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Crude Oil Remediation using Matlab Integrated Agricultural Best Management Practice to Improved Soil Nutrients

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Research Article

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Abstract

Mathematical model of least square method was applied in the monitoring, predicting and simulation of the crude oil remediation using matlab integrated agricultural best management practice to improved soil nutrients. The matlab computer program language was considered in the mapping system layout of Cell B1: Crude oil polluted soil + Dried poultry manure, Cell B2: Crude oil polluted soil + Dried goat dung and Cell B3: Crude oil polluted soil + Fine saw dust. The equation of the function determine from the model simulation yield the following mathematical expression after the determination of the function coefficients of a, b and c as well as the results obtained are presented as $y_{B1} = -0.015x^2 + 1.11x + 8.9$, $y_{B2} = -0.02x^2 + 1.12x + 3.9$ and $y_{B3} = -0.02x^2 + 1.77x + 6.25$. The problem was resolved using matrix of 3x3 method and results obtained revealed the significant of the techniques in monitoring, predicting and simulating the improved soil concentration through the mechanism of matlab integrated agricultural best management practice.

Keywords: Crude oil; Remediation; Matlab; Integrated; Agricultural; Management; Improved soil nutrients

Introduction

Crude oil contamination in Niger delta area of Nigeria is gaining more prominence as a result of increased upstream and downstream activities of the petroleum industry. However, high level of environmental degradation is experienced in this zone due to poor environmental management. In view that the crude oil is a naturally occurring, black liquid that is found in geological formations beneath the Earth's surface, refined into various types of fuels. It property defines the characteristics of hydrocarbons of various molecular weights and other organic compounds. The needs to enhance environmental clean-up especial in Niger Delta area of Nigeria is an issue of concern as well as functional parameters that may influence the remediation. Investigation on crude oil spill reveals that liquid petroleum can be released into the environment by accidental discharge of vessel or pipeline. It most cases, the process can occur on a large scale and is mostly seen in water bodies which it occurrence can be attributed to human negligence as well results to high level of a major form of pollution [1-6]. The sources of the spill are many, crude oil can be released by tankers on land, in water

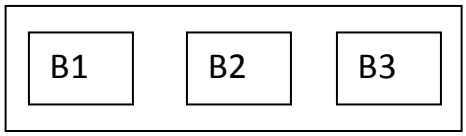
bodies, the spill occurs due to drilling rigs, offshore oil platforms as well oil spills and their effects can also be experienced greatly on the environment [7-10]. The damage caused on the environment in most cases is permanent or takes a long time to clean up when the intervention response is low. As oil spill, it floats on water body surface as well prevents sunlight to pass through it. The shiny substance that you see sometimes on top layer of water is nothing but oil which makes it difficult for plants and sea animals to survive because of the toxicity which induce the characteristics of the environment or the ecosystem [11-16]. Cleaning up of oil spill is not an easy task it entails various factors and procedures need to be considered before carrying out operations. Some of them being amount of oil spilled, composition of contaminants, temperature of water, physicochemical properties of the substances etc. [9-13]. Even though the public attention towards oil spills has grown in the last three decades, they have been happening for over a century. Since the coming of the industrial revolution, such accidents have been occurring. However, the large scale problems that follow oil spills and their effects are more obvious to us today.

Investigation conducted by various research groups revealed that the problem of environmental pollution has assumed an unprecedented proportion in many parts of the world as well as the crude oil contamination is one of the world's most common environmental problems as reported by various research groups [8-17]. The need to restate the ecological characteristics as well as the nutrients for agricultural best used is an issue of major concern to the engineers, environmentalist's etc. [14-16]. The present study is carried out to examine the effect of application of organic manure (poultry dung, goat dung) and sawdust on crude oil contaminated soil in order to enhance its bioremediation as well as its effectiveness in soil nutrient improvement for agricultural usage. Matlab computer program language was used to examine the trend of nutrient reinstated upon the influence of bioremediation on polluted soil environment of Niger Delta region.

Materials and Methods

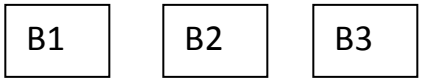
Mapping System

A simple mapping system was layout to examine the characteristics of the activators added to improve the induced soil nutrients by the presence of the crude oil. In this note the soil was divided into five treatment cells as presented in Figure 1. Each cell was 3.3m x 3.3m.



Cell B1: Crude oil polluted soil + Dried poultry manure
Cell B2: Crude oil polluted soil + Dried goat dung
Cell B3: Crude oil polluted soil + Fine saw dust

Mathematical Modeling

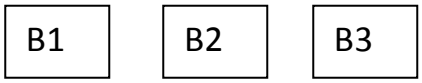


Cell K1: Crude oil polluted soil + Dried poultry manure
Cell K2: Crude oil polluted soil + Dried goat dung
Cell K3: Crude oil polluted soil + Fine saw dust

Computational Procedures

The computational parameters for the simulation of polluted soil using matlab computer program language to monitor and predict nutrients improvement using integrated agricultural best management system was abiturally chosen and formulated into matrix concepts as shown below.

