BENIN JOURNAL OF PHYSICAL SCIENCES
BJPS Vol. 1(1), June, pg. 19-26 (2024)
www.bjps.org.ng

The Air Quality Measurement of OML-147 Flow and Environs Located at Owa-Alidinma, Delta State, Nigeria

J. C. MORKA

Department of Physics, University of Delta, Agbor, Delta State, Nigeria.

Received: 11/04/2024 ***Accepted:*** 20/05/2024

Abstract

This study investigated the environmental and health impact of gas flaring of the OML-147 flow station located at Owa-Alidinma, Delta State. Air quality parameters were measured in four locations. Carbon (iv) oxide, CO_2, measurements were carried out using a non-dispersive infrared (NDIR) analyzer, particulate matter $PM_{2.5}$ and PM_{10} measurements were conducted using beta attenuation monitor (BAM) and a tapered element Oscillating microbalance (TEOM) respectively. Noise levels were assessed using a sound level meter. Nitrogen dioxide, NO_2, measurements were carried out using a chemiluminescence continuous analyzer. Simple statistical tools of mean, standard deviation, standard error and percentage were employed in the analysis of data. The mean values of the air quality parameters studied in this paper when compared with WHO guideline limits were $PM_{2.5}$ $(0.009\mu g/m^3 < 15\mu g/m^3)$, $PM_{10}(0.014\mu g/m^3 < 15\mu g/m^3)$, $NO_2(0.070\mu g/m^3 < 25\mu g/m^3)$, $O_3(0.018\mu g/m^3 < 100\mu g/m^3)$, SO_2 (undetected), $CO(0.200\mu g/m^3 < 4\mu g/m^3)$. These were all below the WHO and NUPRC guideline limits and so negative impacts on the ecosystem are unlikely. The noise level mean value (86.8dBA) compared to 70dBA and 75dBA recommended by WHO and NUPRC respectively were higher by 24 % and 15.7 % respectively.

Keywords: *Flaring, Environment, Noise, Particulate, Pollution*

1. INTRODUCTION

Gas flaring is a common practice in the oil and gas industry, where unwanted gases are burned off during the production process or even sometimes vented when regulatory frame work governing gas operation becomes a hindrance or when re-injecting the connected gas back into the reservoir is not achievable.

*Corresponding author, e-mail: johnmorka2@gmail.com

While this may seem like a harmless practice, it has severe environmental and health implications. Gas flaring is a significant contributor to air pollution and climate change, emitting harmful pollutants such as carbon (iv) oxide, sulfurous acid anhydride, and nitrogen oxide into the atmosphere. Furthermore, the toxic smoke from gas flaring can cause respiratory problems, skin irritation, and other serious health complications for people living in nearby communities (Ismail and Umukoro, 2012).

Gas flaring has been a topic of concern for many years, and extensive research has been conducted to explore its environmental and health implications. Several studies have documented that high levels of gas flaring are associated with increased health challenges. (Alam *et al*, 2020). However, Roupa and Isaiah (2020) developed a cogeneration gas turbine system that harnesses waste gases emitted during gas flaring to generate electricity and other valuable products like chemical feedstock's.

A study conducted by Alam *et al.* (2020) found that gas flaring operations in the Niger Delta significantly contributed to air pollution, exposing the surrounding communities to harmful pollutants and causing severe health problems. This is a clear indication that gas flaring poses a significant threat to environmental sustainability and calls for immediate action.

This paper therefore assessed the environmental effects of gas flaring in the OML-147 flow station location located at Owa-Alidinma, Delta State, Nigeria. The study also examined the levels of pollution caused by gas flaring and whether they meet the global standard levels. Also carried out in this work are the impacts of gas flaring on the health and well-being of the local communities and the measures that can be taken to mitigate these impacts.

2. MATERIALS AND METHODS

2.1 *The Study Area*

The study was carried out at the Oil Mineral Lease (OML-147) flow station located at Owa- Alidinma in Ika South Local Government Area, of Delta State, Nigeria. The OML-147 is owned by the Nigerian National Petroleum Cooperation (NNPC)/Pan Ocean Oil Cooperation joint venture gas gathering station with open gas flaring facility. Geographically, the facility is located at latitude 6.0265^0 N and longitude 6.2854^0 E in Delta State, Nigeria. The facility is bounded by Ekuku-Agbor town to the North, by Oliogo town to the South, Ejeme-unor town to the East, and Obi-Anyima town to the West.

