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Environmental Audit of Camelite Paint Manufacturing Company Located at Agbor, Delta State, Nigeria. Case Study: Analysis of Effluent/Borehole water Discharge

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ABSTRACT: An Environmental Audit (E.A) study of physiochemical and bacteriological effluent and borehole discharges of Camelite paint Manufacturing company limited, Agbor was investigated. pH was determined using the pH meter pre-calibrated using buffer 4 and 9. TDS contents were estimated using Lovibond conductivity meter. Heavy meal concentrations were determined with Spectra AA varion 400 plus Atomic Absorption Spectrometer. Total aerobic bacterial counts were determined by the pour-plate technique technique. Total coliform counts were determined by the Most Probable Number (MPN) technique. The study revealed low pH, low TDS and small quantities of cations and heavy metal presence, and high total coliform bacteria counts of 42.2MPN/100ml which contributed to the bacteriological pollution of rivers and coastal waters resulting in limited possibilities of their use for recreation. It is suggested that to detect coliform organisms in water, either the multiple tube-fermentation-technique or the use of the Membrane Filter be employed because of the disadvantages associated with the so called Most-Probable-Number technique whose test is not sensitive to large fluctuations in coliform densities. Management of Camelite should consider pollution abatement and ensure compliance with environmental requirements.

I. INTRODUCTION

Environmental Audit, EA, is one of the available enforcement tools used as agent of sustainable growth comprising a systematic documented, periodic and objective evaluation of the process technology, equipment performance, raw materials in use, quality and quantity of waste generated and their effects on the air, soil, vegetation, underground and surface water, with the aim of facilitating management control of environmental practices and assessing compliance with companies and meeting regulatory requirements.

In general, paint industries release significant amount of hazardous wastes to the environment, in particular, large quantities of untreated waste water are routinely discharged to the surface water ecosystem.

A close assessment of the chemical and bacteriological constituents of the studied parameters is often imperative for effective monitoring of their quality status.

Many scholars have conducted studies on these parameters within the sedimentary formations of Southern Nigeria (Etu-Efuotor, 1981; Amadi , 1989, Olobaniyi and Owoyemi, 2004).

The broad aims of this environmental Audit are to:

- Assess compliance with regulatory requirements (DPR, FEPA, WHO,etc) as well as company policies on environmental matters and sustainable development.
- Facilitate management control of environmental practices.
- Help local management to control the quality of existing operations and develop strategies for improvement in anticipation of future needs by:

i Identifying and proffering measures to minimize actual or potential company exposure to environmental liabilities.
ii Documenting the company's environmental status.
iii Transferring know-how on cost effective environmental techniques, as measures and procedures, as well as giving timely warning of situations that may need improvement.

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iv Providing assurance that operations do not have unacceptable environmental effects.

Environmental Audit acts as internal control process to ensure that environmental protection and management procedures are being enforced vigorously. It will also ensure that enforcement of company policy, procedures and standards are in line with management's responsibility and in compliance with environmental legislation

Apart from the three major attributes of physical, chemical and biological considerations examined, it also includes the need to:

- Evaluate time management systems, plant operations, monitoring practices and data procedures and plans.
- Identify current and potential environmental problems through groundwater and effluent discharge study.
- Recommend improvement to the management of the operations, and especially pollution abatement.
- Evaluate company policy
- Assess the current environmental status of the company and evaluate compliance with existing regulatory requirements.

II. MATERIALS AND METHODS

2.1 Area of study

The study was carried out at Camelite Paint Manufacturing Company Ltd, Agbor, Delta state, Nigeria. The study area lies between latitude 6º 16' 0" North and longitude 6º 9' 0" East (fig. 1). The main source of water in the factory is bore hole.

