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Efficiency Of Sewage Treatment Plant, Laam, Nishat, Srinagar, Jammu And Kashmir, India

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Abstract: The current study was undertaken at Sewage treatment plant (STP) Laam, Nishat, Srinagar situated between 33°25´ to 34°50´ N & 74°75´E geographical coordinates at the shores of world famous Dal lake. Comparative analyses were undertaken for raw sewage entering the STP and treated sewage discharged into the Dal Lake at aforesaid site. The parameters which were analyzed during the study included Temperature, pH, Electrical conductance, Biochemical oxygen demand (BOD), Chemical oxygen demand (COD), Chloride (Cl^-), Sodium, Potassium, Total dissolved solids (TDS), Total suspended solids (TSS), Totalsolids (TS), Nitrogen (as nitrate-nitrogen and ammonical-nitrogen), and ortho-phosphate. It was observed that the concentration of TS, TSS, TDS, Na^+, K^+, Ca^+, Mg^+, Am. Nitrogen, Orto-phosphate, BOD and COD was reduced by 59%, 66%, 50%, 33%, 73%, 30%, 66%, 49%, 60%, 77% and 74% while as that of Cl, NO_3^-, and dissolved oxygen increased by 67%, 51% and 99% respectively after treatment at STP.

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Key Words: Sewage treatment plant, Dal lake, Biochemical oxygen demand (BOD), Chemical oxygen demand (COD)

Introduction

Sewage is water-carried wastes, in either solution or suspension that is intended to flow away from a community. Also known as wastewater flows; sewage is the used water supply of the community. It is more than 99.9% pure water and is characterized by its volume or rate of flow, its physical condition, its chemical constituents, and the bacteriological organisms that it contains. Depending on their origin, wastewater can be classed as sanitary, commercial, industrial, agricultural or surface runoff. The spent water from residences and institutions, carrying body wastes, washing water, food preparation wastes, laundry wastes, and other waste products of normal living, are classed as domestic or sanitary sewage. Liquid-carried wastes from stores and service establishments serving the immediate community, termed commercial wastes, are included in the sanitary or domestic sewage category if their characteristics are similar to household flows. Wastes that result from an industrial process or the production or manufacture of goods are classed as industrial wastes. Their flows and strengths are usually more varied, intense, and concentrated than those of sanitary sewage. Surface runoff, also known as storm flow or overland flow, is that portion of precipitation that runs rapidly over the ground surface to a defined channel. Precipitation absorbs gases and particulates from the atmosphere, dissolves and leaches materials from vegetation and soil, suspends matter from the land, washes spills and debris from urban streets and highways, and carries all these pollutants as wastes in its flow to a collection point (Metcalf and Eddy,2003).

Wastewater treatment plant is a combination of separate treatment processes or units, designed to produce an effluent of specified quality from a waste water (influent) of known composition and flow rate. Aims of wastewater treatment are, to convert the waste materials present in wastewater into stable oxidized end products that can be safely disposed of to inland waters without any adverse ecological effects and protect public health (Uzma and Rafiq, 2012).

Materials And Methods

The present investigation was carried out in Sewage treatment plant, Laam, Nishat, Srinagar situated between 33°25´ to 34°50´ N & 74°75´E geographical coordinates. Disposal site of treated sewage is Dal lake which is a multi-basined, open drainage type lake (Zutshi and Khan, 1978). Catchment area of the STP includes residential areas of Zabarwan, Bain, Nishat, Ishbar and Shalimar. The treatment in the STP is categorized into three distinct parts. Pre-treatment comprises of screening and grit removal. Biological treatment comprising of fluidized aerobic bioreactors (FAB), followed by clarification, and tertiary treatment comprising of chemicals addition and precipitation to remove phosphates, and addition of chlorine to remove the E- coli. The samples were taken from four components of the STP namely, the receiving sump, FAB- I, FAB-II and the outlet. Sewage samples were collected in the first week and third week of each month for a period of one year in plastic bottles, between 8:00 a.m. and 10:00 a.m. the samples were then brought to the laboratory for analysis. Standard methods as given in American public health association (APHA, 2010) were used for the analysis.

