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Physico – chemical and Budgeting study of Wastewater from Latifabad and Qasimabad Talukas of Hyderabad District, Pakistan

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Abstract

The wastewater from South – West parts of Hyderabad district i.e. Latifabad Taluka included Hussainabad areas is disposed – off into Southern Sewage Treatment Plant (SSTP) and agriculture fields, whereas from Qasimabad Taluka, it goes into open fields. During this study, some effects of biological treatment were noted at SSTP and Qasimabad areas. The transparency increased from 5.25 to 12.3cm and 4.92 to 19cm, dissolved oxygen increased from none to 4.7 mg/l and none to 3.7 mg/l, biological oxygen demand (BOD_5) decreased from 243 to 40 mg/l and 118 to 49 mg/l, chemical oxygen demand (COD) decreased from 348 to 61 mg/l and 429 to 75 mg/l, total Kjeldahl nitrogen decreased from 27.8 to 1.26 mg/l and 20.8 to 0.9 mg/l at SSTP and Qasimabad open fields respectively. Some positive results were also recorded in total phosphate content during biological treatment of wastewater.

The total quantities of wastewater discharge from these areas are calculated to be 36067.3 cubic meters per day (m^3/day) (9.53 MGD). The results indicate that 8.961 ton/day (t/d) of chloride, 0.15 t/d of total hydrolysable phosphate, 0.789 t/d of Kjeldahl nitrogen, 59.67 t/d of total residues, 45.004 t/d of total filterable residues, 14.105 t/d of non – filterable residues, 6.83 t/d of sodium, 2.734 t/d of calcium, 2.751 t/d of magnesium and 0.746 t/d of potassium are being discharged from these localities.

Keywords: Physico – chemical, Budgeting, Wastewater, Hyderabad district.

Introduction

Hyderabad, the second largest and populous city of Sindh is situated about 160 km east of Karachi and consists of three city Talukas i.e. Hyderabad, Latifabad and Qasimabad. The total population of Hyderabad including its city Taluka according to PC – I of HDA is about 1.6 million (Anonymous, 2000). This city is also facing a great problem of safe disposal of its wastewater at proper places like other cities of Pakistan. The wastewater from south – west parts (Latifabad, Hussainabad and Qasimabad) of the Hyderabad city is mainly disposed off without any treatment into open areas and agriculture fields. However some of it was disposed off into Southern Sewage Treatment Plant (SSTP) during study period, 1999 – 2000. The wastewater from Hyderabad city is mainly disposed off without any treatment into Phuleli canal by gravity flow. SSTP is located near Kohsar about 2km south of Latifabad unit 11. SSTP has been constructed for biological treatment of the sewage of southern areas (Latifabad) of the city. It has three facultative and three maturation ponds. The total capacity of SSTP according to design is 6 MGD (Balfour and Sons, 1984), but two facultative and one maturation ponds were partially functioning during study period. Now a days hardly any water goes into it. It is because the local farmers divert most of the wastewater towards agriculture fields. Very little work has been done towards budgeting of sewage (Abdullah *et al*, 2004).

The present work examines the quantitative budgeting with chemical load on the wastewater after and before biological treatment from Latifabad and Qasimabad Talukas of Hyderabad District.

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Material and Methods

Ten samples of wastewater were collected; five from the disposal stations and five from SSTP and Qasimabad open fields. The samples were collected during Nov. 1999 to May 2000 at an interval of 4 to 5 weeks in clean pre – washed 1.5 L plastic bottles after rinsing several times with sampled water. The samples from wastewater disposal stations were collected at the time, when pumps were actually in operation and from open sewers with the help of 1 L bucket. The time of collection of sample, temperature of air 1 m above surface of water and wastewater were measured with mercury thermometer and Sacchi depth was measured with Sacchi disc at the individual sampling site. The samples were transferred to the laboratory as soon as possible after collection and analyzed for physico – chemical parameters.

Conductivity, salinity, and total dissolved solids (TDS) were determined with WTW LF 320-conductivity bridge. Alkalinity, chloride and hardness were determined by titrimetry by using standard hydrochloric acid (0.01N), silver nitrate (0.01N) and EDTA (0.01M) solution respectively. Dissolved oxygen (DO) was evaluated by Wrinkler method. Chemical oxygen demand (COD) was determined by acid dichromate oxidation method using silver sulphate as catalyst. Kjeldahl nitrogen and ammonia nitrogen were determined by using standard procedures (APHA, 1976). Total phosphate – phosphorus were determined by spectrophotometry using Hitachi 220 spectrophotometer.

