Adverse Effects of Gas Flaring on Galvanized Roofing Sheets and Some Agricultural Crops at Mkpanak, Ibeno Local Government Area of AkwaIbom State

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ABSTRACT: Gas Flaring in the oil-rich Niger Delta Region of Nigeria continues to degrade the environment, affecting human, animal and plant lives. Even inanimate objects are affected. Increase in temperature of the atmosphere, greenhouse effect, acid rain/acidification of aquatic environment, poor agricultural yields and changes in the ecosystem etc. have been mentioned as some of the adverse effects. A field study was conducted to investigate the adverse effects of gas flaring on galvanized roofing sheets and some agricultural crops at Mkpanak, Ibeno Local Government Area of AkwaIbom State. Corrugated galvanized roofing sheet of length 243.84 cm and width 66.04 cm which has been exposed in use for one year and four months, was collected from the study area and cut to a size of 100 × 100 mm each using metal scissors. There was also general examination of some agricultural crops and farmlands in the area under study. The quantities of Zn, Fe, Mn, Na, Mg, Ca, Cr, Pb and Ni on the sheets were determined. The results were analyzed. There were significant differences between the exposed and unexposed surface (P = 0.05). The presence of Cu, Mn, Na, Pb and Ni on the exposed surface of the sheets were highly significant. These show that, deterioration of the surface coating had taken place with an exposure of base metals and partial oxidation of the base metals. The sample had burnt spots, these being evidence of deposition of very hot fly-ash on the sheet. Degradation of the sheet was obviously cause by high temperature at the outer surface. The inner surfaces of the sheet were not so affected. Erosion and corrosion around the burnt spots accelerated roof leakages as well as the likely pollution of rain water collected from the roof for domestic use. Some of the general effects of the gas flared as observed within Mkpanak include the stunted growth of cassava, plantain, palm trees, yams and other crops planted within the flare area. There was also peculiar coloration of leaves into brownish red. Destruction of natural vegetation, irritations of human eyes and bodies, vibration of buildings, contamination of soil and water bodies were also experienced. It is recommended that gas flaring should be immediately banned. The gases should be collected and put to use for powering electricity generation devices or liquefied and bottled for domestic and industrial purposes. The Environmental Law Enforcement Agencies, especially DPR (Department of Petroleum Resources), should be more involved in enforcing all existing environmental laws on gas flaring so as to ensure the well-being of the community.

Keywords: gas flaring, emissions, roofing sheets, some agricultural crops, community

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INTRODUCTION

Nigeria had an estimated 5.257 billionm^3 of proven natural gas, making it the ninth largest concentration in the world (Chijoke, 2002). Because of lack of gas collection, purification and utilization facilities in Nigeria, the country flares 73% of the gas it produces and reinvests only 12% to enhance oil recovery. The remaining 15% is used for some commercial purposes, mainly power generation (Julius, 2011a). A study by Abiodun (2004) found that Nigeria accounts for about 28% of the total amount of gas flared globally. This is not only wasteful of the country's natural resource; it also has adverse effects on humans, animals, plants and even inanimate objects.

This project was designed to investigate the adverse effects of gas flaring on galvanized roofing sheets and some agricultural crops at Mkpanak in Ibeno Local Government Area of AkwaIbom State. While these sheets are inanimate, the corrosive effect on them when exposed to gas flaring gives an indication of how serious the effects are on some human organs including the skin, eyes, ears, skull, lungs etc. Gas flaring leads to emission of carbon dioxide (CO_2), carbon monoxide (CO) and a variety of air pollutants, such as volatile organic compounds (which include carcinogen and air toxics) nitrogen oxides (NO_x), sulphur dioxide (SO_2), toxic heavy metals and black carbon soot (Kearns *et al*. 2000; Schwartz and White 1997). In addition to vehicular traffic emissions (CO_x, HC, NO_x, SO_2 and particulate matters), emission from gas flaring and venting systems in the oil-producing Niger Delta mainly contribute to atmospheric pollution in South-South geopolitical Zone of Nigeria (Ajao and Anuriwo 2002; Scheren*et al*. 2002).

