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Physico – Chemical Analysis of Effluents from Jacbon Chemical Industries Limited, Makers of Bonalux Emulsion and Gloss Paints

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ABSTRACT

Effluents from domestic and industrial processing activities can be re-used as source of water for irrigation in arid and semi-arid regions where there is limited availability of water. Heavy metals in paint effluents are not biodegradable and their presence in streams and lakes may lead to bioaccumulation in aquatic organisms. This research was aimed at the analysis of the untreated effluents from Jacbon Industries limited, makers of Bonalux paints, Km2 Nkpor- Obosi Road Obosi, Anambra State, for three sampling periods: November, December 2011 and January 2011. The samples were collected from a discharge point through which it enters the environment and various physico-chemical parameters were determined. Results obtained showed the following average physico-chemical parameters pH(6.25), colour(milky), temperature(35^oC), TDS (224 mg/L at 105^oC), BOD (182 mg/L), COD (1092 mg/L). Others include TS (723 mg/L), TSS (6.15mg/L) electrical conductivity (234 µScm^{-1} at 25^oC), total alkalinity (952 mg/L), total acidity (43 mg/L) and total hardness $CaCO_3$(53 mg/L). Cl^- (49 mg/L), SO_4^{2-} (30 mg/L) and NO_3^-(0.25 mg/L). Results obtained from Atomic Absorption Spectrophotometer analysis (AAS) showed the average metal levels as Ni^+(1.0mg/L), Cu^{2+}(2.46 mg/L), Fe^{2+}(7.57 mg/L), Cd^{2+} (1.74mg/L), Pb^{2+}(0.09mg/L) etc. Finally, organic functional groups determination was carried out for the samples by using an IR Spectroscopy and results showed presence of CH_3, CH_2 stretch of alkane, O-H bend, C=O bend, C_6H_5 stretch of aromatics and –OR undulating functional groups. Results of the physicochemical analysis indicated showed some level of compliance with WHO and NESREA limits except Temperature, BOD and COD.

Keywords: *Analysis, Effluent, Chemical Industries, Bonalux Paints.*

1. INTRODUCTION

In most developed and developing countries, rapid industrialization and man's constant quest for comfort as well as change in taste and fashion has resulted to various forms of advancement in science and technology (Tuner, 1990). This, in turn affects the environment significantly in various ways. In processing basic industrial raw materials to finished goods various harmful wastes, effluents and other toxic by-products are generated alongside the desired products. These toxic materials if discharged untreated into the environment are capable of interfering with the components as well as affecting man and other living components of the ecosystem. For instance, in areas where industrial waste effluents are discharged into surface waters, there is general reduction in the quality of such water and its ability to support aquatic life is equally reduced. Man-made effluent is generally considered to be water pollution, such as the outflow from a sewage treatment plant facility or the waste water discharge from industrial facilities (Womach, 2005).

Discharges of effluents with biodegradable organic substances affect the biological oxygen demand (BOD). On the other hand, effluents with oxidizable substances, which may be organic or inorganic, also affect the availability of chemical oxygen in that water body. Similarly, discharge of wastes (nutrients) from fertilizer plants into water bodies may lead to eutrophication, a process whereby plants and algae grow in a rapid manner to a point where the depth of the water receive little or no sunlight. This phenomenon inhibits photosynthesis and much of the dissolved oxygen (DO) is used up when these plants and algae decay thereby subjecting aerobic aquatic organisms to danger of suffocating.

Solid particles contained in waste waters may also find their way into water bodies, in which case, total suspended solids (TSS) and total dissolved solids (TDS) affects the quality of receiving water by limiting its commercial and domestic importance.

Heavy metals have also been found to be highly toxic especially when their natural concentrations are exceeded. At normal concentration, they promote the functions of the enzymes but could lead to a lot of adverse metabolic reaction when their concentration rises beyond tolerance limit. Such heavy metals as Hg, Cd, Pb and Cu are very harmful to the body; they form complexes with certain enzymes. These heavy metals find their way into water

