Efficiency of Sewage treatment Plant, Hazratbal, Srinagar,Jammu and Kashmir,India.

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Abstract: The current study was undertaken at Sewage treatment plant (STP) Hazratbal, Srinagar located 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), Total solids(TS), Nitrogen (as nitrate-nitrogen and ammonical-nitrogen), and Phosphorous (as ortho-phosphate and total phosphate).It was observed that the concentration of TS, TSS, Am.Nitrogen, Na, K, Ca, Mg, BOD and COD was reduced by 9.3%, 25%, 27%, 28%, 23%, 25%, 32%, 57%, and 60% while as that of TDS, Cl ,NO_3,PO_4,and TP increased by 31%,72%,82%,4%,and 35% respectively after treatment at STP.

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Keyword: Sewage treatment Plant,Dal lake , Biochemical oxygen demand (BOD), Chemical oxygen demand (COD)

Introduction

Wastewater is a complex mixture of natural inorganic and organic material mixed with man-made substances. It contains everything discharged to the sewer, including material washed from roads and roofs, and course where the sewer is damaged groundwater will also gain entry. It is this complex mixture that ends up at the wastewater treatment plant for purification. Wastewater can be splitted into domestic (sanitary) wastewater also known as sewage, industrial (trade) wastewaters and, finally, municipal wastewater which is a mixture of the two. Sewage is correctly the subset of wastewater that is contaminated with feces or urine. The strength and composition of sewage changes on an hourly, daily and seasonal basis, with the average strength dependent on per capita water usage, infiltration, surface run-off as well as local habits and diet. Sewage is 99.9% water with the material that requires to be removed amounting to just 0.1% by volume. This solid material is a mixture of feces, food particles, grease, oils, soaps, salts, metals, detergent, plastic, sand and grit. The organic fraction is composed of proteins, carbohydrates and fats, which reflects the diet of the community served by the treatment system ***(Metcalf and Eddy, 1922).***

Wastewater treatment plant is a combination of separate treatment processes or units, designed to produce an effluent of specified quality from a wastewater (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.

Materials And Methods

The present investigation was carried out in Sewage treatment plant, Hazratbal, Srinagar situated between 34°9´N, 74°91´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 Kashmir University, National Institute of Technology, Hazratbal, Naseem-Bagh, Mirza- Bagh, Kanitar, Saderbal, Mahivar.

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 three components of the STP namely, the receiving sump, the clari-settler 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,1998) were used for the analysis.

Table 1: Description of Sewerage System

STP Hazratbal	**7.5 MLD**
Targeted sewer lines	7909 m
Sewer lines completed	7652.50 m
Targeted laterals	20187 m
Laterals	12557 m
Laterals	65%

Source: *Lakes and Waterways Development Authority, Jammu and Kashmir, India*

Result And Discussion

Table.2.Physico chemical parameters of influent, clari-settler and effluent

Parameters	Influent	Clari-settler	Effluent
Temperature	**8.51** ± 2.67	**10.1** ± 2.72	**10.7** ±2.77
pH	**7.01** ± 0.08	**7.16** ± 0.05	**7.24** ±0.05
E.Conductivity	**626.5**± 3.61	**642.4**±3.66	**650.1** ±3.31

± represents Standard error

Table.3. comparative concentration of TS,TDS and TSS.

Parameters	Influent	Clari-settler	Effluent
Total solids	**409.5** ±33.95	**381.4** ± 27.55	**368.8**±26.87
T.D.S	**121.5** ± 9.06	**148.2** ±11.55	**159.0**±10.09
T.S.S	**288.0** ± 25.59	**236.8** ±17.43	**209.8**±17.43

± represents Standard error

Table.4.Ionic pollutants concentration

Parameters	Influent	Clari-settler	Effluent
Calcium	**24.6** ± 1.81	**21.32** ±1.82	**18.60** ± 1.85
Magnesium	**14.2** ± 2.99	**12.4** ± 2.81	**10.2** ± 2.65
Chloride	**201.1** ±9.23	**242.1** ±12.8	**347.1** ±14.08
Sodium	**195.5** ± 14.28	**156.4** ± 9.19	**139.0** ± 8.11

± represents Standard error.

