The Negative Impact of Gas Flares on the Environment: A Case Study of Zinc Rooftops in the South-south Region of Nigeria.

Dominic Chukwu Onu

Chemical Engineering Department, Federal Polytechnic, P.M.B. 021 Oko, Anambra State, Nigeria

Mobile Number: 08063465546

And

Engr. Eze Emmanuel Ugadu

Chemical Engineering Department, Federal Polytechnic, P.M.B. 021 Oko, Anambra State, Nigeria

Corresponding Email: onudominic@yahoo.com

Abstract

Gas flaring is unarguably a common practice in the South-South region of Nigeria. The region has suffered all forms of pollution, infrastructural and environmental degradation arising from oil and natural gas exploration. It releases Carbon dioxide (CO2), Methane (CH4) and Sulphur dioxide (SO2) which increases the concentration of greenhouse gases resulting in the depletion of the ozone layer that impact negatively on the infrastructural and global environment. Gas flaring have been condemned by many countries of the world and with a call for a stop. This study was carried out on the effect of flare on vegetation, roof tops made of corrugated iron roofing sheet and groundwater.

Key words: Gas flare, Corrosion, pollution, environment, climate change

Introduction

The level of awareness of the natural environment and the sensitive implication of the damage done to the ecology and structure is very critical in creating a balance between the flow of resources from nature to economic activities and the release of residuals from economic activities back to the environment. Petroleum which is pivotal to rapid economic growth and advance in technology enjoyed in the world today has been responsible to a large extent for the devastating environmental damage that has occurred in some parts of the world including the South-south region of Nigeria. The South-south is a region in Nigeria that is heavily polluted by gas flares. EPA explained that greenhouse gas contributes immensely to global warming and climate change by making the planet warmer and thickening the earth's blanket (U.S. Environmental Protection Agency, 2015). The EPA (2015) argues that if flaring remains unchecked, the consequences of climate change and harsh living condition will exacerbate and the global environmental quality will be compromised.

Gas flaring involves the practice of burning off the natural gas associated with petroleum into the atmosphere instead of deploying alternative removal methods that are environmentally friendly. Gas flaring is the primary source of anthropogenic pollutants that are responsible for poor air quality, serious public health issues and ecological degradation in this region. Ismail and Umukoro observed that in 2002 Saudi Arabia, Canada, and Algeria flared 20%,8% and 5% of their natural gas respectively, while Nigeria that is only behind Russia flared 76% of its natural gas (Ismail & Umukoro, 2012). Oil and gas companies often use burning for safe disposal of waste gases during process upsets, start- up, shutdown or during operational emergencies while venting is used as a controlled release of gases into the atmosphere during production operations. Tonje Roland explained that some associated petroleum gas (APG) must be flared for safety reasons pointing out that about 45% of the gas produced is burned on sites in Russia higher than the required secured level (Roland, 2010). Apart from the harmful effects on the ecology and public health, gas flaring is a total economic waste that results in loss of corporate and national revenues. Per Nigerian National Petroleum Corporation (NNPC), gas flaring has been estimated to cost Nigeria over $2 billion annually in revenue loss (NNPC, 2014). APG flare above the standard safety level has a devastating consequence that cut across public health, ecology and the economy.

Why is gas flaring harmful?

Gas flaring is wasteful and environmentally harmful. Gas flaring releases several pollutants, including greenhouse gases such as carbon dioxide and methane, into the atmosphere, which contribute to climate change. These pollutants can damage human health and the environment.

ENVIRONMENTAL IMPACTS OF GAS FLARES IN THE SOUTH-SOUTH REGION OF NIGERIA.

Air Pollution

Gas flares release a variety of pollutants into the air, including carbon dioxide, methane, sulfur dioxide, nitrogen oxides, and black carbon. These pollutants can cause respiratory problems, heart disease, cancer, and other health problems. They can also damage ecosystems and contribute to climate change

Figures 1 & 2: Samples of Gas flaring in the south-south region of Nigeria.

Depletion of vegetation

Sulfur dioxide and nitrogen oxides from gas flares can react with water vapour in the atmosphere to form acid rain. Methane in the hydrocarbon can be burnt-off into the atmosphere, into carbon dioxide and mixes with water (Ujile, 2021b). Acid rain can damage forests, lakes, and streams and harm aquatic life.

Corrosion of structures

Carbon dioxide and methane from gas flares are greenhouse gases that contribute to climate change. Climate change can lead to a variety of negative impacts, including more extreme weather events, rising sea levels, and changes in plant and animal life. Acid rain and other complexes formed in the atmosphere cause corrosion.

Fig.3: Corrosion of structures.

Image obtained from https://www.pcimag.com/articles/109648-five-disasters-caused-by-corrosion

Impact of gas flares on zinc roofs

Zinc roof tops are particularly vulnerable to the corrosive effects of pollutants from gas flares. This can lead to premature damage and replacement of the roofs, which is costly and environmentally damaging.

- **Corrosion:** The pollutants from gas flares can cause zinc roof tops to corrode prematurely. This can lead to leaks, rust, and structural damage.

