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RESEARCH ARTICLE

ENVIRONMENTAL ASSESSMENT OF PETROCHEMICAL WASTEWATER DISCHARGE INTO ELEME RIVER: A CASE STUDY OF PETROCHEMICAL INDUSTRY IN NIGERIA

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ABSTRACT

The study was based on environmental assessment of petrochemical wastewater parameters discharged to Eleme River. Three methods: physical, chemical and biological were employed for the assessment on the physiochemical parameters. Laboratory tests were done on the sample using FEPA set standard for industrial effluent water test. The data obtained from the laboratory tests, further assessment was performed to examine the impact of these parameters to the receiving water body with respect to FEPA standard for industrial wastewater discharge to the inland water. The result showed that some parameters; Biochemical Oxygen Demand (BOD), Total Suspended Solids (TSS), pH, Temperature and Total Dissolved Solid (TDS), TSS, pH, Temperature, and TDS of the wastewater exceeded the FEPA standard by 80%, 91%, 76%, 24%, and 71% respectively. The conceptual model used for the existing treatment plant in Eleme Petrochemical is inadequate and needs improvement. The paper presented a new model as a way forward to improve the quality of wastewater generate from Eleme Petrochemical. Therefore, a new treatment plant design calculations was carried out to modify the existing plant for optimum performance. Finally, the information obtained from this study should be useful tools for further assessment of petrochemical wastewater parameters even to other industrial wastewater in nature.

INTRODUCTION

The modern civilization accompanied by the rapid growth of population increase and in hydrocarbon utilization industrialization has created the situation of huge amount of production of wastewater per day. All over the world today the industries are vexed with the problem of wastewater disposal and management of generated wastewater. Laboratory studies were conducted to assess the petrochemical wastewater generated which was discharged to Eleme River in Niger Delta Area of Nigeria. This study reports on the concentration of physiochemical parameters of the wastewater in Eleme River. Investigation conducted by various research groups revealed that Global fisheries is facing constant decline in the fish stocks, both in coastal and in land water pollution (EG, 1991; Gevard, 1999; James, 1980; King, 1978; Klyhn, 1979; Lynch and Poole, 1999 and Nwaigazie, 2000). The decline can be attributed to constant discharge of effluent water into the lake, river, sea etc. The physiochemical parameters are of the major adversely influencing most body functions. Exposure to Cd is known to produce symptoms like abdominal cramps, nausea, salivation, diarrhea, hypertension, liver Girrhosis etc in human. It may sometimes prove to be carcinogenic or produce teratogenic effects. Thus for healthy fish production, it is very important to evaluate the harmful effects of physiochemical parameters in combination. In the present studies, an attempt has been made to study the effects of physiochemical parameters in water body of fresh and salt water media. (Raven, Berg and Johnson, 1998; Marshal, 1973; Onuoha, 1994 and Keep 1998, Ukpaka, 2004, 2005, and 2006). The organisms living in water environment needs good water for building up body tissue, which further signifies that a balanced diet is necessary for proper functioning of the body. Recent understanding of different biochemical processes has proved useful in determining the mechanisms of toxicity in different protective mechanisms of the body to combat the toxic effect of the pollutants, besides it is also observed that some biochemical alteration occurring in the body give the first indication of stress in the organism and hence the efforts, on the part of pollution, biologists to explore the possibility of making use of the phenomenon to locate certain type of pollutants on nature.

The assessment carried out on Eleme River revealed that small amount of many relative toxic materials released into an aquatic environment cause multiple change in the internal dynamics of aquatic organism in different levels (Benfled and Bandall, 1980; Davis and Cornwell, 19999; Hurley, 1989; Handan, 1976; King, 1978; Atlas, 1988; AWWA, 1990; Camp and Messerve, 1974; Barta, 1988; Chikere, 2000 and Eckenfelder, 1989). The physiochemical parameters of interest includes; temperature, pH, conductivity, turbidity, Dissolved Oxygen (DO), Total Suspended Solids (TSS), alkalinity, Biochemical Oxygen Demand (BOD), oil and grease, phenol, chloride, phosphate, nitrate, sulphate, iron, cadmium, lead, sodium, copper and manganese. From the available literature it appears that the study of physiochemical parameters are very useful in understanding the mechanism of its effect on the water body (Ukpaka, 2007, 2008, 2009 and 2010); PPAGPMI, 2001; Khan, Shaika, Zarina, Lanjekar and Nayab, 2007; Martin and Kulathooran, 2007 and Snnikenthan, Shrihari and Pradecpan, 2007). The present investigation has been conducted to determine the quality of Elele River with respect to the physicochemical parameters.

