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Evaluation of Gas Emissions from Crude oil Polluted Areas and Petroleum Incineration site.

Anunobi, C. N[1], Boisa. N[1], Akinfolarin, O.M[1], Gogonte, E. E[1]

[1]Department of Chemistry, Rivers State University, Port Harcourt, Nigeria

Email address:chinazoanunobi@gmail.com

ABSTRACT

This study accounts for the concentrations of gases emitted at some oil spill locations in Rivers State and incineration of selected petroleum products using fly ash sample incinerator. Aeroqual gas analyzer series 500, was used to determine the concentrations of Carbon dioxide (CO_2) and volatile organic compounds (VOCs) emitted. The concentrations of emitted. Mean concentrations of CO_2 were recorded on oil field emissions are 1098 µg/m^3 and 992 µg/m^3 for Okenta and Orkpor communities respectively. Volatile organic compounds (VOCs) levels were high in oil spill location, Orkpo (13581 µg/m^3) compared to some incinerated materials such as Asphalt (43.03 µg/m^3). SO_2 and NH_3 were insignificant in both oil spill areas and at the burning sites; they were mostly not detected at various locations during this study. Coefficient of variation in percentage (CV %) was determined from the standard deviation and calculated mean values, to know the level of variation in concentration of the measured gases. Statistical analysis was done for both the oil spill gas concentration and the selected Petroleum Products burnt. T-test on two samples assuming equal variances was carried out for the Petroleum Products, and it was observed that there were no significant difference between the Petroleum Products, hence, we fail to reject the null hypothesis. Univariate analysis was conducted in SPSS (Statistical Package for the Social Sciences), to compare the relationship between the concentrations of the gases for all the selected Petroleum products analyzed and that for oil spill locations. Levene's test was carried out for the gases in each petroleum products, and the assumptions met (P>0.05). This study suggests that anthropogenic activities such as burning of petroleum products and oil spill, are responsible for the observed level of gases released into the atmosphere.

Keywords: **Petroleum Products; Refined Diesel; Artisanal Diesel; Oil Spill Communities**

Introduction

One of the significant worrisome environmental problems that has addlepated not only the developed countries but have also affected the developing countries of the world today is air pollution which has in recent past, had caused an increase in death rates.(Pope *et al*.(2002) ; Laden *et al*.(2000). Atmospheric pollution is a process in which some substances, which include gases (for example methane, sulphur dioxide, nitrogen oxides, and carbon monoxides) hydrocarbons, particulate matters (such as dust, smoke, aerosols and fumes), radioactive materials and a lot of others are released in such concentrations that may cause some unpleasant effects on man and environment (Rai *et al*. (2011). Exposure of humans to air pollutants cannot be avoided in today's standpoint, mostly in the urban areas. Air pollution could come from natural sources, however a major anthropogenic source of air pollution is as a result of man's pursuit for a better standard of living and industrialization,

urbanization and hence, results to excessive air pollution. The amount of air pollutant does not only depend on the quantities emitted from air pollutants sources, but it is also dependent on the absorption capacity of the atmosphere and its ability to spread these emissions.(Sengupta, 2003).Gases are one of the significant air pollutant released into the atmosphere, due to human activities. An example of human activities that could cause the release of gases into the atmosphere is the burning of petroleum products.

When petroleum products are burned, a lot of substances are released into the atmosphere, and these substances emitted contaminate the air and pollute the environment. A vast number of the toxic air pollutants, to which we are exposed to are known to be combustion-related (Kinney *et al*. (2002); Lim, (2002); SCAQMD, 2000; Manchester *et al*. (2003). Gas emission go hand in hand with combustion. Combustion is defined as the reaction between a fuel and oxidant followed by the release of heat:

Fuel + Oxidant → Products + Heat

Gas emission is therefore defined as the process whereby different gases are released into the atmosphere, over a specified area and a period of time, as a result of human activities. Gas emission play a major role in high mortality rate annually. (Lee *et al*. (2008), and it leads to atmospheric pollution. Due to anthropogenic activities such as burning of fuel for heat, chemical reactions, leaks from industries and the transfer of other harmful substances into the atmosphere pollution which is detrimental to human health, living organisms and our environment at large. (Khoder, 2002).