Assumption: The model of matrix was further resolved by considering the basic assumption of 3kg of composite oil contaminated soil sample mixed with dried goat dung, saw dust and NPK 15:15:15 respectively while the fifth served as control (polluted soil only).



Putting the cells above into consideration;

x	T (days)	1	5	10
y	C (mol %)	10	15	20

Table 1: Computational parameter for B1

Applying Quadratic Equation of the least square method, thus we have,

$$y = ax^2 + bx + c \quad (1)$$

In terms of first reactor investigation we have,

$$y_1 = ax_1^2 + bx_1 + c \quad (2)$$

$$y_2 = ax_2^2 + bx_2 + c \quad (3)$$

$$y_3 = ax_3^2 + bx_3 + c \quad (4)$$

Substituting the values in table1 into equation (2), (3) and (4), we have

$$a + b + c = 10 \quad (5)$$

$$36a + 5b + c = 15 \quad (6)$$

$$144a + 12b + c = 20 \quad (7)$$

Solving equation (5), (6), (7) simultaneously
Using matrix

$$\begin{pmatrix} 1+1+1 \\ 36a + 6b + 1 \\ 144a + 12b + 1 \end{pmatrix} \begin{pmatrix} a \\ b \\ c \end{pmatrix} = \begin{pmatrix} 10 \\ 15 \\ 20 \end{pmatrix} \quad (8)$$

Resolving equation (8) using matrix transformation approaches the following constants parameters were evaluated as:
a = -0.015
b = 1.11
c = 8.9
Substituting the values of a, b and c into equation (1) above we have the expression in equation (9).

$$y = -0.015x^2 + 1.11x + 8.9 \quad (9)$$

Where, a, b and c are constants, x = t = time (day), y = c = concentration of the soil (mol %)

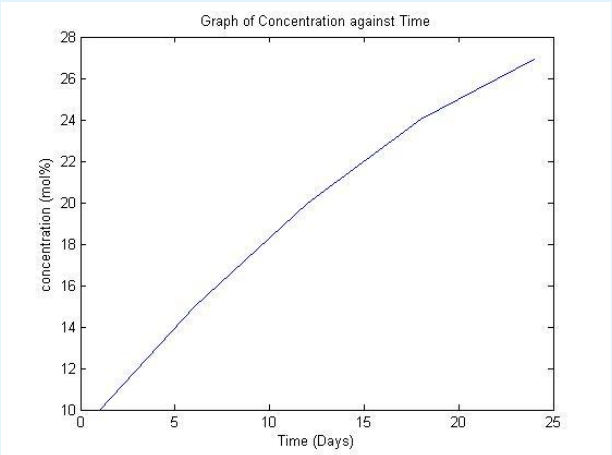


Figure 1: Concentration against Time for B1.

The matlab results obtained from the simulation is demonstrated in Figure 1 for B1 condition. Increase the remediation was observed with increase in time revealing the significant of this approach in monitoring and predicting the effectiveness of condition B1 remediation techniques. The variation in the concentration of the substrate can be attributed to the variation in time as well as the environmental influence. The solution of second order polynomial expression was obtained and can be resolved further to determine the intermediate parameters.

x	T (days)	1	6	12
y	C (mol %)	5	10	15

Table 2: Computational parameter for B2.

Resolving the results presented in table 2, we have

$$a + b + c = 5 \quad (10)$$

$$36a + 6b + c = 10 \quad (11)$$

$$144 + 12b + c = 15 \quad (12)$$

Solving equations (10), (11) and (12) simultaneously, we have

$$\begin{pmatrix} 1+1+1 \\ 36a + 6b + 4 \\ 144a + 12b + 1 \end{pmatrix} \begin{pmatrix} a \\ b \\ c \end{pmatrix} = \begin{pmatrix} 5 \\ 10 \\ 15 \end{pmatrix}$$

Using 3.3 matrix, we have
a = -0.02
b = 1.12
c = 3.9
Substituting the values of a, b and c we have, the expression in equation (13)

$$y = -0.02x^2 + 1.12x + 3.9 \quad (13)$$

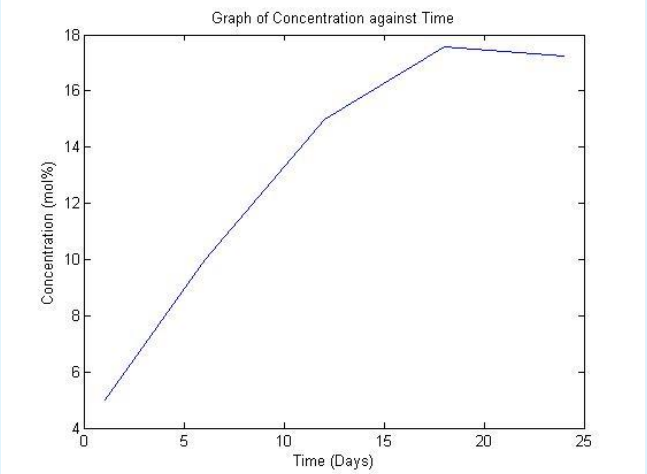


Figure 2: concentration against time for B2.