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MATERIALS AND METHOD

The liquid waste, which is generated by Eleme Petrochemical complex are normally discharge into the Eleme River the South of the complex. The Eleme River emptied into Bonny River through Okpokoro River at Okirika arm for final disposal. The Eleme Petrochemical Industry (EPI) wastewaters were used for the case study. Four sampling points of wastewater were collected within the petrochemical complex namely: sample point 1 at equalization basin, sample point 2 at final discharge basin, about 2.5m away from the equalization basin. This basin is the point where all treatment effluent water from petrochemical complex are pumped to, before finally discharged into the Eleme River, sample point 3 at dissolve air floatation basin, where chemical treatment takes place to coagulate the suspended particles into sludge and scraped before, sending it into biological treatment used for this study were collected with 1litre plastic cans previously washed thoroughly with treated potable water and dried, before use, also they were rinsed with the sample before finally collection of the sample. The interval of collection was once every month, and the containers were labeled accordingly. All samples were transported to the petrochemical complex laboratory and analysed immediately.

Laboratory Tests

Different laboratory test wee conducted using the APHA, (1989) method.

The Model

Equalization Basin Design

The major function of equalization basin is to minimize or control fluctuation in wastewater characteristics in order to provide optimum conditions for subsequent treatment processes. For petrochemical industry wastewater, the hourly flow used for design is shown on Table 1 and calculation is based on material balance produce as stated by Patterson and Menez adopted from Eckenfelder, (1989).

(i) Volume of equalization is given as;
V = average flow x retention time. (1)

(ii) Effluent concentration is calculated as follows using material balance for equalization basin as presented by Eckenfelder, (1989).

$$C_1QT + C_oV = C_2QT + C_2V \quad (1a)$$

Making C_2 the subject of the formula, equation (1a) becomes;

$$C_2 = \frac{C_1 t + C_o V/Q}{T + V/Q} \quad (2)$$

Biological Aeration Tank Design (Activated Sludge)

Completely Mixed Activated Sludge Process Design

The design formulas are by mass balance application and the source of design formula is adopted from introduction to environmental Engineering (Davis and Cornwell, 1998).
For steady state condition mass balance is stated as;

$$\begin{bmatrix} \textit{Biomass} + \textit{biomass} & = & \textit{Biomass} + \textit{biomass} \\ \textit{Influent accumulates} & & \textit{Effluent wasted} \end{bmatrix} \quad (3)$$

$$QX_0 + \left[V \frac{\mu mSX}{KS + S}\right] - k_d X = (Q - Q_w)X_e + Q_w X_r \quad (4)$$

Also in designing aeration tank, the mass balance equation for soluble BOD_5 (food for microorganism) in steady stated is written as

Food = food consumed-food in
In influent by microorganisms effluent wasted (5)
By formula;

$$QS_o - (V)\frac{\mu_m SX}{Y(K_s + S)} = (Q - Q_w S + Q_w S) \quad (6)$$

Supposing percent standard FEPA standard allowable solid by the influent. Therefore calculating allowable suspended solid(s):

S = Total BOD_5 Allowed – BOD_5 in suspended solid.

Also the residence time is calculated with the formula:

$$S = \frac{KS\,(1 + K_d\theta_c)}{\theta_c(\mu_m - K_d) - 1} \quad (7)$$

where $\theta_c - \dfrac{VX}{Q_w X_r}$

$$\therefore \quad 132 = \frac{100\,\theta[(1 = 0.050)\theta_c]}{\theta_c(2.5 - 0.050) - 1}$$

For calculation of detention time (t), the formula stated below is useful

$$X = \theta_c \frac{(Y)(S_o - S)}{\theta_c(1 + K_d O_c)} \quad (8)$$

Chemical Treatment Design

Flocculation Tank Design

The important factor is to bring the particles into contact so that they collide and stick together and grow to size that will readily settle component design Baffled tank design.

