PERFORMANCE EVALUATION OF ABESAN WASTEWATER TREATMENT PLANT

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ABSTRACT

The performance of the Abesan wastewater treatment plant situated at the Abesan Low Cost Housing Estate, Abesan, Lagos had been evaluated. The treatment plant operates on biological treatment method (Activated Sludge Process) with an average wastewater inflow of 6 MLD has been considered for the case study. Thirty – six (36) grab samples of wastewater influent and effluent were collected over a period of six weeks during the dry and rainy seasons. The samples were analyzed for different wastewater quality variables. Average removal efficiencies of the measured parameters from the treated effluents were 96.3% for Chemical Oxygen Demand (COD), 93.3% for Biological Oxygen Demand (BOD), 92.4% for Total Suspended Solids (TSS), and 41.6% for Total Dissolved Solids (TDS) for the dry season. The rainy season average removal efficiency of the measured parameters were 96.8% for COD, 94.6% for BOD, 95.9% for TSS, and 38.6% for TDS. The values obtained for the dry season are lower than that obtained in the rainy season except for TDS. Most of the values of the effluent parameters exceeded the regulatory requirement of the Federal Environmental Protection Agency guideline for effluent limitation. The results obtained from this research conclude that regular routine de-silting and maintenance works of the plant be carried out to allow effective running of the plant.

Keywords: Wastewater, Biological, Effluent, Influent Treatment Plant, Oxidation Ditch,Sludge.

Introduction

As long as human being exists, there would always be the production of biological and chemical waste products. These would be produced either as a direct result of the metabolic process of his body, or as a result of the various domestics and industrial processes of production. Waste produced from these processes must be discharged, and according to (Abdullahi, *et al.,* 2013**)** one of the services the environment renders to man is the assimilation of his waste products. Also according to (Tarret *et al.,* 2012**)** biological waste product produced is usually discharged into river, streams and other natural water bodies. It was believed in the past that waste discharged into these natural water bodies would be treated naturally in a process known as natural attenuation.

The primary considerations in evaluating an existing wastewater plant is in the area of plant operation and control. A major tool required for proper process control is frequent and accurate sampling and laboratory analysis (Kaul *et al.,* 1993). Poor conditions of sewage system, improper design of the plant and organizational problems are important factors that cause treatment plant not to meet the effluent standards overloading due to increase in population and water use, discharge of trade effluents are other reasons of recent times for the poor performance of waste water treatment plants. The treatment efficiency may be badly affected if the system is hydraulically under loaded (Dakers and Cockburn 1990). The poor conditions of sewage system, improper design of the plant and organizational problems are important factors that cause treatment plant not to meet the effluent standards. Research studies has revealed that discharged raw waste in natural bodies not only pollute but also cause the death of natural organism and the destruction of the various eco systems which depend on these water bodies for survival. It has therefore become imperative to carry out some level of treatment of human waste products before discharge into the various natural water bodies (Tillman *et al.,* 2005**).**

Wastewater treatment plant evaluation is to determine the efficiency to which influents coming from the various sewers are treated in different treatment processes. Preliminary treatment processes or Pretreatment as it is sometimes referred to be necessary to ensure efficient and or reliable operation of the main treatment processes (Khorsandi and

Navidjoy 2010). The impurities which need to be removed in water are large floating or suspended solids. In wastewater, however, large floating and suspended solids must be removed initially before the commencement of other treatment processes Preliminary treatment processes for waste water include screening, comminutor, grit removal, oil/ grease removal (Kuyeli, 2008). Grit removal in waste water treatment through the principle of differential settlement;such asGrit channel and Grit settle tank.

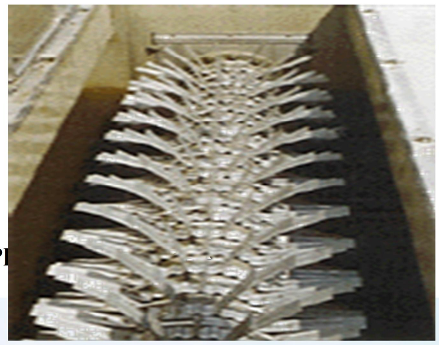

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Plate 2: Aerial View of the Abesan Wastewater Treatment Plant, Ipaja, Lagos State

DESCRIPTIONS OF THE PLANT

The evaluation of the removal efficiency of the wastewater treatment plant was carried out. The physicochemical parameters of the wastewater influent and effluent were measured.

