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ORIGINAL ARTICLE

Nutrient Reduction in Fluidized Aerobic Treatment by Sewage Treatment Plant in Srinagar (J&K)

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ABSTRACT
Huge volume of domestic wastewater is produced in cities due to population growth. Indiscriminate disposal of such water is a cause for pollution of water resources. Hence, treatment of sewage water before it will enter into water becomes necessary. The objective of the study was to monitor the nutrient reduction by sewage treatment plant located in Srinagar city near Dal Lake and its effectiveness in the removal of organic load from sewage. The study was conducted by following the standard methods of APHA 1989. The concentration of Ammonia, Nitrate, phosphate, and total suspended solids were determined by Spectrophotometer. The removal efficiency of the different nutrients by the Sewage Treatment Plant (STP) was very significant. The nutrient removal efficiency ranged between 28% to 46% at study site I, for nitrate nitrogen and Ammonical nitrogen respectively. It was 39.4% to 59% at site II for Total suspended solids (TSS) and Total phosphate (TP) respectively. It is concluded that STP decreases the pollution load of sewage but the efficiency can be improved by changing the design and reduction in the sewage load.
Keywords: *Sewage, nutrients, efficiency, STP*

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INTRODUCTION

In most parts of the world the sewage is discharged into water bodies without proper treatment. In India the practice of treating sewage has gained momentum during the last few decades. The waste water coming from domestic premises like residences, institutions and commercial establishments is termed as sewage or wastewater [1]. Only 0.1% of the domestic and municipal waste water is composed of suspended, colloidal and dissolved solids which are primarily composed of human waste, paper, vegetable matter etc [2]. The pathogen in organic matter of the waste consumes the available oxygen and increase the oxygen demand. The waste water if not treated properly may contaminate the water bodies and land. Moreover, the water cannot be used for agricultural and industrial purposes. Hence, the shifting towards withdrawal of ground water increases that may cause many environment and sociological problems in the area. The installation of sewage treatment plant could reduce the problem of water contamination by reducing the organic and pathogenic load of the water. The treated wastewater could act as an alternative to ground water for industrial and agricultural purpose. The elimination of phosphorus and other organic compounds by waste water treatment plant depends on different requirements.

The total population of the Srinagar City is 1,269,751 as of 2011census. In order to divert the sewage generated in the catchment area of the lake, sewage pumping stations were constructed by the Lakes And Waterways Development Authority (LAWDA). The three sewage treatment plants are located at *Hazratbal, Habak* and *Laam* basin of the lake. The three sewage treatment plant (STP) installed have a design capacity/day of about 15.2 MLD, the total capacity of the sewage Treatment Plant is 3.2, 7.5 and 4.5 at *Habak, Hazartbal* and *Laam Nishat*, respectively.

These treatment plants are used to treat the sewage water and then it is disposed into the Dal lake. In the sewage treatment plant different processes take place during the treatment which includes the screening, grid removal, and sedimentation as primary treatment while the secondary treatment is brought about by microorganism like Bacteria and Algae by growing on organic matter available in sewage water under varying conductions [3]. The aim of the present study is to assess the efficiency of STP for reduction in nutrient load of sewage from Srinagar city.

MATERIALS AND METHODS

Study site:

This study was conducted at three sewage treatment plants viz., Habak STP (34^{0}08'50"N - 74^{0}50'36"E), Hazratbal STP (34°08'06"N - 74°50'29"E) and Lam STP (34°07'42"N - 74°523'36"E) during the year 2013-14. These STPs are situated in the vicinity of Dal Lake with the design capacity of 3.2, 7.5 and 4.5 MLD, respectively [4]. The design of the waste water treatment plants is shown in Fig 1.

Sample collection:

Waste water samples were collected quarterly from different stages of sewage treatment plants. Samples were collected in glass containers, pre-cleaned by washing with non-ionic detergents, rinsed with tap water followed by 1:1 hydrochloric acid and finally with deinoised water. Samples were analyzed to determine the reduction efficiency of sewage treatment plant for nutrients with special reference to nitrate and phosphate by using standards methods prescribed by the APHA [5]. Samples were collected from different sites of a sewage treatment plant respectively, in the morning session in prewashed 2 liter sterilized plastic container within 2- hours, the samples were then transported to the laboratory for analysis as per [5].

