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Application of Screening Effect when Sampling Suspension in Bioremediation Process

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Abstract

Investigation was conducted to examine the significant impact of screening on total phosphate and total nitrogen in soil and water environment polluted by crude oil in Niger Delta area of Nigeria. Matrix Laboratory (MATLAB) computer programme language technique's was inputted from date obtained experimentally as presented in this research work. The effect of screening on sampling of some parameters in terms of colour change on the effective measures to improve bioremediation of pollutants in water and soil environment is a matter of urgent concern to the Chemical engineers, since the intersurface contact is a contributing factor for efficiency of the process. This research demonstrates the significance of screening effect when sampling suspension in bioremediation process using the application of mat lab computer programme language in examining the functional parameters. This research is also aimed at comparing the bioremediation and the effect of screening in suspension of physicochemical in the suspended components to check for the effect and the rate of contributing factors as presented in this research work.

Keywords: Application; Screening effect; Sampling; Suspension; Bioremediation

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Introduction

Environmental pollution of water and soil with petroleum and petrol chemical derivatives has been recognized as one of the most serious problems. There has been increasing concern over the accidental spillage of petrol chemical derived hydrocarbon compounds during technological processes and transportation. Many of these hydrocarbons are considered to be a potential health hazard [1-4]. Physical treatment, using sobbing material followed by incineration for oil removal, is one of the oldest and simplest methods used. This method proved not to be a practical method since it must be used right after the spill occurring, whereas, chemical treatment using chemical emulsifier, proved to be expensive and cannot remove the oil absolutely from the polluted site [5-8]. Bioremediation involves the use of microorganisms or microbial processes to contaminants, attempts to accelerate the natural degradation rates by overcoming factors that limit microbial degradation [9-10]. Conditions for biodegradation are optimized by modifying environmental factors such as pH, temperature, aeration and nutrient addition the process of bio-stimulation [11].

The successful application of bioremediation depends on appropriate bio-gradated microbes and environmental parameters. There are few studies on microbial oil degradation in normal soils. Hydrocarbon degrading microbes have been detected [12]. It has been established that bacteria, not fungi, are the major micro flora of oil contaminated soils. Despite the huge potential of microorganisms to degrade organic compounds under favorable conditions, no single species of microorganism can degrade all the components of petroleum oil and no oil-degrading "superbug" has been engineered. Currently, several organisms are known, each is usually capable to degrade one or, at least, a few petroleum components at a time. The main method that experimental design was the change of one variable at a time method [13-19]. This is an experimental method in which a single factor is varied, while other factors are kept fixed at a specific set of condition. This method leads to unreliable results and wrong conclusions, and is inferior to the factorial design method [20-25]. Therefore, the screening design is appropriate to face the large number of cultural conditions under investigation. Plackett-Burman design comprises of one type of a two-level screening design. It is favored to detect the significant factors affecting the process before proceeding to the optimization stage of experimental design [26-27].

The aim of this work is to investigate the effect of screening when sampling suspension in bioremediation of petroleum oil by

locally isolated microorganisms. The objective was to evaluate the effects of the screening conditions, represented as media components and environmental factors, on the bioremediation and biodegrading of petroleum oil. This is needed to develop a near optimal medium in order to enhance effectiveness on the screening when sampling suspended substances in the bioremediation process by means of statistically designed experiments.

Materials and Methods

The mat lab computer programme language was used in investigating the screening effect of sampling when a suspension is experienced in sampling bioremediation processes. In this case, an experimental data obtained was formulated and expressed in terms of Matrix to analyze the rate of concentration effect upon the influence of screening when suspension if formed in the bioremediation of polluted site with crude oil. The general form of matrix is given by considering the general formula for matrix which is given thus. The concentration of total phosphate and nitrogen was sampled for various time and the mean average evaluated for different series as presented in the work.

Phosphate

Phosphate determination was by the turbid metric method (APHA, 1995). To a 50 mL sample or portion diluted to 50 mL contained in a conical flask, 2.5 mL of conditioning reagent and a quarter spatula full barium chlorides ($BaC1_2$) were added. The mixture was swirled for a minute and the barium sulfate ($BaSO_4$) turbidity read at the fifth minute on Spectronic 21D at 420 nm against distilled water. Sulfate level was read from a calibration curve prepared for known sulfate standards treated the same way as the samples and concentration calculated from:

$$\frac{C\,x1000}{m\ sample}$$

Where, C is mg SO_4/50 mL read from calibration curve. The detection limit is 1.0 mg/1.

Nitrate-Nitrogen

Nitrate measurement was by the Brucine method (APHA, 1995). To a 2.5 mL sample contained in test tube (immersed in ice-cold water), 2.5 mL of 4.0N of H_2SO_4 solution was added and mixed by gentle swirling. After cooling, 0.2 mL brucine sulfate solution was added with mixing. The treated samples in test tube rack were placed in a boiling water bath for 25 min for color development. After cooling the absorption of the resulting yellow color was read on Spectronic 21D at 410 nm. The nitrate-nitrogen was read from calibration curve treated in the same way as the samples. Limit of detection is 0.05 mg/1.