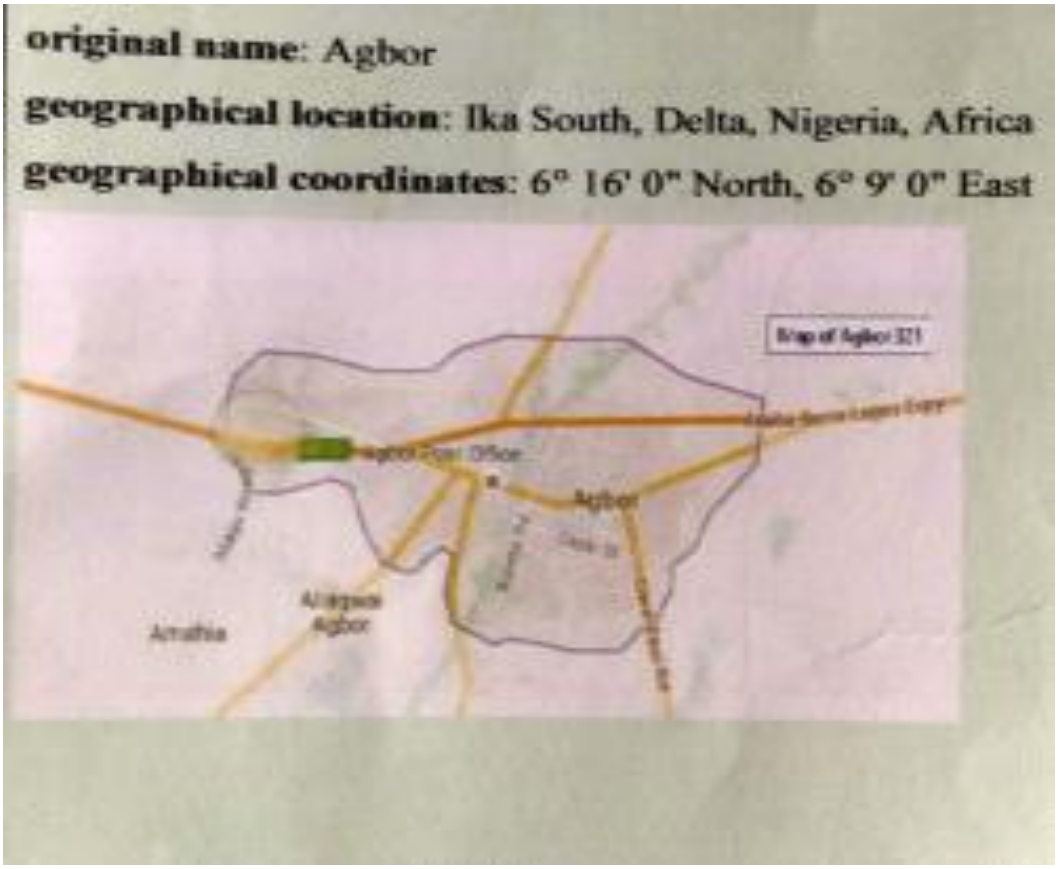

Fig.1: Map of Agbor showing the general coordinates

2.2 Climatic Conditions

The study of the physical features of the entire area shows two topographic highs separated by a valley. Within the valley is river Asimiri,, which flows in a southwest northeast direction (fig. 2). The area lies within the subequatorial climate with wet season of about 96 weeks and annual rain fall of over 2000mm. The area is also humid with average temperature of between 24ºC - 27ºC, (Iloeje, 1981), which adequately supports rainforest kind of vegetation.

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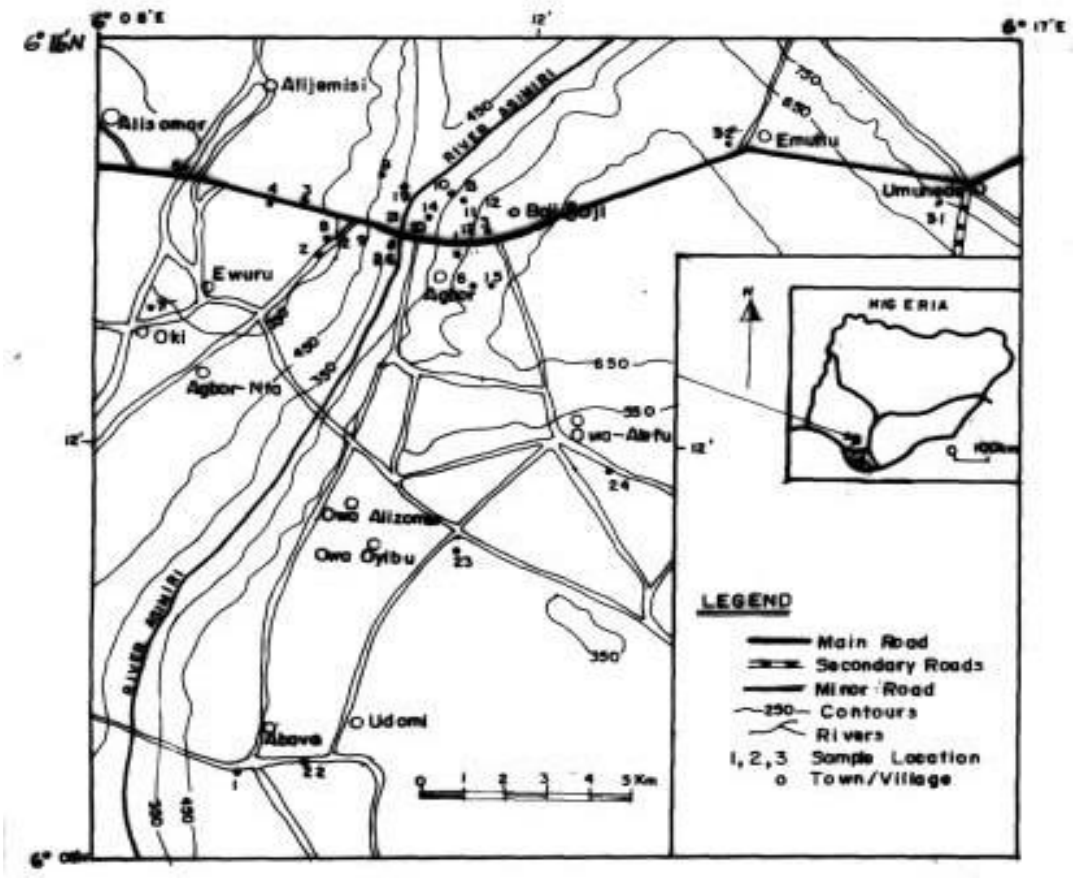