This study aims at evaluating gaseous emissions from selected petroleum products through incineration and oil spill areas, and to seek to find the extent to which the concentration of these gaseous pollutants are released in air and also suggest ways in which they can mitigated.

This research will therefore determine the concentration of gases such as CO_2 and VOCs emitted during the burning of selected petroleum products e.g. refined diesel, asphalt and crude oil. In addition, the study shall determine and compare the concentration of gases present in oil spill locations with those obtained from incinerated petroleum products.

MATERIALS AND METHODS

Sampling Procedures:Sampling was carried out for a period of one month. Samples were randomly collected for a period of one month at different locations in Rivers State (Obio/akpor LGA and Phalga LGA).10L Plastic Jerry can were used to collect the petroleum product samples and stored under cool condition in the laboratory. The refined diesel, artisanal diesel, spent oil, asphalt, tyres and crude oil for the burning were obtained from Elekahia area and Trans-amadi of Port Harcourt City and Obio/Akpor LGA of Rivers State Nigeria respectively.

Study area Description, Site location for oil spill

The gas emissions analysis from incinerated petroleum products was carried out from August to September, 2021 beside chemistry department in Rivers State University. The area is described as a flat lowland and grass land, with no visible trees around its environment, but surrounded by structured facilities, classrooms and laboratories.

The Aeroqual Portable Monitor Series 500

The Aeroqual Portable Monitor Series 500 is mostly used in scientific research for diverse applications. The monitor's base allows for the user to employ one out of numerous sensor heads, each designed to measure different gaseous concentrations separately. (Lin *et al*.(2015); MacDonald *et al*.(2014).The gas analyzer was used to detect the concentration of carbon dioxide (CO_2),and volatile organic compounds (VOCs) present, according to the procedure used in Ibe *et al*.(2020).The Aeroqual air quality gas analyzer series 500 was also used to determine concentrations of CO_2 and VOCs at the oil spill locations. The analysis with the Aeroqual air quality gas analyzer was done from September to November, 2021 at the communities in Ogoni; Wiiyaakara and Kpean Communities (Khana LGA),Okenta and Alode (Eleme LGA),Orkpo and Korokoro (Tai LGA),Bodo and Mogho (Gokana LGA).

RESULTS AND DISCUSSION

The result on figure 4 showed the different concentration levels of CO_2 emitted from oil spill locations, and from Petroleum Products incineration site. From the result, the concentrations of CO_2 in refined diesel (3868 µg/m^3), artisanal diesel (3211 µg/m^3), asphalt (3088 µg/m^3), spent oil (3952 µg/m^3), crude oil (3949 µg/m^3) and tyre (3947 µg/m^3).

For the oil spill areas, the mean concentration of CO_2 were; Bodo community (1027µg/m^3), Mogho CO_2 (1039 µg/m^3), Okenta CO_2 (1098 µg/m^3).Alode, Orkpo, Korokoro , Wiiyaakara and Kpean communities had a CO_2 concentration levels of 1016 µg/m^3,992 µg/m^3,1095 µg/m^3,1004 µg/m^3 and 1033 µg/m^3 respectively.

There was high emission of CO_2 during the incineration of Petroleum products than the emission of CO_2 in oil spill sites. The CO_2 concentration was high during burning, probably because CO_2 is the main product of combustion

$(2CH_4 + 4O_2 \rightarrow 2CO_2 + 4H_2O)$.

Meanwhile, CO_2 emitted had lower concentration at oil spill locations, it could be as a result of an absence of combustion within the oil spill vicinity. The range (992-1095 µg/m^3) of CO_2 in oil spill site shows consistency in the emission and may be attributed to a common factor of heat from the sun's degradation and evaporation of chemical species.