Results and Discussion

The results obtained are presented in tables and figures as shown in this research work.

The general form of matrix 9 **(Table 1)** is given by

$A_{11}x_1 \quad a_{12}x_2 \quad a_{13}x_3 = B_1 \quad 16.x_1 + 14\,x_2 + 12\,x_3 = 14$

$A_{21}x_1 \quad a_{22}x_2 \quad a_{23}x_3 = B_2 \quad 3x_1 + 2\,x_2 + 13\,x_3 = 6$

$A_{31}x_1 \quad a_{32}x_2 \quad a_{33}x_3 = B_3\ 11\,x_1 + 17\,x_2 + 16\,x_3 = 14$

$$\begin{pmatrix} 16 & 14 & 12 \\ 3 & 2 & 13 \\ 11 & 17 & 16 \end{pmatrix} \begin{pmatrix} x_1 \\ x_2 \\ x_3 \end{pmatrix} = \begin{pmatrix} 14 \\ 6. \\ 14 \end{pmatrix}$$

The general form of matrix **(Table 2)** is given by

$A_{11}x_1 \quad a_{12}x_2 \quad a_{13}x_3 = B_1 \quad 1.86x_1 + 0.73\,x_2 + 0.86\,x_3 = 1.150$

$A_{21}x_1 \quad a_{22}x_2 \quad a_{23}x_3 = B_2 \quad 0.33x_1 + 0.177 + 2.40\,x_3 = 0.969$

$A_{31}x_1 \quad a_{32}x_2 \quad a_{33}x_3 = B_3\ 0.08\,x_1 + 2.47\,x_2 + 1.66\,x_3 = 1.403$

$$\begin{pmatrix} 1.86 & 0.73 & 0.86 \\ 0.33 & 0.177 & 2.40 \\ 0.08 & 2.47 & 1.66 \end{pmatrix} \begin{pmatrix} x_1 \\ x_2 \\ x_3 \end{pmatrix} = \begin{pmatrix} 1.150 \\ 0.969 \\ 1.403 \end{pmatrix}$$

The general form of matrix **(Table 3)** is given by

$A_{11}x_1 \quad a_{12}x_2 \quad a_{13}x_3 = B_1 \quad 0.018x_1 + 1.01x_2 + 0.21x_3 = 0.340$

$A_{21}x_1 \quad a_{22}x_2 \quad a_{23}x_3 = B_2 \quad 0.031x_1 + 0.011x_2 + 0.034x_3 = 0.025$

$A_{31}x_1 \quad a_{32}x_2 \quad a_{33}x_3 = B_3\ 0.08x_1 + 4.70x_2 + 1.17x_3 = 1.983$

$$\begin{pmatrix} 0.018 & 1.01 & 0.21 \\ 0.031 & 0.011 & 0.034 \\ 0.08 & 4.70 & 1.17 \end{pmatrix} \begin{pmatrix} x_1 \\ x_2 \\ x_3 \end{pmatrix} = \begin{pmatrix} 0.340 \\ 0.025 \\ 1.983 \end{pmatrix}$$

The results presented in **Figure 1** demonstrate the effect of screening when sampling soil polluted with crude oil upon the influence of bioremediation. The colour effect can be attributed to the following functional parameters such as, the concentration of the total phosphate, microbial concentration,

Table 1 The concentration of the Total Phosphate for various sampling period for Soil polluted with crude oil.

Time/day	Sample	1st (mg/s)	2nd (mg/s)	3rd (mg/s)	Average
7	A	16	14	12	14
14	B	3	2	13	6
21	C	11	17	16	14

Table 2 The Concentration of the Total Phosphate for various Sampling Period for River Water Polluted with Crude Oil.

Time/Day	Sample	1st (mg/s)	2nd (mg/s)	3rd (mg/s)	Average
7	A	1.86	0.73	0.86	1.15
14	B	0.33	0.177	2.4	0.969
11	C	0.08	2.47	1.66	1.403

Table 3 The concentration of the total nitrogen for various sampling period.

Time/ Day	Sample	1st (mg/s)	2nd (mg/s)	3rd (mg/s)	Average
7	A	0.018	1.01	0.21	0.34
14	B	0.031	0.011	0.034	0.025
21	C	0.08	4.7	1.17	1.983

pollutant concentration, soil sample characteristics as well as the period of exposure before carrying out the bioremediation and including the environmental factors. The concentration of the total phosphate decreases with increase in time and suddenly increases with increase in time. The variation on the concentration of the total phosphate can be attributed to the variation in time as presented in **Figure 1**.

Effect on Screening Contaminated River Water Polluted with crude oil upon the influence of time for nitrogen concentration on bioremediation process is illustrated in **Figure 2.**

The results presented in **Figure 2** demonstrates the effect of screening when sampling soil polluted with crude oil upon the influence of bioremediation in the evaluation of the nitrogen concentration. During the sampling processes a colour change was observed to be attributed to the following functional parameters of the concentration of the nitrogen characteristics as well as the period of exposure before carrying out the bioremediation and including the environmental factors. The concentration of the nitrogen decreases with increase in time suddenly increases with increase in time. The variation on the concentration of the nitrogen can be attributed to the variation in time as presented in **Figure 2**.

