CHARACTERIZATION OF WASTEWATERS IN SEMI URBAN SETTLEMENTS IN AGRICULTURE UNIVERSITY OF TIRANA, ALBANIA

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Abstract

Treatment of the wastewater before they discharge into a specific environment is very important in order to control environmental pollution. The most accurate way to determine the character and quantity of domestic wastewater is to measure the existing wastewater flow over a sufficient length of time to determine its variability in terms of composition, concentration and load. This study investigates the contamination level of the wastewaters from different sources, which all collect at the main collector located near the Territory of Agriculture University of Tirana, by analyzing its physic-chemical characteristics as well as nutrients content. The study is based on the data of periodical influent and effluent sampling results generated from month of October 2012 to April 2013. Samples were collected before they discharge into the Lana River and were subjected to our scientific laboratory studies. Experimental results show that the quality of wastewater varies and greatly depends on the origin of the wastewater. Several parameters such as pH, conductivity, dissolved oxygen, total suspended solids, total dissolved solids, alkalinity, calcium, magnesium, chlorides, chemical oxygen demand, biochemical oxygen demand, total nitrogen, total phosphorus were analyzed by Standard Methods for the Examination of Water and Wastewater; APHA, AWWA and WEF, 21st Edition, 2005. Evaluation of the characteristics of wastewater is important because they constitute a health hazard to the community living around the University and the environment in general. For this reason, in the premises of the University, a pilot plant has been designed and is being implemented to ensure the production of high quality of these waters within the norms in the receiving waters, such as waters of the Lana River.

Keywords: *Wastewater, COD, DO, TDS, standard methods.*

INDRODUCTION

Wastewater is the liquid end-product of municipal, agricultural and industrial activity. So, due to its value, wastewater is treated and than discharged to a receiving stream. As such the chemical composition of wastewater naturally reflects the origin from which it comes. Consequently, the water we use for drinking, washing, bathing etc. ultimately ends up back in the stream, river, lake, or groundwater where it will be with drawn, treated, and used again. In addition, the oxygen consuming material in the wastewater must be minimized to protect the receiving stream from low dissolved oxygen conditions which can be deleterious to desirable aquatic species. Nutrients, such as nitrogen and phosphorus, should be removed because when discharged to the aquatic environment, these nutrients can lead to the growth of undesirable aquatic life.

Sample collection

The samples collected and stored in clean polythene bottles fitted with screw caps and brought to the laboratory in the sampling for detailed physic-chemical analysis. These bottles are rinsed before use and these sample bottles were immediately brought to the laboratory for analysis. The sewage water samples were collected at entry and exit of plant wastewater processing. The pH was analyzed on the spot. Alkalinity of the water sample was measured by using phenolphthalein and methyl orange indicators while titrating with chlorhidric acid. Total hardness of sample was estimated by titrating the sample against ethylenediaminetetraacetic acid (EDTA) using erichrome black T indicator. Calcium and magnesium were estimated by using potassium hydroxide and murexide indicator titrating against EDTA. Chloride was measured by Argentometric Method in which sample was titrated against silver nitrate using potassium chromate indicator.

EXPERIMENTAL ANALYSIS

Physic-chemical parameters of these samples were determined by the ISO standards and Standard Methods for the Examination of Water and Wastewater; APHA, AWWA and WEF, 20th Edition 1999 and 21st Edition, 2005. The reagents used for the analysis were AR grade and instruments were of limit of precise accuracy.

pH: pH is termed as negative logarithm of the hydrogen ions concentration. The pH is determined by Satorius pH meter which gives direct values of pH (ISO, 1984). pH of the raw wastewater remained on the alkaline side mostly 7.8. pH was ranging from 7.06 to 8.02. A pH range of 6.5 to 8.4 is desirable for effluent quality for irrigation according to the FAO, 1985 guidelines and the effluent pH and is satisfactory according to the FAO standards since it falls within the desired range of the standards. A very low and a high value of pH is an indication that water needs further treatment. Irrigation wastewater with a pH outside the normal range causes a nutritional imbalance or may contain a toxic ion.

Conductivity: The conductivity is determined by using expressed as µS/cm by conductivity meter (APHA, 1999) . The highest value of electrical conductivity that was recorded was 1750 µS/cm and lowest value being 1090 µS/cm, but in effluent the highest value was recorded 1368 µS/cm and lowest value being 926 µS/cm. Ayers and Westcot, FAO 1985 recommends an electrical conductivity of 0-

2000µS/cm for wastewater to be used for irrigation and values above the range, the effluent may cause slight to moderate problems.

Temperature: A mercury filled centigrade thermometer calibrated from 0^o to 100^oC is used for temperature measurements.

Total dissolved solids: Fifty milliliters of water sample is filtered through ordinary filter paper and water is collected in the evaporating dish of known weight. Further it is heated and water is totally evaporated. Whatever dissolved solid matter is present gets accumulated at the bottom of evaporating dish. The evaporating dish is cooled and weighed. By weight difference method the total dissolved solids is determined (ISO/DIS, 1995).

