# Physiochemical Characterization Of Industrial Effluents: Case Study Of Beverage And Fibre-Cement Plants In Enugu, Nigeria

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**ABSTRACT:** This work focuses on the physiochemical analysis of fibre-cement and beverage effluents using standard APHA method and Atomic Absorption Spectrophotometry. Conductivity, biochemical oxygen demand(BOD),total hardness, pH, metal ion content etc. of the effluents were investigated. With respect to fibre-cement effluent,65mg/l,1578mg/l,2027mg/l and 11were recorded for BOD, dissolved solid, total solids, and pH, respectively. For beverage effluent,40 mg/l,45mg/l,108mg/l and 8.67 were recorded for BOD, dissolved solid, total solid and pH, respectively. Results indicate that the values of parameters for fibre-cement are relatively higher than that of beverage. Both effluents have different levels of pollution loads since some of the major indicators are above recommended standard limit.

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## INTRODUCTION

Most industrial plants in developing countries generate environmentally harmful effluents as a result of their operations. The release of large quantities of these untreated effluents to the surrounding lands and aqua systems upset the balance of the ecosystem(Mahananda *et al*,2010; Patil and Patil, 2010; Rajaran and Ashutost, 2008). A phenomenon that is dangerous to both biotic and abiotic systems. A number of metropolitan rivers in the developing world are the end points of the effluents from these industries (Phiri *et al*,2005; Ethan *et al*,2003). As a result, both boreholes and rivers around polluted areas supply unsafe water which is consumed by the population (Olayinka,2004; Menkiti and Nnaji,2006). The outcome is the intermittent outbreaks of water borne diseases among the population. Water supply in Nigeria is typical of water system in developing countries, a situation that calls to mind the quality of effluents from these companies.

Company A[Co.A] is a fibre-cement production plant located in the industrial estate of Enugu metropolis. Fibre-cement is commonly used in the construction of buildings. The products of the company include fibre-cement roofing sheets and ceiling boards. Fibre-cement is produced from four main raw materials: silica (sand), cement, cellulose paper and water. These materials are mixed together to create a slurry. This is then filtered and fed into a press roller where it produces a layer of fibre-cement ranging from 4mm to 15mm in thickness. The filtrate then flows out into a drainage that channels it into a nearby river.

Company B[Co.B], situated in the outskirts of Enugu metropolis produces various brands of soft drinks. The production process involves the use of large quantities of water, NaOH, detergent, syrup ,etc. The effluent from the company is channeled into the nearby Ajali river. The Ajali river incidentally is the major source of water for Enugu municipal water treatment plant.

The operations of these companies leave in their wake the discharge of waste effluents in nearby rivers(Okafor and Aneke,2006).The economic and environmental cost of these effluents when discharged untreated underscores the needs to evaluate the pollution loads of the effluents via physiochemical characterization(MBS,20000). The characterization was conducted on the effluents as received before it is discharged into rivers.

## EXPERIMENTAL

### Study area

Company A [Co.A] is located at Emene Industrial Layout, Enugu, while Company B[Co.B] is located at 9$^{th}$ mile corner, Ngwo,Enugu.

### Sample collection

Samples of effluents were collected from the effluent channels within the industrial plants. All samples were collected in thoroughly washed polyethylene bottles and tightly closed. Each bottle was rinsed with the effluent sample before the collection.

### Effluent analysis

The temperature was measured using calibrated mercury-in-glass thermometer (0 – 100$^0$C) to the nearest ±0.05$^0$C. HACH Ph meter was used for Ph measurement. Determination of biochemical oxygen demand (BOD), total dissolved solids, total suspended solids (TSS), $Cl^-$, $PO_4^{3-}$ , $SO_4^{2-}$ were carried out according to standard methods for the examination of water and wastewater(Ademoroti,1996;APHA1995).Unicam919 modelatomic absorption spectrophotometer was used for the determination of the following heavy metals: copper (Cu), iron (Fe), arsenic (As), chromium(Cr), cadmium (Cd) and manganese (Mn).

**Data analysis**

t-test tool was used to compare the means of the effluent quality of the industrial plants. Treatment means were separated using the least significant difference at P <0.05.

## RESULTS AND DISCUSSION

**Table 1: Physiochemical properties of effluents from the two industrial plants (mean values of parameters)**

| PARAMETER | CoA | CoB | WHO Limits |
|---|---|---|---|
| Color | $0.03^a \pm 0.01$ | $0.05^a \pm 0.01$ | NS |
| Ph | $1.1^a \pm 0.46$ | $8.67^a \pm 0.21$ | 6-9 |
| Conduc(µS/cm) | $40300^a \pm 571$ | $2000 \pm 200$ | NS |
| Temp(°C) | $2.9^a \pm 1.0$ | $29.7^b \pm 1.0$ | < 40°C |
| Odour | Odourless | Odourless | Odourless |
| Appearance | Pale yellow | Colourless | Clear and colourless |
| Alkalinity(mg/l) | $1350 \pm 2.0$ | $216^b \pm 58.6$ | NS |
| Total solid(mg/l) | $2027^a \pm 1.53$ | $108^b \pm 4.0$ | 2030 |
| Dissolved Solids(mg/l) | $1578^a \pm 2.0$ | $45^b \pm 2.0$ | 2000 |
| TSS (mg/l) | $449^a \pm 3.51$ | $68^b \pm 2.0$ | 30 |
| BOD(mg/l) | $65^a \pm 0.00$ | $40^b \pm 0.0$ | 30 |
| TH(mg/l) | $13652 \pm 6.28$ | $224 \pm 0.02$ | NA |

