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Comparative Study of the Effects of Environmental Pollution on Roofing Sheets: A Case Study

Awara, Biokpomabo Festus
(Rivers State University, Port Harcourt, Nigeria)
Engr. Prof. M. T. Lilly, Engr. Dr. Barinyima Nkoi
Corresponding Author; Awara, Biokpomabo Festus

ABSTRACT :*Environmental pollution from fossil fuel production is still a major problem in the Niger Delta area of Nigeria and the effects have not yet been fully ascertained. It implies therefore, that the solutions needed to curb these effects are yet to be unraveled. to bridge the knowledge gap.This dissertation seeks to comparatively analyse these effects on roofing sheets and consequently proffer solutions to it. Two communities were used as case study; KULA, an oil producing community in Rivers State and ABA, a non-oil producing community in Abia State. Samples of used roofing sheets were obtained from the study areas state and physio-chemical analysis was done employing the application of ASTM G4. Result obtainedshowed that on the average, the rates of corrosion was about 31% higher in KULA than ABA for the same material. Again, results from laboratory tests conducted were used to validate corrosion rates, indicating that the primary cause of the environmental pollution stems from acid rain. Also results from the parameters obtained in the laboratory analyses indicated along-life span and cost effectiveness for Aluminum roofing sheet. This is therefore recommended for use in Kula, Rivers State while, galvanized and Aluminum roofing sheets is recommended for use in any building.*

KEYWORDS: *Pollution, Corrosion, Metal loss, Weight loss.*

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I. INTRODUCTION

Roof is the principal equipment used to cover any building. The roofing sheet a building protects the building top. Animals, weather and rain, heat, wind and sunlight are also protected by it. The word also means the framing or structure which supports that covering. Roofing materials are affected namely by wind, sunlight, rain, hail, snow, atmospheric pollution, and temperature variations and consequently degrade over time.

The roofing sheets being made with different types are affected by human and environmental defective conditions. The roof sheets studied are Aluminum and Galvanized roofing sheets. The studied was carried out at Kula in Rivers State (Oil Producing Community) and Aba in Abia State (Non- Oil Producing City), Nigeria.

The study applied in the second section Corrosion rate, Metal and Weight Losses and Physio- chemical laboratory/ methods to determine the environmental effects of the roofing sheets. The third section discusses the results of the findings of the roofing sheets, and finally the conclusion is discussed in the fourth section.

The environmental and atmospheric adverse changes have drastically affected the life span and quality of roofing sheets in the Niger Delta Region of the Nigeria due to the Crude Oil exploration activities. Thus, the core aim of this work is to study and compare the effects of environmental pollution with a case study of areas where there are activities of oil exploration and the other in non-oil producing areas in Nigeria.

Corrosion rate, Metal and Weight losses and Physio- chemical laboratory/ methods will be used to compare the two selected roofing sheet types.

The main objectives of the study:

- To survey and study effects of environmental pollution on roofing sheets and to evaluate and compare the impact of environmental pollution on the roofing sheets in these two communities under study, Kula, in Rivers State and Aba, in Abia State.
- To perform Physio-Chemical laboratory analysis of the Rainwater for Colour, chloride, sulphide, temperature and pH levels, Total Dissolved Solids (TDS), Total Suspended Solids (TSS), black carbon soot particulates and corrosion deposit on the coupons in the communities under study. The results laboratory

tests will be used to validate whether the primary cause of the environmental pollution whether it stems from acid rain.

II. MATERIALS AND METHODS

MATLAB programme developed to calculate Corrosion rate and Metal loss

$$Corossion\ Rate\ (CR) = \frac{weight\ loss\ \times k}{alloy\ density\ \times exposed\ area \times exposure\ time}$$

$$Metal\ Loss\ (ML) = \frac{weight\ loss\ \times k}{alloy\ density\ \times exposed\ area}$$

where; Weight loss = grams (g), Alloy density = grams per cubic centimeter (g/m^3), Exposure time = hours (s.); and the constant "K" and unit of "Exposed area (m^2)

III. ANALYSIS AND RESULTS

The rates of corrosion for the roofing sheets in Kula and Aba as displayed commenced from the day 1 to the 28th day so that there could be marked differences in the various environments where the tests were conducted and shown in Table 1.

Table 1: Rates of corrosion of the Roofing Sheet as a Function of environment/ exposure time (days).