Orthophosphate was determined when acid molybdate was added to orthophosphate, followed by reduction with ascorbic acid to molybdenum blue. Total phosphate was estimated by persulphate acid hydrolysis, followed by determination as for orthophosphate. Total residues were estimated by evaporating a well - mixed sample (50 ml) gently in pre weighted dry beaker at 80 to 90 °C and dried at 105 ± 5 °C for two hours. The increase in weight of beaker indicated total residues. The filterable and non – filterable residues were calculated by filtering well-mixed sample (50 ml) through pre weighted glass fiber paper filter of Ø 47mm diameter. The filtrate was evaporated and dried 105 ± 5 °C. The increase in weight of filter paper showed non – filterable residues. Condensed phosphate was calculated by subtracting orthophosphate from total phosphate phosphorus. Sodium, calcium, magnesium and potassium were determined by air – acetylene atomic absorption using Varian AA – 20 atomic absorption spectrometer at the conditions recommended by the manufacturer.

Sodium, potassium, calcium and magnesium were determined at 589, 766.5, 422.7 and 285.2 nm respectively in triplicate; with delay time 3 seconds and integration time 3 seconds. Proteins were obtained by multiplying ammonia nitrogen with 6.25 (APHA, 1976) and sodium absorption ratio (SAR) values were calculated by using following equation.

$$SAR = \frac{Na}{\sqrt{\frac{Ca + Mg}{2}}}$$

The water discharge was calculated by using standard formulae (Khurmi, 1978). The parameters were noted from individual sites. The quantity of wastewater from disposal stations was calculated from the rain emergency plan (Anonymous, 1999). All the necessary help was also obtained from the officials of Water and Sanitation Agency (WASA) of Hyderabad Development Authority (HDA).

Results and Discussions

The average minimum and maximum temperatures of air remained between 27.5 to 30.8 ^{0}C and of wastewater in the range of 21 – 26.7 ^{0}C. The results showed a decrease of about 4 ^{0}C at SSTP might be due to open surface. The transparency increased from 4.29 to 19 cm after treatment, because of the settling particles. Conductivity, pH, salinity, TDS, alkalinity, chloride and hardness indicated little change after biological treatment. However, organic portion of the pollution showed an improvement. DO, which was not observed in the wastewater increased from none to 4.7 mg/l (on average basis) at SSTP and 3.7 mg/l at Qasimabad open fields. BOD_5 showed a decrease from 197 mg/l to 40 mg/l at SSTP and from 243 mg/l to 49 mg/l at Qasimabad open fields and COD decreased from 348 mg/l to 61 mg/l after treatment at SSTP and 429 mg/l to 75 mg/l at Qasimabad open fields. Total filterable and total non - filterable residues also showed positive effect with decrease in their concentration in treated wastewater as compared to untreated wastewater (Table1).

The results of total hydrolysable phosphate, orthophosphate and condensed phosphate remained almost same before and after treatment, may be due to decomposition of organic portion of wastewater during biological treatment process. Total Kjeldahl and ammonia nitrogen decreased from 25 mg/l and 19.1 mg/l in wastewater to 1.26 mg/l and 0.53 mg/l after treatment at Latifabad areas respectively and 27.8 mg/l and 16.6 mg/l to 0.9 mg/l and 0.25 mg/l from Qasimabad areas respectively. Similarly the organic nitrogen, nitrite and proteins also showed good effects at treatment plant. The metal ions Na, Ca, Mg and K were examined before and after treatment. The results did not indicate significant effect after treatment. However the study of major cations i.e. Na, Ca, Mg and K show that sodium was dominant cation and potassium contributed the lowest concentration in wastewater. The SAR values were calculated and were found on the margin for the safe use of the treated and untreated wastewater for agriculture. The microbiological activity at SSTP results into the decrease in organic pollution due to aerobic and anaerobic oxidation with the loss of carbon dioxide and nitrogen. Therefore BOD, COD, organic nitrogen and ammonia contents decreased after treatment. However the inorganic (water soluble portion) remained unaffected by the biological treatment. Some effects could be expected due to co-precipitation of suspended solids, but SSTP has not been cleaned since its construction, with the results that equilibrium is maintained without any significant change in their concentrations.