Table.5. Concentration of different forms of nitrogen and phosphorus of influent, clari-settler and effluent

Parameters	Influent	Clari-settler	Effluent
NO_3-N	**946.0** ±69.27	**1683.1** ± 89.83	**1707.0** ± 89.65
NH_3-N	**3493.5** ± 190.43	**3021.1** ± 153.17	**2544.5** ± 124.83
Ortho-phosphate	**1039.7** ± 24.23	**1062.5** ± 22.99	**1078.4** ± 19.92
Total-Phosphate	**1754.0** ± 150.9	**2325.2** ± 181.4	**2353.4** ±182.04
Potassium	**129.2** ± 8.8	**110.8** ± 8.20	**99.2** ± 7.80

± represents Standard error.

Table.6. BOD and COD concentration of influent, clari-settler and effluent.

Parameters	Influent	Clari-settler	Effluent
B.O.D	**350.1** ± 26.0	**225.4** ± 7.42	**149.2** ± 11.59
C.O.D	**677.7** ± 47.02	**434.0** ± 17.19	**274.0** ± 24.60

± represents Standard error.

Table.7. %age Reduction of different parameters during treatment at STP

S.NO	Parameters	%age Reduction
i.	Total solids	**9.3** ± 2.11
ii.	TSS	**25.3** ± 2.43
iii.	Ammonical-Nitrogen	**26.9** ± 0.54
iv.	Sodium	**28.2** ± 1.98
v.	Potassium	**23.5** ± 1.58
Vi	Calcium	**25.5** ± 2.59
vii.	Magnesium	**32.7** ± 4.60
viii.	BOD	**57.2** ± 1.21
ix.	COD	**59.7** ±1.28

± represents Standard error

Table.8. %age increase in concentration of different parameters during treatment at STP

S.NO	PARAMETER	% increase
i.	TDS	**31.7** ± 4.12
ii.	Chloride	**72.6** ±2.30
iii.	Nitrate-Nitrogen	**82.2** ± 5.90
iv.	Ortho-phosphate	**4.0** ± 0.64
v.	Total-phosphate	**34.8** ± 5.45

± represents Standard error.

As evident from Table 1, Mean value of temperature increased from Influent to Effluent from 8.51 °C (± 2.67) to 10.7 °C (± 2.77).

The temperature of wastewater varies greatly, depending upon the type of operations being conducted. The survey of various treatment processes in wastewater treatment shows that temperature is an important factor affecting efficiency of settling and flocculation. Changes in wastewater temperatures affect the settling rates, dissolved oxygen levels, and biological action. The temperature of wastewater becomes extremely important in certain wastewater unit operations such as sedimentation tanks and re-circulating filters (Ghanizadeh et.al., 2001).

The present investigation reveals that mean value of pH increased from influent 7.01 (±0.08,) to Effluent 7.24 (± 0.15).Usually, sewage is acidic to a degree, but it depends on the specific effluents being conveyed by the sewer (Roger, 1973 and Sarrafpour et. al., 2001).

Similarly the mean value of electrical conductivity increased from influent 626.5(±3.61) to Effluent 650.1(± 3.31).The increase in conductivity may be attributed to the increase in concentration of TDS and some ionic pollutants such as PO_4, Cl, NO_3 etc. Electrical conductivity (EC) estimates the amount of total dissolved salts (TDS), or the total amount of dissolved ions in the water. Different sources of ions that add to the conductance of wastewater include wastewater from sewage treatment plants (point source pollutants), and wastewater from septic systems and on-site wastewater treatment and disposal systems (non-point pollutants.

Solids

Total solids are a measure of the suspended and dissolved solids in water. 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 409.57(±33.95) to Effluent 368.85(±26.87).The decrease in Total solids could be attributed to sedimentation process under going during the treatment.

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. They 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 288.0 (±25.59) to Effluent 209.85 (±17.4). The decrease in TSS could be related to the sedimentation during the treatment. (Hall, Antar Gamble, 1999 and Nageswara et. al., 2002).

The present investigation also revealed that the mean value of TDS increased from Influent 121.57(±9.06) to Effluent 159.0(± 10.09).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 with the increased concentration of ions during the treatment processes

Ionic Pollutants.