Fig.2: Topography of study area.

2.3 Effluent sampling and Preservation

Water samples were collected into clean 1 litre plastic cans from each sampling point. For metal concentration determination, one of the points was stabilized with acid. Samples were also collected into sterilized 1 litre plastic cans for biological investigation. The procedures for obtaining these different parameters were conducted in the chemistry and integrated science laboratories, College of Education, Agbor, Delta state.

Effluent water samplings were done at six points using a Ruttner Sampler. Separate samples were collected for the following determinations; Exchangeable cations, Heavy metals, and general phyisco-chemical analysis (using 2 litre plastic bottles)

Samples were preserved in ice chest cooler.

Samples were collected from the only Separator pit in the factory and also from other points within and also from other points within and outside the factory. The borehole sample was first collected for physco-chemical parameters and later for coliform test after steaming the pump head and allowing the pump to run for about 10 minutes. This was to ensure that a true and representative water sample was collected.

Table 1: The Effluent/Borehole sampling points

S/No	Effluent Sample	Sample point Description	Activities
1	Effluent, ∝	Beside Pre assembly and Premix	Resin, Pigment and solvent are mixed to produce an even mill base
2	Effluent, β	Beside Pigment grinding/milling	Mill base produced at the pre-mixing process is sent to the

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			dispenser to finely disperse the pigment particles
3	Effluent, γ	Product finishing/blending	Resin, addictive agents are added to the mill base, the dispersion is now completed. Also, the colour phase is adjusted
4	Effluent, φ	Product filtering, filling and packaging	Blended and toned paint is filtered and packed into a container
5	BHW	Borehole water near the canteen	
6	SEP	Separator Pit	Gravity device that uses centrifugal force to separate particles from suspension

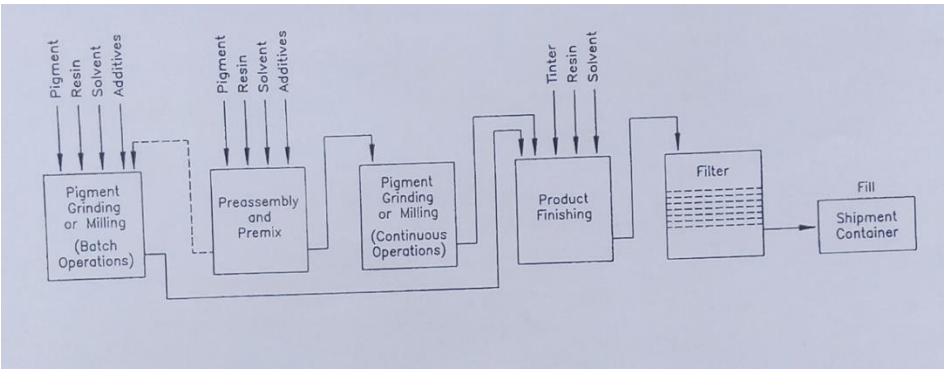

Fig. 3.Flow diagram of paint manufacturing process.