The total water supply by WASA of HDA to Hyderabad city including Latifabad, Hussainabad and Qasimabad area is 1.74×10^5 m^3/d (46 MGD) from six treatment plants situated in different parts of the city. It is assumed that 20 % overall losses could occur in the distribution and collection system, thus 1.41×10^5 m^3/d (36.8 MGD) could be collected. Among these 74 % (103235 m^3/day) of total wastewater were generated into old city areas which is mainly disposed into irrigation canals when passing from the city areas and only 25 % (36067 m^3/day) of wastewater from southern and western parts of the city goes to agricultural fields, open fields and SSTP (Laghari, A., 2001). The details of wastewater contribution at different sampling stations of Latifabad, Hussainabad and Qasimabad are summarized in (Table 2).

Table 1: Physico - chemical analysis of wastewater collected from different sampling stations of Latifabad, Hussainabad and Qasimabad, (n = 6), with mean and S.D ±

Parameters with units	Sampling Stations									
	Latifabad Stations W. Water			Treated W. Water			Qasimabad Stations W. Water		Treated. W. Water	
	1	2	3	4	5	6	7	8	9	10
Air temperature, °C	27.5 ±3.21	29.5 ±4.85	29.3 ±4.1	29.7 ±4.4	30 ±4.6	30 ±4.4	30.8 ±4.7	30 ±4.73	30.3 ±4.7	29.7 ±5.1
Wastewater temperature, °C	25 ±3.7	26.7 ±3.4	25.2 ±3.8	23.3 ±4.7	21 ±5.4	23.7 ±3.8	25.2 ±4.2	25.2 ±3.2	25.2 ±3.9	24.2 ±5.4
Sacchi depth, cm	5.25 ±0.7	6.58 ±2.3	5.5 ±0.95	11.5 ±0.71	9.67 ±2.06	12.3 ±4.37	4.92 ±0.73	6.42 ±3.3	15 ±3.46	19 ±9.54
Conductivity, mS/cm	1.92 ±0.73	2.54 ±0.94	2.07 ±0.3	2.13 ±0.51	2.2 ±0.67	1.94 ±0.5	2.24 ±0.93	2.03 ±0.42	2.38 ±0.5	2.24 ±0.44
pH	6.98 ±0.12	7.07 ±0.22	7.06 ±0.16	7.22 ±0.23	7.12 ±0.2	7.99 ±0.54	7 ±0.21	7 ±0.15	7.63 ±0.41	7.4 ±0.17
Salinity, mg/l	700 ±358	1050 ±472	783 ±172	817 ±172	867 ±225	733 ±175	883 ±387	800 ±245	983 ±147	933 ±150.5
Total dissolved solids, mg/l	1231 ±467	1624 ±608	1318 ±197	1366 ±329	1414 ±423	1244 ±302	1439 ±599	1300 ±270	1524 ±330	1435 ±285
Alkalinity as $CaCO_3$ mg/l	286 ±99.8	301 ±153	325 ±113.5	296 ±119	307 ±132	231 ±65	422 ±167	345 ±106	335 ±90	311 ±77
Chloride, mg/l	289.4 ±142	402 ±161	285 ±62	327 ±62	346 ±95	333 ±70	324 ±139.5	341 ±80	477 ±74.5	414 ±64
Hardness as $CaCO_3$, mg/l	358 ±176	456 ±215	358 ±136	358 ±136	405 ±101	335 ±104	322.5 ±101	345 ±109	412.5 ±115	410.5 ±115
Dissolved Oxygen, mg/l	ND	ND	ND	1.35 ±0.97	2.58 ±0.73	4.7 ±1.4	ND	ND	3.7 ±3.2	3.415 ±2.7
BOD, mg/l	192 ±44	164 ±46	197 ±79.6	40 ±14	46 ±18	40 ±12.7	243 ±19.5	118 ±28.6	49 ±5	53 ±10.75
COD, mg/l	338 ±85	290 ±89.6	348 ±153.6	61 ±23	71 ±30	63 ±21.5	429 ±37.5	209 ±55.3	75.2 ±8.4	80.11 ±18.4
Total residues, mg/l	1617.2 ±745	2023 ±691	1679 ±222.4	1724 ±374	1753 ±43	1578 ±314.	1784 ±569	1614 ±333	1849 ±349	1886.5 ±394
Total filterable residues, mg/l	1158.2 ±365.6	1591 ±591	1295 ±202	1333.5 ±334	1380 ±415	1222 ±290	1402 ±580	1272 ±265	1488.2 ±317	1404 ±277
Total non – filterable residues, mg/l	421 ±296	432 ±140	385 ±73	397.5 ±48	373.3 ±58.5	355.2 ±74	369 ±144	342 ±87.4	361 ±60	483 ±61
Total hydrolysable phosphate, mg/l	3.745 ±1.9	3.3 ±1.04	4.74 ±0.93	4.35 ±1.12	2.67 ±1.2	2.73 ±1.2	5.9 ±0.7	4.21 ±0.5	4.14 ±0.5	4.68 ±0.5
Ortho phosphate, mg/l	3.06 ±1.8	2.7 ±1.04	3.91 ±0.93	4.1 ±1.05	2.4 ±1.3	2.39 ±1.4	5.15 ±0.7	3.53 ±0.73	3.73 ±0.59	4.2 ±0.48
Condensed phosphate, mg/l	0.412 ±0.15	0.625 ±0.36	0.83 ±0.5	0.265 ±0.07	0.273 ±0.09	0.338 ±0.3	0.74 ±0.4	0.68 ±0.6	0.41 ±0.14	0.48 ±0.3