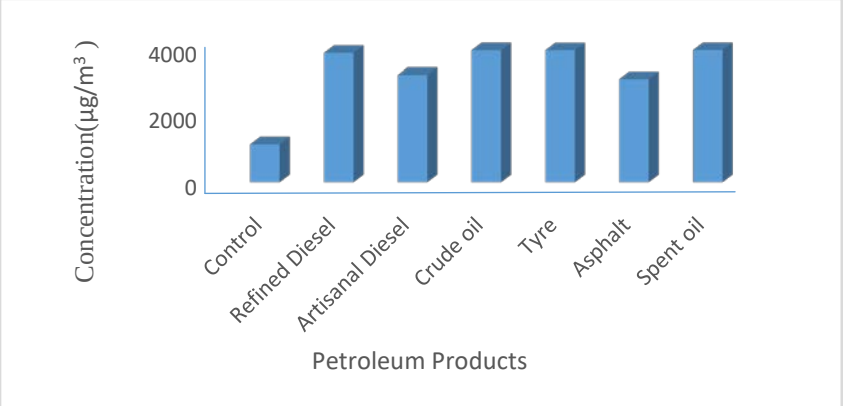

Figure 1(a): Gas analysis results of carbon dioxide (CO_2) at Petroleum Products Incineration Site

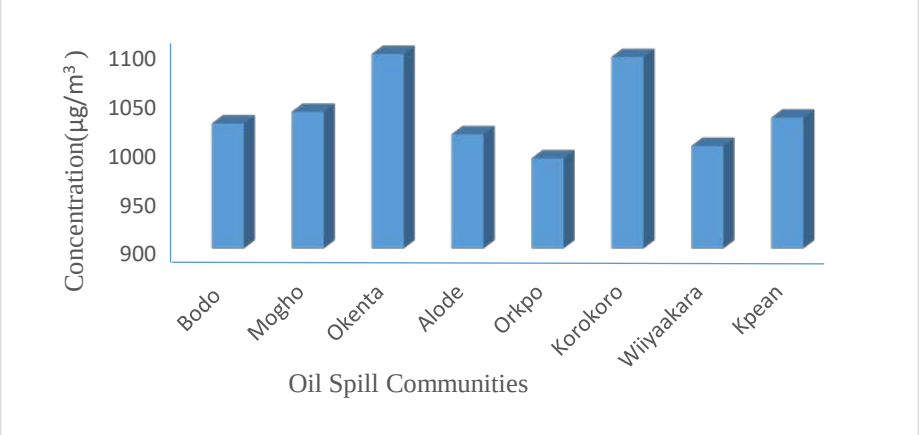

Figure 1(b): Gas analysis results of carbon dioxide (CO_2) at oil spill areas

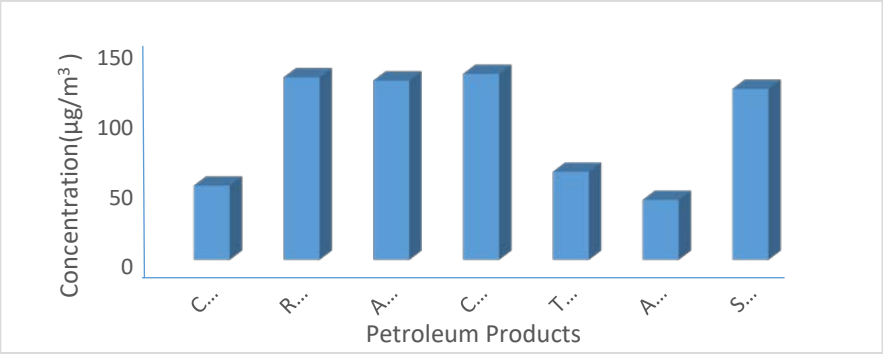

Figure 2(a): Gas analysis result of VOCs from Petroleum Products Incineration Site

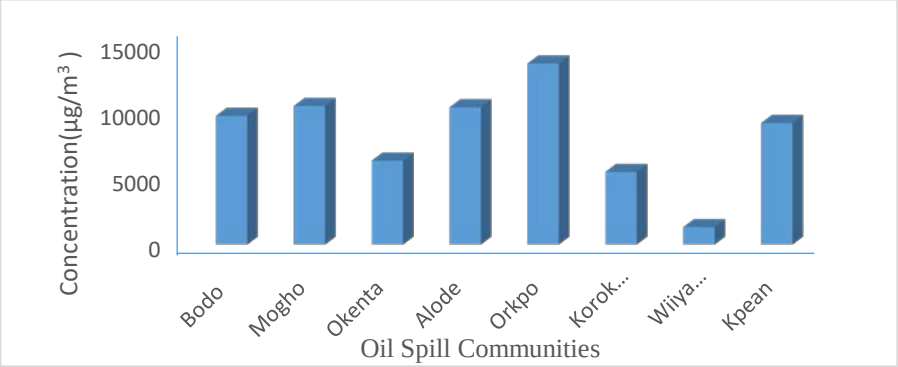

Figure 2(b): Gas analysis result of VOCs at Oil Spill Locations.

