Global Scientific JOURNALS

GSJ: Volume 7, Issue 4, April 2019, Online: ISSN 2320-9186
www.globalscientificjournal.com

SEASONAL VARIATIONS AND IMPACTS OF GAS FLARING ON THE DEHYDROGENASE ACTIVITY OF SOILS OF THREE COMMUNITIES IN THE NIGER DELTA AREA OF NIGERIA.

Elenwo, C.E[1]., Ogboghodo, I.A[2]., Adekunle, A.T[2] and Ogbemudia, I.[2]

[1] Department of Crop / Soil, Rivers State University , Nkpolu, Port Harcourt Nigeria

[2]Department of Soil Science and Land Management, University of Benin, Benin City, Nigeria

Abstract

Seasonal variations and impacts of gas flaring on the dehydrogenase activities (µg $TPFg^{-1}$ soil) on the soils of three communities where gas is flared in the Niger Delta region of Nigeria were investigated during the two prevailing seasons in the area which is the dry and wet seasons. Soil samples were collected around flow stations in three communities in the region belonging to one of the oil exploration companies in the area. Some physical and chemical parameters determined include; pH, moisture content, total hydrocarbon, total petroleum hydrocarbon organic matter, sand, silts and clay. These flow stations are labeled S1, S2 and S3 respectively. Soil Samples were collected and heat radiation was measured at 50, 100 and 150 meters away from the flare and the control taken at 2000 meters away from the flare and replicated three times. The data generated were subjected to analysis of variance to get the means. Results showed that dehydrogenase activity in S1 (Station1) in the two seasons had values ranging from 3.03 - 255.6Ug TPFg-1 soil with the highest values (201.7 and 255.6 Ug TPFg-1 soil) respectively for dehydrogenase activity at 150 m from flare and the least values at 50 m having mean values of (3.03 Ug TPFg-1 soil) and (5.93 Ug TPFg-1 soil) in both seasons. Station 2 (S2) had the highest value for dehydrogenase at the control in the dry season with a mean value of (39.23 Ug TPFg-1 soil) in the wet season while at 50 m away from the flare, it recorded a mean value of (21.0 Ug TPFg-1 soil) and the least activity (2.50 and 5.53 Ug TPFg-1 soil) was recorded at the 150 meters away from the flare in both seasons. Station3 (S3) had the highest value at 100 m in the dry season with a mean value of 10.27 Ug TPFg-1 soil and in the wet season at the control with a mean value of 106.87 Ug TPFg-1 soil. The least at 50 m and the control in the dry season with a mean value of (3.13 Ug TPFg-1 soil) while in the wet season, 50m had the least (8.5 Ug TPFg-1 soil). Heat radiation in all three flow stations decreased as distances increased, except in Station 2 where radiation increased at 100m away from the flare and at the control with mean values of 200 and 220 $\mu/w/cm^2$ respectively.

Key words: Dehydrogenase activity, Radiation, Dry and Wet Seasons, Gas flaring

INTRODUCTION

Dehydrogenase is an enzyme such as any of the respiratory enzyme that activates oxidation reduction reactions by transferring hydrogen from substrate to acceptor. Dehydrogenase activity is used as a tool to indicate the level of electron transfer in soils and also the microbial activity as it is mainly outside the cells and also associated with viable cells. The way a particular biochemical characteristic and the total microbial activity affect themselves is often times unknown especially in the case of complex system like soils, where the microorganism and processes involved in the degradation of the organic compounds are highly diverse. (Nannipieri *et al*.,1990). Soil dehydrogenase is closely related with the microbiological oxidation and reduction process. (Gu *et al.*, 2009). Dehydrogenases are one of the most essential among all the enzymes in the soil environment and are used as an indicator of overall soil microbial activity (Zhao *et al.*, 2010). They are closely connected with oxido-reduction processes of microorganisms (Moeskops *et al.*, 2010).The most important thing about dehydrogenases is that they are pollution indicator as they lack the ability to accumulate extracellular in the soil. Dehydrogenases are significant in the role of biological oxidation of soil organic matter (OM) by the transfer of hydrogen from organic substrates to inorganic acceptors (Zhang *et al*, 2010). Most specific dehydrogenases transfer hydrogen to ethernicotinamide adenine dinucleotide phosphate (Subhari *et al*., 2001). Thus DHA serves as an indicator of the microbiological redox – systems and could be considered a good and adequate measure of microbial oxidative activities in the soil.