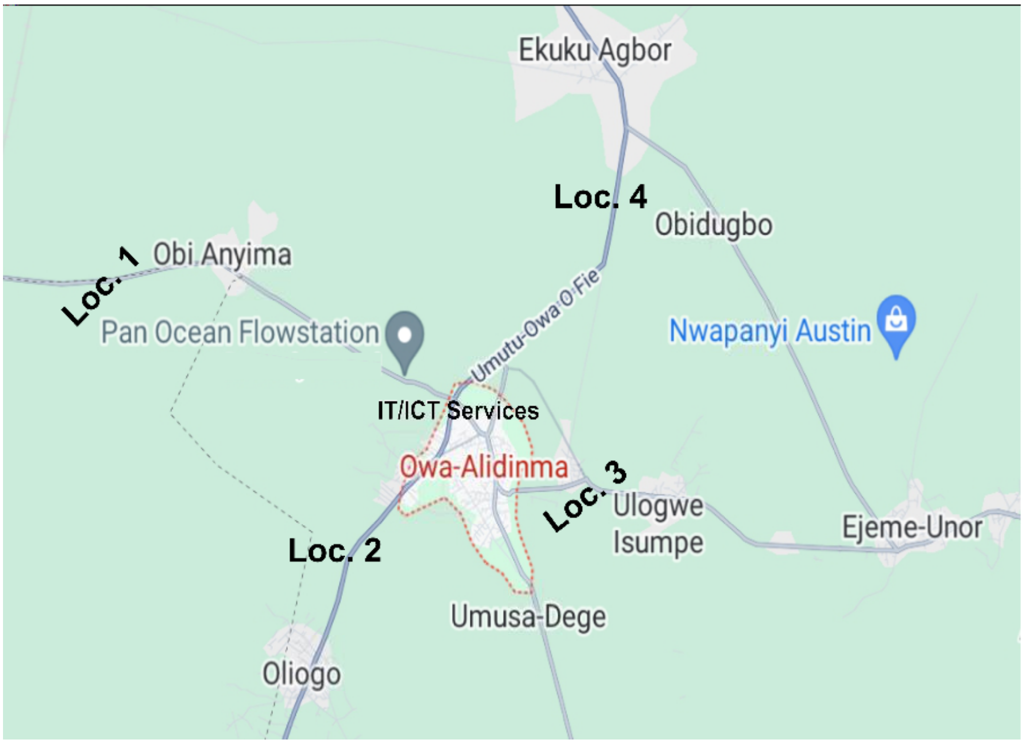

Figure 1: *Map of Owa-Alidinma, showing the OML-147 location.*

The Owa-Alidinma flow station has two different flare stacks and these are; one vertical flare stack and one horizontal flare stack.

Figure 2: *OML-147 Vertical gas flare stack at Owa-Alidinma flow station (Azeez, 2017).*

Figure 3: *OML-147 Horizontal gas flare stack at Owa-Alidinma flow station (Azeez, 2017).*

2.2 Sample Locations

Four sampling locations were wittingly selected for the air quality parameters.

Location 1: Upstream of the OML-147 flow station (120 m from the flow station)

Location 2: Downstream of the OML-147 flow station (220 m from the flow station).

Location 3: Small camping area within the OML-147 along Ejeme-Unor Road. (520 m from the flow station).

Location 4: Control: After the IT/ICT junction, towards Ekuku-Agbor (1000m from the flow station).

2.3 Data Collection

The study was conducted around the surrounding areas of the OML-147 Flow station located in Owa-Alidinma, Delta State. Measurements of gases such as CO_2, NO_2, O_3, SO_2, H_2S, CH_4, CO, and NH_3, as well as particulate matter ($PM_{2.5}$ and PM_{10}), noise level, wind speed (WS), relative humidity (RH), and temperature were conducted using various measurement techniques. Samples were collected between 8:30am and 9:30am (30 minutes) for four months duration in the month of June to September 2023 (Totaling 122 days).