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bodies from industries that generate them as part of their waste effluents. The heavy metals have cumulative effects over the years; the presence of these heavy metals in the ecosystems has increased as a result of increase in industrialization process. Health problems such as genetic mutation, deformation, cancer, kidney problems etc, have been attributed to pollution by heavy metals. Lot of works have been carried out on effluents in industries, Onuegbu et al, 2008, studied treated effluents and sludge samples from Nigerian Guinness Brewery. The untreated effluents contain a lot of pollutants that are harmful to human beings when they exceed the permissible limits (Onuegbu et al , 2007). Emongor et al., 2005, determined pollution indicators in and around Gaborone industrial effluent. Zahoor and Abdul Kabir, 2006, investigated the effect of Wastewater from Quetta City on the Germination and Seedling Growth of Lettuce (*Lactuca sativa* L.). Annian et al., 2007, investigated the bioaccumulation of Some Trace Metals (Mg, Fe, Zn, Cu) from Begger's Bowl *Cymbium melo*. Adebayo et al., 2007 carried out the chemical analysis of some industrial effluents that discharge into Lagos Lagoon,

This research is focused on the analysis of untreated waste effluent from Jacbon Industries limited, Km 2, Nkpor-Obosi Road Obosi, Anambra State, for three sampling periods, November and December 2010, and January 2011 with the aim of assessing the environmental impact of the waste effluents from the industry.

Jacbon Industries limited is a large scale industry that specializes on production of both water and oil based paints (Emulsion and Gloss paints), wood finish and glue.

Effluent in the man-made sense is generally considered to be water pollution, such as the outflow from a sewage treatment plant facility or the waste water discharge from industrial facilities (Womach, 2005).

One of the major advantages of effluent water from domestic or agricultural processing activity is that it can be re-used as source of water for irrigation especially in arid and semi-arid regions where limited water availability is already a constraint on development. In some developed economies, effluent water from various sources are recycled (treated) to generate portable water for municipal supply while the organic residue resulting from such treatment are converted to fertilizer for crop production.

Similarly, effluents rich in nutrients when discharged into farm lands could help boost the fertility of the soil in addition to development of shells and bones in aquatic animals by those rich in calcium and magnesium. On the other hand, effluent water rich in nutrients may lead to eutrophication which imparts the dissolved oxygen in the receiving aquatic environment.

Effluent irrigation may also lead to microbial contamination of air, soils and plants in the vicinity of the irrigation site. Thus, various health problems in plants and animals could be traced to contamination of the ecosystem by highly polluted effluents (Sangodoyin, 1995).

2. MATERIALS AND METHODS

The samples of untreated effluent were collected from discharged point for three sampling periods: November and December 2010, and January 2011 and were refrigerated at 4^oC.

3. DETERMINATION OF PHYSICO-CHEMICAL PARAMETERS

The physico-chemical parameters of the samples were investigated as shown: colour, pH, temperature, total dissolved solid, (TDS), Total solid (TS), total suspended solid (TSS), Electrical conductivity (EC). Others include: total acidity, total alkalinity, total hardness, biochemical oxygen demand (BOD) and chemical oxygen demand (COD) using standard procedures (Ademoroti, 1996). The sample was digested using Atomic Absorption Spectrophotometer, Buck Scientific AAS 205 model. Air acetylene flame type, at a flame temperature of 2000K and flame height of 6mm (Friendland et at., 1992). The results were compared with WHO limits.

Further tests were carried out to determine the organic functional groups present in the samples using Fourier Transform Infrared Spectrophotometer (Azogu, 2010).

4. RESULTS AND DISCUSSION

The results of physico-chemical analyses, Atomic Absorption Spectrophotometry (AAS) and Fourier Transform Infrared Spectrophotometry (FTIR) are shown in Tables 1-3. The results of the physico- chemical analysis of the effluent from Jacbon Industries limited Obosi, Anambra State are shown in Table 1 with a view of accessing the environmental impact of the waste effluents.

The average temperature of the sludge samples is 35^o C. This value is within the Nigerian Environmental Standards and Regulations Enforcement Agency (NESREA) limit, which is about, 40^oC but slightly above the World Health Organization Standard, which is between 20 –32^oC. This slight difference could be attributed to heat exchange from machineries.

The average pH of the sludge sample is 6.25 which are within the WHO permissible limit of 6.5 – 8.5 and NESREA limit of 6.0 – 9.0; therefore there could be no danger on the receiving environment. The observed pH is

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due to the use of ammonia solution as buffer in water based paints.

