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THE QUANTITY OF HEAT RADIATION FROM GAS FLARING AGHIGHO AREA OF NIGER DELTA

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ABSTRACT

The evaluation of heat radiation was determined in the Niger Delta area of Nigeria. Aghigho vi was considered under this work. The distances considered from the point of flare were 100 1000m at a continuous interval of 50m. A computer programme was developed to simulate the The simulated results showed that the farther the distance from the point of flare, the lesser the radiated as shown in the simulated results. Based on the results it is also observed that the distar between 100m and 850m are unsafe zones for human habitation.

INTRODUCTION

Besides environmental contamination of air, water, soil and food has become a threat to the continuous existence of many plant and animal communities of the ecosystem and ultimately threatens the very survival of the human race. One of the major gas flaring industries in Nigeria is the petroleum's, which operations are characterized by sets of hazards. The nature and magnitude of these hazards are dependent on series of factors and vary significantly from one sector to another. While it is true that the Niger Delta of Nigeria suffers a great deal from immediate impact of gas flaring, it is now increasingly recognized that the contribution of the petroleum industry to the environment's degradation goes far beyond the immediate vicinity of the oil producing areas. The Nigerian oil field in the Niger Delta area produces about two millions barrels of oil per day and most of this oil comes from reservoirs containing gas, which is produced with the oil. This associated gas, a by-product of the country's lifeline petroleum exploration activities is separated from the oil at flow station and more than 95% of it is flared. (Onosode, 1996).

The main components of the flared gas include carbon dioxide (CO_2), methane (CH_4), nitrous oxide (NO_4), water vapour (H_2O) sulphur dioxide (SO_2), (although the sulp contained in the Nigerian Petroleum Crude practically negligible). According to Aduku a David (1997), it is estimated that the gas fla in Nigeria released 35 million tones of carb dioxide and 12 million tones of methane in year. Though the amount of methane releas into the atmosphere appears to be less tha carbondioxide, methane has a higher globa warming potential (64 against 1 for CO_2) (Imevbore, 1981). Carbon dioxide (CO_2) and methane (CH_4) are the main green house gases detected hrer, and these have been seen to raise the average global temperature by about 0.5°C within the last century (Onosode, 1996). Emissions from gas flaring are difficult to evaluate as only little is known about the flame temperature. The flares are said to be operating at temperatures between 300 to 1400°C, which may be the case in the center of the flame. Natural gas production to date in Nigeria is mainly associated gas with an average oil ratio of 1049Scf/bb www.ipcc.com 1996. Since 1970s, the higher level of oil production of about 2million barrels of oil per day has brought about the production of large quantities of associated gas. More than 90% of the 2 million cubic feet of gas produced in Nigeria is flared;

(this Corresponds to 1 8 millions cubic feet of gas flared per day) www ipcc.com 1996 The associated problems with the emissions of these gases into the atmosphere are predominantly found in the Niger-Delta Communities Amidst conflicting claims, field evidence seems to support the widespread postulation that flaring, apart from impacts on human has a direct relationship with acidification water and crop damage The increasing profile of climatic changes as an issue of growing global concern has drawn attention to the role of Nigeria's gas flaring in the built-up of greenhouse gases, which has necessitated the research in finding the quantity of heat radiated from gas flaring in Aghigho area of Niger Delta.

Conceptualization of the modeling techniques

Assumptions

The followings are assumptions made in developing the mathematical model

i There is complete combustion in air (i.e. co-product during combustion are attacked by free oxygen in the air to form CO_2)

ii Heat generated from the flare is absorbed by the soil, evaporates water around the flare while the rest is reflected back.

iii. The region for research consideration is tropical forest.

iv The area is assumed to be a bed of soil i.e. soil of constant heat capacity.

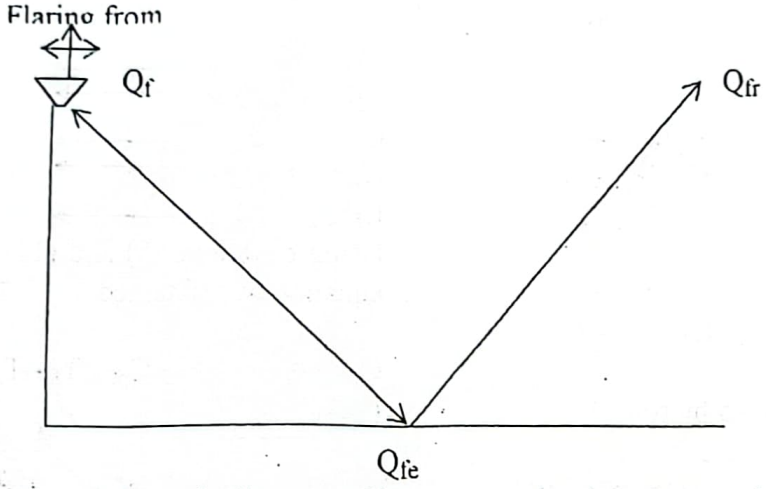

Fig1: Schematic diagram of heat generation in a flare station.