For rapid mixing tank, the design formula is

$$P = KT\,(n)^3\,(D)^5\rho \quad (9)$$

Drag force on the paddle is given as

$$P = \frac{CDA\rho(V\rho)^3}{2} \quad (10)$$

Design equation is

$$T_o = \frac{V}{Q} \quad (11)$$

Therefore, the equation by Eckenfelder, (1989) for mixing volume is given as;

$$G = \sqrt{\frac{P}{\mu V}} \quad (12)$$

$$\therefore \quad \frac{V}{G^2\mu} = P$$

Using the equation

$$\text{Di} = \frac{(P)^{15}}{[(\rho K_T)(n)(\rho)]}$$

For peak factor (PF) Determination: therefore, the peak factor of the flow is defined by Davis and Cornwell, (1998) as;

$$Peak\ \ flow = \frac{\text{peak factor} \times \text{influent} \times \ flow\ \ rate}{Overflow\ rate\ (m^3/m^2)} \qquad (13)$$

Sedimentation Basin Design

In designing discrete setting, basic factor affecting setting is the terminal velocity and it is defined by the equation

$$V = \sqrt{\frac{4g(\rho s - \rho l)D}{3C_d \rho}} \qquad (14)$$

Reynolds number less than 1.0 viscous force predominate and the formula becomes;

$$C_d = \frac{24}{NR_e} \quad \text{and} \quad NR_e = \frac{\rho S - \rho l}{\mu}$$

where μ is the viscosity of the liquid substituting into equation (6) becomes;

$$C_d = \frac{\rho S - \rho l}{18\mu} gD^2 \qquad (15)$$

RESULTS AND DISCUSSION

Parameters of interest were studied on investigating the physiochemical component of effluent water discharge into Eleme River. The following physiochemical parameters were analysed: pH, temperature, conductivity, turbidity, Dissolved Oxygen (DO), Total Suspended Solid (TSS), Alkalinity, Total Dissolved Solid, (TDS), Biochemical Oxygen Demand (BOD), phenol, chloride, phosphate, nitrate, sulphate, iron, cadmium, lead, sodium, copper and manganese. The results of different sampling point are present in tables for the various month of investigation. The variation in the physiochemical parameters concentration can be attributed to constant discharge of wastewater in the receiving body (Eleme River) as well as other environmental factors. Similarly, the variation in the physiochemical parameters concentration can be attributed to the following: inadequate treatment in the sedimentation basin unit, chemical treatment unit, activated sludge unit, and equalization basin unit as well as the flow characteristics of the Eleme River. The summary of the results are present in Table 1 to 8 for selected physiochemical parameter.

The results of the analysis obtained from one month indicate increase in some physicochemical parameters in different sampling points as well decrease in concentration of the parameters as shown in Table 1. Some of the parameters concentrations are within the international acceptable limit while some are above. This means that some of the physicochemical parameters concentration, its characteristics influence the Eleme River as a result of effluent discharge. The results showed above 80% increase in BOD concentration, 91% on TSS concentration, 76% on pH concentration, 24% on temperature and 71% on TDS concentration whereas other parameters are within the acceptable limit. From Table 2, it is seen that decrease in physiochemical parameters are obtained as the samples are analysed from one point to the other as well increase as presented. Increase in physicochemical parameters can be attributed to continuous discharge of effluent water on the river as well as constant accumulation of contaminants. Similarly, the increase in the physiochemical parameters can be attributed to low dissolution rate, high rate of spreading, poor treatment method applied, high volume of wastewater discharge into the river etc. The result of physicochemical parameters for 3months sampling in Eleme River indicate increase in some physicochemical parameters above the acceptable limit as recommended by International Bodies. Similarly, some of the physicochemical parameters are within the acceptable limit. Parameters of temperature, pH, BOD, TDS, and TSS concentration are above the acceptable limit with values of 24%, 76%, 80%, 71% and 91% respectively. The changes in the physicochemical parameters of Eleme River can be attributed to continuous discharge of wastewater, high quality of wastewater discharged, low spreading rate of wastewater, and other environmental factors as shown in Table 3.