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 present investigation reveals that the mean value of chloride increased from Influent 201.1(±9.23) to Effluent 347.14(±14.08, . Increase in the mean value could be attributed to the addition of chlorine compounds during treatment (Nageswara, V.V and Shruthi, D., 2002)

Comparing chloride with sodium and potassium the present investigation reveals that the mean value of Sodium decreased from Influent 195.57(±14.28) to Effluent 139.0(± 8.11) and that of Potassium decreased from Influent 129.28(±8.8) to Effluent 99.28(± 7.80).Gradual decrease during treatment from raw to treated sewage may be due to exponential growth phase during biological treatment that resulted in the active uptake of respective ion from sewage. (Gray, 2004)

Ionic pollutants with reference to calcium and magnesium revealed that the mean value of Calcium decreased from Influent 24.65(±1.81) to Effluent 18.60(± 1.85) while that of magnesium decreased from Influent 14.22(± 2.99) to Effluent 10.21 (± 2.65).

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 micro-organisms during treatment. (Nathanson, 2003).

Nitrate –Nitrogen:

Nitrogen is one of the principle nutrients of concern in treated wastewater discharges. The increased use of Nitrate-Nitrogen and discharge of partially treated industrial wastes to rivers, lakes and groundwater leads to exceedingly high nitrate-nitrogen levels of nitrate- nitrogen are major factor in the problem of water bodies. The present investigation reveals that the mean value of Nitrate-Nitrogen increased from influent 946.7(±69.27) to Effluent 1707.0(± 89.65). Increase in the value of NO_3-N from influent to effluent could be related to the nitrification process taking place during the treatment especially in the FAB and Clari-settler (Behera et. al., 2007).

Ammonical- Nitrogen:

Ammonia is created by the decomposition of organic matter. Ammonification is the process of converting organic nitrogen to ammonia through biological activity under anaerobic conditions. This activity is found in sewers and anaerobic digestion. Ammonia is highly toxic to aquatic organisms and can detrimentally affect growth and health Ammonia could be removed by nitrifying bacteria, it is oxidized to nitrate, the latter is being most used. (colt and Armstrong, 1981).

The present investigation reveals that the mean value of Ammonical-Nitrogen showed decreasing trend from influent 3493.5(±190.43) to Effluent 2544.5(± 124.83).Decreasing trend could be due to the increased rate of nitrification caused by micro-organisms under aerobic conditions provided by FAB technology, resulting in the conversion of Ammonical-Nitrogen into Nitrate –Nitrogen (Hall, Antar Gamble, 1999).

Phosphorous:

Phosphorus is often the limiting nutrient for plant growth, meaning it is in short supply relative to nitrogen. Phosphorus usually occur in nature as phosphate. Phosphate that is bound to plant or animal tissue is known as organic phosphate. Phosphate that is not associated with organic matter is known as inorganic phosphate. Inorganic phosphate is often referred to as orthophosphate or reactive phosphorous. It is the form most readily available to plants, and thus may be the most useful indicator of immediate potential problems with excessive plant and algal growth. (Wenzel and Ekanma, 1997., Mulder and Rensink, 1987., Metcalf and Eddy, 1991., Henze, 1996, Sedlak, 1991).The present investigation reveals that the mean value of Ortho-Phosphate increased from influent 1039.7(±24.23) to Effluent 1078.42(± 19.9) while that of Total Phosphate increased from influent 1754.0(±150.9) to Effluent 2353.4(± 182.04).

It was found that there was an increasing trend in the values of Ortho-phosphate from raw to treated sewage samples. This could be attributed to the fact that almost all forms of Phosphates revert to the soluble ortho-phosphate form. Metal salt of aluminium, poly aluminium chloride (PAC) used as coagulant has its limitations for phosphorus removal, for it has lower net charge (Hammer, 2003).

Biological Parameters:

Biological oxygen demand(BOD) and chemical oxygen demand

The present investigation reveals that the mean value of BOD decreased from Influent 350.14(± 26.0) to Effluent 149.2(± 11.59).BOD of sewage decreased with treatment but BOD of effluent is much above the required range of 30-40 mg/l. Ineffective BOD reduction could be attributed to the lack of proper operation and maintenance. (Verma, et. al., 2006) (Priyanka, et. al., 2008)

Comparing BOD with COD the mean value of COD also decreased from Influent 677.71(± 47.02) to Effluent 274.0(± 24.60).

Maximum permissible limit of COD is 120 mg/l and here it was observed that COD reduction was not in accordance with the required standards. This could be related to inadequate chemical dosage. (Verma, et. al., 2006) (Priyanka, et. al., 2008).

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