Dissolved oxygen (Electrochemical probe method) indicates the amount of oxygen in water and was measured using inoLab 730 Oxi-meter (ISO 5. , 1990).

Total-P reflects the amount of all forms of phosphorous in a sample. Phosphorus was measured in sample by spectrophotometry using reagent ammonium molybdate etc. (ISO 6. , 1986). Nitrate-nitrogen – in sulfuric and phosphoric acid solutions nitrate ions react with 2, 6-dimethylphenol to form 4-nitro-2, 6-dimethylphenol that is determined photometrically (ISO 7.-3. , 1988) .

Analysis of wastewater before treatment

The quality of domestic wastewater was examined in triplicates. Apparently, it was grey in color with mordant smell. Parameters such as pH (7.77), NO_2 (0.15 mg/L), NO_3 (1.08 mg/L), TDS (480 mg/L), of the domestic wastewater were within the standard limits of WHO and US-EPA. However, PO_4 (3.02 mg/L), EC (510 µS/cm), Chloride (131.1625 mg/L), Total Alkalinity (517.5 mg/L) Calcium (139.135 mg/L), Magnesium (28.87 mg/L), DO (0.53 mg/L), BOD5 (134.83 mg/L) and COD (165.77 mg/L) were considerably deviated from their prescribed limits, indicating the high level of contamination.

Analysis of wastewater after treatment

Electrical conductivity and removal of solids

The value of EC, TSS and TDS ranged from 660 µS/cm, 44 and 597 mg/L respectively in the untreated samples of colony wastewater. According to (WHO, 2004), the prescribed value of EC, TSS and TDS in drinking water is 400-1215 µS/cm, 25-80 mg/L and <1000 mg/L respectively. In this study, it was found that EC value of untreated wastewater decreased gradually during treatment due to decrease in TDS and TSS levels as EC is directly dependent on the suspended and dissolved solids (García-Mesa J.J., 2010). This decrease in EC might be related to the conversion of NO_2 into diatomic molecular nitrogen (N_2), which also decreases EC levels of domestic wastewater. TSS concentration reduced to 0. On the other hand, TDS showed initial increase in its value 1655 mg/l, it decreased to minimum reduction (891 mg/L) (table 1-2).

RESULTS AND DISCUSSION

Physical and Chemical Parameters:

Removal of Organic Pollutants

Organic pollutants include Biological and Chemical Oxygen Demand and are inter-related with the amount of dissolved oxygen. Dissolved oxygen is important parameter in water quality assessment and reflects the physical and biological processes prevailing in the water bodies (Sehar S., 2011).The concentration of DO in raw water sample was very low i.e. 0.53 mg/L. A noteworthy improvement in the quality of water was observed in terms of DO with subsequent increase in hydraulic retention time until it reached maximum up to 3.95 mg/L in final treatment. Adequate dissolved oxygen is necessary for good water quality. Oxygen is a necessary element to all forms of life. Natural stream purification processes require adequate oxygen levels in order to provide for aerobic life forms. As dissolved oxygen levels in water drop below 5.0 mg/l, aquatic life is put under stress. The lower the concentration, the greater the stress. Oxygen levels that remain below 1-2 mg/L for a few hours can result in large fish kills.

The untreated (raw) wastewater had high range of COD and BOD_5 (165.77 and 84.44 mg/L) as compared to US-EPA standards i.e. (5-8mg/L and 8-10 mg/L) respectively (USEPA:, 2006). These high values were due to the presence of large amount of organic compounds in the domestic wastewater. Maximum activity was observed with 8 days HRT where both COD and BOD values were reduced up to 88.5% and 99.9 %. (Akratos C. S., 2007) also found COD and BOD_5 removals of 91 and 90.1% respectively with HRT of 8 days and there was no significant improvement in their reduction by increasing the HRT (i.e. 16 and 20 days). This decrease in BOD_5 and COD values might be due to high biodegradation of organic contaminants of wastewater during constant microbial activities.

Nutrient removal

Effect of hydraulic retention time on various nutrients (nitrogen, phosphorus, nitrate and nitrite) was observed. Nitrogen and Phosphorus are considered as one of the major nutrients and enter in the form of ammonium and orthophosphate into sewage from detergents and human excreta etc. and are source of eutrophication in receiving water bodies. They are removed from wastewater by the use of partial nitrification - denitrification process and biomass production. No prescribed values are defined by WHO for removal of ammonium-nitrogen and phosphate. However, according to US/EPA it should not exceed 0.05 mg/L if streams discharge into lakes. Present research showed 26.59 mg/l ammonium-nitrogen and 3.02 mg/L of phosphate in raw sewage. The concentration of ammonium-nitrogen and phosphate declined during treatment and showed values of 0.03 mg/l ammonium-nitrogen and 1.7 mg/l phosphate.