Taking heat balance from Fig.1

$$Q_f = Q_{fe} + Q_{fr} \quad \text{---------(1)}$$

Where:

Q_f = heat from flare gases.

Q_{fe} = heat absorbed by earth from flare gas.

Q_{fr} = reflected heat from the earth surface.

$$= Q_{soil} + Q_{evap} = Q_s + Q_v \quad \text{--------(2)}$$

Where,

Q_s = heat retained by soil

Q_v = heat used in vaporizing water

Substituting equation (2) into (1) gives

$$Q_f = Q_s + Q_v + Q_{fr} \quad \text{----------(3)}$$

$$Q_{fr} = Q_f - Q_s - Q_v \quad \text{----------(4)}$$

Simplifying each of the above

$$Q_f = \frac{q_f \rho_f V_f F_{12}}{A} \int_{T_s}^{T_f} Cp_f \, dt$$

$$= \frac{q_f \rho_f V_f F_{12} [T_f - T_s] C_{pf}}{A} \text{ -------(5)}$$

Where

q_f = heat released by $1m^3$ of flare gas

V_f = volume of gas flared

F_{12} = view factor

C_{Pf} = specific heat of flare gas

ρ_f = density of flare gas

A = area of receiving surface.

T_f = temperature of flare gas

T_s = soil temperature

And

$$Q_s = M_w C_w \int_{Ts}^{T_f} dt + M_w \lambda_w \text{--- (6)}$$

Where:

M_w = mass of water

C_w = specific heat capacity of water

λ_w = latent heat of vapourisation of water

From the above equation:

$Q_v = M_w C_w [T_f - T_s] + M_w \lambda_w$ -----(7)

Also

$$Q_s = M_s C_s \int_{Ts}^{T_f} dt$$

$$Q_s = M_s C_s [T_f - T_s] \text{ -------(8)}$$

Where:

Qs = heat retained by soil.

Ms = mass of soil.

Cs = specific heat capacity of soil.

Substituting equations (5), (7) and (8) into (4)

$Q_{fr} = (q_f \rho_f v_f F_{1.2})/A [T_f - T_s] C_{pf} - [M_w C_w [T_f - T_s] + M_w \lambda_w] - M_s C_s [T_f - T_s]$

$Q_{fr} = (q_f \rho_f v_f F_{1.2})/A C_{pf} [T_f - T_s] - M_w C_w [T_f - T_s] - M_w \lambda_w - M_s C_s [T_f - T_s]$----------(9)

According to Alakpodia, (1980). Fraction of the heat radiated from the source strikes the receiving surface.

Hence,

$Q_c = \alpha Q_f (1 - a)$ ---------- (10)

Where:

a = Alakpodia Constant

α = Absorptivity factor which varies with distance

$\alpha Q_f (1 - a) = M_w C_w (T_f - T_s) - M_w \lambda_w - M_s C_s (T_f - T_s)$----------(11)

Experimental

Monthly gas production and utilization data (associated gas) was obtained from federal office of statistics Abuja for a period of one year, 2000. The data collected (i.e. volume of the gas flared) are presented in Table 1 and were used in the model equation to carry out simulation using visual basic programme. The distances considered from the point of flare were 100m-1000m at a continuous interval of 50m. From assumption that combustion is complete in the air, the amount of CO_2 released by burning 1g of associated gas can be calculated from stochiometry as follows,

$CH_4 + O_2 \longrightarrow CO_2 + 2H_2O$

$C_2H_6 + {}^7/_2O_2 \longrightarrow 2CO_2 + 3H_2O$

$C_3H_8 + 5O_2 \longrightarrow 3CO_2 + 4H_2O$

$C_4H_{10} + {}^{13}/_2O_2 \longrightarrow 4CO_2 + 5H_2O$

$C_5H_{12} + 8O_2 \longrightarrow 5CO_2 + 6H_2O$

Using equations (5) and (11), the following equation was obtained

$$Q_{fr} = \frac{q_f \rho_f v_f F_{1.2} C_{pf} (T_f - T_s) - \alpha q_f (1 - \text{(12)}}{A}$$

Equation 12 is the model equation for heat radiated. Therefore using ρf = 80, Constant, F_{12} = 0.065 a Constant, Cpf = a Constant, Td = 973, Td = (T_f - Constant, and a = 0.31, a Constant, V_f of gas flared, d = 50 To 1000 step 50, total gas produced per month, assigned to Alfa are; If (d >= 50) And 200) Then Alfa = 0.225, If (d >= 20 (d <= 400) Then Alfa = 0.22, If (d And (d <= 600) Then Alfa = 0.215 601) And (d <= 1000) Then Alfa =

area, heat radiated per month for Aghigho programme was computed using visual basic