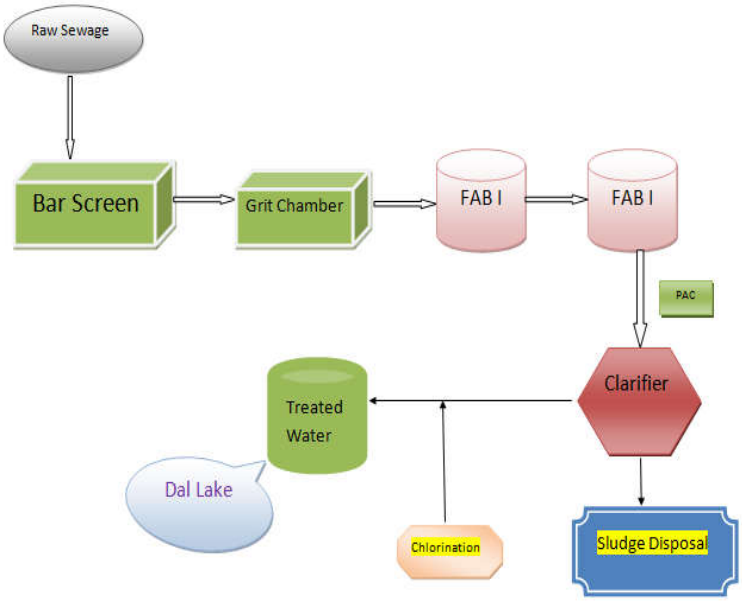

Fig 1: Flow chart of Sewage Treatment Plants

Analysis of physic-chemical properties:

pH, Electrical conductivity and TDS:

pH was measured by digital portable pH meter- Systronics. Electric conductivity was measured by digital portable meter. The TSS was measured with the help of TDS meter. Ammonical nitrogen and nitrate nitrogen was determined by the Alkaline-Permanganate method. The available phosphorous and ortho-phosphate was determined using the Bray and Kurtz method. The intensity of color developed after a pause of 10 minutes was measured on UV-VSR DR 4000 spectrophotometer and readings were compared with standard curve.

Statistical Analysis: The mean values and Standard error of mean were calculated by using Duncan's multiple range tests.

RESULTS

The pH of the raw sewage sampling site I was 6.85 and it was 7.15 for effluent which was treated in different chambers of the STP. 36.36, 44.96, 28.7, 32.76, 39.91% of reduction was achieved at site I in the values of TSS, Ammonical. Nitrogen, Nitrate nitrogen, Ortho- phosphate and Total phosphate, respectively (Table I).

Table 1: Mean values of physico- chemical parameters of Hazratbal sewage treatment plant at site I

Parameters	**RAW**	**G.C**	**FABI**	**FABII**	**CLRF**	**EFFL**	**Reduction (%)**
pH	6.85±0.15	7.08±0.16	7.08±0.18	7.17±0.15	7.23±0.11	7.15±0.15	---
Conductivity	599.5±30.3	604.7±26.7	629±8.4	608±25.4	595±28.1	657.5±10.9	----
TSS	165±26.3	145±27.2	125±22.1	115.5±22	87.5±17.9	60±20	36.36
Ammonical. nitrogen	1866±47.4	1812±36.1	1505±71.1	1185±47.4	987±94.8	839±32	44.96
Nitrate nitrogen	970±48.4	871±55.9	550.5±13.5	480.5±68.8	392.25±54.2	278.5±24.7	28.7
Ortho-phosphate	1031.5±43.2	931.74±9.3	699.75±77.1	551.75±70.3	451.5±40.3	338±37.5	32.76
Total phosphate	1636±57.8	1489±58.9	1162.5±31.6	854.25±95.3	740.25±40.8	656±92.25	39.91

The TSS was 165±26.3,145±27.2,125±22.1,17.5±22.1,87.5±17.9, and 60±20.00 mg/l for raw sewage , grid chamber, FAB I , FAB II, CLRFIER, EFFLUENT, respectively. 39.4, 55, 46, 49, 49.4 % of reduction was achieved at site II in the values of TSS, Ammonical Nitrogen, Nitrate nitrogen, Ortho- phosphate and Total phosphate, respectively (Table II).

Table 2: Mean values of physico- chemical parameters of Habak sewage treatment plant at Site II

Parameters	**RAW**	**G.C**	**FABI**	**FABII**	**CLRF**	**EFFL**	**Reduction (%)**
pH	7.20±0.15	7.29±0.14	7.06±0.10	7.18±0.04	7.20±0.02	7.20±0.06	----
Conductivity	640.2±10.5	653±48.4	657.5±59.6	645.25±13.1	636.25±70.3	636.5±4.3	----
T.SS	177.5±23.2	155±22.5	135±19.3	115±21.7	97.5±18.8	70±14.7	39.4
Ammonical Nitrogen	1526.7±19.7	1419±33.0	1221.5±21.7	1002±85.0	880±99.7	839.75±97.7	55
Nitrate nitrogen	787.25±8.5	737±64.7	619±47.6	484.75±2.2	416.5±43.4	364.5±45.9	46
Ortho-phosphate	929.5±90.5	823±78.6	737.5±55.9	524±49.6	493±49.6	456±34	49
Total phosphate	1530±35.1	1434.5±38	1240.2±99.2	946±72.8	587.25±93.5	757±44.3	49.4%

The values of Ammonical Nitrogen was 1614.75±19.2,1545.50±93, 1382.5±79.5, 1068.25±17, 1024.5±77, 796.5±54.0 mg/l for raw sewage , grid chamber, FAB I , FAB II, CLRFIER, EFFLUENT, respectively. However, the values of Nitrate Nitrogen was 1163.5±26.1,1097.15±23.5, 836.5±90.5, 620.5±75.4, 496.75±47.5, 410±43.6 mg/l for raw sewage , grid chamber, FAB I , FAB II, CLRFIER, EFFLUENT, respectively. 33, 49, 35, 43.8, 36.97 % of reduction was achieved at site III in the values of TSS, Ammonical Nitrogen, Nitrate nitrogen, Ortho- phosphate and Total phosphate, respectively (Table III).