CO_2 measurements were carried out using a non-dispersive infrared (NDIR) analyzer (Nwaichi and Uzazobona, 2011), NO_2 measurements were conducted using a chemiluminescence continous analyzer (Satish *et al.*, 2018), Ozone (O_3) was measured using an ozone analyzer equipped with an ultraviolet (UV) absorption cell (Efe and Ede, 2017), SO_2 measurements were carried out using a UV fluorescence analyzer (Rattanapan and Sudprasert, 2019), while H_2S measurements were conducted using a lead acetate tape analyzer. CH_4 measurements were conducted using a non-dispersive infrared (NDIR) analyzer, and CO measurements were conducted using an electrochemical sensor (Nwakire, 2014). NH_3 concentrations were measured using a chemiluminescence analyzer. Pm2.5 and Pm10 measurements were conducted using a beta attenuation monitor (BAM) and a tapered element oscillating microbalance (TEOM), respectively (Yeheyis *et al*, 2019). Noise levels were assessed using a sound level meter (Siong *et al*, 2018), and WS, RH, and temperature were measured using their instruments anemometers, hygrometers, and thermometers, respectively.

3. RESULTS AND DISCUSSION

The air quality parameters measured at the experimental locations are presented in Table 1. $PM_{2.5}$ with a mean value of 0.009 ± 5.19$0.009 \pm 5.19 \times 10^{-6}$μg/m^3 had its maximum (0.012μg/m^3 at location 3, and minimum (0.090μg/m^3) at location 4. PM_{10} with a mean value of $0.014 \pm 0.00\ \mu g/m^3$ had its maximum ($0.017\ \mu g/m^3$) at location 3 and minimum value of ($0.090\ \mu g/m^3$) at location 1,2 and 4.

NO_2 with a mean value of $0.070 \pm 8.2 \times 10^{-6}\ \mu g/m^3$ had its maximum (0.090 $\mu g/m^3$) at location 4 and minimum (0.057 $\mu g/m^3$) at location 1.

CO and NH_3 mean values of $0.200 \pm 0.00 \mu g/m^3$ respectively also had same value across locations 1,2,3 and 4. SO_2, CH_4, and H_2S were undetected in this study.

O_3 with a mean value of $0.018 \pm 0.00\ \mu g/m^3$ had its maximum ($0.030\ \mu g/m^3$) at location 3, and minimum value of $0.011\ \mu g/m^3$ at locations and 4 respectively. The mean noise pollution level in this study was $86.8 \pm 8.21 \times 10^{-4}$ dBA, with a maximum (88.1 dBA) at location 4 and minimum (85.7 dBA) at location 2.

The mean noise pollution level $86.8 \pm 8.21 \times 10^{-4}\ dBA$ far exceeded WHO and NUPRC standards. This high level of noise suggest that residents around Owa Alidinma OML-147 flow station may experience hearing lost and emotional stress (Siong *et al*, 2018).

Table 1: *Composition of flared gases in the four selected Locations around the OML-147 flow station.*

Gases	Unit of Measurement	Measured Values					WHO Daily Standard Compared	NUPRC Standard Compared
		Location 1	Location 2	Location 3	Control 4	Mean Values		
Pm 2.5	$\mu g/m^3$	0.009	0.009	0.012	0.008	0.009	15	35
Pm 10	$\mu g/m^3$	0.013	0.013	0.017	0.013	0.014	45	25
NO_2	$\mu g/m^3$	0.057	0.065	0.069	0.090	0.070	25	0.06
CO	$\mu g/m^3$	0.200	0.200	0.200	0.200	0.200	4	10
SO_2	$\mu g/m^3$	0.000	0.000	0.000	0.000	0.000	40	0.01 – 0.10
CH_4	$\mu g/m^3$	0.000	0.000	0.000	0.000	0.000		2
H_2S	$\mu g/m^3$	0.000	0.000	0.000	0.000	0.000		120
O_3	$\mu g/m^3$	0.020	0.011	0.030	0.011	0.018	100	0.070
NH_3	$\mu g/m^3$	0.200	0.200	0.200	0.200	0.200		0.055
CO_2	$\mu g/m^3$	614	567	549	526	564		
Noise	Dba	87.3	85.7	86.2	88.1	86.8	70	75
Temp.	^oC	34.0	30.5	30.6	31.5	31.7		
Wind Speed	m/s	0.90	0.90	1.90	2.00	1.43		
Wind Direction	-	WS 52^O	NE 25^O	NE 37^O	NE 25^O			
Relative Humidity	%	65.4	67.9	71.7	78.2	71.3		

Legend: WS = West South, NE = North East

Source: Fieldwork by Researcher, 2023; 9:30am – 10:00am (30 minutes); averaging period of 24hours. WHO standard, 2021; NUPRC, 2023.

