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Efficiency Evaluation of Sewage/Wastewater Treatment Plant in Ogunu, Warri, Delta State

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***Abstract*—** *Physical, chemical and microbiological efficiency of Sewage/Wastewater Treatment Plant (STP) located in Ogunu, Warri, Delta State, was determined. This was done by studying the applied technology and comparing analyzed results of its influent and effluent with that of regulatory set limits of the Federal Ministry of Environment (FME), Department of Petroleum Resources (DPR) and World Health Organization (WHO). The result obtained from the samples collected from the influent of the Donparker Sewage Treatment Plant, showed that the Sewage/Wastewater quality was highly contaminated and the result of its Effluent showed that the Plant was very effective and efficient, because it was able to bring all the stated parameters to be within regulatory limits. The Result also showed that the influent was acidic while the effluent was approximately neutral. Comparison of the results of analysis of the parameters in the sewage/wastewater samples with the Federal Ministry of Environment (FME), Department of Petroleum Resources (DPR), and World Health organization (WHO) set limits revealed that pH and Dissolve Oxygen (DO) were below the regulatory limits for the influent but within the regulatory limits for the effluent. The Total Suspended Solid (TSS), Nitrate, Phosphate, Five day Biochemical Oxygen Demand (BOD5), Chemical Oxygen Demand (COD), Total Dissolved Solids (TDS), Turbidity, Oil & Grease, Total iron, Zinc, Conductivity and Feacal Coliform in the influent were far above the regulatory set limits but below the regulatory limits in the effluents after treatment. Also the result revealed that Lead, Mercury, Arsenic, cadmium, Nickel, Cooper, Chromium, Residual Chlorine and Temperature were below the regulatory limits both for the Influents and effluents. The treatment plant was able to satisfactorily reduce the highly polluted influent within the regulatory limits after treatment thus ensuring that the effluent was environmentally friendly. It was recommended that combined sewage treatment technology as used by the Donparker Sewage treatment Plant should be applied for the treatment of highly polluted Sewage/Wastewater for effectiveness*.

***Keywords*—** *Contaminated, Effluent, Environment, Influent, Treatment Plant*.

I. INTRODUCTION

1.1. Wastewater

(Davis and Masten, 2009) defined wastewater as water that contains parameters that exceed the permissible limits that makes it impure and hazardous to environment. It is the water discharged from homes, businesses and industries that contains dissolved, suspended and particulate organic and inorganic materials. The term is also used as a synonym for sewage/domestic waste water (Patrick, 2007). And according to (Andrew, 2012) it could be defined as liquid waste collected in a sewage system and conveyed to a treatment plant for processing. Narayanan (2009) stated that several problems arise from untreated effluent, these are environmental problems (hardness, land and air pollution), death of humans, animals and aquatic life, scale formations, corrosion, water borne diseases, surface and ground water pollution that can cause epidemic.

Narayanan (2009) states that physical contaminants such as suspended Solids are important for esthetic reason, and because they can lead to the development of sludge deposit and anaerobic conditions. He went on to state that physical materials such as sands, stones, gravels and woods, which are insoluble in water can also affect the characteristics of the water such as the temperature, color of water and turbidity. Many chemical contaminants such as biodegradable organics are composed principally of proteins, carbohydrates and fats according to Butani (2006). He also stated that biodegradable organics are measured mostly in terms of BOD (Biochemical oxygen demand) and COD (chemical oxygen demand). If discharged untreated to the environment, the biological stabilization of these materials can lead to depletion of natural oxygen resources and to the development of septic conditions. According to Tchobanoglous et al. (1985), inorganic constituents such as calcium, sodium, and sulphate are found to be in original domestic water supply and may have to be removed if the waste water is to be reused.

Narayanan (2009) also stated that certain heavy metals can have negative impact upon biological waste treatment processes and life stream due to their toxic nature.