Result And Discussion

Temperature

One of the physical parameter which is directly related with physical, chemical and biological reactions is temperature. Observation of temperature of sewage is useful in indicating the rate of biological activity. Normally temperature of sewage is slightly higher than that of the water supply. The temperature of wastewater becomes extremely important in certain wastewater unit operations such as sedimentation tanks and re-circulating filters (Ganizadeh et al.,2001). As evident from Table 1, Mean value of temperature increased from Influent to Effluent from 11.25 °C (± 1.60) to 11.95 °C (± 1.54).

On the other hand that mean value of pH increased from influent 7.14 (± 0.07) to Effluent 7.41 (± 0.13). Measurement of pH is one of the most important and frequently used tests in the waste water chemistry. Its determination is one of the important objectives in biological treatment of waste water. It is also a strong indicator of carbonate and bicarbonates. Usually the pH of municipal wastewater is found to be alkaline. In this study it was found that pH value increased from raw to treated sewage, this is in accordance with Stevans et al. 2004 and Uzma and Rafiq, 2012.

Similarly the mean value of electrical conductivity increased from influent 559 (±6.62) to Effluent 598 (± 3.64) Table.1. The increase in electrical conductivity (EC) may be attributed to the increase in concentration of TDS and some ionic pollutants such as PO_4, Cl^-, NO_3^-, etc. EC is controlled by number of sources of pollutants, which may be signaled by increased EC. Sources of ions are wastewater from sewage treatment plants (point source pollutants), and wastewater from septic systems and drain field on-site wastewater treatment and disposal systems (non-point pollutants).

Solids

Total solids are a measure of the suspended and dissolved solids in water. Suspended or dissolved in water or wastewater is considered as solids. A high amount of solids in water generally makes it undesirable for consumption. Solid analyses are important in the control of biological and physical wastewater treatment processes and for assessing compliance with regulatory agency wastewater effluent limitations. The present investigation reveals that the mean value of TS decreased from Influent 1038mg/l (± 99.6) to Effluent 424 mg/l (± 28.95) as shown in Table.2. Fig.1. The decrease in Total solids could be attributed to sedimentation process under going during the treatment.

Dissolved solids are those that pass through a water filter. They include some organic materials, as well as salts, inorganic nutrients, and toxin. Increased values of TDS could be related to the increased concentration of ions. The present investigation reveals in Table.2, Fig.1. that the mean value of TDS increased from Influent 453 mg/l (± 64.11) to Effluent 226.16 mg/l (± 25.22). Increased values of TDS could be related with the increased concentration of ions during the treatment processes.

Suspended solids are those that can be retained on a water filter and are capable of settling out of the water column onto the stream bottom when stream velocities are low. These include silt, clay, plankton, organic wastes, and inorganic precipitates such as those from acid mine drainage. The present investigation reveals that the mean value of TSS decreased from Influent 590 mg/l (± 38.45) to Effluent 197 mg/l (± 4.83). The decrease in TSS could be related with sedimentation during the treatment. These results are in agreement with that of Hall,1999 and Nageswara and Shruthi, 2002.

Ionic Components

Ionic pollutants with reference to calcium and magnesium revealed that the mean value of Calcium decreased from Influent 4.18 mg/l (±0.45) to Effluent 2.95 mg/l (± 0.13). while that of Magnesium decreased from Influent 3.56 mg/l (± 0.29) to Effluent 1.18 mg/l (±0.15) in Table.3, Fig.1. Calcium and magnesium can be circumvented by the addition of detergent phosphates. About half of the phosphate in sewage is derived from the detergents used, which contributes to lake eutrophication. Magnesium is often associated with calcium primarily due to similar chemistry. Decrease in concentration could be attributed to the grit separation, sedimentation process and active uptake of calcium and magnesium by microorganisms during treatment (Nathanson, 2003).