The result of gas analysis carried out at Mogho community (N 007^0 $16^{'}$ $37.9^{"}$ and E 04^0 $31^{'}$ $02.9^{"}$), in Gokana LGA in Ogoni, Rivers state had varying concentrations. The mean concentration for O_3 was 0.78 µg/m^3, it might be as a result low levels of photochemical oxides. CO had the lowest concentration after ozone, its concentration was 0.98 µg/m^3, and it was probably due to incomplete combustion. The average value of CO_2 was 1039 µg/m^3, which was not as high as the VOCs; probably the absorption level of CO_2 was high due to the presence of trees and vegetation, which led to high absorption of CO_2 and low emission of carbon dioxide. H_2S, NH_3 and SO_2 were not detected, they read zero; theoretically ozone formation is highly dependent on some factors such as solar radiation and temperature. Volatile organic compounds had a concentration value of 10,383 µg/m^3, which was high when compared to other gases emitted; it could be due to petroleum products contain high levels of VOCs, when exposed to an open air, it readily escapes into an open air, which could result to high emission of VOCs into the surrounding air. NO_2 had a mean value of 0.103 µg/m^3, which could be due to low level of photochemical oxidants. The variations in concentration of the gases fall under little variation since their CV% were less than twenty percent (CV %< 20).

Statistical analysis

Statistical analysis for the study was done for the selected petroleum products, to compare the concentration of the gases. Statistical analysis of data acquired from the burning of the petroleum products was done using t-test of two samples assuming equal variances.

The t-test helped to understand if there was were significance difference between the analytes of interest, also if the null hypothesis should be retained or rejected .The t-test on two samples assuming equal variances were done between the mean concentration values of the gases for two different petroleum products burnt, to determine if there were significant difference between them.

For the t-test analysis between of the mean values of refined diesel and artisanal diesel, it was observed that the P-value which was 0.445723 was greater than alpha ($P>0.05$), therefore we fail to reject the null hypothesis, that the refined diesel do not emit the same level of gaseous air pollutants as the artisanal diesel during burning. Also that there is no relationship between the refined diesel and the artisanal diesel. ($P>0.05$).

Co-efficient of variation (CV %) was used to determine the variation in concentration of the gaseous pollutants analyzed. Variation was categorized as little variation (CV% < 20), moderate variation (CV% 20 – 50) and high variation (CV% > 50). The results of the gas analysis showed little variation in concentration of the gaseous air pollutants, since all had their CV% < 20.

Univariate analysis was conducted in SPSS, to compare the relationship between the concentration of the gases for each of the selected Petroleum products analyzed and oil spill locations. Levene's test was carried out for the gases in each petroleum products, and the assumptions met ($P>0.05$). Results for the descriptive statistics showed that was a significant difference in mean concentration of the gases for all the gases in each of the selected petroleum products incinerated and the oil spill communities. Artisanal diesel $F(9, 17) = 0.950$, $P=0.510$.

Conclusion

This study found that Carbon dioxide produced from Petroleum Products incineration were higher than CO_2 at oil spill emissions. Carbon monoxide released during burning were slightly higher than CO released in oil spill , however its concentration could cause less negative effects on humans and the environment ,since the concentration observed during the gas analysis was less than the limit of 9ppm specified by US EPA NAAQS . The level of ozone concentration emitted was less than the 0.070ppm limit of the US NAAQS (National Ambient Air Quality Standard). Volatile organic compounds (VOCs) emissions were found to be extensive from oil spills, but the levels were lower in burning of petroleum products. During burning prevailing in petroleum products incineration, SO_2 and

NH_3 were not at a quantifiable level during burning and consequently not detected, hence their toxicological effect to humans and the environment could be minimal.

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