According to Sincero and Sincero (2008), carbons, nitrogen and phosphorus are essentially nutrients for growth when discharged to aquatic environment; these nutrients can lead to the growth of undesirable aquatic life. When discharged to excessive amounts on lands, they also lead to the pollution of ground water. Davis and Masten (2009) also posited that biological pathogens are communicable diseases that are easily transmitted by pathogenic organisms in wastewater. They went on to state that some of the wastewater pathogens commonly found include: *Vibro cholera* which causes cholera and typhoid fever caused by *Salmonells typhi* and *Bacillus anthracis* causes anthrax.

II. METHODOLOGY

2.1. Study Area

The study area is Warri Township in Delta State, Nigeria. It is located on latitudes 50 27’ N and 50 36’ N and longitudes 50 40’e and 50 48’ E. The human occupation in the Warri area includes trading, fishing, manufacturing, farming and mining.

Warri is home to the Warri refinery and other petro-chemical industries.

2.1.1. Vegetation and climate

The Natural Environment in the study area is an integrated mosaic of aquatic, semi terrestrial (Mangrove fresh and salt water swamps) and terrestrial habitat, the specie *Rhizophora racemosa* is dominant. The wildlife in the area includes mammals, aves, reptiles, amphibians. The climate of Warri is humid sub-equatorial long wet season lasting from March to October that alternates with a shorter dry season that last from November to February. The climate is influenced by two prevailing air masses namely the south-west monsoon wind and then North-east trade wind. Annual average temperature is about 27^0C with no marked seasonal departure from the average. Annual rainfall in the Warri area is up to 2500mm with double peak rainfall regime which takes place both in June and September.

2.1.2. Soil and geology

Soil in Warri are well drained to deep poorly drained soil; sandy, sandy loam or loamy sand surfaces over sandy loam, sandy clay loam, loam or sandy clay. Previous analysis of Cone Penetration Test (CPT) logs of soil in the project area revealed that the sub-soil in the swamp and submerge terrain in the site is highly susceptible to compression due to presence of organic clay and peat. It also has increasing compaction state with depth.

Geologically, Warri is underlain by a sequence of sedimentary formations with a thickness of about 8,000 meters and include from bottom to top; Akata formation, Agbada formation, Benin formation and the Somebreiro –Warri delta plain sand. The water table is influenced by tidal regime, it is very close to the ground surface and varies from 0–4 meters. The underground water of the study area is acidic, while that of the surface water is slightly acidic/alkaline.

The ambient air quality of the area is within regulatory standard.

2.2. Analytical Procedures

The Donparker Sewage/Wastewater treatment Plant technology was studied in detail; influents and effluents were taking six months apart and was analyzed to determine the efficiency of the technology in treating Sewage/Wastewater to produce effluent that are Environmentally friendly. The results were compared with national and international environmental regulatory standards to ascertain its efficiency.

The Donparker Sewage/Wastewater treatment Plant applies a mixture of physical, biological and chemical treatment. It also uses a combination of Aeration and multimedia filtrations technology as well as disinfection. The plant uses electricity to power its pumps to ensure enough oxygen is supplied during aeration, adequate pressure during filtration, return of spilled influent or improperly treated effluent to aeration tank, pumping of ground water from borehole as well as for chorine and polymer dosing. Electricity is also use to power the Multi Plate Screw Press Sludge treatment Plant.

The plant consists of 2 units of the following: Bar Screen/Grit Chamber; Aeration/Clarifier Tank; 3units each of Multimedia filter Tanks; 2 Micron Filters; Chlorine Contact/Disinfection Tank; Chlorine Mixing Tank; Air Blower Pump 5KW and Effluent Pump 5.5HP. It also consists of a unit of: Multi Plate Screw Press Sludge treatment Plant; Sludge Pump 7.5HP; Effluent Return pump5.5 HP; Clean Water Pumps 2HP; Chlrorine / Polymer Dosing Pump 0.5HP; Chlrorine/Polymer Stairer machine; Electrical Control Panel; Spill Containment Pit and Spill Containment Drains.

2.3. Sampling Point

The sampling point for this project work was at the influent receiving tank and the effluent discharge line of the Donparker Sewage Treatment Plant, Ogunu, Warri, Delta State.