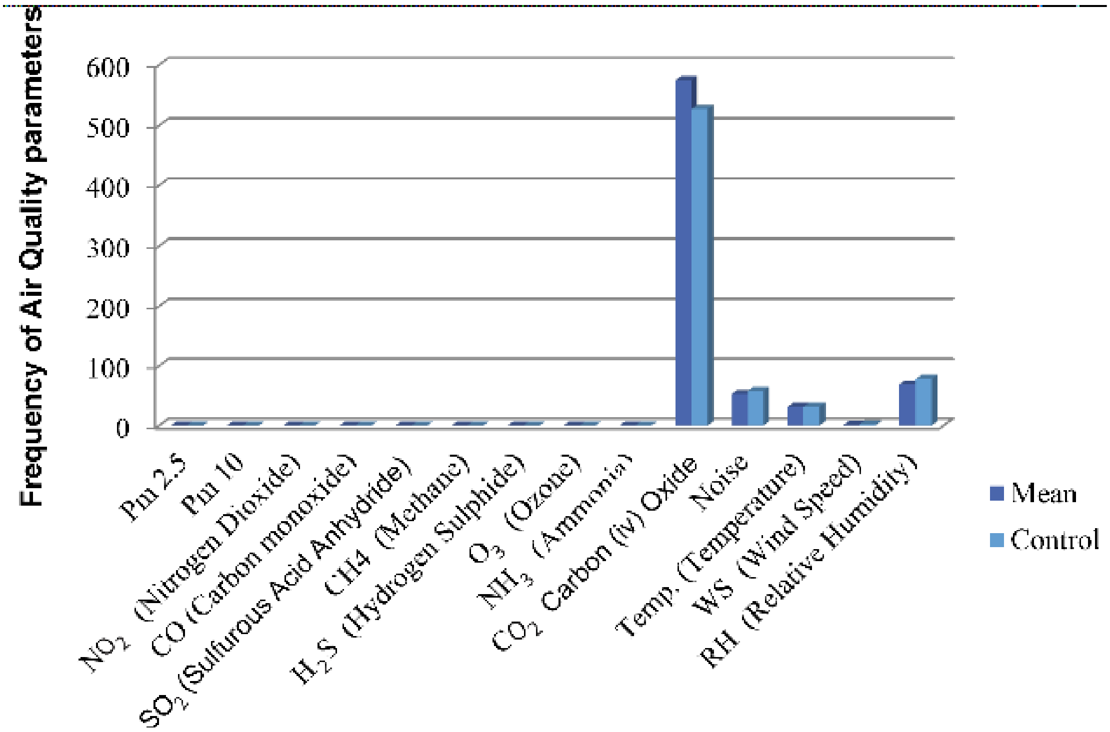

Figure 4: *Frequency of air quality parameters*

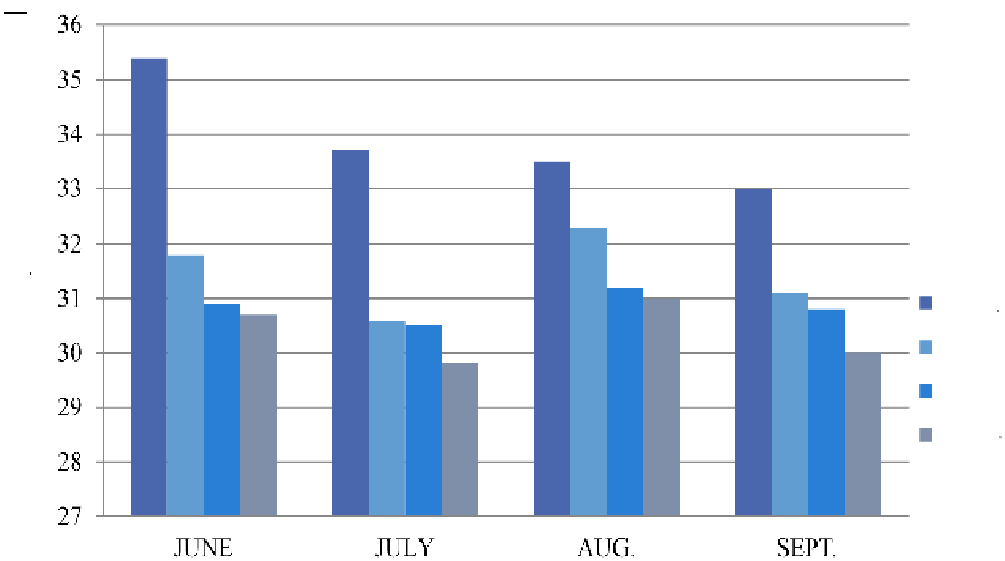

Figure 5: *Temperature records in the sampling locations*

Figure 4 showed that the frequency of CO_2 released from gas flaring at the Owa-Alidinma OML-147 flow station exceeded levels recorded at the Control locations.