Material	Environment	Rates of corrosion (mpy)			
Days		7-day	14-day	21-day	28-day
Galvanized Steel	KULA	0.0997622	0.09382222	0.0648473857	0.039941145
	ABA	0.0044322	0.00400112	0.005932333	0.003364071
Aluminum	KULA	0.02876566	0.046565655	0.06232334	0.0323235
	ABA	0.00133677	0.00123345	0.00121876	0.00115564

3.1 Rates of Corrosion in Galvanized Steel

Plots of weight loss in Galvanized Steel in mg was made against the number of days which in this case is 28 days in order to ascertain whether or not there is any weight loss due to corrosion.

For KULA community, the corrosion rate was highest at the onset but started slowing down for reasons which could not be ascertained at the time of this research. Hence, requires further investigating. This is unlike the case of Aba community which had lower corrosion rate at the beginning but flattened out before the 28th day of commencing the investigation. See Figure 1

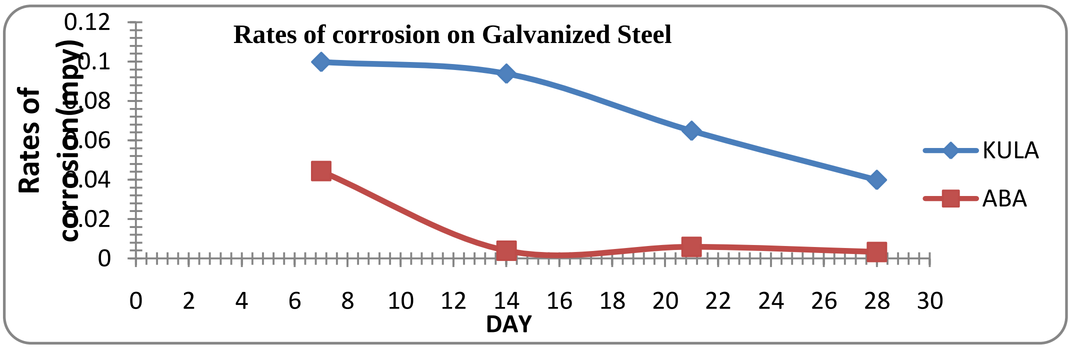

Figure 1: A Plot of Galvanized Steel Rates of Corrosion as a function of Environment/ Day

Rates of corrosion can be seen to be higher in KULA than in ABA for the same Galvanized steel deployed for same number of days. The rates of corrosion increased during the first and second weeks but by at the second week, it decreased due partly to passivation; increased in the 28th day. This increase is attributed due to the destruction of the protective oxide on the surface of the structure.

3.2 Rates of Corrosion in Aluminum Sheet

Plots of weight loss in Aluminum in mg was made against the number of days which in this case is 28 days in order to ascertain whether or not there is any weight loss due to corrosion.

For KULA community, the corrosion rate was least at the onset but got to the maximum on the 20th day for reasons which could not be ascertained at the time of this research. Hence, requires further investigating. This is unlike the case of Aba community which had lower corrosion rate at the beginning but flattened out before the 28th day of commencing the investigation. See Figure 2.

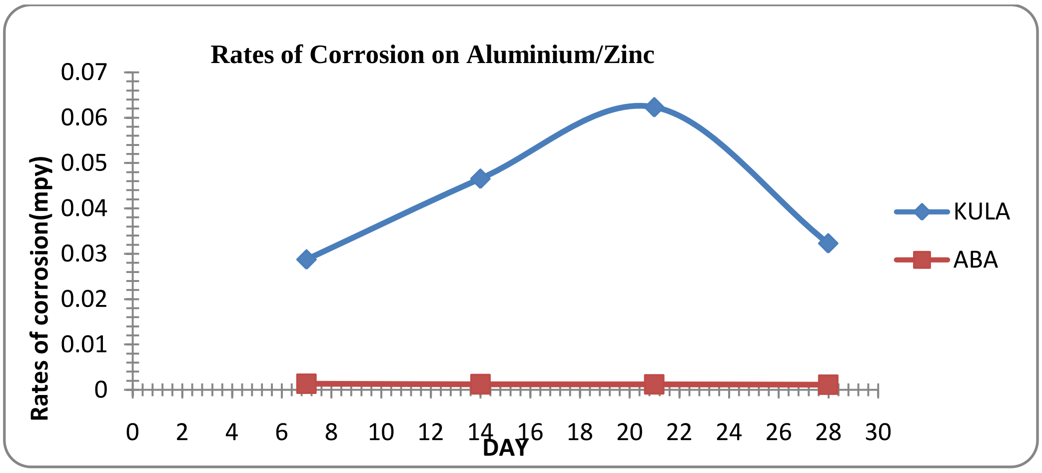

Figure 2: A Plot of Aluminum/Zinc rates of corrosion as a function of environment/ Day

From the figure displayed above, it can be seen that the aluminum/ Zinc alloy presented an initial slow corrosion rate, this increased steadily during the second and the third weeks but a sudden decrease in the corrosion rate was observed in the fourth week been 28th day. This behavior is perhaps due to the protective action of the corrosion oxide rain. Although, the material was deployed, a cursory looks at the graph shows clearly that KULA exhibit tendency which can be hypothetically stated that corrosion rate is high on Aluminum used in that area.