In Table 4 results on the physicochemical parameters continued to show increase in contamination level of Eleme River with increase in continuous discharge of wastewater. The analysis results obtained for 4 months. Sampling indicate 24%, 76%, 80%, 71% and 91% increase in temperature, pH, BOD, TDS and TSS. These parameters concentration are above the acceptable limit as recommended by the international Bodies. The continuous increase in the physicochemical parameters can be attributed to the plant design factor such as equalization basin design, biological aeration tank design, chemical treatment design, sedimentation basin design, and experimental test. The results of the analysis obtained from one month indicate increase in some physicochemical parameters in different sampling points as well decrease in concentration of the parameters as shown in Table 5. Some of the parameters concentrations are within the international acceptable limit while some are above. This means that some of the physicochemical parameters concentration, its characteristics influence the Eleme River as a result of effluent discharge. The results showed above 80% increase in BOD concentration, 91% on TSS concentration, 76% on pH concentration, 24% on temperature and 71% on TDS concentration whereas other parameters are within the acceptable limit.

Results obtained in Table 2, illustrates the characteristics of the physicochemical parameters. From Table 2, it is seen that decrease in physiochemical parameters are obtained as the samples are analysed from one point to the other as well increase as presented. The increase in physicochemical parameters can be attributed to continuous discharge of effluent water on the river as well as constant accumulation of contaminants. Similarly, the variation in the physiochemical parameters can be attributed to low dissolution rate, high rate of spreading, poor treatment method applied, high volume of wastewater discharge into the river etc. The result of physicochemical parameters for 7 months sampling in Eleme River indicate increase in some physicochemical parameters above the acceptable limit as recommended by International

Bodies. Similarly, some of the physicochemical parameters are within the acceptable limit. Parameters of temperature, pH, BOD, TDS, and TSS concentration are above the acceptable limit with values of 24%
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Table 1: Result of physiochemical parameters for month 1

Parameters	SP.01	SP.02	SP.03	SP.04
Temperature °C	24.7	26.4	25.4	27
pH	6.90	7.33	5.85	5.99
Cond μ/cm	996	329	352	76.20
Turbidity NTU	10.96	8.28	37.23	3.9
DO mg/l	6.5	7.43	5.23	3.9
TSS mg/l	118.45	20.10	8.11	6.85
Alkalinity mg/l	60.15	17	47	26
TDS mg/l	468.0	153.8	24.5	7.89
BOD_5 mg/l	2.4	1.00	2.00	1.5
Phenol mg/l	0.26	<0.001	0.07	<0.01
Chloride mg/l	12.02	0.48	5.01	0.93
Phosphate mg/l	2.87	<0.1	1.65	<0.1
Nitrate mg/l	6.62	4.16	5.8	4.32
Sulphate mg/l	0.760	0.037	0.511	0.73
Iron mg/l	0.233	0.058	0.129	0.120
Cadmium mg/l	0.0233	0.004	0.013	0.008
Lead mg/l	<0.001	<0.001	<0.001	<0.001
Sodium mg/l	7.012	50.896	5.581	3.428
Copper mg/l	0.09	0.004	0.029	0.012
Manganese mg/l	<0.001	<0.001	<0.001	<0.001

NB: SP = Sampling Point: 01, 02, 03 and 04

Table 2: Result of physiochemical parameters for month 2

Parameters	SP.01	SP.02	SP.03	SP.04
Temperature °C	26.1	25.2	25.4	24.8
pH	8.3	7.05	5.55	6.19
Cond μ/cm	927	140	924	135
Turbidity NTU	47.69	2.38	13.83	2.95
DO mg/l	3.8	6.94	4.6	5.8
TSS mg/l	96.75	4.68	70.98	30.85
Alkalinity mg/l	230	24	90	48
TDS mg/l	449.36	428.7	11.9	58.93
BOD_5 mg/l	2.8	1.01	2.2	195
Oil and Grease mg/l	11.3	1.54	5.8	2.4
Phenol mg/l	0.23	<0.001	0.06	<0.01
Chloride mg/l	17.02	1.55	13.01	3.93
Phosphate mg/l	<0.001	<0.001	0.001	0.001
Nitrate mg/l	4.06	24.16	3.8	3.13
Sulphate mg/l	0.600	0.030	0.556	0.185
Iron mg/l	0.233	0.058	0.129	0.120
Cadmium mg/l	0.001	<0.001	0.007	0.003
Lead mg/l	<0.001	<0.001	<0.001	<0.001
Sodium mg/l	7.012	50.896	5.581	3.428
Copper mg/l	0.09	0.004	0.029	0.012
Manganese mg/l	<0.001	<0.001	<0.001	<0.001