2.4. Sampling and Analysis

A clean glass bottle of 500 ml was filled to the neck directly from the sample point and quickly capped. Samples for heavy metals were preserved with 1:1 Nitric acid.

Immediately after samples were collected, the temperature, pH, conductivity and dissolved oxygen were measured. Samples were analyzed at minimum time after collection to avoid microbial degradation. Samples for physiochemical analysis were stored in ice-chest packed in well scaled coolers and then transported conveniently to the laboratory where they were refrigerated at 40^oC prior to analysis.

III. Results and Discussion

The Donparker Sewage/Wastewater Treatment plant treatment technology, which is a combination of primary (Screening), secondary (aeration, sedimentation), and Tertiary (filtration and disinfection) processes produced a colourless and odourless effluent, free of bacteria and viruses, with all analyzed parameters within local and international regulatory standard as shown in Table 3.1.

3.1. Result

TABLE 3.1. Result of Analysis of Influent and Effluent Sewage/Wastewater Sample from Donparker Sewage/Wastewater Treatment Plant.

Parameters	Pre-Treatment Analysis	Post-Treatment Analysis	FME Limit	DPR Unit
pH	5.48	7.07	6.5 – 8.5	6.5-8.5
TSS (Mg/L)	915.21	21.90	30.00	45.00
Nitrate (Mg/L)	27.81	0.13	N/A	10.00
Phosphate (Mg/L)	44.18	0.27	N/A	2
Residual Chlorine (Mg/L)	<0.1	0.26	1.00	0.8
DO (Mg/L)	1.67	11.37	4.0 -5.0	5.0
BOD_5 (Mg/L)	126.71	9.61	10.00	30.00
COD (Mg/L)	628.09	21.27	30.00	40.00
TDS (Mg/L)`	9,971.06	164.18	2000.00	2000.00

Temp. (^{O}C)	23.19	25.73	N/A	35.00
Oil & Grease (Mg/L)	20.42	1.79	10.00	10.00
Conductivity (μSCM^{-1})	987.80	32.00	N/A	N/A
Feacal Coliform (CFU/100ml)	68,600.90	96.61	200	200
Zinc (Zn^{2+}) (Mg/L)	1.98	0.11	1.00	1.00
Lead (Pb^{2+}) (Mg/L)	<0.005	<0.005	0.02	0.05
Total iron (fe^{2+}) (Mg/L)	0.42	0.07	1.50	1.00
Turbidity (NTU)	184.60	2.10	N/A	N/A
Mercury (μg/L)	<0.0001	<0.0001	0.05	0.1
Arsenic (Mg/L)	<0.0001	<0.0001	0.01	0.01
cadmium(μg/L)	0.03	<0.005	0.40	0.40
Nickel (Mg/L)	0.01	<0.0002	0.06	0.02
Cooper (Mg/L)	0.039	<0.001	1.5	1.5
Chromium (Mg/L)	0.02	<0.001	0.03	0.03

3.2. Discussion

The result obtained from the samples collected from the influent of the Donparker Sewage Treatment Plant, Ogunu, Warri, Delta State shows that the Sewage/Wastewater quality is highly contaminated and the result of its Effluent shows that the Plant is very effective and efficient, because it was able to bring all the stated parameters to be within regulatory limits.

The comparison of the results of analysis with the Federal Ministry of Environment (FME), Department of Petroleum Resources (DPR) and World Health Organization (WHO) regulatory standards limits at which wastewater is allowed for discharge into the environment, showed that the influent was highly polluted with contaminants while the effluent was within regulatory set limits. There is need for wastewater to be treated with the advanced technique used by Donparker Sewage Treatment Plant, which have been able to reduce problems associated with environmental pollution caused by untreated wastewater discharge into the environment. The process of treatment employed remove about 99% of all the pollutant and impurities, especially the removal of plant nutrients that causes eutrophication in lakes as shown by the result.

From the data obtained, the pH was increased from a mean value of 5.48 to a stable mean value of 7.07 and is in line with regulatory set limit of 6.5-8.50.