3.3 Physio--Chemical Analyses of Properties for Un-Intercepted (Atmospheric) and Intercepted (Zinc) Rainwater at Various Locations

The data below describes the environmental characteristics of ABA community in Abia State through the physio-chemical analysis of properties for the area. This data was harvested on different dates on site as a basis for analysis whether or not there is acid rain in the community.

3.3.1 Variation of Physio-chemical Properties of Rainwater at Various dates in ABA community in Abia State

The data below describes the environmental characteristics of KULA community (oil producing community) in Rivers State of Nigeria through the physio-chemical analysis of properties for the area. This data was harvested on different dates on site as a basis for analysis whether or not there is acid rain in the community. It takes into account the pH, Temperature, Salinity, Alkalinity etc. of the area.

3.4 Comparison Between the Physio- Chemical Characteristics of Kula and Aba Communities.

3.4.1 Variation of pH, Temperature and Turbidity in the Zinc

The comparison between the physio-chemical characteristics of Kula and Aba was analyzed and from Figure 3, can be seen the there is on the average high temperature in the KULA environ as compared to Aba. However, the pH of water in KULA is less than that tested for in ABA but the turbidity in KULA is higher than ABA on the average.

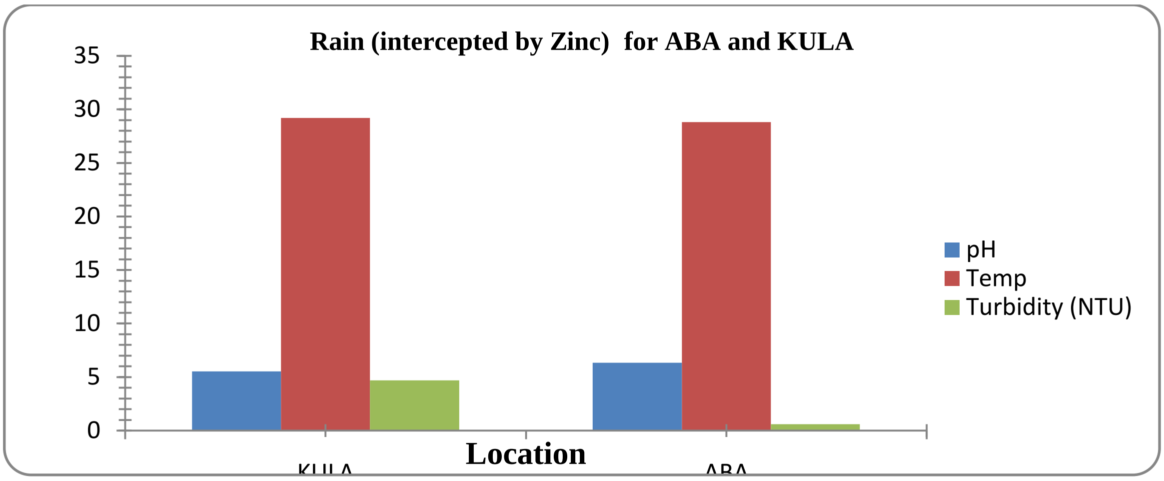

Figure 3: Plot of Rain variation intercepted by Zinc of pH,Temperature and Turbidity for KULA and ABA

3.4.2 Variation of pH, Temperature and Turbidity in the atmosphere (Rain)

It can be seen on the average that from the atmosphere in ABA and KULA without the interception of the roofing sheet (zinc), Figure 4 shows the pH for ABA is higher than that of KULA, the temperature variation for KULA is about 29.3 ^{c}o. higher than that of ABA which is about 28^{o}C and the Turbidity of KULA is relatively higher than that of ABA.

