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Critical Evaluation of Effects of Gas Flaring On The Environment (A Case Study Of Niger Delta, Nigeria)

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Abstract

In order to critically evaluate the effect of gas flaring on the environment using Niger Delta as a case study, the following parameters were collected from the location of study. These includes: Air, Water Sample, and Soil Sample. For the purpose of analysis, the samples were tested for the following, for water quality the physicochemical properties were tested and for soil sample, soil temperature, heavy metals contents and total hydrocarbon were also tested. For air quality and climatic condition, carbon monoxide, sulphur dioxide, nitric oxide and soot particles, air temperature, relative and absolute humidity, wind speed and direction were all tested. Analysis on these samples revealed that the soil, water, some other hydrocarbons within the flare source and the air quality are within the limit of the Federal Ministry of Environment (FMENV), the Department of Petroleum Resources (DPR) and the World Health Organization Standard. From the graphical interpretation, it is pertinent to note that the thermal energy is high in the soil around the flare source, that is at zero meter depth and the temperature decrease as one dug down vertically into the soil. My analysis is in consonant with the work earlier done by Oyenkunle (1991) that crop planted 600m away from flare source suffered 100% lost compared to crop planted 1000 metre away from the flare source which suffered only 10% lost. This confirmed that around the flare source there are high levels of thermal energy. My assertion tallies with IKelegbe (1993) observation that free disposal of gas through flared generate tremendous amount of heat which is felt over an average radius of 0.5km thereby causing thermal pollution. It is therefore my submission that the poor nature of plant growth in the region of flaring region is characterized by the toxic and harmful effect of gas flaring on the environment.

Keywords:- Gas Flaring

Introduction

Gas flaring on the environment has long being credited to oil production activities which has negative impact on the environment. Gas flaring can be defined as the disposal of gas into the atmosphere by burning of fossil fuel in the oil field and refineries when no other use could be made of such gas at that particular time. The environment literally means the surrounding. The environment is the aggregate of atmosphere, Biosphere, hydrosphere and lithosphere and sets of condition which directly or indirectly influence not only the life of organisms but also the communities at a particular place. According to **TRESHOW (1970)** he defined environment as "environment includes all factors and forces prevailing internally and externally or around and in the plants and animals" it includes all light, moisture, wind, temperature, soil, organism pollutants, insecticides, pesticides, Radioisotopes and man.

Total environment extend from the microcosm within every cell to the cosmos of the atmosphere and universe. Usually, it's viewed as the effect of high intensity and temperature on the environment which causes various degrees of pollution because of the resultant variation in air chemistry of the atmosphere, biological and soil condition in the immediate environment of region. Flared gases are components of non-condensable as well as a mist of entrained liquid whose heavy hydrocarbon and heavy metal contents are to get burnt along with the light hydrocarbons with varying degrees of complete combustion.

Flared gas causes serious effect on the environment and man which ranges from damage to materials, building, deteriorated soil and affect vegetation and living organism.

Most of these gases are flared due to lack of commercial outlet. Drilling companies routinely flared or vent these gases for safety reasons or where no infrastructure exists to bring it to market. The above situation permits the

practice to separate the associate gas from the oil by mechanical agitation at flow station nearer to the well head and after the extraction, some of the natural gas liquid from the gas, the remaining portion was/are wastefully disposed through flaring. During gas flaring, the hydrocarbon molecules are continually broken down into minute sizes and this minute sizes or particle combine with oxygen to form carbon monoxide as illustrated in equation 1.1. in excess supply of oxygen, the carbon monoxide react to form carbon (iv) oxide, if the supply of oxygen is inadequate the carbon (iv) oxide will then accumulate resulting in the formation of soot particle.

Environmental contamination of air, water, soil and food has becomes a threat to continue existence of many plants and animal communities of ecosystem and ultimately threaten the very survival of human. Gas being flared into the environment is one of such indiscriminate discharge. The gases flared undergo combustion reaction to form acidic gas such as nitrogen oxide (No_x), sulphur oxide (So_x) and carbon oxides (Co_x) depending on the impurities on the location.

$C_xH_y + (x+ y/4)+ O_2 < > X\ Cox_2+ y/2\ H_2o$ ---------- (1.1)

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Table 1: Gas Flared At Region 2009

Mouth	**Volume of gas flared (m^3/s)**
January	30,253
February	28,000
March	26,645
April	20,016
May	21,000
June	18,246

July	18,260
August	16,400
September	18,645
October	19300
November	21,000

Source: Data supply by oil firm in Niger Delta

Table 2.2: Gas Flared At Region For 2010

Mouth	**Volume of gas flared (m^3/s)**
January	18,003
February	17,260
March	16,360
April	18,246
May	16,460
June	14,360
July	13,450
August	10,045
September	11,656
October	14,645
November	14,345

Source: Data supply by oil firm in Niger Delta

Table 2.3: Gas Flared At Region For 2011

Mouth	**Volume of gas flared (m^3/s)**
January	16,345
February	18,645
March	13,040
April	12,40
May	14,200

Source: Data supply by oil firm in Niger Delta

Table 2.4: Volume Of Gas Flared By Individual Country Of The Word (%)

Country	**Flared Gas**	**Share of World Total**
Algeria	6.80	6
Angola	4.30	4
China	3.20	3

Egypt	0.90	1
Indonesia	4.50	4
Iraq	10.50	10
Nigeria	16.20	16
Mexico	5.60	5
North Sea	2.70	3
Russia	11.50	11
Venezuela	4.50	4
USA	2.80	3
Other countries	33.0	30
World	**107.5**	**100**

Source: NGC

Table 2.5: Who Standard For Desirable and Permissible Pollutant Level

Parameter Permissible (Units)	**Height Desirable**	**Highest**
pH	7.85	6.5-9
Totl solid (PPm)	500	1500
Pb (PPm)	0.05	0.1
Oil (PPm)	0.01	-
C/(PPm)	200	600
SO_2 (PPm)	200	400
Cm (Mg/L)	0.5	1.5
Fe (PPm)	0.1	1.0
Mn (PPm)	0.05	0.5
Zn	5	15.0

Source: International Operation Handbook for Measurement of Background Atmospheric Pollution (WHO)

Table 2.6:DPR Effluent Limitation

Parameter (Units)	**Inland**	**Near Shore**
pH	6.5-8.5	6.5-85
Temperature (°C)	35	40
Fe (PPm)	1.0	-
C.(PPm)	600	2.000
Zn (PPm)	1.0	-
Pb (PPm)	0.05	-

Source: Environmental Guidelines and Standard for the Industry.