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Products of gas flaring are the gases that are emitted during gas flaring due to complete and/or incomplete combustion of carbon compounds which are harmful to communities. These include: Carbon II oxide produced by incomplete combustion process of carbon compounds such as octane (C_8H_{18}) as shown in Equation 2 (Julius, 2011b);

$$2C_8H_{18} + 170_2 \rightarrow 16C0 + 18H_20 \text{……………………………………………(Eqn.1)}$$

Carbon II occurs naturally in the atmosphere but is higher in areas where gas is flared(Julius, 2011b). It isa poisonous gas and its presence in the air at high concentration causesdeath to human beings.Hydrogen suiphide is a poisonous gas with a repulsive smell like that of a rotten egg. Hydrogen sulphide in air often causes the change of colour of paints due to its reaction with a metallic pigment. The presence of substantial amounts of Sulphur dioxide in the atmosphere is one of the major causes of acid rain (Julius, 2011b). It is a poisonous gas with a very irritating smell like that of burning matches.Carbon dioxide gas, when released during gas flaring combines with rain water to form trioxocarbonate (iv) acid, which results in acid rain (Julius, 2011b). This acid rain causes corrosion of metals and roofing sheets amongst other things.Rapid corrosion of corrugated iron roofs (galvanized iron sheet) witnessed in the oil-producing communities in the Niger Delta have been linked to acid rain in some studies (Ekpoh and Obia 2010; Obia 2010; Nkwocha and Pat-Mbano 2010; Obia*et al*. 2011a and Obia*et al*. 2011b). Nitrogen dioxide is a reddish brown gas with an irritating smell and is poisonous.Soot is black particles formed during incomplete combustion, which takes place during gas flares and is accompanied by smoke. Smoke and soot have dark and tiny physical characteristic.The dark characteristic make them good absorbers of sunlight. In absorbing sunlight, layers of air are heated and radiated, thus increasing temperature around flaring surrounding.The tiny characteristic make them act as nuclei for cloud formation in the upper environment, resulting in acid rain.The emission of carbon (iv) oxide and carbon (ii) oxide, nitrogen (iv) oxide, nitrous oxide and hydrogen sulphide from gas flaring stations constitute what environmentalist call primary pollutants (Ademoroti, 1996).

Agoawike (1995) summarized that in oil producing areas in Delta State to Ogoni in Rivers State and Oguta in Imo State even at Mkpanak in Ibeno Local Government Area of AkwaIbom State, the story is the same. Farmlands are rendered useless, rivers depleted of aquatic lives and the air polluted by gas emissions.Ahiakwo (1995) opined that oil industry in Nigeria is the foundation of under-development in Ogba-land where cases of atmospheric, thermal and surface pollution abound. In the past decades, efforts have been multiplied in Nigeria to reduce gas flaring and eventually end the practice altogether. Most of the companies are also in the process of setting up power plants that utilize gas. With all these projects, both Nigerian Government and oil company officials expressed hope that gas flaring would end by 2011 (Oseji, 2011). But up till now, gas flaring has not been stopped. The specific objectives of this study were:

(1)to highlight some environmental effects emanating from the gas flared at Mkpanak gas plant, and,

(2) to determine the nature and level of effects of gas flaring at Mkpanak in Ibeno Local Government Area of AkwaIbom State on galvanized roofing sheets.

MATERIALS AND METHODS

Study Site:

Mkpanak is situated in Ibeno Local Government Area, AkwaIbom State, Nigeria, its geographical coordinates are 4^{o} 34′ 07″North 7^{o} 58′ 35′′East / 4.568693′North 7.976396″ East.

Samples, Location from Gas Flaring Facility and Sampling Techniques

The three gas flaring facilities within the community were less than 3km from the location where the test samples of galvanized roofing sheet was taken. It is continuous flaring and been so for over 20 years. Corrugated sample of galvanized roofing sheet of length 243.84 cm and width 66.04 cm which has been exposed in used for one year and four months was collected from the study area. The over lapped, unexposed portion of the sheet was identified and also cut into sizes. Both the exposed and unexposed samples were visually examined. The sample was cut to a size of 100 × 100 mm each using metal scissors.The labelled samples were latter cut into small pieces using scissors. The samples both exposed and unexposed were labelled and the surfaces exposed to the weather elements were identified. The samples were taken to the Hegada Scientific Services Limited Ibadan, Oyo State, Nigeria for analyses. The milled samples were digested using method as described byWilliam and George, (2005)and the digests were analyzed using Atomic Absorption Spectrophotometer (AAS).