- **Shortened lifespan:** Zinc roof tops that are exposed to gas flares typically have a shorter lifespan than those that are not. This can increase the cost and environmental impact of replacing roofs
- **Reduced property value:** Properties with damaged zinc roof tops may have a lower property value.
- A study found that zinc roof tops in the Niger Delta corroded at a much faster rate than those in other parts of Nigeria (Abali et al., 2018). The study found that the Niger Delta region of Nigeria has a very high rate of corrosion of roofing sheets, especially those made of galvanized sheets, due to the high level of atmospheric pollutants emitted mainly from gas and other industrial activities.
- These pollutants react with the galvanized corrugated iron sheet, causing its deterioration. The study also mentions that air pollutants act faster in the dry season than the rainy season when acid rain is diluted beyond pH of 5.3, which is more than its corrosion strength (Abali et al., 2018).

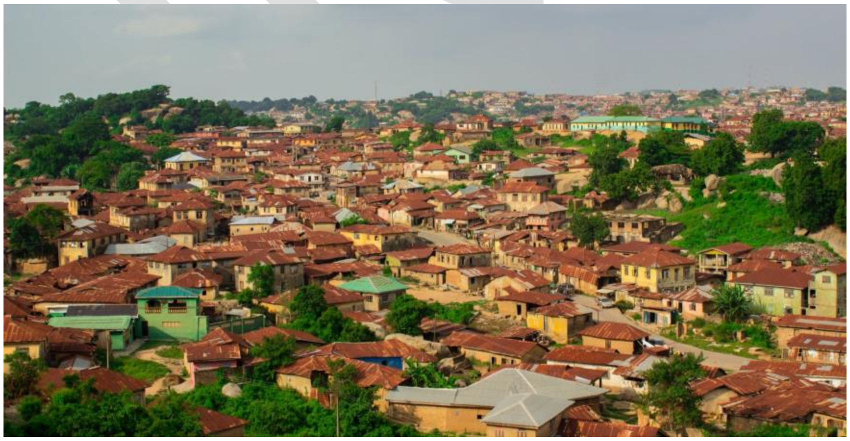

Fig. 4: Impact of gas flares on Zinc roofs

METHODOLOGY

Two communities were considered as in Southern Ijaw L.G.A and Twon Brass community in Brass L.G.A of Bayelsa State, Nigeria as shown in the Figure:

A. Ologbobiri

B. Ogboinbiri

C. Twon Brass

Map: The map indicting the study sites in respective Local Government Area of Bayelsa State, Nigeria.

Map source:https://www.researchgate.net/figure/Study-sites-in-respective-local-government-area-table-1-numbers-of-PSC-Collected-Culex_fig1_269984611

RESULTS AND DISCUSSION

Results obtained from the developed model are presented in Tables 1 and 2

Table 1: Concentration levels of active ingredient considered in roofing sheets from the study areas: Ologbobiri, Ogboinbiri and Brass.

Sample Location	Sample Identification	g/100g	(mg/kg)

Ologbobiri	A_{11}	6.45	0.022	32.95	<1.0	25
	A_{21}	1.67	0.019	26.07	<1.0	30
	A_{31}	1.48	0.009	31.93	<1.0	20
	A_{41}	0.98	0.015	22.14	<1.0	35
	A_{51}	1.8	0.024	30.9	<1.0	28
Ogboinbiri	B_{11}	2.56	0.019	26.66	<1.0	36
	B_{21}	1.56	0.013	13.97	<1.0	52
	B_{31}	1.14	0.011	14.81	<1.0	56
	B_{41}	0.92	0.008	15.9	<1.0	49
	B_{51}	1.25	0.014	18.61	<1.0	46
Brass	C_{11}	1.39	0.013	26.89	<1.0	51
	C_{21}	1.43	0.014	17.37	<1.0	49
	C_{31}	2.08	0.021	15.59	<1.0	45
	C_{41}	1.18	0.015	17.6	<1.0	40
	C_{51}	1.29	0.024	19.47	<1.0	38
(Conc) New Zinc roofing sheet		10.2	0.035	41.56	<1.0	<1.0
		Zinc	Chromium	Iron oxide	Sulphate	Chloride

Table 2: Estimated corrosion on samples of zinc coated steel from the study areas: Ologbobiri, Amassoma, and Ogboinbiri

Sample Location	**Sample Identification**	**Surface Area (cm^2)**	**Surface Area (inch^2)**	**Initial weight (g)**	**Final weight (g)**	**Weight loss (g)**	**Duration (Year)**	**Corrosion rate (mpy) (eight loss x 22300)/ a.d.t**
Ologbobiri	A_{11}	407	65.12	48	35	13	01-May	0.514
	A_{21}	38	60.8	50	48	2	05-Oct	0.034
	A_{31}	220.73	35.32	55	48	7	15-Oct	0.1225
	A_{41}	364.64	58.34	50	37	13	15-30	0.091
	A_{51}	385.2	61.63	50	48	2	<1	0.501
Ogboinbiri	B_{11}	363.5	58.16	40	35	5	02-May	0.2214
	B_{21}	208.52	33.36	30	25	5	05-Oct	0.1544
	B_{31}	208.52	33.36	30	25	5	15-Oct	0.093
	B_{41}	284.2	45.47	37.5	25	12.5	15-30	0.0965
	B_{51}	418	66.88	50	48	2	<1	0.462
Brass (Control)	C_{11}	440	70.4	50	40	0	01-May	0
	C_{21}	479	75.68	50	49.5	0.5	05-Oct	0.0068

	C_{31}	404	64.64	75	74	1	15-Oct	0.00543
	C_{41}	409	65.5	62.5	62	0.5	15-30	0.00268
	C_{51}	517.5	82.8	55	55	0	<1	0

MASS TRANSFER APPLICATION IN CORROSION KINETIC STUDIES/PROTECTION

Mass transfer kinetics are important for understanding and controlling corrosion rate.