Table 2.7: Nigerian Ambient Air Quality Standard (Fmenv)

POLLUTANTS	TIME OF AVERAGE	LIMIT
Soot Particles	Daily average of daily values one hour	250,mg/m^3
Sulphur Oxide	Daily average of hourly value one hour	0.001 ppm (26mg/m^3) 0.1 ppm (260mg/m^3)
Carbon Monoxide	Daily average hourly 8-hourly average	10 ppm (11.4mg/m^3) 20 ppm (22.6mg/m^3)
Nitrogen Oxide	Daily average of hourly values	0.04-0.06ppm (75-113,mg/m^3)

Source: Guidelines and Standards for Environmental Pollution Control in Nigeria

Methodology

The experimental procedure for this project includes collection of sample from the flow station at Niger Delta where the unused gas is flared.

a) Air Quality and Climatic Condition

The method for the determination of air quality parameter such as sulphur dioxide (sox), Nitrogen oxide and carbon monoxide and suspended soot particles were determined by laboratory analysis procedure. Adequate precautions were taken to ensure accuracy of the data analysis. The analytical procedures were chosen with high sensitivity to ensure qualitative calibration of the data.

Air samples were collected at two distinct point around the flare source designated as S-Z and W-Z, also the climatic condition were ascertain by using the appropriate apparatus to measure the temperature of four transect source, beginning from the flare source, to about 150M, while the relative and absolute humidity, wind speed and it direction are also know at two position N-A and N-B.

b) Sulphur Oxide (SO_X)

The ambient air is drawn using a device called the gas bubble with a flow rate of one cubic metre per minute (1 m^3/min) for an average of time of 4 hours. This is base on the So_2 absorption from air in a solution of potassium tetrachloromerurate (II), as the dichlorosuifitomercurate (II) was formed and then it was reacted with perasosancline methly sulphur acid and intensive colour was produced and was measured by means of spectrometer and the result were related to the amount of sox present in the corresponding air sample by means of the calibration curve.

c) Nitrogen Oxide (NO_2)

The nitrogen oxide in the ambient air also drawn by the device mention in 3.1.1 above and is to be converted to nitrite ion by contacting it with an absorbing solution of dialoging coupling agents, this absorbing solution is standardized by using 0.75 mole of $NaN0_2$ solution to produced the same colour as one mole of $N0_2$ Nitrogen oxide concentration in the sample is read from the calibration curve and its also related to the volume of the air sample in cubic metre (m^3).

d) Carbon Monoxide (Co)

The carbon monoxide was performed by an automatic monitor called the Neotox Co. monitor. The principle of this operation was based on Non-Dispersive infra-red (NDIR) method. The limit of detection was reduced to 2ppm of carbon monoxide. The unit of detection was lower than 2ppm of carbon monoxide.

e) Soots Particle

Air of known ambient volume is drawn through a glass fitter of a known weight under a fixed gabbed roof by means of a heavy turbine at a steady flow rate of between 1.2 to 1.8 m^3/min, the filter is reweight after sampling. Suspended particle that has diameter of between 0.1 and 100mm are removed from air steam by filtration process on the glass fibre filter. The mass concentration (µg/m^3) of the suspended soots particle in the air can then be determined by measuring the mass of the particle and dividing it by the volume of the air sample.

$$\text{Mass concentration } (\mu g/m^3) = \frac{mass\ of\ soot\ particle}{volume\ of\ air\ sample.}$$

f) Climatic Condition

The following parameters were all carried out in the field were the gas is flared. These include the air temperature, absolute and relative humidity and the wind speed.

g) Water Quality

The method for the water quality parameters are shown in table

TABLE 3.1: Method Used For The Water Quality Analysis

Parameter	Analysis method equipment
P. H	Philips PH Meter
Salinity	Silver nitrate titration
Heavy method	Atomic Absorption spectrometry

Water sample were collected and taken along Regions beginning from the flaring source.

h) Ph of Water Sample

The PH meter and water sample procedure:-The PH meter is for the determination of both Alkalinity and salinity of a water sample. The PH meter was standardized using the calomel electrode as reference electrode and a glass electrode both electrode were dipped into the sample mixture and the power was then switch on and the PH value were read off.

i) Salinity of Water Sample

The salinity of the water sample is obtain by first determining the, chloride ion of the water sample by using the Atomic Absorption Spectrometry (AAS). The chloride ion was then used to determine the salinity of the waster sample by the test kid meter, this process involved dipping the Test Kid meter into the chloride solution and the salinity is read off from the calibrated curve on the Test Kid metre.

j) Total Alkalinity Of Water Sample

Apparatus and reagent used: Volume of pipette = 25ml, funnel, stirring rod white tile, 250ml conical flask, standard solution of tetraoxosulphate (vi) acid (0.02 M H_2S0_4), methyl red indicator.

Procedure: A suitable amount of water solution (25ml) was measured using the pipette into the conical flask, 2-3 drops of methyl red indicator was added to it and titrate against 0.02 MH_2S0_4 solution while stirring and an end point was reached where a colour changes to permanent red show end point.

$$\text{Total Alkalinity (mg/L)} = \frac{litre\ value\ x\ 1000}{vol.of\ sample\ used}$$

k) Heavy Metal Content of Water Sample

The water sample of different point in the regions were diluted in a mixture of trioxonitrate (v) acid ($HN0_3$) at about 135^0C and resulting solution were taken to Pocema Laboratory Ltd for Atomic Absorption spectrometry analysis for the various heavy metals.

l) Soil Quality

The soil sample were collected at various distances of four transect area identified as South, West North and East. These sample were taken along measure grids 0-50 meters apart from the gas flaring source at individual transect point.

m) Soil Temperature

The soil sample was dogged from a depth of 50 cm with the soil temperature recorded instantly with a thermometer. The air temperature was also recorded of each grid before that of the soil was determine. The thermometer is placed in the soil for a constant reading to be attained before the soil temperature was recorded in each grid.

n) Heavy Metal Content Of The Soil Sample

The same principle is used as in the determination of heavy metals in water sample.