2.5 Physico-chemical study

The analytical procedures for physical, chemical and bacteriological parameters were determined generally in accordance with the overall specifications of American Public Health Association (APHA, 1985). T

The pH of the effluents was determined using glass electrode pH meter which was pre-calibrated using buffer 4 and 9 (APHA, 1992). Temperatures were measured in situ on the field.

The TDS contents of the samples were estimated using Lovibond conductivity meter.

The concentration of Na^+ and K^+ were determined using a flame photometer. Ca^{2+} and mg^{2+} were measured by EDTA titrimetriy, while Cl^-, HCO_3^{2-} and CO_3^{2-} were measured using titrimetric methods. NO_3^- content of the samples was determined by the Braine-Sulphate method (APHA, 1995).

SO_4^{2-} was determined by the turbidimetry method. Colloidal Barium sulphate was formed by the reaction of sulphate with barium ion in a barium chloride – hydrochloric acid solution in the presence of glycerol and ethyl alcohol.

Po_4^{2-} was determined by the stannous chloride (APHA, 1995).

The concentrations of heavy metals (Fe, Pb, Zn, Mn) were determined with spectra AA Varian 400 plus Atomic Adsorption Spectrometer. This analysis was carried out twice and the average values were obtained. Total aerobic bacterial counts were determined by the pour-plate technique while Total Coliform counts were performed by the Most Probable Number (MPN) technique.

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III. RESULTS AND DISCUSSION

The results of the physic-chemical study are as presented in tables2, 3 and 4.

Table 2 Physical Parameters Results of Effluent and Borehole samples.

Points	pH	Temp.°C	TDS	EC	THC
A	7.0	28.0	24.0	44.5	21.0
B	6.5	27.0	40.1	80.2	28.5
Γ	5.4	26.7	15.2	27.8	13.4
Φ	5.7	28.5	14.7	23.6	28.8
BHW	5.5	26.0	12.3	22.0	8.0
SEP	4.9	26.5	41.2	88.2	29.7

TDS in mg/L
EC in µs/cm
THC in mg/L

Table 3 Chemical Parameters Results of Effluent and Borehole samples

Points	Na^+	K^+	Ca^{2+}	Mg^{2+}	Fe^{2+}	Zn^{2+}	Mn^{2+}	Pb^{2+}	HCO_3^-	CO_3^{2-}	Cl^-	SO_4^{2-}	NO_3^-	PO_4^{2-}
A	4.5	1.7	4.1	0.5	0.41	0.62	0.03	0.02	12.0	0.10	4.5	0.20	0.10	0.10
B	10.3	2.8	7.3	1.4	0.35	0.60	0.02	0.01	12.0	0.70	4.2	4.0	2.4	2.4
Γ	4.1	1.2	1.6	0.8	0.21	0.73	0.02	0.00	4.0	0.80	5.1	0.80	0.7	0.7
Φ	2.5	0.8	2.5	2.0	0.11	0.20	0.02	0.00	4.0	0.80	8.4	0.30	0.2	0.2
BHW	2.5	0.8	2.5	0.4	0.11	0.18	0.02	0.00	4.0	0.60	9.3	0.10	0.2	0.2
SEP	10.4	3.8	8.0	0.9	0.28	0.51	0,02	0.00	3.0	0.40	16.2	2.0	1.7	1.7

All measurements in mg/l

Table 4 Bacteriological Analysis results of Effluent and Borehole Samples

Points	Total Aerobic Counts (cfu/ml	Total Coliform (MPN/100ml)S
A	12	29
B	36	58
Γ	149	43
Φ	372	28
BHW	24	42
SEP	12	53

Table 5 Effluent Samples and bacteriological composition compared to DPR/FEPA/WHO standard for drinking water

N=6 Parameters	Minimum Value	Maximun Value	Mean	DPR/FEPA/WHO permissible limit
pH	4.9	7.0	5.83	6.5-8.5
Temp.°C	26.0	28.5	27.1	-
TDS	12.3	41.2	24.6	1500
EC	22.0	88.2	47.7	1500
THC	8.0	29.7	21.6	500
Na^+	2.5	10.4	5.73	500
K^+	0.8	3.8	1.85	50
Ca^{2+}	1.6	8.0	4.33	200
Mg^{2+}	0.4	1.4	1.00	150
Fe^{2+}	0.11	0.41	0.25	0.03-1.00
Zn^{2+}	0.18	0.73	0.47	5.00
Mn^{2+}	0.02	0.03	0.02	0.1-0.20
Pb^{2+}	0.00	0.02	0.005	0.01
HCO_3^-	3.00	12.0	6.50	500
CO_3^{2-}	0.10	0.80	0.57	-
Cl^-	4.2	16.2	7.95	500
SO_4^{2-}	0.10	4.00	1.23	400