- Mathematical correlations were developed to predict the behaviour of iron roofing sheets on exposure to different environmental conditions.
- The analytical results from Atomic Absorption Spectroscopy (AAS) of chromium, iron oxide and zinc contents for the locations considered were fed into the developed equation.
- Corrosion rates were determined by weight loss method and model equation, and the results from the two methods are in agreement.
- Corrosion rates by weight loss method were 0.514mpy and 0.221mpy for locations A and B respectively within the first five years; while corrosion effects on roofing sheet were noticed to be 0.0068mpy at location C from 5 – 10 years. The developed model provides solutions which have direct application to the prediction of corrosion rates on iron roofing sheets.

The rate constants for location A is 0.36/hr; and location B = 0.174/hr; location C = 0.

CONCLUSION

- The kinetic processes of corrosion rates established in this work are applicable in any environment similar to the one considered (coastal/industrial).

- The correlations of rate constants to corrosion rates are innovations that should be studied further for baselines to determine corrosion rates
- This should override the weigh loss method that most times gives low precision and unreliable data.
- The research has shown clearly that corrosion of the iron/zinc roofing sheet is more pronounced in the industrial/coastal environment when compared to the city of Brass in the hinterland of Bayelsa state.
- That is to say in the minimum, that the industrial activities in these regions have brought about an accelerated corrosion rate.

RECOMMENDATION

These challenges faced by local communities from gas flares are enough ways for ending gas flaring practice in South-south, Nigeria.

The Government should make stringent laws and take drastic action against defaulting companies not just by payment of fines but the penalty issued for gas flaring should be made stringent as to compel oil and gas operators to redesign their facilities in such a way to avert environmental degradation.

Furthermore, the gas flare flues can be processed and converted into energy.

Environmentalist and human right activists should not get tired in their quest to ending the practice in the oil producing areas South-South, Nigeria.

REFERENCES

1. Abali, H. W., et al (2018). Corrosivity of pollutants from gas flares on galvanized roofing sheets in Idu, Rivers State, Niger Delta of Nigeria. Journal of Environment Pollution and Human Health, 6(1), 1-6.
2. Ismail, S. O., & Umukoro, E. G. (2012, July). Global Impact of Gas Flaring. Energy and Power Engineering, 4, 290-302. https://doi.org/10.4236/epe.2012.44039
3. Roland, T. H. (2010). Associated Petroleum Gas in Rusia: Reasons for non-utilization Fridtjof Nansens Institutt. Fridtjof Nansens Institutt.
4. Ubong, I. et al (2001): Modelling corrosion Rates or Corrugated Iron Roofing Sheets in three locations in Akwa Ibom State, Nigeria, In: A Technical Report on the Air Quality, Precipitation and Corrosion Studies of Qua Ibo Terminal (QIT) flare and the environs. September 2001 pp 90-98. Client: Mobil Producing Nigeria Unlimited.
5. Ujile, A. A. and Ehirim, E.O. (2014). 'Mathematical Modelling of Corrosion Process of Zinc/iron roofing sheet in Coastal/Industrial Environment,' IOSR Journal of Engineering (IOSRJEN). ISSN €: 2250-3021, ISSN (p): 2278-8719 Vol.04, Issue 05 (May, 2014), ||V3|| PP27-35
6. Ujile, A. A. (2021b). Water-Energy-Food Nexus and Climate Change: The Challenges and Opportunities for Chemical Engineers, Plenary session Paper, 51st Annual Conference/AGM Nigerian Society of Chemical Engineers (NSChE), Theme: "Chemical Engineering and the Changing World" 10th – 13th November 2021.
7. Ujile, A.A. (2023). Inaugural Lecture Rivers State University, February: Contending with Reliability, Availability, Sustainability of Water and Infrastructure Protection using Chemical Engineering Mass Transfer, Series No. 85

8. https://www.flickr.com/photos/foeaction/3201462147/in/album-72157612649194256/ (Accessed on 8th September 2023) https://www.flickr.com/photos/foeaction/3201462147/in/album-72157612649194256/
9. (https://www.researchgate.net/figure/map-of-Akwa-Ibom-State-Showing-Local-Government-Areas fig6_320450251 Accessed on 8th September 2023)
10. U.S. Environmental Protection Agency (EPA). (2015, September 14). Sulfur Dioxide. Retrieved November 28, 2015, from EPA Web site: http://www3.epa.gov/airquality/sulfurdioxide