Table 1: Physicochemical analysis

Parameter	Sample	WHO limit	NESREA Limit
Colour	Milky	-	-
pH	6.25	6.5-8.5	6-9
Temperature(^oC)	35	20-32	<40
TDS mg/L at 105^oC	224	500	2000
EC µScm^{-1} at 25^oC	234	900	-
TS mg/L	723	500	500
TSS mg/L	6.15	30	30
Total hardness mg/L $CaCO_3$	53	100	-
Total acidity mg/L $CaCo_3$	43	-	-
Total alkalinity mg/L $CaCo_3$	952	-	-
BOD_5mg/L	182	-	30
COD mg/L	1092	-	80
Cl^-mg/L	49	250	600
SO_4^{2-}mg/L	30	250	500
NO_3^-mg/L	0.25	10	20

Higher value of 24 mg/L was obtained for BOD, although this value falls within the NESREA Limit of 30mg/L, it is higher than the recommended WHO limit of 15 mg/L. The presence of organic compounds such as nitro cellulose used as thickener, alkyd resins and acrylic /styrene co-polymer used as dispersants and binders accounts for the high content of biodegradable organic matter which impacts the BOD.

Likewise, COD for the sample sludge is 46 mg/L; this is also slightly above the WHO permissible limit of 40mg/L, but fall within the recommended limit of NESREA which is 80 mg/L. Availability of oxidizable inorganic compounds such as pigments and additives are responsible for the impact on chemical oxygen demand.

The result obtained for the total hardness of the sludge samples was 53mg/L whereas WHO and NESREA permissible limit were 100mg/L and 10mg/L respectively. This implies that the sludge has little or no hardness. Total dissolved solids, TDS includes inorganic salts, inorganic matter and dissolved materials such as carbonates, sulphates, chlorides, calcium, sodium, potassium and magnesium. From the analysis, TDS concentration was 224mg/L, which complied with WHO Permissible limit of 500mg/L for discharge into potable waters and NESREA specified limit of 2000mg/L,

The colour of the sludge sample from visual observation shows milky/chalky shade. This is quite evident because calcium carbonate, polyvinyl acetate (PVA) and acrylic/styrene dispersions used in paint formulation are all white or milky in colour.

The results of average Atomic Absorption spectroscopy are shown in Table 2.

Table 2: Average Metal level in milligram per litre (mg/L)

Metal ions	Concentration	WHO limit
Zn^{2+}	1.0	15.0
Cu^{2+}	2.46	1.0
Fe^{2+}	7.57	1.0
Cd^{2+}	1.74	0.01
Na^+	4.06	200
K^+	3.07	200
Cr^{3+}	5.31	0.05
Bi^{3+}	2.34	-
As^{3+}	0.40	0.01
Pb^{2+}	0.09	0.01
Hg^{2+}	0.98	0.001
Se^{2+}	3.05	0.01

From the results; it could be observed that the concentration of zinc is 1.0mg/L which complied very well with WHO maximum permissible level of 15.0mg/L. Zinc is an important component of white and red pigments. Its low concentration in the sludge sample may be due to low dosage of white and red pigments during paint formulation and also as a result strong binding of pigment with other ingredients.

Copper is a trace element required by plants in a very minute quantity for growth and development. Excess of it could be very detrimental even in humans. The AAS result shows that the concentration of copper in the sample sludge is 2. 46 mg/L which appears to be very high compared with the standard, approved by WHO which is 1. 00mg/L. The high concentration of copper may be attributed to the use of blue and green pigments of copper compound.

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Iron has amazingly high concentration, too high for human tolerance when compared with the WHO standard of 1.00 mg/L. Extensive use of iron oxide (Fe_2O_3) as red, yellow and brown pigments by paint manufacturers accounts for this abnormal value of 7.57mg/L. Cadmium concentrated in the examined sludge is 1.74 mg/L. This is quite high considering the 0.001mg/L which is the maximum permissible level by WHO. Cadmium is introduced into paints through a large variety of insoluble organic dyes such as cadmium red. This high value of cadmium will invariably introduce pollution into the environment.

Sodium and Potassium have relatively low concentrations, hence cannot in any way constitute threat to the environment.

An abnormal value of 5.31 mg/L was recorded as the concentration of chromium in the sludge sample when compared to 0.05mg/L being the recommended WHO standard. Owing to the exceptional brilliance, great opacity, good permanency and excellent light fastness of chrome yellow, chrome green, emerald green [$Cr_2O(OH)_4$] etc, they are extensively consumed in paint industries as colourants.

Red lead in forms of Pb_3O_4 has a brilliant colour, which is quite resistant to light, and corrosion is extensively used as priming coat for structural steel. Therefore, the high concentration of lead in the sample is attributable to the high preferential usage of lead as pigments as driers for gloss finishes. It is evident that concentration of some metal contaminants such as zinc, sodium and potassium are low while the rest appear to be higher. Nevertheless, continuous discharge could cause serious environmental pollution.