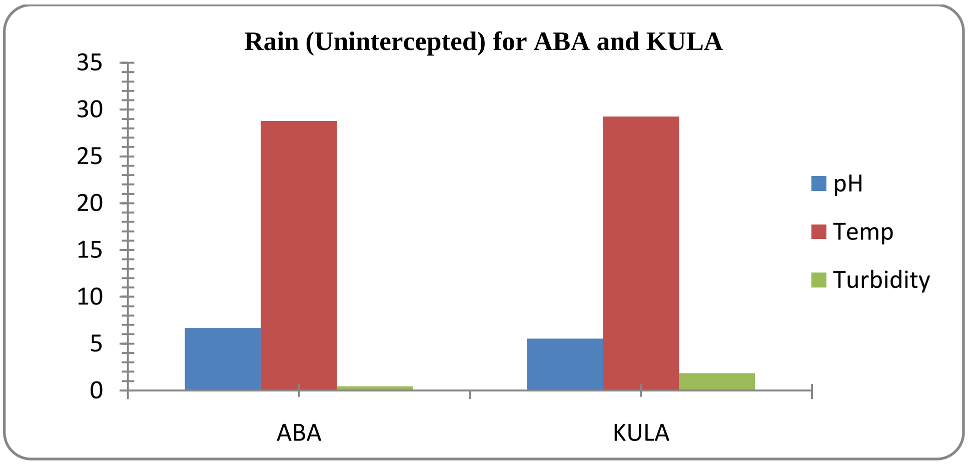

Figure 4: Plot of Rain (atmosphere) variation of pH,Temperature and Turbidity for KULA and ABA.

3.4.3 Variation of Electrical Conductivity, Salinity, Total Dissolved Solids and Total Hardness in the Zinc.

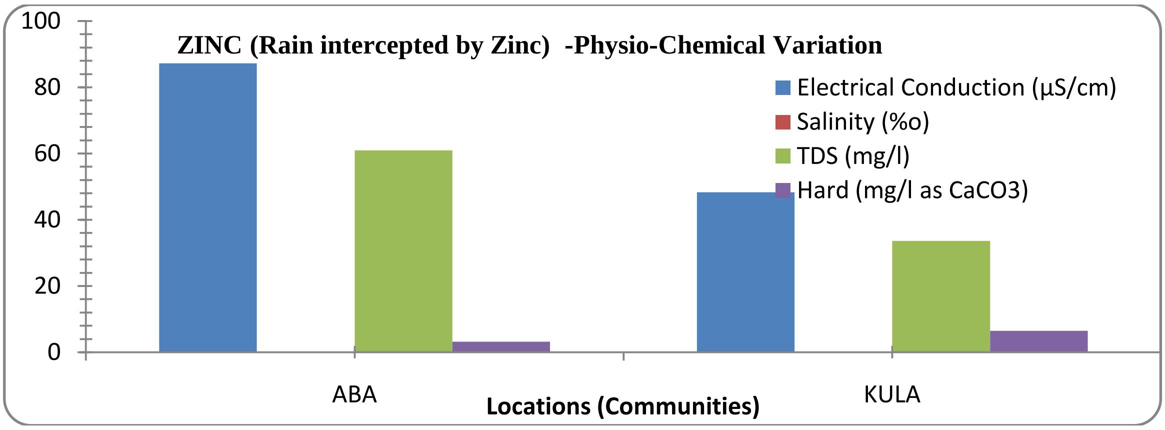

Figure 5: Plot of Zinc variation of EC,Salinity, Total Dissolved Solids, and Total Hardness for KULA and ABA

It can be seen on the average that from the atmosphere in ABA, the Electrical Conductivity, Salinity, Total dissolved solids and Hardness of the intercepted rain by the Zinc is relatively higher than in KULA.

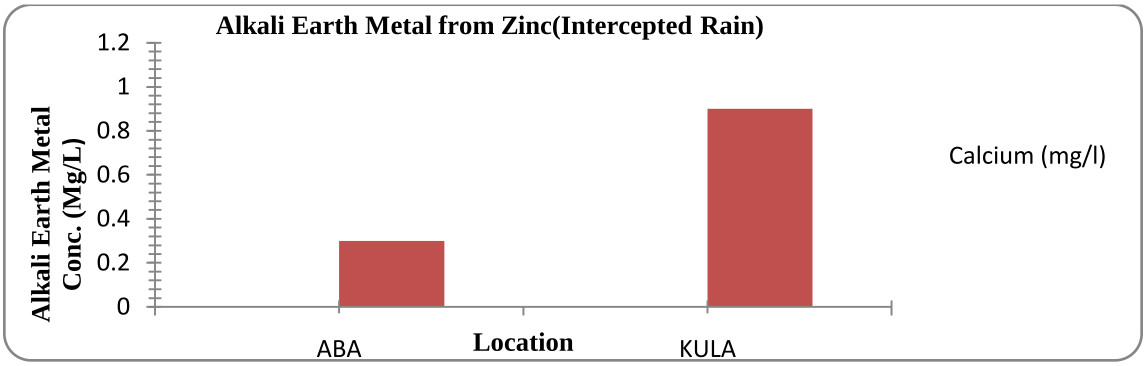

Figure 6: Comparison of Alkali Earth Metals Variation in Aba and Kula for Rain intercepted by Zinc

The figure 4.9 shows the variation of Alkali earth metals in Kula and Aba towns. As can be seen, the rate of Calcium and Magnesium in KULA town is relatively higher than that of ABA. This can be suggested to come from the Zinc – acid rain, because the rain in this case is been intercepted by the zinc. So, when the corrosive effects of the acid rain hit the zinc, it obviously would form a metal solution like the Calcium and Magnesium.

