	25	739	243	496	19	7.6	4.15	8.2	25	192	178	230	53.2
24/04/2016	25.5	748	248	500	20	7.6	4.02	8.5	23	201	200	240	54
Mean ± SD	20.9 ±2.5	737.4 ±12.6	233.7 ±12.5	503.7 ±6.5	15.3 ±4.9	7.3 ±0.6	5.3 ±0.7	6.9 ±0.9	23.3 ±2.5	199.0 ±5.2	173.3 ±11.5	224.5 ±12.1	49.2 ±2.5

an average value 5.1±0.7. At SS-3 the DO ranged from 0.75mg/l-1.95mg/l with an average value1.3±0.4. At SS-4 the DO ranged from 4.02 mg/l-5.2 mg/l with an average value5.3±0.7. The maximum DO (6.22 mg/l) was found at SS-2 on 18/01/2016 (Table 2) and Minimum DO (0.70 mg/l) was found at SS-1 on 24/04/2016 (Table 1). During the study period dissolved oxygen decreases both in treated and untreated waste water because the temperature of waste water was increasing from January to April. Higher temperature decreased the solubility of oxygen in the water. The dissolved oxygen was increased in treated water because of aeration. However on the same aeration the dissolved oxygen decreased from January to April because the temperature was increased. A more or less similar trend was observed by Bhutiani *et al.* (2003) Khanna *et al.* (2003), Nisha *et. al.*(2016) and Madan and Verma (2011).

Biochemical Oxygen Demand (BOD):A measure of the oxygen required to oxidize the desirable organic matter in a water sample to stable the inorganic compounds and gives an approximate index of organic pollution. Biochemical oxidation is brought about by microorganisms that utilize organic matter as a source of carbon and in doing to consume dissolved oxygen. At SS-1 the BOD ranged from 90 mg/l-129 mg/l with an average value 111.8 mg/l ±11.9 mg/l. At SS-2 BOD ranged from 3.6 mg/l-7.3 mg/l with an average value 5.7 mg/l ±1.2 mg/l. At SS-3 the BOD ranged from 94 mg/l-129 mg/l with an average value 114.0 mg/l ±10.6 mg/l. At SS-4 the BOD ranged from 5.2mg/l-8.5mg/l with an average value 6.9 mg/l ±0.9 mg/l. The Maximum BOD (129 mg/l) was found at SS-1 on 24/04/2016 (Table 1) and at SS-3 on 24/04/2016 (Table 3) and Minimum BOD (3.6 mg/l) was found at SS-2 on 17/02/2016 (Table 2).

BOD followed an increasing trend both in treated and untreated water. However in the treated water the BOD decreased to a great extent from 119.9mg/l±5.5mg/l to 5.7mg/l±1.2mg/l in the case of 18MLD STP while in case of 27MLD STP from 114.0mg/l±10.6mg/l to 6.9mg/l±0.9mg/l. The reduction in BOD depends on the aeration provided because the microorganism uses oxygen for the breakdown of organic matter which imparts BOD to the water. In our case the BOD was decreased to a great extent because of proper oxygenation. Similar trend of results in BOD before and after treatment were observed by Khanna *et al.* (2002) Prachi *et. al.* (2014) and Kulkarni *et. al.*(2016).

Chemical Oxygen Demand (COD): Chemical Oxygen Demand (COD) is the oxygen required by the organic substance of water to oxidize them by a strong chemical oxidant. At SS-1 the COD ranged from 231mg/l-246 mg/l with an average value 240.5 mg/l ±5.5 mg/l. At SS-2 COD ranged from 16 mg/l-30 mg/l with an average value 22.7 mg/l ±3.6 mg/l. At SS-3 the COD ranged from 232 mg/l-252 mg/l with an average value 242.7 mg/l ±5.3 mg/l. At SS-4 the COD ranged from 20 mg/l-27 mg/l with an average value 23.3 mg/l ±2.5 mg/l. The maximum COD (252 mg/l) was found at SS-3 on 07/04/2016 (Table 3) and minimum COD (16 mg/l) was found at SS-2 on 18/01/2016 (Table 2).Significant reduction was observed in COD in treated water because of proper oxygenation. Microorganisms utilise the oxygen which was provided by the aeration to degrade the chemical matter present in the waste water thus reduced the COD. Similar trend of results in COD before and after treatment were observed by Bhutiani and Khanna (2002), Khanna and Bhutiani (2003) and Kulkarni *et. al.*(2016).