Influent

The waste water gets into the sump tank from the sewer lines. The large debris is retained by the screen and removed utilizing the specialized rake supplied. The remainder of the waste water is pumped into the aeration ditch via the de-gritting channel.

Clarifier

The mixed liquor flows from the aeration ditch flows by gravity into the clarifier via the aerator effluent channel. The sludge settles mechanically via sludge scrapper to the centre bottom of the clarifier while treated effluent flows over a V-notched weir into the clarifier (Larsdotter, 2009)

Disinfection of Effluent

Disinfection is the final process before the effluent is discharged directly to a designated watercourse. (Bani, *et al.,* 2009). Disinfectant is batch-mixed in the disinfectant storage tank. The disinfectant solution is injected into the contact tank by an adjustable disinfectant dosing pump. The disinfectant kills off any pathogens in the effluent with a minimum retention time of 30 minutes before it is finally discharged. The concentration of the chlorine stock to be made is calculated according to the inflow rate, the desire dosing concentration is approximately 8 mg/l. The dosing pump rate is 4l/h if run at 100%.

Sludge Thickener

Biological treatment of wastewater perforce produces excess biological solids due to the growth and multiplication of bacteria and other microorganisms in the system. The excess biomass thus produced needs to be bled out of the system, and disposed off efficiently (Ammary, 2007).

EXPERIMENTAL LABORATORY TEST PROCEDURE

Methods

The test carried out on the samples were as listed below

i. Biological oxygen demand (BOD_5)
ii. Chemical oxygen demand (COD)
iii. Total suspended solids (TSS)
iv. Total dissolved solids (TDS)

Biological Oxygen Demand (BOD_5)

The object of this procedure is to determine the amount of oxygen used up in the process when bacteria convert biodegradable organic matter to inert. The BOD of the sample is based on the amount of oxygen used up in the five- day period.

Apparatus required to carry out the test include litre graduate, plunger rod, siphon, BOD bottles, and BOD incubator.

Procedures

i. 500ml of sample was added in a litre graduate. It was filled with dilution water to the 1 litre mark. It was latersStirred thoroughly with plunger type rod being careful not to entrain any air in the sample
ii. Sample was siphon from graduate to three BOD bottles and incubate two of these for 5 days at 20^{o}C (Be sure to keep a water seal at the neck of the BOD bottle)
iii. An initial dissolved oxygen (DO) was then run on the remaining bottle and indicate "initial reading"
iv. Repeat steps 1-3 above for the same station using a second dilution for better accuracy.
v. After incubation for five days(+2 hours), run a DO on the samples and record "final reading"
vi. The difference in the initial reading and the average of the final reading should be between 2-5 mg/l for maximum accuracy.

Calculation

(Initial Reading –Final Reading) X 100% dilution = 5-day BOD (mg/l)%

Chemical Oxygen Demand (COD)

The object of this procedure is to determine the amount of oxygen needed to remove the chemical constituent of the wastewater.

Apparatus required to carry out the test include Potassium dichromate (K_2CrO_2), Concentrated H_2SO_4, COD reactor, conical flask, and Ferroin indicator

Procedures

1. Prepare the COD reagent by adding 2ml of K_2CrO_2 into 3ml of Conc. H_2SO_4
2. Add 2ml of the sample to be analysed into the reagent
3. Put the resulting solution into the COD reactor and allow it to react for two hours.
4. After two hours of heating, allow to cool for ten minutes
5. Pour the solution into a conical flask and then add 2drops of Ferroin indicator and titrate.
6. Stop titration when chocolate colour is observed.
7. Take the reading from the titer value and calculate the COD from the blank and reagent titer values.

A blank COD analysis must have been done by separately taking 2ml of distilled water and heating up in the COD reactor and allowing cooling for ten minutes. Then titrate and take the reading. Do same for the reagent alone.

