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Effect of Temperature and Time on Assessment of Methane Production from Microbial Degradation of Solid Waste in Port Harcourt, Rivers State, Nigeria

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Abstract: ***This research was to investigate the effect of temperature and time on emission of Methanefrom breakdown of solid waste by Methanogens. The assessment was carried out in three (3) dumpsites atRumuokoro, Rumuosi and Eliozu, in the morning, afternoon and evening using lamcornIII which measured both atmospheric temperatures. At Rumuokoro dumpsite by 8.00hrs, 0.20ppm of Methane was emitted at 28^0C, by 14.00hrs, 0.10ppm of Methane was emitted at 31^0C and by 18.30hrs, 0.09ppm was emitted at 28^0C. In Rumuosi dumpsite at 20^0C 0.1ppm of Methane was emitted by 8.20hrs, 0.09ppm at 31^0C by 13.40hrs and 0.09ppm at 28^0C by 18.12hours. Similarly at Eliozu dumpsite by 10.30hrs, 0.09ppm was emitted at 30^0C, 0.09ppm at 30^0C by 13.00hours and 0.1ppm at 31^0C by 17.40hours. There was no significant relationship between Methaneemitted and atmospheric temperature (p>0.05). There was alsono significant relationshipbetween the time and emission of Methane (p>0.05). Consequently,Methane gas absorbs heat in the afternoon and release same in the morning and eveningwhen the Methanogens would have degraded the waste overnight. Methaneserves as alternative source of energy and production of ceramics if harnessed instead of acting as greenhouse gas which aids global warming.***

Keywords: Methanogens, Degradation, Landfilling, Biogas, Decomposition.

1. Introduction

Microbial degradation of solid waste implies the breaking down of organic components of waste to inorganic form by Microorganismswhich can readily serve as nutrient to variety of organisms and source of energy to humans. Waste can also be defined as materials which though may no longer be needed but may be used for other purposes (Oducha, 1994).

When waste is dumped on land, Methanogensreadily colonize them and carry out degradation or transformation of degradable (organic) materials in the waste; provided the right environmental conditions are present. One major problem of urbanization is solid waste generation (Onibokun, 1989).

When anaerobic bacteria decompose waste, the end product is Methane (Morns, 1996). Waste generation started from the early man, who used natural forest resources as food and shelter and subsequently discard the remnant either as food remains or as human waste (Wachukwuand Eleanya, 2007). The rate of decomposition depends on the temperature, carbon/nitrogen ratio, PH, moisture, oxygen and chemical composition of the waste (Medina, 1997).

Methane is also called “swamp gas”. It is a greenhouse gas formed as a result of decomposition of carbon containing substances found in oxygen free environments by Methanogens in landfills (Taraloand Taralo, 1999). Also Ruminating animals such as cattle, sheep and goat belch Methaneinto the air as a byproduct of digestion (Nester *et al.*, 2001). Methanogens produce Methane from the oxidation of hydrogen gas and the reduction of carbon dioxide as follows.

$$4H_2 + CO_2 \longrightarrow CH_4 + 2H_20$$

This is example of anaerobic respiration. Methane is lighter than air, colourless odorless and flammable. It has a melting point of 182^0C and boiling point of 161.5^0C. It is used as fuel in India to drive steam generators. Also used as raw materials in the manufacturing of chemicals, baking of bricks and ceramics tiles.

Methane is a primary constituent of landfill gas and a potent greenhouse gas when released to the atmosphere (Ackerman, 2000). Increase production of Methane contributes to greenhouse effect, with gradual global warming that could have dire results (EPA, 2008).

Globally, landfills are the third, largest human induced emission source of Methaneaccounting for about 12% of global Methaneemission (Oyegun and Ologunorisa, 2002).

According to an environmental protection agency report, (2008) an estimated global landfill Methaneemission is put at 747.38 million metric tons of carbon dioxide equivalent. The major factors driving landfill gas emission are the amount of organic material deposited in landfills, type of landfill practices, extent of anaerobic decomposition and the kind of landfill Methanerecovery and decomposition (Ayoade, 2003).

The study was carried out to ascertain the level of Methane gas emitted from the waste dump as a result of microbial degradation by Methanogens and also to ascertain if temperature and time have effect on the emission of Methane gas.

2. Materials and Methods

2.1 Study Area

The research was carried out in the city of Port Harcourt, Rivers State of Nigeria. The occupants are people from

different ethnic group and beyond and they include civil servants, farmers, fishermen, traders, oil and gas workers and expatriates from other countries. Port Harcourt has an international airport, seaport and a lot of migrant workers from other parts of the world. The city has quite a number of markets and sundry businesses and as such there is beehive of commercial and industrial activities which lead to an abundant generation of waste.

2.2 Study Sites

The study was carried out in seven waste dumpsites which were within the metropolis, the includeRumuokorodumpsite, Eliozu dumpsite and Rumuosi dumpsite.

2.3 Analysis

A total of 3 major dumpsites situated at Rumokoro, Rumuosi and Eliozu were visited in the morning, afternoon and evening hours at different times. The Methane gas and the atmospheric temperature were estimated at different times using Lamcam III gas analyzer which was suspended into the atmosphere or point source for about 10 minutes. The figures were displayed on the automated LCD screen of the equipment and recorded.

3. Result

The Methane emission at Rumuokoro, Rumuosi and Eliozu according to temperature and time is shown. There was no significant relationship between Methane production and atmospheric temperature ($p>0.05$). As shown in table 1.

The time also has no significant effect on Methaneemission $p>0.05$ as shown in table 2.

Figure 1 shows the graphical representation of Methane gas emitted in comparison to time and temperature. This shows no significant difference in emission of Methane in relation to time and temperature.