The Result also shows that the influents are acidic but the effluent was approximately neutral. Comparison of the results from analysis of the parameters in the sewage / waste water samples with the Federal Ministry of Environment (FME), Department of Petroleum Resources (DPR), and World Health organization (WHO) set limits revealed that the values of pH (5.48) and Dissolve Oxygen (DO) (1.67 mg/L) were below the regulatory limits in the influent but in the effluent, after treatmet, they had values of 7.07 and 11.37 mg/L respectively, which were within the regulatory limits. The result also revealed that the Total Suspended Solid (TSS), Nitrate, Phosphate, Five day Biochemical Oxygen Demand ($BOD_{5)}$, Chemical Oxygen Demand (COD), Total Dissolved Solids (TDS), Turbidity, Oil & Grease, Total iron, Zinc, Conductivity and Feacal Coliform in the influent had values of 915.21, 27.81, 44.18, 126.71, 628.09, 9971.06, 184.60, 20.42, 0.42, 1.98mg/L, 987.8 μSCM^{-1} and 68,600.90 CFU/100 mL respectively, which were far above the regulatory set limits. However, their values of 21.9, 0.13, 0.27, 9.61, 21.27, 164.18, 2.10, 1.97, 0.07, 0.11 μSCM^{-1}, 32.00 μSCM^{-1} and 96.61 CFU/100 mL respectively in the effluents after treatment were below the regulatory limits. Also the result revealed that Lead, Mercury, Arsenic, cadmium, Nickel, Cooper, Chromium, Residual Chlorine and Temperature were below the regulatory limits both for the Influents and effluents (Table 3.1). From the result, the influent pH and DO were lower than regulatory minimum limits while BOD_5, COD, TSS, oil and grease, some heavy metals and some other parameters were all higher than regulatory maximum limits, meaning that the influent was highly polluted while the effluent was environmentally friendly.

IV. CONCLUSION

When we consider the result from the influent and effluent analysis, we can rightly say that the Donparker Sewage/Wastewater Treatment Plant technology is efficient in treating sewage to an environmentally friendly state. So also, when we consider the effect of untreated waste water discharge into receiving water bodies, we can rightly say the treatment plant is curbing the problems arising from the improper management of sewage/Wastewater which include detrimental effects to health of human beings, aquatic lives, floras and fauna.

Comparison between the results from the analysis the of influent with the regulatory set standard shows that the influent is highly polluted, while the comparison between the result from analysis of the Effluent with regulatory set standards shows it is environmentally friendly and safe for discharge to receiving water bodies.

For effective protection of our environment from the detrimental effect associated with untreated wastewater, its treatment is essential. Hence for Quality Assurance and Quality Control pre and posted treatment analysis should always be carried out on sewage and waste water effluent before discharge.

The result of the influent analyzed shows that it is very strong and highly polluted, while the result of the Effluent analysis shows its environmentally friendly, which is a clear indication that the Sewage/Wastewater Treatment Plant is efficient. The result of the influent and effluent analysis shows that the Donparker Sewage Treatment Plant is very efficient and was able to bring all analyzed parameters after treatment to be within regulatory limits.

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The purpose of analyzing and treating wastewater is to be able to detect and eliminate the characteristic pollutants in it to avoid pollution of receiving water bodies or land.

The treatment and analysis of wastewater is of great importance. The results gotten from most parameter analyzed before treatment are above regulatory limit. This result obtained may be different for other classes of wastewater; this is because natural changes and sources of Sewage/ Wastewater can alter the values gotten from other places / Sources.

Analysis of wastewater helps to ascertain the quality of the water, because that will enable the analyst to select the appropriate treatment process to curtail and avert the negative effect the pollutants in the water may have on the environment, flora and fauna.

However, based on the experiments on this project work, it can be stated that all sewage/waste water should be treated and their influent and effluent be analyzed to ensure they meet regulatory limits before discharge to the environment to prevent the contaminants present in sewage/waste water from polluting the environment, thereby causing biological and health hazards to living things in the environment.

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