Another ionic pollutant chloride is essential in the human diet and passes through the digestive system unchanged, thereby becoming one of the major components of raw sewage. The wide use of zeolite spheres in water softeners also contributes a large amount of chloride to sewage and wastewaters. Chloride ion, and its salts, such as sodium chloride are very soluble in water (Green, 2001). The present investigation in Table 3 revealed that the mean value of chloride increased from Influent 99.0 mg/l (± 9.29) to Effluent 147 mg/l (±10.79) Table 3. Fig. 2. Increase in the mean value of chloride could be attributed to the addition of chloride compounds during treatment (Nageswara and Shruthi, 2002).

Comparing chloride with sodium and potassium the present investigation reveals that the mean value of Sodium decreased from Influent187 mg/l (± 13.22) to Effluent 126 mg/l (±4.76) and that of Potassium decreased from Influent 80.85 mg/l (± 8.18) to Effluent 22.18 mg/l (± 1.80). It was observed that potassium content decreased from raw to treated sewage. This could be due exponential growth phase during biological treatment which resulted in the active uptake of potassium ion from sewage. These findings are in agreement with the Goldman (1983).

Nitrate-Nitrogen

Nitrate represents the end product of oxidation of nitrogenous matter and its concentration depends on the nitrification and de-nitrification activities of micro-organisms. Biological nitrogen removal, consisting of nitrification and de-nitrification, is generally believed to provide the most economical means of controlling nitrogen in wastewater effluents. Nitrification is a two-step process accomplished by two groups of autotrophic bacteria under aerobic conditions. Ammonia is first oxidized to nitrite by Nitrosomonas sp., and nitrite is further catalyzed to nitrate by Nitrobacter sp. Nitrate formation is normally regarded as the rate limiting step in nitrification. The present investigation reveals that the mean value of Nitrate-Nitrogen increased from influent 1085 µg/l (±232) to Effluent 2215 µg/l (± 389) Table 4, Fig.2. These findings are in agreement with Tripathi et al., 1991.

Ammonical-Nitrogen

Ammonical-Nitrogen is a measure for amount of nitrogen in sewage water. Ammonical nitrogen content determines the nutrient load and pollution level in a water body as it is the most important plant nutrient. The present investigation reveals that the mean value of Ammonical-Nitrogen showed decreasing trend from influent concentration of 2387 µg/l (± 217) to effluent concentration of 1219 µg/l (±109) Table.4. This considerable decrease in the sewage from inlet to that of outlet could be related to the increasing rate of nitrification caused by microorganisms, that results in the conversion of NH_3-N into NO_3-N (Colt and Armstrong,1981). Other possible factor may be the increase in temperature from inlet to outlet that decreases the NH_3-N content and increases the rate of nitrification by providing a favorable condition for the microorganisms to grow. These findings are in agreement with the Silva et al, 2002.

Ortho-Phosphate

Phosphate is a very common form of phosphorous present in different wastewaters. Municipal sewage contains organic phosphates, polyphosphates that frequently need to be removed in order to permit wastewater treatment plant effluents to be discharged into water bodies. The usual forms of phosphorous found in aqueous solutions include Orthophosphates, and Polyphosphates. Usually polyphosphates undergo hydrolysis and revert to the orthophosphate forms. Phosphate determination is useful in measuring the water quality since it is an important plant nutrient and may play a role of limiting factor among all other essential plant nutrients (Dugan, 1972). The present investigation reveals that the mean value of Ortho-Phosphate increased from 742 µg/l (±116.2) in influent to 299 µg/l (±21.68) in Effluent.

Biological Oxygen Demand And Chemical Oxygen Demand

Biochemical oxygen demand is a measure of the quantity of oxygen used by these microorganisms in the aerobic oxidation of organic matter. The present investigation in Table.5. reveals that the mean value of BOD decreased from 261mg/l (± 9.29) in Influent to 59.43 mg/l (± 3.86) in Effluent. The reason for reduction is owed to mechanical aeration and aerobic digestion. During the study it was also observed that the efficiency of reducing BOD_5 levels were reduced during winter conditions owing to low water temperature and reduced microbial activity. These results are in agreement with Verma et al, 2006 and Uzma and Rafiq, 2012.