Table 1 Monthly gas (associated gas) production and utilization in Aghigho

Month	Gas produced	Gas consumed	Gas re-injected	Gas flared
January	343.43	314.14	0.00	29.29
February	355.13	328.04	0.00	27.09
March	461.07	460.38	0.00	0.69
April	536.32	431.29	0.00	105.02
May	636.0	439.9	0.00	132.5
June	1252.20	410.58	0.00	716.40
July	962.70	432.63	0.00	433.80
August	1218.15	395.56	0.00	700.78
September	820.34	666.73	0.00	71.58
October	945.0	545.4	0.00	305.6
November	719.67	251.09	0.00	396.62
December	931.16	272.43	0.00	565.62

RESULTS AND DISCUSSION

The model equation was programmed using isual basic. The result obtained at various volume of gas flared are presented in Table 2.

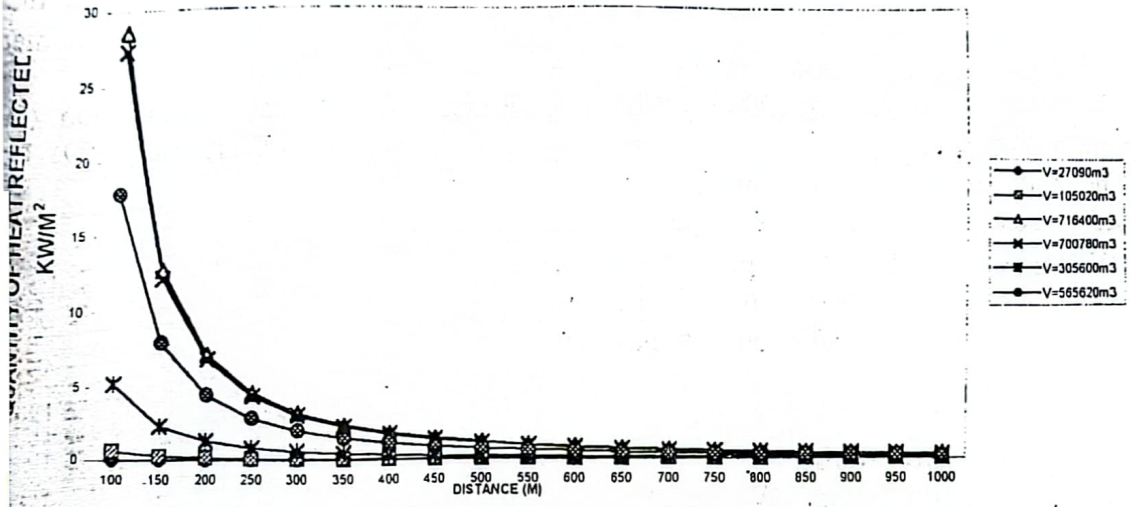

Fig 2.0 GRAPHICAL REPRESENTATION OF SIMULATION RESULT FOR AGHIGHO

n the simulated result, it was observed the month of June was actually the th where a large quantity of heat was ted which is attributed to the largest ne of gas flared for that year. It could be observed that at any average ces of between 100 m and 350 m the ty of heat radiated was as high as 2.93 kW/m^2 and 1.95 x $10^3 kW/m^2$ respectively. It is shown in Fig 2 where the maximum quantity of heat is indicated at a distance of 100 m from the point of flare. This distance could generally be regarded as an unsafe area, especially for farming. This region where heat radiated is indicated to be high which progressively decrease as the distance increases away from the point of flare, agrees with Akinbami *el al* (1990).

Month where high quantity of heat radiated are observed are actually due to the high volume of gas, which progressively decreases as the distance increases away from the point of flare. The radiant heat energy and other pollutants from flow stations and gas plants as a result of gas flaring in the Niger delta area of Nigeria has led to strain in the relationship between oil explorer and the host communities. This continued due to the inability of either the government or the company to quantify the resultant effect of gas flaring on the environment.

CONCLUSION

From the research work, the following could be deduced:

* The simulation results of the developed model show that increase in the volume of gas flared results to an increase in the quantity of heat radiated.

* As the distance increases away from the point of flare, the quantity of heat radiated decreases

* The effect of heat radiated is mostly going to be felt at a distance of 100 m within the point of flare.

* The result obtained from the model can be used to determine the possible effects of the heat radiation on the environment.

The model has helped in quantifying the pollution potential of heat radiation from gas flaring.