Results and Discussion

The results of the study are discussed in relation to their likely consequences on the effect of gas flaring on the environment and relating these results obtained to conform to the guide line of the Department of Petroleum Resources (DPR) and those of the Federal Environmental Protection Agency (FEPA) now called Federal Ministry of Environment (FMENV). And World Health Organization (WHO).The results are discussed on individual parameters measured. These include:

- Water PH
- Water salinity analysis
- Heavy metal content of water sample (in the regions)

Air Temperature

- Concentration of suspended particle, sulphur dioxide carbon monoxide, Nitrogen dioxide
- Soil Temperature
- Total hydrocarbon content of soil
- Heavy metal content of soil

Water Quality

The Physio-Chemical Properties Of Water

The physio-chemical parameter of water sample are presented in table 4.1, 4.2 and 4.3 respectively, the PH value of water sample, waters salinity analysis and water alkalinity with recognitions of D.P.R. and W.H.O standard for comparison.

The data of table 4.1, 4.2 and 4.3 show clearly that the and bore-hoe water within the scopes of study conformed with the D.P.R. and W.H.O standard with respect to the hydrogen ion (PH) and chloride concentration and having mean concentration and salinity of 7.03% and 30.54 respectively. From the concentration and salinity value, it means that the bore-hoe water is highly saline in nature.

Heavy Metal Content Of Water Sample

Table 4.4 show the variation in the heavy metal content of the water sample, the spread of Fe, Pb and slightly Zn shows that the water is highly polluted as illustrated in figure 4.1 to 4.4. The high content nature of Iron may follow as a result of the high salinity of the water sample which resulted in the high corrosive nature of the water sample. The metals presented were in the order of fe>zn = pb>mn. While copper was not detected. The deposition of metallic parts from unused cars and heavy machinery and certain iron-based alloy dumped in the water and on the land may lead to the high corrosive nature of the immediate environment there by resulting to high level of iron constituent in the water.

Air Quality And Climatic Condition

Suspended Soots Particles

From all indication the observation of the suspended particle variation shows a clear linked between the gas flared as a major source of contributor to the emission of particle in the area. At the S-Z the highest level of particle observation shows that the S - Z transect point is the highest and it is relatively closer to the limits of the Nigeria ambient air quality standard in table 2.4.

a) Sulphur Dioxide

The concentration of sulphur dioxide was not appreciably detected as a result, the concentration was very low ranging between (16-20 $\mu g/m^3$) lower than the detectable limit of 25 $\mu g/m^3$ which is the acceptable limit. Generally,

it is understood that trace of sulphur dioxide of (16 -20 μg/m^3) suggest that the sulphur content of Nigeria crude oil and natural gas is very minimal to be noticed.

b) Carbon Monoxide

A reference site was chosen from the flared point, it was observed that the carbon monoxide value of 2.5 -3.5 ppm was noticed and it was suggested that this range of value of carbon monoxide was triggered by certain biological activities. However there is a slight increase in the value of carbon monoxide within the flare source inferring that the emission of this gas was done by flaring.

Though the carbon monoxide level many increase, but it is still within the acceptable limit of the Nigeria ambient air quality standard presented in table 2.4

c) Nitrogen Dioxide

From table 4.5, the level of nitrogen dioxide concentration show an appreciable increase in its atmospheric composition this may be due practically to the activity of gas flaring on the environment. The level though increase are still within the acceptable limit of the Nigeria ambient air standard as presented in table 2.4

d) Air Temperature And Climatic Condition

From table 4.6 and the respective bar chart representing the mean temperature variation along four transect point. The air temperature is independent of the direction. At each transect point; there is a minimal temperature shift or fluctuation. The average temperature variation within the flare source is an indication that though thermal energy may be carried by plume of the flare gas, there is a clear indication that energy is been consumed by both radiation and conduction processes.

There is the necessity that owing to high temperature within the flare source there will be a tendency of vapor being form during the process of combustion of hydrocarbons in combination to produce a higher moisture concentration around the flare source. This is seen in table 4.7 showing a lower relative humidity closer to the flare source, this process accounted for temperature. The table also shows the wet bulb and dry bulb temperature from which the relative and absolute humilities are calculated, it also show the wind speed at various time of the day and their respective direction.

Soil Quality

Temperature Of Soil Profile

There is a greater temperature variation with depth at the sub-surface; this can be seen in figure 4.9 to figure 4.1.2 this figure represent a temperature profile at 150 metre from the flare source. The slope of the temperature was laid closely to the heat transfer into the dug soil, the distance was too sensitive to the temperature as interpreted by the graph.

Table 4.1: Ph Value Of Water Sample

Water Samples Grid S/N	Distance From Gas Flared (m)	PH Values
1.	0	6.5
2.	50	6.0
3.	100	6.0
4.	150	5.7
5.	200	6.5
6.	250	5.7
7.	300	7.2
8.	350	7.2
9.	400	7.0
10.	450	7.0

Table 4.2: Salinity of Water Sample

Water Samples Grid S/N	Distance From Flared Gas (m)	Salinity (PPm)
1.	0	295
2.	50	30.0
3.	100	30.0
4.	150	30.5
5.	200	31.2
6.	250	29.5
7.	300	31.3
8.	350	31.5
9.	400	30.9
10.	450	31.0

Table 4.3: Alkalinity of Water Sample

Water Samples Grid S/N	Distance From Flared Gas (m)	Alkalinity
1.	0	100
2.	50	165
3.	100	150
4.	150	125
5.	200	130
6.	250	110
7.	300	115
8.	350	105
9.	400	125
10.	450	102

Table 4.4:Heavy Metal Content Of Oyigbo (Okoloma) Water Sample (Ppm) From Aas Test

Water Sample Grid, S/N	Fe	Zn	Pb	Cu	MN
1.	650	45	68	ND	2.5
2.	540	60	40	ND	3.6
3.	510	40	26	ND	2.4
4.	360	30	13	ND	3.8
5.	480	28	18	ND	4.5
6.	310	18	10	ND	5.0
7.	240	25	16	ND	6.4
8.	340	16	14	ND	3.9
9.	200	20	20	ND	4.8
10.	300	22	42	ND	4.3