Comparing BOD with Chemical Oxygen Demand (COD) it is the measurement of the amount of Oxygen in water consumed for chemical oxidation of pollutants. The COD determines the amount of organic matter present in the waste water, making it a useful measure of water quality. The present investigation reveals that the mean value of COD decreased from Influent 546.50 ± 21.04 to Effluent 142.33 ± 7.71. The decrease in COD from inlet sewage to that of outlet sewage is mainly due to the decrease in organic and inorganic materials present in the sewage while going through a series of physical and biochemical processes in the sewage treatment plant at Laam, Nishat. Here it was observed that COD reduction is not in accordance with the required standards. These are in agreement with Mohammadi et al, 2004 and Uzma and Rafiq,2012. As the sewage has much higher COD than the maximum permissible limits. This could be related to inefficient chemical dosage. Similar results were obtained for COD removal upto 70-80 % by use of alum and $FeSO_4$ concentration (Assillian, 2006).

Table 1. Physicochemical parameters of Influent, FAB-I, FAB-II and Effluent

Parameters	Influent	FAB-I	FAB-II	Effluent
Temperature (^{0}C)	**11.25** ± 1.60	**11.43** ± 1.59	**11.90** ± 1.51	**11.95** ±1.54
pH	**7.14** ± 0.07	**7.47** ± 0.25	**7.53** ± 0.22	**7.41** ± 0.13
E. Conductivity (µS/cm)	**559** ± 6.66	**576** ± 5.15	**590** ± 4.55	**598** ± 3.64

± represents Standard error

Table 2. Comparative concentration of TS, TDS and TSS

Parameters	Influent	FAB-I	FAB-II	Effluent
Total solids (mg/l)	**1038** ± 99.6	**635** ± 63.65	**535** ± 55.04	**424** ± 28.95
T.D.S (mg/l)	**453** ± 64.11	**283** ± 34.91	**284** ± 45.65	**226** ± 25 22
T.S.S (mg/l)	**590** ± 38.45	**352 ± 35.95**	**241** ± 10.56	**197** ± 4.83

± represents Standard error

Table 3. Ionic pollutants concentration

Parameters	Influent	FAB-I	FAB-II	Effluent
Calcium (mg/l)	**4.18** ± 0.45	**3.43** ± 0.22	**3.10** ± 0.11	**2.95** ± 0.13
Magnesium (mg/l)	**3.56** ± 0.29	**3.35** ± 0.24	**2.18** ± 0.24	**1.18** ± 0.15
Sodium (mg/l)	**187** ± 13.22	**152** ± 6.89	**139** ± 5.94	**126** ± 4.76
Potassium (mg/l)	**80.85** ± 8.18	**61.63** ± 4.76	**40.43** ± 3.18	**22.18** ± 1.80
Chloride (mg/l)	**99.0** ± 9.29	**108** ± 8.37	**116** ± 7.92	**147** ± 10.79

Table 4. Concentration of nitrate-nitrogen, ammonical-nitrogen and ortho-phosphorus of Influent, FAB-I, FAB-II and Effluent

Parameters	Influent	FAB-I	FAB-II	Effluent
Nitrate-Nitrogen (µg/l)	1085 ± 232.97	1321 ±251.81	1881 ± 342.33	2215 ±389.24
Ammonical-N (µg/l)	2387 ±217.13	2016 ± 201.0	1721 ± 178.0	1219 ± 109.0
Ortho-phosphate (µg/l)	742 ± 116.21	438 ± 44.91	344 ± 39.74	299 ± 21.68

± represents Standard error.

Table 5. BOD and COD concentration of Influent, FAB-I, FAB-II and Effluent

Parameters	Influent	FAB-I	FAB-II	Effluent
B.O.D (mg/l)	**261** ± 9.29	**184** ± 9.99	**118** ±7.40	**59.43** ±3.86
C.O.D (mg/l)	**546** ± 21.04	**392** ± 20.04	**259** ± 14.81	**142** ± 7.71
D.O (mg/l)	**0.13** ± 0.04	**2.95** ± 0.71	**8.28** ± 0.71	**11.16** ± 0.83

± represents Standard error.

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