Dehydrogenase can utilize both O_2 and other compounds as terminal electron acceptors, although anaerobic microorganisms produce most dehydrogenases. Therefore, DHA reflects metabolic ability of the soil and its activity is considered to be proportional to the biomass of the microorganisms in soil.

Soil dehydrogenase activity is regarded as the most important part of the unimpaired cells. They are not found outside the cells in the soil. Organic matter dehydrogenation is by hydrogen and electrons transfer from substrates to acceptors which is also the measurement of degradation process. (Kumar *et al.*,2013). Therefore the soil microbiological activity is essential in soil nutrient cycling; its activity is necessary in both the mineralization transformation of organic matters and plant nutrients in soil ecosystem. Dehydrogenase activity has been said to be a check for pollution in the soil but Dick and Kandela (2005) revealed that enzymes associated with soils polluted with heavy metals or crude oil need a very high amount of oil to be administered before enzyme activity will be decreased, as such lighter petroleum products do not generally restrain enzyme activity. Therefore, enzyme activity is not an appropriate tool for checking hydrocarbon-polluted soils.

Nigeria flares about 50% of her total associated gas produced. This amounts to 850 billion cubic feet per year (Bcf/y) and often results in the release of acid rain, smog causing and greenhouse gases. Enormous amount of heat is also emitted in the process. Natural gas flares causes varying degrees of environmental pollution. The magnitude of these effects on soil microbiological, meteorological, soil chemical and physical parameters have been adequately documented (Oyet, 2003). The low height of flare stacks ensures local pollution at ground level and nearby dry deposition including close bearing vegetation and soil (Akpojivi and Akumagba, 2003).

Kalita *et al.*, (2012) reported that soil temperature is more important than air temperature to plant growth as well as soil microbial activity.

This research aims at establishing the impacts of the two prevailing seasons of the year and the heat radiation on the soils of the area at the various distances away from the flare on the dehydrogenase activity of the soils of the experimental area.

MATERIALS AND METHODS

Location of Sites

Three flow stations belonging to an oil company operational in the area were sampled and were labeled S1,S2 and S2 respectively. The three flow stations where soil samples were collected are within the Niger Delta Region of Nigeria

.

Apparatus used for the experiments

Pyronometer :(UVX radiometer) was used to measure heat radiation against wind-ward direction of the specified distances away from the flare. This was used to measure heat radiation. The radiation was taken from wind-ward direction and was measured at 50 meters interval i.e. 50m, 100m 150m away from the flare and the control respectively.

Ambient Thermometer: this was used to measure atmospheric or ambient temperature on site. It measured the degrees of hotness or coldness in a particular sampling point.

Soil Thermometer: this was used to determine the temperature of the soil at any sampling point.

Sky master WM (350) wind mate -: this was used to measure the wind speed and direction at the time of sampling.

Tape:- the tape was used to measure distances.

Trowel:- this was used to collect soil samples into sampling bags and sterile bottles

Collection of Soil Samples

Sampling was done twice; dry season in Late November and raining season in early August the following year. Soil samples were taken from 0- 15cm depth at 50 m intervals; 50 m, 100 m and 150 m away from flare stack and then control about 2km away. Thus, 12 soil samples were taken from each station; giving a total of 36 samples for each season and 72 for both dry and wet seasons. The samples were labeled S, T and R to represent station, distance and replicate, respectively; such that samples from the first flow station were labeled: $S_1T_1R_1$, $S_1T_1R_2$, $S_1T_1R_3$, $S_1T_2R_1$, $S_1T_2R_2$, $S_1T_2R_3$, etc. These soil samples were put in sterile bottles and maintained at room temperature before analysis at the laboratory.

Dehydrogenase activity

Test for dehydrogenase activities was carried out using aggregate soil samples as described by Pepper and Garba (2004).

Data Analysis

Data generated from this investigation were subjected to analysis of variance (ANOVA) using Duncan Multiple Range Test (DMRT) to separate the means at 5% level of probability.