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Parameters with Units	Sampling Stations									
	Latifabad Stations W. Water			Treated W. Water			Qasimabad Stations W. Water		Treated. W. Water	
	1	2	3	4	5	6	7	8	9	10
Kjeldahl nitrogen, mg/l	19.62 ±12.8	19.74 ±10.15	25.025 ±11.8	10.7 ±5.9	1.26 ±0.8	2.6 ±1.5	27.85 ±11.2	20.84 ±9.8	0.9 ±0.3	5.55 ±2.19
Ammonia Nitrogen, mg/l	16.96 ±11.14	16.37 ±10.3	19.09 ±8.53	7.4 ±4.3	0.53 ±0.45	1.6 ±1.5	16.6 ±6.3	14 ±6.16	0.25 ±0.2	3.78 ±2.65
Organic nitrogen, mg/l	2.65 ±2.1	3.37 ±2.07	5.935 ±5.34	3.29 ±2.8	0.74 ±0.5	1 ±0.35	11.22 ±6.35	6.84 ±4.69	0.64 ±0.2	1.77 ±1.3
Nitrite nitrogen, mg/l	0.106 ±0.04	0.109 ±0.05	0.11 ±0.06	0.0625 ±0.02	0.067 ±0.01	0.145 ±0.04	0.12 ±0.06	0.1 ±0.04	0.0675 ±0.005	0.3 ±0.2
Proteins, mg/l	106.35 ±69.87	98.2 ±70	136.1 ±75	46.26 ±27	3.22 ±2.8	10 ±9.3	104 ±39.7	87.7 ±36.64	1.55 ±1.1	23.33 ±16.8
Sodium (Na), mg/l	168.8 ±103.6	277.15 ±116	176.7 ±44	232.3 ±40	249.4 ±74	225.5 ±48	214 ±67	229.6 ±104	257.5 ±14.8	210 ±49.6
Calcium (Ca), mg/l	70.1 ±23.8	90 ±28	75.22 ±7.74	87.625 ±5.9	97.425 ±17	76.4 ±12.6	65.5 ±10.3	87.125 ±25.7	101.62 ±9.3	9.23 ±5
Magnesium (Mg), mg/l	64.8 ±49.5	69 ±17.1	82.63 ±58	87.775 ±49.5	93.81 ±44	85 ±48	77.7 ±50	122.6 ±125.7	133.67 ±86	115.65 ±72
Potassium (K), mg/l	38.325 ±36.6	30.858 ±12	34.18 ±14.3	31.3 ±12	24.3 ±16.6	38 ±32	42.125 ±11.5	28.82 ±15	33.21 ±5.5	29.2 ±9.3
SAR	3.1 ±0.6	4.63 ±1.8	3.82 ±0.8	4.4 ±1.16	4.55 ±1.46	4.61 ±1.5	4.7 ±1.85	4.63 ±1.51	4.2 ±0.96	3.86 ±0.86

Sampling Stations

1	Latifabad Unit No. 9 (Disposal station)	Disposed wastewater to SSTP and in agricultural fields.
2	Latifabad Unit No. 10 (Disposal station)	Disposed wastewater to agriculture fields.
3	Latifabad Unit No. 11 (Disposal station)	Disposed wastewater to SSTP and in agricultural fields.
4	*SSTP 1A	Facultative pond of wastewater treatment plant.
5	*SSTP 3A	Facultative pond of wastewater treatment plant.
6	*SSTP 1B	Maturation pond of wastewater treatment plant.
7	Hussainabad (Disposal station)	Disposed wastewater to agriculture fields.
8	Qasimabad (Disposal station)	Disposed off into open fields adjacent to loop bund.
9	Qasimabad near Qadir nagar	Biologically treated wastewater.
10	Qasimabad near Naseem nagar	Biologically treated wastewater.