Table 4.5: Air Quality at Designated Point

Parameter (Unit Average Time)	Sample	Point
	S-Z	W-Z
Suspended soot particle (mg/m^3) 3 hours	95	65.8
Carbon Monoxide	4.0	3.5
Sulphur Dioxide	N.D	ND
Nitrogen Dioxide (mg/m^3) 3 hours	28	D.0

Table 4.6 : Air Temperatures

Transect	Distance from source (m)	Point of grids	Temperature (°c)
South	0	S-z_a	180
	50	S-z_b	160
	100	S-z_c	100
	150	S-z_d	80
West	0	W-z_a	160
	50	W-z_b	140
	100	W-z_c	120
	150	W-z_d	60
North	0	N-z_a	200
	50	N-z_b	180
	100	N-z_c	140
	150	N-z_d	100
East	0	E-z_a	140
	50	E-z_b	100
	100	E-z_c	80
	150	E-z_d	60

Table 4.7: Climatic Condition Of Designated Area, Used As North Zone A And East Zone A.

North Zone - A

Time	Wind Speed (ms^{-1})	Wind Direction (°)	Dry Bulb (°)	Wet Bulb (°)	RH%
12.00 Noon	1.00	46.0	32.0	27.0	65
1.30pm	1.50	48	31.5	27.5	65
2.30pm	3.00	58	32.0	28.0	65
3.30pm	3.50	43	32.5	27.0	70
4.30pm	2.50	39	31.5	26.0	70

East Zone - A

Time	Wind Speed (ms^{-1})	Wind Direction (°)	Dry Bulb (°)	Wet Bulb (°)	RH%
1.00pm	3.0	60	93.5	28.5	65
1.30pm	3.0	56	85.4	29.0	60
2.00pm	4.0	50	95.5	30.0	65
2.30pm	3.5	65	100	27.0	70
3.30pm	3.0	65	103	30.0	65.6

Table 4.8: Temperature Variation Of Soil Sample Of Selected Points

Depth (CM)	N-Z (°C)	E-Z	S-Z	W-Z
0	32	30.0	31.5	30.0
5	31.5	30.5	30.0	30.0
10	31.0	29.5	30.0	29.5
15	30.0	27.0	29.0	27.0
20	29.0	27.0	27.0	27.0

25	28.0	26.0	27.5	27.5
30	27.0	25.5	28.0	26.0
35	27.0	25.0	28.0	26.0
40	27.0	25.0	28.0	26.0

Table 4.9: Hydrocarbon Content Of Transect Points Of Soil Using Aas Analysis

Point of Grids	Aliphatic Hc Wt %	Aromatic HC Wt %	Total Hc Wt %	Percentage Aliphatic Hc	Percentage Aromatic Hc
S-A	0.003	0.008	0.011	27.27	72.72
S-B	0.006	0.015	0.021	28.57	71.43
S-C	0.008	0.014	0.022	36.36	63.64
S-D	0.005	0.009	0.014	35.71	64.29
W-A	0.009	0.018	0.027	33.33	66.67
W-B	0.001	0.014	0.015	6.67	93.33
W-C	0.013	0.040	0.053	24.53	75.47
W-D	0.018	0.016	0.034	52.94	47.06
N-A	0.013	0.007	0.020	65.00	35.00
N-B	0.040	0.003	0.043	93.02	6.98
N-C	0.006	0.005	0.011	54.55	45.45
N-D	0.008	0.006	0.014	57.14	42.86
E-A	0.007	0.008	0.015	46.67	53.33
E-B	0.005	0.009	0.014	35.71	64.29
E-C	0.008	0.019	0.027	29.63	70.37
E-D	0.014	0.018	0.032	43.75	56.25

Table 4.10: Heavy Metal Content Of Soil Sample (Ppm) From Aas Analysis

Grid Point	**Fe**	**Pb**	**Zn**	**Cr**	**Mn**	**Cu**
S-A	1750	1300	46	ND	ND	6.5
S-B	1700	1600	39	ND	ND	5.4
S-C	1400	1400	76	ND	ND	5.2
S-D	1900	1000	82	ND	ND	5.0
W-A	850	900	30	ND	ND	6.2
W-B	800	600	25	ND	ND	6.0
W-C	860	500	16	ND	ND	6.0
W-D	900	400	10	ND	ND	6.0
N-A	1000	830	80	ND	ND	7.5
N-B	650	800	78	ND	ND	7.5
N-C	800	900	45	ND	ND	6.5
N-D	800	1000	56	ND	ND	6.9
E-A	1700	1600	90	ND	ND	7.0
E-B	1800	1800	95	ND	ND	7.0
E-C	1850	1750	86	ND	ND	7.5
E-D	1950	1600	85	ND	ND	8.0