NB: SP = Sampling Point: 01, 02, 03 and 04

Table 3: Result of Physiochemical Parameters for month 3

Parameters	SP.01	SP.02	SP.03	SP.04
Temperature °C	27.23	27.06	26.45	26.15
pH	7.09	6.73	5.67	6.73
Cond μ/cm	85	287	129.4	168.6
Turbidity NTU	13.22	3.47	11.07	6.79
DO mg/l	4.33	7.32	2.90	3.88
TSS mg/l	3.89	4.95	3.02	2.9
Alkalinity mg/l	57	38	25	24
TDS mg/l	5.63	134	68.02	98.11
BOD_5 mg/l	2.8	1.00	2.6	2.0
Oil and Grease mg/l	8.5	0.8	5.4	1.9
Phenol mg/l	0.36	<0.001	0.067	0.03
Chloride mg/l	29.12	27.07	26.54	21.00
Phosphate mg/l	8.00	0.47	3.3	0.58
Nitrate mg/l	4.14	6.61	4.02	1.75
Sulphate mg/l	1.250	0.187	0.42	0.216
Iron mg/l	2.65	0.68	0.089	0.04
Cadmium mg/l	0.03	<0.001	0.007	0.003
Lead mg/l	0.134	0.132	0.046	<0.012
Sodium mg/l	4.35	7.53	5.22	4.04
Copper mg/l	0.015	0.002	0.012	0.005
Manganese mg/l	<0.001	<0.001	<0.001	<0.001

NB: SP = Sampling Point: 01, 02, 03 and 04

76%, 80%, 71% and 91% respectively. The changes in the physicochemical parameters of Eleme River can be attributed to continuous discharge of wastewater, high quality of wastewater discharged, low spreading rate of wastewater, and other environmental factors as shown in Table 7. In Table 8 results on the physicochemical parameters continued to show increase in

Table 4: Result of Physiochemical Parameters for month 4

Parameters	SP.01	SP.02	SP.03	SP.04
Temperature °C	24.69	24.88	25.45	24.93
pH	6.40	6.78	5.97	6.12
Cond μ/cm	66.7	269	124.14	159.4
Turbidity NTU	11.52	1.98	9.7	5.66
DO mg/l	4.77	5.3	5.96	5.0
TSS mg/l	20.97	7.30	18.79	12.13
Alkalinity mg/l	34	18	25.4	29
TDS mg/l	32	128	59	76
BOD_5 mg/l	2.8	1.09	2.2	2.0
Oil and Grease mg/l	10.25	1.8	5.8	2.3
Phenol mg/l	0.425	0.302	0.754	0.349
Chloride mg/l	5.29	27.36	36.36	29.00
Phosphate mg/l	2.84	<1.067	0.605	4.78
Nitrate mg/l	<0.813	<1.067	6.45	4.78
Sulphate mg/l	0.813	0.039	0.605	0.193
Iron mg/l	0.169	0.083	0.101	0.05
Cadmium mg/l	0.024	0.035	0.032	0.016
Lead mg/l	0.153	0.152	0.059	0.072
Sodium mg/l	4.35	7.53	5.22	4.04
Copper mg/l	0.001	0.006	Insignificant	0.003
Manganese mg/l	<0.001	<0.001	<0.001	<0.001

NB: SP = Sampling Point: 01, 02, 03 and 04

Table 5: Result of Physiochemical Parameters for month 5

Parameters	SP.01	SP.02	SP.03	SP.04
Temperature °C	29	28.5	29.35	27
pH	9.10	7.5	6.9	7
Cond μ/cm	197	309	108	242
Turbidity NTU	179	7.9	300	71
DO mg/l	4.7	5.7	3.9	3
TSS mg/l	90.5	4.59	33	27
Alkalinity mg/l	20	13	22	15
TDS mg/l	66	198	48	23
BOD_5 mg/l	2.3	0.7	1.9	1.1
Oil and Grease mg/l	7.0	1.2	2.1	1.6
Phenol mg/l	0.42	0.01	0.19	0.03
Chloride mg/l	4.56	10.36	2.02	1.97
Phosphate mg/l	2.26	0.06	2.02	0.72
Nitrate mg/l	4.45	2.64	3.92	2.2
Sulphate mg/l	4.48	0.87	3.03	2.05
Iron mg/l	0.197	0.073	0.1004	0.039
Cadmium mg/l	0.024	0.035	0.032	0.016
Lead mg/l	0.169	0.167	0.063	0.79
Sodium mg/l	8.95	11.05	1.32	0.982
Copper mg/l	0.003	<0.001	<0.081	<0.001
Manganese mg/l	<0.001	<0.001	<0.001	<0.001