Total Hardness (TH): Hardness in water is due to natural accumulation of salts from content with soil and geological formation or it may enter from direct pollution by industrial effluents. Hardness is temporary if it is associated with mainly carbonates and bicarbonates and permanent if associated with sulphate and chlorides. At SS-1 the TH ranged from 212mg/l-248mg/l with an average value 235.1 mg/l ±8.7 mg/l. At SS-2 TH ranged from 178 mg/l-210 mg/l with an average value 190.7 mg/l ±9.1 mg/l. At SS-3 the TH ranged from 214 mg/l-249 mg/l with an average value 237.5 mg/l ±7.9 mg/l. At SS-4 the TH ranged from 190 mg/l-210 mg/l with an average value 199.0±5.2. The maximum TH (249 mg/l) was found at SS-3 on 29/03/2016 (Table 3) and minimum TH (190 mg/l) was found at SS-4 on 07/04/2016 (Table 4). Similar trend of total hardness in sewage were observed by Auwal *et. al.*(2013).

Acidity: The capacity to react with a strong base to fixed pH is called acidity of water. In sample of industrial wastes the acidity is due to presence of hydrolysable metal ions whereas in fresh water the acidity is due to presence of free CO_2. At SS-1 the acidity ranged from 315 mg/l-344 mg/l with an average value 329.80 mg/l ±9.20 mg/l. At SS-2 acidity ranged from 295 mg/l-312 mg/l with an average value 302.53 mg/l ±6.20 mg/l. At SS-3 the acidity ranged from 310 mg/l-350 mg/l with an average value 329.87 mg/l ±10.57 mg/l. At SS-4 the acidity ranged from 208 mg/l-240 mg/l with an average value 224.53 mg/l ±12.06 mg/l. The maximum acidity (350 mg/l) was found at SS-3 on 24/04/2016 (Table 3) and minimum acidity (208 mg/l) was found at SS-4 on 04/01/2016 (Table 4).

Alkalinity: The total alkalinity of water is measure of the capacity to neutralize a strong acid. The alkalinity in water is generally imparted by the salts of carbonates, bi carbonates, phosphate and nitrates etc. and together with hydroxyl ions in the Free State. At SS-1 the alkalinity ranged from 178 mg/l-211 mg/l with an average value 198.2 mg/l ±9.6 mg/l. At SS-2 alkalinity ranged from 160 mg/l-205 mg/l with an average value 181.3 mg/l ±10.9 mg/l. At SS-3 the alkalinity ranged from 187 mg/l-211 mg/l with an average value 201.1 mg/l ±9.1 mg/l. At SS-4 the alkalinity ranged from 154mg/l-200mg/l with an average value 173.3 mg/l ±11.5 mg/l. The maximum alkalinity (211mg/l) was found at SS-3 on 24/04/2016 (Table 3) and at SS-1 on 25/02/2016 (Table 1) and minimum alkalinity (154 mg/l) was found at SS-4 on 02/03/2016 (Table 4). Similar trend of total alkalinity in sewage were observed by Mamta Bhardwaj (2014).

Chloride: At SS-1 the chloride ranged from 96.5 mg/l-112.9 mg/l with an average value 104.7 mg/l ±5.0 mg/l. At SS-2 chloride ranged from 49.2 mg/l-57.2 mg/l with an average value 51.7 mg/l ±2.6 mg/l. At SS-3 the chloride ranged from 99.7 mg/l-110.9 mg/l with an average value 103.6 mg/l ±3.9 mg/l. At SS-4 the chloride ranged from 45.4 mg/l-54 mg/l with an average value 49.2 mg/l ±2.5 mg/l. The maximum chloride (112.9 mg/l) was found at SS-1 on 21/03/2016 (Table 1) and minimum chloride (45.4 mg/l) was found at SS-4 on 29/03/2016(Table 4). Chloride in both treated and untreated effluent was found under the limit. However chloride content in treated water was decreased in both the treatment plant. Chloride in sewage water was due to cloth washing. However during the treatment process chlorine is also used in the chlorination tank to reduce the smell and colour. A more or less similar trend of chloride in outlet was observed by Kumar and Chopra (2012).

Conclusion

Clean water supply is an essential requirement for the establishment and maintenance of diverse human activities. Waste water treatment process plays an important role and is an effective means in the conservation of water because the treated water can be used in different types of activities such as floor washing, irrigation, and gardening in place of fresh ground and surface water. The results obtained during this study indicate that all major waste water quality parameters were reduced to much extent after the treatment in both the treatment plant (18MLD and 27MLD). In the comparison of both the treatment plant on the basis of results obtained during the study period it was found that 18MLD plant was working more efficiently than 27MLD treatment plant.