Key: Superscripts indicate significant difference between samples ($p < 0.05$)
NS: Not stated
TH: Total hardness

**Table 2 Mean values of mineral elements and heavy metals.**

| PARAMETER | CoA | CoB | WHO Limits(2010) |
|---|---|---|---|
| Ca (mg/l ) | 9418 ±0.2 | 200.4 ±0.20 | 200 |
| Magnesium (mg/l) | 4240 ±0.20 | 24.32± 0.02 | 200 |
| Copper (mg/l) | 0.10 ±0.00 | 0.20 ±0.02 | < 1 |
| Chloride (mg/l ) | 106 ±0.02 | 177±0.10 | 600 |
| Manganese (mg/l ) | 0.02±0.00 | 0.00±0.00 | 5 |
| Chromium (mg/l ) | 4.33±0.03 | 0.54±0.02 | < 1 |
| Sulphate (mg/l) | 951.20±0.20 | 951.20 ±1.0 | 500 |
| Cadmium (mg/l) | 0.05±0.01 | ND | <1 |
| Arsenic (mg/l) | ND | 3.4±0.20 | 0.1 |
| Iron (mg/l) | 36.3±0.02 | ND | 20 |
| Phosphate (mg/l) | ND | 470 ±53.70 | 5 |

Table I shows the values of the physicochemical parameters obtained from the effluents of the two industrial plants: Co.A and Co.B. Table 2 shows mean values of mineral elements and heavy metals for both industrial plants.

Co.A effluent contained higher values of colour (0.08 ± 0.01), pH (11 ± 0.46), conductivity (40300 ± 200 $Scm^{-1}$), alkalinity (1350 ± 2.0 mg/l), total solids (2027± 1.53 mg/l), dissolved solids (1578 ± 2.0 mg/l), suspended solids (449 ± 3.51 mg/l), biochemical oxygen demand (65 ± 0.00 mg/l), total hardness (13652 ± 6.28 mg/l), calcium (9418 ± 0.2000 mg/l), and chromium (4.33± 0.03ppm). On the other hand, the effluent from Co.B has higher values of phosphate (470 ± 53.70mg/l), arsenic (3.4 ± 0.20mg/l), chloride (177 + 0.10 mg/l) and copper (0.20 ± 0.02mg/l). Temperature and manganese have fairly close values for both Co.A and Co.B effluents.

The pH values varied between 11 ± 0.46 and 8.67 ± 0.21 for Co.A and Co.B,respectively as shown in table 1. The alkaline nature of the pH values could be attributed to the type of raw materials used in the processing of the products. Silica, cement, cellulose and water were the major materials for the formulation of fibre-cement products. NaOH as a component of washing agent, contributed to the alkaline nature of Co.B effluent. From the results of the independent samples test, it was observed that there was significant difference in the values of Ph of Co.A and that of Co.B. The Ph value of Co.A effluent was fairly higher than the WHO limits (6 – 9)(WHO,2010), whereas that of Co.B effluent was within the standard limit.

There were marked variations in values of the electrical conductivity, hardness, turbidity, and total dissolved solids of the two companies. The values of these parameters were higher in Co.A effluent. These parameters were within the standard limits except in the case of suspended solids where 449 ± 3.51 and 68±2.0 mg/l are recorded for Co.A and Co.B,respectively. The lower value of conductivity in the Co.B effluent may be due to the use of synthetic detergents in its operations and these could precipitate ionic species resulting in low conductivity. The higher conductivity in Co.A effluent could be attributed to the relatively low dissolved oxygen in it.

The principal ions causing hardness in natural water are calcium and magnesium. Others which may be present though in much smaller quantities, are iron, manganese, strontium and aluminium(Nsi,2007). The prevalence of some of these ions in the formulation of fibre-cement may be the cause of high concentration of hardness in Co.A effluent.

The total suspended solids (TSS) refers to the suspended insoluble materials occurring in surface or waste water, which makes them objectionable for almost all uses. TSS may be due to the presence of colloidal particles arising from discharges of sewage and industrial waste or to the presence of large number of micro organisms.

The levels of biochemical oxygen demand varied significantly (t=3.67, P< 0.05) between the effluents of Co.A and Co.B. Both BOD values lie above the limit, an indication of organic loads in the effluents as indicated by values of TSS,dissolved solids etc.(WHO,2010;FEPA,1991; Ethan *et al*,2003).

Temperature values for waste water samples are contained in table 1. There was significant difference (t= 3.67, p<0.05) in temperature variation between the effluents from Co. A and Co.B. Also the temperature levels as indicated in table 1 are below the limits(WHO,2010). Temperature value is important because at higher than the limit, the ability of water to solubilise and hold oxygen is reduced. In essence, biological equilibrium of aquatic system is disrupted if oxygen balance is not maintained(Ipinmrotu *et al*,2007).

Furthermore, for Co.A effluent, the mean levels of chloride, copper, manganese and cadmium were within limits whereas sulphate, magnesium, chromium and iron were above limits. For the Co.B effluent, mean concentrations of magnesium, copper, manganese and chromium were within limits but phosphate and arsenic were above the limits.

## CONCLUSION

It can be concluded that most of the parameters values for Co.A are relatively higher than that of Co.B and WHO limit. However,the effluent from both companies are risk to the human, animal and plant health.There is need to improve the quality of the effluents before being discharged to the environment.

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