NB: SP = Sampling Point: 01, 02, 03 and 04

Table 6: Result of Physiochemical Parameters for month 6

Parameters	SP.01	SP.02	SP.03	SP.04
Temperature °C	30	28	31	30
pH	6.58	12.90	12.90	9.25
Cond μ/cm	78.5	6.52	62.23	45.65
Turbidity NTU	179	7.9	101.52	210
DO mg/l	4.5	5.0	12.54	10.5
TSS mg/l	90.5	4.59	100	101
Alkalinity mg/l	20	13	55	65
TDS mg/l	66	176	150	120
BOD_5 mg/l	3.8	1.3	5.12	2.85
Oil and Grease mg/l	9.0	3.2	2.54	1.54
Phenol mg/l	0.42	0.01	0.65	0.54
Chloride mg/l	6.10	12.430	12.15	15
Phosphate mg/l	2.3	1.9	15	3.52
Nitrate mg/l	4.45	2.64	3.565	5.23
Sulphate mg/l	5.09	272.7	120	201
Iron mg/l	0.079	0.064	0.21	0.056
Cadmium mg/l	0.055	0.17	0.015	0.045
Lead mg/l	-0.036	-0.030	0.045	0.012
Sodium mg/l	7.89	12.06	5.62	2.01
Copper mg/l	0.003	<0.001	-0.25	0.012
Manganese mg/l	0.051	0.032	0.081	0.021

NB: SP = Sampling Point: 01, 02, 03 and 04 contamination level of Eleme River with increase in continuous discharge of wastewater. The analysis results obtained for 4 months. Sampling indicate 24%, 76%, 80%, 71% and 91% increase in temperature, pH, BOD, TDS and TSS. These parameters concentration are above the acceptable limit as recommended by the international Bodies. The continuous

Table 7: Result of Physiochemical Parameters for month 7

Parameters	SP.01	SP.02	SP.03	SP.04
Temperature °C	31	39	29	29.8
pH	9.89	12.09	7.07	6.64
Cond μ/cm	172	79.03	230	69.8
Turbidity NTU	156	9.23	101	150
DO mg/l	3.8	4.4	3.4	2.3
TSS mg/l	123.6	6.86	15	25
Alkalinity mg/l	22	9.86	5.23	5.2
TDS mg/l	66	176	81	96
BOD_5 mg/l	4.21	2.58	25	29
Oil and Grease mg/l	9.0	3.2	1.2	12
Phenol mg/l	0.56	0.01	0.012	0.06
Chloride mg/l	5.002	27.512	18.52	0.6789
Phosphate mg/l	1.5	1.5	4.50	0.5
Nitrate mg/l	3.506	4.023	2.00	0.42
Sulphate mg/l	0.139	3.090	0.116	0.048
Iron mg/l	0.017	0.064	0.011	0.03
Cadmium mg/l	-0.0102	-0.017	-0.0120	-0.0010
Lead mg/l	-0.036	-0.030	0.005	-0.0010
Sodium mg/l	9.804	11.86	0.26	9.02
Copper mg/l	<0.006	<0.003	<0.0012	0.004
Manganese mg/l	<0.010	<0.003	0.054	0.021