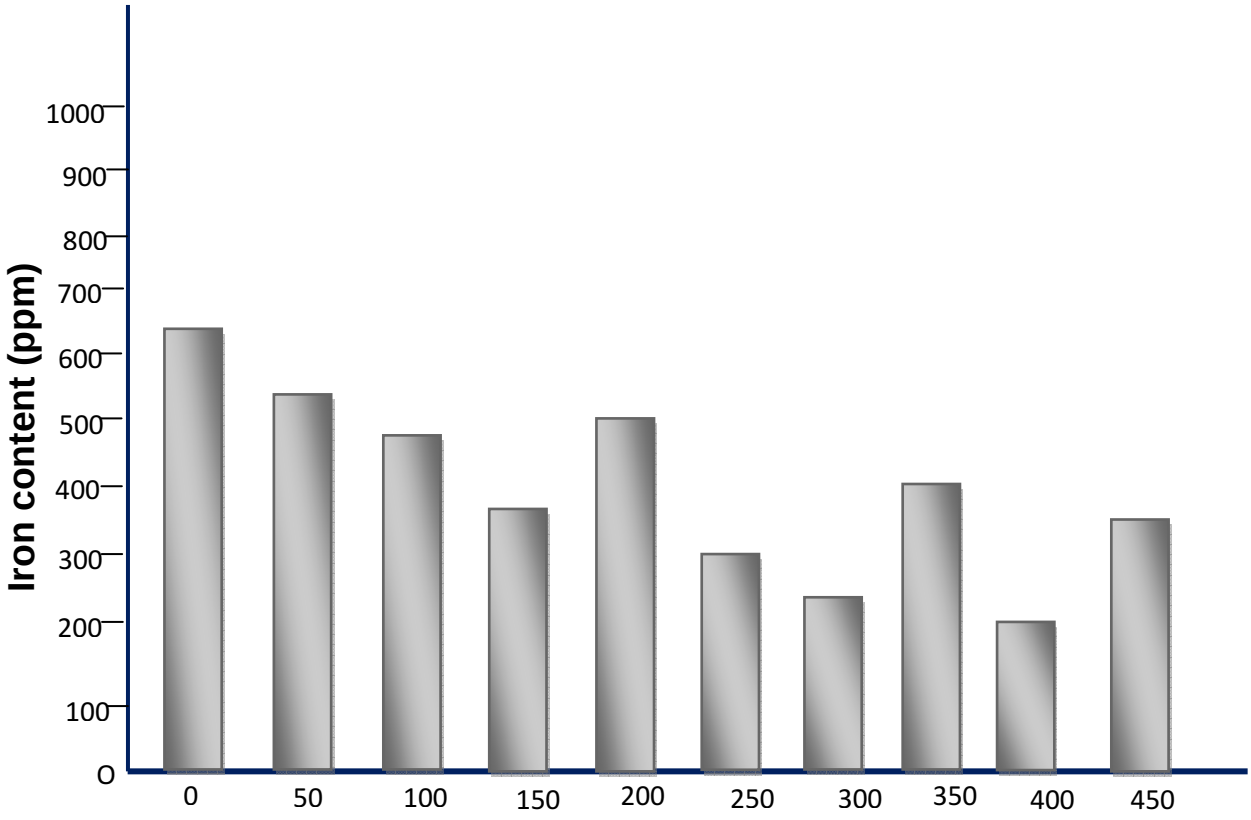


Fig 4.1: Distance from the flare source in metre (Bar chart of iron content of water sample in region)

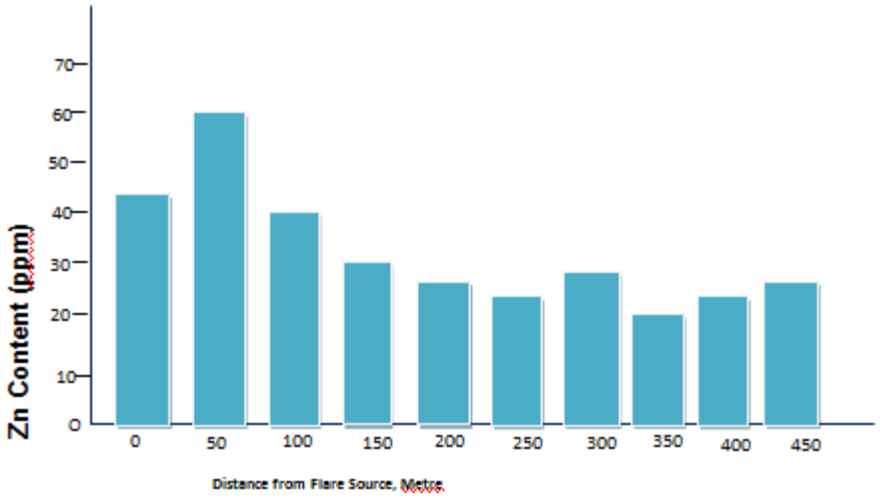


Fig 4.2: Distance from flare source in metre (Bar chart of Zn content of water sample).

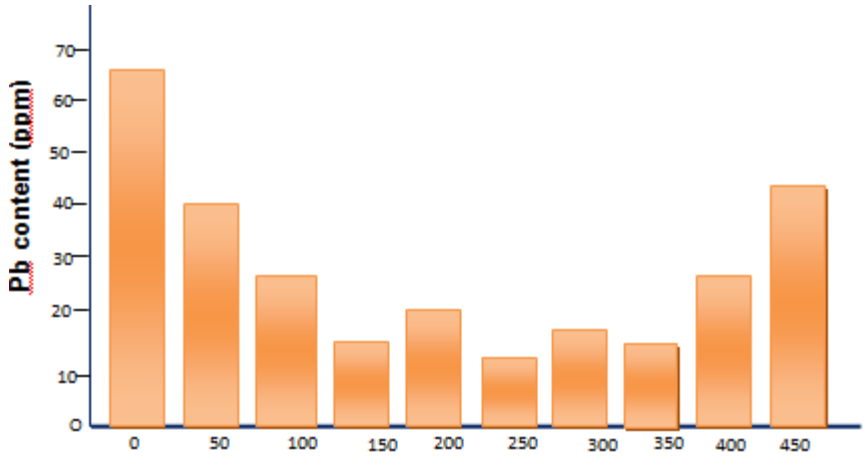


Fig 4.3: Distance from flare source in meter (Bar chat of Pb content of water sample)

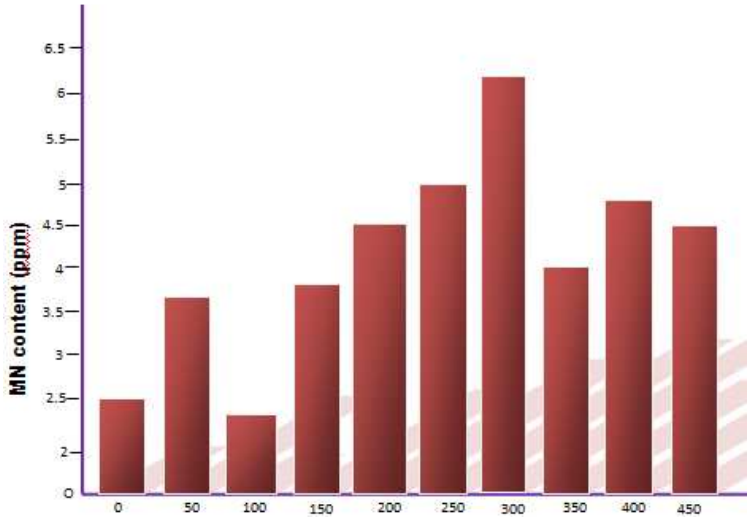


Fig 4.4: Distance from flare source in metres (Bar chat of MN content of water sample