Calculation;

$$\left(\frac{2000}{Reagent\ titer\ Value}\right) * (Black\ Titer\ Valu\ e - Sample\ Titer\ Value)$$

Total Dissolved Solid (TDS)

100-150ml of wastewater sample was placed in a weighed conical flask and evaporated to dryness in an oven at 105°C. Afterwards, the flask was cooled in a desiccator and weighed using an analytical balance until a constant weight is obtained.

Calculation

$$\text{TDS (mg/L)} = 1000 * \frac{M_{t-} M_d}{V} \qquad 2$$

M_t = weight of flask + dried residue (mg)

M_d = weight of flask (mg) V = Sample Volume (ml)

4. RESULT

The result analysis for dry season is presented below:

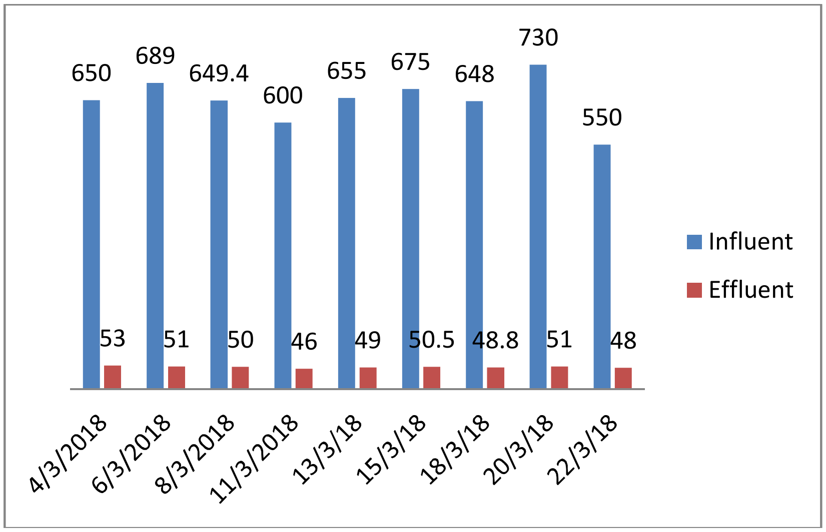

Fig. 1: (Total Suspended Solids); The Influent and Effluent Reading for Dry Season (ppm).

TSS (Total Suspended Solid)- Influent concentration of TSS varied between 550 ppm to 689 ppm.The TSS Mean values of 649.6 ppm was reduced to 49.7 ppm at the effluent Mean level.This shows an overall pollutant efficiency of about 92.4%.

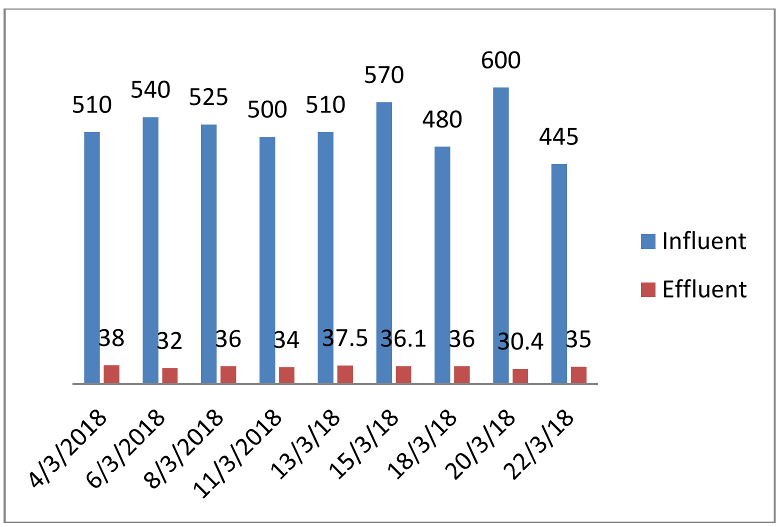

Fig.2: (Bio Chemical Oxygen Demand) Influent and Effluent Reading for Dry Season. (mg/l).

BOD (Bio Chemical Oxygen Demand)- Influent concentration of BOD varied between 445 mg/l to 600 mg\l.The BOD Mean values of 520 mg\l was reduced to 35 mg\l at the effluent Mean level.This shows an overall pollutant efficiency of about 93.3%.