NB: SP = Sampling Point: 01, 02, 03 and 04

Table 8: Result of Physiochemical Parameters for month 8

Parameters	SP.01	SP.02	SP.03	SP.04
Temperature °C	30	31	31	29
pH	7.00	9.89	12.90	11.00
Cond μ/cm	79	9.25	148	98
Turbidity NTU	109	10.12	5.2	98
DO mg/l	4.03	5.4	2.02	9.2
TSS mg/l	81.9	4.96	26.9	222
Alkalinity mg/l	20	13	5.02	8.3
TDS mg/l	128	141	5.9	26
BOD_5 mg/l	2.809	2.39	1.01	0.59
Oil and Grease mg/l	8.95	2.7	1.2	3.3
Phenol mg/l	0.42	0.01	0.02	0.06
Chloride mg/l	11.56	14.00	3.9	6.2
Phosphate mg/l	1.03	1.23	-0.25	0.78
Nitrate mg/l	5.02	4.97	4.2	6.13
Sulphate mg/l	5.09	272.7	7.32	4.13
Iron mg/l	0.080	0.043	0.005	0.07
Cadmium mg/l	0.070	0.025	0.015	0.075
Lead mg/l	-0.029	0005	-0.001	-0.001
Sodium mg/l	7.89	12.06	5.12	9.10
Copper mg/l	0.003	<0.0021	-0.014	-0.045
Manganese mg/l	<0010	<0.003	<0.00101	<0.0054

NB: SP = Sampling Point: 01, 02, 03 and 04

increase in the physicochemical parameters can be attributed to the plant design factor such as equalization, basin design, biological aeration tank design, chemical treatment design, sedimentation basin design, and experimental test.

Conclusion

The present study revealed an interesting insight on a few physiochemical parameters of the wastewater discharge in Eleme River. The results showed an increase in Biochemical Oxygen Demand (BOD) value of 80%, Total Suspended Solids (TS) value of 91%, pH value of 76%, temperature value of 24% and Total Dissolved Solids (TDS) value of 71%. Depending upon the source, nature quality and quantity of wastewater generation, the variation occurs in the experimental value of the analysed parameters for the different samples. This study gives an idea about the quantitative aspect and nature of the wastewater discharge into the Eleme River. It can be expected that this study will inspire further investigation regarding the other aspects and characteristics of the physicochemical parameters of the wastewater after eight months.

The following conclusion was drawn from the study:

1. The composition of wastewater discharge into the Eleme River by the petrochemical Industry is hazardous and the characteristics shows that the chemicals composition is above the acceptable limit as recommended by International bodies.
2. The treatment techniques put in place by the company is inadequate to handle the wastewater generated per day.
3. The treatment equipment in place should be replaced with new one of modern technology.
4. Constant treatments on the Eleme river should be carried out in every 3months interval as a way forward to enhance environmental clean up as well as increase the portability of River water for domestic use, aquatic use etc.
5. If measures are not taken by the Federal Government to stop this habit exacted by Oil companies in Nigeria in terms of waste treatment and management there is tendency that the ground water within the vicinity of Eleme with contaminated in due cost.
6. This paper present the current status of Eleme River in terms of physiochemical parameters. One may say that the level or the degree of pollutant in the Eleme River is majorly cost by the industrial activities taken place with the area. Although there are domestic waste disposed in the Eleme River but the impact is not significant, because the microorganisms present in the aquatic environment needs them for then food.

Therefore, this paper recommend adequate treatment of wastewater as well ensure that hazardous components are not discharge into the Eleme River, since the River save as a major source for drinking, domestic uses, industrial uses etc.

Nomenclature

G	=	Initial concentration of effluent (mg/l)
Q	=	Flow rate (m^3/s)
T	=	Temperature (°C)
C_o	=	Effluent concentration at accumulation stage (mg/l)
C_2	=	Final concentration of effluent (mg/l)
Cd	=	Concentration of the decay rate (mg/l)
g	=	Acceleration due to gravity (m/s^2)
t	=	Time (second)
V	=	Volume of a tank (m^3)
X_o	=	Initial biomass concentration (mg/l)
X	=	Final biomass concentration (mg/l)
S	=	Substrate concentration (mg/l)
K	=	Equilibrium constant (dimensionless)
Q_w	=	Mass flow rate of wastewater (kg/s)
X_e	=	Biomass concentration in effluent (mg/l)
X_r	=	Biomass concentration removed (mg/l)
μ	=	Viscosity
μ_m	=	Specific microbial growth rate (mg/l/s)
K_s	=	Equilibrium constant of the substrate
S_o	=	Initial concentration of the substrate (mg/l)
BOD_5	=	Biochemical Oxygen Demand (kg/l)
θ_C	=	Retention time
K_d	=	Equilibrium constant of the decay rate
C	=	Concentration of the effluent (mg/l)

A	=	Filter area (m^2)
NRe	=	Renold's number (dimensionless)
ρ	=	Density (kg/m^3)
P	=	Pressure (N/m^2)
L	=	Reactor length (m)
D	=	Impeller diameter (m)

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