Result

Table1: Effect of Heat Radiation on Soil Dehydrogenase Activity in flow station (1) at various Distances in Dry and Wet season

This is presented on Table 1. In the dry season, in flow station (1) the dehydrogenase content was significantly influenced by sampling distances. 150 m had the highest dehydrogenase with a mean value of 201.7 and significantly different from control, 50 m and 100 m away from the gas flare. The least dehydrogenase content was observed at the 50 m away from the flare with a mean value of 3.03.

The radiation was not significantly different among the sampling distances; 50 m had the highest with a mean value of 206.7 while the least radiation was observed in the control with a mean value of 180.0 In the wet season, the dehydrogenase content was significantly influenced by sampling distances; 150 m had the highest dehydrogenase with a mean value of 255.6 and significantly different from control, 50 m and 100 m away from the gas flare and the least dehydrogenase content was obtained in 50 m away from the flare with a mean value of 5.93.The radiation was significantly influenced by the sampling distances, where 50 m had the highest with a mean value of 280.0 while the control had the least value for radiation with a mean of 180.0.

Table1: Effect of Heat Radiation on Soil Dehydrogenase Activity in flow station (1) at various Distances in Dry and Wet season

Sampling distance	Dehydrogenase (μg TPFg^{-1} soil)	Radiation (μ/w/cm^{2})
	Dry season	
50	3.03b	206.7a
100	5.07b	200.0a
150	201.7a	186.7a
Control	7.53b	180.0a
L.S.D (p<0.05)	18.87	26.64
	Wet season	
50	5.93b	280a
100	11.13b	273.3a
150	255.6a	246.7b
Control	15.47b	180c
L.S.D (p<0.05)	51.04	14.89

- Means followed by the same letters in the same column are not significantly different from one another at 5% of probability using Duncan multiple ranged test (DMRT)

Effect of Heat Radiation on Soil Dehydrogenase Activity in Flow Station (2) at various distances in the Dry and Wet Seasons.

This is presented in Table 2. In flow station (2) in the dry season; the dehydrogenase content was not significantly different in the sampling distances. Control had the highest dehydrogenase with a mean value of 39.23 while the 150 m away from the gas flare obtained the least with a mean value of 2.50.

The radiation was significantly influenced by the sampling distance, where control had the highest with a mean value of 220.0 while the least radiation was recorded in 150 m and 50 m away with a mean of 186.7

In wet season the dehydrogenase content was not significantly different in the sampling distance where 50 m had the highest dehydrogenase with a mean value of 21.00 while the 150m away from the gas flare obtained the least with a mean value of 5.53.

The radiation was significantly influenced by the sampling distance, where 50m had the highest with a mean value of 233.3 while the least radiation was obtained at the control with a mean of 200.0.

GSJ: Volume 7, Issue 4, April 2019
ISSN 2320-9186

Table 2: Effect of Heat Radiation on Soil Dehydrogenase Activity in flow Station (2) at various distances in Dry and Wet Seasons

Sampling distance	Dehydrogenase (μg TPFg^{-1} soil)	Radiation (μ/w/cm^2)
	Dry Season	
50	5.63a	186.7b
100	4.03a	200.0b
150	2.50a	186.7b
Control	39.23a	220.0a
L.S.D ($p<0.05$)	35.69	17.62
	Wet Season	
50	21.0a	233.3a
100	8.87a	220.0b
150	5.53a	220.0b
Control	20.53a	200.0c
L.S.D($P<0.05$)	29.56	5.77

- ❖ Means followed by the same letters in the same column are not significantly different from one another at 5% of probability using Duncan multiple ranged test (DMRT)

Effect of Heat Radiation on Soil Dehydrogenase Activity in flow Station (3) at various distances in Dry and Wet Seasons

This is presented in Table 3. In flow station (3) in the dry season, the dehydrogenase content was significantly influenced by sampling distances. 100m away from the flare had the highest value for dehydrogenase activity with a mean value of (10.27) and significantly different from 150m, control and 50m away from the gas flare. The least dehydrogenase content was obtained in 50m away from flare and control with a mean value of (3.13).

The radiation was significantly influenced by the sampling distances, 50m had the highest with a mean value of (300.0) and significantly different from control, 150m, 100m and the least radiation was recorded at the control with a mean value of (206.7)

In the wet season, the dehydrogenase was significantly influenced by the sampling distances, the highest dehydrogenase was recorded at the control with a mean value of 106.87 which is significantly different from 150m, 100m and 50m and the least value for dehydrogenase was recorded at the 50m away with a mean value of 8.50.