Table 1: Methane gas emission according to temperature and time at different locations

S/N	Location	Methane Result in ppm (%)	Temperature in ^{0}C (%)	Time in hours (%)
1	Rumuokoro	.20(21)	28.00(10.50)	8.00(6.60)
2	Rumuokoro	.10(10.50)	31.00(11.65)	14.00(11.60)
3	Rumuokoro	.09(9.50)	28.00(10.5)	18.30(15.15)
4	Rumuosi	.10(10.50)	29.00(10.90)	8.20(6.80)
5	Rumuosi	.09(9.50)	31.00(11.65)	13.40(11.10)
6	Rumuosi	.09(9.50)	28.00(10.50)	18.12(15.00)
7	Eliozu	.09(9.50)	30.00(11.30)	10.30(8.50)
8	Eliozu	.09(9.50)	30.00(11.30)	13.00(10.80)
9	Eliozu	.10(10.50)	31.00(11.65)	17.40(14.4)
	TOTAL	.95(100)	266.00(100)	120.72(100)

Table 2: Methane gas emission according to time of the day and dumpsite

Period of the day	Rumuokoro (o) (e)	Rumosi (o) (e)	Eliozu (o) (e)	Total	X^2	P.value (0.05)	Comment
Morning Hours	0.2(0.16)	0.1(0.15)	0.09(0.115)	0.39	0.017	<0.05	Not Significant
Afternoon Hours	0.1(0.115)	0.09(0.083)	0.09(0.083)	0.28	0.003	<0.05	Not Significant
Evening Hours	0.09(0.115)	0.09(0.083)	0.10(0.082)	0.28	0.01	<0.05	Not Significant
TOTAL	0.39	0.28	0.28	0.95	0.04	<0.05	Not Significant

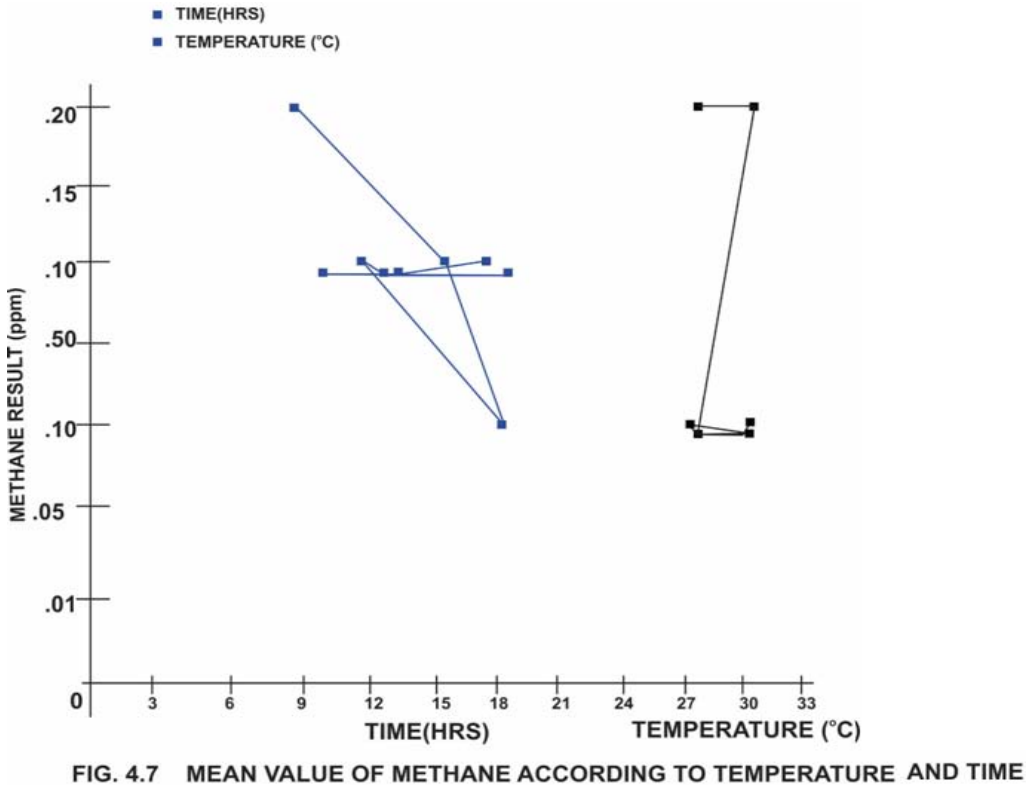

FIG. 4.7 MEAN VALUE OF METHANE ACCORDING TO TEMPERATURE AND TIME

4. Discussion

From the result obtained it was shown that Methane gas had the highest level in the morning hours, 0.20ppm, 0.1ppm and 0.09ppm than in the evening and afternoon. The reason being thatMethane traps and absorbs more heat from the atmosphere during the day and starts emitting them by degradation of waste by Methanogens in the morning.

Therefore there was no significant relationship between the emission of Methane and temperature ($p>0.05$). Also there was no significant relationship between the time and production of Methane ($p>0.05$). The normal range of Methane is 70 parts per million (ppm). The low value obtained could be due to the fact that the waste are brought to the dumpsites every time and thus fresh refuse are used to cover the old ones when degradation could be taking place actively. Moreover most refuse dumps are fresh.

Since Methane gas production is increasing and as such the disruption of temperature balance is imminent as reported by Ackemann (2000), it becomes necessary to extract Methane gas for other purposes as fuel for steam generators as done in India and production of ceramics.

5. Conclusion

Methane is a primary constituent of landfill gas and a potent greenhouse gas when released to the atmosphere, excess Methaneemitted can also be diverted to other meaningful areas.

Better management of our waste can significantly reduce emissions of greenhouse gas to the atmosphere. We can also turn waste materials into resources to be valued and also reduce the amount of waste we produce and the amount of energy we use.

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