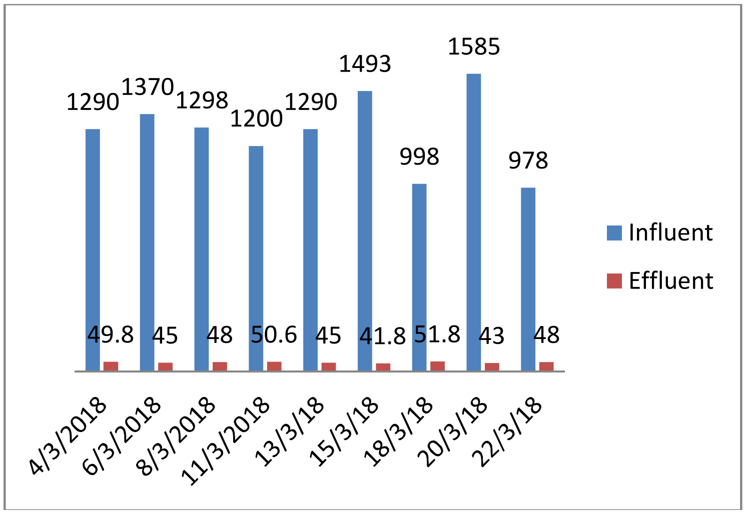

Fig. 3: Chemical Oxygen Demand) Influent and Effluent Reading for Dry Season (mg/l).

COD (Chemical Oxygen Demand)- Influent concentration of COD varied between 978 mg/l to 1585 mg\l.The COD Mean values of 1278 mg\l was reduced to 47 mg\l at the effluent Mean level.This shows an overall pollutant efficiency of about 96.3%.

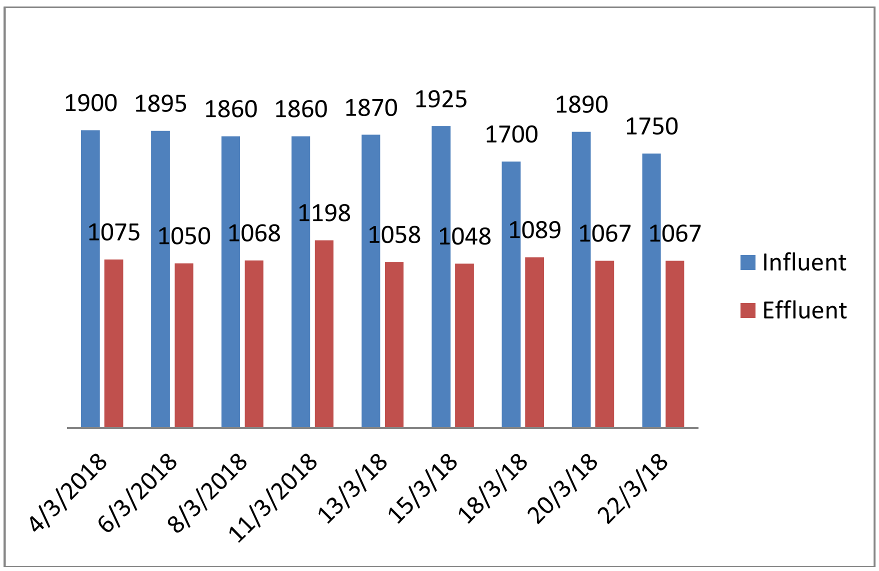

Fig. 4: (Total Dissolved Solid) influent and effluent reading for dry season (ppm).

TDS (Total Dissolved Solid)- Influent concentration of TDS varied between 1700 ppm to 1900 ppm.The TDS Mean values of 1850 ppm was reduced to 1080 ppm at the effluent Mean level.This shows an overall pollutant efficiency of about 41.6%.

Result Analysis of Raining Season:

Figures 1 to 4 represents the chart results of the physio chemical analysis of water influents and effluents for raining season.