Table 2: Contribution of wastewater from Latifabad, Hussainabad and Qasimabad.

Sampling station	Quantity of wastewater (million liters per day)	Quantity of wastewater (m^3 / day)	% Contribution	Disposing area
1	14.54	14536	40.3	Agriculture fields
2	1.10	1090	3.01	Agriculture fields
3	11.35	11356	31.5	Agriculture fields & SSTP
4	3.63	3629	-	SSTP 1 (Maturation pond)
5	NIL	NIL	-	-
6	3.02	3024	-	Agriculture fields
7	1.36	1363	3.78	Agriculture fields
8	7.72	7722	21.41	Open fields
9	-	-	-	-
10	-	-	-	-
Total	42.72	42720	100	

Table 3: Total load of various chemical components in wastewater collected from Latifabad, Hussainabad and Qasimabad.

Parameters with units	Sampling Stations										Total weight Ton/day
	Latifabad Stations W. Water			Treated W. Water			Qasimabad Stations W. Water		Treated W. Water		
	1	2	3	4	5*	6	7	8	9*	10*	
Total residues, Ton/day	23.5	2.205	19.07	6.256	-	4.77	2.431	12.46	-	-	59.67
Total filterable residues, Ton/day	16.83	1.734	14.70	4.841	-	3.69	1.911	9.823	-	-	45.004
Total non – filterable residues, Ton/day	6.12	0.471	4.37	1.441	-	1.07	0.503	2.641	-	-	14.105
Chloride, Ton/day	2.21	0.438	3.24	1.187	-	1.01	0.44	2.633	-	-	8.961
Total hydrolysable phosphate, Ton/day	0.051	0.004	0.054	0.016	-	0.01	0.038	0.161	-	-	0.789
Kjeldahl nitrogen, Ton/day	0.285	0.021	0.284	0.039	-	0.01	0.038	0.161	-	-	0.789
Sodium (Na), Ton/day	2.45	0.302	2.01	0.842	-	0.68	0.292	1.776	-	-	6.83
Calcium (Ca), Ton/day	1.02	0.098	0.854	0.318	-	0.23	0.089	0.673	-	-	2.734
Magnesium (Mg), Ton/day	0.942	0.075	0.938	0.319	-	0.26	0.106	0.690	-	-	2.751
Potassium (K), Ton/day	0.045	0.034	0.388	0.114	-	0.11	0.057	0.222	-	-	0.746

* Due to stagnant water residues were not obtained.

The loads of chemical constituents i.e. chloride, total hydrolysable phosphate, total Kjeldahl nitrogen, total residues, filterable residues, non – filterable residues, sodium, calcium, magnesium and potassium were calculated on the basis of chemical analysis of wastewater from Latifabad, Hussainabad and Qasimabad areas on average flow basis and detailed results of individual sampling stations are summarized in Table 3.

Total load from all sampling stations was calculated as, chloride 8.961 t/d, total hydrolysable phosphate 0.15 t/d, total Kjeldahl nitrogen 0.789 t/d, total residues 59.67 t/d, total filterable residues 45.004 t/d, total non – filterable residues 14.105 t/d, sodium 6.83 t/d, calcium 2.734 t/d, magnesium 2.751 t/d and 0.746 t/d of potassium.

Conclusion

Some positive effects of biological treatment plant at SSTP were observed during the study period, but the results of the water quality for the wastewater from Latifabad, Hussainabad, Qasimabad and SSTP are on the border line for permissible limits before and after biological treatment and could not be used without proper mixing with fresh water. It is recommended that proper cleaning of treatment plant should be carried out on priority basis to make the ponds effective for treatment.

The wastewater from Latifabad and Hussainabad is disposed off by WASA (HDA) towards SSTP, is diverted for irrigation without treatment. Notice should be taken by the responsible health authorities for the safe disposal.

The domestic wastewater may contain heavy metals. It is recommended that the crops which are used raw or uncooked should be investigated for metal accumulation.

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