Effect on Screening Contaminated soil Polluted with crude oil upon the influence of time for nitrogen concentration on bioremediation process is illustrated in **Figure 3.**

The results presented in **Figure 3** demonstrates the effect of screening when sampling soil polluted with crude oil upon the influence of bioremediation in the evaluation of the nitrogen concentration. During the sampling processes a colour change was observed to be attributed to the following functional parameters of the concentration of the nitrogen characteristics as well as the period of exposure before carrying out the bioremediation and including the environmental factors. The concentration of the nitrogen decreases with increase in time suddenly increases with increase in time. The variation on the concentration of the nitrogen can be attributed to the variation in time as presented in **Figure 3**. The colour effect can be attributed to the following functional parameters nature of the reagents, pollutant concentration as well as the period of exposure before carrying out the bioremediation and including the environmental factors.

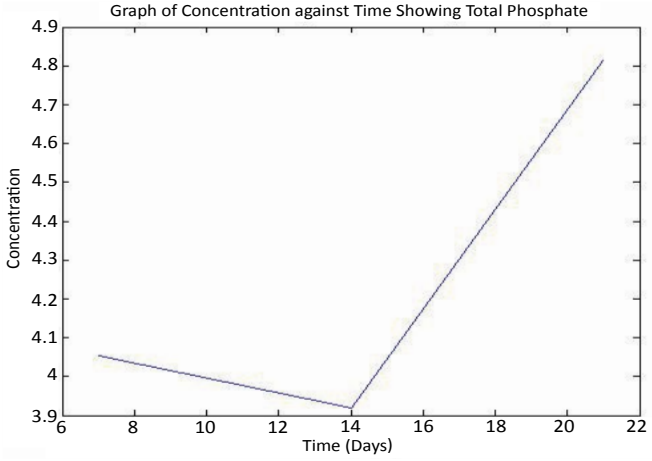

Figure 1 Showing a Matlab Result of the Colour Effect on Screening Contaminated Soil Polluted with crude oil upon the influence of Total Phosphate on bioremediation process.

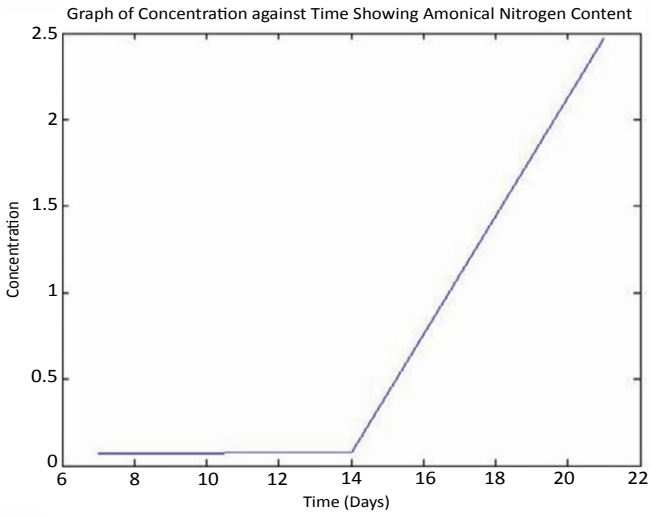

Figure 2 Showing a Matlab Result of the Nitrogen Content Concentration against Time in River Water Environment Polluted with Crude Oil.

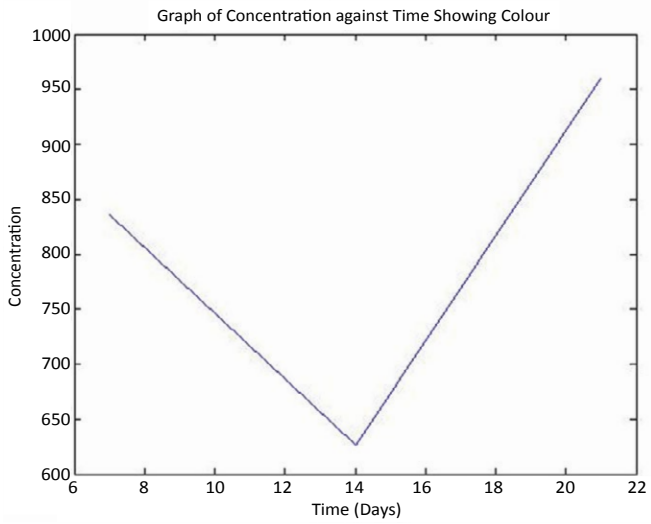

Figure 3 Showing a Matlab Result of the Colour Effect on Screening Contaminated Soil Polluted with crude oil upon the influence of Nitrogen on bioremediation process.

Conclusion

The following conclusion was drawn from the research work such as:

1. Screening process will help improve the environmental safety on the hazard associated with sampling suspended system.

2. The screening will be found useful in effective and efficient management of our ecosystem when bioremediation process is applied
3. Reduction on the inhibiting effect on bioremediation process will be achievable
4. Screening will activate and stimulate the bioremediation process
5. Screening will increase the inter-surface contact for effective remediation of the process.

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