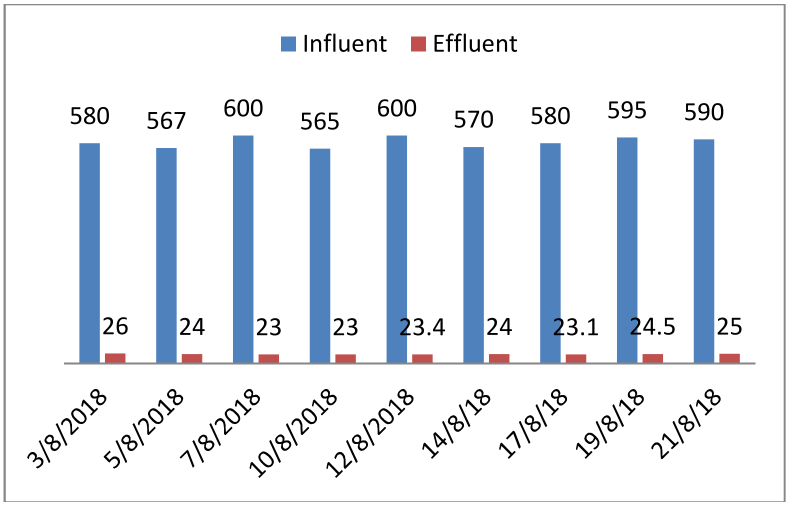

Fig. 5: (Total Suspended Solids) Influent and Effluent Reading for Raining Season (ppm).

TSS (Total Suspended Solid)- Influent concentration of TSS varied between 565 ppm to 600 ppm.The TSS Mean values of 583 ppm was reduced to 24 ppm at the effluent Mean level.This shows an overall pollutant efficiency of about 95.9%.

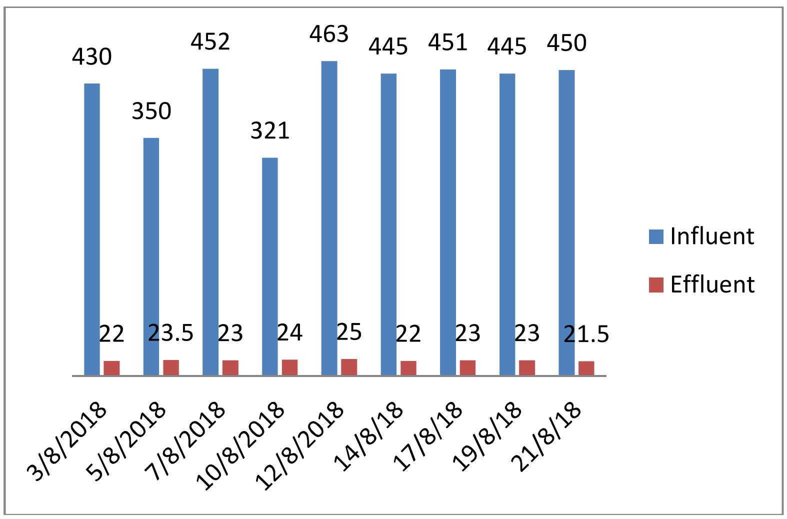

Fig. 6: (Biological Oxygen Demand) Influent and Effluent Reading for Raining Season. (mg/l).

BOD (Bio Chemical Oxygen Demand)- Influent concentration of BOD varied between 321 mg/l to 463 mg\l.The BOD Mean values of 423 mg\l was reduced to 23 mg\l at the effluent Mean level.This shows an overall pollutant efficiency of about 94.6%.

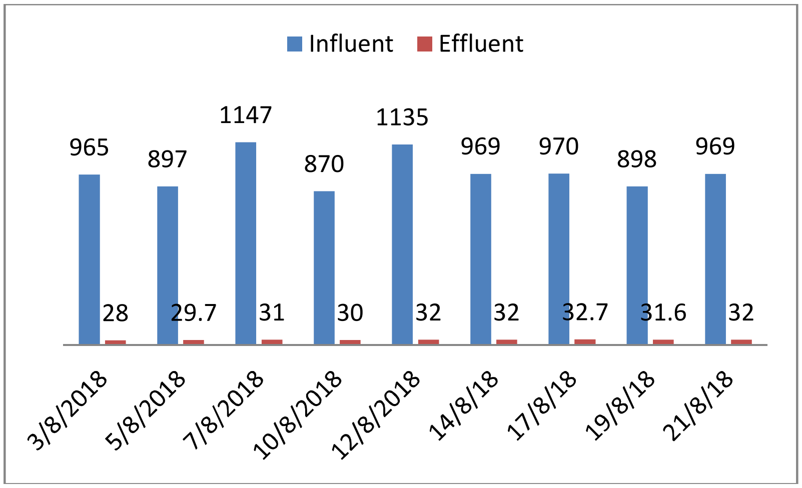

Fig. 7: (Chemical Oxygen Demand) Influent and Effluent Reading for Raining Season (mg/l).