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NO_3^-	0.10	2.40	0.88	40-70
PO_4^{2-}	0.10	1.20	0.37	-
Total Aerobic counts (cfu/ml)	12	372	199.8	-
Total Coliform (MPN/100ml)	28	58	42.2	0/100ml

IV. DISCUSSION

pH

The pH of the samples has a minimum value of 4.9 at point SEP and a maximum value of 7.0 at point α with a mean value of 5.83 (Table 2 and 5). The pH values at all the points are within the permissible limits for industrial effluents and borehole water set by DPR/FEMA/WHO.

Temperature

The temperature values ranged from 26.0ºC to 28.5ºC. The minimum value was at point BHW and the maximum value was at point γ with a mean value of 27.1ºC (Tables 2 and 5).

Total Dissolved Solids (TDS)

The TDS value has a minimum of 12.3 at point BHW and a maximum value of 40.1 at point β with an average value of 24.6. The DPR/FEPA/WHO permissible limit for TDS is 1500mg/l (Table 2 and 5). The borehole water has a low dissolved solid value of 12.3mg/l and falls within acceptable limit for portable water.

Electrical Conductivity, EC

The electrical conductivity of the effluent water samples varied widely. The least value of 22.0µs/cm was obtained at point BHW while the maximum value of 88.2 µs/cm was obtained at point SEP.

Total Hydrocarbon Content (THC)

The effluent samples have the least THC of 8.0 at point BHW and a maximum value of 29.7 at point SEP. The mean value was 21.6 which is below th permissible standard by DPR/FEPA/WHO.

Exchangeable cations (Na^+, K^+, Ca^{2+}, Mg^{2+})

All the cations analysed for namely, Na^+, K^+, Ca^{2+}, Mg^{2+}, were detected in varying degrees in all the sampled points (Table 3)

Heavy Metal (Fe, Zn, Mn, Pb)

Heavy metals were detected in small quantities in all the sampled points.

Apart from the points α and β which had 0.02 and 0.01 respectively for Pb^{2+}, all other points did not detect Pb^{2+}, (Table 3).

Nitrate (NO_3^-)

The nitrate content of effluent samples showed some variations. It has minimum of 0.10 at α and maximum of 1.7 at point SEP (Table 3). It has a mean value of 0.88 which is very low compared to the permissible limit of 40-70 by DPR/FEPA/WHO.

Chloride (Cl)

The chlorine values from the sampled points ranged from 4.2 at point β to 16.2 at point SEP, with a mean value of 7.95. This is in conformity with the required standards by WHO, (Tables 3 and 5).

Sulphate (SO_4^{2-})

Sulphate was detected in all the sampled points. The minimum value was at point BHW (0.10) and maximum value of 4.00 at point β, (Table 3)

Phosphate (PO_4^{3-})

Phosphate was detected in the samples in small quantities. The mean value was 0.37.

Bacteriological quantity

The result of the bacteriological analysis from the study is as presented in table 4 above. Total aerobic bacteria counts range between 12cfu/ml and 372cfu/ml while the coliform counts have values from 28 to 58 MPN/100ml with a mean value of 42.2MPN/100ml. This value far exceeded the WHO standard requirement of 0/100ml., (Tables 4 and 5). This means the samples were all contaminated with pathogenic micro organisms.

V. CONCLUSION

The study revealed low pH and low TDS. These are characteristics of tropical regions of high rainfall, (Rose, Hawkes and Webb, 2000).

Also, the low EC within the study area is indicative of low salinity sodium hazards. The study also revealed contaminated effluent waste water with pathogenic micro organisms due to total coliform count whose mean value was 42.2 MPN/100ml compared to 0/100ml permissible by DPR/FEPA/WHO.

This high value contributes to the bacteriological pollution of rivers, coastal waters,

resulting in limited possibilities of their use for recreation. It is therefore necessary to disinfect it, control its bacteriological quantity, especially when discharged into surface waters used for recreational purposes.

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