Table 3: Mean values of physico- chemical parameters of Laam sewage treatment plant at site III

Parameters	**RAW**	**G.C**	**FABI**	**FABII**	**CLRF**	**EFFL**	**Reduction**
P.H	6.81±0.25	6.92±0.24	6.81±0.25	6.77±0.26	6.91±0.23	6.89±0.29	----
Conductivity	540.25±59.6	544±57.7	541±54.9	539.75±51	527.75±99	517.25±59.2	----
T.SS	180±14.1	147.5±13.7	17.5±15.4	100±10.8	80±9.1	60±8.1	33
Ammonical. Nitrogen	1614.75±19.2	1545.50±93.	1382.5±79.5	1068.25±17	1024.5±77	796.5±54.0	49
Nitrate nitrogen	1163.5±26.1	1097.15±23.5	836.5±90.5	620.5±75.4	496.75±47.5	410±43.6	35
Ortho-phosphate	1102±30.05	1033.5±41.9	785.5±32.7	595.25±34.8	530±17.26	483±24.40	43.8
Total phosphate	1649±39	1600.5±21	1195.75±98.3	981±10.99	797±25.4	609.75±23.2	36.97

DISCUSSION

The objective of the installation of STP in city of Srinagar is to prevent eutrophication of the Dal Lake. It is to mention that eutrophication has reduced the area of Dal lake from 22 km^2 to 8 km^2 [6]. It is well known fact that in most developing countries the STP is not working properly [7] that causes contamination of lakes, rivers and ponds [8][9]. Hence, effective treatment methods are being employed to treat the water in order to prevent contamination. The overall percentage in the removal of nutrients increased as the sewage passes into different chambers of the STP that can be attributed to the different treatment processes in STP. The nutrients originating from different sources like households, agriculture run off and from the catchment tributaries is contaminated with heavy nutrients and other acidic substances. In our study, the sewage received by the STP was slightly acidic and the treated effluent is slightly alkaline. The slightly change in the percentage is an indication that pH is regulated by carbon dioxide and bicarbonates as has also been reported by [10].

The reduction in the TSS may be argued with the fact that in the clarifier most of nutrients get settled down physically or by the use of coagulants. The concentration of ammonical nitrogen decreased from 1866±47.4 mg/l to 839±32.00 mg/l which is about 46.5% reduction at site I and it was 55% and 49% respectively at site II and site III. The ammonical nitrogen decreased due to the action of microorganisms in the sewage.

We found different variations in the reduction in the values of ammonical nitrogen, nitrate nitrogen, Orthophosphate, total phosphate of the three STP located at different locations in the city. This is due to different operating conditions and variations in the composition of sewage received by the three different STP). During present study the overall concentration of Ammonical- Nitrogen was found highest (1866±47.4 µg/l, 1526.7±19.7µg/l and 1614.7 ±19.2µg/l in raw water at all the three sites *viz Hazratbal, Habbak, Laam*). Its concentration continuously decreased at all three sites as sewage water passes through different processes of treatment. The decrease in ammonical nitrogen is due to the fact that bioreactors containing aerobic bacteria which cause biological oxidation of nitrogen from ammonia i.e (Nitrification and denitrification)[11]. The concentration of ortho-Phosphate at Hazratbal 1031.5±43.2 µg/l Habbak 929.5±90.5 µg/l and Laam 1102±30.05 µg/l is due to the fact that raw sewage contains high nutrient load. Concentration of ortho-Phosphate also shows decline as it passes through different processes of sewage treatment plant. Ortho- Phosphate was removed from sewage treatment plant both chemically as well as biologically during chemical process. The chemical poly aluminum chloride is used which helps in the precipitation of nutrients usually with salt of iron e.g., ferric chloride alum or lime and settle down along with sludge due to anerobic digestion [12]. Ortho-Phosphate can also be removed biologically in a process called enhanced biological phosphorous removal with specific bacteria called polyphosphate accumulation organisms (PASO) as they are selectively enriched and accumulate large quantities of phosphorous within their cells up to 20% of their mass. It is concluded that STP remove various nutrients from the sewage but the efficiency can be improved by changing the design and reduction in the sewage load. Regular studies are needed to confirm the role of the treatment procedures in the elimination of other factors such as biochemical oxygen, nitrogen and phosphorus by the Sewage Treatment Plant. In city of Srinagar regular monitoring of the different treatment plant process units is recommended to detect any malfunction timely and ensure prompt repairs. Different microbial cultures need to be identified too that can improve the efficiency of the STP for reduction of nutrient load.

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