COD (Chemical Oxygen Demand)- Influent concentration of COD varied between 870 mg/l to 1147mg\l.The COD Mean values of 980 mg\l was reduced to 31 mg\l at the effluent Mean level. This shows an overall pollutant efficiency of about 96.8%.

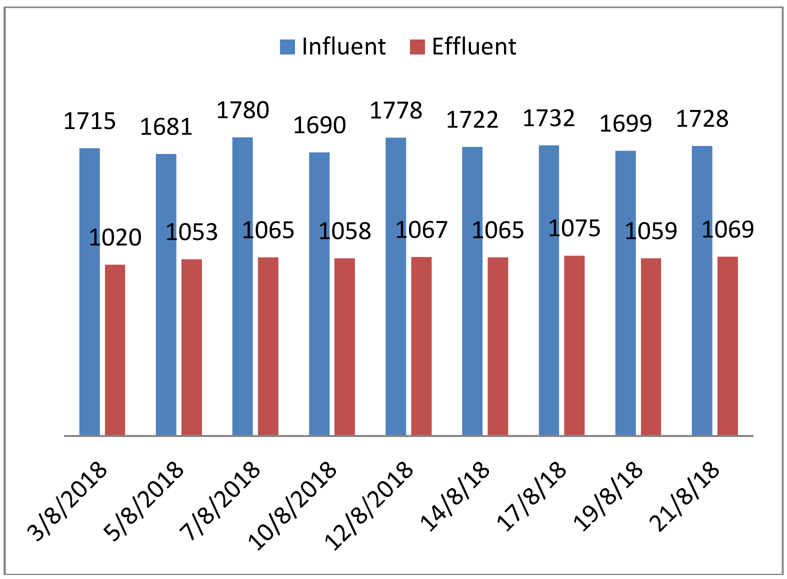

Fig. 8: (Total Dissolved Solid) Influent and Effluent Reading for Dry Season (ppm).

TDS (Total Dissolved Solid)- Influent concentration of TDS varied between 1681 ppm to 1780 ppm.The TDS Mean values of 1725 ppm was reduced to 1059 ppm at the effluent Mean level.This shows an overall pollutant efficiency of about 38.6%.

CONCLUSION

A wastewater treatment plant of the activated sludge process as biological treatment method has been considered for performance evaluation. The overall performance of the existing plant was satisfactory. The evaluation of performance efficiency of the plant was undertaken in terms of effluent quality. The evaluation was based on the plant operation data on TSS, BOD_5, COD, and TDS measurements for the period of six weeks.

The recorded data for the TSS, BOD, COD, and TDS for the periods under review are presented in Figure 1 to figure 8 on Daily variations of these parameters for the period of testing are shown graphically. These samples were analyzed for different wastewater quality variables. Average removal efficiencies of the measured parameters from the treated effluents are 96.3% for Chemical Oxygen Demand (COD), 93.3% for Biological Oxygen Demand (BOD), 92.4% for Total Suspended Solids (TSS), and 41.6% for Total Dissolved Solids (TDS) for the dry season. During the rainy season average removal efficiency of the measured parameters are 96.8% for COD, 94.6% for BOD, 95.9% for TSS, and 38.6% for TDS.

The results of the current study shows high performance of the Abesan wastewater treatment plant in both season especially during the rainy season which recorded low organic and inorganic loading of the influent experienced during this season. The TDS concentration removal efficiencies recorded in both seasons were considerable low. This suggests that the plant was ineffective in the ability to remove both organic and inorganic nutrients in wastewater influents.

The result also shows clearly that the Abesan waste water treatment plant works efficiently well in removing organic nutrients in waste water as seen at the effluent level in percentage in both seasons varying from 92.4% to 96.8% with TSS, B0D AND COD while lacks in removing inorganic nutrients in waste water for TDS with the percentage varying from 38.6% to 41.6% for both season at the effluent level which is considered too low.

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