References

APHA 2016. *In: standards methods for the examination of the water and waste water.* American Public Health Association, New York.

Aramini, J.M. McLean, M, Wilson, J, Holt, J, Copes, R, Allen, B and Sears W. 2009. *Drinking water Quality and Health Care Utilization for Gastrointestinal Illness in Greater Vancouver*, Environmental and Workplace Health Reports and Publications.

Auwal Sarkinnoma , Chindo Istifanus Yarkasuwa and Kolo Alhaji Modu 2013. Analysis of Physicochemical Parameters of Sewage Water used for Irrigation in Bauchi Metropolis – Nigeria. ***Journal of Environment and Earth Science***, Vol.3(10),pp.37-41.

Bhardwaj, Mamta 2014. Physico-Chemical and Biological Analysis of Sewage Water along Hindon River Ghaziabad City (U.P) India. ***International Journal of Engineering Research & Technology (IJERT).*** Vol. 3(3), pp.781-785

Bhutiani, R., Khanna, D.R. and Kumar, Arun 2015. Physico-chemical characterization of Sugar Mill Effluent. ***Indian Journal of Scientific research and Technology.*** 3(2):13-16.

Bhutiani, R., Khanna, D.R., Tyagi, Varun and Ahamad, Faheem. 2015. Removal of turbidity in dairy waste water through aquatic macrophytes.***International Journal of Research –GRANTHAALAYAH,****3(9):1-3*

Bhutiani, Rakesh and Khanna, D.R. 2002. Physico–chemical analysis of a fertilizer plant. ***Jr. Natcon*** *14(2): 347-349.*

Bhutiani, Rakesh, Khanna, D.R. and Sarkar, P. 2003. Waste management strategy of a fertilizer Plant. ***Env. Cons. Jr.*** 4(1-3): 109-122.

Bolawa, OE and Gbenle, GO. 2012. Analysis of industrial impact on physiochemical parameters and heavy metal concentrations in waters of river Majidun, Molatori and Ibeshe around Ikorodu in Lagos, Nigeria, ***Journal of Environmental Science and Water Resources***, Vol.1(2), pp.34–38

Borkar, R.P., Gulhane, M.L., and Kotangale, A.J. 2013. "Moving Bed Biofilm Reactor – A New Perspective in Wastewater Treatment", ***Journal of Environmental Science, Toxicology and Food Technology***, Vol. 6, (6) pp. 15-21

Chapman, D 1996. "*Water Quality Assessment. A Guide to the Use of Biota, Sediments and Water in Environmental Monitoring*," 2nd Editon, E&FN Spon, New York.

CPCB 2009. *Status of water quality in India*, CPCB, Ministry of Env. and Forest Delhi

David N Ogbonna 2014. The Impact of Untreated Sewage Wastes discharge on the Physico-chemical properties of Rivers in Port Harcourt Metropolis. ***World Journal of Scientific Research and Reviews*** vol.2(2) pp.1 – 19

Girisha, S.T., and Raju, N.S. 2008. "Effect of sewage water on seed germination and vigour index of different varieties of groundnut (*Arachis hypogaea* L.)", ***Journal of Environmental Biology***, Vol. 29(6) pp. 937-939

Khanna, D. R. and Bhutiani, R., 2008. "Laboratory manual of water and waste water analysis. Daya Publishing House, New Delhi

Khanna, D.R. and Bhutiani, Rakesh, 2003.Ecological status of Sitapur pond at Haridwar (Uttaranchal) India, ***Ind. J. Env.&Ecopl.*** 7(1) 175-178

Khanna, D.R., Bhutiani, Rakesh and Kumar, P. 2003. Characterization of a treated distillery effluent. ***Jr. Nature env. & Poll. Tech.,*** Vol 2(1): 113-114

Khanna, D.R., Bhutiani, R., Tyagi, Bharti, Tyagi, Prashant Kumar and Ruhela, Mukesh 2013. Determination of water quality index for the evaluation of surface water quality for drinking purpose. ***International journal of science and engineering.*** Vol 1(1):09-14.