3.4.4 Variation of Alkali Earth Metal Concentration (Magnesium and Calcium) in Rain Intercepted by Zinc

Alkaline earth metal concentration from each of the communities was analyzed and plotted in the Figure 7. This is predominantly obtained from direct rain from the atmosphere.

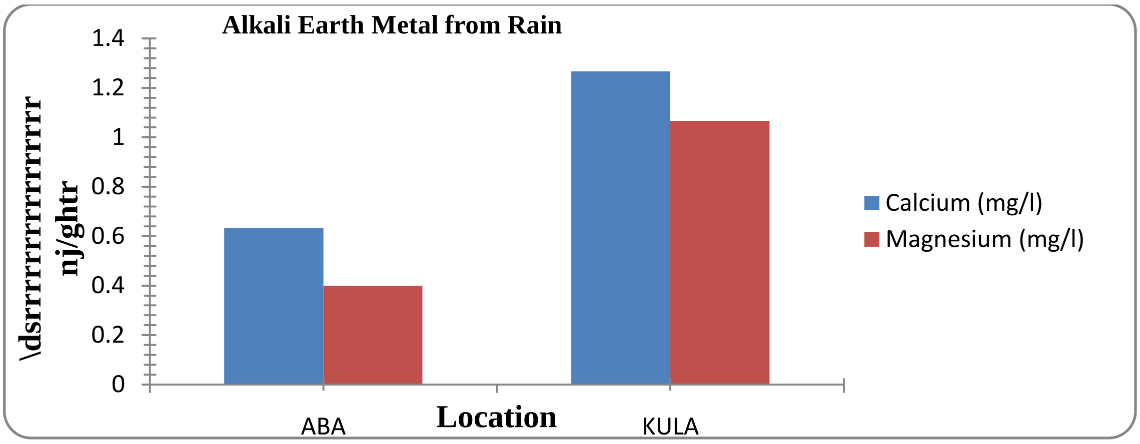

Figure 7: Comparison of Alkali Earth Metals Variation in Aba and Kula for Rain (Unintercepted)

Figure 7 shows the alkali earth metal from rain in KULA is relatively higher than those from ABA. This can be explain to mean that on the overall the Alkali earth metal is usually higher in areas where are oil exploration activities as compared to areas where there are no oil exploration.

3.5 Physical Examination Results

The physical examination results are given in Table 2 and all the observed features for each material and environments are given.

Table 2: Physical examinations of coupon in different environments.

Environment	Galvanized Steel	Aluminum Alloys
ABA	Wear of the surface, heavy rust Totally dissolved, localized pitting	Localized peeling of coating Dull surface

KULA	Total wear, increased localized pitting Weight loss with thick brownish deposits	Increased localized peeling of coating Roughness of the surface, Grey deposits

As can be seen in Table 2 above, the results of the physical examination of the coupons shows that there was wear and heavy of the galvanized steel surface in ABA community. This is followed by localized peeling of coating of the Aluminum alloys in Aba community.

Comparatively, there was total wear, increased localized pitting, weight loss and brownish deposit of the galvanized steel in KULA community. This was followed by increased localized peeling of coating, roughness of the surfaces and grey deposits of the Aluminum alloys.

IV. CONCLUSION

From the results of the analysis, laboratory tests and physical examinations, it can be seen that Galvanized steel, Aluminum alloys had higher rates of corrosion in KULA environment than in ABA environment. Aluminum alloys appear to be more corrosion resistant in all the environments investigated. The initial corrosion rate is also lower and steadily decreased with time. It could be inferred that the aluminum alloy provides a better corrosion resistance in this environment, followed by the aluminum/ zinc alloy.

The physical examination conducted for the various roofing sheets showed that corrosion was more severe in galvanized steel in KULA environment/ less in ABA.

Having conducted rainwater contamination and laboratory tests, rates of corrosion and weight loss analyses, this study concludes therefore that the rainwater in KULA is highly contaminated and unsafe for human consumption and that it is equally causing corrosion in roofing sheet in the area. This can be attributed to gas flaring in the area which is also a main cause of low crop yield.

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