The radiation was significantly influenced by the sampling distances, where 50m had the highest with a mean value of (346.7) and not significantly different from 100m and 150m. However, it was significantly different from control which had the least value for radiation among the sampling distances with a mean value of (213.3)

Table 3: Effect of Heat Radiation on Soil Dehydrogenase Activity in flow Station (3) at various distances in Dry and Wet Seasons

Sampling distance	Dehydrogenase (Ug TPFg-1 soil)	Radiation ($\mu/w/cm^2$)
Dry Season		
	Dry Season	
50	3.13b	300.0a
100	10.27a	240.0b
150	4.17b	233.3b
Control	3.13b	206.7b
L.S.D (0.05)	5.75	42.64
	Wet season	
50	8.5c	346.7a
100	45.17b	333.3a
150	11.97c	326.7a
Control	106.87a	213.3b
L.S.D (0.05)	20.14	24.01

- Means followed by the same letters in the same column are not significantly different from one another at 5% of probability using Duncan multiple ranged test (DMRT)

Discussion

Effects of Distances from Flare on Soil Dehydrogenase Activity in the three Flow Stations in the Dry and Wet Seasons

The highest dehydrogenase activity was observed at the 150 meters away from flare in flow station (1) with a mean value of 201.267 and significantly different from control, 50m and 100m away from the gas flare. This also may have been as a result of that point being situated in a forest with a high liter deposit of organic matter at that sampling point. According to Dick and Kandela (2005) enzymes associated with soils polluted with heavy metals or crude oil have revealed that a very high amount of oil must be administered before enzyme activity will be decreased, as such lighter petroleum products do not generally restrain enzyme activity. Therefore, enzyme activity is not an appropriate tool for checking hydrocarbon-polluted soils. The control also had the lowest value; this may also be as a result of leaching of the top soil due to erosion and prolonged fertilizer and insecticides application.

Flow station (1) in the wet and dry seasons had the highest values for Total hydrocarbon content at the control among the sampling distances. The control at flow station (1) in wet and dry seasons had the least values for dehydrogenase. This agrees with the findings of Abdukareem (2005) which stated that pattern at which pollutants are dispersed at ground level is as a result of the amount of gas flared, speed of wind, discharge velocity and proximity to flaring source. Flow station (1) had the largest volume of gas being flared in both seasons. Wind speed and direction may have aided dispersal rate and pattern. Another reason can also be as a result of anaerobic and insufficient supply of oxygen condition of soils which can give rise to anaerobic decomposition resulting in formation of methane and Carbon (iv) oxide, thereby increasing the level of Total hydrocarbon in the control site of flow station(1). Anomohanran (2012) observed pollution within a distance of 2.15 km in the wet and 2.06km in the dry seasons from a thermal plant. He further mentioned that several metrological parameters are responsible for the rate of dispersal of pollutant gases. Some of the outstanding ones include wind speed and direction, nearness to ocean. Eneitimi *et al* (2017) reported that season can influence the dispersal rate of pollutants or soots and season can affect that dispersal of pollutants resulting from emissions.

Flow station (2) had the highest values for radiation and the dehydrogenase at the control in the dry and wet seasons, 50 m away from the flare had the highest value for dehydrogenase activity. The higher value for the radiation in flow station (2) at the control may be due to exposure to radiation from the sun; therefore solar radiation would be the reason for the high value. Radiation in flow station (2) did not influence dehydrogenase activity. In station (3), distances influenced radiation and dehydrogenase activity. Except in the dry season, where the highest value for dehydrogenase activity was at 100 meters away from flare. In flow station (3), more dehydrogenase enzyme activities were recorded in the wet season. Wolinska and Stepniewoka (2012) reported that soil dehydrogenase activity increases highly under anaerobic conditions and that there are many other environmental factors, which are soil moisture, oxygen availability, oxidation reduction potential, pH, organic matter content, depth of the soil profile, temperature, season of the year, heavy metal contamination and soil fertilizer or pesticide use that possibly affect dehydrogenase activity in the soil environment greatly. The results from this work shows that radiation did not affect dehydrogenase activities in the three flow stations in the both seasons but wet season did which shows that soil moisture content is an important factor for dehydrogenase activity in soils.