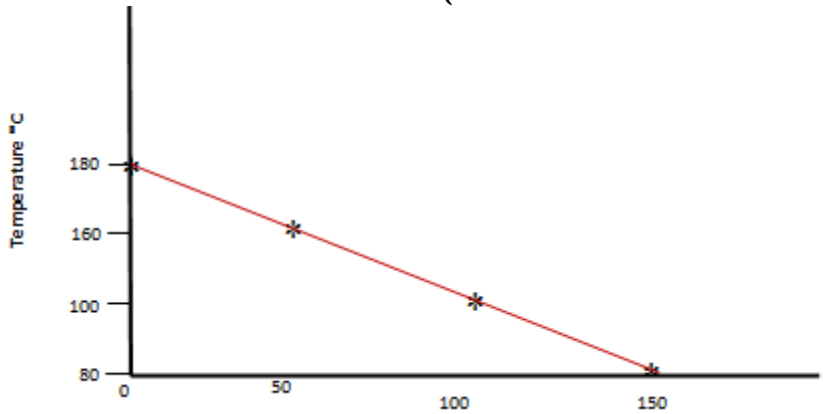


Fig 4.5 Air temperature vs distance from flared source along the transect south (Distance from flare source (m)

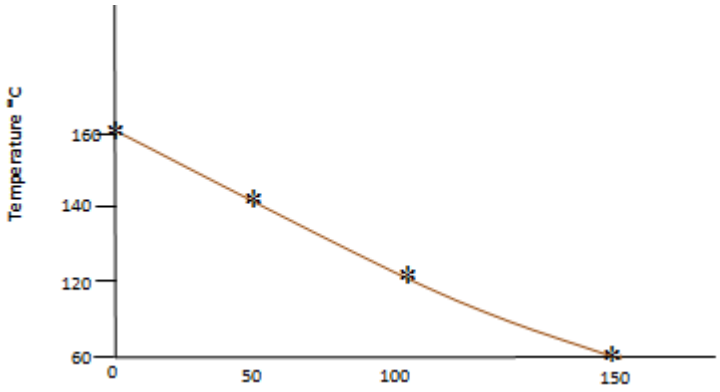


Fig 4.6 Air temperature vs distance from flared source along the transect west (Distance from flare source (m)

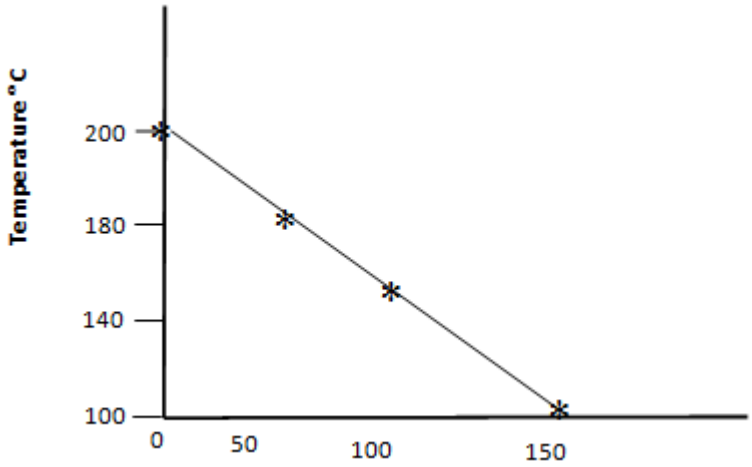


Fig 4.7 Air temperature vs. distance from flared source along the transect North (Distance from flare source (m)

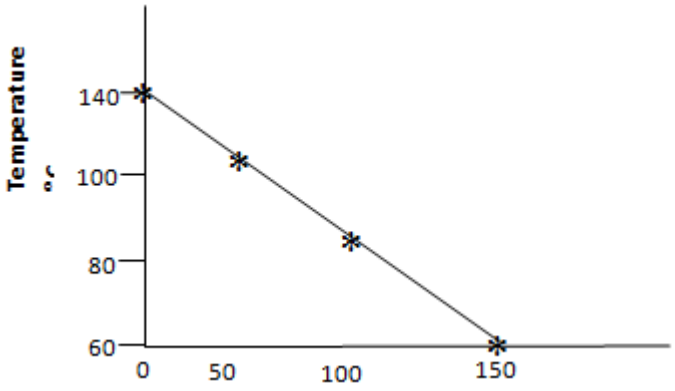


Fig 4.8 Air temperature vs distance from flared source along the transect East (Distance from flare source (m)

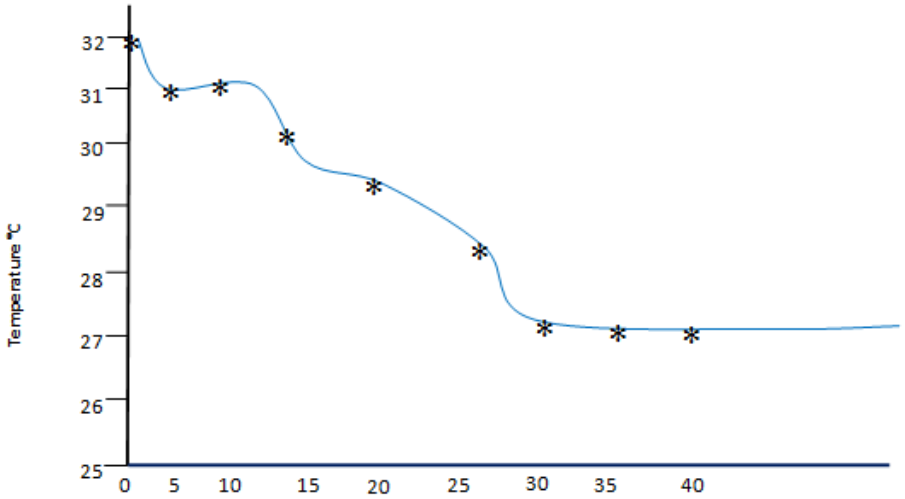


Fig 4.9: Temperatures against depth in N-Z, a distance of 150m within the flare source