In the present study, it was observed that initially the concentration of nitrate-nitrogen and nitrite-nitrogen in the untreated raw sample for wastewater was up to 1.08 and 0.15 mg/L respectively. But, during partial nitrification–denitrification process showed that nitrate-nitrogen form reduced and nitrite-nitrogen (NO_2-N) conversion into the diatomic molecular nitrogen (N_2) and due to which a decreased was observed in EC of domestic wastewater. The most effective reduction was observed at the effluent i.e. nitrate-nitrogen concentration remained close to zero throughout the cycle, whereas nitrite-nitrogen at the end of the cycle were close to zero.

CONCLUSIONS

The results of the study show the levels of the important chemical parameters in agricultural use of wastewater. All the parameters had values within permissible ranges of European Directive and Albanian Standard. The present study was concluded that the pilot plant SBR installed in the territory of Agriculture University of Tirana, Albania is working extensively. The maximum removal of COD (88.5 %), BOD (99.9%), total nitrogen (97.3 %), ammonium- nitrogen (99.8%), nitrate-nitrogen (92.35 %) and total phosphorus (59.6%) were recorded after final treatment. Thus it is helpful in the control of the pollution of Lana River.

ANNEX

Table1. Descriptive statistics of the wastewater (influent) characteristics at the inlet of pilot plant

	pH	EC (µS/cm)	TDS (mg/l)	Sal (mg/l)	TSS (mg/l)	DO (mg/l)	BOD (mg/l)	COD (mg/l)
Count	30	30	30	30	30	30	30	30
Mean	7.776667	1455.88889	1364.889	0.511111	26.04444	0.537778	84.44444	165.7778
Standard deviation	0.294958	222.711794	198.0981	0.136423	15.4275	0.342993	45.30759	68.80185
Minimum	7.06	1090	1058	0.3	10	0.16	30	92
Maximum	8.08	1750	1655	0.7	54	1.04	150	277
Range	1.02	660	597	0.4	44	0.88	120	185

Table2. Descriptive statistics of the wastewater (effluent) characteristics at the outlet of pilot plant

	pH	EC (µS/cm)	TDS (mg/l)	Sal (mg/l)	DO (mg/l)	COD (mg/l)	BOD (mg/l)
Count	30	30	30	30	30	30	30
Mean	7.804	1253.6	1213.2	0.42	3.34	30.2	2.6
Standard deviation	0.390679	184.831815	181.1455	0.130384	0.734609	11.69188	3.714835
Minimum	7.11	926	891	0.2	2.21	16	5
Maximu m	8.02	1368	1314	0.5	3.95	47	8
Range	0.91	442	423	0.3	1.74	31	3

Table3. Descriptive statistics of the wastewater (influent) characteristics at the inlet of pilot plant

	$N\text{-}NH_4$ (mg/l)	**$N\text{-}N0_3$ (mg/l)**	**$N\text{-}NO_2$ (mg/l)**	**N Tot. (mg/l)**	**P Tot. (mg/l)**	**Total Alkalinity (mg/l)**	**Chloride (mg/l)**	**Calcium (mg/l)**	**Magnesium (mg/l)**
Count	30	30	30	30	30	30	30	30	30
Mean	26.59444	1.088889	0.154444	32.63444	3.027778	517.5	131.1625	139.135	28.8775
Standard Deviation	14.62267	0.105409	0.134454	12.90512	1.290492	72.92976073	28.24868791	7.702952356	14.65906268
Minimum	10.2	1	0.04	16	1.6	72.929761	28.248688	7.7029524	4.09
Maximum	55.4	1.2	0.5	57.2	5.47	640	163.07	150	40.3
Range	45.2	0.2	0.46	41.2	3.87	567.07024	134.82131	142.29705	36.21

Table4. Descriptive statistics of the wastewater (effluent) characteristics at the outlet of pilot plant

	$N\text{-}NH_4$ (mg/l)	**$N\text{-}N0_3$ (mg/l)**	**$N\text{-}NO_2$ (mg/l)**	**N Tot. (mg/l)**	**P Tot. (mg/l)**	**Total Alkalinity (mg/l)**	**Chloride (mg/l)**	**Calcium (mg/l)**	**Magnesium (mg/l)**
Count	30	0 30	0.02 30 0.7	30 1.7	30	30	30	30	30
Mean	0.03	0	0.02	0.7	1.7	441.25	135.5925	164.2325	12.7425
Standard Deviation	0.26163	0.05972158	0.005773503	0.130384	0.462623	9.601432185	23.69931684	8.677906934	4.544933305
Minimum	0.03	0	0.02	0.7	1.7	9.6014322	23.699317	8.6779069	4.5449333

Maximum	0.4	0.14	0.03	1	2.68	450	163.07	174	17.78
Range	0.37	0.14	0.01	0.3	0.98	440.39857	139.37068	165.32209	13.235067

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