Visual observations were made of the vegetation in the area to assess the effects of the environment on the health of the plants.

MKPANAK GAS FLARING PLANTS

RESULTS AND DISCUSSION

Elemental composition of exposed and unexposed samples

Figures 4.1 and 4.2 show the elemental compositions of exposed and unexposed samples.Tables 4.1 and 4.2 show the result of analysis of elemental composition of exposed and unexposed Samples (minor and major element).There were significant differences between the exposed and unexposed samples ($P = 0.05$). Cu, Mn, Na, Pb and Ni were highly significant at ($P = 0.05$). This indicates that deterioration of the surface coating had taken place with an exposure of the base metal and partial oxidation of the base metals. Gas flaring accelerates the corrosion of galvanized roofing sheet when heavy mist and dews occur in the area. They are contaminated with considerable amounts of acidic substances and the film of moisture covering the metal can be quite acidic and can have a pH as low as 3. Under these conditions the zinc is dissolved but as the corrosion precedes the pH rises and when it has reached a sufficiently high level basic salts are once more formed and provide further protection for the metal. As soon as the pH of the moisture film falls again, owing to the solution of acidic gases, the protective film dissolves and renewed attack on the metal occurs. Nkwocha, (2010) reported that corrosive effects of these acidic gases on roofing materials and metallic objects appeared greater during the months of lighter rains. During this period, the scanty rain droplets and high concentrations of SO_2 and NO_2 with an average pH value of 4.9, all combined to form acidic solutions which acted as corrosive agents, exerting high oxidative stress on the metallic surface of buildings especially on roof tops (Bhatia 2009, Lowton1997, Jones 1996). (Ovri and Iroh 2013) also reported that corrosion is minimal in pure air of less than 100% relative humidity but in the presence of minute concentrations of impurities, such as sulphur dioxide, serious corrosion can occur with visible precipitation of moisture once the relative humidity of the air rises above a critical and comparative low value. Although humidity plays a vital part, the impurities in the air are decisive in determining the rate of corrosion in atmosphere of the requisite humidity of which in their absence corrosion is not serious even in highly humid air. Obia and Obot (2010) also reported that galvanized iron roofing sheets corrosion in Niger Delta is due to a combination of atmospheric climate and pollutant factors; rainfall and aerosol.

Some of the general effects of the gas flared as observed within Mkpanak include the stunted growth of cassava, plantain, palm trees, yams and other crops planted within the flare area. There was also peculiar coloration of leaves into brownish red. Destruction of natural vegetation, irritations of human eyes and bodies, and the vibration of buildings(usually experienced is possibly due to increased air flow as air is heated) contamination of soil and water bodies were also experienced.

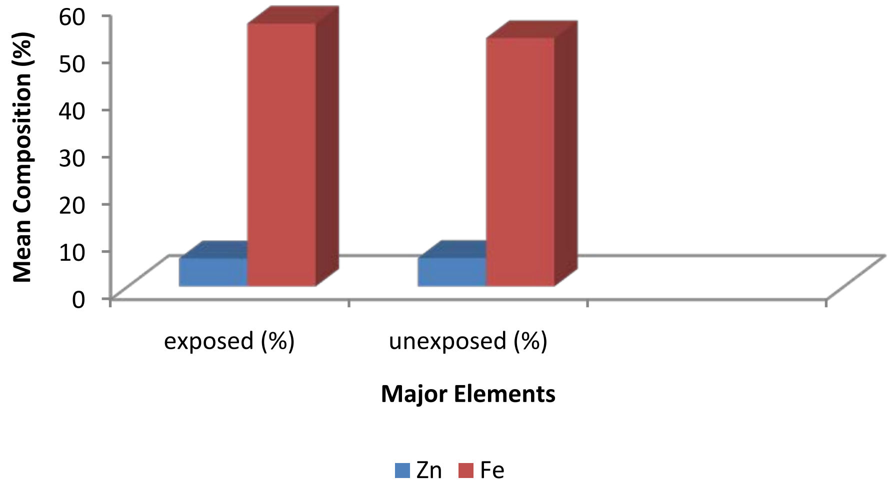

Figure 4.1: Surface Elemental Composition of Exposed and Unexposed Samples (Major Element)