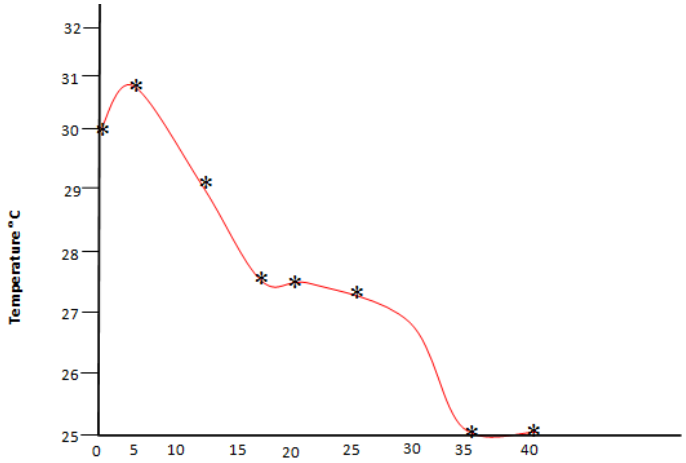


Fig 4.10: Temperatures against depth in E-Z, a distance of 150m within the flare source

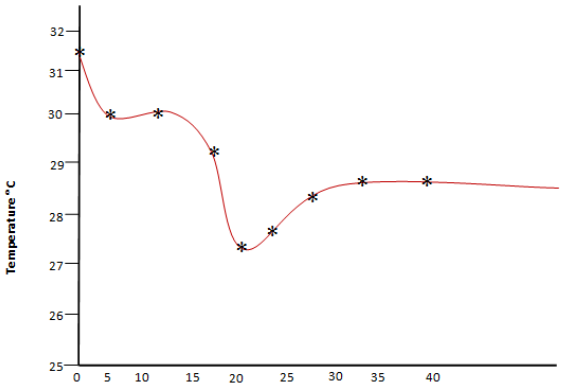


Fig 4.11 temperatures against depth in S-Z, a distance of 150m within the flare source

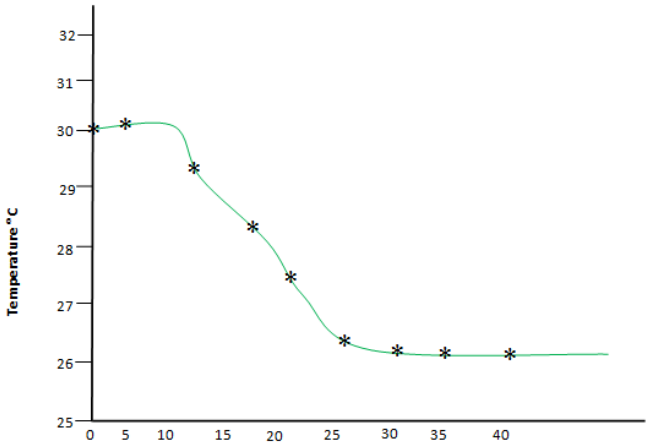


Fig 4.12 temperatures against depth in W-Z, a distance of 150m within the flare source

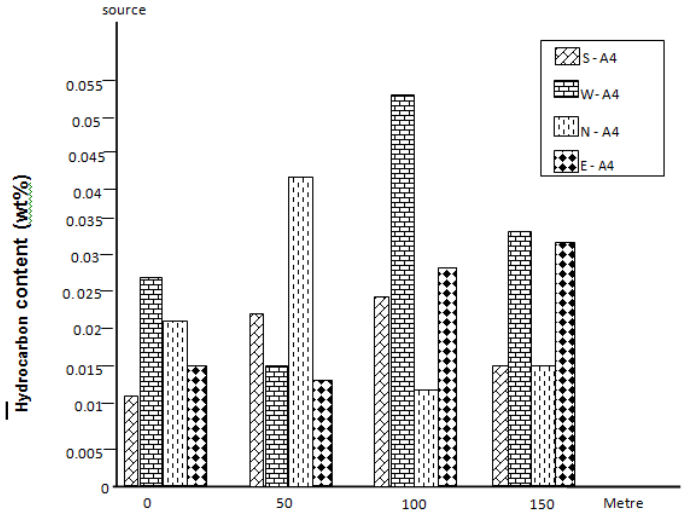
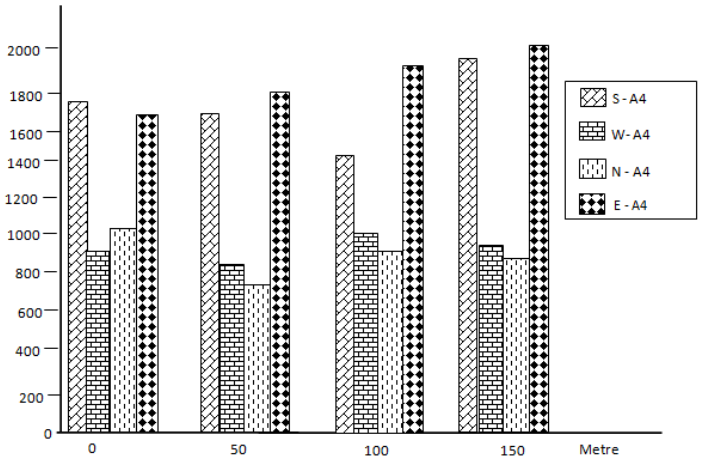
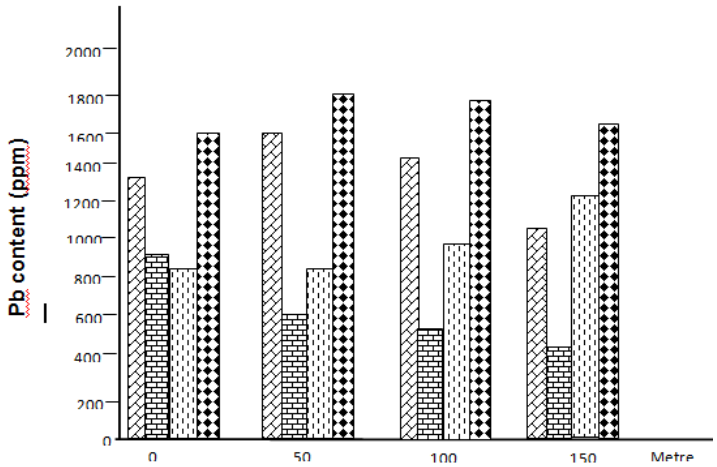