The matlab results obtained from the simulation is demonstrated in Figure 2 for B2 condition. Increase the remediation was observed with increase in time revealing the significant of this approach in monitoring and predicting the effectiveness of condition B2 remediation techniques. The variation in the concentration of the substrate can be attributed to the variation in time as well as the environmental influence. The solution of second order polynomial expression was obtained and can be resolved further to determine the intermediate parameters.

x	T (days)	1	6	12
y	C (mol %)	8	16	24

Table 3: Computational parameter for B3.

From table 3, using the equation (1) above we have the following expression, thus:

$$y_1 = a + b + c = 8 \quad (14)$$

$$36 + 6b + c = 16 \quad (15)$$

$$144a + b12 + c = 24 \quad (16)$$

Resolving equations (14), (15) and (16) in terms of matrix we have,

$$\begin{pmatrix} 1+1+1 \\ 36+6b+1 \\ 144a+12b+1 \end{pmatrix} \begin{pmatrix} a \\ b \\ c \end{pmatrix} = \begin{pmatrix} 8 \\ 16 \\ 24 \end{pmatrix}$$

The computation determination of the constants is given below as:

a = -0.02
b = 1.77
c = 6.25

$$y = -0.02x^2 + 1.77x + 6.25$$

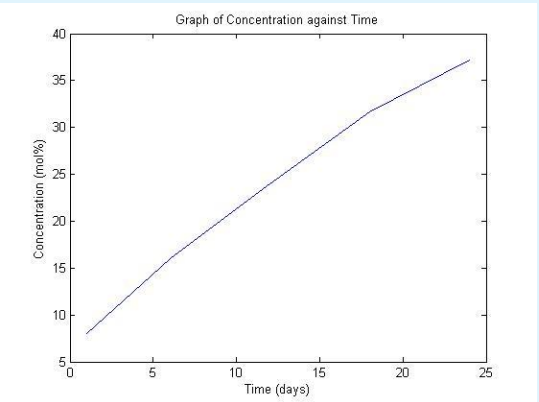


Figure 3: Concentration against Time for B3.

The matlab results obtained from the simulation is demonstrated in Figure 3 for B3 condition. Increase the remediation was observed with increase in time revealing the significant of this approach in monitoring and predicting the effectiveness of condition B3 remediation techniques. The variation in the concentration of the substrate can be attributed to the variation in time as well as the environmental influence. The solution of second order polynomial expression was obtained and can be resolved further to determine the intermediate parameters.

Conclusion

The following conclusion was drawn from this research as stated below:

1. This study shows that those organic supplements containing nitrogen and phosphorus have great potentials for the remediation of soils contaminated with petroleum hydrocarbon within a reasonable time. In addition, climatic conditions play an important role in accelerating the rates of biodegradation.
2. Treatment of polluted soil with nutrient supplements would result in bioremediation of such soils over time; that is, the use of the right types and quantities of nutrients and provision of favorable environmental conditions for the growth of the oil-eating microbes.

3. The use of poultry manure yielded the greatest degree of bioremediation in this study; it is also a cheap method to use.
4. Matlab computer program language is a useful instrument that can be applied in monitoring and predicting the rate bioremediation of polluted soil for agricultural utilization.
5. The microbial build up in the system can be monitored by using matrix concepts with the aid of matlab approach.

Contribution to knowledge

The research carried out on crude oil remediation using Matrix Laboratory (MATLAB)
Integrated agricultural best management practice to improved soil nutrients are presented as stated below:

1. The numerical techniques of least square method can be used in solving the problem of monitoring, predicting and simulation of the crude oil remediation as well the rate rehabilitation of the soil enviroment.
2. The characteristics of soil nutrient can be predicted for various years, if the process is not influence by the environmental factors, such as, flood, rainfall, topographe etc.
3. The matlab computer program language was considered as well as the necessary mathematical approach in putted to established equations that were found useful in computing the functional parameters.
4. The mapping system layout of Cell B1: Crude oil polluted soil + Dried poultry manure, Cell B2: Crude oil polluted soil + Dried goat dung and Cell B3: Crude oil polluted soil + Fine saw dust is a fundamental bases for developing this techniques.
5. The equation of the function determine from the model simulation will give us an optimum rate of bioremediation of soil for agricultural utilization to achieve high yield.
6. The research showcases the significance of the bio-argumentation substance to improve the soil nutrient induced by petroleum constituencies.

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