Figure 5 shows that Location 1 consistently recorded the highest temperature values across all sampling periods, followed by Location 2 and 3, respectively while the Control location consistently had the lowest temperature values. The high temperature values recorded in this study was as a result of increased thermal energy radiation due to gas flaring activities associated with the OML-147 station located at Owa-Alidinma. This high temperature regime has negative effect on vegetation leading to decrease in growth and productivity and balance ecosystem (Akuro, 2012).

4. CONCLUSION

The findings of this study highlight's the need for urgent mitigation measures to urgent mitigation measures to reduce noise pollution from gas flaring at the OML-147 flow station and environ located at Owa-Alidinma, Delta State.
Arising from the above findings, the researcher recommends

- The use of flaring monitoring systems and optimizing process controls to help reduce the identified flaring levels at the OML-147 flow station located at Owa-Alidinma.
- The use of modern flare tips with appropriate design configurations in other to adequately address fuel and air mixing during operations.
- Carbon capture and storage (CCS) technology has been identified to be used to reduce greenhouse gas emissions from gas flaring. This should be encouraged by the relevant agencies for compliance.

CONFLICT OF INTEREST

No conflict of interest was declared by the authors.

REFERENCES

[1] Akuro, A. (2012): Air quality survey of some locations in the Niger Delta Area. *Journal of Applied Science and Environmental Management*. 16(1), 137-146.

[2] Alam, M. S., Islam, M. A., and Hassan, M. K. (2020). Impacts of the gas flaring activities on air quality and human health in the Niger Delta region of Nigeria. *Environmental monitoring and assessment*, 192(1), 1-18.

[3] Azeez, G.A (2017): Natural gas flaring-Alternative solutions. *World Journal of Engineering and Technology* 5, 139-153. https:doi.org/10.4236/wjet. 2017.51012

[4] Efe, S. I., and Ede, P. N. (2017). Impact of gas flaring on air quality and health in the Niger Delta region of Nigeria. *International Journal of Environmental Science and Technology*, 14(4), 797-810.

[5] Ismail, O.S and Umukoro, G.E (2012). Global Impact of Gas Flaring. *Energy and Power Engineering.* 4(4) 290-302 doi:10.4236/epe.2012.44039.

[6] Nigerian Upstream Petroleum Regulatory Commission (NUPRC), 2023.

Nwaichi, E.O and Uzazobona, M.A, (2011). Estimation of the CO_2 level due to gas flaring in the Niger Delta. *Research Journal of Environmental Sciences* 5 (6), 265-570.

[7] Nwakire, C. (2014). The impact of gas flaring on the air quality: A case study of Izombe in Eastern Nigeria. *International Journal of Engineering Research and Reviews.* 2(3) 61-71

[8] Rattanapan, S., and Sudprasert, W. (2019). Sulphur dioxide sources from geothermal power plants: A review. *Journal of Environmental Management*, 244, 399-407.

[9] Roupa, A. and Isaiah, A. (2020): Techno-economic and performance analysis of associated gas utilization in gas turbines. *Journal of New views in Engineering and Technoloy (JNET).* 2(1), 2020.

[10] Satish, U., Rajasekaran, S., and Kumar, A. N. (2018). A review on nitrogen oxides emissions from combustion sources. *Journal of Environmental Management*, 212, 355-367.

[11] Siong, W., Sambile, J., and Justin, D. J. (2018). Ambient noise level measurements in oil and gas drilling rig sites. *Malaysian Journal of Public Health Medicine*, 18(1), 153-157.

[12] Yeheyis, M., Fenta, A., and Dibaba, A. (2019). Air quality monitoring and analysis of gaseous pollutants: A review. *Journal of Environmental Management*, 231, 10-22.