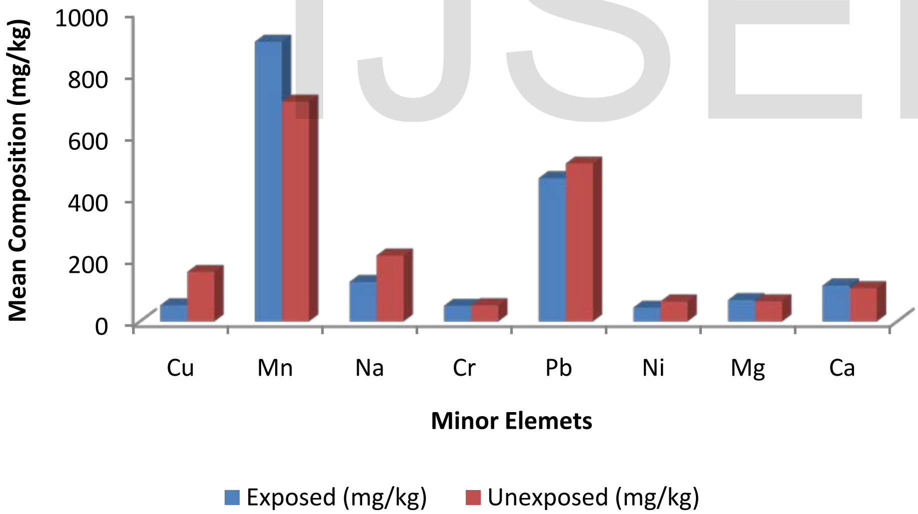

Figure 4.2: Surface Elemental Composition of Exposed and Unexposed Samples (Minor Elements).

Table 4.1: T-Test Analysis of Surface Elemental Composition of Exposed and Unexposed Samples (Major Elements).

Element	Exposed (%)	Unexposed (%)
Zn	5.9 ± 0.02	6.0 ± 0.01
Fe	55.6 ± 0.71	52.5 ± 0.92

Table 4.2: T-Test Analysis of Surface Elemental Composition of Exposed and Unexposed Samples (Minor Element)

Element	Exposed (mg/kg)	Unexposed (mg/kg)

Cu	52.0* ± 1.41	160.5* ± 0.71
Mn	903.0* ± 4.24	709.0* ± 2.83
Na	127.5* ± 0.71	213.0* ± 2.83
Cr	50.5 ± 2.12	52.5 ± 2.12
Pb	463.5* ± 3.54	509.0* ± 4.24
Ni	44.5* ± 2.12	64.5* ± 2.12
Mg	69.0 ± 1.41	65.0 ± 1.41
Ca	116.0 ± 1.41	107.5 ± 2.12

1. Values are means and standard deviation.
2. Means in the same row without asterisks are not significantly different at p = 0.05.

CONCLUSIONS

Results from this study revealed that degradation of the sheet was cause by high temperature at the outer surface. Erosion and corrosion around the burnt spots accelerated roof leakages as well as possible pollution of rain water collected from the roof for domestic use. Gas flaring accelerates the corrosion of galvanized roofing sheet when heavy mist and dews occur in the area. They are contaminated with considerable amounts of acidic substances and the film of moisture covering the metal can be quite acidic and can have a pH as low as 3. Under these conditions the zinc is dissolved but as the corrosion precedes the pH rises and when it has reached a sufficiently high level basic salts are once more formed and provides further protection for the metal. As soon as the pH of the moisture film falls again, owing to the solution of acid gases, the protective film dissolves and renewed attack on the metal occurs.It is recommended that gas flaring should be immediately banned. The gases should be collected and put to use for powering power generation devices or liquefied and bottled for domestic and industrial purposes. The Environmental Law Enforcement Agencies, especially DPR (Department of Petroleum Resources), should be more involved in enforcing all existing environmental laws on gas flaring so as to ensure the well-being of the community.

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