Fig 4.13 multiple bar chart of hydrocarbon content of soil sample at a distance of 50 metre interval from the flare source



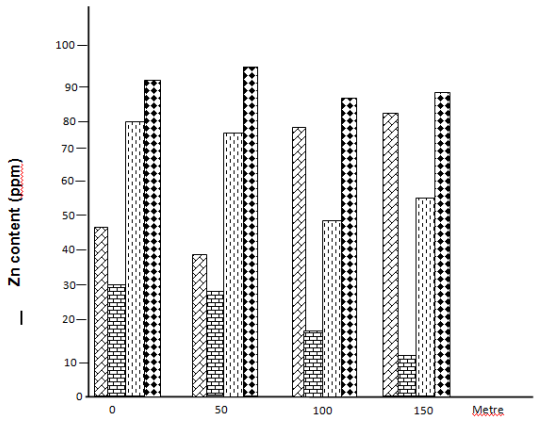
Distance from flare source (m)

Figure 4.14 show multiple bar chart of fe contents of the four transect of soil sample.



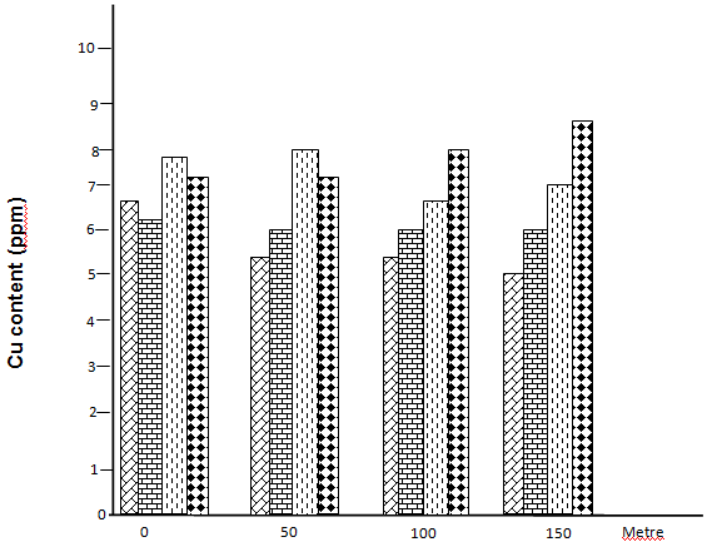
Distance from flare source (m)

Figure 4.15 show multiple bar chart of pb contents of the four transect of soil sample.



Distance from flare source (m)

Figure 4.16 show multiple bar chart of Zn contents of the four transect of soil sample.



Distance from flare source (m)

Figure 4.17 show multiple bar chart of Cu contents of the four transect of soil sample.

Conclusion and Recommendation

In view of the experimental analysis carried out and the verbal discussion with the some of the people met during my frequent tripped to region of gas flare, Niger Delta. The following conclusions were drawn. With readings from the temperature variations level in the area, the level of carbon monoxide, nitrogen dioxide and soot particles are all dependents on the source of the gas flared. Also there was no sulphur dioxide noted in the entire air samples that were analyzed, meaning that the crude oil in Nigeria is a "sweet crude" (No sulphur).

The soil temperature variation gradients suggest a measure of heat transfer to the soil from the flared. It shows that any crops or plant planted below 30cm depth will surfer a high thermal effect because the temperature gradient shows a decrease in temperature as the soil is dogged down vertically.

In the same manner, the hydrocarbon composition of the soil contents around the region shows clearly that there is decrease in the hydrocarbon content of the area with decrease in distance to the flare source. It also means that gas flaring may not only be the source of contaminations of water but it may also be as a result of saver pit. The differences that are seen in the composition of heavy metals in the regions around the flared source is an indication that gas flaring contribute immensely to the emission of heavy metals into the environment.

It was observed that crops plants in these communities suffered a great lost during harvesting. This is because of the proximity of these communities to the flared source. Farmers in the area agreed to the earlier review made by Oyenkunle (1991) that their cassava suffered the absence of ascorbic acid, and equally they can feel the impact of heat radiation from the smoke stack at a close flow station. Also high iron content of the soil sample on analysis confirmed the high saline nature of water sample in the region of flaring and this is due to the fact that metallic object dumped as waste was under corrosion and the leach water now contributed for the high saline nature of water.

Recommendation

It will serve a purpose if these flare gas are used for re-injection in to the formation for enhance oil recovery. It also play important role in.

- It is best in maintaining the pressure of the reservoir
- This gas can be stored in the gas cap found in the pool of existing oil.
- This gas that is flared can also be used for recycling process of dry gas from the liquefied petroleum gas and gasoline that have been stripped. These gas that is being flared can be used or converted to liquefied natural gas (LNG) as it is done in Bonny and exported to increase our foreign earning and to alleviate the suffering of the poor people of Oyigbo in particular and Nigeria in general.

The two houses of House of Assembly and Senate should as a matter of urgency ensured the passage of the Petroleum Industry Bill (PIB), perhaps some clauses in the bill will favour the poor farmers in Oyigbo flaring area and the Niger Delta people to see to the long suffering in the hands of these multinational oil companies to stopped gas flaring. The Nigeria National Petroleum Corprontric (NNPC) should ensure that the oil and gas company are involved in polices which enhance environmental sustainability in their area of operation and that the oil and gas company implement the international design for flare stack, especially in the sterilization area within the gas flared zone.

The international standard specifications for sterilization are;

- The flare flame must be luminous and bright and devoid of the usual dark and blue hazes at any operating gas flow rate.
- The least approach for sterilization distance should not be less than 45.73 metres from the top of the flare stack.
- The grand state temperature not more than 27k at any maximum sterilized distance from the flare source.

If the law maker, the NNPC and the multinational oil company understand the meaning of sustainability, I think if the above recommendations are met the flaring region will be a safer region to stay.

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