Khanna, D.R., Bhutiani, R., Tyagi ,Varun and Ahamad Faheem, 2014. Impact of Sugar Mill Effluent on Physico-chemical Properties of Malin River at Najibabad, Bijnore. ***Indian. J. Sci. Res.***Spl. Ed & NSESIR, pp.5-10

Khanna, D.R., Bhutiani, Rakesh and Trivedi, Manoj. 2002. Impact of paper mills effluent on Hindon River Saharanpur (UP).***Him. Jr. Env. Zool*** Vol. 16(1): 125- 128

Kulkarni Bhakti , Wanjule R.V. Shinde, H.H. 2016. Performance Assessment of 100 MLD Sewage Treatment Plant Based On C-TECH Technology at Vashi, Navi Mumbai. ***International Journal of Innovative Research in Science, Engineering and Technology***, Vol. 5(6), pp.9388-9395

Kumar Vinod and Chopra A. K 2012. Monitoring of Physico-chemical and microbiological Characteristicsof Municipal Waste water at Treatment Plant, Haridwar city (Uttarakhand) India. ***Journal of Environmental Science and Technology***, Vol.5(2) pp.109-118.

Madan, Sangeeta and Verma, Neelam 2011. A preliminary study on sewage quality improvement through water hyacinth (*Eichhornia crassipes*). ***Environment Conservation Journal***. Vol.12(3) pp.63-66

Metcalf and Eddy 2003. *Wastewater Engineering, treatment and reuse*, New Delhi: Tata McGraw-Hill Publishing Company Limited.

Nagajyothi, P.C, Dinakar, N., Suresh, S., Udaykiran, Y., Suresh, C., and Damodharam, T. 2009. "Effect of industrial effluent on the morphological parameters and chlorophyll content of green gram (*Phaseolus aureus* Roxb)", ***Journal of Environmental Biology*** Vol. 30 pp. 385-388.

Nath, K., Singh, D., Shyam, S., and Sharma, Y.K. 2009. "Phytotoxic effects of chromium and tannery effluent on growth and metabolism of *Phaseolus mungo* Roxb", ***Journal of Environmental Biology*** Vol.30(2) pp. 227-234.

Negi Mohan Singh and Sahu Vaishali 2015. Performance Evaluation of 9 MLD Sewage Treatment Plant At Gurgaon And Cost Effective Measures In Treatment Process. ***Civil Engineering and Urban Planning.*** Vol.2(3),pp.1-7

Nisha jain, Sumit Kumar, Sumit kumar, Jigisha Vanjani and Sukul Kumar 2016. Performance Assessment of Sewage Treatment Plant at Delawas, Jaipur, India.SSRG ***International Journal of Civil Engineering*** (SSRG-IJCE) – vol-3(5),pp.251-255

O. H. I. Aly 2014. A New Development of Wastewater Treatment Unit for Paint Shop in Vehicle Industry. International Journal of Sciences: ***Basic and Applied Research (IJSBAR***), pp.15-25

Pierce, JJ; Weiner, RF and Vesihind, AP 1998."*Environmental Pollution and Control*," 4th Edition, Butterworth-Heinemann Press, Boston.

Prachi N. Wakode and Sameer U. Sayyad 2014. Performance Evaluation of 25MLD Sewage Treatment Plant (STP) at Kalyan. ***American Journal of Engineering Research*** (AJER),Vol.03(03), pp.310-316

Ramana, S., Biswas, A.K., Kudus, S., Saha, J.K., and Yadava, R.B.R. 2002. "Effect of distillery effluent on seed germination in some vegetable crops", ***Biorecourse Technology*** Vol.82 pp. 273–275

Ravish Kumar Chauhan 2014. " Physico-Chemical Analysis of Untreated Sewage Water of Ladwa town of Kurukshetra District of Haryana and Need of Waste Water Treatment Plant" ***Int..J.Curr. Microbiol. App.Sci*** 3(3), pp.326-333

Saravanmoorthy, M.D., and Ranjitha, K.B.D. 2007. "Effect of textile waste water on morpho-physiology and yield on two varieties of peanut (*Arachis hypogeal* L.)" ,***Journal of Agricultural Technology***, Vol. 3 pp. 335– 343.

Sharma H., Arora B. B., Bhardwaj R. K., Bhardwaj V. and Harada H. 2014. Evaluation of UASB Efficiency: Sewage Treatment System along the Yamuna River Basin in India.***Int. J. Res. Chem. Environ***. Vol. 4(4) ,pp.177-183

Sharma,B.K. and Kaur. H. 2011. *In: Environmental Chemistry*. Goel Publishing House Meerut. 4 pp.251-262

Trivedy RK and Nakate SS. 2001. *Treatment of hospital waste and sewage in hyacinth ponds*. In: Trivedy, R.K., Kaul, S. (Eds.). Low Cost Wastewater Treatment Technologies. ABD, Jaipur, India. . pp. 132–163

Trivedy, P.K. and Goel, P.K. 1986. *Chemical and Biological methods for water pollution studies*. Environment Publication, Karad.