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Monitoring of Dumpsite Gas Emission and Its Implications to Health

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ABSTRACT

This study monitored the emission of gases and particulate matter from a dumpsite in Ikot Ekpene L.G.A., Akwa Ibom State, using an Industrial Gas Analyzer FD 600 forensic detector. The measured concentrations were carbon monoxide (CO) at 2 ppm, carbon dioxide (CO_2) at 416 ppm, formaldehyde (HCHO) at 0.008 mg/m³, total volatile organic compounds (TVOCs) at 0.016 mg/m³, particulate matter $(PM)_{2.5}$ at 12 µg/m³, PM_{10} at 129 µg/m³, hydrogen sulfide (H_2S) at 0.2 ppm, ammonia (NH_3) at 0.2 ppm, and methane (CH_4) at 0.2%. The Air Quality Index (AQI) was 118, while the temperature and humidity were 30°C and 80%, respectively. Results show that H_2S and PM_{10} exceeded permissible limits, posing health risks, while other pollutants were within standard thresholds. The findings highlight the need for improved waste management practices to mitigate environmental and health impacts. **KEYWORDS:** Gas emission, Dumpsite, Particulate Matter, Air Quality Index, Health Risk

1. INTRODUCTION

The practice of dumping solid waste in open space is still obtainable the world over, both in developed and developing countries. This system of open dumping of waste comes with its attendant impact on the environment and public health[1]. The rise in the production of municipal solid waste with its hazardous effect on the environment and public health in Bangladesh has been linked to rapid population growth and urbanization[2,3,4]. The prevalence of this open solid waste disposal in Nigeria has been attributed to insufficient waste management capacity and unplanned development amongst other factors[5]. Also lack of organized landfill sites, deficient urban planning and negligence in the enforcement of waste disposal regulations were observed as reasons why dumpsites are found in residential areas of developing countries[6].

The site where solid wastes are disposed without environmental controls is referred to as dumpsite[7]. One of the major challenges faced by developing countries is the disposal of waste[8]. Waste disposal to open dumpsites is a common practice in developing countries[9].

Effort had been made to design an engineered (Semi – aerobic) landfill in Akure with a view to motivate a shift from using dumpsite which had been the major waste disposal method in Nigeria amidst its negative impacts on the environment[10], but a study had noted lack of enough land for sitting landfill as a major issue[11].

Open dumping has been classified as a type of landfills in addition to semi-controlled landfill and the sanitary landfill[12]. Landfill gas and Biogas are produced through biological decomposition process produces biogas[13,14].

Microbial activity on biodegradable wastes is responsible for the continuous production of landfill gases[15]. Waste degradation in landfills produces leachate and gases such as methane, carbon dioxide and green-house gases[16,17]. Although landfill methane can help to produce electricity, generating CO_2 as by-product, which produces less effect of global warming[18], the emissions from landfills affect environmental quality and human health[16]. CO_2 emission into the atmosphere can lead to global warming and ozone layer depletion[19,20,17].

Open dumpsite causes air pollution issues as the biogenic hydrocarbon gases like polychlorinated dibenzo – p – dioxins, non-methanic volatile organic compounds, polycyclic aromatic hydrocarbon and dioxin, release during the anaerobic microbial attack on the solid waste are converted to gaseous pollutants like hydrogen sulphide, carbon monoxide, ozone, sulphur dioxide, carbon dioxide and oxides of nitrogen[21]. Particulate matters (PMs) are generated in dumpsites when decomposed wastes are

disperse by wind and also due to certain anthropogenic activities such as sorting of waste, tipping and waste compaction by bulldozers, stock piling of soil and other related activities[22].

There is a certain claim by some environmentalist that the negative impact of PM on public health has caused premature deaths of about 22,000 adults and 700 teenagers[23].

Landfill areas produces foul smell and vermin which is the major cause of diseases. Respiratory illnesses and cancer are associated with landfill site exposure[24]. Landfill impact socioeconomic and public health as a result of groundwater contamination and the diffusion of leachate into the wider ecological system due to insufficient recycling site activities[25]. Research have shown that the quality of groundwater closed to dumpsite is affected by the subsurface percolation of the leachates[26]. With the dearth of data on dumpsite gas emissions in Ikot Ekpene and due to the proliferation of dumpsite in residential areas with its attendant impacts on public health and environment, this study was therefore carried out to monitor gas emissions from dumpsite and its implications to health, as it might be useful to the authorities concerned.

2. MATERIALS AND METHODS

2.1 Gaseous Emission Data Acquisition

The data were collected from a dumpsite along Aba road in Ikot Ekpene L.G.A of Akwa Ibom State, South South of Nigeria with the Global Position System (G.P.S) coordinates of N5^0 8^{1}17.05884" latitude and E 7^{o}42^{1}55.13724" longitudes. The research was carried out in the morning hours by 11am for a period of 1 hour during the dry season using an Industrial Gas Analyzer FD600 Forensic Detector. The air quality detector was used for the measurement of air quality index (AQI), carbon monoxide (CO), carbon dioxide (CO_2) total volalite organic compounds (TVOCs), hydrogen sulphide (H_2S), ammonia (NH_3), methane (CH_4), fomaldehyde (HCHO), particulate matters ($PM_{2.5}$ and PM_{10})

2.2 Procedure for the operation of the Gas Monitor:

The unit was placed in normal air, and the switch was turned to the gas position. The red LED and the sounder was beeped three times every one second. The LED was displayed to show 0.00 or 20.9. If not, the ZERO was re-set to adjust until the display read 0.00, or the CAL preset was adjusted to read 20.9. At this instant, the detector was ready for use. The unit was held at arm's length at 1.5m about ground level, then the unit was adjusted to alarm position to check battery level and gas position was then turned then the reading was taken to the LED display.