Conclusion

This study showed that dehydrogenase activity reduced as distances increased away from flare, except in flow station (1) where 150 meters away from flare had the highest value for dehydrogenase activity. Heat radiation was significantly influenced by distances in all three flow stations as heat radiation reduced with increase in distances away from the flare. However in the three flow stations radiation did not affect dehydrogenase activity but season did. All three study flow stations had higher values for dehydrogenase activity in the soils of the study flow stations than their control sites in the wet season.

References

Abdulkareem, A. S. (2005). Evaluation f ground level concentration of pollutant due to gas flaring by computer stimulation. A case study of the Niger Delta area of Nigeria. A publication for the Department of Chemical Engineering, Federal University of Technology Mina. Pp. 2 – 10.

Akpojivi R. and Akwumagba, P. E. (2003). Effects of gas flare on soil fertility prepared for the SPE Middle East oil and gas shows Bahrain pg. 1 – 2.

Anomohanran, O. (2012). Thermal effect of gas flaring at Ebedei Area of Delta State, Nigeria. The *Pacific Journal of Science Position and Technology* 13 (2): 555 – 560.

Dick, R.P. & Kandeler, E. (2005). Enzymes in soils. Encyclopedia of Soils in the Environment. 448-455. 10.1016/B0-12-348530

Enetimi, I. S. and Sylvester C. I. (2017). A review of impacts of gas flaring on vegetation and water resources in the Niger Delta Region of Nigeria. *International Journal of Economy, Energy and Environment*, 2 (4): 48 – 55.

Gu, Y. Wag, P. and Kong, C. (2009). Urease, Invertase, Dehydrogenase and polcyphenoloxidease activities in paddy soils influenced by allelophatic Rice variety. *European Journal of Soil Biology*, 45: 436 – 441.

Kalita, B., Sharma, H. P. and Bortahkur, S. (2012). Study on effect of natural gas flaring (light pollution) on soil Health/Environment of paddy field of Assam near the vicinity of oil wells India Ltd. *Journal of Plant Development Science*, 4(4): 439 – 443.

Kumar, J., Sharma, G. and Mishra (2013). Soil microbial population number and enzyme (activities in relation to Altitude and forest degradation. *Soil biology and chemistry Journal*, (24): 761 – 767.

Moeskops, B. Buchan, D. Sleutel, S. herawaty, L., Husen, E., Saraswati, R. Setyorini, D. and De Neve, S. (2010) Soil microbial communities and activity under intensive organic and conventional vegetable farming in West java Indonesia. *Applied Soil Ecology Journal,* 45: pp. 112 – 120.

Nannipieri, P. Ascher, J.Ceccheni, M. T., Lan N., Pretnrmellar, G., Benell, G. (2003). Microbial diversity and soil functions. *European Journal of Soil Science.* 54 (4): 655.

Oyet, G.I. (2003). Effect of thermal radiation on the physico-chemcial properties of some cassava cultivars. (*Esculenta crantz*). A Ph.D thesis to the institute of pollution studies, pp. 1 – 7, 81 – 89.

Pepper I.I and Garba. (2004) Environmental Microbiology. A laboratory manual. Academic press Inc. New York.

Subhani, A .,Changyong,H., Zhengmiao, Y., Min L and El-ghamry,A(2011) Impact of soil environment and Agronomic microbial /dehydrogenase enzyme activity in soil. A review of *Pakistan Journal of Biological sciences* (4)1088-1094.

Wolinska, A and Stepniewoka, Z. (2012). Dehydrogenase activity in the soil environment. In: CAnuto Yasin, Partly funded by polish Ministry of Science and Higher Education (grant N 305).

Zang, N.,He,X., Gao, Y., Li,Y.,Wang, H., Ma, D., Zang, R. and Yang, S. (2010). Pedogenic carbonate and soil dehydrogenase activity in response to soil organic matter in Artemisia Ordosica community pedosphere, 20, pp. 229 – 235.

Zhao, Z., Li, S., Liu, J., Peng, J. and Wang, Y. (2010). The distance decay of similarity in climate variation ad vegetation dynamics. *Environ. Earth Sci*. 73: 4659 – 4670.