The results of Infrared Spectra analyses shown in Table 3 indicate that the following chromophores were present in the sludge sample.

Table 3: FTIR results for the samples

WAVE NUMBER	FUNCTIONL GROUP OR BOND OBSERVED	CLASS OF COMPOUND
3697.18	CH_3, CH_2 stretch of alkanes	Alkanes
2932.96	C = O bend	Carbonyl functional groups
1624.60	OH – bend	Hydroxyl group
1522.68	C_6H_5 stretch of aromatics	Arenes
400.00	-OR undulating	Esters

CH_3, CH_2 stretch of alkanes, C=O band of carbonyl groups, OH- band of hydroxyl functional groups with absorptions in the region of 3697.18cm^{-1}, 2932.96 and 1624.60 respectively.

Also, C_6H_5- band and –OR undulating were observed in the region of 1522.68 and 400.00 respectively.

Considering the infrared analysis, it is obvious that the waste effluent contains considerable amount of organic load, which in turn impacts the BOD and COD to the receiving environment.

5. CONCLUSION

From the results of the physico- chemical analyses, it is evident that all the analyzed parameters showed compliance with NESREA and WHO standards except that of temperature, BOD and COD which although are within the NESREA limit but are slightly above the WH permissible limit.
The results of the Atomic Absorption Spectroscopy indicate that different kinds of metals are contained in the waste water sample; hence contamination of the ecosystem is eminent.

REFERENCES

[1] Adebayo O.T., Balogun A.M. and Olubiyi O.A., (2007). Chemical Analysis of Some Industrial Effluents That Discharge into Lagos Lagoon, Nigeria . *Research Journal of Environmental Sciences, 1: 196-199.*
DOI: 10.3923/rjes.2007.196.199

[2] Ademoroti. C.M.A. (1996), "*Principles of Analytical Chemistry*." Foludex Press Ltd. Ibadan. pp.21-32.

[3] Annian Shanmugam , Chendur Palpandi and Kaila Kesavan, (2007). Bioaccumulation of Some Trace Metals (Mg, Fe, Zn, Cu) from Begger's Bowl *Cymbium melo* (Solander, 1786) (A Marine Neogastropod). *Research Journal of Environmental Sciences, 1: 191-195.*

DOI: 10.3923/rjes.2007.191.195

[4] Azogu C.I. (2010), Laboratory Organic Chemistry, Techniques, Qualitative Analysis, Organic Preparation and Spectroscopy, 2rd Ed pp 99 -105.

[5] Emongor V., Nkegbe E, Kealotswe B. , Koorapetse I , Sankwasa S. and Keikanetswe S., (2005). Pollution Indicators in Gaborone Industrial Effluent. *Journal of Applied Sciences, 5: 147-150.* **DOI:** 10.3923/jas.2005.147.150

[6] Friendland A. J., Craig B.W. Miller E., Siccama T.G. and Johnson,(1992). Ambio XXI(6):400

[7] Onuegbu T. U.,Ajiwe V.I.E., Arinze R.U. and Okoye L.O.(2007). Analysis os untreated Effluents from Guinness Brewery In Nigeria, Journal of Applied sciences, 10(4): 7466-7473.

[8] Onuegbu T.U.,Okoye L.O., Dioha I.J., Okoye P.A.C. and Nwako P.M. (2008). Treated effluents and sludge samples: A case Study of Nigerian Guinness Brewery. J. Chem. Soc. Nigeria, 33 (1): 6-9. http:/www.chemsocnigeria.org/:jcsn/2008:html

[9] Sangodoyin A.Y. (1995), *"Characteristics and Control of Industrial Effluent-generated Pollution."* Journal of Environmental Management and Health 6 (4):15-18.

[10] Tuner II, B.L., Clerk W.C., Kates R.W., Richards J.F., Mathews J.T. and Meyer W.B. (1990). "The *Earth as Transformed by Human Action*" Cambridge University Press. pp 14-15.

[11] Womach J. (2005), "*Water Supply and Sanitation in the United States*". Congressional Research Service Document. CWA Sections 301, 306 and 307.

[12] Zahoor Ahmad Bazai and Abdul Kabir Khan Achakzai, (2006). Effect of Wastewater from Quetta City on the Germination and Seedling Growth of Lettuce (*Lactuca sativa* L.). *Journal of Applied Sciences, 6: 380-382*

DOI: 10.3923/jas.2006.380.382

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