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Table 2: Simulation Result for Heat Radiation in Aghigho

MONTHS	JAN.	FEB.	MAR.	APRIL	MAY	JUNE	JULY	AUG.	SEPT	OCT.	NOV	DEC
VOL.(m^3)	2.93E+04	2.71E+04	6.90E+02	1.05E+05	1.33E+05	7.16E+05	4.34E+05	7.01E+06	7.16E+04	3.06E+05	3.97E+05	5.66E+05
DIST.(m)	Qfr (kw/m^2)	Qfr(kw/m^2)	Qfr(kw/m^2)	Qfr(kw/m^2)	Qfr(kw/m^2)	Qfr(kw/m^2)	Qfr(kw/m^2)	Qfr(kw/m^2)	Qfr(kw/m^2)	Qfr(kw/m^2)	Qfr(kw/m^2)	Qfr(kw/m^2)
100	4.78E-02	4.08E-02	2.65E-05	6.14E-01	9.77E-01	2.86E+01	1.05E+01	2.73E+01	2.85E-01	5.20E+00	8.76E+00	1.78E+01
150	2.12E-02	1.82E-02	1.18E-05	2.73E-01	4.34E-01	1.27E+01	4.66E+00	1.22E+01	1.27E-01	2.31E+00	3.89E+00	7.91E+00
200	1.19E-02	1.02E-02	6.61E-06	1.54E-01	2.44E-01	7.14E+00	2.62E+00	6.83E+00	7.13E-02	1.30E+00	2.19E+00	4.45E+00
250	7.64E-03	6.54E-03	4.23E-06	9.82E-02	1.56E-01	4.57E+00	1.68E+00	4.37E+00	4.56E-02	8.32E-01	1.40E+00	2.85E+00
300	5.31E-03	4.54E-03	2.93E-06	6.82E-02	1.09E-01	3.17E+00	1.16E+00	3.04E+00	3.17E-02	5.78E-01	9.73E-01	1.98E+00
350	3.90E-03	3.33E-03	2.15E-06	5.01E-02	7.98E-02	2.33E+00	8.55E-01	2.23E+00	2.33E-02	4.24E-01	7.15E-01	1.45E+00
400	2.98E-03	2.55E-03	1.65E-06	3.84E-02	6.11E-02	1.79E+00	6.55E-01	1.71E+00	1.78E-02	3.25E-01	5.47E-01	1.11E+00
450	2.36E-03	2.02E-03	1.30E-06	3.03E-02	4.83E-02	1.41E+00	5.17E-01	1.35E+00	1.41E-02	2.57E-01	4.32E-01	8.79E-01
500	1.91E-03	1.63E-03	1.05E-06	2.46E-02	3.91E-02	1.14E+00	4.19E-01	1.09E+00	1.14E-02	2.08E-01	3.50E-01	7.12E-01
550	1.58E-03	1.35E-03	8.65E-07	2.03E-02	3.23E-02	9.44E-01	3.46E-01	9.04E-01	9.43E-03	1.72E-01	2.89E-01	5.89E-01
600	1.33E-03	1.13E-03	7.25E-07	1.71E-02	2.71E-02	7.93E-01	2.91E-01	7.59E-01	7.92E-03	1.44E-01	2.43E-01	4.95E-01
650	1.13E-03	9.66E-04	6.16E-07	1.45E-02	2.31E-02	6.76E-01	2.48E-01	6.47E-01	6.75E-03	1.23E-01	2.07E-01	4.21E-01
700	9.74E-04	8.33E-04	5.29E-07	1.25E-02	1.99E-02	5.83E-01	2.14E-01	5.58E-01	5.82E-03	1.06E-01	1.79E-01	3.63E-01
750	8.48E-04	7.26E-04	4.60E-07	1.09E-02	1.74E-02	5.08E-01	1.86E-01	4.86E-01	5.07E-03	9.24E-02	1.56E-01	3.17E-01
800	7.46E-04	6.38E-04	4.03E-07	9.59E-03	1.53E-02	4.46E-01	1.64E-01	4.27E-01	4.45E-03	8.12E-02	1.37E-01	2.78E-01
850	6.60E-04	5.65E-04	3.55E-07	8.49E-03	1.35E-02	3.95E-01	1.45E-01	3.78E-01	3.95E-03	7.19E-02	1.21E-01	2.46E-01
900	5.89E-04	5.04E-04	3.16E-07	7.58E-03	1.21E-02	3.53E-01	1.29E-01	3.37E-01	3.52E-03	6.42E-02	1.08E-01	2.20E-01
950	5.29E-04	4.52E-04	2.82E-07	6.80E-03	1.08E-02	3.17E-01	1.16E-01	3.03E-01	3.16E-03	5.76E-02	9.70E-02	1.97E-01
1000	4.77E-04	4.08E-04	2.53E-07	6.14E-03	9.77E-03	2.86E-01	1.05E-01	2.73E-01	2.85E-03	5.20E-02	8.75E-02	1.78E-01