3. RESULTS AND DISCUSSION

3.1 Results

The results for the monitoring of dumpsite gas emission in Ikot Ekpene L.G.A., Akwa Ibom is shown in Table 1.

CO (ppm)		2		10		9
CO_2 (ppm)		416		-		-
HCHO (mg/m^3)	0.008		0.1		0.1	
TVOC (mg/m^3)	0.016		0.5		0.3	

Pollutants	Concentration	FEPA	WHO
$PM_{2.5}$ (µg/m³)	12	25	10
PM_{10} (µg/m³)	129	50	50
H_2S (ppm)	0.2	0.005	-
NH_3 (ppm)	0.2	0.2	0.2
CH_4 (%)	0.2	-	-
AQI	118	-	-
Temperature (°C)	30	-	-
Humidity (%)	80	-	-

Table 1 Results of dumpsite gas emission in Ikot Ekpene.

3.2 Discussion

The data obtained from this study confirmed the emission of various pollutants from the dumpsite in Ikot Ekpene, Akwa Ibom State, Nigeria. The observed pollutants are due to waste degradation in the dumpsite (Sallam, 2020). The pollutants monitored were CO, CO_2, HCHO, TVOC, $PM_{2.5}$ and PM_{10}, H_2S, NH_3, and CH_4. AQI of the location was also determined in addition to temperature and humidity. The concentrations of CO, CO_2, NH_3, CH_4, HCHO, and TVOCs were within acceptable thresholds.

Regarding particulate matter, the site presents mixed results. The $PM_{2.5}$ concentration of 12 µg/m³ is compliant with FEPA's 25 µg/m³ threshold but slightly exceeds WHO's more stringent 10 µg/m³ guideline. However, the PM_{10} concentration, recorded at 129 µg/m³, surpasses both FEPA and WHO recommended limits of 50 µg/m³, raising significant health concerns. Elevated PM_{10} levels are associated with respiratory and cardiovascular complications, especially among children, the elderly, and individuals with preexisting conditions[27,28]. Similarly, a study reported PM_{10} values averaging 130 µg/m³ around open dumpsites in Nigeria, attributing the cause to airborne dust and the uncontrolled combustion of waste[29]. Mitigation strategies such as establishing vegetative buffers and dust suppression systems could play a crucial role in controlling particulate spread[30].

The hydrogen sulfide (H_2S) concentration was found to be 0.2 ppm, which significantly exceeds the FEPA guideline of 0.005 ppm. H_2S, often released during the anaerobic breakdown of sulfur-rich organic materials, is a well-documented hazardous gas with a distinctive rotten egg odor. Short-term exposure to H_2S at such levels may cause mucosal irritation, respiratory distress, and nausea[31]. Comparative studies such as that by Musa *et al.*[32], confirmed elevated H_2S emissions in unmanaged landfill zones across southwestern Nigeria, reinforcing the necessity for gas collection and odor control systems. Reducing the volume of sulfur-containing waste and adopting anaerobic digestion technologies could mitigate such emissions.

The Air Quality Index (AQI) measured at 118 indicates that air conditions are "Unhealthy for Sensitive Groups." This classification reflects cumulative exposure to elevated particulate and gaseous pollutants and signals heightened risk to individuals with respiratory conditions, children, and older adults[33]. Recent work by Abubakar *et al.*[34] on peri-urban dumpsites in northern Nigeria observed similar AQI ranges, underlining the correlation between poor waste handling and degraded air quality. This necessitates urgent reforms in landfill management practices.

Environmental parameters recorded a temperature of 30°C and a relative humidity of 80%, which are characteristic of tropical regions. These climatic conditions are known to intensify microbial activity, thereby accelerating the decomposition of organic matter and the subsequent emission of gases such as CH_4, NH_3, and H_2S[35]. Efficient environmental controls and periodic aeration can help moderate these emissions.

Overall, the data point to specific pollutants—especially PM_{10} and H_2S—as major contributors to air quality degradation around the dumpsite. Coordinated efforts involving source reduction, improved waste segregation, vegetative buffers, and gas recovery technologies are imperative to mitigate both public health and environmental impacts.

4. CONCLUSION

The findings of this study reveal that gas emissions from the monitored dumpsite in Ikot Ekpene pose significant health and environmental concerns, particularly due to elevated levels of hydrogen sulfide (H_2S) and particulate matter (PM_{10}), which exceeded permissible limits. Although other pollutants such as CO, CO_2, NH_3, CH_4, HCHO, and TVOCs were within acceptable thresholds, the Air Quality Index (AQI) of 118 indicates that the overall air quality is unhealthy for sensitive groups. These results underscore the urgent need for effective waste management strategies and continuous environmental monitoring to safeguard public health and ensure sustainable urban living conditions.

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CONFLICT OF INTERESTS

The authors declare no conflict of interests.

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